RESEARCH ARTICLE

Perspectives on Herbal Anti-Diabetic Drug Formulations in Current Pharmacology

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ABSTRACT

All ages people are affected by the chronic complications of diabetes mellitus. Numerous synthetic medications have been developed to treat diabetes, which has become more common across the globe. These medications, while effective as antihyperglycemic medicines, come with a number of side effects, are expensive, and are out of reach for the vast majority of people who live in underdeveloped nations. Due to their accessibility and harmless nature, medicinal plants have already been traditionally utilized to cure a variety of illnesses throughout history. Phytochemicals found in medicinal plants provide a number of health advantages. Healthcare professionals are looking into plant-based medicines as a potential supply of antidiabetic pharmaceuticals because of their high efficacy and lack of adverse effects as diabetes prevalence rises. The active phytoconstituents are being identified and thoroughly studied in order to gain a better understanding of the mechanism of action of therapeutic plants. Here, we focus on the perspectives of pharmacologically active Phytomolecule formulations produced from medicinal plants that demonstrate antidiabetic action and the role they now play in managing and treating diabetes in the present scenario. These natural molecules might be suitable for developing new approaches to treatment or potent treatment options for diabetes.

Keywords: Diabetes, Pharmacology, Medicinal Plants, Phytoconstituents

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INTRODUCTION

The prevalence of Type 2 Diabetes Mellitus (T2DM) is a significant and developing public health issue. Diabetes is predicted to affect 9.3% of the world's population or 463 million people, in 2019, 10.2% of that population, or 578 million people, in 2030, and 10.9% of that population, or 700 million people, in 2045 [1]. Over 90% of them have type 2 diabetes, which is responsible for over a million fatalities yearly [2]. Lack of insulin, an anabolic hormone, can lead to abnormalities in how proteins, lipids, and carbohydrates are metabolized [3].Low insulin levels, insulin resistance in target tissues, insulin receptor levels, primarily in skeletal muscles and adipose tissue and to a lesser extent in the liver, the signal transduction system, effector enzymes or genes, and/or the signal transduction pathway, are the causes of these abnormalities in metabolism [4]. As the disease progresses, tissue or vascular damage causes serious complications, such as diabetic neuropathy, retinopathy, cardiovascular, nephropathy, cerebral, pulmonary, and ulcers, peripheral vascular diseases, and thyroid gland disorders, which have serious morbidity and mortality rate [5]. There are already a variety of anti-diabetic medications on the market to treat hyperglycemia, most of which operate by increasing insulin sensitivity, balancing insulin, increasing insulin secretion, and promoting glucose uptake. Insulin and numerous oral hypoglycemic medications, such as metformin, sulfonylureas, α-glucosidase inhibitors, meglitinide analogues, SGLT-2 inhibitors, thiazolidinediones, DPP-IV inhibitors, and GLP-1 analogues, are being used as available therapy for the treatment and management of diabetes. These medications, which aim to improve insulin sensitivity, enhance insulin secretion, and lower blood glucose levels by boosting glucose uptake or excretion in adipose tissue, are typically accompanied by a variety of negative effects. Some of these include gaining weight, hypoglycemia, digestive system issues, liver damage, kidney failure, hypersensitivity reactions, diarrhoea, flatulence, and abdominal bloating[6]. Drug resistance and the fact that there aren't enough treatments to stop the disease's long-term effects are two other significant drawbacks of these medications.

The search for alternative medications with higher efficacy, potency, and fewer side effects has been increased due to the problems associated with insulin and oral antidiabetic drugs, as well as the restricted drug tolerance, adverse effects, and expense. It's interesting to note that interest in drug discovery research into natural antidiabetic medicines, particularly those derived from medicinal plants has grown. These agents may improve β-cell function and treat problems linked with diabetes while having fewer unfavourable side effects[7]. Although no effective treatment for DM has been discovered, it can be managed with insulin, dietary changes, and oral anti-diabetic medications. An alternate treatment option might be provided by herbal medications. The drawbacks of existing anti-diabetic therapy include compromised cost, accessibility, affordability, and tolerance. Herbal remedies have long been used to cure a wide range of ailments because they contain a variety of phytochemicals. They are thought to be naturally effective, safe, and have fewer adverse effects[8]. Due to their availability, cheaper cost, fewer problems, and milder side effects than synthetic medications, herbal medications have been shown to be more effective at controlling and managing diabetes. Herbal remedies work through a variety of techniques to decrease insulin resistance, increase insulin production, protect pancreatic beta cells, and lower blood sugar levels in the blood [9].

Over the years, thousands of plant species have been utilised as complementary medicines for a variety of illnesses; more than 800 of these have been found to have anti-diabetic properties [10]. These plants have been researched for their ability to cure various forms of diabetes and may serve as sources for future natural antidiabetic drug discovery studies [11]. Several medicinal plants that have historically been employed for their antidiabetic properties are currently being researched for possible commercialization as contemporary medications. In developing nations, where the expense of allopathic therapy is high and the traditional usage of herbs to treat diabetes is widespread, this is especially true [10]. Asian nations like China, India, Sri Lanka, Bangladesh, Pakistan, Nepal, Thailand, Bhutan, and others frequently prescribe traditional herbal treatments [12].These plants' antidiabetic effects are thought to be mediated through a number of mechanisms, including the stimulation of insulin secretion from pancreatic beta-cells, an increase in insulin binding to receptors, a decrease in insulin resistance, and an improvement in glucose tolerance. Other mechanisms of action include promoting glucose metabolism, enhancing β-cell mass and function, and raising

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plasma insulin, which lowers blood glucose levels in the circulation [13]. Herbal medicines have historically been used to treat a variety of ailments in addition to diabetes, including ulcers, wounds, inflammation, infections, diarrhoea, dysentery, malaria, rheumatism, hypertension, obesity, pneumonia, and kidney problems [14]. The major goal of this review is to examine the traditional plant-based treatments for diabetes and/or their phytoconstituents. These may serve as the foundation for developing novel anti-diabetic medications that are more effective and have fewer side effects than those currently on the market.

Modern-day applications of Ethnomedicine
Indigenous individuals who care about human health practice ethnomedicine, a traditional form of medicine. It is the source of contemporary medicine as well as all other conventional medicinal systems, such as Ayurveda, Siddha, Unani, and Nature Cure [15]. Through experimentation and blunders, information about plants with therapeutic properties has been passed down from one generation to the next for more than hundreds of years. In the rural and indigenous communities of various developing countries, ethnomedicine is very common [16]. Around 80% of the world's population, according to data gathered from the World Health Organization, relies on traditional treatments [17]. For both conventional and traditional medicines, medicinal plants have long been acknowledged as a significant source of raw ingredients [18]. Since they are readily available to them, natural herbal medicines are the go-to option for India's impoverished and rural populations. For those residing in isolated places, plant-based medications serve as the only source of medical care. Numerous botanists, anthropologists, folklorists, and medical professionals are researching ethnomedicines in places like Russia, Africa, and a few European nations [15]. The majority of people in impoverished countries receive less than acceptable modern healthcare as a result of people's inability to access decent healthcare and financial limitations [19]. Since many folk remedies have been shown to be successful in treating a wide range of illnesses (including digestive tract disorders, skin conditions, kidney and liver diseases, malaria, ulcers, heart conditions, pneumonia, diabetes, and many others), even developed nations have thought about using these medications [20].

Synthetic versus plant-based medicine
Many medications on the market today have been produced directly or indirectly from natural sources such as healing plants and animals [21,22]. Natural products made from plants have played a significant part in drug research programs and still do. Due to the toxicity and multiple negative consequences of allopathic medicines, the number of herbal drug manufacturing firms, which is linked to the current surge in interest and demand for herbal medicines, can be greatly extended [23]. Plant-based medicines have become a significant alternative source of existing therapeutics, particularly in rural and/or developing areas, because oftheir ease of use, availability, affordability, and generally low risk of side effects [21]. Additionally, plant-based medications offer a plentiful supply of physiologically active substances with pharmacological action and few side effects [21]. Plant-based medications have been extensively used for generations to treat the illnesses of local populations in many developing countries that have easy access to these sources. Countries with high population densities, like China and India, have made significant contributions to the development of complex traditional medical practices like acupuncture, ayurvedic medicine, and herbal medicine [24]. The right drugs for the management and treatment of diabetes should be chosen after taking into account a variety of criteria. This covers efficacy, side effects, financial implications, the possibility to cause weight gain, the dangers of hypoglycemia, comorbidities, and patient compliance. Despite the fact that oral antihyperglycemic drugs can lower plasma glucose levels by increasing insulin production or lowering insulin resistance, they are also linked to a number of other negative effects. The mainstay of treatment for type 2 diabetes, metformin, has a favourable safety profile but is nonetheless linked to moderate side effects including low risks of hypoglycemia and gastrointestinal tract disturbances (nausea, dyspepsia, diarrhoea). According to earlier research, metformin use on a regular basis can lead to vitamin B12 and folic acid deficiencies in people[25].There have been reports of headaches, nasopharyngitis, and upper respiratory tract infections associated with DPP-IV inhibitors such sitagliptin, saxagliptin, and linagliptin [26]. Hypoglycemia is the most frequent side effect of sulphonylureas such glimepiride and gliclazide. Minor adverse effects of these medications include weight gain, nausea, headaches, drowsiness, and hypersensitivity reactions. Hypoglycemia is the most severe side effect of insulin injections. Additionally, the side effects of insulin include perspiration, disorientation, and weight gain or loss[26].

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Plant-based medicines, in contrast to synthetic pharmaceuticals, do not interfere with the body's natural healing process; rather, they hasten recovery by bolstering the healing process, which eventually results in a steady recovery. Herbal remedies have a reputation for enhancing the immune system in addition to their capacity to assist the body in returning to a healthy state. A healthy lifestyle and the use of highly effective herbal medications with minimal side effects and a robust immune system encourage improved body metabolism and higher dietary nutritious absorption [23]. The use of medicinal plants is thought to be a safer and more effective alternative to synthetic anti-diabetic medications, regardless of whether they exhibit insulinotropic, insulin-mimetic, or any other antihyperglycemic effects [27].

Plant-Based Medicines' Pharmacological Activity

Many plant-based medicines have been known for years, but only a few of them have recently begun to gain attention. However, due to these medications' widespread underreporting of side effects, there is still significant doubt regarding their pharmacological activity as well as their acute and chronic side effects [28]. Few plants are effective for the purposes for which they were intended, while some are weakly therapeutically effective or lack sufficient scientific evidence to support their anticipated effects [29]. It is urgently necessary to conduct a thorough scientific analysis of the molecules responsible for pharmacological activity as a result of the rise in the use of plant-based medicines. A study of the pharmacological qualities and phytoconstituents of plant-based medications might uncover new pharmacological traits that weren't known or used in conventional medicine [30]. It has been proposed that the mechanism of action of herbal medications involves the simultaneous targeting of several physiological processes through interactions between various biochemicals and cellular proteins [31]. Herbal medicines may have the ability to change biological systems from a diseased to a healthy state by creating interactions between several components and multiple targets. The therapeutic abilities of the phytomolecules allow for the use of lower dosages with fewer toxicity and side effects [31]. The phytochemicals that operate through numerous routes, such as cAMP, which promotes insulin production without altering the K^{ATP} channel, are what give medicinal plants their anti-diabetic properties; [32] PI3K: which aids in the translocation of the glucose transporter in the liver, skeletal muscles, and adipose tissue; [33] AMPK: The activation of the 5′-adenosine monophosphate-activated protein kinase pathway increases insulin sensitivity by reducing lipolysis and lipogenesis. AMPK also increases glucose absorption in skeletal muscles by transferring GLUT4-containing intracellular vesicles across the plasma membrane[34]. For instance, phlorizin, which is derived from the bark of apple and pear trees, decreases plasma glucose levels by increasing glucose excretion in urine and reducing glucose reabsorption in the kidneys through the inhibition of SGLT [35]. Some phytomolecules may be able to restore and defend pancreatic β-cells against deterioration by lowering the glucose burden, [36] inhibiting the activity of the enzymes α-glucosidase and α-amylase causes the 3T3L1 cells to take up glucose, [37] lowering the levels of lactic dehydrogenase, γ-glutamyl transpeptidase, glycosylated haemoglobin, glycogenolysis, and gluconeogenesis in the liver, inhibiting glucose-6-phosphate and DPP-IV, and exerting a hepato-pancreatic protective effect [38]. As an illustration, Figure 1 depicts a summary of the several routes involved in the antidiabetic effect of flavonoids.

Impact of Phytochemicals on Diabetes

Plants are the main source of biologically active substances that may eventually help researchers find and create new medications [39]. Primary and secondary metabolites are both produced by plants. Primary metabolites are substances that are required for the growth and development of plants as well as for key metabolic processes including glycolysis and photosynthesis, including carbohydrates, proteins, and lipids. Secondary Plants do not require metabolites to grow and develop; rather, they are in charge of regulating interactions between environmental factors and plant species, and they have very particular plant functionalities [40]. More than 13,000 secondary metabolites from medicinal plants have been purified and identified. Numerous chemical classes, including alkaloids, terpenoids, flavonoids, phenolics, tannins, saponins, xanthones, and glycosides can be used to classify these phytochemicals [41]. Numerous of these phytochemicals are known to have therapeutic effects, such as antidiabetic activity [41]. As a result of their antihyperglycemic activity and ability to lessen the difficulties related to diabetes, several phytochemicals extracted from various plant species have been scientifically confirmed for their role in the treatment and management of diabetes [42].

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For instance, the flavonoid rutin, found in the leaves of several plants, such as Annona squamosa and Azadirachta indica (neem), has been shown to have a variety of positive benefits, including anti-inflammatory, anti-cancer, antiviral, anti-allergic, and antioxidant qualities [43]. The prevention of diabetes mellitus, hepatotoxicity, and heart disease has also been demonstrated for rutin-containing plants [43]. Rutin lowers plasma glucose, enhances the function of pancreatic β-cells, and improves glucose tolerance to produce its anti-diabetic effects [6]. Quercetin and isoquercetin, two other flavonoids contained in Annona squamosa leaves, have also been discovered to have an antihyperglycemic effect by blocking α-glucosidase and decreasing blood sugar levels [44]. The tetranortriterpenoid meliacinolin, isolated from the leaves of A. indica, has been discovered to inhibit α-glucosidase and α-amylase in Type 2 diabetic mice with rutin and quercetin [45]. Another phytochemical with hypoglycemic qualities is nimbidin, which is derived from neem seeds [45]. Allium sativum (garlic) contains compounds called quercetin, allyl-propyl disulfide, allicin, cysteine sulfoxide, and S-allyl cysteine sulfoxide that have been shown to improve insulin sensitivity in target cells and inhibit insulin activation brought on by the liver [46]. According to reports, the garlic compound alliin can act similarly to the drugs glibenclamide and insulin[46]. The compounds found in Camellia sinensis (tea) leaves, epigallocatechin-3-gallate, epicatechin-3-gallate, epigallocatechin, and epicatechin, can also lower plasma glucose levels by strengthening β-cell function, increasing insulin production, and improving glucose metabolism [47]. These phytomolecules may exhibit their anti-diabetic effects in several ways, most frequently by acting as insulinotropic or insulin-mimetic agents, as well as by enhancing β-cell function, raising insulin sensitivity, enhancing glucose tolerance and metabolism, and inhibiting the activities of various enzymes.

The Role of Plant-Based Drug Formulations in Diabetes Available on the Market
The development and sale of plant-based medicines have become increasingly popular during the past few decades in many European nations [48].The latter are referred to as phytomedicines or herbal formulations. These formulations' safety profiles and effectiveness in treating a variety of illnesses have been established and validated. Herbal formulations can be manufactured as a variety of formulations, including tablets, capsules, elixirs, suspensions, solutions, emulsions, and powders, just like any other allopathic medication[49]. Phytomedicines can either be made from a single herb or a combination [23]. For the treatment and management of diabetes, many plant-based medicines have been sold internationally. Antibetic, Diabetics, Diasol, Diabetica, Diabet, Diasol, Diabecon, Diabecure, Dia- sulin, Dia-Care, Diabecure, Diabeta, Diabeta Plus, Dianex, Diashis, GlycoNase, GlucoCare, Glyoherb, SugarMax, Karmin Plus, and Sugar Loss are a few of these[23,50]. These products are made of a variety of anti-diabetic plants' separate components. For maximum efficiency, several of these remedies are sold with instructions for nutrition, rest, and exercise [23,50].

The Prospect of Plant-Based Anti-Diabetic Drugs
The development of about 75% of herbal medications used around the world was based on the work of traditional medicine practitioners [47]. In addition to being employed in several treatments, cosmetics, perfumes, and the food and beverage sector, medicinal plants will continue to be valued for their inherent potency and safety[51].Traditional medicinal plants' biologically active constituents have produced several therapeutically useful therapeutics and continue to be important in the search for new medications. So, it stands to reason that plants used in traditional medicine could be a source for the development of new diabetes medications. Blood glucose-lowering qualities in Type 2 diabetes are provided by the most frequently prescribed synthetic medicine, metformin, and the hunt for more such medications is ongoing[48].Moreover, any plant-derived anti-diabetic medication having a different mode of action from currently available anti-diabetic medications is highly likely to be employed in clinics [52]. Although wealthy nations have recently shown interest in adopting herbal medications and therapies, the usage of plant-based medicines is still more common in underdeveloped nations. Worldwide demand for plant-based anti-diabetic medications is rising as the prevalence of diabetes mellitus rises. The most sought-after nations are anticipated to be India, China, and Japan, which have an abundance of medical plant species and are the biggest exporters of medicinal plants globally [53]. To determine the advantages and mode(s) of action of these substances in the management and treatment of diabetes, additional research is needed on the pharmacokinetics/pharmacodynamics of various phytoconstituents in animal studies and clinical use. To create novel, effective antidiabetic medications, in-

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depth research is required into the pharmacology, toxicity, metabolism, and tissue distribution of traditional medicines and their phytomolecules [54].

CONCLUSIONS

The prevalence of diabetes mellitus has increased significantly, especially in developing nations. To treat and manage diabetes, recent research efforts have focused on finding novel natural sources of antidiabetic medicines. Traditional medicinal herbs are being thoroughly explored for novel targets, modes of action, and administration routes since they may one day be regarded as suitable candidates for the control of diabetes plant-based antidiabetic medications are affordable, easily accessible, and have few side effects. They, therefore, represent promising novel antidiabetic drugs. With the advancement of research into medicinal plants, scientists and medical professionals have begun to create fresh classes of anti-diabetic medications based on the pharmacology of the phytochemicals derived from these plants. However, further research is necessary to fully understand the molecular, therapeutic, and physiological effects of these recently identified anti-diabetic medications to manage and control diabetes mellitus globally.

Declaration of competing interest
We have no competing interests to declare.

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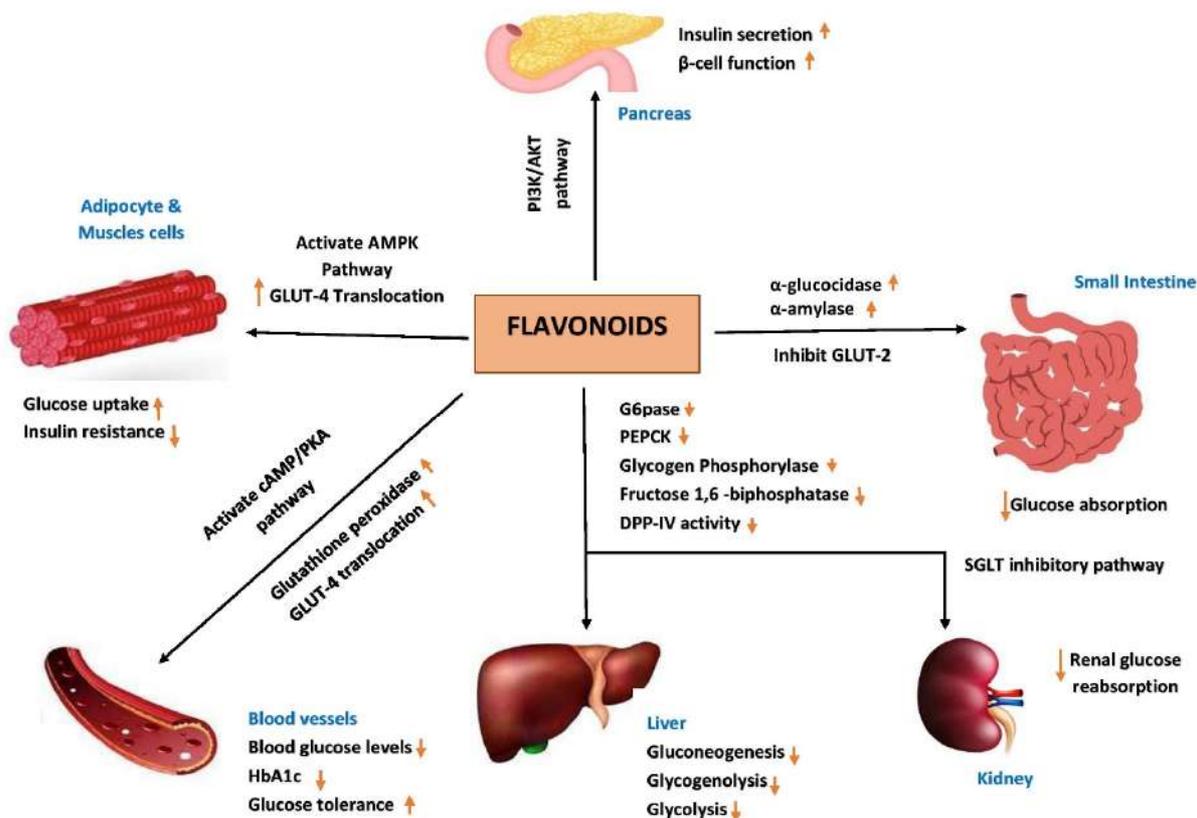
Figure 1. Different molecular routes by which flavonoids exert their antidiabetic effect: through the PI3K/AKT signalling pathway, flavonoids promote β-cell function and insulin secretion; adipose tissue and skeletal muscle glucose absorption are increased by increasing GLUT-4 translocation via AMPK activation; reduce insulin resistance by activating PPAR expression; cAMP/PKA pathway activation lower blood glucose levels and enhance glucose tolerance; to lower HbA1c levels, increase the glutathione peroxidase activity; reduce gluconeogenesis, glycogenolysis, and glycolysis in the liver by downregulating G-6-Pase, PEPCK, glycogen phosphorylase, 6-bisphosphatase, fructose 1, and DPP-IV activity; Reduce renal glucose reabsorption by inhibiting the SGLT pathway; reduce the activity of GLUT-2, α-glucosidase α-amylase, and to lessen the absorption of glucose in the small intestine.

RESEARCH ARTICLE

A New Series of Schiff's Base Metal Complexes of Dehydroacetic Acid Analogue and their Antibacterial Activity

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ABSTRACT

The reaction product of formic acid hydrazide with Dehydroacetic acid analogue employed in the formation of a series of new Schiff base metal complexes of Nickel(II), Copper(II), Cobalt(II), Manganese(II) and Zinc(II) with a tridentate(three donor atoms) Schiff base ligand. ¹H and ¹³C NMR, IR(infrared) spectroscopy and mass spectrometry were used to characterize all of the produced metal complexes and ligands. The azomethine N and enolic O atoms are involved in coordination with metal ions, according to the IR spectrum data and the ligand behaves as a tridentate ligand with ONO donor atoms. The complexes mass spectra demonstrate the development of metal ligand bonding in a 1:1 stoichiometric ratio (M:L). Using Gentamycin as a reference medication, all newly synthesized complexes were tested for activity against both gram-positive and gram-negative bacteria. Metal complexes have been found to have higher activity than ligands and some changes in ligand structure could lead to stronger antibacterial drugs in the future.

Keywords: DHA (Dehydroacetic acid analogue), Tridentate Schiff base, Antibacterial properties Spectroscopy.

INTRODUCTION

"Schiff base" was firstly prepared by "Hugo Schiff" [1] and after his name they are spelled so. Compounds with an imine [—C=N—]"functional group" are identify as "Schiff bases". These are the byproducts of "primary amines and carbonyl compounds" condensation [2-3]. It process pain relief(analgesic)[4-7] activity against cancer[8-12]

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activity against swelling reddishness (anti-inflammatory)[13-17] property of preventing oxidation (antioxidant)[18-19] preventing convulsions (anticonvulsant)[20-21] activity against microbes (antimicrobial)[22-25] anthelmintic[26] properties which make Schiff base a highly valuable compound for pharmacological research. Additionally, the antibacterial and analgesic properties of reduced Schiff base metal complexes are assessed and compared to industry benchmarks[27]. Besides that "Dehydroacetic acid ((DHA = 3-acetyl-4-hydroxy-6-methyl-2H-pyran-2-one)" also act as an antifungal and antibacterial agent as well as an antimicrobial, antiseptic, and herbicide, and because moulds and yeast are harmed by DHA, it is utilized as a stabilizer in food additives and cosmetics[28]. DHA derivatives have been demonstrated to bind to DNA. In addition, many 4-hydroxypyran-2-one analogues have been shown to block HIV protease, one of the key enzymes needed for HIV replication[29]. The Dehydroacetic acid molecules were utilized to boost the vitamin C's stability and to safeguard veggies throughout food preparation[30].So "Dehydroacetic acid (3-acetyl-4-hydroxy-6-methyl-2H-pyran-2-one)" and Schiff base and their derivatives all have almost common pharmacological effects so they can be combined together to increase overall potency. In the current study, a "novel hydrazone Schiff base" was prepared by reacting DHA analogue with formic hydrazide, considering these "observations" & exploring the possibility of certain "new compounds" in mind. Ni(II), cupric ion, Zinc (II)and Manganese (II),metal salts were react with the produced "ligand" and evaluated by "techniques" such as "analysis of elements", Proton-"NMR" and carbon-thirteen NMR (^{13}C NMR), "Infrared spectroscopy", "mass spectrometry" and so on. Furthermore, "Schiff base and its metal complexes" were given permission to be screened for "anti-bacterial" activity in the hopes of discovering new and promising antibacterial medicines.

MATERIALS AND METHODS

The "DHA" from Merck's was utilized without further "Purification". The grade of any further chemicals, "including solvents" was "LR". In this study, double distilled water was used. Using a Bruker AVANCE NEO 500 MHz instrument, the Proton-"NMR" &"^{13}C-NMR" of the "ligand and complexes" carried out, respectively. "IR spectra" carried out using the "KBr pellet method" on a PerkinElmer Spectrum Version 10.5.4 IR Affinity in the 4,000–400cm^{-1} range. The Agilent (ALR-QC-LCMS) Mass Spectrometer was used to collect mass spectra. The LECO 9320analyzer was used to determine carbon, nitrogen, and hydrogen levels.

Experimental Section
Synthesis of Dehydroacetic Acid Analouge
10 g dehydroacetic acid added in 100ml "R.B" flask and was treated slowly with concentrated sulphuric acid along with constant stirring. Due to exothermic nature of reaction temperature of mixture raised to 80 - 90°C.mixture was constantly agitated almost for one hour at this temperature. After that it is allowed to cool at rt than cold water was added. Solid obtained was washed with distilled H_2O and allowed to dry. Then the dried product was treated with propionic acid in presence of "DCC"&"DMAP" in presence of toluene as a solvent. The product obtained was put into "ice-cold"-H_2O and the 'solid' so formed was "filtered" and washed with chilled H_2O to get a white colour solid. The product obtained was characterized by various techniques.

Characterization of analogue
^{1}HNMR[(CD3)2SO,500.00*10^{6}Hz]
("partspermillions"):02.38(S,3H,methyl);4.66(S,1H,"ringproton");2.75(m,2H,CH2);1.31(t,3H,CH3);   6.13(S,1H,OH)
The appearance of extra CH_2 at 2.75 (m,2H,CH2) confirms formation of analogue.

Synthesis of Ligand
In accordance with the steps outlined below, the ligand was created by reacting formic hydrazide (0.01 mol) with DHA analogue (0.01 mol). Formic hydrazide (10 mmol) was dissolved in twenty five milliliters of "aqueous ethanolic solution" while being constantly stirred, and 25 ml of a warm ethanolic mixture containing (0.01 mol) DHA was then added After being refluxed for an hour in the H_2O-bath, the "Reaction Mixture" was then to "cool" at rt. The end

result underwent filtering, two washes with 70% "aqueous ethanolic solution" and four hours of drying in a "hot air oven" at sixty- five degree Celsius. The resulting 'solid' has no colour.

Characterization of ligand

Color: Colourless.

Yield: 85%,

"M.Pts".: 212 degree Celsius

"IR";;:[K−Br ;, "centimeter inverse"];;03418(w);;,m-(O-H),1,662(s),m-[C=N]; 1,690(s), m-[C=O :]; 1,260(s), m-[C−O :].

"Proton-NMR";;:[(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"): : 1.94 (s;3H, methyl);0.87 (m,:3H, "CH₂-CH₃");1.61 [m,2H, −N=C−CH₂]; 8.20 (s;1H, -CHO); 6.20 (s;1H, ring proton); 7.14 [s;1H, CONH]; 12.18 (s;1H, "enolic").

"¹³C NMR"[(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"): 23.33 (C^1st); 163.07 (C^2nd); 103.31 (C^3rd);181.46 (C^4th);82.32 (C^5th);160.37 (C^6th);153.13 (C^7th);19.25 (C^8th);10.51 (C^9th);182.07 (C^10th).

"MS"; *m/z* ["M:1"] 224.12 "Anal.Calcd".for$C_{10}H_{12}N_2O_4$: Carbon, 53.57,Hydrogen, 5.39, Nitrogen, 12.49, Oxygen, 28.54.

"[SYNTHESIS OF METAL COMPLEXES]"

"{GENERAL PROCEDURE}"

By combining twenty-five milliliters of CH_3OH solution of the "ligand (FL¹)" with ten milliliters of CH_3OH solution of the "metal salt", several metal compounds were created. The "pH" of the 'resulting "ReactionMixture" was adjusted to 8.0 with the addition of a 10% CH_3/KOH solution. The solution was then allowed to cool at rt. after four hours of refluxing. The complexes were "filtered" & "washed" with excess ethyl alcohol to "remove" unneeded "metal salts", then "dried" for six hours at 70°C in a hot air oven, and the compounds were found to be 'non-hygroscopic' at rt.

'COMPLEX 1'

[($C_{12}H_{14}N_2O_6$)*Mn] FL¹(Mn)*

Color: Orange

'Yield':83%

"M.Pts";;:281degrees Celsius.

"IR";;:[K−Br : , "centimeter inverse"];;3466;(w),;;m(O-H); 1,683(s),m-[C=N];; 1,588(s),m-[C=O :]; 1,288(s),m-[C−O :].;491(s),m-[M−N];642(s),m-[M−O :]

Proton-"NMR";;:[(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"):2.2 (s, 3H, "Methyl");0.85 [t,3H, −N=C−CH−CH₃]; 2.51 (s, 3H, -COCH₃); 1.66 (m, 1H,-N=C-CH₂); 5.62 (s,1H, "ringproton"); 7.12 (s, 1H[s;1H, CONH]; 8.21 (s, 1H, -CHO).

"MS"; *m/z* ["M:1"] 337.0"Anal:Calcd":.for $C_{12}H_{14}N_2O_6Mn$:"Carbon";;,42.74, "Hydrogen";;, 4.18, "Nitrogen";;, 08.31; "Oxygen";;, 28.47; "Manganese";;, 16.29.

COMPLEX 2

[($C_{12}H_{14}N_2O_6$)*Zn] FL¹(Zn)*

Color: Colourless

Yield:84%

"M.Pts":279degree Celsius

"IR";;:[K−Br : , "centimeter inverse"];;3468(w);;, m(O-H); 1,623(s), m-[C=N];;1,588(s),m-[C=O :];;1288(s),m-[C−O :].;;491(s),m-[M−N];642(s),m-[M−O :].

Proton-"NMR";;:[(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"):,2.18 (s, 3H, "Methyl");0.85 [t,3H, −N=C−CH−CH₃]; 2.51 (s, 3H, -COCH₃);1.62 (m, 1H,-N=C-CH₂); 5.48 (s,1H, "ringproton"); 7.18 (s, 1H, CONH];8.28 (s, 1H, -CHO).

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"MS";: m/z ["M:1"] 346.0 "Anal;Calcd".for $C_{12}H_{14}N_2O_6Zn$:" Carbon";: 41.46;"Hydrogen";: 4.06;"Nitrogen";: 08.06; "Oxygen";: 27.61 ; " Zinc";: 18.81.

COMPLEX 3

[($C_{12}H_{14}N_2O_6$)Ni] *FL¹(Ni)*

Color: Green

Yield:81%

"M.Pts":284degree Celsius

"IR";:[$K-Br$, "centimeter inverse"];;3466;(w);;, m(OH); 1,623(s),m-[$C=N$];;1,575(s),m-[$C=O$];;1,366(s),m-[$C-O$].;;491(s),m-[$M-N$];;;642(s),m-[$M-O$]..

Proton-**"NMR"**;;:[(CD3)2SO,)500.00*10⁶"Hz"] ("partspermillions")::2.24 (s, 3H, "Methyl");0.84 (t,3H,; 2.50 [s, $-N=C-CH-CH_3$]; 3H, -COCH₃);1.64 (m, 2H,-N=C-CH₂);;5.66 (s,1H, "ringproton"); 7.14 [s, 1H, $CONH$];; 8.28 (s, 1H, -CHO).

"MS";: m/z ["M:1"] 340.02 **"Anal.Calcd".;; for**$C_{12}H_{14}N_2O_6$**Ni**: Carbon; 42.27; "Hydrogen";; 4.14, "Nitrogen";; 08.22; "Oxygen";; 28.16 ; "Nickel";; 17.22.

COMPLEX 4

[($C_{12}H_{14}N_2O_6$)Cu] *FL¹(Cu)*

Color: Colourless

Yield:79%

"M.Pt":277°degrees Celsius.

"IR";:[$K-Br$, "centimeter inverse"];;3443;(w);; m-[OH]; 1,617(s),m-[$C=N$]; 1,585(s),m-[$C=O$];;;1,274(s),m-[$C-O$].;491(s),[$M-N$];;642(s),m-[$M-O$].

Proton-**"NMR"**:: [(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"):2.16 (s, 3H,"Methyl");0.64 (t,3H, $-N=C-CH-CH_3$]; 2.58 (s, 3H, -COCH₃);1.48 (m, 1H,-N=C-CH₂); 5.36 (s,1H, "ringproton"); 7.18 (s, 1H, $CONH$];8.32 (s, 1H, -CHO).

"MS":: m/z ["M:1"] 345.01 "Anal.Calcd".for $C_{12}H_{14}N_2O_6Cu$: "Carbon";;41.68, "Hydrogen"; 4.08, "Nitrogen";; 08.10; "Oxygen";; 27.76 ; "Copper";;18.38.

COMPLEX 5

[($C_{12}H_{14}N_2O_6$)Co] *FL¹(Co)*

Color: Colourless

Yield:80.5%

"M.Pts":290degrees Celsius.

"IR";:[$K-Br$, "centimeter inverse"];;3330;(w);;,m-[OH]; 1,658(s), m-[$C=N$];1,614(s),m-[$C=O$];;;1,240(s),m-[$C-O$].;;491(s), $M-N$];;642(s),m-[$M-O$].

Proton-**"NMR"**;[(CD3)2SO,)500.00*10⁶Hz] ("partspermillions"):2.18 (s, 3H, Methyl);0.66 (t,3H, $-N=C-CH-CH_3$];; 2.54 (s, 3H, -COCH₃);1.44 (m, 1H,-N=C-CH₂); 5.34 (s,1H, "ringproton"); 7.20 (s, 1H, $CONH$]; 8.33 (s, 1H, -CHO).

"MS": m/z ["M:1"] 342.02"Anal.Calcd".for $C_{12}H_{14}N_2O_6Co$: Carbon;;42.24, "Hydrogen";; 4.14, "Nitrogen";; 08.21; "Oxygen";; 28.14 ; "Cobalt";; 17.27.

RESULTS AND DISCUSSION

Chemistry

From the literature it has been observed that DHA and its derivatives possess a lot of chemical and physical significance. R.P. Saini and Sushil kumar from our research lab well explored the chemistry and biology of DHA

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and its derivatives. Encouraged from their innovative findings it is envisioned that metal complexes of Dehydroacetic acid analogue may possess enhanced biological activity. We started our research from the synthesis of a chemical analogue of DHA namely (4-hydroxy-6-methyl-2-pyrone)reported in literature. It involves treatment of DHA with 40ml concentrated H_2SO_4 and mixture is heated at 80 to 90°Cfor 3 to4 hours then cold water is added the resultant solid was dried and treated with propionic acid and DCC for 8 hours and "resultant solid obtained was "filtered" and "dried" to obtain the desired compound". The synthesized analogue was characterized by its Mass, ^{1}H NMR and ^{13}C NMR spectroscopy. Singlet at 2.38ppm is due to CH_3 attached to ring; sharp peak at 4.66ppm is due to ring proton, a multiplet at 2.75ppm due to 2H of CH_2, triplet at 1.31 is due to CH_3 adjacent to CH_2, enolic OH shows singlet at 6.13 ppm. The appearance of extra CH_2 at 2.75 ppm due to 2H of CH_2 confirms formation of analogue.

The synthesis of the ligand from analogue of DHA was performed by the reaction DHA analogue created by dissolving Formic hydrazide (0.01 mol) of aqueous ethanolic solution while being constantly stirred, and   warm ethanolic mixture containing (0.01 mol) DHA analogue was then added. After being refluxed for an hour in the "H_2O-bath", the "reaction mixture" was then "cool to at rt" & washed with ethanolic solution, The resulting solid has no color and was characterized by it Proton- NMR,^{13}C-"NMR" and "Mass spectroscopy". "The Proton-NMR Spectrum" of the ligand showed an intense peak of 3 methyl protons of DHA molecule as a singlet at delta value 1.94. The 3 methyl protons of (CH_2-CH_3) observed as an adjacent multiplet at 0.87 delta value. The singlet at 8.20ppm is due to 1 H of -CHO while the singlet at 6.20ppm due to ring proton. The CONH proton resonated at 7.14 and the enolic proton of the DHA ring observed as a singlet at 12.18ppm. Appearance of peak at 7.14ppm confirms formation of ligand. Similarly, ^{13}C NMR (DMSO-d_6, 500 MHz) of the Ligand possesses an extra carbon at19.25 which indicates the formation of the analogue from DHA itself. and appearance of an additional peak due to carbon of (-C=NH) at 153.13 further confirms the synthesis of ligand. The 23.33ppm due to "methyl" of DHA. The mass spectral analysis of the above compound showed M+1 peak at mass spectra peak at 224.12.

The ligand was "dissolved in "CH_3OH/H_2Osolution" this was poured to the "methanolic solution of metal acetate". The 'resulting reaction mixture' was refluxed for three to four hrs at 70 degrees Celsius. "The pH of the resulting reaction mixture' was adjusted to 8.0". During refluxing period, the solid was separates out and mass was then allowed to cool at rt. "The solid was filtered and washed with chilled methanol". The obtained solid was further recrystallized by ethyl alcohol and dried at 70degreesCelsiusin a "hot air oven". The complete physical and chemical analysis of the above synthesized compounds was performed and was again "characterized by Proton-NMR", "^{13}C-NMR", "Mass spectrometry"&"IR spectroscopy". In all complexes values of NMR comes approximately same and were in accordance with expected values A triplet due to 3H of methyl proton of CH2-CH3 observed at delta .85, multiplet due to 2 protons of *-N=C*-CH2observed at delta 1.66,singlet of methyl 3H attached with aromatic ring observed at delta 2.2, singlet due to 3 protons attached with carbonyl group COCH3 observed at delta2.51,sharp singlet due to ring proton observed at delta 5.62,singelet due to one proton of CONH observed at delta 7.12,and H of aldehyde group observed at delta 8.12.

Mass spectra of complex [($C_{12}H_{14}N_2O_6$)Mn]FL[1](Mn) gives peakat*337.0*,[($C_{12}H_{14}N_2O_6$)Zn] FL[1](Zn)give peak at*346.0*,[($C_{12}H_{14}N_2O_6$)Ni] FL[1](Ni) give peak at*340.02*,[($C_{12}H_{14}N_2O_6$)Cu] FL[1](Cu)give peak at345.01,[($C_{12}H_{42}N_2O_6$)Co] FL[1](Co)give peak at 342.02 all values were found to be in accordance with expected values. "IR spectrum" of prepared "ligand" gives the information of "characteristic bands" at1690, 1662 and 1260cm⁻1.These Bands may be assigned to t$_{c=o}$(carbonyl group), "t$_{c=N}$(azomethine) and t$_{c-o}$(enolic) stretching modes, respectively" ("AnouElEnein*etal.,*2007").The absence of a weak wide band in the "spectra" of "metal complexes" shows that the "enolic" hydroxy group was removed, and the "metal ion" was then coordinated with the "enolic" group through the "O" atom of the "enolic" group. It can also be supported by a rise in "enolic C-O stretch" frequency of up to 15–40 cm-1.As compared to the "metal-free ligand," the tC=N in the "IR spectra" of "metal complexes" moved to a lower frequency, suggesting that the "N" atom of the "azomethine" group was involved in coordination with the "metal ion."("Mohammedshafi *et al.,* 2011"). It

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may be due to the donation of none bonded electrons presents on 'N' atom of "azomethine" to the "vacant*d*-orbitals" of "metal ions". The presence ofa bandat 3,400–3,500cm⁻¹may bedueto lattice water ("Pouralimardan *et al.,* 2007"). "Furthermore "IR spectra of metal complexes" show "characteristic 'without-ligand'bandsin640–670and460–491cm⁻¹region" whichcan be assigned to t$_{M-O}$ andt$_{M-N}$vibrations, respectively (Nakamoto,1986)".

Biological Activity

Using *Gentamycin* as a reference medication, "allnewly synthesized complexes" were evaluated for their "anti-bacterial activity" towards both "gram-negative(-ive) & "gram-positive(+ive) bacteria". Results are summarized in the form of diameter of 'zone of inhibition' at 1 mg/ml concentration.

CONCLUSION

In this study, a "novel tridentate heterocyclic Schiff base (FL1)"&associated "metal complexes" from the 3d-Series were 'designed and synthesized'. According to "IR spectroscopy", "Mass-Spectrometry" and "Proton-NMR spectrum" data, metal complexes of "Manganese(II)", "Cobalt(II)","Nickel(II)", "Copper(II)"&"Zinc(II)" exhibit "square planar(SP)" geometries. "Ligand forms coordinate bond with metal ion (FL1)" via "N" &"O" donor atoms via removal of proto from "enolic oxygen" atom. The mass spectrum displays a stoichiometric "metal-to-ligand" ratio of 1:1. The metal complexes of Nickel(II), Cobalt(II) and Cupric ion have greater activity against bacteria than the "free ligand", whereas the "metal complexes" of "Manganese(II)", "Zinc(II)", and "Cobalt(II)" have less "antimicrobial activity" in comparison of "ligand". The "ligand and its derived complexes" were found to be less effective against tested bacterial strains than the usual treatment, though. Future development of a more potent antibacterial agent could result from a modification to the ligand structure.

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Table.1: NMR of Complexes

Protons	$FL^1(Mn)$	$FL^1(Zn)$	$FL^1(Ni)$	$FL^1(Cu)$	$FL^1(Co)$
CH_3 CH_2-	.85	.85	.84	0.64	.66
-N=C-CH_2	1.66	1.62	1.64	1.48	1.44
$C6H5$-$CH3$	2.2	2.18	2.24	2.16	2.00
O=C-$CH3$	2.51	2.51	2.50	2.58	2.54
CH(ring proton)	5.62	5.48	5.66	5.36	5.34
-CONH-	7.12	7.18	7.14	7.18	7.20
HC=O	8.21	8.28	8.28	8.32	8.33

Table.2: Mass Spectra of Complexes

Complex	$[(C_{12}H_{14}N_2O_6$ Mn] $FL^1(Mn)$	$[(C_{12}H_{14}N_2O_6$ Zn) $FL^1(Zn)$	$[(C_{12}H_{14}N_2O_6$ Ni) $FL^1(Ni)$	$[(C_{12}H_{14}N_2O_6$ Cu) $FL^1(Cu)$	$[(C_{12}H_{14}N_2O_6Co)$ $FL^1(Co)$
m/z[M:1]	*337.0*	*346.0*	*340.02*	*345.01*	*342.02*

Table.3: FTIR Data of Ligand and Complexes

Ligand/Complexes	m(OH)	m(C=N)	m(C=O)	m(C–O)	m(M–N)	m(M–O)
FL^1	3418	1662	1690	1260	-	-
FL^1(Cu)	-	1,617	1,585	1,274	478	643
FL^1(Ni)	-	1,623	1,575	1,366	491	639
FL^1(Co)	-	1,658	1,614	1,240	460	639
FL^1(Mn)	-	1,623	1,588	1,288	484	660
FL^1(Zn)	-	1,623	1,572	1,298	486	637

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Entry	E. Coli	S. Aureus	Enterococcus	K. Pneumonia
Ligand	8	9	9	8
Mn	14	9	9	9
Cu	15	10	8	14
Zn	8	11	15	13
Co	9	18	16	15
Ni	18	19	18	17
Gentamycin	24	24	23	24
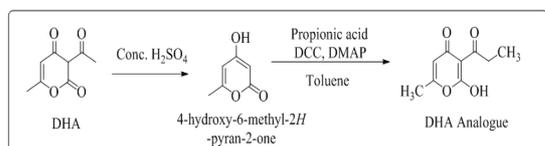
**Fig.1: Synthetic scheme of Ligand**
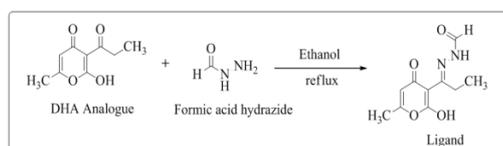
Fig.2: Synthetic scheme of Ligand

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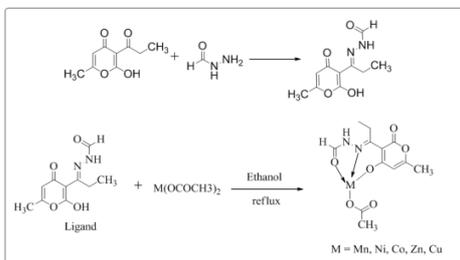
**Fig. 3.Synthesis of ligand and metal complex**
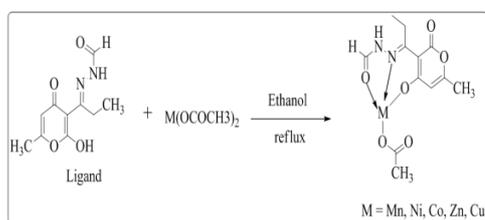
**Fig. 4 Synthetic Scheme of Metal Complexes from Ligand**
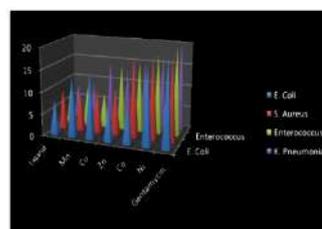
**Fig.5.“A graphical representation of the 'antibacterial' activity of synthesized compounds with comparison to ligand”**
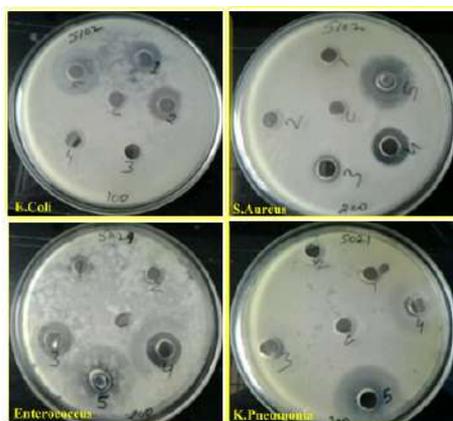
Fig .6.“Antibacterial activity of synthesized ligands and their metal complexes, L(Ligand in center), 1= Mn, 2-Cu, 3=Co, 4= Zn, 5=Ni”.

REVIEW ARTICLE

A Literature Review on Physical Therapy in Mortons Neuroma

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ABSTRACT

Morton's neuroma is a common condition that mostly affects women in their middle years, and many different etiological explanations have many different etiological explanations that have been put up. These hypotheses include intermetatarsal bursitis, ischemia, chronic recurrent trauma, and entrapment. Although there is perineural fibrosis, the inaccurate terminology suggests that a nerve tumor is the underlying disease mechanism. Instead, a histological study reveals that there is inflammatory tissue. Particularly affected is the third planter webspace, which contains the common digital nerve and its branches. Magnetic resonance imaging and ultrasonography may also be performed in addition to clinical examination and history-taking, which are the usual methods for making a diagnosis. Custom orthotics, shoe modifications, injections of steroids, sclerosing agents, and local anesthetics are some of the current nonoperative treatment options. There is evidence to support the use of functional face-taping, physical therapy, and strengthening exercises for Morton's neuroma. A Literature Review on Physical Therapy In Morton's Neuroma was the base for this investigation. Pub Med, Research Gate, Google Scholar, and Science Direct were the databases utilized to search for papers. The title, abstracts, and full-text literature were used to find and screen all potentially pertinent studies. To determine the availability of further papers, the citations, and references of pertinent articles were also checked. After searching databases for the terms Morton's neuroma, metatarsalgia, physical therapy, shockwave therapy, and manipulative therapy, a sample size of 25 was discovered. Additional publications were examined in light of the inclusion and exclusion criteria and the year of publication, and ultimately 10

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pertinent articles for this systematic review were found. Participants having a diagnosis ofMorton's neuroma, discomfort in their foot measured on a 10-cm numerical scale, Ballet Dancers, Adults above the age of 18, No gender discrimination. Were included in the study. A total of 26 papers, out of 35, were reviewed. The outcomes reveal that Morton's neuroma care with physical therapy is effective. Morton's neuroma is a condition that causes excruciating pain that regularly presents to podiatrists. Conservative therapy is a significant component of the treatment since the majority of Morton's neuroma patients may be treated non-operatively and only a small percentage of people require surgical therapies when these approaches are inadequate. There hasn't been much research done to look at the benefits of manipulative therapy, shock wave therapy, functional facial taping, and physical therapy for treating Morton's neuroma.

Keywords: Morton'sneuroma, metatarsalgia, physicaltherapy, shockwave therapy, manipulative therapy.

INTRODUCTION

A throbbing, burning pain and sensitivity on the plantar surface of the foot, typically around the third and fourth metatarsophalangeal joints, with pain spreading along the corresponding toes, is referred to as Morton's metatarsalgia [1]. The use of manipulative treatment for ailments affecting the lower extremities (such as Morton's neuroma) gives the impression that research into and implementation of manipulative therapy techniques for conditions affecting the lower extremities has just begun [2]. The ailment is named after Thomas George Morton, an American orthopaedic physician, who initially described it as "An unusual and painful affection of the fourth metatarsophalangeal articulation" in a case series involving 15 patients [3]. Neuralgia affecting the common plantar digital nerves of the metatarsal area is called Morton's neuroma (MN) [4]. A favourable feeling of tenderness when the metatarsal spaces are palpated. Morton's neuroma is suspected by Mulder's test. The drawer test is a crucial diagnostic procedure for plantar plate injuries. Ask for sesamoid-specific radiography images if a patient complains of discomfort during resisted plantarflexion of the first metatarsophalangeal joint [5]. Morton's neuroma, also known as interdigital neuritis, Morton's metatarsalgia, or interdigital neuroma, is a frequent and excruciating ailment of the foot. It makes up a sizable percentage of the foot and ankle surgeon's duty [6]. A benign growth of the third common digital branch of the medial plantar nerve is known as Morton's neuroma. Burning pain between the metatarsal heads in the plantar foot, which frequently radiates to the two adjacent toes, is the most typical symptom. Acute, ongoing, throbbing, or intermittent pain may develop, and it may get worse while moving about [7].

Morton's neuroma, which has an incidence of 87.5 per 100,000 persons and primarily affects middle-aged women, is characterized by perineural fibrosis of the common plantar digital nerve. 8 Initial treatment for this illness is often nonoperative and involves lifestyle changes such as avoiding tight-fitting shoes, orthotics, physiotherapy, and local corticosteroid injection [8]. Symptomatic A frequent and excruciating foot ailment is Morton's neuroma. After carpal tunnel syndrome, it is the neuropathy that is most prevalent. To assess the nature of the pain and the mechanical presentation, mechanical diagnostic therapy employs end-range, repetitive motions [9]. The reasons include structural foot malalignment, plantar callosities, plantar warts, subluxation, dislocation, or synovitis of the metatarsophalangeal joints, hallux valgus, hallux rigidus, Freiberg disease, interdigital (Morton's) neuroma, stress fractures, and trauma. Morton's neuroma [10].Neuroma of Morton The reasons include structural foot malalignment, plantar callosities, plantar warts, subluxation, dislocation, or synovitis of the metatarsophalangeal joints, hallux valgus, hallux rigidus, Freiberg disease, interdigital (Morton's) neuroma, stress fractures, and trauma [11]. The anatomical features of the metatarsals (M) that impact how they relate to one another and the rest of the foot are the primary cause of primary metatarsalgia. For instance, individuals with acquired hallux valgus or congenital

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shortness of M1 experience higher stresses via M2. Other factors include disproportionately long M2 or M3, congenital metatarsal head malformations, tight gastrocnemius or triceps muscles, fixed equines of the foot, pes cavus, and any anomaly of the hindfoot that overloads the forefoot.

Secondary metatarsalgia is caused by conditions that increase metatarsal loading via indirect mechanisms. One such mechanism is chronic synovitis, which induces overextension of the metatarsophalangeal (MTP)joints and atrophy with distal migration of the plantar fat pad. Thus, metatarsalgia may develop in patients with rheumatoid arthritis, gout, or psoriasis. Secondary metatarsalgia may also be due to neurological disorders (e.g., Charcot-Marie-Tooth disease), metatarsal malunion, or sequelae of Freiberg disease [12]. Applied manipulative therapy (manipulation, mobilization, and/or other manual or functional techniques), with or without additional therapy, was the operational definition of chiropractic treatment [13]. 50 men out of every 100,000 and 100 females. It can be argued that Morton's neuroma refers specifically to lesions in this locality, to the exclusion of identical lesions at other anatomical locations, because the initial description by Durlacher in 18452 and the more well-known description by Morton in 18763 both refer to a lesion of the third inter-metatarsal (IM) space [14]. Some writers prefer to use the term interdigital neuroma instead of Morton's neuroma, which was previously used to characterize interdigital neuroma in the third web space, even though the condition is prevalent and not specific to the third web space. The third common digital nerve is susceptible to micro-damage due to excessive motion between the third and fourth metatarsals, the tethered third common digital nerve in the third web space, the third and fourth metatarsal heads flanking the third common digital nerve, the thick third transverse intermetatarsal ligation covering the third common digital nerve, and excessive weight-bearing stress on the forefoot, especially when wearing pointed and high-heeled shoes [15]. Both conservative and surgical modalities are treatment options. Nonoperative treatments include nonsteroidal anti-inflammatory drugs, wider shoes with lower heels, soft metatarsal pads to reduce forefoot pressure, a metatarsal bar to shift pressure proximally, and total-contact orthoses.2 If these management approaches fail, corticosteroid injection is widely used and can relieve inflammation in some patients; however, pain can recur after some weeks or months [16]. Women are affected by the ailment more frequently than males (10 times more frequently), most likely as a result of a narrow foot causing traction on the interdigital nerve. It is common in athletes like runners and dancers, especially ballerinas in demi-pointe, and is often brought on by overextension of the MTP joints and recurrent stress to the metatarsals. 44 These strains may cause the bursa to enlarge further, increasing the interdigital nerve's compression and intermetatarsal ligament thickening [17].

In various trials, the use of ultrasound therapy was proven to have pain-relieving benefits (37–39). However, a double-blind, randomized, placebo-controlled experiment revealed that adding ultrasonic therapy to a stretching regimen had no beneficial impact on either pain relief or function. The Claw toe might be caused by a rupture of the so-called plantar plate (e15). The plantar plate must be presumed to have ruptured if the MTP joint does not align when pressure is applied to the planter aspect of the metatarsal head (Kelekian push-up test). Additionally, the dorsal proximal interphalangeal joint is frequently subjected to pressure from the shoe's top when the joint is impinged upon [18]. Mulder's sign, which is only present in 20% of people with symptomatic Morton's neuroma, is an audible and "palpable click when pressure is given to the sole and the metatarsals are subsequently pushed together" in Morton's neuroma patients. Magnetic resonance imaging (MRI) is sometimes used to spot abnormal presentations, but a review claims that these MRIs done before surgery may be a waste of money and create a risky medical-legal precedent. The size of Morton's neuroma may also be determined using ultrasound and X-rays, and problems in the bone structures that can result in forefoot discomfort can be ruled out [19]. A highly specialized structure makes up the skin on the plantar portion of the foot. The plantar fat pad, which cushions the metatarsal heads, can occasionally become atrophic with aging and stop offering appropriate cushioning. As a result, there is widespread soreness below the metatarsal heads. A broad-toed, soft-soled shoe with a soft insole is typically worn by the patient during treatment to increase the cushioning beneath the foot [20].

In addition to being the second-most common complaint in the great toe after hallux valgus (HV), hallux rigidus (HR) is the most prevalent degenerative arthritis of the foot, affecting roughly 2% of people between the ages of 30 and 60 [21]. Healthcare assistants should inform and reassure patients with Morton's neuroma who may need

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assistance with daily tasks while receiving therapy. As the body ages, the transverse arch, which supports the midfoot bones and toes, weakens and the supporting pillars begin to move. During walking, the toes become more supple and may be pressed together. The intermetatarsal nerves are subjected to aberrant pressure as a result [22]. According to Thompson and Hamilton's description of the drawer test,71 the proximal phalanx is moved dorsally on a stabilized metatarsal head. It is regarded as the most reliable clinical test for determining the pathology of the second MTP joint (sensitivity: 91.5%; specificity: 99.8%) [23]. Numerous orthotic devices intended to relieve pressure in these locations have been developed as a result of the treatment of metatarsalgia caused by the plantar prominence of the metatarsal heads. d. Taping was seen to more quickly transfer stresses anteriorly to the forefoot, which was predicted to exacerbate metatarsalgia symptoms [24]. Before surgery, non-surgical therapies for MN are advised as therapeutic alternatives. Clinicians also deal with patients who either refuse surgical intervention or are not candidates for surgery owing to contraindications. All doctors caring for this population would benefit from a thorough analysis of the non-surgical therapies. For MN, doctors may advise a variety of therapies [25]. The onset of pain is frequently gradual, and up to 50% of asymptomatic people may have neuromas. A common complaint of plantar webspace can lead to a clinical diagnosis that is up to 99% correct. Weight-bearing activities exacerbate discomfort, paraesthesia, and numbness, which are relieved by rest and massage [26].

MATERIALS AND METHODS

Study design
PRISMA (preferred reporting items for systematic review and meta-analysis) criteria served as the foundation for this literature evaluation.

Search method and eligibility criteria
PubMed, Research Gate, Google Scholar, and Science Direct were the databases that were searched for papers. Morton's neuroma, physical therapy, shockwave therapy, and manipulative therapy were the terms used in the search. The items that came up after the search was carefully screened. From the title, abstracts, and evaluation of the full-text literature, all potentially pertinent publications were found. To determine the availability of further papers, the citations, and references of pertinent articles were also checked.

Inclusion criteria
The articles were included if they met the following criteria:
- The studies were carried physical therapy in Morton's neuroma
- The articles were from 2011-2020
- Articles were including above 18 years
- The studies were published in the English language
- Full-text articles

Exclusion Criteria
- Articles of past 2011
- Articles explaining surgical interventions only
- Articles where patients other than dancers as subjects
- Articles that include musculoskeletal diseases in the lower limbs, symptomatic central and peripheral nervous system diseases, diabetes mellitus, and rigid deformities in the feet.

SELECTION OF INCLUSION AND EXCLUSION CRITERIA:
5 articles were chosen based on inclusion and exclusion criteria [2,6,8,9,11,13,14]. All seven of these papers used a systematic study design. To properly analyze articles, only English-language articles were chosen. Due to English being the preferred and advantageous language, there is less likelihood of a mistake occurring when analyzing these articles. Considering non-English language publications may have resulted in incorrect interpretation, incorrect

analysis, and the acquisition of incorrect information. As a result, this review may be used to cite papers that are written in English and that have accurate analyses and interpretations of the data. This evaluation includes articles that were published between the years of 2011 and 2020, so the scenario of physical treatment in Morton's neuroma. Pre-2005 articles were not included. Full-text papers were chosen so that comprehensive information could be gleaned from them. Articles that lacked information on participants with additional symptomatic lower limb musculoskeletal illnesses, symptomatic central and peripheral nervous system diseases, diabetes mellitus, and stiff foot deformities were disqualified since it was unrelated to the purpose of the study. The focus of this study is the physical treatment for Morton's neuroma, hence papers that did not offer material pertinent to that focus were not taken into consideration.

RESULTS

Out of 25 articles, 10 articles were retrieved that fulfilled the eligibility criteria using the above-mentioned selection strategy. Many articles were excluded for not meeting the requirements, not fulfilling the inclusion and exclusion criteria, and many because they were duplicates. The findings of these 10 articles are summarized in the table below.

OUTCOME MEASURES

In these articles, various results were utilized. James W. Brantingham (2009) utilized the short-form McGill Pain Questionnaire, the visual analogue (VAS) and numerical rating pain (NPRS) scales, and the primary patient report of improvement. Using AdnanAFara's (2010) Interdigital (Morton's) neuroma surgical result, The Foot Questionnaire (MOXFQ), EuroQoL (EQ), time trade-off (TTO), and EQ visual analogue scale were all utilized by Alastair Faulkner in 2020. (VAS), LEFS, and FAAM surveys were utilized by Borja Pérez-Dominguez in 2020. Michael David Post (2019) utilized the global rating of change and the numeric pain rating scale (NPRS) (GROC), utilized in 2019 by Hilda Alcantara Veiga de Oliveira Functional Disability Scale, or VAS Michael D. Post used in 2019 LEFS score, the Numeric Pain Rating Scale, B. Tengku Nazim Barry G. Matthews (2019) and Tengku Yusof (2022) both employed the VAS and the Johnson scale. VAS was utilized by David G. Cashley (2015) used VAS and pressure threshold meter reading (PTM)

NEED OF THE STUDY
According to the study, physical therapy is useful in treating Morton's neuroma. Numerous papers provide evidence that physical treatment for Morton's neuroma has improved. A categorization method called Mechanical Diagnosis and Therapy (MDT) uses direction-specific therapy to address orthopaedic disorders based on mechanical and clinical responses to repeated end-range motions. to evaluate the performance of bespoke insoles in Morton's neuroma patients. Neuralgia affecting the common plantar digital nerves of the metatarsal area is called Morton's neuroma (MN). There are few evidence-based treatment options for this illness, and the efficacy of physiotherapy is constrained. In the third intermetatarsal area, a sensitive and soft nodularity was seen during a physical examination, accompanied by a strong discomfort that was consistent with Morton's neuroma. Although rheumatoid arthritis was not ruled out, a foot ultrasound revealed Morton's neuroma. According to the research, Morton's neuroma responded well to the fascial taping approach and manipulative treatment. A special treatment plan is necessary for metatarsalgia brought on by an inflammatory condition.

DISCUSSION

The major goal of this case study, according to Borja et al (2020), was to ascertain the impact of a combined physical therapy method on Morton's Neuroma discomfort and functioning. This intervention resulted in an improved reaction to a clinical evaluation as well as improvements in several measures assessing pain maladaptive attitudes and functioning. This improvement may be attributable to a comprehensive program of care that includes soft tissue

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massage, active and passive joint mobilizations, and education on how the body processes pain. All of these studies provide credence to our assertion that this illness responds well to physical therapy. None of the publications under review evaluated pain maladaptive beliefs or chronic pain. employed a VAS scale to assess pain intensity, but our study was the first to use self-reported questionnaires about unwarranted pain perceptions. The present series and a previous study show that manual therapy and repeated end-range motions are efficient treatment options for people with Morton's neuroma and offer long-term symptom alleviation. Since walking discomfort is the primary cause of patients seeking therapy, it was decided to utilize it as the study's primary end measure. Several clinical trials have shown improvement in foot pain with the use of this type of foot orthosis for metatarsalgia, but there is no evidence for this use in Morton's neuroma patients. Even though both groups increased their walking distance after treatment, there was no difference between the groups in the 6-minute walk test, even though the self-reported function had improved. Even though walking discomfort is the predominant complaint, the patients started the protocol by walking an average of 483 meters, which is usual for a population without foot problems.

According to Joao N. Malta et al. (2022), when employing clinical tests like the digital nerve stretch test for diagnosis, manual therapy and manipulations have been proven to ameliorate symptoms in the treatment of MN in podiatric or chiropractic care. Conversely, a plantar orthosis with metatarsal unloading is used in the conservative treatment of Morton's neuroma. Conservative care and steroid injections offer long-term pain relief in roughly 30% of instances. The surgical removal of Morton's neuromas should be explored for the remaining individuals. Rita Spina et al. (2002) state that Morton's neuroma is of significant clinical relevance due to the high prevalence of incapacitating pain in patients, many of whom are young and frequently in professional sports. There have been a lot of studies done on Morton's neuroma and the several different treatment options available. Others, on the other hand, support surgery when conservative approaches fall short of considerably reducing the patient's discomfort and incapacity. In this paper, functional facial taping for Morton's neuroma exhibits promising outcomes. James W. Brantingham (2009) states that this literature review "revealed new, recent, and previously noticed (secondary to limitations previously discussed)" publications regarding manipulative treatment, typically with adjunctive therapy (frequently exercise and/or rehabilitation and soft-tissue therapy, secondarily, in conjunction with modalities, NSAIDs, etc.), but also without it. The majority of manipulative therapy used to treat extremity disorders is delivered as multimodal therapy, combining exercise, soft tissue treatment, modalities, multiple extremity joint manipulation, and/or combined spinal and extremity joint manipulation. This type of therapy is typically condition- and patient-specific.
The goal of this retrospective case study, according to David G. Cashley et al. (2015), was to explain how manipulation was used to treat individuals with Plantar Digital Neuralgia (Morton's neuroma). The results imply that more research is necessary to fully understand the function of modification. There may be some value in this course of treatment for PDN given that the patients saw an improvement in their symptoms, and the majority experienced complete remission.

Faith Davis et al (2012) state that the goal of this case report was to outline how massage treatment affected one client's Morton's neuroma-related pain symptoms after six weeks of weekly massages and daily at-home activity. For this client, the treatment series was successful, especially in lowering the discomfort during and after exercise, which allowed her to resume her regular activities. The comprehensive treatment strategy, which included massage, sustained rest without exercise for the first three weeks after the massage, and compliance with the home care exercise that improved the foot's stability, may have reduced discomfort. Each of these procedures helps patients similarly lessen their symptoms. According to Deepak B. et al. (2004), 63%–75% of patients choose conservative therapy over surgical treatment. Chiropractic care can be merged with rehabilitative and certain other conservative care techniques, and it can play a substantial role, especially in the early phases (e.g., therapeutic ultrasound, electrical stimulation, nutritional supplements, etc.) However, further research, such as comparison studies between allopathic and chiropractic management, is required to support these therapies.

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LIMITATIONS

Given that so many relevant publications were only available in the databases, we were only able to screen 35 articles. This demonstrates that physical treatment for Morton's neuroma has not been the subject of many investigations.

- Due to the lack of research, universal evaluation of frequently afflicted regions, and outcome measurements, physical therapy was not performed in Morton's neuroma patients.
- Additionally, it must be noted that the review considered articles that were written in English only.

STRENGTH

- Since there were fewer publications included in our study, there was very little chance of bias and we were able to give precise data on the prevalence rate of physical therapy in Morton's neuroma.
- This systematic review has expanded the field of study for examining Morton's neuroma prevalence of physical treatment.

CONCLUSION

Morton's neuroma is a common but difficult pathological condition that mostly affects middle-aged females' third plantar webspace and causes perineural fibrosis of the common digital nerve branches. Although there are several ideas on the precise cause, chronic repeated trauma seems to be a significant factor. The majority of cases should be diagnosed with clinical evaluation and straightforward bedside testing, with just a small minority requiring further radiological investigation. A study of the literature identifies several effective treatment methods, such as local steroid injection, nerve decompression, and neurectomy, but also identifies a dearth of high-quality evidence-based research. Preventing the development of a stump neuroma and improving the result in terms of pain are two benefits of transposing the proximal nerve stump after a neurectomy.For Morton's neuroma, nonoperative therapy is also beneficial. A combined physical therapy strategy, which displays positive gains in both pain relief and functioning in those presenting with a clinical presentation of Morton's neuroma, can be used to end physical treatment.

ACKNOWLEDGEMENT

ABBREVIATIONS

SL.NO	ABBREVIATION	FULL FORM
1	VAS	VISUAL ANALOG SCALE
2	NPR	NUMERIC PAIN RATING SCALE
3	MOXFQ	MOX FOOT QUESTIONNAIRE
4	EQ	EUROQOL
5	TO	TIME TRADE_OFF
6	LEAFS	LOWER EXTREMITY FUNCTIONAL SCALE
7	FARM	FOOT AND ANKLE ABILITY MEASURE
8	GROC	GLOBAL RATING OF CHANGE
9	PTM	PRESSURE THRESHOLD METER READINGS
10	MN	MORTONS NEUROMA

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Table 01. List of Summarized Articles

| AUTHOR	STUDY DESIGN	STUDY PARTICIPANTS/ARTICLES REVIEW	OUTCOME FACTORS	PREVALENCE/ RESULTS
James w. Brantingham (2009)	Systemic review	389	primary patient report of improvement, algometry, visual analog (VAS) and numerical rating pain (NPRS) scales, the short-form McGill pain questionnaire	50%
AdnanAFara (2010)	Pilot study	36	Surgical outcome of interdigital (Morton's) neuroma	85%
Alastair Faulkner (2020)	Observational study	44 patients were nonoperative and 94 patients were treated operatively	Foot Questionnaire (MOXFQ), EuroQoL (EQ) time trade-off (TTO), EQ visual analog scale (VAS)	85%
Borja Pérez-Domínguez(2020)	Systemic study	30	LEFS and FAAM questionnaires.	50%
Michael David Post (2019)	Systemic study	3	numeric pain rating scale (NPRS), global rating of change (GROC)	60%
Hilda Alcantara Veiga de Oliveira (2019)	A double-blind randomized controlled trial	72	VAS, functional disability scale	80%
Michael D. Post (2019)	Systemic study	2	Numeric Pain Rating Scale, LEFS score	50%
Tengku Nazim B Tengku Yusof (2022)	Systemic study	24	VAS	68%
Barry G. Matthews (2019)	Systemic study	25	VAS, Johnson scale	95%
David G. Cashley (2015)	Retrospective study	38	Visual analog pain scales (VAS) and pressure threshold meter readings (PTM)	80%

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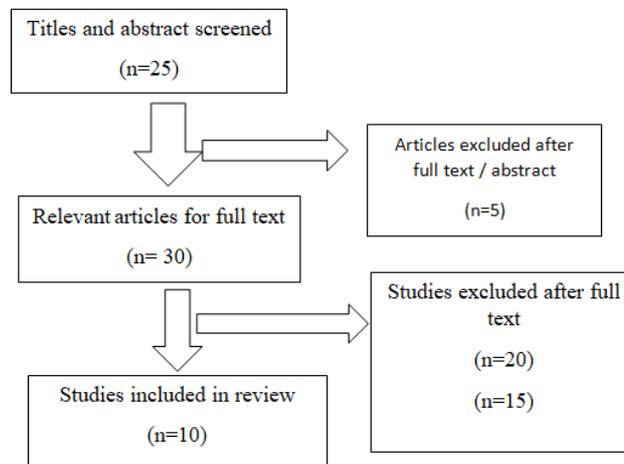
Figure 1: Literature identification, screening, and inclusion process result

RESEARCH ARTICLE

Link based Similarity Prototype Pattern Matching Method for Infected Patients' Recovery in Pandemic Situation

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ABSTRACT

Traditional pattern-based classifiers perform awfully unfit based on similarity link on pandemic causes of medical data. The recovery trend of a patient is typically messy and frequently lacks sufficient data to identify the causes, Due to the hybrid link structure, the linkages offer diverse sources for informative classification. Determining a suitable measure for classification of patient recovery using the similarity link structure prototype pattern is the goal of this work. The proposed Hybrid FP-Growth algorithm with a link similarity pattern matching method aims to improve learning methodologies for prediction and diagnosis of both large and small datasets. The given model can be fairly testing when dealing with medical data, can often contain a large amount of data. Based on recall, accuracy, recall time, normalised mutual information, and precision, the proposed method's performance is related to the presentmethods.

Keywords: Classification, Feature Selection, Link Prediction, Pattern Matching, Similarity.

INTRODUCTION

The prevalence of chronic diseases has dramatically increased as a result of improvements in the quality of life. Early disease diagnosis is crucial because doing so lowers the likelihood of developing these conditions into chronic illnesses. Therefore, the idea of disease prediction gains popularity and spreads among researchers. The process of

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predicting diseases necessitates a countless quantity of data because to the diversity of medical data. Data analysis has been increasingly important in recent years, particularly in the medical industry, especially to the pattern recognition of categorical attributes. The attributes related to the categorical data is presented in an unordered fashion because it is a collection of categories in which each value corresponds to a specific type, also known as qualitative data. Nominal and ordinal categories are two major divisions of categorical data. The concealed behavioural data analysis is inspected on categorical data using pattern subtraction method to discover hidden correlations in the data set to detect the frequent set of items. Also, the rules often relate to the pattern in which items are arranged.

Functions are learned the required information from the data include training, extrapolation,and prediction [1] for categorical data [2] is a novel endeavour. While at the meantime, the number of absolute values is imaginable and is growing exponentially [3] in order to learn from categorical medical datasets. Deep Neural Network (DNN), Long-Short Term Memory (LSTM), Gaussian Process Latent Variable Model (GPLVM) and the Categorical Latent Gaussian Process were applied (CLGP) in the given previous studies. Dimensional reduction accomplishes using the neural network [4].

The Patients are initially categorized based on related item genres, tag features, and other handler data. Given set contains multiple genres and manages overlapping circumstances to pertain the genre efficiently. Analyses the most recent patient record based on time because the data change over time. Utilizing the clustering technique, the proposed hybrid method first prepares the data for association rule mining by reducing the dimensions at the item level to categorize and forecasts to provide better recommendations.

The proposed research study's innovation is its use of the collaborative filtering method to address the data sparsity issue for pattern matching. With the aid of the clustering technique, the element level data reduction is initially managed. Items are grouped according to a model pattern and the most recent pattern prototype preference is derived with extra features like time. To recover the performance of the proposed system, parallel and distributed Hybrid FP-Growth algorithm with a link similarity pattern matching (HFLSPM) are implemented. The recurrent objects are saved in the form of a matrix rather than being stored in a transactional database, which reduces the memory usage when building a Tree. The quantity of scans in candidate data sets is simultaneously decreased. The research study's main contribution is outlined in the list below. Section 2 provides various kinds of algorithms used for hybrid similarity prototype pattern matching. Section 3 offerings the proposed system, section 4designates the cluster prototype pattern matching and experiments for evaluating performance against the existing methods, and section 5 concludes the work.

REVIEW LITRATURE

The pattern matching is the knowledge of a situational interpretations of distinct observational data, understanding of the suitable among a curvature and a usual information point, knowledge of how effectively two or more hypotheses jive, and insight how well speculations associate with the data. S. Misra ed al., [1]mentioned the pattern causes all sorts is constructed using the same rule shrub that was previously used to analyse the items. The keyarea of the pattern identification scheme is to reduce the number of rules that Snort must evaluate against the payload. By dropping the number of directions assessed, the time consumed on any single packet is condensed. This tolerates Snuffle to handle more packs and connect at nearer hustles.

Applications such as gene sequence identification, computational linguistics, and computer-aided diagnostics all use categorical data in some capacity. The Bayesian non-parametric technique is used to handle categorical data to effectively represent the latent Gaussian distribution. It can gauge density. Wang, C et al., [3] explains a general classification model was used to classify the categorical data, and the hidden stochastic approach was used to estimate the class-conditional densities. This method will work better with categorical data than the previous ways.

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The main flaw in this technique was its time need, which made calculation more difficult and unstable. Xu J et al.[2] details the semi-supervised learning approach to imply and optimize relevancy and moderate indolence exploiting Pearson's correlation coefficient. This strategy focused primarily on creating the extremely pertinent model parameters. The incremental search model, exceptionally easy to implement and reduces complexity, evaluates the relevance of attributes while computing features for coefficients and features for label factors. The dissimilarity metrics were also developed in accordance with determined specifications. Additionally, the United Characteristic Resemblance for Substances (CASO) and Coupled Feature Likeness for Standards (CASV) dealings were used to assess the regularity dispersal and the characteristic requirement aggregation.

Xiong T etal., [4] deals in their work may have a problem that prevents it from adopting extremely huge amounts of data by modifying attribute learning methodologies. A novel framework for clustering categorical sequences was established in this study, known as the variable-order Markov approach based on Biased Conditional Possibility Dispersal (WCPD). In accordance with the weight uses the fuzzified indicator generative model, the first directive Markov model was used to signify actual unqualified sequences. A two-tier statistical model and a decisive hierarchical algorithm were used to accurately cluster for the categorical sequence.

Karimi M etal., [5] given the completely associated deep neural network (DNN) is the maximum mutual deep erudition model. DNN practices the numerous layers to gradually extract higher-level structures from the raw input. Dissimilar physical models be contingent on obvious deep learning approaches are well-organized to switch large datasets without the need for wide-ranging computational properties, manipulative pattern acknowledgment to map the contacts among observed notes of minor fragments. Deep learning operates profound and dedicated designs to learn beneficial to pographies of the raw data.

Wu et al [6] uses the tuning curve method, forced to settle on physiologically conceivable reactions that expose the understanding structures for algorithmic makeup. Thus, neuronal populations are seen as dispersed mappings of low-dimensional latent variables in LVMs using simple tuning turn interpreters. This viewpoint is combined with the perspective on individual tuning qualities of individual networks has biological significance. The translator in corporates a functional base tuning curve forms may be utilised by several association networks.

Joshi RP, et al [7] mentioned a method on the normal blood count and sex utilised as two factors in a logistic regression technique to build an ML model. Data gathered from the patient's full blood test results of emergency room visitors who were over the age of 18. The LSTM methodusages an internal transitional loading is managed by certain connections recognized as doors to assurance future linkage. Even though they are straightforward, LSTMs excel in a variety of applications. Three layers make up a typical LSTM network: input, recurrent LSTM, and output.
 Marlin et al.,[8] purposes capturing scant inter category patterns. Modelling the communities engaged using a straightforward latent map and a non-linear translation of facts to get possibilities is one strategy that might be used and input the results of the concealed space convolution kernel into a SoftMax to derive possibilities. Process of Categorical Latent Gaussian (CLGP) perform a nonlinear transformation of the latent space using sparse Gaussian processes (GPs). The direct Gaussian prototypical is improved by applying a Gaussian development through a rectilinear covariance function. A perpetual concealed space is transformed linearly by this model, producing discrete observations.

To arrests cant multi-modal unqualified dispersals conceivable method would be to perfect the unceasing illustration with an unpretentious concealed intergalactic and all non-linear alteration of facts in the space to acquire odds. All the dimensionality reduction methods discussed before PPCA projected observation space data to latent space. There are difficulties in projecting latent space data to high dimensional space, primary being that the solution can be one to many [9]. Significant restraint of the body of work concise and presumed the data is fully observed the values of the evident variables are available at all pragmatic time points. Nevertheless, this statement embrace in various practical circumstances where only minor subsets of the observable variables are sampled at irregularly spaced time points [10].

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Reinforcement learning can detect and classify from the simple input and derive the task-specific descriptions of chemical structures, in contrast to typical machine learning techniques that rely on chemical entities explicitly generated by domain knowledge. The interpretability for showing the biological importance underlying the prediction and the demand for vast, high-quality sets for model training, however, are the limits of deep learning methods [11]. The models mentioned above have drawbacks. For extensive longitudinal data, over which measurement happens in continuous time, discrete-time methods may be oversimplified. when the measurements' time points are not evenly spaced out and when the quantity of measurements varies between people.

PROPOSED METHOD

The first stage towards giving a doctor description and suggestions is to evaluate the disease status of a person in relation to a disease's component. For certain medical and dietary advice to be worthwhile, it is first necessary to consider the current situation. In this activity, sensitive data is used to provide predictions regarding a person's prognosis for a certain therapy component. Nutritional advice can be given with better precision after estimating current condition. The suggested algorithm may anticipate a result in classification, regression, prediction, and cluster tasks by knowledge patterns in drill data. However, makes it possible to integrate data in massive quantities and at a high level of complexity, making studies that would not be feasible otherwise viable. Both ML applications, where resemblances between statistics points serve as the base for the output of ML procedures in an unsupervised scenario and suggested procedures are qualified on known labels, are useful in Node. Thus, advances in ML are opening previously intractable problems. Particularly in the context of Node, ML offers a wide range of applications.

The data is divided into subsets using the gathering algorithm to make best use of intra-cluster parallel while abating inter-cluster similarity. The challenge is creating an efficient decision tree that will enable frequent patterns in the data streams. The suggested algorithm examines concurrent time sequences in order to predict future values and identify the appropriate method of data collection from dispersed patient nodes with a variety of characteristics.

Let $D = \{x_1, x_2, ...x_n\}$, the traditional set of items labelled m definite patient's record $A_1, A_2, ...A_m$ througharea $D_1, D_2, ...D_m$ respectively. The charge of set V_i is the established values of A_i are present in D using Eq. (1). Then $u_j(x_k) = u_{kj}$ denotes the grade ofmembership for the kth object in the$j$th cluster.

$$u_{kj} = \begin{cases} 1 & if \ x_k \in C_j \\ 0 & otherwise \end{cases} \qquad (1)$$

Where $C = \{C_1, C_2, ... , C_c\}$ denote a set of c disjoint and non-empty partitions. The representation of the associations has less consistent basis of evidence, when used as a pointer of similarity between nodes. Although there are numerous variations between samples and links, as stated above may presume that many of them have similar types of symptoms, i.e., include links to link to his own pattern[12]. By interpreting the links as new in this instance can deploy kinship of mutations. To further refine this classification, let *d* be the design of patients and let *Pd* be set of patients link with *d*, called the parents of *d*. The cogitation similarity between two folios *d*1 and *d*2 is defined as in Eq. (2).

$$kinship(d_1, d_2) = \frac{P_{d_1} \cap P_{d_2}}{\left| P_{d_1} \cup P_{d_2} \right|} \qquad (2)$$

Demonstrates that d_1 and d_2 are more closely linked the more parents they have in common. This value is scaled by the entire set of parents, resulting in a range of kinship between 0 and1. A method based on a nearest neighbour classifier was used to evaluate the link-based similarity metrics [13]. Based on the categories given to the k

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documents in the training set that are the most similar, this classifier assigns a category label to a test pattern. Let Eq(3)assign d a relevance value $S_{C_i,d}$ that links d to each recovery pattern category.

$$S_{C_i,d} = \sum_{d' \in N_k(d)} kinship(d,d')f(c_i,d') \qquad (3)$$

where $N_k(d)$ stand the k adjacent neighbors of d in the exercise set and $f(c_i, d')$ is a role that yields 1 if text d' fits to type c_i and 0 otherwise. But frequent item set mining of design is a rudimentary data withdrawal model that denotes to endeavoring to excerpt or excavation knowledge from greatquantities of facts.

Assuming that the items of node v and its parent node are the $(i+j)$ th and ith frequent items x_{i+j} and x_i, respectively, then $f'(v)$ can be computed by Eq. (4).

$$f'(v) = f(x_{i+j}) \prod_{t=1}^{t=j-1} (1 - f(x_{i+t})) \qquad (4)$$

A node v appears as a child of its parent only if all frequent items ranked between its parent node and itself do not appear, using the above statements and equations the proposed Hybrid FP-Growth algorithm with the linkshas the similarity pattern matching method developed as shown below.

Hybrid FP-Growth Algorithm with Link Similarity Pattern Matching Method
Initialize
Randomly divide users into M groups D= $(D_1, D_2, \ldots\ldots\ldots D_m)$of dissimilar magnitude

Input D: Dataset; min_sup:minimum support threshold.
data D'◄── Read data from D
similarity get ◄── Frequent Pattern set (data D',min_sup)
if similarity = ∅ then
exit ()
end if
for d=1 to M do
if C_k = apriori-kinship(f_k.) {makes the item set with pattern resemblance}
for each $A_i \in D$ do
D'=subset (C_k ,A_i) {Recognize all candidates belong to D}
k=k+1
for each candidate feature set $S_{c,d} \in C_k$ do
$\sigma(C_k) = \sigma(C_k) + 1$ {increase the count}
End for
End for
$F_k = \{c|c \in C_k \wedge \sigma(C_k) \geq M \times min\_sup$ {Extract the selected features}
Until $F_k=∅$ then cutting down the prefix set
If $F_k=∅$ then has Coverage true◄──
Else
k=k+1
collect all the estimated count $f'(v)$ for each node v at the level d
Use the domain $C_k \cup D$
Update nodes by converting all negative counts to 0
End for
Return the HFLSPM Tree D'

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Users inside each cluster use the full secrecy reasonable after randomly assigning the patients to M groups of different sizesε. To make up for the underestimating, the predicted count of node v should multiply M. It has come to light that the total procedure improves accuracy and fulfils the HFLSPM.

Cutting down predefined prefix set
Remember that such size of the starting candidacy identifiers set C_k at each level d quickly increases during the chaotic tree construction (e.g., thousands or more). The accuracy would suffer substantially as a result. after the size influences a determined edge (i.e., k), to reduce the size at each level by trimming possible precedes [14,15]. Despite the possibility of information loss and underestimating, this cut down solves the problem of size expansion and performs well in experiments. By using equation (4), limit the candidate prefix set within a fixed size $\xi \cdot k$ in term of temporal guessing frequencies, here ξ is a regulating constraint. The chronological shot regularity T (v, x) of each candidate prefix (v, x)$\in C$ is computed equation (5) as follows.

$$T(v,x) = f'((parent(v).x) \times f(c_i, d\,')) \qquad (5)$$

Therefore, the best technique to minimize noise is to set negative frequencies to 0. However, in order to maintain impartiality, we must deduct the same amount from total frequencies as we add to them. Additionally, as approximately half of favourable harmonics should have an inflated probability, subtracting values from them causes about halves of them to lower the background.

EXPERIMENTS

In this chapter, we compare the effectiveness of HFLSPM Algorithm to the cutting-edge protocol SVSM, LSTM, GPLSTM and CLGP and experimentally assess its performance. A 16GB RAM and 3.4GHz Intel Core i5-7500 CPU are used for all experiments. When using the similarity measure, the initial cluster facilities are modified with the cluster labels. A Hamming distance is used to update the distance. The mean slashes inside the cluster are derived following the modification of cluster facts. Finally, by retrieving the cluster output, the cluster data points are recovered based on the cluster member.

Dataset
This section offerings a presentation investigation of the suggested mechanism on the medical dataset used in the 2020 Analytics Vidhya Hackathon on Healthcare Analytics (AV: Healthcare Analytics II) by Kaggle, with categorical attributes shown in Table.1. (30% of the data sets are used for testing and 70% for training). At the period of admission, infirmaries can identify patients who are at high risk of long-term readmission by using the performance analytics parameter. Once recognized as an affected role at high risk for LOS can have overall therapeutic approaches improved to reduce LOS and lessen the possibility of infection in staff or visitors. Additionally, prior awareness of LOS might help with planning logistics like room and bed allotment. Consider that you've recently been hired by Health Man, a non-profit company whose goal is to run hospitals in a competent and effective way, as a data scientist. The goal is to precisely anticipate the duration of stay with respectively persistent on an specific source so that infirmaries may utilize this statistics to improved assign properties and activate. There are 11 different categories for the length of stay, fluctuating from 0 to 100 days.

Parameters
Precision
Precision is clearly defined as a quality that is utilized to gauge how well a categorization approach is working.
$$Precision = \frac{TP}{TP + FP}$$

Recall

Recall refers to the estimated model's capacity to select a guaranteed session's illustration as a data set. It is also known as purposeful understanding.

$$Recall = \frac{TP}{TP + FN}$$

Normalized Mutual Information

NMI is between 0 and 1, and a greater NMI indicates better clustering. When c=1 (the partition of inferred clusters) and y=1 (the partition provided by the true classes), purity is equal to 1, we have purity = 1. Be aware that most of our cluster in massive datasets did not directly match to true classes, but rather did so with object classes.

Accuracy

The term "accuracy" refers to how closely a restricted value resembles a reference or known value. Along with the weighted arithmetic means of Recall and Inverse Recall, accuracy is also reported for Precision and Inverse Precision.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

PERFORMANCE AND COMPARATIVE ANALYSIS

Each algorithm and dataset received 100 runs to test the performance, with q set at 1.5. The actual quality of each clustering algorithm is represented by the mean clustering accuracy shown in Table 2, and the stability of each algorithm's clustering performances may be assessed using the listed variance. The consistency of clustering performance improves with decreasing variance of clustering accuracy. An improved test accurateness rate of roughly 80.86 as mean, 82.2 for best, 80 for worst, and 0.01 SD is revealed by this study for the proposed method. Table 3 displays the exactness and recall scores for the provided dataset for the proposed and current algorithms. According to the presented table, the precision and recall rates for the suggested method when compared to the existing methods are high. The final row displays the results of the suggested method. The performance of the proposed method on the given data set will make the efforts on the performance metrics are detailed in the figure 1, the test cases based on the whole dataset and the acquired confirmation are shown in the figure based on the recovery history of the record. In the figure.2. the relative values of the anticipated method with the present methods are detailed based on the given dataset in detail. The mean value of the performance, the best reaction based on the parameters, and the worst response level of the individual features are compared with the given metrics. The proposed HFLSPM gives the better performance almost (10%) then the CLGP and the other given existing methods.

CONCLUSION

The medical industry, which in turn manages the enormous amount of data, found it difficult to cluster categorical data now. The most crucial factor in the speedy treatment and cure of diseases is the early disease prediction. This suggested mechanism successfully applied the clustering technique to a vast set of categorical data. In the beginning, both minor and great measure categorical data are provided as input. These data have already been pre-processed, and new proposed hybrid feature extraction techniques are used to extract the features. Then, a cutting-edge multi-objective based optimized approach is used to choose the features. The study showed that the clusters method was appropriate for large datasets, whereas our cataloguing method is best suitable for trivial datasets. Additionally, a little dataset. This made it clear that the suggested method would produce outcomes that were easier to anticipate the disease and more accurate. A comparison of the suggested method's results utilising performance criteria such as precision, NMI, recall, and accuracy reveals that it outperforms the alternatives.

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Table.1. Dataset Description

Attributes	Description
case_id	Case_IDlisted in Clinic
Hospital_code	Singlecypher for the Hospital
Hospital_type_code	Exclusive code for the category of Hospital
City_Code_Hospital	City Code of the Hospital
Hospital_region_code	Area Code of the Hospital
Available Extra Rooms in Hospital	Numeral of Additional rooms available in the Hospital
Department	Section overlooking the case
Ward_Type	Cipher for the Division type

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Ward_Facility_Code	Cryptogram for the Division Facility
Bed Grade	Complaint of Bed in the Division
patientid	Sole Patient Id
City_Code_Patient	City Code for the patient
Type of Admission	Charge Type recorded by the Hospital
Severity of Illness	Strictness of the infectionverified at the time of admission
Visitors with Patient	Quantity of Companions with the persistent
Age	Stage of the patient
Admission_Deposit	Payment at the Admission Time
Stay	BreakTimes by the patient

Table. 2. Performance analysis of Existing and Proposed Models in terms of accuracy

Test Accuracy Rate (%)				
Models	**Mean**	**Best**	**Worst**	**SD**
DNN	58.68	60.79	56.83	1.27
GPLVM	62.09	66.18	60.4	2.19
LSTM	58.77	64.76	54.19	3.2
CLGP	71.45	77.97	60.79	4.81
HFLSPM	**80.86**	**82.2**	**78.32**	**0.01**

Table.3. Performance analysis of proposed method in terms of precision and recall

| Models	Recall	Precision
RF	62.14	32.42
DNN	53.37	33.47
GPLVM	61.25	30.03
LSTM	55.36	36.05
CLGP	53.37	28.85
HFLSPM	**62.68**	**32.65**
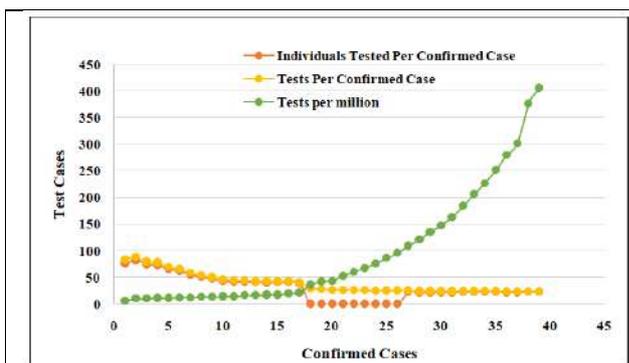
Figure. 1. The improvement in the Patient Recovery Analysis using Proposed Method
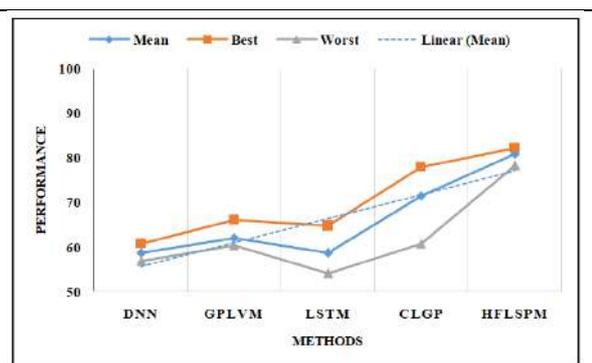
Figure. 2. The comparison of the proposed method with the existing methods

RESEARCH ARTICLE

Treatment of Hair Loss and Early Greying with A Poly Herbal Formulation

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ABSTRACT

*Hair plays*a vital role in making you look younger or old and also plays an important role in the personality of human. The pigmentation problem, dandruff, loss of hair is the major problem associated with hairs. Ayurvedic system is the traditional system of medicine having major treatment across the world. The aim of study was to develop a hair oil formulation using *Aloe vera*(leaves), *Indigofera tinctoria* (Whole plant), *Trigonella foenum graecum*, (seeds), *Bacopa monnieri* (leaves), *Nigella sativa*(seeds), *Cocos nucifera*(oil) are with purported claims of better growth of hair and diminution in loss of hair .According to the Government of India's Protocol for Testing Ayurvedic, Siddha, and Unani Medicines, the oil was standardised and prepared in accordance with the Ayurvedic Formulary of India. According to the Indian Ayurvedic Formulary, fruits and leaves were purified. Both a physicochemical and organoleptic evaluation were carried out.

Keywords: Ayurvedic Formulary, Hair loss, *Aloe vera, Indigofera tinctoria, Trigonella foenum-graecum, Bacopa monnieri, Nigella sativa, Cocos nucifera*

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INTRODUCTION

One of the most significant bodily parts, hair comes from the skin's ectoderm and affects a person's overall appearance. Along with the sebaceous gland, hair is an ornamental structure. Given its unique capacity for self-regeneration, hair is a dead body part with no neural connections [1-3].For more than 2000 years, alopecia has been recognised as a dermatological condition. It is widespread all across the world [4]. Today, there is a global movement toward returning to the usage of herbal remedies and moving toward a more natural way of life. For a healthy lifestyle, people prefer natural foods, herbal remedies, and natural healing techniques. The allopathic system on its own is becoming insufficient, necessitating the use of herbal medications as a supplement. The best method for protecting people's health is to use both traditional and modern systems. Clinical studies have shown that herbal remedies can promote hair growth. The main issues related to hair loss include hair fading, dandruff, and hair dropping. Hair loss is a major worry. There are several synthetic medications available for treating hair loss, but they don't work long-term and come with negative side effects as well. Herbal remedies may be used to address this issue.In the long term, utilising Ayurveda is safer and preferable. Compared to products that contain a variety of substances, the side-effect profile of these products is "nil". Herbal hair oil encourages hair growth while preventing dandruff, hair loss, and early greying. It functions at the hair's root and gives the hair a natural black colour [5]. Androgenetic or androgenic alopecia (baldness), Alopecia areata, Telogen effluvium, Chemotherapy-induced alopecia are different the types of hair loss [6-10]

MATERIALS AND METHODS

Collection, Identification And Authentication Of Plants
Aloe vera (leaves), *Indigofera tinctoria* (Whole plant), *Trigonella foenum-graecum* (seeds), *Nigella sativa* (seeds), *Cocos nucifera* (oil) and *Bacopa monnieri* (leaves)were purchased from local market of Calicut, identified and authenticated from Department of Botany, University of Calicut, Kerala.

Drug Materials
The components used for making hair oil are gathered, filtered, and weighed individually [11,12]. The quantity of each ingredient is tabulated in Table No. 1. Using the exception of the seeds of *Nigella sativa* and *Trigonella foenum-graecum*, the fresh plant medicine ingredients were gathered, coarsely ground with a mechanical grinder, filtered with muslin cloth, and produced as fresh juices. Prior to use, the seeds of *Trigonella foenum-graecum* and *Nigella sativa* were shade-dried and kept in airtight containers.

Formulation of Polyherbal Hair oil
Except for *Trigonella foenum-graecum* and *Nigella sativa* seeds, all of the medication ingredients were juiced and passed through muslin fabric. Both *Nigella sativa* and *Trigonella foenum-graecum* seeds were dried and processed into a fine powder. Juice and powdered medicines were combined with coconut oil. One of the three conventional procedures for making the hair oil was the direct boiling method. In this procedure, the fresh plant material was weighed, combined with the powdered medication, and then simmered alongside the coconut oil in a steel kettle while being constantly stirred and heated until the medication had fully extracted into the oil base. For three hours, the boiling procedure was carried out with constant stirring.85 to 100 °C was maintained as the temperature. The oil was then stored after being purified via muslin fabric. Further preparation was done using the improved formula.

Evaluation of Prepared Hair Oil
Standard physical and chemical assessment techniques, organoleptic properties**,** Viscosity, such as specific gravity, pH, refractive index, acid value, saponification value, and iodine value, were used to assess the manufactured formulation [13].

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RESULTS AND DISCUSSION

Formulation of Poly-Herbal Hair oil
Table 2: Percentage quantity of each of the ingredients and the parts used
The poly herbal hair oil was formulated as per standard procedure by direct boiling method and stored in air tight container for further study. The percentage quantity of each of the ingredients and the parts used are tabulated and given in Table No. 2.The percentage of leaves of *Aloe vera, Bacopa monnieri* and *Indigo feratinctoria* were 8.50%, seeds of *Nigella sativa* and *Trigonella foenum-graecum* were 2.56% and 14.55% of oil from *Cocos nucifera,* which is similar to standard other poly herbal hair oils.

Evaluation of prepared hair oil
a) Organoleptic evaluation
Table 3: Result showing organoleptic evaluation
The parameters of organoleptics were assessed. The oil is greasy to touch, greenish brown in colour, and has a distinctive aroma that is reminiscent of traditional polyherbal hair oils.
a)Physicochemical evaluation
Table 4: Result showing physicochemical evaluation
The weight per ml and specific gravity of the formulation was found to be 0.9844 g/ml±0.0004,Viscosity was found to be 0.9431±0.0001 Poise, Refractive index was found to be 1.574±0.001, Acid value was found to be 2.70±0.03, Saponification value was 259.71±0.01, Iodine value was found to be 15.68±0.01 and pH was found to be 6.10±0.005.

CONCLUSION

A multi-herbal hair oil including *Aloe vera* (leaves), *Indigofera tinctoria* (whole plant), *Trigonella foenum-graecum* (seeds), and *Nigella sativa* (seeds) was prepared by employing the direct boiling method and the recommended recipe to treat hair loss and premature hair greying. On the prepared Polyherbal hair oil, various physicochemical analyses were done. The outcome demonstrates that the physicochemical parameters fell within acceptable bounds. The findings indicate that this herbal composition is a good and efficient treatment for hair growth, pigmentation issues, and hair loss.

ACKNOWLEDGMENT

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Table 1: Quantity of each of the ingredients and the parts used

Sl.No	Ingredients	Parts Used	Quantity (g)
1.	*Aloe vera*	Leaves	260
2.	*Bacopa monnieri*	Leaves	260
3.	*Indigofera tinctoria*	Whole plant	260
4.	*Trigonella foenum-graecum*	Seeds	85
5.	*Nigella sativa*	Seeds	85
6.	*Cocos nucifera*	Fixed oil from the endosperm of fruit	QS

Table 2: Percentage quantity of each of the ingredients and the parts used

Sl.No	Ingredients	Parts Used	Quantity (%)
1.	*Aloe vera*	Leaves	8.50
2.	*Bacopa monnieri*	Leaves	8.50
3.	*Indigofera tinctoria*	Whole plant	8.50
4.	*Nigella sativa*	Seeds	2.56
5.	*Trigonella foenum-graecum*	Seeds	2.56
6.	*Cocos nucifera*	Fixed oil from the endosperm of fruit	14.55

Table 3: Result Showing Organoleptic Evaluation

Sl.No.	Parameters	Observation
1	Colour	Greenish brown
2	Odour	Characteristic
3	Texture	Greasy to touch

Table 4: Result showing physicochemical evaluation

Sl. No.	Parameters	Observation
1	Specific gravity	0.9844±0.0004
2	Viscosity	0.9431±0.0001 Poise
3	Refractive index	1.574±0.001
4	Acid value	2.70±0.03
5	Saponification value	259.71±0.01
6	Iodine value	15.68±0.01
7	pH	6.10±0.005

RESEARCH ARTICLE

Changes in Foot Posture in Patients with Knee Osteoarthritis

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ABSTRACT

Knee OA has been viewed as a dynamic process of wear & tear of the articular cartilage. As the severity of OA changes or progress, the alignment of the lower extremity is affected giving knee varus / valgus. This also brings about deviation in the ankle & foot. The present study was planned to see the changes in foot posture in subjects with knee osteoarthritis. Consecutive subjects diagnosed with OA Knee (N=50), referred for Physiotherapy and satisfying inclusion criteria were recruited for the study. Of the total, 34 were bilateral & 16 were with unilateral OA. 50 normal self-reported healthy individuals were also recruited. Foot posture was measured in OA & normal group with the help of FPI and ND test. Mean Q-angle of control was 16.1 ± 1.8 and OA group was 13.6 ± 2. In control group there was no significant correlation of Q-angle with FPI (p=0.14) or ND (p=0.24). Similarly, FPI & ND were not correlated (p=0.13). In OA group Q-angle was significantly correlated with FDI (p=0.02) and not with ND (p=0.27). In comparison to the control, all the variables i.e. Q-angle, FPI & ND were statistically increased in the OA group (p=<0.001). FPI & ND test show that OA group (mild to moderate on KL score) was significantly pronated compared to normal.

Keywords: Knee Osteoarthritis, Body Mass Index, Q-angle, Foot Posture Index, Navicular drop test.

INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative joint disease and is the common musculoskeletal condition worldwide, the leading cause of disability among elders resulting in pain, fatigue, functional limitations, increased healthcare utilization and high economic costs to society impacting heavily on the quality of life. It is estimated worldwide that 10% - 12% of adults and 18% of women aged ≥60 years and older have knee OA. The prevalence of OA in India is reported to be in the range of 17 to 60.6%.The prevalence of OA increases with age and generally affects women more frequently than men; mostly after menopause because of the loss of estrogen which increases a woman's risk of getting osteoarthritis**.**

The exact aetiology of OA remains unclear. Associated risk factors includes advancing age, genetic predisposition, prior knee injury, repetitive use of joints / micro trauma, muscle weakness, joint laxity etc. play major role in development of OA. Occupational activities that physically load the joint like squatting and kneeling, regular heavy weight lifting, climbing, and high physical workload contribute to the occurrence and/or progress of the disease. Pain is the predominant symptom of OA knee and it aggravates with joint use and relieves with rest. As OA progresses, pain may become more persistent and can appear also at rest and during the night. Tenderness around knee joint line, crepitus, morning stiffness and restricted ROM due to osteophyte formation, reduced muscle strength, wasting and swelling are also the symptoms of OA knee and ultimately leads to deformity. OA has been viewed as a dynamic process of wear & tear & repair of the articular cartilage. This starts with grinding mechanism at the point of contact leading to cartilage abrasion, exposing the bone, which progresses to bone at the margin of the joint hypertrophying to form spurs, known as osteophytes. All this is due to reduction in the superficial proteoglycan content, collagen fibrils deteriorating with increase in water content.

Kellgren and Lawrence (K&L) score is used to identify and grade radiographic diseases in OA. The American College of Rheumatology criteria for diagnosis of OA are clinical, radiological, or clinico-radiological. As the severity of OA changes progress the alignment of the lower extremity is affected giving knee varus / valgus. This also bring about deviation in the ankle & foot. On weight bearing external knee adduction moment is considered as measure of disturbed medio-lateral forces, although its contribution to knee OA is not proven. Knee varus due to collapse of medial compartment is said to be responsible for the progression of knee OA, associated with changes in ankle foot posture statically & dynamically. The changes in the lower extremity alignment may lead to pain impaired functions. However, it is unclear whether the foot posture is the result of knee malalignment or vice versa. An observational scoring system based on measuring and rating angles and position of foot anatomical landmarks i.e., Foot Posture Index (FPI) has been developed for evaluating static foot posture. This is said to be able to measure the foot in multiple planes. The Navicular drop (ND) test is also clinical procedure and valid predictor of navicular height when the foot moves from sub talar neutral non weight bearing to a relaxed weight bearing stance. Several studies recommend foot wear changes to provide relief in OA knee. We see a number of patients who are referred with OA knee to Physiotherapy OPD. The objective of the study was to see the changes in the foot posture with the Foot Posture Index and Navicular Drop Test in patients with knee osteoarthritis and to compare the same with normal individuals.

MATERIALS AND METHODS

This is a hospital based, observational study done over a period of 6 months in vadodara district of Gujarat. The objective of the study was to see the changes in the foot posture with Foot Posture Index and Navicular Drop Test in patients with knee osteoarthritis. Clinically diagnosed OA knee patients who able to bear weight on both the lower limbs and stand without assistance were included in the study. Patients with other multi joint disorders, musculoskeletal and neurological impairment in lower limb, any past history of injury to ankle joint, deformity of foot and ankle joint, uncontrolled systemic diseases that affect their standing and walking were excluded from the study. Participants were explained about the study and informed consent was obtained. Initially total of 108 patients were recruited out of which 8 were excluded because of personal reasons therefore total included subjects were 100 in that

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50 patients were with OA and 50 people were self-reported healthy individuals. Foot posture was measured with the help of FPI and Navicular Drop Test.

Method of Measurement of FPI

Participants were made to stand in relaxed stance position with double limb support. They were instructed to stand still, with their arms by the side and looking straight ahead. During the assessment, it is important to ensure that the participant does not swivel to try to see what is happening for them, as this will significantly affect the foot posture. The assessment was done by moving around the participant and uninterrupted access to the posterior aspect of the leg and foot.

The six clinical criteria were noted with observation of rear-foot and forefoot including
1. Talar head palpation. (palpation for talo-navicular congruence)
2. Supra and infra lateral malleolar curvature. (observation and compression of the curves above and below the lateral ankle malleoli)
3. Calcaneal frontal plane position. (inversion / eversion of the calcaneus)
4. Bulging in the region of the talo-navicular joint
5. Height and congruence of the medial longitudinal arch
6. Abduction / adduction of the forefoot on the rear-foot

For FPI - Each item will be scored on a 5-point scale between -2 and +2 and provides a total sum of all items between -12 (highly supinated) and +12 (highly pronated).

Method of measurement of Navicular Drop Test

Navicular drop test was measured as the difference between vertical height of navicular with STJN and relaxed stance of navicular height. The participantswere placed in a sitting position with their feet flat on a firm surface and with the knees flexed to 90 degree and ankle joints in neutral position. The most prominent point of the navicular tubercle while maintaining subtalar neutral position was identified and marked with a sketch pen. Subtalar neutral position was established when talar depressions are equal on medial and lateral side of the ankle. While one assessor maintains subtalar position, another assessor places anindex card on the inner aspect of the hind-foot, with the card placed from the floor on a vertical position passing the navicular bone. The level of the most prominent point of the navicular tubercle was marked on the card. The participants were then asked to stand without changing the position of the feet and distribute equal weight on the both feet. In the standing position, the most prominent point of the navicular tubercle relative to be floor were again identified and marked on the card. Finally, the difference between the original height of the navicular tubercle in sitting position and weight bearing position were assessed with measure tape rendering the ND test values in millimeters. For ND test values of ND under 10 mm as normal and values over 10 mm as abnormal.

RESULTS AND DISCUSSION

The patients with OA, especially those with severe medial compartment OA, have been seen to exhibit genu varum with malalignment leading to more pronated foot so, the present study was planned to see foot changes in patients diagnosed as OA knee. There were 50 OA knee cases with mean age 53 ±7.3. As per literature age is the most powerful risk factor of OA, apart from age there are various other risk factors that may predispose to OA which is more common in women and the age related changes are said to exponentially increase after 50 years. In the present study the % age of women with OA was also found to be more than the men i.e. 62% females & 38 % males. The BMI of the case group was 28.36±4.20 indicating that these patients with OA were in the category of overweight. Normally while walking an individual puts about 3 times the body weight on the lower limbs every step. Thus increased body weight is noted to be an important risk for developing OA. Moreover, weight loss interventions have shown reduction in symptoms. Recent studies have shown that body fat, particularly central fat deposits are found biochemically active and produce certain substances which can have deleterious effect on chondrocytes of the cartilage. Obesity may be

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associated with weakness which also can contribute to development of OA. The mean Q-angle in the normal group in the present study was 16.1 ± 1.8. (Table 2A) The Q-angle is said to be important as it tracks the patella, although its clinical relevance is debatable. The Q-angle of 10-15^0 measured with either knee in full extension or slight flexion is considered as normal, women have more Q-angle due to wider pelvis. There is a minimal difference in Q-angle between men & women i.e. 13.3^0 in men & 15.7^0 in women& another study gives range of Q-angle as varying between 11.2±3 in men to 17±3 in women respectively. Excessively large Q-angles are said to result in chondromalacia patella and predisposition to recurrent subluxation.

In present study in OA /case group the Q-angle was found to be reduced with mean of 13.6 ± 2, majority of the participants were females. In normal controls, the Q-angle was not found to correlate to the changes in foot posture i.e. both FPI & ND (Table 2A & 2B). There was no significant correlation between the foot posture index and navicular drop test either (Table 2C). For foot posture changes the OA i.e. case group was compared with control i.e. normal age &BMI matched. As seen in Table 4A in both the Rt & Lt OA, the Q-angle is significantly correlated to the FPI. This indicates that the foot has already started to pronate. There are many studies indicating that OA leads to pronation of foot. This is because varus deformity of knee changes frontal plane kinetics & kinematics of foot, bringing about increased pronation moment at the sub talar joint. Grade III & IV of KL score are said to lead to pronated / excessively pronated foot.

There was no correlation between the Q-angle & ND in the OA group. (Table 3B) This probably is because the OA group had majority of patients on the KL score falling in the mild to moderate category suggesting that foot wear corrections at this stage might help. Moreover, the compensatory foot posture changes can occur depending on the available range at ankle & foot. The comparison between the groups i.e. the control & OA group shows that all the three variables i.e. Q-angle, FPI & ND are statistically significantly increased in the OA group. (Table 4). The foot posture index & Navicular drop tests are valid & reliable clinical measures [44,45,46,48,49]. that could effectively contribute to the conservative management especially for identifying malalignment of leg affecting ankle & foot.

There are different views with regards to OA knee reflecting in to foot. Medial compartment OA tends to evert / pronate and internally rotate rear foot with fore foot inversion apparently this is said to reduce medial compartment loading. The conservative management by early lateral wedge insoles have been recommended as an alternative to surgical wedge osteotomy in helping to shift the weight laterally in medial compartment OA. Similarly, medial wedges have been recommended for the lateral compartment OA [54]. These offer simple, cost effective strategy, carries great potential as biomechanical studies show that lateral wedges reduce the medial compartment loading during walking by 4-12 %. [55]. There is trend to work & design a shoe that will offload the knee. Due to variability in load modifying interventions judicious use of the foot wear corrections is recommended.

CONCLUSION

In the normal group there was no statistically significant correlation between Q-angle, FPI & ND. Mean Q- angle of OA group (13.5±2) was statistically significantly decreased compared to mean of normal group (16.1±1.8). FPI & ND was statistically increased in the OA group compared to normal. Q-angle was statistically significantly correlated to FPI in OA group.FPI & ND test show that OA patients (mild to moderate on KL score) were having significantly pronated foot compared to normal.

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Table 1: Demographic Parameters of Two Groups

Variables	Case group (n=50)		Normal group (n=50)		P-value
	Mean	**SD**	**Mean**	**SD**	
Age (year)	53.00	7.23	51.56	8.565	0.366
BMI(kg/m2)	28.36	4.20	27.2686	11.0025	0.514

Table 2: Intra group comparison using paired T- test (Normal Group)
Table 2A: Correlation of Q-angle and FPI in control group

N	Site	Q-angle		FPI		P-value
		Mean	**SD**	**Mean**	**SD**	0.147
50	Rt	16.090	1.7748	0.50	.953	
50	Lt	16.150	1.8440	0.54	.973	0.131

Table 2B: Correlation of Q-angle and ND in control group

N	Site	Q-angle		ND test		P-value
		Mean	SD	Mean	SD	0.238
50	Rt	16.090	1.7748	.04	.283	
50	Lt	16.150	1.8440	.04	.283	0.243

Table 2C: Correlation of FPI and ND in control group

N	Site	FPI		ND test		P-value
		Mean	**SD**	**Mean**	**SD**	.113
50	Rt	.50	.953	.04	.283	
50	Lt	.54	.973	.04	.283	.131

Table 3: Intra group comparison using paired T- test (Case Group)
Table 3A: Correlation of Q-angle and FPI in OA group

N	Site	Q-angle		FPI		P-value
		Mean	SD	Mean	SD	0.032
50	Rt	13.733	1.8595	7.71	1.891	
50	Lt	13.531	2.0902	7.43	2.074	0.020

Table 3B: Correlation of Q-angle and ND in OA group

N	Site	Q-angle		ND test		P-value
		Mean	SD	Mean	SD	0.103
50	Rt	13.733	1.8595	10.69	1.440	
50	Lt	13.531	2.0902	9.57	1.990	0.276

Table 4: Inter group comparison of Q-angle using independent T- test
**Table 4A - Comparison of mean of Q-angle between two groups**

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Q-angle - Rt	Case	50	13.733	1.8595	.2869	<0.001
	Normal	50	16.090	1.7748	.2510	
Q-angle - Lt	Case	50	13.531	2.0902	.3225	<0.001
	Normal	50	16.150	1.8440	.2608	

Table 4B – Comparison of FPI between two groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
FPI - Rt	Case	50	7.71	1.891	.292	<0.001
	Normal	50	.50	.953	.135	
FPI - Lt	Case	50	7.43	2.074	.320	<0.001
	Normal	50	.54	.973	.138	

Table 4C - Comparison of ND test between two groups

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
ND test - Rt	Case	50	10.69	1.440	.222	<0.001
	Normal	50	.04	.283	.040	
ND test - Lt	Case	50	10.24	1.792	.276	<0.001
	Normal	50	.04	.283	.040	

Fig. 1: Flow diagram of the study

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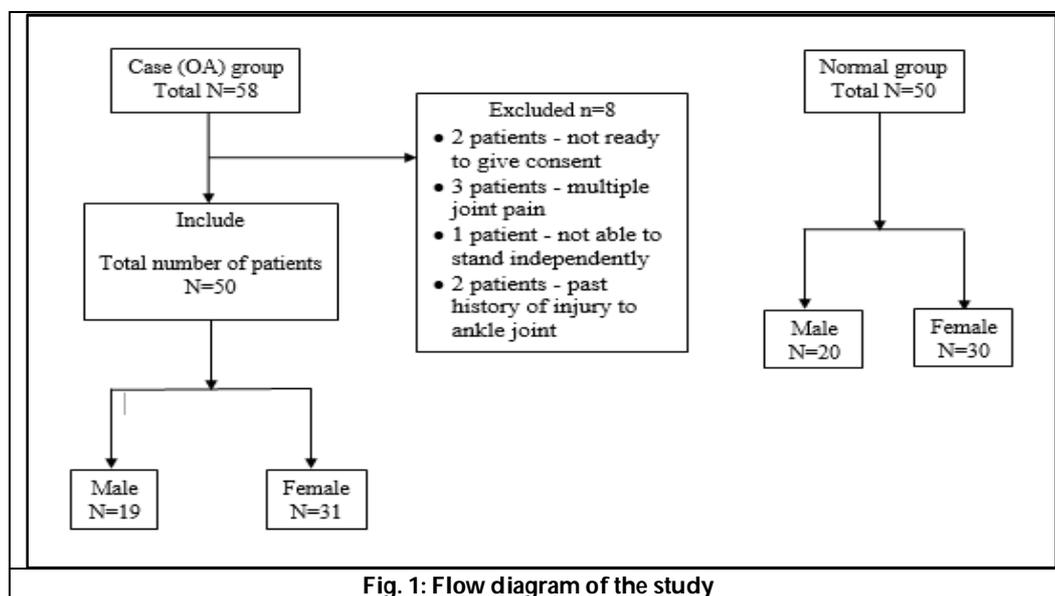
An Energy Efficient Smart Location Tracker Aid for Elderly with Cognitive Disorder

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ABSTRACT

Living assistance systems catering to the need of elderly people affected with Alzheimer and suffer with loss of cognitive functioning or dementia, is still a challenge. When such people go out and forget their return path to home, the caretakers should be able to track them, otherwise it may be causing harm to these senior citizens, as well as it could be an anxiety for the society. This study addresses the above concerns and is focused on the design of an assistive device (which does not need an operation from the user's end), that support the aged or physically challenged with memory loss and acts as a relief to their caretakers. This wearable device is designed in such a way that the route travelled by the person with this wearable device/node, can be tracked from any place, with help of the integrated web API using Python Flask or using mobile phone through the associated mobile app. Since the route travelled with map is displayed, any person, even without much technical knowledge can extend supporting hands. The device has a coverage across the country as GSM network is used. A Virtual Private Server (VPS)in a cloud provider data centre with a secure network is used in the design. The VPS is used to relay messages from the nodes to core server, data movement is guaranteed and since, no data is stored on the cloud VPS, the issue of data security is also addressed.

Keywords: Alzheimer, Dementia, Living Assistance Systems, GSM network, Virtual Private Server.

INTRODUCTION

Alzheimer's disease, a serious brain functioning disorder, is the most common type of dementia, in aged population [1]. Alzheimer's affected people show loss of cognitive functioning and behavioural disorder. The symptoms of

dementia may be minimal in the initial stage, but the symptoms may worsen as the disease progresses and affects the brain severely. At least 44 million people are living with dementia, making the disease a global health crisis and as per the statistics, in India alone, more than 4 million people have some form of dementia [2]. Predicting the exact time of appearance of dementia in a person, is specific aspect of difficult-to-diagnose clinical condition, and the complexity of impairment observed including neural, cognitive, and social levels is of highly controversial nature [3]. One of the authors has witnessed a true incident of the unexpected memory loss leading to the drowning of a close relative affected with dementia. The scope of this work is to be highly beneficial to the society in reducing the count of accidents and drowning cases in this regard. The work is an attempt towards reducing the stress of family members about their elder relatives with disability/ dementia/ Alzheimer's.

With the growing fashion of nuclear families in the society and the caretakers being employed or mostly cannot be at home during day time, results in forcing elderly people alone at home. This work has produced the prototype of a tracking device, that allows caretakers to keep tract of the activities of patients suffering from Alzheimer, when they go out alone. It enables the consumers of the service to receive real-time data pertaining to the senior citizens with the disability.The software stores and manages details including location, operation, user logs, history, and other information. The proposed system makes good use of popular geo-location technology that combines a phone/ laptop/ Raspberry Pi application connected to Ethernet. This system can also connect the to the caretaker/family members by clicking a button that lets them interact with that person. It will transmit location data back to the server at regular intervals.

Research Gap Analysis
Precisely, the authors attempt to address the following open research queries:
1. Systems available in the market mostly do not provide an end-to-end solution in which the nodes and the data generated by the nodes are in control.
2. Nodes mostly use AGPS (assisted GPS, it only knows tower location. Not actual location of the tracking unit). This AGPS data can be incorrect by over 1-2 km in rural areas/highways. Units which use an actual GPS receiver and operate as standalone devices are rarely available.
3. Existing products have data pushed to third party cloud. Also, system crashes are commonly observed.

LITERATURE REVIEW

Macro Cavallo *et al.* observed that in patients having the condition of dementia, the neuropsychological and neuropsychiatric evaluation of the disease may be true for some particular moment only [3] stresses the highly essential requirement for such assistive device. Units which use an actual GPS receiver and operate as standalone devices in a cost-effective manner are very minimal. Peter Stopher *et al.* in the study on GPS data on personal travel and vehicular travel, manipulated data collected from GPS devices carried by people or placed in personal vehicles, and used to produce records of the trips made over a period of days or weeks [4]. But data management was projected as a critical issue here. Pankaj Verma and J.S Bhatia [5] has come up with the design of a GPS-GSM based tracking device for controlling theft of a vehicle and proposed the further enhancement by the use of developing a mobile based application to get the real time view of the vehicle instead to check it on PC, which would be more convenient for the user to track the target. Sakib, S. and Bin Abdullah, M.S [6] , in the study PS-GSM based inland vessel tracking system for automatic emergency detection and position notification. R Pramana *et al.* [7] in the work SMS gateway for ship emergency, had proposed tracking device that is developed is to determine the position of the GPS in Ship emergency naviagation. Both these works were not properly addressing the cost efficiency and the security of data.

A study resulted in a tracking device for dementia people, which sends the location coordinates of the person travelling to the caretaker's mobile device byManasi H. Kasliwal *et al.* [8]. The study could address only the current location and SMS facility to mobile, and could not help if the caretaker is not having an android enabled mobile

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device. In view of Covid'19 pandemic medical emergencies, review on the potential of mobile applications for quarantine monitoring, medical emergency and contact tracing was done by many researchers [9,10] revealed the impact of mobile apps for location tracking. E. Bhaskaran Priyanka *et al.,* exploited the possibility of data storage and analysis with a cloud server wirelessly via Wi-Fi efficient data communication, in their study on the integration of IoT for intelligent transportation in oil industry [11].The option of a local server that connects to the VPS to upload all the sensor collected data in aquaponics farm was explored by Akhil Nichani *et al.* [12]. The possible usage of VPS to provide this data in real time was a motivational literature for exploring the possibility of a cloud enabled VPS with a secure network.

METHODOLOGY

The study has designed an IoT based assistive device. The system has a replicable node which once designed can be simply manufactured in any quantity, each with a unique nodeID. The nodeID (or nodeHash) is programmed into the unit at the time of manufacture. It cannot be modified during the life of the node unit. There is an Arduino based Global Positioning System (GPS) node which shares real-time position back to the server. The node is connected to the cellular network at all time. Nodes operate independently of each other. They are connected to the GSM network using an individual SIM card. As long as the node is in the coverage area of the SIM provider, it will post data in real time back to the server. The node can operate autonomously for several days without requiring its battery to be recharged as one of the lowest power consuming GSM module is used.

A server connected to the Ethernet/Wi-Fi will be collecting the data from the nodes as well as serving the user side web/API components. Use of VPS enables seamless movement of the server from one internet provider to another. No reconfiguration is needed every time a network change happens beyond control of the infrastructure administrators. As a VPS is used to relay messages from the nodes to core server, the data is secure and its movement is guaranteed. There is no data stored on the cloud VPS. The assistive device (node) can be customised and embedded inside backpack, everyday essentials etc. when position is to be determined and tracked in real-time. Smartphone users can use associated mobile application to track the location of the person in real time. Only authorized people can log into this application. Figure 1 depicts the working architecture of the system.

The Technical Design
a. Get location data in real-time of the node – The study has chosen to use the A9G module by AiThinker for determining location (latitude & longitude). The module uses a hybrid positioning system, including GPS, BDS and GNNS.
b. Push location data to a centralized storage/database – Design includes Arduino Pro mini as the master to push location data via A9G's GPRS connection. A raspberry pi runs a Python API to receive the data and insert it into mongoDB. A9G consumes about 460 milliwatts for 2-3 seconds to push the data over GPRS . The Raspberry Pi server consumes about 2-5 watts when powered on.
c. Will need to have built in battery – Uses BL-5C cellular phone battery which has a capacity of 1000mAh.
d. Should be able to safely recharge the battery –Selected a TP4056 based charger module with built-in battery protection to provide recharging capability to the node.

The administrator function embedded in the GPS-Based Location Tracking System provides the functionality for monitoring the user. Database chosen for this design is residing on the Core server. Database Engine used is MongoDB Community Edition and MongoDB 4.2.12 version is used.

Raspberry Pi
A computer monitor, or television can work as display for Raspberry Pi, but for best results, a display with HDMI input has to be used. An appropriate display cable to connect the monitor to Raspberry Pi and computer keyboard

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and mouse also is required in hardware. Any standard USB keyboard and mouse can work with Raspberry Pi and a good quality power supply is essential [13].

Tinc

Tinc is an open-source piece of software that is used to connect a home server and set up a basic VPN on Ubuntu. SSH Keys can be used for authentication which secure s the Raspberry Pi as only someone with the private SSH key only is authenticated to the system. tinc need to be installed on both the home server and the cloud server. Initially establish a reliable VPN between Pi and cloud server to enable access to a static IP address. The cloud server can pass the traffic through the VPN link to the Pi at home. Raspberry Pi uses Raspberry Pi OS and cloud server is a Vultr cloud server running Ubuntu [14,15].

Python Flask Framework

An API (Application Programming Interface) is a simple interface that defines the types of requests (demands/questions, etc.) that can be made, how they are made, and how they are processed. In order to create the API [16, 17,18, 19], Flask framework is used. Flask is a widely used micro web framework for creating APIs in Python. It is a simple yet powerful web framework which is designed to get started quick and easy, with the ability to scale up to complex applications.

Prototype Design

The design implementation of the Node Prototype (to be customized as Wearable Device) is shown in Figure 4 and Figure 5 depicts the server. When the Node is in on state, Boost module status boosts the battery voltage to a stable 5V DC from the battery input that can vary between 3.2 to 4.2V depending on the state of charge of the battery. The Node Status LED will blink in various patterns depending on the status of the node, the GPS and GPRS module.

Testing

The server is powered up and pyServer.py (our API and web pages) is run. The node data is cleared from DB via mongo db. remove command. The node is powered up and user confirms a solid green light on the unit. The node data logged is seen to update in real time on the web UI. An Android mobile application also has been designed for feasibility of the use of the device.

File Description

pyServer.py – main API and web code
MAP2.html – template of tracker page with Google maps integration
MAP_Blank.html – template of tracker page with "No Data" text overlay
login.html – template of login page.

Real Time Experimental Analysis

The User Interface has two components namely Login page and Tracker page. Figure 6 illustrates the User Interface Login pages of Web and Mobile Application. The tracker page gets the map data from Google maps. The page has the waypoints in MongoDB sent to Google maps to plot the data points before sending to user's browser. The page also provides information on the Start and End location, node ID, user name and last updated time. It auto refreshes every 30 second which ensures accuracy.   The sample results obtained on the route travelled by the person wearing/carrying the assistive device at various travel distances is represented in Figure 8 through Figure 10. The acquired real time data when compared with the actual route of travel, error rate was minimal. Figure 11 shows the error rate in seconds for the sample distances taken in kilo meter. The device will work efficiently throughout the country and can work if effectively if roaming pack is activated. The performance of the network in terms of latency, propagation delay and processing time in seconds is represented in Figure 12 for various sample distance in Km. The delay was found to be very minimal in all the test cases. The location accuracy of the node is found to be 2.5 to 5 metres.

CONCLUSION

This research has designed 'Locate Us', a tracking aid which enables the consumers of the service to receive real-time data pertaining to the age-old people suffering with cognitive function disorders. This system also helps the caretaker/family members to connect and interact with the elderly person by clicking a button. The design transmits location data back to the server at regular intervals which ensures accuracy. The proposed system makes good use of popular technology that combines a phone/ laptop/ Raspberry Pi application connected to Ethernet. The device (node) can be customized to be embedded in the user's garment also. This Implementation is cost efficient. System components are carefully chosen keeping in mind the per-unit cost as well as their long-term availability. Software which resides on the server can be customized as per the needs. Usage of non-proprietary, open-source software keeps the licensing costs at zero. Nodes operate independently of each other.

The future enhancements on which the authors are currently working include
The node can be customized to support more functionalities. The node can be enhanced to transmit data back over 4G networks. SMS OTP Security (SOS) via SMS [19], email and push notification to fixed number in case of emergency. Geo fencing alarms can be implemented in software to send alert if node goes outside, a certain coverage limit/ entersany hazardous area.

ACKNOWLEDGEMENT

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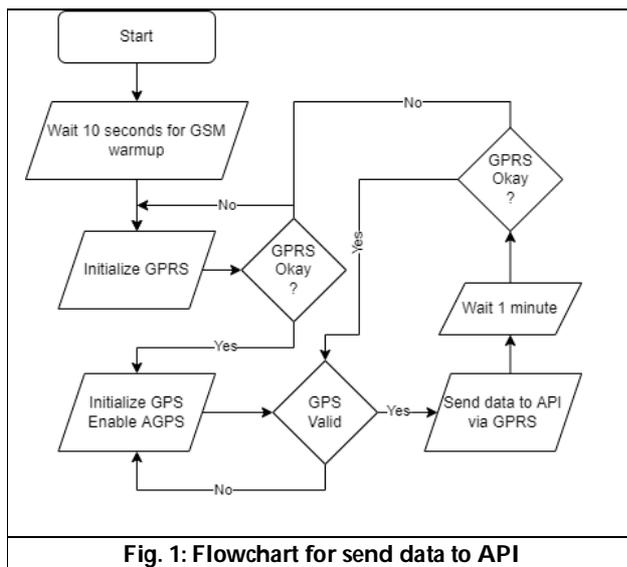
| Fig. 1: Flowchart for send data to API	Fig. 2: System Architecture
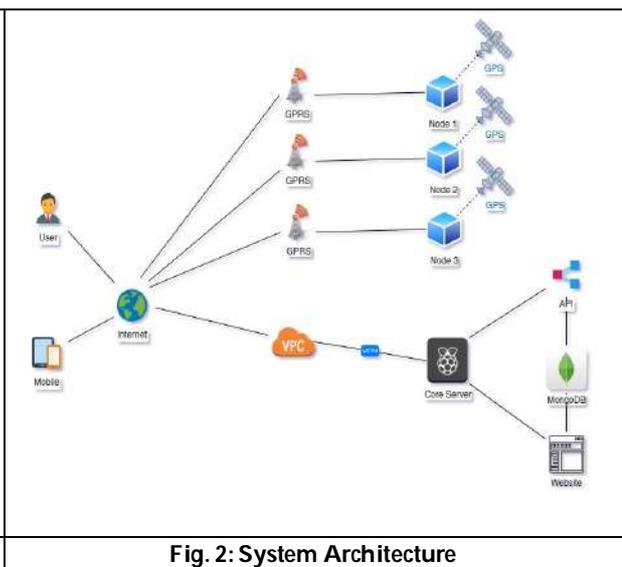
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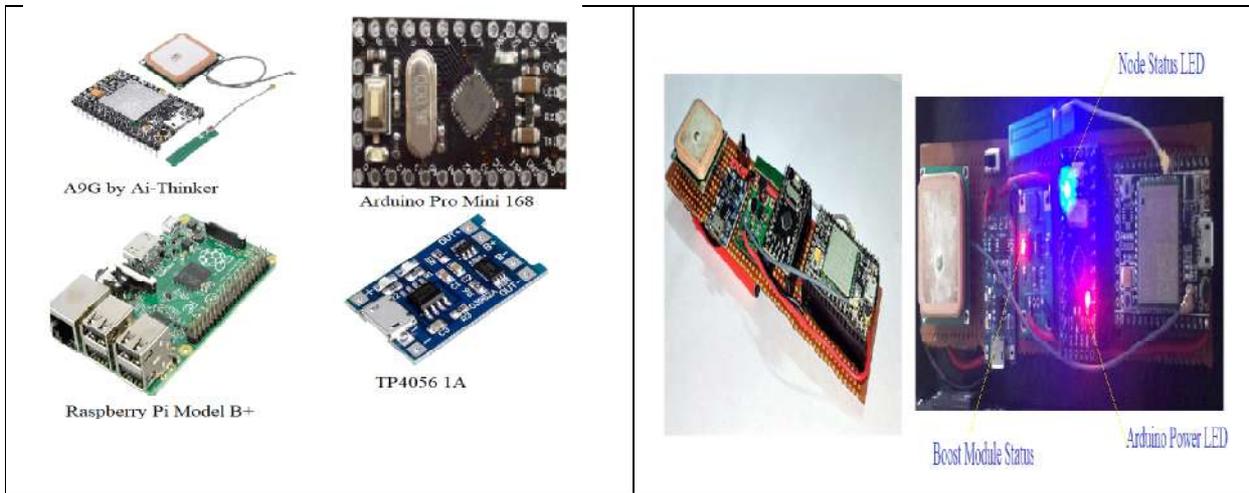
Fig. 3: Modules Castoff

Fig. 4: Node Prototype
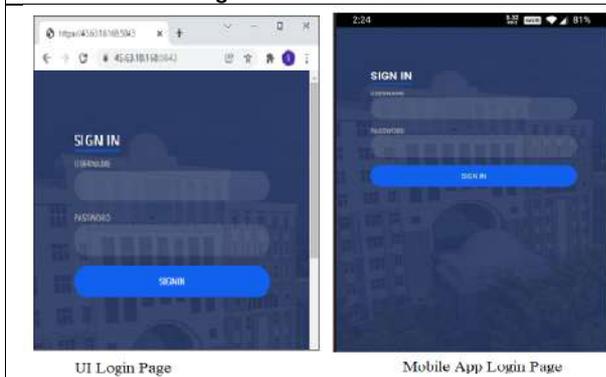
**Fig 6: UI Login of Web and Mobile App**

Fig 5. The Server
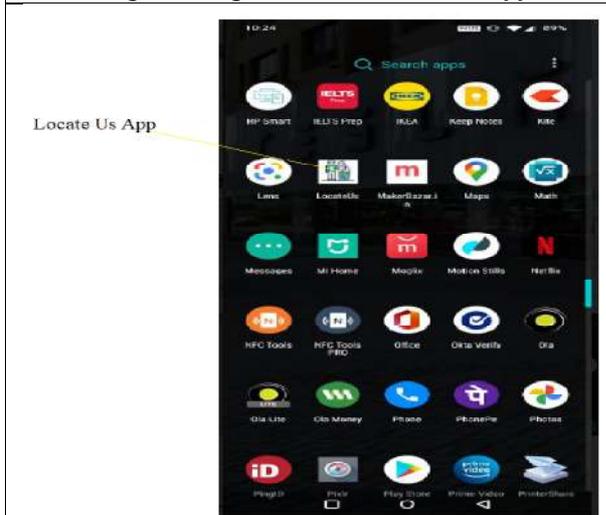
**Fig. 7: The Locate Us Application**
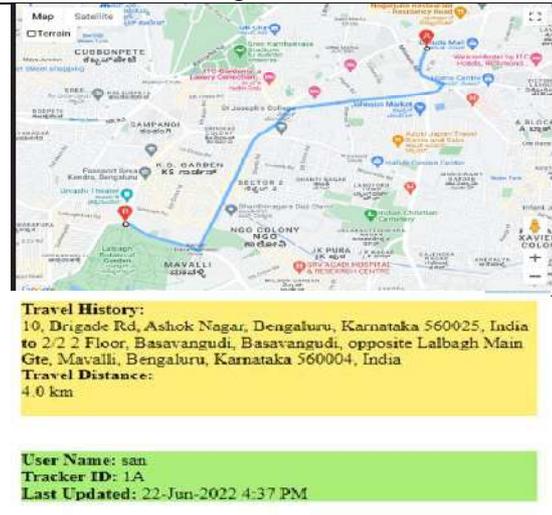

Fig. 8: Route of Travel for a distance 4Km

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Travel History:
Yelahanka, Yelahanka, Ambedkar Colony, Yelahanka New Town, Bengaluru, Karnataka 560065, India to 1st Floor Bhartiya city, Thanisandra Main Rd, Kannuru, Bengaluru, Karnataka 560064, India
Travel Distance:
15.9 km

User Name: san
Tracker ID: 1A
Last Updated: 23-Jun-2022 1:54 PM
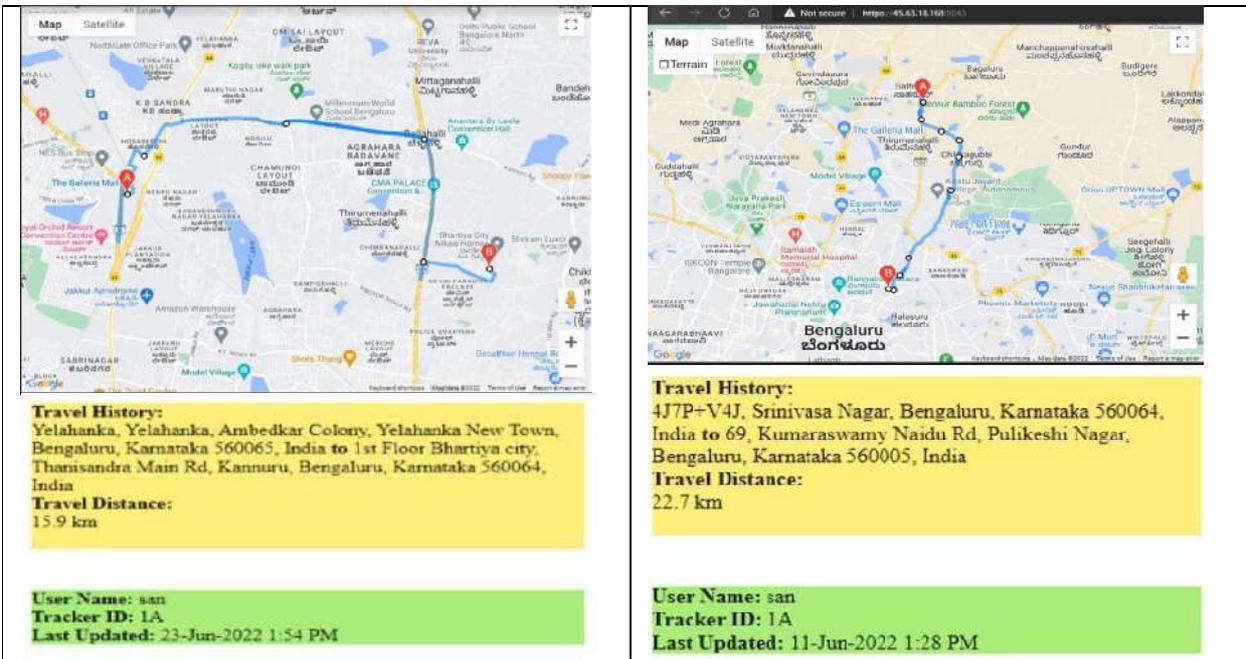
Fig. 9: Route of Travel for a distance 15.9 Km

Travel History:
4J7P+V4J, Srinivasa Nagar, Bengaluru, Karnataka 560064, India to 69, Kumaraswamy Naidu Rd, Pulikeshi Nagar, Bengaluru, Karnataka 560005, India
Travel Distance:
22.7 km

User Name: san
Tracker ID: 1A
Last Updated: 11-Jun-2022 1:28 PM

Fig. 10: Route of Travel for a distance 22.7 Km

Fig. 11: Error rate in seconds
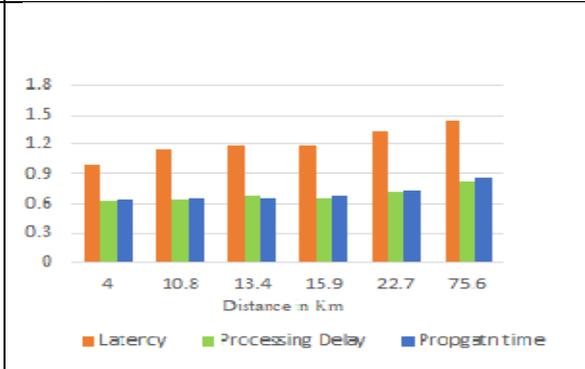
Fig. 12: Network Performance

REVIEW ARTICLE

Triphala – An Overview and it's uses in Dentistry

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ABSTRACT

Ayurveda is science of life it is both promotive and preventive in nature. Dental plaque is the primary etiological agent in periodontal disease. Chemical plaque control forms an effective adjuvant to mechanical plaque control in inaccessible areas, handicap, debilitating diseases. Although there are many chemical plaque controls agents available like chx, sanguinarine, essential oils, phenols etc. But due to side effects and resistance there is a need for agent with minimum side effects and effective results one such wonder herb is Triphala consisting of three fruits and having immense medicinal properties. This article will give the medicinal properties of Triphala & uses in dentistry.

Keywords: Triphala, periodontal disease, dental caries.

INTRODUCTION

In India the concept of Ayurveda appeared in 2500 and 500 BC. Ayurveda literally means "science of life" because more attention was given on Man and his illness in ancient Indian health care system. It encouraged unique health practices, Paid attention on diet &Herbal formulations and compounds. Herbal Medicines were widely used because of its low cost, minimal or no side effects & Easy Availability. According to WHO In developing countries 80% of

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population is dependent on traditional medicines for their primary health care needs. There are certain side effects of Allopathic drugs to overcome that WHO has advised researchers to explore and search uses of herbs and plant extracts. From many years herbal products have been used for maintaining oral hygiene. Dentistry is not any specialized branch in Ayurveda, but it is included in shalakya tantra. Recently focus has increased on use of Ayurvedic medicine in oral and dental health. In Traditional ayurvedic medicine Triphala is most commonly used it is known to be tridoshic rasayana which balances (vata, Pitta& Kapha) which governs life[1].

Chronic inflammation is the most common disease process to affect the periodontium and is major factor responsible for tooth loss in adults; persistence of infection at the gingival margins leads to progressive inflammation and usually to destruction of the supporting tissues. In Ayurvedic text (Sushruta Samhita) "Dantamula" means "Periodontium" and their disorders are as "Dantamulagata rogas", We can correlate them according to their clinical features. Shitada, Dantapupputaka, Danavestaka, Shaushira, Mahashaushira paridara, Upakusha, Dantavaidarbha vardhana, Adhimansa, Dantanadi (5) - Vatika, Paitrika, Kaphaja Sannipathka, shalayaj. Out of 15 Dantamulagata rogas only first 8 are seems to like similar with periodontal diseases (Chronic gingivitis and chronic periodontitis) on the basis of different clinical features[2].

Triphala It is the combination of three fruits
1. –Amalaki (Emblica officinalis)
2. –Haritaki (Terminalia Chebula)
3. –Vibhitaki (Terminalia Belerica) [3]

Amalaki also known in Sanskrit as Dhatri (nurse) has anti-oxidant and anti-aging properties. It is rich in vitamin C, tannins ,carotene, riboflavin, nicotinic acid and. It is useful in cancer, diabetes, ophthalmic, liver and heart disorders, ulcer, anemia. It has immunomodulatory, anti-pyretic, analgesic, cyto-protective, anti-tussive and gastro-protective action [4,5]. *Terminalia chebula* (Hiritaki or Black Myrobalan) Rich in tannins, anthraquinones and polyphenolic compounds, hiritaki comprehensively used in Ayurveda, Unani and Homoeopathic medicine. It exhibits anti-bacterial activity against a number of Gram-positive and Gram-negative human pathogenic bacterial species, Antifungal & Antiviral properties. It has anti-mutagenic/anticarcinogenic activity, antioxidant activity, adaptogenic and anti-anaphylactic activities, immunomodulatory activity, cyto-protective and radioprotective activity. It is also effective in hypolipidemia/hypercholesterolemia, improving gastrointestinal motility with anti-spasmodic activity, diabetes, and retinopathy and wound healing [6] *Terminalia belerica* (Bibhitaki) It is rich in termilignan, thannilignan, anolignan B, gallic acid, ellagic acid, ß-sitosterol, arjungenin, belleric acid, bellericosidem and flavonoids. It possesses antioxidant, anti-spasmodic, bronchodilatory, hypercholesterolemic, anti-bacterial, cardio-protective, hepato-protective, hypoglycemic and hypotensive properties [7, 8].

Triphala contents: Tannins which has astringent property. Tannins produce stimulation of phagocytic cells, host mediated tumor activity and antiinfective actions. They bind with proteins and inactivate microbial adhesins, enzymes and cell envelope transport proteins [9, 10].
Quinones- Provides stable free radicals, quinones exert antimicrobial effect by complexing irreversibly with nucleophilic amino acids in proteins, that leads to protein inactivation & loss of function. Flavonoids-They complex with extracellular and soluble proteins and complex with bacterial cell walls. More lipophilic flavonoids disrupt microbial membranes. These compounds inhibit Vibrio cholera O1, Shigella, Streptococcus mutans in vitro. Inhibition of isolated bacterial glucosyltransferases in *S. mutans* and reduction of fissure caries by about 40% has also been demonstrated. Gallic acid- Gallic acid possesses antioxidant activity & hepato-protective and. suppresses cancer cells growth [11]. *Emblica officinalis* (EO) contains the highest content of vitamin C (478.56 mg/100 mL). Vitamin C is co-factor in the conversion of proline into hydroxyproline which is one of the essential constituent of connective tissue has anti-oxidant property, wound healing and its deficiency leads to gum bleeding and periodontal diseases [12].

Terminalia chebula by its anticaries property prevents plaque formation on tooth surface by inhibiting sucrose-induced adherence and glucan-induced aggregation, the two processes which foster the colonization of the organisms on the surface of the tooth. It inhibits the growth and accumulation of S. mutans on the surface of the tooth. This in turn prevents the build-up of acids on the tooth surface and thus prevents further demineralization [13, 14]. 0.6% Triphala mouthwash has shown to have significant anti-caries activity, which is comparable to that of chlorhexidine without possessing disadvantages as staining of teeth and at much less cost although there was no evidence of remineralization of tooth structure[15]. Matrix metalloproteinases play a vital role in periodontal destruction. Triphala shows strong, inhibitory activity against polymorphonuclear leucocytes (PMN) type collagenase, especially matrix metaloproteinase (MMP)-9 at a concentration of 1500 µg/ml [16]. Analgesic and Anti-pyretic Effect The analgesic and anti-pyretic action of Triphala is due to its action to block the effect or release of the endogenous substances that stimulate pain nerve endings [17, 18] Strong antioxidant Property is due to presence of *T.belerica , E.officinalis, T.belerica*(ellagic and gallic acid), *E.officinalis* contains gallic acid derivatives including epigallocatechin gallate and in T. chebula, gallic acid is the major ingredient phenolic nature of these ingredients is responsible for scavenging free radicals[19-22]

Triphala in Periodontitis:

Anupama Desai, Anil M, Surangama Debnath (2010) [15] :- Conducted a clinical trial to evaluate the effects of 0.6% triphala as a mouthwash in comparison with chlorhexidine in 24 chronic generalized periodontitis patient. Triphala was found comparable to chlorhhexidine. Neeti Bajaj, Shobha Tandon (2011) [23] :- Studied the effect of 0.6% Triphala mouthwash and 0.1% Chlorhexidine mouthwash on dental plaque, gingival inflammation, and microbial growth and compare it with commercially available Chlorhexidine mouthwash. Ritam S. Naiktari , Pratima Gaonkar, Abhijit N. Gurav (2014) [24] :- Compare the efficacy of triphala mouthwash with 0.2% chlorhexidine mouthwash in 120 hospitalized patients with periodontal diseases. Agent, useful in reducing plaque accumulation and gingival inflammation thereby controlling periodontal disease. Its cost effective easily available & well tolerable with no reported side effects. Ritesh Bhattacharjee, Sridhar Nekkanti, Nikesh G. Kumar, Ketan Kapuria (2015) [25] :- Studied to evaluate the efficacy of 0.6% triphala mouthrinse (aqueous) in the reduction of plaque and gingivitis among 60 school children. The reduction in GI & PI in Triphala group can be attributed to antibacterial action against gram positive- negative microorganisms, strong antioxidant activity, as well as strong inhibitory activity on polymorphonuclear leukocyte type matrix metalloproteinases.

Apoorva SM, Vinayashree MP, Suchetha A (2015) [26]:- Conducted a clinical trial to compare and evaluate the effectiveness of two commercially available gum gels containing Triphala and Cinnamomum in the reduction of plaque and gingival inflammation in 60 subjects having chronic gingivitis, HiOra-GA® gum gel was found to be more effective than Herbashine Herbal Gum Paint ® Which was attributed to presence of jatiphala, arjuna & Triphala. A R Pradeep , Deepak Kumar Suke , Dr. Santosh S Martande (2016) [27] :- Studied the efficacy of triphala mouthwash in reduction of plaque & gingivitis in 90 chronic generalized gingivitis. There was also significant reduction in microbial counts in all the groups at all the time intervals. Similar studies for reduction of plaque, gingival index and gingival bleeding were done by Sahana Umesh Baratakke (2017) [28], Pratibha Mamgain, (2017) [29], Mohammed Irfan, (2017) [30]

CONCLUSION

Although Triphala is not a substitute for conventional dentistry but can be use as adjunct because of its immense medicinal properties. Wonder drug Triphala needs more &long term exploration in dentistry.

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RESEARCH ARTICLE

Machine Learning based Recommender System for Economical Diet Packages and Physical Exercise Charts towards T2DM

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ABSTRACT

Data is growing significantly and is being generated from a variety of sources at a quick rate due to the rapid growth of technology. The variability and complexity of the data make it challenging to store, analyse, and interpret. Although improvements in hardware technology enable us to store such enormous amounts of data, more work needs to be done in the areas of analysis and knowledge development. Human skill is crucial for data analysis, yet because of human limits, large amounts of data cannot be processed. Although there are several traditional/conventional procedures used for data analysis, they fall short due to concerns with data such as high velocity, high volume, high variety, high veracity, etc. Statistical methods are another strategy utilised for data analytics, however they are excessively sluggish, expensive, and fully dependent on the knowledge, competence, and analytical skills of the expert. For instance, many statistical techniques that work well with small data sets do not scale to large data sets. Similar issues are faced by many conventional/traditional techniques that excel at handling tiny amounts of data. The work describes the implementation of a recommender system for affordable diet regimens and exercise schedules for various patient categories. Designing diet regimens and exercise schedules for various patient categories has been examined utilising the reverse feature engineering technique and findings obtained by applying the fuzzification method. The framework for end-user recommendations of affordable diet packages has been used.

Keywords: Machine Learning, Diet plans, Web Crawler / Web Scraper.

INTRODUCTION

Generally speaking, recommender systems are computer programmes that make suggestions to users based on their choices [1]. The usage of recommender systems helps users find the items they are interested in, delivers the items to the appropriate users, identifies products that are highly relevant to users, aids websites in increasing user engagement, etc. [2]. Based on the user's preferences, interests, and physiological activity, the recommender system uses an information extraction methodology [3]. Recommender systems have gotten a lot better. Due to their contributions in several spheres of life, they have gained attention in the present [4-5]. Knowledge-based, content-based, collaborative, and hybrid recommender systems are the four primary types of recommender systems and are utilised in various ways depending on the issue domain. Using their subject knowledge, human experts can make recommendations to the user using knowledge-based recommender systems [6]. When using a content-based recommender system, features from the contents of previously evaluated items are extracted in order to provide recommendations based on user profiles [7]. The collaborative filtering recommender system forecasts user behaviour by combining product ratings or recommendations, identifying commonalities, and then recommending related products to users who share those characteristics. In order to profit from the complementing advantage, hybrid recommender systems combine two or more recommender techniques in various ways [8]. Retail, media, education, healthcare, e-commerce, and other industries are just a few of the application domains where recommender systems are successfully used for various aspects.

The primary goal of developing a recommender system is to draw out the pertinent information regarding a client's inquiries. Due to the complexity and heterogeneity of the data available from many sources, users are unable to make informed decisions. As a result, recommender systems are information filtering systems that anticipate user behaviour based on actions using copious, dynamically created information [9]. The design of intelligent frameworks to provide proper management and reduce complications to various chronic diseases like Diabetes, Alzheimer's, Dementia, Cancer, Heart Disease, Parkinson's, etc. at an earlier stage is another important role that recommender systems play in the field of healthcare [10]. In order to prescribe medication, recommend a diet, and encourage physical activity based on a person's unique physiological traits, recommender systems are being researched. Diabetes is a fatal chronic condition that affects millions of individuals worldwide. The disease has become a global threat as a result of a considerable rise in the number of persons with diabetes over the past ten years. Of all diabetes kinds, Type 2 Diabetes Mellitus (T2DM) affects 90% of the population. Due to their significance in terms of leading a healthy lifestyle, food and exercise recommendation frameworks for a number of chronic diseases are currently required [49]. Healthcare personalised personal diet and exercise recommendation systems are reported to be understudied [11]. A healthy lifestyle assists the individual to lower their risk of disease and offers tangible health advantages [12]. This chapter proposes and implements a knowledge-based recommender system for the Realistic Healthcare Management System for Type 2 Diabetes Mellitus Disease (RHMST2DM), which suggests food regimens and exercise schedules for various patient categories based on the severity of T2DM. It generates diet regimens and fitness advice using inferences derived from user profiles using a machine learning approach. Additionally, the system suggests affordable diet packages by obtaining the contents of suggested diet goods from several sources.

Reverse Feature Engineering of Lifestyle Indicators
To determine whether a patient has diabetes or not, the outcomes of predictive ML/EL models are divided into two groups, diabetic and non-diabetic patients (binary classification problem), as mentioned in chapters 4 and 5. Reverse feature engineering was used to further categorise the non-diabetic patients into low risk, moderate risk, and high risk subclasses. Fuzzy logic has been used in the process of reverse engineering features. In disciplines like artificial intelligence and machine learning where data values are ambiguous or imprecise with regard to the solution to a problem, fuzzy logic is frequently applied [13]. Real-world issues are complicated, making it challenging to design precise answers in the face of ongoing ambiguities and uncertainties. Fuzzy logic is a straightforward method for drawing conclusions even when the data is noisy, hazy, confusing, inaccurate, or even when certain pieces of information are missing. To cope with reasoning that is approximate rather than precise, one uses a multivalued

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logic. The idea of membership is the foundation of fuzzy logic. A number termed truth value, which has a range of 0 to 1, is used to represent values. Absolute values of 0.0 and 1.0 stand for "true" and "false," respectively. Fuzzification is the conversion of a crisp quantity into a fuzzy value using fuzzifiers or membership functions. A precise value frequently lacks the ability to capture the exactness of a truth because it contains uncertainty. Making decisions based on such information is challenging and might result in tricky and prone to mistakes. In these circumstances, a fuzzy value is required to express the fact. In membership functions, sharp values are transformed into fuzzy ones. For this reason, a variety of membership functions are available; some of the most well-liked membership functions include those with triangular, trapezoidal, spline, and gaussian shapes. Function for Spline-Based Membership: Spline-shaped membership functions have been employed to fuzzify data during the reverse engineering process. The S-shaped membership function is another name for the spline-based membership function, which is a mapping on the x-axis [14].

Figure 1 displays a graphic illustration of the Spline-shaped membership function. Core, Support, and Boundary are the three features that define a membership function. The degree of membership is used in the membership function to scale down the data samples from "0.0 to 1.0". Additionally, lifestyle parameters and class variables have had their actual values fuzzified. The Spline-shaped membership function has been investigated using the Java Eclipse IDE environment. The significance of using the membership function was to determine the degree to which each predicate variable contributed to the outcome (class variable).

The primary goal was to give suitable care and management to potential patients in order to lessen the complexity of T2DM at an earlier stage and improve quality of life and life expectancy. Age, urination, thirst, weight, height, fatigue, and outcome are the lifestyle factors taken into consideration throughout the reverse feature engineering process. Figure.2 displays the outcomes of the experiment using the Spline-shaped membership function. The class variables' actual values were 0 and 1, where 0 denotes a non-diabetic state and 1 denotes a diabetic state. Additionally, utilising the feature engineering approach, non-diabetic patients have been divided into three classes, A, B, and C. The outcomes of all relevant parameters are used to calculate the likelihood of developing diabetes in the future. Fuzzified values of the predicate have been measured using the Spline-Shaped Membership Function.

Representation of Categories
'A' [0.0-0.3] represents the people having low risk of being involved in T2DM.
'B' [0.4-0.6] represents the people having moderate/middle risk being involved in T2DM.
'C' [0.7-0.9] represents the people having high risk of being involved in T2DM.

Recommender System Architecture for RHMST2DM
The suggested architecture, which is presented in Figure.3, outlines a practical method for recommending affordable diet packages and exercise regimens to diabetic patients and potential patients. The architecture has looked into the outcomes of using lifestyle parameters and machine learning and deep learning approaches to predict type 2 diabetes. To determine different thresholds of lifestyle characteristics and their contribution to disease, reverse feature engineering was used. To create food regimens and exercise schedules for various patient categories, the predictive analytical results of T2DM were discussed with professionals such as dieticians and nutritionists. Additionally, data regarding suggested diet programmes was extracted using a web crawler or web scraper to create affordable diet packages. Lastly, the affordable, customizable diet plans. All patient categories will be advised to follow specific, affordable food regimens and exercise schedules in order to establish healthy living habits. Here is a detailed discussion of the various RHMST2DM recommender system architecture components:

T2DM prediction using lifestyle indicators: EL/ML models were used to predict T2DM
The results fall into two categories: diabetic (1) and non-diabetic (0) patients since the problem statement calls for binary classification to determine if a patient has diabetes or not. Reverse feature engineering is used to further divide the non-diabetic (0) class variable into the low risk, moderate risk, and high risk categories in order to give early-stage candidate patients with health recommendations.

Charts for diet plans and physical activity

The development of necessary and ideal diet plans and exercise schedules for various patient categories involved in this phase's reverse feature engineering process and predictive analytical results, which were discussed with experts like diabetologists, endocrinologists, dieticians, and nutritionists. The recommendation method made use of the created diet programmes and exercise charts.

Economical Diet Packages

Recommendations for diet plans are fed into the architecture of web crawlers and web scrapers, which then compare diet-related products based on criteria like Product ID, Product Name, Product Quantity, Product MRP, Product RS, and Product Discount. These criteria were chosen to produce the budget-friendly diet programmes.

Charts recommending diet and exercise regimens

The algorithm then suggests affordable diet plans and exercise schedules for various patient categories based on prediction findings after creating the cost-effective diet packages as described in step no. 3. By updating diet programmes and exercise schedules in accordance with user profiles and lifestyle behaviours, the recommendation process will also benefit end users.   **4.**

Design of Diet Plans and Physical Exercise Charts

In maintaining and controlling blood sugar levels, especially when dietary modifications are involved, the use of technology has proven to be quite beneficial. In addition to improving the health fitness of potential patients or candidates, proper food programmes and exercise regimens offer tangible health benefits to prevent complications of diabetes illness at early stages [15]. By regulating glucose levels, the advantages of healthy food plans and activity schedules serve to control and reduce the risk of T2DM [16-17]. Fortunately, lifestyle changes including adopting a nutritious diet, engaging in regular exercise, and losing weight can help people with pre-diabetes avoid becoming type 2 diabetes. Depending on a person's propensity for diabetes, different diet/food and exercise regimens are necessary. Green leafy vegetables, fresh fruits, whole grains, legumes, nuts, and healthy fats are all part of a balanced diet that provide our bodies with the nutrients they need to function properly. One of the key pillars in the therapy of T2DM is diet, which should be tailored to the individual's preferences, age, metabolic control, and co-occurring medical disorders. Designing balanced diet plans with the appropriate list of foods that provide the necessary nutritional values in sufficient quantity is urgently necessary. Additionally, it offers the appropriate details on physical activity charts that take health issues into account. Dietary guidelines and exercise schedules have been created with this in mind With the help of specialists, the findings of the reverse feature engineering process were thoroughly reviewed in relation to the contributions made by each lifestyle aspect. Both diabetic and non-diabetic individuals had diet plans and activity schedules created. Additionally, several food regimens and activity schedules have been created for people with low, moderate, and high risk of developing diabetes (non-diabetic class). For patients who may become diabetic and those who are already diabetic, dieticians and nutritionists advise a list of foods to avoid and exercise schedules. Table [1-2] lists the meal programmes and exercise schedules for the various patient categories. Customized meal plans and exercise schedules might assist patients in establishing healthy living habits in advance.

Recommendation Process for Economical Diet Packages

Non-communicable diseases including T2DM diabetes, cardiovascular disease, cancer, etc. have an increasing financial burden that is widely acknowledged. For those in poor socioeconomic groups, hospital care and readmission costs constitute a barrier to adopting good eating practises [18]. An obstacle to following a healthier diet plan is the price of food for individuals with lifestyle diseases. Given the worrisome global development rate of chronic degenerative diseases [19], healthy eating habits cannot be put off any longer as a top concern. The economical diet model shows a considerable decrease in healthcare expenses related to the management of T2DM by adhering to the Mediterranean diet's nutritional guidelines, and it was developed using computational approaches. A cost-effective diet model can offer a platform for accessing and identifying of Economical diet model can provide

platform to access and identify the most affordable diet items over different sources for different categories of people.

Data Sources

Information about the suggested diet programmes was gathered from a variety of websites. The diet packages for patients with T2DM categorization are being collected using an API (Application Program Interface) that was built and makes use of famous websites as data sources. The selection of websites like Bigbasket20, Nature's Basket21, Sabzi Bhazi22, Freshindiaorganics23, Amazon24, Flipkart25 and Proveg Website as data sites was made possible by the availability of the daily diet goods that end consumers need on these online grocery stores. Figure.4-7 displays a few examples of various websites that were used as data sources for the diet suggestion process.

Architecture for Development of Economical Diet Packages

Web mining techniques are frequently used to collect data from various sources where it would be challenging to manually gather pertinent information about the contents. Additionally, manual extraction requires a lot of time and is not always error- and bug-free. The inexpensive diet packages were designed using the architecture depicted in Figure.8. Using Python scripting, the Uniform Resource Locators (URLs) of web sources have been retrieved. Additionally, a web crawler or web scraper was utilised to retrieve the pertinent data from the websites for the diet products. The content database contained the extracted contents. Finally, several patient classifications were taken into consideration when designing the affordable diet programmes.

URLs Searching

The Uniform Resource Locator on each website's page has been used to search for information about diet programmes from various online sources. The URLs are entered into the web crawler or web scraper so that it can access the online pages and collect the necessary data from their contents. By scripting lines of code using computer languages like Python, URLs offer automated options for searching pertinent info. For the extraction and structuring of data parameters, Python's library of packages, such as Selenium, Beautiful Soup, and Pandas, is quite extensive. Figure.9 displays the scripting software in action when URL-searching the Flipkart website.

Data Extraction

There is a vast amount of information available on the internet in many data types, including unstructured, semi-structured, and structured data. It won't be feasible to retrieve data from websites' web pages because certain websites lack their own APIs. Web scrapers are used to retrieve the information that has to be recognised in order to get over the limitations of API approaches. Web scrapers like Data Miner26, Webharvy27, and import.IO28 were used to retrieve the information on suggested diet programmes. For data extraction, the developer creates scraping applications in a variety of computer languages, including Python29, R-Language30, Java31, C32, and C++33. The Python programming language and Jupyter Notebook34 have been used in this work to collect data from various websites depending on the URLs. Data from web pages of those specified URLs that were found and downloaded by web crawler was extracted using a web scraper.

Web Crawler/Web Scraper

Web crawlers, a crucial component of search engines, are frequently employed to gather information from the internet [20]. Every day, a sizable number of new web pages are created, and the pertinent data is also always updating. In order to retrieve relevant data, the World Wide Web is systematically and automatically browsed through using a process called web crawling [21]. In this study, a web crawler has been utilised to gather the URLs of various online storefronts and traverse them iteratively in order to keep a database list of URLs. Data from Web Pages of those URLs that have been found and obtained using crawlers has been extracted using data scraping. The web scraper extracts the necessary diet-related data. Dietary advice from dietitians and nutritionists is extracted and kept in the content database as data. By analysing the commodities from several online shopping websites, the database is used to create affordable diet packages.

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Extracted Contents

This application is used to extract the nutritional information from various diet products found on websites like Bigbasket, Nature's Basket, and Amazon. Green leafy vegetables, fruits, pulses, and diet-related other essential data items are currently extracted from the contents. Product ID, Product Name, Product Quantity, Product MRP, Product RS, and Product Discount are the retrieved items for affordable diet packages [22]. These criteria are used to determine the most affordable diet packages for patients in various classification categories.

Content Database

The information that is scraped from websites with various URLs is stored in content databases. The recorded data for the Bigbasket website is shown in Figure.10. Additionally, the information from other websites has been extracted and kept in a content database. To determine the most affordable diet package, the content database's data has been compared. The customers have been given the budget-friendly diet packages [23].

CONCLUSION

In this work is describes the application of a recommender system for affordable food regimens and exercise schedules for various patient categories. To develop the diet plans and activity charts for patients, the reverse feature engineering process has been explained, and the outcomes obtained by utilising the fuzzification method have been investigated. Dieticians and nutritionists have been active in creating food programmes and exercise schedules for a variety of patient populations. It has been discussed how to build cost-effective diet packages for end consumers. Data on the diet items were gathered from several online shopping sites using a web crawler or web scraper as part of the process of generating affordable diet packages. WebCrawler and Web Scrapper have both extracted the URLs of websites. WebCrawler has extracted the URLs of WebPages, and Web Scrapper has been used to examine every URL in order to collect the needed information. Finally, all patient categories were advised to follow affordable diet regimens and exercise schedules.

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Table .1: Diet Plan for Diabetic Patients for diet purpose

Diet Plan :1- Low/Moderate Risk Non-Diabetic Patients	
BEFORE **BREAKFAST**	➢ Fenu Greek Soaked Water ➢ Cinnamon Brewed Water
BREAKFAST	➢ **Scrambled Eggs & Oats** ➢ 2 Eggs Whites ➢ Oats in Eggs ➢ Oats with Veggies (if Vegetarian) ➢ Cubs of cheese
12:30	➢ Salad ➢ Veg Fiber with Soup

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LUNCH		➢ **Rice/Dal/Roti**
	02:00	➢ Chakki Atta Roti 2 with Veggies
		➢ Dal soup
		➢ 1 cup Brown Rice
	03:00	➢ Cinnamon Brewed Water
	04:00	➢ Tea with 2 Marie Biscuit
	05:00	➢ 1 cup Cucumber Juice
DINNER		➢ **Rice/Dal/Roti**
	08:00	➢ Moong/Dhulia/Masoor/Arhar Dal Palak
		➢ Dal Tadka Eat with 2 Chapatti
Diet Plan 2 – Low/Moderate Risk Non-Diabetic Patients		**1.**
BEFORE		➢ Tale Gooseberry Juice (30 ml in water)
	BREAKFAST	➢ Lemon Water
		➢ Fruit Salad (Apple, Guava, Papaya)
	BREAKFAST	**Scrambled Eggs & Oats**
		➢ Porridge
		➢ Oats
		➢ Dal pan cake
		➢ Roti with curd
		➢ Bread omelette/Bread butter
		➢ Upma
		➢ Idly
	12:00	➢ Mix seeds
		➢ Dry fruits
	01:30	➢ Salad
		➢ Veg Fiber
LUNCH		**Rice/Dal/Roti**
	02:00	➢ Dal
		➢ Sabzi
		➢ Portion of Rice
		➢ Chicken/Cheese (once in a week)
	05:00	➢ Tea with Snack
	06:00	➢ Coconut Water
	07:00	Soup (Veg/Non-Veg)
DINNER		**Rice/Dal/Roti**
	08:00	➢ Roti
		➢ Sabzi
		➢ Dal
BEFORE SLEEP		➢ Cup of Milk with a dash of Turmeric
		➢ Sabzi
Diet Plan 3 – High Risk Non-Diabetic Patients		➢
BEFORE BREAKFAST		➢ Cinnamon Water
		➢ 2 Almond + 1 Walnut
		➢ 1 small Teaspoon Flax Seeds
BREAKFAST		**Scrambled Eggs & Oats**
		➢ 2 slices of Brown/Wheat Bran Bread
		➢ Salad
		➢ Quinoa

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	➤ Steel-cut Oats ➤ Spiced Butter Milk
11:00	➤ 1 Green Apple ➤ Skin Carrot ➤ Guava
12:00	➤ **1/2** Peach
01:00	➤ Salad (Cucumber + Onion + Tomato) ➤ with Lemon
LUNCH **02:00**	**Rice/Dal/Roti** ➤ Wheat Atta Roti ➤ Brown Rice ➤ Beans ➤ Legumes ➤ Black Chana
03:00	➤ Cinnamon Water
04:00	➤ Green Tea
05:00	➤ Nariyal Pani
06:00	➤ Tea or Coffee
07:00	Veg Fiber
08:30	**Rice/Dal/Roti** ➤ Egg Whites ➤ Veggies ➤ Wheat Atta Roti ➤ Missi Roti

Table .2: Diet Plan for Diabetic Patients for physical concept

WALKING	It will help diabetics lose weight and lessen the difficulties associated with high blood sugar levels.
CYCLING	Cycling can help people reach their fitness objectives while limiting joint stress if they have diabetes neuropathy, a disorder that results from nerve loss. Diabetes neuropathy causes lower joint pain.
SWIMMING	Another joint-friendly workout choice is aquatic activity. Swimming, water aerobics, aqua jogging, and other aquatic exercises, for instance, can work your heart, lungs, and muscles while causing minimal joint stress.
TEAM SPORTS	A good aerobic workout is provided by several recreational sports. Try out ultimate frisbee, softball pairs tennis, basketball, and soccer.
YOGA	It can aid those with Type 2 Diabetes Mellitus in controlling their weight, cholesterol, and blood sugar levels. Additionally, it can help you feel happier, get better sleep, and lower your blood pressure.
Exercise Chart for Non-Diabetic Patients	
WALKING	It will help diabetics lose weight and lessen blood sugar-related complications.
CYCLING	Cycling can help people reach their fitness objectives

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	while limiting joint stress if they have diabetes neuropathy, a disorder that results from nerve loss. Diabetes neuropathy causes lower joint pain.
SWIMMING	Another joint-friendly workout choice is aquatic activity. Swimming, water aerobics, aqua jogging, and other aquatic exercises, for instance, can work your heart, lungs, and muscles while being relatively easy on your joints.
TEAM SPORTS	A good aerobic workout is provided by several recreational sports. Try out ultimate frisbee, softball pairs tennis, basketball, and soccer.
YOGA	It can aid those with Type 2 Diabetes Mellitus in controlling their weight, cholesterol, and blood sugar levels. Additionally, it can help you feel happier, get better sleep, and lower your blood pressure.
Exercise Chart for Non-Diabetic Patients	
WALKING	It will help diabetics lose weight and lessen blood sugar-related issues.
CYCLING	Cycling can help people reach their fitness objectives while limiting joint stress if they have diabetes neuropathy, a disorder that results from nerve loss. Diabetes neuropathy causes lower joint pain.
SWIMMING	Another joint-friendly workout choice is aquatic activity. Swimming, water aerobics, aqua jogging, and other aquatic exercises, for instance, can work your heart, lungs, and muscles while being relatively easy on your joints.
TEAM SPORTS	A good aerobic workout is provided by several recreational sports. Try out ultimate frisbee, softball pairs tennis, basketball, and soccer.
YOGA	It can aid those with Type 2 Diabetes Mellitus in controlling their weight, cholesterol, and blood sugar levels. Additionally, it can help you feel happier, get better sleep, and lower your blood pressure.
JOGGING	For those who are predisposed to diabetes, jogging might be a type of exercise. It makes the body more responsive to insulin.

| Figure.1: Shape of Spline-Shaped Membership Function	Figure.2: Results of Reverse Feature Engineering
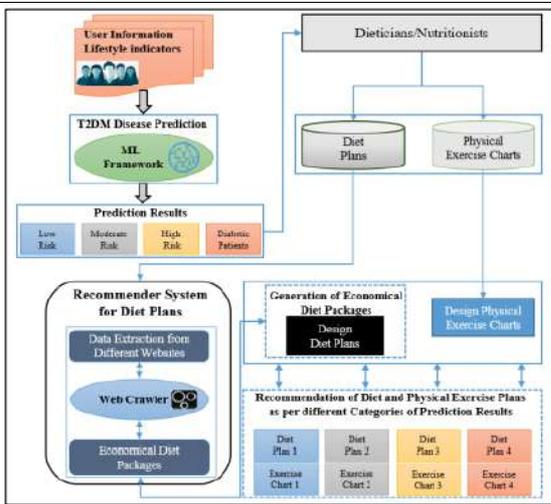
Figure.3: Architecture of Recommender System	Figure.4: Nature's Basket Website
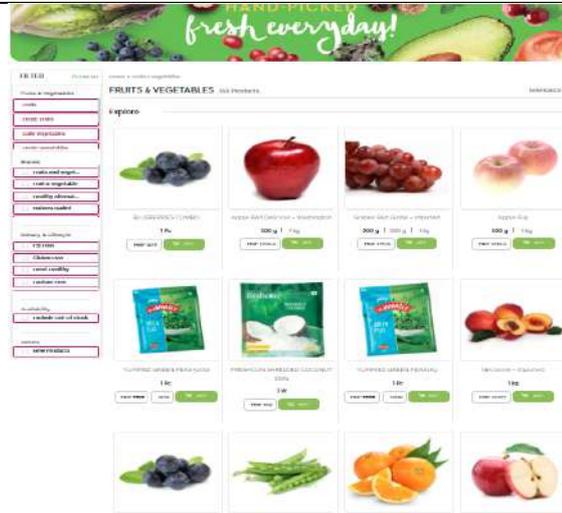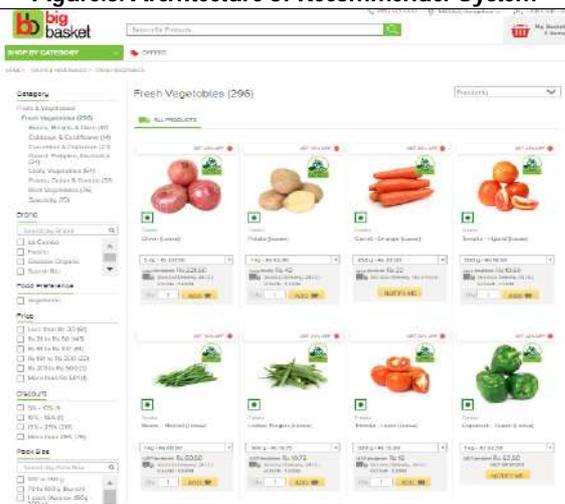
Figure.5: Big Basket Website	Figure.6: Flipkart Website
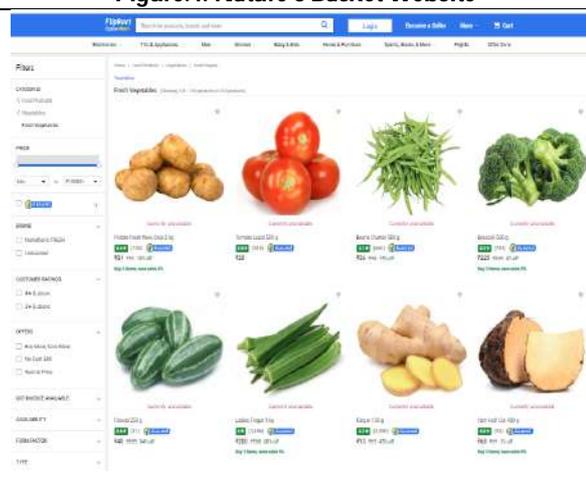
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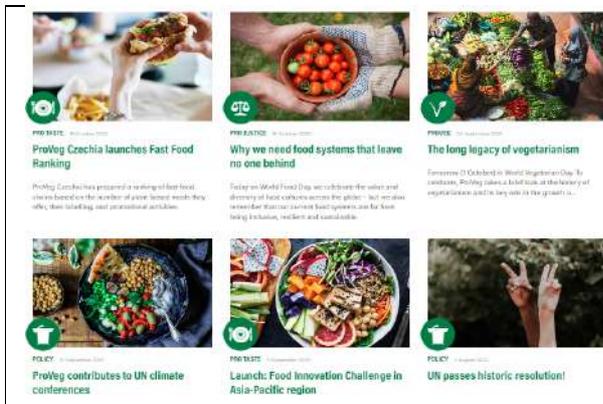
Figure. 7: Proveg Website
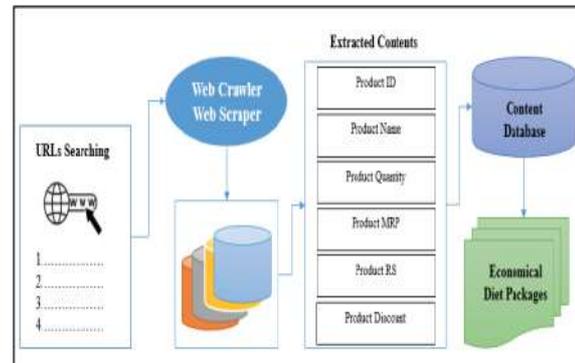
Figure.8: Architecture for Economical Diet Packages

Figure.9: Python code execution for URLs Searching

Figure.10: Extracted Contents regarding Diet Items

RESEARCH ARTICLE

Form and Structure in Gary Snyder's Poetry: Analysis of the Ultimate State of Consciousness

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ABSTRACT

When every form of thought ceases to exist, when the mind finds nowhere to go and spins in the void, when language becomes nothing and fails to perform its chores, when explanation seems meaningless and absurd, then there is an emptiness that begins to speak. Gary Snyder employs ellipses in his poetry to emphasise the emptiness that is prevalent all over the universe. An ellipse is emptiness. It is not about leaving things somewhere in the poetical form. The importance of ellipses is that they leave things out at the right spot. When the reader feels the void at the right moment of reading, the search for the unexplainable begins. At the end of this search to fill the void, the reader would attain intuition and wisdom. Gary Snyder's poems are infused with absence. He weaves the void into the structure and form of poetry. If the reader reads carelessly, he will miss the beauty of the emptiness that is blended with it. Gary Snyder incorporates absences into vocabulary, imagery, and structure in his early wilderness poems. He tries to re-invoke the idea of emptiness and the objective reality that is central to Zen Buddhist teachings. Zen Buddhism calls this emptiness as *sunyata*, as in the Tamil tradition, it is called சூனியம் ('Cūṉiyam'). Zen Buddhism indicates objective reality as *tathata*. Duality has been identified as objective reality in the West since time immemorial. But the East conceived the singularity thousands of years ago. Duality often makes humans suffer and makes them think that they are the doers of action.T.S. Eliot says, "They know and do not know, what it is to act or suffer / They know and do not know, that action is suffering and suffering is action/Neither does the agent suffer / Nor the patient act." On the contrary, singularity advocates that action takes place without any concrete cause. This paper

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discusses the structure and the concept of emptiness in Gary Snyder's poems. The researcher has taken the poetry collection "The Back Country" by Gary Snyder as the subject of this article.

Keywords: *emptiness, சூனியம் ('Cūṉiyam'), tathata, duality, Singularity*

Gary Snyder's way of writing poetry is somewhat different from the mainstream writing. His style of poetry resembles the Japanese haiku tradition. He puts together his poetry in a way that shows the philosophy of emptiness, or void.In his article, Jody Norton says:

Gary Snyder builds absences into the structure, imagery, and syntax of his texts in order to inscribe the essential Zen Buddhist perception of the identity of *sunyata,* which literally means 'emptiness', and *tathata,* or may call it as suchness and objective reality of existence, in the form itself of each poem. (41)

Poets and philosophers express through different means in order to make people understand that this universe is void and nothing in it is real. In the same way, Snyder uses spaces between the words and sometimes breaks up the lines to show the philosophy of emptiness. He uses syntactic structures very different from normal writing. Providing empty spaces in between the lines gives an opportunity for the reader to leap into the imaginary realm. Many great intellectuals often emphasise that the human imagination is everything. Whatever we imagine will manifest in the physical realm.

Through his poetry, Snyder also gives the reader an opportunity to live in the imaginary world for a moment. All around the world, every religion converges on this ideology of imagination very strongly. Orients firmly believe in the philosophy of imagination more than Occidents. And they have a very long tradition of philosophy to support this phenomenon. The Orient has a variety of spiritual sects and cults, but their fundamental ideology and themes are alike. For instance, the East has Tao, Zen, and Buddhism.

Snyder uses the Zen Buddhist philosophy of 'emptiness' in the syntax and structure.In his poetry, Snyder uses the Zen Buddhist philosophy of 'emptiness' in syntax and structure. He brought this philosophical concept into the physical form of his poetics.He also employs the philosophical concept of *tathata* in his works. The term *tathata* indicates the suchness that exists in living and non-living things and the objective reality of the world. Perceptions about the world may differ from person to person, but the objective reality of the universe remains the same irrespective of ideology of individuals.

People in the West used to thinking about the world in dualist terms. They are always searching for opposites in everything they encounter in their life. They do not believe in the concept of oneness or the Absolute. That is why science has evolved on the basis of empiricism. They do not take anything as true without evidence. However, the absence of evidence is not proof of absence. Both tangible items and thoughts are defined by binary oppositions, for example, good and evil.

We put the actual against the ideal. In other words, we try to compare reality with ideology. But sometimes the ideology that we are following or practising fails to teach us 'what is life.' Because life is so dynamic. It is not static or stagnant. It is always changing its course from one direction to another. Unfortunately, philosophers can only succeed in recording the life that is lived. They took down only the footprints of life and made it an ideology to attain life. They can never ever be able to conquer life.

Life is not a dead thing. It is so lively and energetic. We are elevating ideology at the expense of actual life. As Plato puts it, we constantly redefine our lives in accordance with thousands of ideologies we have been following.

Buddhism undermines such definitional endeavours by doubting abstract thought's ability to perceive or describe reality in any manner other than deceptive ones. Mind cannot be described in dualistic terms like "Absolute" and "conditional." The mind comes from the oneness and it will go and merge with the source after the mortal body dies. So, there is no duality. What we perceive as duality in this world is only an ignorance of reality.

Gary Snyder's poetry avoids abstractions in favour of a sequence of physical images that vividly describe the practical world. Snyder's lyrics, as a matter-of-fact as they look, rely as much on what they leave out as what they include. In other words, we can say that he uses absence in physical form as much as presence. He tries to upset our comfortable relationship in reading poetry with enjambment or end-stopped. He employs absences and gives the reader some unconventional reading experience.

He short-circuits our conventional way of reading and understanding. We used to read poems by separating and combining the structures that make us decipher the meaning of the poem. He has produced his poems with syntactical and structural ellipses. And he refused to give the complete images to the readers. This incomplete imagery in the poem makes the reader jump into the world of imagination to fill in the void in the poem.

Snyder elevates the reader to a higher level by giving a grip on natural objects to complete the unfilled imagery in the poemand it paves the way to attainintuition. For him, 'Imagination is everything.'All are born out of imagination in this universe. Whatever we imagine with our minds becomes a physical reality. So, Snyder emphasises the requirement of imagination to a great extent in his of writings. T.S. Eliot says, "They know and do not know, what it is to act or suffer/They know and do not know, that action is suffering and suffering is action/Neither does the agent suffer/Nor the patient act" (Eliot)

The rules of grammar, user manuals, style guides for a language, and other tools are meant to make language more organised and logical. Language has to be learnt for communication. Knowing the systematic structure of language makes the learners to use it with utmost convenient. When necessary parts are absent from language structures, whether lines, sentences, or poetry forms then the conversation become nonsensical.

In his poems, Snyder voluntarily left out the conventional sentence structure, syntax, and other proper writing forms. His methods, however, strive for more than just perplexing the reader tounderstand the meaning of the poem. His goal is to use the grammatical, syntactical, and semantic spaces in language, which are the basis for all structuralist work, to create a kind of instant understanding that language is not theoretically meant to create to understand everything, especially the absence.

In an effort to guide the Zen student toward his own direct spiritual experience, Zen Buddhist teachings allude to an ultimate truth by one term or another, since language must make temporary use of names for any spiritual experience. However, such terms are not meaningful in the conventional sense since the "meaning" they imply cannot be captured by a specific phrase. Whatever experience or thing that they try to point out with language always eludes them.

No one could exactly capture and preserve spiritual experience through language. Sometimes, we can approximately capture that particular experience with language. The partial knowledge of that experience would transfer from one generation to another. Here, absence plays a more vital role than presence. In other words, silence gives us what we are searching for rather than an utterance. Defining the Absolute as a separate entity from everything else is to mistakenly give it a place as an entity or a thing to be found in the world, like a treasure.

In this modern era, people are thinking that taking the path towards knowing the Absolute is like enrolling in the gym or playing some sports. Searching for the Absolute has become an extra-curricular activity for people. They have perceived the concept of Absolute as being far removed from their daily lives. They fail to see that Oneness, or

the Absolute, is mingled with life. The Absolute is not a dead thing or some inanimate concrete object, but it has life and it is so vibrant and dynamic.

In a traditional way, we can say that God is another word we are using to point out the Absolute. The Absolute cannot be excluded from life, and vice versa. Life and Absolute are the two sides of the same coin. That is why Snyder stays away from making any direct reference to the Absolute. Through his use of ellipsis, parataxis, and spaces in his poems, he hints at the idea of Absolute in a roundabout way.

In several of his poems, he eliminates the speaker, or the subject of the poem, as the doer of the action. Snyder's views on the nature of the self are consistent with those of Buddhism, which holds that the self is an illusion. The removal of the subject is often followed by the replacement of verbs with verbals. The poet conveysaction via the use of ellipsis without referring"I" who takes action but rather as an activity that is just occurring.

This concept of self is unreal, according to many philosophical systems, including Buddhism. "Self" is pure illusion. We often think that we are doing something in our lives. And for that action, there are reactions. If we receive positive response, then we are encouraged and we will be very happy. We take the credit for it. We go on to say that we have done hard work to achieve this.

In contrast, if our attempts end in failure, we blame God and fate. We never accept or blame us for the cause of failure. So, from birth to death, we believe that we are the doer of the action and, at the same time, we are the receiver of the consequences. Depending on the outcome of the action, we will be happy or unhappy. Most of the time, we suffer. However, reality differs greatly from what we perceive in our daily lives.

Snyder says that there is no doer in this universe. Everything is preordained. We are just a catalyst to initiate the action and become the witnesses to it. We are powerless to change or initiate a new action. We are just following the blueprint that is already laid down. That is why Snyder has not referred to the subject as the cause of the action in his poems, rather the action just happens of its own.

In his poetry, Snyder uses tangible natural imagery like earth, plants, and animals that are both powerfully sensual and general in their conception.Generalization ofimagery serves two purposes: it rejects the proper and its characteristics without rejecting particularity (the common), and it suggests that the poem's corporeal experience is neither individually nor historically unique.

Whereas, other writers provide readers with poems that are dense with meaning or have a specific message to convey.In Snyder's case, it is exactly the opposite. He never fully presents the poem with meaning; instead, he allows for an infinite number of actualizations by leaving out connectors between the words, syntactical structures, and proper poetic form.

The position of the reader changes from just being the receiver of the text to being the creator of the text. The reader can only create or comprehend the poem by refusing to be just a witness to it. He then goes on to fill the space in the poem with his power of imagination. The poems require the readers to actively engage their imagination. This participation in the creating process ultimately ends up in the highest state of imagination; that is, intuition. Snyder emphasizes the need to go beyond intellectual and discursive approaches to complete the poetic experience through the use of imagination and intuition.

Snyder's poetry contains many aspects of the poetics and aesthetic practices of the *shih* poetry of *T'ang* Dynasty of China and the Japanese *haiku*. In addition to that, it also contains the Buddhist philosophy of non-conception and the conception of the Void. These philosophies and forms of poetry serve as an ontological basis for writing poetry. Snyder mixes these assumptions and practices with his own experience, imagination, and voice to create a unique elliptical style. This style tries to make form not an extension of content but an expression of it.

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The nature of the Chinese language itself is responsible for many of the *shih's* peculiarities. The Chinese language has characters rather than letters. It is a pictural language. And it is a case-insensitive language with no gender or number distinction. The *T'ang* dynasty's *shih's* nouns are interesting because they often refer to concrete objects rather than abstract ideas. There is no word to describe the abstract feelings we have in life.

This form of writing influenced Snyder so much that he adopted this technique in writing poetry. He did not use any abstract things, but rather he used concrete objects in all of his poems. Through concrete objects, he tries to represent abstract forms without any explicit evidence to the abstract.

In addition to person, number, voice, and mood, Chinese verbs lack tense. They do not need a subject or an object since they are autonomous in their expression. As a result, despite their existence in the language, personal pronouns are never employed. A five-character shih line often has no verb at all.For instance, we may look at the elements that we have spoken about thus far in the *shih* poetry below:

公雞烏鴉苫店　　月
cock　　　crow　thatch　　inn　moon

人　　　痕迹木头桥霜
　　man　　　tracewood　　　bridge frost
　　　　　　　　　　　　　　　(Norton 44)

Not only do these lines lack verbs and verbals, but also connectives, prepositions, and articles. They are made up of a group of nominal components arranged in a highly elliptical syntactical relationship that "strongly suggests the actuality of the situation" (Yip 25), but for which no predetermined imaginative synthesis has been established. For the sake of the overall meaning of the passage,Wai-lim Yip suggests the translation as follows:

(At) cockcrow, the moon (is seen above) the thatched inn; Footprints (are seen upon) the frost (covering) the wooden bridge. (Yip 25)

Yip characterises the *T'ang* Dynasty *shih* technique as "vigorouslyunanalytical presentation" (Yip 20).It is an image-based poem as opposed toconcept, in which the visuals are not clearly situated nor completely rendered,andit is unclear what exactly their interrelationships are.

According to Burton Watson, *T'ang* Dynasty landscape poetry,"offers us a landscape which is not really a landscape at all . . . but rather a blank canvas . . . inscribed 'tree,''bird,''mountain,''water' in the appropriate areas, upon which we are asked to execute our own realization of the scene."(55)

Jordan Norton says that,
Spaces are created, both in the figuring forth of the imagery and in the poem's syntactical and structural chains, in order to draw the reader into an imaginative actualization of situations and events that have been minimally suggested by the selected, juxta- posed images of the text. Such imaginative activity may, in turn, lead on to a wordless recognition of the true nature of what is thus envisioned.(45)

Observing the line once more:

cock　　　　　crow　　　　thatch　　　　inn　　　　moon
man　　　　　trace　　　　wood　　　　bridge　　　frost
　　　　　　　　　　　　　　　　　　　　　　　　　(Norton 45)

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By reading the above lines, the reader gets a strong conception of the tangible nature of the world. It would be very surprising to know that there is no individuation or particularity in nature as we have in humans.Snyder's poetry uses a lot of generalized imagery.Several examples of this kind of generalized imagery may be found in the poems, such as "August on Sourdough", "A Visit from Dick Brewer": "Meadows and snowfields, hundreds of peaks,"and "summer mountain rain" (BC 25).

A field is neither a field nor the field, but simply field, a generic symbol that the imagination must actualize. Snyder regularly omits definite and indefinite articles as a grammatical complement to this lack of specificity in the imagery. For instance, the first few words of "Across Lamarck Col" are as follows:

Descending hillsides in
half morning light, step over
small down pine,
I see myself as stony granite face. (BC 106)

T'ang's shih poets often define their nouns simply and inexpensively bygiving the broad strokes of their imagery: "green willow" is a good hypothetical example, but "delicately tinctured foliage shimmering with an aquamarine refulgence" is not that much economical as the one before.Snyder uses similar economy of usage in various poems. A particularly potent illustration of the strongly nominal nature of his imagery may be seen in the following passage from "The Spring":

the foreman said let's get a drink
&drove through woods and flower fields
 shovels clattering in back
 into a black grove by a cliff
 a rocked in pool
 feeding a fern ravine
 tin can to drink
 numbing the hand and cramping in the gut
 surging through the fingers from below (BC 18)

The only real descriptor in the sentence is "Black", and it plays as an adjective. The nouns"Flower" and "Fern" are used as adjectives in the poem. He invented "rocked in" as new past participle. The tone of this piece is extremely intimate and personal. These lines from the poem, however, are more appropriate as a sample of the technique that he used throughout the poem and an example of the open-endedness. It is a perfect example of using broad imagery in poems like in shih poetry. This form and theme of Snyder's poetry remain us "This Lime-Tree Bower My Prison" in which Coleridge writes:

…dell, o'er wooded, narrow, deep,
And only speckled by the mid-day sun;   (para.1)

While simultaneously attempting to be aesthetic wholes, which they are, Snyder's poems nevertheless have Void that neither the poet nor the reader has yet filled. Snyder's poems eventually serve to communicate to the reader more than just a certain meaning to comprehend.

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REVIEW ARTICLE

Myasthenia Gravis: A Review

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ABSTRACT

Myasthenia gravis is a commonest autoimmune disorder that affects the NMJ. NMJ is transmitting action potential from nerve to muscle cells. Symptoms such as difficulty swallowing, Double vision or seems that limbs are common somatic complaints of the patient. The antigens which are targeted by Abs in MG are located all over the post-junctional region and can be classified under two main groups of antigens transmembrane or extracellular antigens and cytoplasmic or intracellular antigens. This review summarises the diagnostic test involved in MG such as the edrophonium test, ice pack test, sleep test, serocological test, cogans lead twitch test, and electrodiagnosis test. Available treatment for MG patients Acetyl Cholinesterases inhibitor, corticosteroid and immunosuppressants. The "classical" treatments of MG include molecules alleviating the symptoms, drugs targeting the autoimmune mechanisms of the disease, and thymectomy. Besides the long-term management of the disease, severe myasthenia crises require particular treatments, including intravenous immunoglobulin (IVIg) infusions, plasmapheresis, and non-specific medical aid unit management in case of respiratory involvement. The recent drug used in Myasthenia gravis is Efgartigimod ,Ravulizumab, DESCARTES-08, etc.

Keywords: Myasthenia gravis, etiology and symptoms, pathophysiology, Cortactinantibodies, Diagnosis and treatment, recent target for disease

INTRODUCTION

Myasthenia gravis is the commonest autoimmune disorder that affects the NMJ [1]. It's an estimated worldwide prevalence of between 15 and 179 per million people. MG causes fluctuating weakness that worsens with activity and as the day progresses, and ocular weakness causes ptosis and diplopia [2]. With modern treatment facilities like

immunotherapy, thymectomy, and medical care facilities available, population-based studies show that MG and non-MG individuals have identical life expectancy [3]. However, the disease progresses over weeks or months, with exacerbations and remissions [4]. The name myasthenia, Latin and Greek in origin, means "grave, or serious, muscle weakness." there's no known cure, but with current therapies, most cases of myasthenia are not as "grave" as the name indicates. Available treatments can control symptoms and sometimes allow people to have a relatively high quality of life. Most people with the condition have a normal life expectancy [5]. While a variety of immunosuppressive therapies are available, around 10% of patients with MG are termed refractory, experiencing frequent relapses upon lowering their immunotherapy or remaining clinically unstable on their current immunotherapeutic treatment regimen [6,7]. Myasthenia (MG) is caused by antibodies that target the post-synaptic membrane. These antibodies are common to the nicotinic acetylcholine receptor (AChR) but during a smaller proportion of cases, antibodies to muscle-specific tyrosine kinase (MuSK) or lipoprotein receptor-related protein 4 (Lrp-4) are often present instead [8,9,10].

Etiology
The most common cause of MG is autoantibody. Similar to other autoimmune disorders, myasthenia gravis occurs in genetically predisposed individuals. Infection, immunization, surgeries, and drugs are the factors to a specific event or trigger to the onset of the current problem. Nicotinic acetylcholine receptor, muscle-specific kinase, and lipoprotein-related protein IV are common in the NMJ against which auto-antibody is produced. For the formation and maintenance of NMJ, including distribution and clustering of the AchR.The agrin-LRP4-musk protein complex is essential [11]. A thymoma is a tumor of the thymus & implicated in the production of antibodies. Approximately 10 percent of MG patients have a thymoma [12].

Symptoms
Initial Symptoms
MG does not appear with common symptoms like fever, pain, or nausea. Mainly patients that consider the first appearance of diplopia, ptosis are uncommon symptoms as a curiosity rather than the manifestation of an illness. Symptoms such as difficulty swallowing, Double vision seems that limbs are common somatic complaints of the patient first be suspected of having a primary psychiatric disease common for MG patients for this reason some patients are compelled to pursue all avenues of diagnosis [13,14].

Clinical Manifestations The most common ocular symptoms are throughout Myasthenia gravis. The loss of awareness of diplopia when the gaze is disconjugate implies that there has been time for central nervous system (CNS) adaptation and suppression of the eccentric image, which means the disturbance of eye movements has been present for at least several weeks. Myasthenia gravis can affect any of the muscles that are under voluntary control, Eye muscle:- The first sign and symptoms of Myasthenia Gravis that involve eye problems such, •Ptosis (drooping of both eyelids or one) Diplopia (double vision) may be improved or resolved when one eye is closed [15,16]. Face and throat muscles:-15% of people the first symptoms of Myasthenia gravis involved throat muscles and the face which can; •A speech impairment refers to an impaired ability to produce speech sounds and may range from mild to severe, depending on which muscles have been affected. In some cases, liquids are trying to swallow come out of your nose, and difficulty in swallowing. Effect chewing- If you've been eating something hard to chew, such as steak, your chewing muscles may tire halfway through a meal. Change facial expressions-You might look like you are snarling when you smile [17,18] Neck and limb muscles:-There are also symptoms of weakness in the neck, arms, and legs associated with myasthenia gravis. Having weak legs can make it difficult for you to walk. weak neck muscles make it hard to hold your head [19,20].

Pathophysiology
A synaptic connection among the presynaptic motor nerve terminal and postsynaptic skeletal muscle membrane is a neuromuscular junction. NMJ is sending impulse from nerve to muscle cells. The antigens which are targeted by Abs

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in MG are located all over the post-junctional region and might be classified beneath two main groups of antigens area unit transmembrane or extracellular antigens and protoplasm or intracellular antigens [21].

Physiology of a Normal Neuromuscular Junction
Acetylcholine is discharged from the presynaptic membrane binds to the AChR. The receptor's cation channel opens transiently, manufacturing a localised electrical end plate potential. If the amplitude of this potential is enough then it generates an action potential that spreads throughout the length of the skeletal muscle cells, triggering the discharge of calcium from internal stores and resulting in muscle contraction. Spontaneous release of acetylcholine includes contents from a single vesicle, giving rise to a low amplitude depolarization of the muscle membrane miniature end-plate potentials. With the impulse, an outsized large choice of vesicles releases neurotransmitter in "quanta". This produces an outsized depolarization, "endplate potential" (EPP) of the muscle membrane, main to a propagated impulse and muscular contraction. During repeated nerve stimulations, the amount of acetylcholine launched step by step decreases after the preliminary few stimuli, so called as "synaptic rundown". Under normal conditions, the amplitude of the EPP is more than necessary to produce an action potential and triggering muscle contraction. This excess is termed as "safety factor". The protection element i.e safety factor depends on several elements which include the amount of acetylcholine released and the quantity and integrity of the AChRs, amongst others. The reduced safety factor in association with a normal "synaptic rundown" result into progressive decline in muscle power on repeated stimulations in myasthenia gravis [22].

The disease can be associated with multiple Antibodies Targeting Transmembrane or Extracellular Antigens which include:
AChR (postsynaptic acetylcholine receptor) antibody: 85% patients
AChR autoantibodies are particularly of the IgG1 and three subtypes, then they are divalent and complement activating [23].Binding of those antibodies to AChRs consequences in activation of the classical complement pathway with assembly of the membrane attack complex (MAC). Calcium influx through the MAC leads local harm to the membrane, with launch of AChR-containing membrane particles into the synaptic cleft [24].The damaged postsynaptic membrane suggests a faded response to acetylcholine, as measured electrophysiologically (figure)by way of reduced amplitudes of EPPs and mEPPs. it's not widely appreciated that the complement damage also causes a loss of voltage-gated sodium channels, which are located within the secondary folds and raising the threshold that the EPP must reach to trigger the muscle action potential [25].Bivalent AChR IgG also can cross-link adjacent AChRs, increasing the normally slow rate of internalisation and lysosomal degradation of the AChRs (In mice normal half life is around 10 days) and leading to a loss of AChRs even in the absence of complement attack.(Figure2) [26].Perhaps, maximum of the antibodies do not direct block of AChR characteristic, although AChR block has been proven with some character affected person sera [27].

Healthy Neuromuscular Transmission
By exocytosis, the nerve terminal can release the contents of every vesicle (quanta) of neurotransmitter. It activates the intrinsic ion channels of neurotransmitter receptors (AChRs) within the postsynaptic membrane to supply a tiny low, transient change referred to as a miniature end-plate potential (mEPP).The nerve action potential opens voltage-gated cation channels (VGCCs) and triggers exocytosis of the many quanta of neurotransmitter and at the same time produces the (much larger) EPP. The amplitude of the EPP is quite enough to reach the threshold which is required to activate the postsynaptic voltage-gated sodium channels (VGNaCs)A muscle action potential generated

The Myasthenia Gravis Neuromuscular Junction.
AChRantibodies(substantially immunoglobulin(Ig) G1) activate complement, leading to membrane attack complex-intermediated injury to the post-junctional membrane. By divalent antibodies the postsynaptic AChr area unit are depleted causing AChRinternalisatio And because of the loss of AChRs leads to lower mEPP and EPP amplitude The EPP might not reach threshold, particularly once the nerve is repetitively activated.

MuSK (muscle-specific kinase) antibody: 5%
MuSK is a muscle membrane protein, which has an extracellular domain, transmembrane helix domain and cytoplasmic domain with tyrosine kinase activity. The extracellular domain have three immunoglobulin like regions and a cysteine-rich domain, also called Frizzled-like domain. The bulk of MuSK antibodies bind to the Ig-like regions of the MuSK extracellular domain [28,29].AChR antibodies and MuSK antibodies are unlike belong primarily to the IgG4 subclass, which do not activate complement and are largely functionally monovalent due to Fab arm exchange [30,31]. Their pathogenicity appears to stem, from inhibition of relations between MuSK and collagen Q or LRP4 via binding to the primary Ig-like domain of MuSK andsubsequent reduction of both agrin-induced and agrin-independent AChR clustering [32,33,34]. The titer of MuSK antibodies appears to correlate with disease severity, both in individual patients and within the population [35,36].

LRP4 (Low-Density Lipoprotein Receptor-Related Protein 4) antibody: 2%(R-0)
LRP4 has a central part in synaptic development and maintenance. It is a transmembrane protein and containing several low-density lipoprotein domains. For neural agrin LRP4 acts as the muscle receptor, propagating the signal to MuSK for AChR clustering at the NMJ [37].LRP4 autoantibodies are detected in some MG cases. Inhibition of the LRP4-agrin interaction appears to be responsible, at least in part, for their pathogenicity [38,39,40,41].Still, LRP4 antibodies belong substantially to the IgG1 subclass [38,41].And they have been shown to cause in vitro complement mediated cell lysis of C2C12 myotubes[41].So complement activation could also play a role in MG patients. The LRP4 is also present on motor neurons in the brain. Interestingly, LRP4 antibodies have also been detected in 10–23% of amyotrophic lateral sclerosis (ALS) patients and are therefore not simply specific for MG [42,43].

Agrin antibodies
Agrin is a proteoglycan and released from the motor nerve that binds to LRP4. It forms LRP4-agrin complex that is critical for MuSK activation and AChR clustering at NMJ [44].The agrinAbs are tested in patient sera by CBAs (HEK293 cells transfected with recombinant agrin proteins) or ELISA technique [45].AgrinAbs were detected in 50% of known triple seronegative MG patients (that is, AChR, MuSK or LRP4 antibodies negative) [46,47].However, agrinAbs are also detected in MG patients (2–15%) with or without AChRAbs and MuSK antibodies [48,49].In a recent study, although most agrin positive cases were presented with severe form of disease and they responded well to standard MG remedy [50].

Acetylcholinesterase (AChE)/Collagen Q (ColQ) Antibodies (ColQAbs)
ColQ proteins expressed in the extracellular matrix at NMJ are pivotal for anchoring and concentrating AChE (i.e., AChE/ColQ complex) [51,52].At the synaptic basal lamina the interaction with MuSK protein anchors this complex. ColQ Abs likely interrupt the AChE/ColQ complexes, therefore decreases the quantities of AChE at the cellular surfaces [53].Further, the MuSK Abs can block ColQ-MuSK interactions that ultimately may reduce AChR clustering. Anti ColQ fused with the transmembrane domain of contactin-associated protein-like 2 (CASPR2) in CBAs have detected ColQAbs in 3% of MG patients, despite the fact that comparable frequencies are mentioned inside the controls [54,55]. Other antibodies, to each intra- and extracellular targets, have a poorly outlined role in the pathogenesis of the condition and are found in some patients titin (a striated muscle protein) antibodyRyR (ryanodine receptor) antibody [56].

Auto antibodies Targeting Intracellular Proteins
Although intracellular localization of those antigens makes them uncertain to play a direct part in MG pathogenicity, still, they might be helpful biomarkers for clinical characteristics, and/ or thymus pathology in MG cases [51,57,58].

Striational Antibodies [Titin Abs and Ryanodine Receptor (RyRAbs)
Titin is that the largest living thing macromolecule in skeletal muscle cells. The titin Abs square measure usually tested in patient sera by business technique, ELISA, and RIPA tests [57,59].TitinAbs square measure detected in around 20–40% AChRAb positive MG cases, with associated symptoms recently onset MG and thymoma-associated MG, therefore the presence of titin Abs in early onset MG patients may well be a biomarker for thymoma

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[60,61,62,63,64,65].Titin Abs also are detected in close to thirteen of renowned triple seronegative MG cases (that is, AChR, MuSK, or LRP4 Abs negative) [66,67,68].Analogous to titin, RyRAbs also are related to late onset MG and thymoma [69,70].The RyRAbs square measure detected by ELISA technique or western blot strategies. However, recently, flow cytometric CBAs are used for the quantification of those antibodies with advanced sensibility than ELISA methods [52,71].In addition, the MG patients with redness also as late onset MG, thymic abnormalities associated MG tested positive for the presence of anti-titin, and RyRAbs [62,72,73,74].

Cortactin Antibodies (CortactinAbs)
Cortactin is associate degree intracellular macromolecule that promotes simple protein assembly and MuSK mediated AChR clump at NMJ. . The cortactinAbs can be detected by ELISA or western blotting. CortactinAbs are detected in 20% of SNMG, still, they are also detected in 10% of AChR MG patients and 5% of healthy controls [75,76].Most of the patients with cortactin Abs are associated with ocular or mild GMG [76,77,78].

Recent Target for Disease
Treating MG implies considering many parameters: the form of the illness (i.e. ocular, mild or severe generalized MG), the age of the patient, and also the presence of different conditions (e.g. pregnancy, severe diabetes or blood vessel hypertension) or treatments that will lead to associate absolute or relative reason of a doubtless helpful drug. Most patients can want a long-run treatment, typically for his or her whole life, however selecting the optimum treatment isn't invariably straightforward, as reliable, controlled studies scrutiny the various treatment choices are scarce, for the most part because of the large non uniformity of patients' presentation and severity, and additionally to the variations ascertained in their management to keep with the "local culture" of their physicians. The "classical" treatments of MG include molecules assuaging the symptoms, medicine targeting the reaction mechanisms of the illness, and thymectomy. Beside the long-run management of the illness, severe myasthenia crises need explicit treatments, together with blood vessel immunoglobulin (IVIg) infusions, pheresis and non-specific medical care unit management just in case of metabolic process involvement. One ought to additionally invariably prompt that myasthenia symptoms will worsen (sometimes dramatically) due to potentially aggravating medicine, like quinine, macrolides or beta-blockers [89].

CONCLUSION

Myasthenia gravis (MG) is the most common primary disorder of neuromuscular transmission. It has been learned about the pathophysiology and immunopathology of MG during the past 30 years. Tremendous progress has been made in the treatment of myasthenia gravis in the last eight decades, making it one of the most treatable autoimmune disorder in humans beings. Different therapeutic approaches have been developed for MG cases and also diagnosis test are available at laboratories of health care system. The recent development of biological, which have a more targeted mechanism of action and different side effect profiles, may change the treatment algorithm of MG treatment in the future.

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Table 1. Tests involved in diagnosis of myasthenia-gravis.

Sr. No.	Test	Observation
1	**Edrophoniumtest(Tensilon Test)** A small amount of the drug Tensilon (edrophonium chloride) is injected into pateint arm or hand via an IV needle. Once injected, the drug usually kicks in within 30 to 45 seconds.The small amount of Tensilon that is injected only lasts in the body for about 5 to 10 minutes. So, during the span of the multiple smaller doses of the drug (usually about 2 milligrams) are given [79,80]. Then doctor will ask you to perform a series of movements over and over again to see if the drug is working. Some of these movements may be ● Crossing and uncrossing your legs ● Standing up and sitting down ● Raising your arms above your head till they get tired ● Taking a series of deep breaths [81]	Tensilon prevents the breakdown of an acetylcholine. When working properly, nerve cells release acetylcholine in order to activate muscles [80]. If someone begins to feel a sudden improvement in muscle strength, it could mean that they have MG.
2	**Ice pack test** Heat was noted to worsen an MG-patient's fatigue and weakness, while cold, on the contrary improved them , which gave the idea for a simple local cooling test: application of an ice-pack over a symptomatic eye for 2–5 min [82,83].	It was found to reduce ptosis and ophthalmoparesis and leads to improved neuromuscular responses [82,83].
3	**Sleep test** This involves asking the patient to rest in a quiet and darkened room with eyes closed as if to sleep. The palpebral apertures are	In MG the improvement of the ptosis has been postulated to be due to an increase in the amount of Ach

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	measured before and after the procedure. This test may be impracticable in contemporary clinical situation [84].	released upon awakening [84].
4	**Serological tests** Serologic tests check for the presence of antibodies within the body fluid (a element of blood).Seropositive means that there is presence of the antibody in the blood, and seronegative means that the antibody was not detected [85].	In 90% of patients with MG, a positive check result confirms a identification of MG. However, for both AchR antibodies and MuSK antibodies 6% to 12% of patients with myasthenia may test negative. These patients have seronegative MG and are more likely to have ocular MG than those who are seropositive [85].
5	**Cogan's lid twitch test** This was described by David Cogan. The patient is asked to look downwards for about 15 -20s, then to look right up back to the initial gaze [86].	In this response the lid shows a momentary upward twitch [86].
6	**Electrodiagnostic tests** Repetitive stimulation of peripheral nerves Single-fiber electromyography [87].	Positive in approximately 90% of GMG patients and 30%-60% of oMG patients Positive in 95%-99% of MG patients [87].

Table 2. Treatment for myasthenia gravis.

Treatment	Drug	Dose	Duration of effect	Adverse effects
A)Acetyl cholinesterase inhibitors	i)Pyridostigmine Bromide	Starting at 30 mg three times a day, then increasing to 60-90 mg four times a day.	4 hours	-Abdominal pain -Diarrhoea -Excessive saliva secretion
B) Corticosteroids	i)Prednisolone	Started at a low dose of 10-20 mg/day and increased by 5 mg every third day up to 60 mg/day [88].	Improvement or effect usually begins in 2-4 weeks, with maximum benefit after 6-12 months or more.	-Weight gain -Hypertension -Hyperglycemia -Osteoporosis -Aseptic necrosis of the hip - Cataracts -Immunosupression
C) Immunosuppresants	i) Azathioprine	Starting at low dose of 50 mg/day if tolerated the dose is gradually increased depending upon response.	Takes 3-6 months to start working.	-Idiosyncratic flu -Bone marrow suppression -Liver toxicity
	Ii)Cyclosporin			-35% patient can't tolerate drug due to nephrotoxicity -Increase in blood pressure

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	iii) Cyclophosphamide	-	-	-
	iv) Methotrexate	-	-	-
	v) Mycophenolatemofetil	Recent drug		
D) Plasmapherisis	-	-	-	-
E)Intravenous immunoglobulin	-	-	-	-
F) Thymectomy	-	-	-	-

Table 3. Recent target for MG.

Cholinesterase inhibitors	Immunosuppressive (IS) drugs	Rituximab
By inhibiting the action of acetylcholinesterase at the NMJ, these molecules increase the half-life of neurotransmitter and optimize its potential interaction with AChR. They need to be a section of the first-line treatment of MG Patients [89].Pyridostigmine sixty mg is the main drug utilized in clinical practice throughout the globe, and provides relief at a variable dose in line with the patients' symptoms. The drug intake ought to be prescribed late inside the evening. facet effects of cholinesterase inhibitors embrace muscle cramps andcontractures, diarrhea. A cholinergic crisis with muscle weakness is feasible simply just in case of over indefinite quantity of the molecule and may be differentiated from myasthenia paralysis. Of note is that the actual fact that anti-MuSK MG patients usually responds poorly to enzyme inhibitors, and should even sometimes worsen beneath treatment.	hey may be another to steroids, particularly in sufferers over sixty years older, in steroid-resistant styles of MG. They are extensively used as a concomitant remedy that permits tapering the doses of prednisone in steroid established patients with generalized forms of MG. Prescribing every steroids and IS medicine among the primary section may be a commonplace habit in a very few centers, aiming at limiting the entire extended term consumption of steroids.Azathioprine,mycophenolatemofetil,Cyclosporine, methotrexate and tacrolimus are presently thought of as doubtlessly useful in MG [89]. The primary medicine are sometimes used as firstline IS medicine, and every one of them need associate ok observation of potential facet outcomes.Cyclophosphamide, a remedy used in chemotherapies but in addition suppress- ing the immune gadget, can also be currently and once more proposed in non-responders [90].	This antiCD20 B-cell depleting monoclonal antiframe has tested to be a major weapon within the fight in opposition to instances of MG that do now not meet therapeu- tic goals with IS treatment. At the prevailing time, it is thus a 2d-line treatment, all the a lot of so rare however intense complications.

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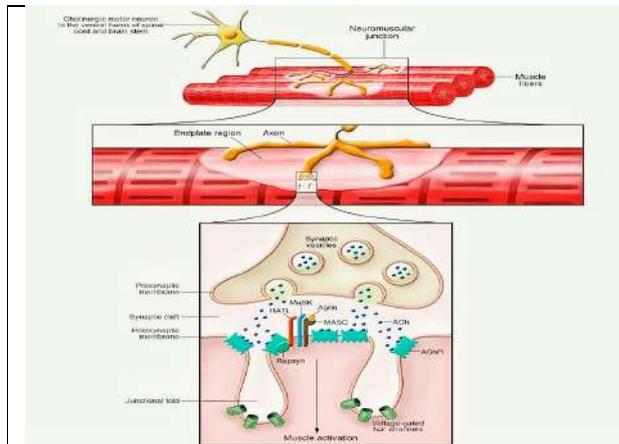
Figure 1.Functioning of Neuromuscular junction.
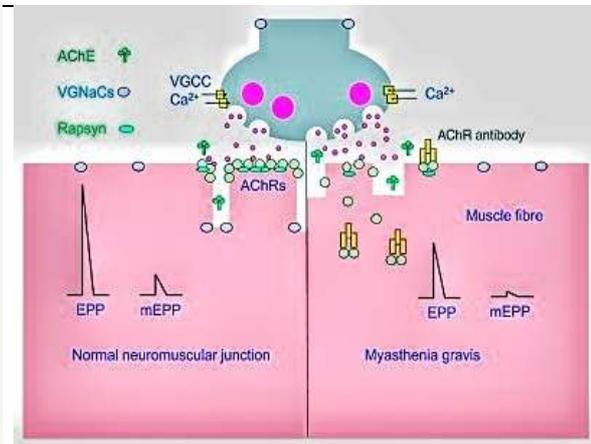
Figure 2.Assessing neuromuscular transmission.

RESEARCH ARTICLE

Life Skills Inculcation as Predictor of Entrepreneurship among Tribal Students

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ABSTRACT

India is developing rapidly almost in all sectors. Along with this, expectations, hopes, aspirations are growing up to contribute maximum to such developments. The sector which needs main attention is the education because it is the only instrument which contributes to further growth in all other sectors. It is therefore to keep it on priority to equip children with some skills along with the academics. Such skills which may empower students to become successful entrepreneurs and good citizens are life skills. Life skills are the abilities of positive and adaptive behaviours that enables individuals to deal effectively with the demands and challenges of life (WHO). Many organizations have enlisted such skills. WHO and as per 21stCentury Skills there are certain skills that helps to empower the students to become an entrepreneur such skills are Self- Efficacy, Effective Communication, Problem Solving, Creative Thinking, Critical Thinking, Decision Making and Leadership and Responsibility. Through this paper an attempt has been made to highlight the importance of such skills for the upliftment of tribal students to become better entrepreneurs in their respective vocational areas. Secondly, to point out the evidences indicating the successful rate of such students possessing such skills. Thirdly, to present the empirical evidence about the present status of the extent of life skills among tribal students indicating the need for more initiatives by comparing them with other students through a case study and finally to explore and suggest various techniques which will be helpful for the inculcation of such skills.

Keywords: Life Skills, Tribals Community, Entrepreneurs, Problem Solving, Decision Making.

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INTRODUCTION

India is a developing nation. Children in India have a variety of demands and rights as well as a variety of living conditions. In addition to their rights to adequate nutrition, a safe and supportive environment, the chance to reach their full potential and generally leading healthy, happy and fulfilling lives. They also need to be educated, healthy and skillful in order to be productive and well-adjusted citizens of the future. Children in our nation confront a variety of difficulties. Many of them are first-generation students who have several difficulties in school. They may be vulnerable in numerous ways as a result of socioeconomic and cultural factors. They could make risky and hazardous decisions as a result of peer pressure and a lack of positive role models (Nayar). With a population of over 10 crore, tribal groups or Adivasis form a large community in India. Largely confined to forests and villages of central, south, and northeast India, the tribal population has been dependent on the jungle and produce for their livelihood. Tribal groups have always shared a unique relationship with nature and follow sustainable practices of livelihood. With religious practices of worshiping nature and land laws that give collective rights to communities, the tribal way of life is unique.

However, due to lack of accessibility and development, the standard of life among tribal groups remains poor. Low literacy, high dropout rates from schools, malnutrition and poverty have always high in India's tribal population. According to the 2011 census, the literacy rate in tribal India is 59 percent, far below the national average of 73 percent. With an exception of the northeastern states of Mizoram, Nagaland and Meghalaya, a sizeable tribal population in Madhya Pradesh, Orissa, Jharkhand, Chhattisgarh, Rajasthan and Andhra Pradesh and Jammu and Kashmir remains illiterate. (Sourab Roy 2019). But turning problems into opportunities, there is a rise in entrepreneurship across tribal groups of India. By connecting agriculture and forest produce with markets using technology, creation of self-help groups, empowering women, and creating self-sustainable enterprises, a number of tribal entrepreneurs are changing the face of tribal India.

To celebrate these entrepreneurs and build greater dialogue around the problems of tribal India, along with their methods and approaches, NITI Aayog organized India's first Global Tribal Entrepreneurship Summit in Dantewada, Chhattisgarh, recently. The summit aimed at addressing poverty, malnutrition, low literacy and poor health using the power of enterprise and technology (Sourab Roy 2019). The govt. of Indiahas aimed for imparting skill training to 50 crore people by 2022 in various fields from rural and urban areas alike, and help women, youth and deprived population in the obtaining benefits from various schemes and institutions of the government, so that they can live a dignified life. As per the WHO Life- Skill as "the abilities for positive and adaptive behavior that enable individuals to deal effectively with the demands and challenges of everyday life" there are ten life skill has been given by world health organization which are as given below:

21st century skills: With the onset of 21st century, the entire world has witnessed an era of intense transformation in all areas, whether it is education, global trade and economy, technology or society. Naturally, for such times, a different skill- set is required that would enable an individual to cope- up and succeed in facing the challenges in real- life, leading to his holistic progress. There skills are addressed as 21st century skills/ learning skills/ transversal competencies etc.

The process of entrepreneurship helps in the transformation of ideas into innovations and creating new economic opportunities and thus entrepreneurship play a critical part in the success of any nation. However, in order to be successful an entrepreneurial and innovative friends' culture in a country skills and knowledge are the important. As a result, entrepreneurial, skill and knowledge are critical for economic growth and social development. Skill development is a necessary component of a country's successful business and culture. Entrepreneurship refers to businesses and enterprises that engage in various economic activities by utilizing and effective management of available resources to provide for and fulfil the required goods and services. A skill can be described as a ability acquired to work in a specific sector. Thus, skill development can also be defined as the improvement of one's skill in

order to become a more efficient and capable human resources. The entrepreneurship education prepares young minds to learn future skills. The young generation should be encouraged to launch their own forms because entrepreneurship creates a variety of opportunities and considerably boost the nation's economy. Life skill education in entrepreneurial skill will assist students in spotting potential business possibilities as well as to teach them how to overcome obstacles in the future. There are some essential skills that teaches for entrepreneurship education such as critical thinking, problem solving, self- awareness, life skill prepares the children to handle such uncertainties in the future and help them to emerge ad solution finders. It also helps to define the personality of an individual and it is very difficult to learn life skill in the traditional books and classroom studies.

Significance of the study
- Now a days the young minds is being regarded as the most productive members of society, because to their physical and intellectual capability. However, in practice, most of them are unable to maximize their potential due to the lack of motivation and guidance.
- The new issues necessitate as early and effective response from a socially responsible educational system. Education in incredibly important nowadays, but the kind of education that help people support and live better lives is even more important. Education nowadays is very important but the kind of education to support and live life better is more important.
- The cardinal focus of education is to extraordinary focus on the development of such skills in students, as they are very important and building blocks for a dynamic citizen that help the students make them entrepreneurs for better economic development in the country.
- According to the central board of school education in India, it is vital to improve both scholastic and co-scholastic areas, thereby making life skills education is mandatory subjects in the curriculum. It fills the void between fundamental functioning and capabilities.

Objectives of the Study
- To highlight the importance of such skills for the upliftment of tribal students to become better entrepreneurs in their respective vocational areas.
- Secondly, to point out the evidence indicating the success rate of such students possessing such skills.
- Thirdly, to highlight the extent / present status of life skills among tribal students through case study
- finally, to explore and suggest various techniques which will be helpful for the inculcation of such skills.

OBJECTIVES WISE DISCUSSION
To highlight the importance of such skills for the upliftment of tribal students to become better entrepreneurs in their respective vocational areas.

As per the WHO and 21st century skills there are some skills which is very important for the tribals adolescents for the development of entrepreneurship or start their own business-like Self- Awareness, Critical Thinking, Problem Solving, Decision Making, Leadership and Responsibility, Effective Communication and Information and Communication Technology.

Self- Awareness
Children who are self-aware have the ability to perceive other accurately and will help them to align their teams' strengths to the business. Successful entrepreneur knows how to harness their inner strength. Self-awareness enables you to develop an authenticate personal brand.

Problem Solving
Problem solving in business is very important when making decisions related to finance, legal issues and employers. The entrepreneurial problem solving is the process of using innovation and creative solutions to close the gap by resolving societal, business and technological problems.
There are two types Adaptive and Innovative

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Adaptive means to seek the problems in ways that are tested and known.
Innovative means using those techniques that are unknown to the market.
Effective Communication: Communication is a way to make interaction between people. Entrepreneur always try to improve their communication skills because it will assist them in sharing their ideas and presenting them clearly and to constantly work in better way with their staff, team members, clients.
Having good communication skills will also help an entrepreneur at the time to project explanation, elevator pitches, presentation, training as well as many other areas where a person have face to face talk with people.

Leadership and Responsibility
Starting and running a business is a huge and very serious responsibility. Depending on the size of your business several people will be depending on you, including you. The quality of relationship you have with your employees, investor and suppliers will be largely determined by the quality of leadership you can demonstrate. To me leadership is a combination of several different qualities, self-motivation, self- belief, discipline, personal responsibility, integrity communication, emotional intelligence are just some of the most critical element that defines a leaders.

Decision Making
In the real world, it doesn't really matter how much you know or what you can do. The people who become successful in the real world are those who take action. It doesn't matter how much you know, think, dream, plan, analyze, nothing will be achieved except you actually take action. In my opinion, the ability to make decisions even when you don't have all the information you need is a distinctive skill that most successful entrepreneur have. They are the willing to take a risk and to something rather than wait until they are hundred percent certain, like most of us would.

Information and Communication Technology
Technology change can reduce the cost of trade, opening up new market opportunities for rural region. The impact we all know that Facebook, skype, twitter, snapchat and google some of the great examples of tech entrepreneurship. Technology entrepreneurship is a company leadership styles that is built on the process of discovering high-potential technology, intensive business prospects, gathering resources such as talent and cost and managing rapid growth with real time decision making skills.

Critical thinking skills
It is closely related to problem solving, but it goes beyond that, critical thinkers formulate a number potential solutions to a problem and consider them all before deciding on the best bone. It also helps entrepreneurs assess a situation and came up with a logical solution. Employers look for candidates with critical thinking because it helps solve problems and build strategies for business growth. This skill helps entrepreneurs logically connect ideas, evaluate arguments, find inconsistence in work and solve problems or complex issues.

Secondly, to point out the evidence indicating the success rate of such students possessing such skills
But turning problems into opportunities, there is a rise in entrepreneurship across tribal groups of India. By connecting agriculture and forest produce with markets using technology, creation of self-help groups, empowering women, and creating self-sustainable enterprises, a number of tribal entrepreneurs are changing the face of tribal India.

To celebrate these entrepreneurs and build greater dialogue around the problems of tribal India, along with their methods and approaches, NITI Aayog organized India's first Global Tribal Entrepreneurship Summit in Dantewada, Chhattisgarh, recently. The summit aimed at addressing poverty, malnutrition, low literacy and poor health using the power of enterprise and technology.
1. Tensing Bodosa: building world's first elephant friendly tea farms
2. MendhaLekha: India's first bamboo economy village

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3. Women of Odisha: when 'pattals' trended in Europe
4. Aranya: building a tamarind economy in tribal Chhattisgarh
5. EAGL: using goats to fight poverty in tribal Maharashtra
6. ALC India: empowering 65,000 women by turning them into entrepreneurs
7. Last Forest: providing livelihood to 6500 tribals in remote Nilgiris
8. Gothrathalam: an alternate school for tribal children in Kerala

Thirdly, to highlight the extent / present status of life skills among tribal students through case study Under this objective there are certain objectives that we framed for the case study
1. To study the extent of life skills among tribals and non- tribals adolescents.
2. To compare the extent of life skill among tribals and non- tribals adolescents.
3. To compare the extent of life skills among tribal and non-tribal adolescents with reference to following:
   a) Male
   b) Female
   c) Rural(Residential Background)
   d) Urban(Residential Background)

Hypotheses
1. There will be no significant difference in the extent of life skills among tribal adolescents.
2. There will be no significant difference in the extent of life skills among tribal and non- tribal adolescents with reference to following:
   a) Male
   b) Female
   c) Rural(Residential Background)
   d) Urban(Residential Background)

METHODS
Survey method under descriptive method of research was used.

Population
The Tribals and Non-Tribals Students studying in the Govt. Hr. Sec. School in Dist.Kathua constituted in the population for the present investigation.

Sample
The sample was collected through simple random sampling tech. under probability sampling. Out of total no. of Govt. Higher Sec. Schools (37 in number), 25% (i.e., 9 schools) of them were selected. The mode of selection of the sample from the selected schools has been given in the table 1 below: Therefore, total number of 135 tribal and non-tribal adolescents were selected randomly for the present investigation.

Tool
The Life Skill Scale standardized by Dr. Chandra Kumari and Ayushi Tripathi in the year 2020 has been used for the present work.

Analysis and interpretation of data
The information related to the analysis and interpretation of the data has been given in the tables 2 & 3 below

FINDINGS AND CONCLUSIONS

Findings
From the analysis of above indicated tables, following conclusions and findings may be drawn:

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1. Majority (65.18%) of the students are possessing above average level of life skills, a good percent (33.33%) of the students possessing average level of life skills and only 0.01% are possessing below average level of life skills.
2. The extent of life skills has been significantly found more among non- tribal adolescents in comparison to tribal adolescents.
3. There was no significant difference in the extent of life skills among **male** tribals and non-tribal adolescents.
4. There was a significant difference in the extent of life skills among **female** tribals and non-tribal adolescents.
5. There was a significant difference in the extent of life skills amongtribals and non-tribal adolescents belonging to**rural** background.
6. There was a significant difference in the extent of life skills amongtribals and non-tribal adolescents belonging to **urban** background.

CONCLUSIONS

From the above findings it may be pointed out that majority of the students (whether tribal and non- tribals) are possessing high degree of life skills. Also, the degree of life skills has been significantly found more among non-tribals in comparison to tribal adolescents but there was no significant difference in the degree of life skills among tribal and non- tribal adolescents when compared on the basis of male and there was a significant difference in the degree of life skills among tribal and non- tribals adolescents when compared on the basis of female and locality.

Finally, to explore and suggest various techniques which will be helpful for the inculcation of such skills
Imparting life skill education has been researched meticulously. Different techniques used to enhance life skills in students.

Classroom Discussions
It is an activity that provides opportunities to the students learn and practice through problem solving. It enables the students to develop their understanding to the subject and deeper comprehension. It built listening, assertiveness and empathy abilities.

Brainstorming
It enables the learners to spontaneously and generate ideas. Helps the learners and think out of the box. It encourages the students for creative problem solving and the application of creativity among students. It is essential to weigh the benefits and drawbacks of idea or to order ideas in accordance with predetermined standards.

Role Plays
It's a good way to practice skills, imagine how to manage a hypothetical issue in real life, develop empathy for others and their perspectives, and get more awareness of one's emotions. And to encourage the participation for the entire classes.

Groups
When there is time shortage, groups are advantageous since they increase students'contribution. It enables for students' interactions and help them and get to know one another better, which helps with teamwork and team development.

Educational Games and Simulations
It promotes fun, active learning and meaningful discussion by having participants to work hard and prove to gain points. They require the application of knowledge, attitudes and skills that they allow the students to get their assumptions and talents in a relatively safe setting.

Analysis of Situation and Case Studies
It provides an opportunity to examine, investigate, issues, dilemmas and safely test solutions for it. It also provides opportunities for working together in groups, sharing ideas, new learning and gives insight and sometimes promotes to see the things differently.

Case studies
Act as potent catalysts for thoughts and debates. Students create or develop critical thinking and decision-making skills by participating in his thought process. It also provides opportunities to tackle risks or obstacles and devise solutions to them.

Story-Telling
Can assist students think about local issues and build critical thinking abilities, creative skills for writing some stories, or interaction skills for telling skills stories. Story telling lends itself to drawing analogies or making comparisons, which aids in the discovery of healthy solutions. It also improves concentration, attention, and listening abilities as well as patience and endurance.

Debates
Allows you to address a specific issue in depth and creatively. Students can discuss for instance; smoking is prohibited in public places in their neighborhood. It enables pupils to defend a position that is important to them. It provides an opportunity to exercise higher order thinking skills.

Blended learning
It is also known as hybrid learning; in this method we integrate technology with digital media with traditional instructor led in the classroom activities. The students in the blended learning are flexible to customize their learnings. In this method we use online and offline for both teacher and students Like learning stations, labs and flipped classrooms.

DISCUSSION

A relevant and effective application of life skill education is an urgent need in today's society. Imparting life skill education to kids can be beneficial since it specifically addresses the requirements of children's assists in motivating them and provides practical, cognitive, emotional, social, and self- management skills for life adjustment and self-reliance. Life skill play an important role for the development of entrepreneurship. Entrepreneurship plays a vital role in the growth of our economy. It acts as catalyze in fostering the initiative to undertake economic activities for the production and distribution of wealth. In tribal areas larger amount of potential, remain untapped due to lack of supportive means and management. Proper entrepreneurial skill and marketing talent are to be given to tribal entrepreneurs through proper training programmes for carrying entrepreneurial activities. What the tribal entrepreneurs need is encouragement and support from the family members, government and societies. These tribal entrepreneurs must be involved in modern small-scale units. If they are properly trained and provided with the required capital the informal sector will develop, and this, in turn, will reduce the search of livelihood.

RECOMMENDATIONS

Although significant progress has been made in the last decade and in the current study to reflect that life skill education is an effective mode of education that enhances the social, emotional, thinking, communication, leadership and responsibility skills of adolescents and helps the 21st century youngsters to achieve their goals by strengthening their abilities to meet the needs and demands of today's society's and be successful in life.

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Entrepreneurship educational institutions and skill training institute should be located in different regions in order to make it accessible for the youths and to motivate them for starting up new businesses. Awareness program with the help of successful tribal entrepreneurs as role model should be carried out to reduce the social stigma towards taking up new businesses in the tribals community. Agriculture, forestry and mining based allied sectors should be promoted for entrepreneurial activities in order to have optimum utilization of available rich bio- diversity in the state.

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Table. 1

S. No.	Name of the School	No. of Selected Students
1.	Govt Hr. Sec. School Forelain	15
2.	Govt Hr. Sec. School (Boys) Kathua	15
3.	Govt Hr. Sec. School (Girls) Kathua	15
4.	Govt Hr. Sec. School Bani	15
5.	Govt Hr. Sec. School Lowang	15
6.	Govt Hr. Sec. School Basohli	15
7.	Govt Hr. Sec. School Billawar	15
8.	Govt Hr. Sec. School Budhi	15
9.	Govt Hr. Sec. School Nagri	15
	Grand total	135

Table.2 . Extent of Life Skills

S. No.	Levels of Extent of Life Skills	Number of Students	Percentage
1.	Above Average	88	65.18%
2.	Average	45	33.33%
3.	Below Average	2	0.01%

Table. 3. Comparative analysis of Extent of Life Skills with Respect to Gender & Locality

S. No.	Categories	No. of Students	Mean	Standard Deviation	C. Ratio
1	Tribals	79	162.85	5.36	2.85**
	Non- Tribals	56	173.11	7.56	
2	Tribals (Male)	46	163.37	6.77	1.38
	Non-Tribals (Male)	19	170	16.4	
3	Tribals (Female)	34	161.91	15.67	2.57**
	Non- Tribals (Female)	37	176.05	14.4	
4	Tribals (Rural)	36	160.28	11.75	2.68**
	Non- Tribals (Rural)	39	173.03	10.85	
5	Tribals (Urban)	34	160.71	9.09	2.96**
	Non- Tribals (Urban)	26	174.27	11.88	

Note: (*) Means Value Significant at 0.05 Level of Significance

(**) Means Value Significant at 0.01 Level of Significance

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Fig. 1. life skill	Fig. 2. 21st century skills/ learning skills/ transversal competencies
	4Cs: Critical Thinking, Creativity and Innovation, Collaboration, Communication
	IMT: Information Literacy, Media Literacy, Technology Literacy
	FLIPS: Flexibility and Adaptability, Leadership and Responsibility, Initiative and Self- Direction, Social and Cross- Cultural Interaction.

RESEARCH ARTICLE

Linear Regression with Bagging based Prediction for Renewable Solar Power Generation – A Hybrid Model Approach

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ABSTRACT

Utilization of energy has been increased due to industrialization and globalization. In many parts of the world, conventional methods have been in use to generate energy from Natural resources such as fossil fuels and leads to excess pollution. Hence there is a need to look into alternate methods of energy generation using renewable natural resources such as Solar energy, Wind energy etc. For decades, a lot of research is going on in this area and still there is a need to improvise the existing methods to generate energy using renewable natural solar resources that make solar energy more affordable. Artificial Intelligence (AI) is a branch of computer science and is proven to be effective for prediction and forecasting in various fields. Machine learning and Deep learning are sub fields of AI and are being used extensively by researchers for predicting the photovoltaic power (PV). Recent studies shows that in India, the contribution of solar power is just 3% in overall consumption of energy required. Hence, there is a need to conduct more research in this area and help investors to move towards investments in renewable solar power generation that help to conserve non-renewable resources. The outcome of PV Power depends not only on PV but also on weather, climate and various other factors. This paper proposed Linear Regression with Bagging (LRB) a hybrid model-based approach for predicting Renewable Solar Power Generation using AI, an affordable solution for next generation. The power plant dataset available online in the Kaggle website, is used in this proposed work and found that the performance of LRB model is better than Linear Regression model.

Keywords: Artificial Intelligence, Deep Learning, Machine Learning, Photovoltaic Power, Renewable Energy, Solar Energy Generation

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INTRODUCTION

Globalization has brought revolution in the industrialization that requires more resource utilization and energy consumption. Every man-made product is consuming certain natural resources.   In the context of energy consumption, when the rate of consumption exceeds the rate of replenishment/recovery then the resources are called as non-renewable resources. Fossil fuels are an example for these non-renewable resources, which require millions of years for replenishment. In many parts of the world, conventional methods have been in use to generate energy from natural resources such as fossil fuels, which are non-renewable natural resources and leads to excess pollution. Hence there is a need to look in to alternate methods such as renewable solar energy to meet the increasing demands of power consumption. Moreover, solar energy being clean and green, leads to pollution free environment and many countries started investing rapidly in solar power generation [1]. Solar energy being renewable and abundant in nature, can be effectively utilized for power generation but depends on various other parameters such as humidity, solar radiance, clouds, photovoltaic cells etc., [2]. Solar energy is generated using various techniques such as Photovoltaic technology, Concentrated Solar Power (CSP) technology etc. In Photovoltaic technology solar panels made of silicon material is used to convert solar radiation to DC current and inverters are used to convert them to AC current and then will be transferred to the electric grid or stored in the batteries for future use. In CSP technology, solar radiation is collected and converted to heat energy and then turbines are used to generate electricity which is known as solar thermal energy. In this process, either water or fluids are used to generate electricity which a huge amount of water is wasted or the impact of fluids used may be hazardous to the environment. Hence, PV technology is considered to be clean and green technology for solar power generation and world-wide, researchers are conducting research to predict effective solar PV power generation techniques.

The progress in large and small-scale PV systems has economic and ecological advantages but due to the unpredictability in outputs of PV system grid operators phase various management and operational issues as PV systems are dependent on parameters such as weather. Due to the non-linearity in PV power output, the use of renewable energy in the pre-defined grid makes the system complicated by making the grid production and consumption imbalance [2]. Hence, accuracy of the prediction is critically important and researchers in [2, 5, 6] proposed various parameters to be considered in the prediction of PV power output. The important considerations are –a) Forecasting methods in different time zones like short, medium and long term; b) The meteorological data like wind speed, cloud coverage, temperature, aerosol index and irradiance etc.; c) Physical attributes as power rating, azimuth angle, module type, tilt angle etc; d) Meteorological data-driven historical weather data long with previous measurements of PV system outputs; e) physical, statistical, persistence and combined methods used for estimating output of PV systems.

Aerosol index [4] is another important factor to be considered in the prediction of PV output, that affects the solar radiation which is used to measure the attenuation of the sunlight or solar radiation due to fog, dust and other suspended particles. Aerosols are mainly induced by power plant emission, desert dust, volcano smoke, biomass burning etc., and block the sunlight by absorbing, diffusing or scattering light. Based on above all factors prediction of PV power forecasting is classified into two methods: physical models using cloud imagery and ML & DL models[4]. Machine learning models are advantageous as they are fast, low cost and give accurate results for predictions. On the other hand, deep learning uses multilayered neural networks and tolerates high noise data by integrating unrelated data sources by identifying non-linearity in the data. Further, deep learning has the ability to extract features automatically. Hence, ML & DL models can be used for prediction and fore casting of PV power. General objectives of PV power forecasting are predicting environment-based parameters associated with the PV system such as solar irradiation to calculate PV power and predicting the active solar power directly [4].

The PV power forecasting has various challenges to be addressed as solar photovoltaic (PV) power estimation is difficult due to intermittent meteorological parameters as well as important to predict solar PV power for proper operation and control of renewable energy-based power system as future global energy supply is to have enormous

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integration among Renewable Energy (RE) sources (particularly unpredictable sources such as wind and solar) along with the existing or future energy supply structure. Contribution In this paper, a comprehensive review on AI models for solar PV power prediction and forecasting has been done in the perspective of hybrid model approach. We explored main objectives of PV prediction and forecasting and various challenges to be addressed while using AI models. We also explored potential research directions and key issues to be focused on unresolved issues. In this paper, we studied various AI based models and a comparison study is given for building AI models.

Solar Power Prediction Models

Forecasting for solar PV power generation has become one of the key technologies for improving the quality of operational scheduling of the solar PV power system and reducing spare capacity [2].

LLIFA model (LASSO And LSTM Integrated Forecasting Algorithm)

Internet of Things (IoT) brought new innovations and progress in many industries. Smart Grid(SG) is one of its kind in which internet of power and information is a special form of IoT and Smart Grid together in which critical energy management is involved for renewable energy resources. Authors in [7] integrated novel methods least absolute shrinkage and selection operator (LASSO) and long short term memory (LSTM) in a forecasting model to predict short-term of solar intensity using meteorological data. In this model, various other models like machine learning, time series, statistical and data clustering are combined. In this model, k-means ++ is used initially for clustering and then LSTM is used for forecasting and to learn the non-linear relationships then LASSO model is used to capture linear relationship in the data. Hence, LLIFA is a hybrid collaborative model using k-means++ clustering, LASSO and LSTM predicts short-term solar intensity with better precision. But when there is an increase in time-scale, the model decreases in precision accuracy. Hence, this model is not suitable for long-term prediction and accurate forecasting models are needed to predict on different time scales.

LSTM- CNN model

Neural networks are modeled encouraged by the working of neurons in the human brain. Deep learning algorithms are used to solve complex problems using varied, unstructured and inter-connected dataset. Authors in [8] used two popular deep learning algorithms like long short term memory (LSTM) and convolutional neural network (CNN) for constructing a hybrid model to predict solar photovoltaic system output in Australia with a trade-off between accuracy and efficacy. They used long-term historical dataset from 1990-2013 that belong to various Australian locations. This combine model of LSTM and CNN is developed and tested to assess the performance. The aim of this work is to predict the long term time horizon PV power(2 years ahead) and hence useful for planning power generation and reserve estimations in power systems with high penetration of solar PV or other renewable energy sources.

NARX ANN model

In forecasting PV irradiation, various environmental and meteorological data are used. Authors in [4] used aerosol index (AI) parameter as input in addition to various input parameters such as ambient temperature, pressure, wind speed etc. The aerosol index is correlated with other parameters and higher the aerosol index larger the attenuation of global solar irradiance which makes solar PV panels less productive. A forecasting model using Non-linear Auto-Regressive Exogenous Artificial Neural Network (NARX ANN) is trained using Delhi based one-month historical meteorological data at an average of three hours' time-horizon. Efficacy of the proposed model is validated and tested based on Mean Square Error (MSE) between predicted values and measured values. Existing forecasting models considered temperature, humidity, wind direction and wind speed data to find a precise prediction for three-hour ahead of solar PV power generation. In addition to that constructed using aerosol index for forecasting and found to be accurate.

SVM - SMC model

Authors in [9] proposed a smart DC micro-grid (SDMG) system framework to satisfy users demands efficiently by utilizing renewable energy and the grid power by considering energy management system for multiple loads using dynamic load control architecture. The prediction model comprises of two sub-modules. First module is solar irradiance and wind speed prediction model and the second one is power prediction model. Support Vector Machine (SVM) is used to predict the solar irradiance and wind speed and given as input for the power prediction model to predict the output produced by RE sources. The SDMG model uses SVM as a learning algorithm to predict day-ahead renewable generation. The model exhibits some uncertainties such as excess RE and uncontrolled base loads. To address these   uncertainties, a direct load control (DLC) strategy using sliding mode control (SMC) is used to balance the power flow in SDMG.

LSTM model

Authors in [10] used a LSTM model to forecast one hourly prediction of solar irradiance for predicting the solar PV output using South African data. The result of LSTM forecasting model is compared with results of SVM and feed forward Neural Network (FFNN) and found to be better than SVM and FFNN.

PVP Net model

A deep neural network-based convolutional neural network (CNN) is used to construct PVP Net model by authors in [11]. A PVPNet model is used for short-term forecasting of a PV system output power using the information such as temperature, solar radiation, and PV system output power in the past five days while predicting the PV system output power for the next 24 hours. The authors claim that this model can reduce the monitoring expenses, the initial cost of hardware components, and the long-term maintenance costs of the future PV farms successfully.

Robust Expanded Extreme Learning Machine (EELM) model

EELM model is designed to predict the solar power for different time horizon and weather conditions efficiently. Authors in [12] integrated two independent models Functional Link Neural Network (FLNN) and Extreme learning machine (ELM) to provide non-linearity and thus producing accurate results. EELM model trains the network using the non-linear inputs. The proposed model can be applied for the effective management of electricity in future and may help to improve the energy market efficiency.

Short-term PV power prediction using Ada Boost and Elman

Researchers used machine learning hybrid algorithms for high precision forecasting. Authors in [13] proposed a high precision PV system output power prediction model based on improved AdaBoost and Elman. AdaBoost, Elman algorithms are initialized with training data. Elman algorithms parameters are optimized using Bat Optimization algorithm. Using optimized Elman algorithm base learner is trained and generated. Base learner is applied to individual samples and the averaged output of all predictions is the prediction result. This hybrid model has high prediction accuracy for the solar PV power output. RMSE metric is used for validating the accuracy of the model.

Solar Power Generation Forecasting With a LASSO-Based Approach

Least absolute shrinkage and selection operator (LASSO) is a popular method for regression analysis in statistics which is beneficial for regularization and variable selection [14]. A historical dataset consisting of past 30 days data for the target date is used for training the model. An advantage of the LASSO-based algorithm is its ability to select suitable variables for prediction, by tuning the loss function with parameter λ. Variable selection has two advantages such as reducing computational complexity and simplifying prediction model. LASSO-based approach is highly competitive solution for forecasting short or medium-term solar PV power output using a small historical data. A unified clustering-based prediction framework to provide short term prediction of PV power output. The intermittent nature of RE generation determining the energy allocation is a challenging task. Authors in [15] proposed a unified clustering-based prediction framework with tree-based algorithms for short-term prediction of PV power output. This hybrid model uses TS-SOM and XGBoost that are tree-structured machine learning algorithms for prediction. TS-SOM algorithm is used to realize the weather clustering module whereas XGBoost is

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used for performing short-term PV output prediction. The model generates accurate results while utilizing limited resources and hence suitable for edge computing.

Artificial Intelligence

Artificial Intelligence (AI) as a branch of computer science implements human logic thinking and behavior for decision making and has been used extensively for solar energy prediction by researchers. In this section, we discuss few commonly used algorithms, their basic concepts under machine learning and deep learning for solar PV power prediction and related research.

Machine Learning

Machine learning (ML) algorithms being subset of AI, used extensively to learn from the data during the training phase and built model can be used for predicting for the new unseen data. Application of machine learning algorithm for prediction involves various steps as shown in Figure 1 below: Application of ML algorithm involves user intervention in feature extraction/selection step. ML model can be designed by applying algorithms on data and training the model. The accuracy of the model depends on the features selected to develop the model. Various ML supervised algorithms such as logistic regression, discriminant analysis, naïve Bayes, nearest neighbour, decision tree, RF, SVM and unsupervised algorithms such as clustering, principal component analysis can be used for model development. These algorithms perform better on linear data, hence to handle non-linear data we may require to use advance ML algorithms or deep learning algorithms.

Deep Learning

Deep learning being a subfield of ML basically uses neural networks which simulate the working of neurons in the human brain with more than three layers. These algorithms can handle non-linear data and noisy data as well. Deep learning model development involves various steps as shown in Figure 2 below: During the application of DL algorithm for model development user intervention is not required and hence not explainable model. It works as a black box model and feature engineering/selection is done by the algorithm itself. Various DL algorithms such as Artificial Neural Network (ANN), Recurrent Neural Network (RNN), Convolutional Neural Network (CNN), feed forward neural network (FFNN), Long Short-Term Memory (LSTM) etc., can be used for model development.

Comparative Analysis of Various Models

We studied various models for forecasting the PV power output based on various parameters such as ambient weather, pressure, meteorological conditions, wind speed, solar irradiation, aerosol index etc., and also used PV outputs also as input for the future predictions. Researchers developed various models for forecasting PV power output based on time-horizon (short-term, medium-term or long-term), to maintain the smart-grid balance or to predict the solar irradiance which is a vital parameter for PV power output prediction.

Comparison based on Time Horizon

Long-term prediction helps to assess the plant capacity and to maintain the grid balance but due to intermittent nature of input parameters based on environment these may not be accurate. Short and medium-term forecasting models are accurate in prediction of PV power output but may not help for the ahead of planning the power plant operation and management functionalities to balance the PV power output. The below table gives the list of models used for short-term, medium-term and long-term prediction. Various forecasting models based on time horizon are summarized in the table 1 above.

Comparison based on hybrid model

For forecasting the PV power output various machine learning and deep learning models are used. Few machine learning algorithms works better on linear data and also depends on feature engineering techniques. Deep learning algorithms works on non-linear data and also can handle noisy data. Many researchers proposed hybrid models which take the advantage of both linear and non-linear data and can work on noisy data and further deep learning

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algorithms can do feature extraction as part of the execution of the model. Hence, the forecasting results of hybrid model will be better than single models. Table 2 above shows various models belonging to either single algorithm model or hybrid model.

A Hybrid Model Linear Regression with Bagging (LRB)

We studied various algorithms for hybrid model as part of this survey and authors in [2] emphasize that hybrid models have high accuracy than single model. In this section we propose a hybrid model Linear Regression with Bagging (LRB)using Linear Regression model and Meta-bagging model for PV power output of a plant using a sample data set available online. Linear Regression is a supervised learning model that determines the best fit line among the set of independent and target attributes. The simple linear regression equation is given below:

$$y = b_o + b_1 x$$

where the intercept is b_0, slope is b_1 and x and y are the independent and dependent variable. The Mean Squared Error (MSE) cost function is calculated for the average of squared error occurred between the predicted values and actual values as given below:

$$MSE = 1\frac{1}{N}\sum_{i=1}^{n}(y_i - (a_1 x_i + a_0))^2$$

Meta–Bagging or Bootstrap aggregating is an ensemble based meta-algorithm developed in order to bring the improvement in accuracy and stability of ML techniques applied in statistical classification and regression that reduces variance to avoid over fitting. The dataset used in this paper is a free dataset available in Kaggle website, used for research purpose. The methodology to implement proposed LRB as a hybrid model algorithm is provided in Figure. 3 and its flowchart as in Figure. 4. A solar power generation dataset is used for forecasting the solar PV power output of two plants Plant 1 and Plant 2 using weather data. The performance of proposed sample hybrid algorithm LRB is compared with Linear Regression and meta-bagging algorithms provided in Figure 5 & 6 models.

CONCLUSION

Solar being renewable energy and available abundant in nature and the PV power generation is considered as clean & green and environment friendly. To conserve non-renewable energy for future there is a need to depend on renewable energy such as solar and wind. A systematic review of various Artificial Intelligence models used for forecasting solar PV power output has been conducted in taxonomy perspective and comparative results are discussed. We studied various Artificial Intelligence based machine learning and deep learning single models as well as hybrid models. Hybrid models used for forecasting provides high accuracy results compared to single algorithm models. In this paper, we proposed and demonstrated a hybrid LRB model on power plant dataset available online in the Kaggle website, which is provided freely for research purpose. The hybrid model exhibits better performance compared to single algorithm model and in this proposed work, the performance of LRB model is better than Linear Regression model. A hybrid LRB model is advantageous compared to single models as it comes with the features of handling both linear and non-linear data.

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Table 1: Time Horizon Based Models For Forecasting

Model	Short term	Medium term	Long term
LASSO And LSTM Integrated Forecasting Algorithm [7]			✔
LSTM- CNN model [8]			✔
NARX ANN model [4]	✔	✔	
SVM - SMC model [9]		✔	
LSTM model [10]		✔	
PVPNet model [11]		✔	
Robust Expanded Extreme Learning Machine (EELM) model [12]	✔	✔	✔
Short-term PV power prediction using AdaBoost and Elman [13]	✔		
Solar Power Generation Forecasting With a LASSO-Based Approach [14]	✔	✔	
A unified clustering-based prediction framework to provide short term prediction of PV power output [15]	✔		

Table 2: Single Algorithm And Hybrid Algorithm-Based Models For Forecasting

Model	Single algorithm model	Hybrid algorithm model
LASSO And LSTM Integrated Forecasting Algorithm [7]		✔
LSTM- CNN model [8]		✔
NARX ANN model [4]		✔
SVM - SMC model [9]		✔
LSTM model [10]	✔	
PVPNet model [11]	✔	
Robust Expanded Extreme Learning Machine (EELM) model [12]		✔
Short-term PV power prediction using AdaBoost and Elman [13]		✔
Solar Power Generation Forecasting With a LASSO-Based Approach [14]	✔	
A unified clustering-based prediction framework to provide short term prediction of PV power output [15]		✔

Figure 1. Steps involved in ML process

Figure 2. Steps involved in DL Process

Algorithm:

Step 1: Start

Step 2: Select the dataset from the two solar plants

Step 3: Data preprocessing to check for missing values and apply Attribute selection for the datasets

Step4: Transform the data into numeric and normalize it.

Step 5: Splitting of Data: 80% Training, 20% Testing and cross validation with 10-folds

Step 6: Implementation of AI based ML models – Linear Regression, Meta –Bagging and LRB Hybrid model

Step 7: Performance evaluation based on correlation coefficient, RAE, RRSE and Time.

Step 8: Stop.
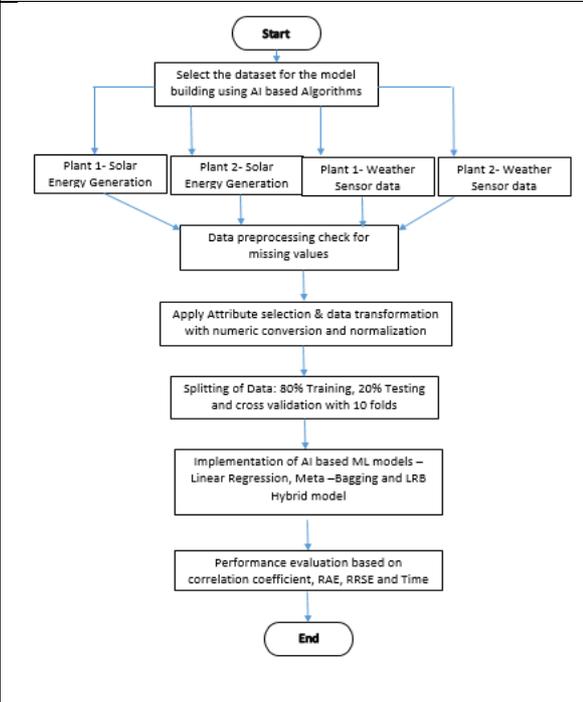
Figure 3. Algorithm for implementation of a hybrid model LRB

Figure 4. Methodology for a hybrid LRB model to forecast solar PV power

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Power Generation: Plant 1

	Linear Regression		Meta - Bagging		Proposed- LRB	
	Split	Crossval	Split	Crossval	Split	Crossval
correlation coefficient	0.985	0.985	0.987	0.987	0.987	0.987
RAE	17.1	17.2	14.2	14.3	15.5	15.7
RRSE	17.3	17.3	15.9	16.0	16.0	16.1
Time	0.6	0.5	31.7	32.6	37.7	33.4

Power Generation: Plant 2

	Linear Regression		Meta - Bagging		Proposed- LRB	
	Split	Crossval	Split	Crossval	Split	Crossval
correlation coefficient	0.991	0.990	0.991	0.990	0.991	0.990
RAE	3.6	3.6	3.04	3.05	3.18	3.21
RRSE	13.5	14.3	13.2	13.9	13.2	14.0
Time	0.6	0.7	17.0	17.8	16.5	18.3
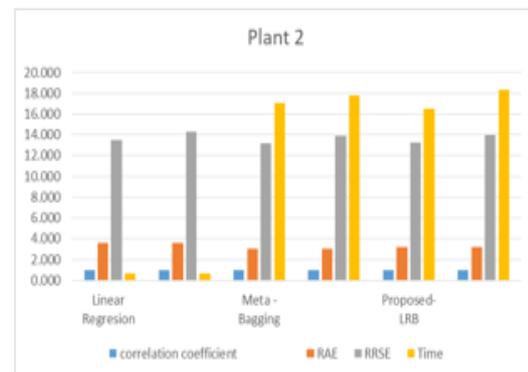
Figure 5. Performance of hybrid LRB model for Plant 1	Figure 6. Performance of hybrid LRB model for Plant 2

RESEARCH ARTICLE

Optimal Block Pulse Wavelet Quadrature Method For Multidimensional Integrals In Bayesian Statistics

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ABSTRACT

A new wavelet-based Block pulse wavelet quadrature method is proposed for solving multidimensional integrals of smooth arbitrary functions which are obtained from Bayesian statistics, numerically up to 15-dimensions integrals, the effectiveness and accuracy of the proposed quadrature method are illustrative with several numerical examples.

Keywords: Multidimensional integrals, Quadrature rule, Block pulse function, Smooth function

INTRODUCTION

The wavelet-based quadrature is widely applied in image processing, signal analysis, numerical analysis etc., the quadrature method is proved to be efficient and effective tool for solving 1-dimensional, 2-dimensional and multidimensional integral problems are arrived in machine learning, statistical pattern recognition, computational biology, artificial neural network, finance, quantum mechanics etc.
the multidimensional integral problems in the form [1] as

$$I = \int_{[0,1]^k} f(t)e^{-ng(t)}\, dt \qquad (1)$$

Where $f(t)$, $g(t)$ are k- dimensional polynomial and n is the natural number
and

$$I = \int_{\Omega} P_1^{v_1}(t)P_2^{v_2}(t)P_3^{v_3}(t) - - - - - -P_i^{v_i}(t)\, dt \qquad (2)$$

Where $\Omega \in R^i$, $t = (t_1, - - - - -t_i)$, $p_i(t)$ are i-dimensional polynomial and v_i are integers
In the Bayesian statistics and its applications, it is often necessary to numerical approximation of two kinds of multidimensional integrals by Monte Carlo method(MCM) Latin hypercube sampling (LHS), Sobol sequence (SOBOL), Fibonacci numbers (FIBO) [1-5]. In this paper, we show the numerical examples that the multidimensional

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integral of eqn. (1) and (2) can be successfully approximated using Block pulse wavelet quadrature method on $[0,1]^m$ for $m = 3,4,5,7,15,20$ dimensionsWe organize this paper as follows. In section II, we demonstrate the Block pulse wavelet quadrature method to evaluate multidimensional problems up to 20-dimensions and in section III choosing the multidimensional problems of the smooth functionscompare the results with reference value given in [1-5]

Block Pulse Wavele Quadrature Method

The Block pulse wavelet quadrature is defined over the interval [0, T) as follows

$$\emptyset_k(t) = \begin{cases} 1, & kh \leq t < (1+k)h \\ 0 & otherwise \end{cases} \qquad (3)$$

where $k = 0,1,2,3,4 - - - -,(m-1)$ and $h = T/m$

If $f(t) \in L^2[0,1)$ is integrable over [0, T) then

$$\int_0^1 f(t)dt \cong \sum_{k=1}^m f_k \int_0^1 \emptyset_k(t)\, dt = \sum_{k=1}^m \frac{1}{m} f_k$$

the nodal points t_i as

$$t_i = \frac{2k-1}{2m} \quad , \quad k = 1,2,3,---,m$$

numerical integral based Block- pulse wavelet quadrature method is

$$\int_0^1 f(t)dt = \sum_{i=1}^m \frac{1}{m} f\left(\frac{2k-1}{2m}\right)$$

In generally

$$\int_a^b f(t)dt = \frac{1}{m}\sum_{k=1}^m (b-a)\, f\left((b-a)\frac{(2k-1)}{2m} + a\right)(4)$$

For 2-dimension integral

$$\int_0^1 \int_0^1 f(t_1,t_2)dt_1 dt_2 = \frac{1}{m^2} \sum_{i_1=1}^m \sum_{i_2=1}^m f(A,B)$$

For 3-dimension integral

$$\int_0^1 \int_0^1 \int_0^1 f(t_1,t_2,t_3)\, dt_1 dt_2 dt_3 = \frac{1}{m^3} \sum_{i_1=1}^m \sum_{i_2=1}^m \sum_{i_3=1}^m f(A,B,C)$$

For 4-dimension integral

$$\int_0^1 \int_0^1 \int_0^1 \int_0^1 f(t_1,t_2,t_3,t_4)dt_1 dt_2 dt_3\, dt_4 = \frac{1}{m^4} \sum_{i_1=1}^m \sum_{i_2=1}^m \sum_{i_3=1}^m \sum_{i_4=1}^m f(A,B,C,D)$$

For 5-dimension integral

$$\int_0^1 \int_0^1 \int_0^1 \int_0^1 \int_0^1 f(t_1,t_2,t_3,t_4,t_5)dt_1 dt_2 dt_3\, dt_4 dt_5 = \frac{1}{m^5}\sum_{i_1=1}^m \sum_{i_2=1}^m \sum_{i_3=1}^m \sum_{i_4=1}^m \sum_{i_5=1}^m f(A,B,C,D,E)$$

For n-dimension integral

$$\int_0^1 \int_0^1 --- \int_0^1 f(t_1,t_2,t_3-,-,-t_n)dt_1 dt_2 --- dt_n = \frac{1}{m^n} \sum_{i_1=1}^m \sum_{i_2=1}^m --- \sum_{i_n=1}^m f(A,B,C,D,E,F,-,-,-)$$

Where

$$A = \frac{(2i_1-1)}{2m}, \quad B = \frac{(2i_2-1)}{2m},$$

$$C = \frac{(2i_3-1)}{2m}, \quad D = \frac{(2i_4-1)}{2m},$$

$$E = \frac{(2i_5-1)}{2m}, F = \frac{(2i_6-1)}{2m}, -----------$$

NUMERICAL RESULTS

Consider the following integral of smooth functions with 4, 5, 10, 15- dimensions with exact value

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Example.1 (4-dimension)

$$I_1 = \int_{[0,1]^4} t_1 t_2^2 e^{t_1 t_2} \sin(t_3) \cos(t_4) \, dt_1 dt_2 dt_3 dt_4$$
$$= 0.108975$$

Example.2 (5-dimension)

$$I_2 = \int_{[0,1]^5} e^{-100\, t_1 t_2 t_3} (sint_4 + \cos t_5) \, dt_1 dt_2 dt_3 dt_4 dt_5$$

$$= \int_{[0,1]^5} e^{-100\, t_1 t_2 t_3} sint_4 dt_1 dt_2 dt_3 dt_4 dt_5 + \int_{[0,1]^5} e^{-100\, t_1 t_2 t_3} cost_5 dt_1 dt_2 dt_3 dt_4 dt_5$$
$$= 0.1854297367$$

Example.3   (10-dimkension)

$$I_3 = \int_{[0,1]^{10}} \frac{4 t_1 t_3^2 \; e^{2\, t_1 t_3} e^{t_5 + \,-\,-\,-\, + t_{10}}}{(1 + x_2 + x_4)^2} \, dt_1 dt_2 dt_3 - - - - - - dt_{10}$$
$$= 14.808435$$

Example.4 (15-dimension)

$$I_4 = \int_{[0,1]^{15}} (\sum_{i=1}^{10} t_i^2)\, (t_{11} - t_{12}^2 - t_{13}^3 - t_{14}^4 - t_{15}^5)^2 \, dt_1 - - - - dt_{15}$$

$$= \int_{[0,1]^{15}} (t_1^2 + t_2^2 + t_3^2 + t_4^2 + t_5^2)(t_{11} - t_{12}^2 - t_{13}^3 - t_{14}^4 - t_{15}^5)^2 \, dt_1 - - - - dt_{15}$$

$$+ \int_{[0,1]^{15}} (t_6^2 + t_7^2 + t_8^2 + t_9^2 + t_{10}^2)(t_{11} - t_{12}^2 - t_{13}^3 - t_{14}^4 - t_{15}^5)^2 \, dt_1 - - - - dt_{15}$$
$$= 1.96440666$$

The problem of solving the multiple integrals with several variables is inherently much more difficult than the linear equations of a single variable, we have applied block pulse wavelet quadrature method to evaluate the multidimensional integral problems computationally by use of mathematical software MAPLE – 13

CONCLUSIONS

In this paper an numerical quadrature rule are presented by use of block pulse wavelet quadrature method and tested the multiple integrals or multidimensional integrals in Bayesian statistics which is used machine learning and artificial intelligence, the present numerical method results are more accurate and easy to compute

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Appendix

```
restart :
Digits := 15 :
 n := 40 :
x1 := 0 :
x2 := 1 :
x3 := 0 :
x4 := 1 :
x5 := 0 :
x6 := 1 :
x7 := 0 :
x8 := 1 :
x9 := 0 :
x10 := 1 :
```

$$A := x1 + \frac{(x2 - x1) \cdot (2 \cdot i - 1)}{2 \cdot n} :$$

$$B := x3 + \frac{(x4 - x3) \cdot (2 \cdot j - 1)}{2 \cdot n} :$$

$$C := x5 + \frac{(x6 - x5) \cdot (2 \cdot k - 1)}{2 \cdot n} :$$

$$E := x7 + \frac{(x8 - x7) \cdot (2 \cdot l - 1)}{2 \cdot n} :$$

$$F := x9 + \frac{(x10 - x9) \cdot (2 \cdot m - 1)}{2 \cdot n} :$$

$$f(x, y, z, t, u) := \exp(-100 \cdot x \cdot y \cdot z) \cdot (\sin(t)) :$$

$$Z1 := \left(\frac{1}{n^5} \right) \cdot evalf \left(\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{m=1}^{n} f(A, B, C, E, F) \right);$$

0.064655179970964

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$$Digits := 15:$$
$$n := 40:$$
$$x1 := 0:$$
$$x2 := 1:$$
$$x3 := 0:$$
$$x4 := 1:$$
$$x5 := 0:$$
$$x6 := 1:$$
$$x7 := 0:$$
$$x8 := 1:$$
$$x9 := 0:$$
$$x10 := 1:$$
$$A := x1 + \frac{(x2 - x1) \cdot (2 \cdot i - 1)}{2 \cdot n}:$$
$$B := x3 + \frac{(x4 - x3) \cdot (2 \cdot j - 1)}{2 \cdot n}:$$
$$C := x5 + \frac{(x6 - x5) \cdot (2 \cdot k - 1)}{2 \cdot n}:$$
$$E := x7 + \frac{(x8 - x7) \cdot (2 \cdot l - 1)}{2 \cdot n}:$$
$$F := x9 + \frac{(x10 - x9) \cdot (2 \cdot m - 1)}{2 \cdot n}:$$
$$f(x, y, z, t, u) := \exp(-100 \cdot x \cdot y \cdot z) \cdot (\cos(u)):$$
$$Z2 := \left(\frac{1}{n^5}\right) \cdot evalf\left(\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{k=1}^{n} \sum_{l=1}^{n} \sum_{m=1}^{n} f(A, B, C, E, F)\right);$$

0.11835051308192
$$I2 := Z1 + Z2;$$
0.18300569305289

Table 1.

Exact value	Order M	Computed value of I_1 by Block pulse wavelet quadrature method
$I_1 = 0.108975$	10	0.108475736363569
	20	0.108849886558919
	30	0.108919301856824
	40	0.108943606697108
Exact value	**Order M**	**Computed value of I_2 by Block pulse wavelet quadrature method**
$I_2 = 0.1854297367$	30	0.181252895112226
	40	0.183005693052890
	50	0.183854617500471

	60	0.183854297500471
Exact value	**Order M**	**Computed value of I_3 by Block pulse wavelet quadrature method**
$I_3 = 14.808435$	30	14.7860034042157
	40	14.7958125657434
	50	14.8003553753703
	60	14.8084316532127
Exact value	**Order M**	**Computed value of I_4 by Block pulse wavelet quadrature method**
$I_4 = 1.96440666$	10	1.81308005522981
	20	1.85277795341053
	30	1.93517086643672
	40	1.96442754900495

RESEARCH ARTICLE

An Analytical Study on the Performance of a GaAs - InAs p-i-n quantum dot Solar Cell

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ABSTRACT

Incorporation of quantum dots (QDs) within the intrinsic region of   p-i-n structure has remarkably improved its efficiency over normal cells. Mainly QDs are used to enhance light absorption range of the solar spectrum. The present theoretical work includes the investigations on the spectral response, short circuit photocurrent density and open circuit voltage of a GaAs- InAs p-i-n quantum dot solar cell (QDSC) with various device parameters such as QD size, shape and intrinsic region width, and the results obtained is interpreted graphically. This is observed that performance of the cell may be improved by changing the size of the QDs. Finally depending on the analytical results, the optimized values of efficiency and fill factor are calculated correspondingly.

Keywords: Rectangular box shaped quantum dots; InAs/GaAs; dot size; intrinsic layer thickness; p-i-n structure; QDSC.

INTRODUCTION

Lot of theoretical and experimental works on p-i-n solar cells has been done by various researchers [1-4] to utilize the full solar spectrum. In their study, quantum dots (QDs) have been used to tune the band gap for enhancing the absorption range. Spectral response has been analyzed with the variation of dot size [5]. Optical absorption spectra have been investigated in detail considering Gaussian size distribution of cubic or spherical dots with infinite potential barrier at the boundaries [6]. Short circuit current and open circuit voltage are related to quantum dot

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parameters such as dot size, size non-uniformity, shape, and dot materials [7, 8]. Besides, quantum dot layer and dot volume density also influence on the photocurrent density and open circuit voltage [9-11]. Several works have been reported that short circuit current enhances and open circuit voltage degrades because of reducing effective band gap for insertion of QDs layer in the i-region [12, 13]. Partial solution of the loss of open circuit voltage has been discussed in [13, 14]. S. Kumar et al has reported numerical formula for measuring the confinement energy of electron and hole, and they have also extensively studied about the absorption spectra of III-V semiconductor quantum dots taking into account the effects of Gaussian size distribution [15]. A theoretical model has been proposed by H.L. Weng et al [16], in which they have computed various device parameters in terms of QDs material, dot size, size dispersion, dot volume density and spacer thickness. A new empirical formula for calculating the absorption coefficient of QDs has been presented by A. Benahmed et al [17], in which they have included the absorption of light hole and heavy hole. Recently a numerical analysis of the temperature dependence on various characteristic parameters related to charge carriers in a quantum dot solar cell has been performed by M. A. Humayun et al. [18]. In this study, following the model proposed by V. Aroutiounian [1], a theoretical investigation has been carried out on the spectral response, short circuit photocurrent density and open circuit voltage of a GaAs-InAs p-i-n quantum dot solar cell depending on the QDs size and width of the intrinsic region, in which QDs have been assumed as a rectangular box in shape and uniform in size, and of infinite potential at the boundaries.

ANALYSIS
Schematic diagram of a InAs/ GaAs quantum dot (QD) solar cell is presented in Fig. 1 with necessary dimensions. Intrinsic region of this cell is composed of self-assembled InAs / GaAs QDs. This is assumed that QDs are rectangular box in shape and uniform in size distribution. W_p, W_n and W_i are the thicknesses of p-type, n-type and intrinsic i regions along z direction respectively.

Calculation of spectral response and short circuit current density
In this paper, calculation of photocurrent contributed from each layer has been carried out following the model proposed by Aroutiounian [1]. Basically we are concerned in calculation of photocurrent generated inside the i-region. This current is sourced from InAs QDs and GaAs barrier material of i-region. For incident radiation of wavelength λ the carrier generation rate of QDs may be represented as [1].

$$G_D(\lambda, z) = \alpha_D(\lambda)F(\lambda)[1 - R(\lambda)]exp[-\alpha_D(\lambda)(z - W_p)] \qquad (1)$$

where $\alpha_D(\lambda)$ is the absorption coefficient of QDs ensemble, $F(\lambda)$ is the photon flux of incident light and $R(\lambda)$ is the surface reflection coefficient. The absorption coefficient $\alpha_D(\lambda)$ of QDs is the addition light hole and heavy hole absorption coefficient to conduction band, given by [17]

$$\alpha_D = \alpha_{c-lh} + \alpha_{c-hh} \qquad (2)$$

The expressions of α_{c-hh} and α_{c-lh} are respectively approximated as [19]

$$\alpha_{c-hh}(E) = 2.2 \times 10^6 \frac{\left(\frac{\mu_{rhh}}{m_o}\right)^{3/2}}{E} \sqrt{\frac{E - E_{tr}}{q}} \quad (cm^{-1}) \qquad (3)$$

$$\alpha_{c-hh}(E) = 2.2 \times 10^6 \frac{\left(\frac{\mu_{rlh}}{m_o}\right)^{3/2}}{E} \sqrt{\frac{E - E_{tr}}{q}} \quad (cm^{-1}) \qquad (4)$$

with electric charge $q = 1.6 \times 10^{-19} C$, m_o is the rest mass of electron, E is the energy of incident photons, $\mu_{r(hh,lh)} = \frac{m_e m_{(hh,lh)}}{m_e + m_{(hh,lh)}}$ is the reduced mass of heavy- holes and light-holes, and m_e, m_{hh}, m_{lh} are the effective mass of electrons, heavy holes and light holes respectively, these masses can be evaluated by linear interpolation [20], and E_{tr} is the transition energy, given by [17]

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$$E_{tr} = E_g + E_e + E_h \tag{5}$$

where E_g is the band gap energy of the material (InAs) of QD, and E_e and E_h are the confinement energy of electrons and holes. The electrons and holes confinement energies in an ideal rectangular box shaped QD of length l_x, breath l_y and height l_z is given by [15].

$$E_e = \frac{\pi^2 \hbar^2}{2m_e}\left[\frac{n_x^2}{l_x^2} + \frac{n_y^2}{l_y^2} + \frac{n_z^2}{l_z^2}\right] \tag{6}$$

$$E_h = \frac{\pi^2 \hbar^2}{2m_h}\left[\frac{n_x^2}{l_x^2} + \frac{n_y^2}{l_y^2} + \frac{n_z^2}{l_z^2}\right] \tag{7}$$

where m_h is the average effective mass of holes, and n_x, n_y and n_z are the any positive integers which determine the energy of the level.

Now the photocurrent contributed form QDs is measured as

$$J_D(\lambda) = q\int_{W_p}^{W_p+W_i} G_D(\lambda, z)dz \;=\; qF(\lambda)[1 - R(\lambda)] \times [1 - exp(-\alpha_D W_i)] \tag{8}$$

Again, electron-hole pairs generation rate in the barrier material of i-region is basically contributed by the residual volume of GaAs occupied in a fraction $(1 - n_D V_D)$ of the QD-layer. Hence the carrier generation rate in the barrier GaAs material of i-region is seen as

$$G_B(\lambda, z) = \alpha(\lambda)F(\lambda)[1 - R(\lambda)]exp\{-\alpha(\lambda)W_p\}(1 - n_D V_D)\alpha(\lambda)$$
$$\times exp[-(1 - n_D V_D)\,\alpha(\lambda)(z - W_p)] \tag{9}$$

where n_D is the volume density of QDs and $V_D = L_x L_y L_z$, is the volume of each QDs.
The corresponding photocurrent density can be calculated as

$$J_B(\lambda) = q\int_{W_p}^{W_p+W_i} G_B(\lambda, z)dz$$
$$= F(\lambda)[1 - R(\lambda)]exp\{-\alpha(\lambda)W_p\} \times exp[-(1 - n_D V_D)\,\alpha(\lambda)W_i] \tag{10}$$

Now photocurrent density sourced from intrinsic region is
$$J_i(\lambda) = J_D(\lambda) + J_B(\lambda) \tag{11}$$

Spectral response of the cell is thus given by
$$SR(\lambda) = \frac{J_{ph}(\lambda)}{qF[1 - R(\lambda)]}$$
$$= \frac{J_n(\lambda)}{qF[1 - R(\lambda)]} + \frac{J_p(\lambda)}{qF[1 - R(\lambda)]} + \frac{J_D(\lambda)}{qF[1 - R(\lambda)]} + \frac{J_B(\lambda)}{qF[1 - R(\lambda)]}$$
$$= SR_{front}(\lambda) + SR_{base}(\lambda) + SR_D(\lambda) + SR_B(\lambda) \tag{12}$$

where $SR_{front}(\lambda)$, $SR_{base}(\lambda)$, $SR_D(\lambda)$ and $SR_B(\lambda)$ are the spectral response contributions from front and base regions, and intrinsic InAs QDs and GaAs barrier material, and the electron current density $J_n(\lambda)$ and hole current density $J_p(\lambda)$ collected from p-type and n-type layers can be easily obtained from [1].

The total short circuit photocurrent density is obtained by integration over the wavelength of the spectrum as
$$J_{sc} = f_i\left[\int_0^{\lambda_1}\left(SR_{front}(\lambda) + SR_{base}(\lambda) + SR_B(\lambda)\right)d\lambda + \int_{\lambda_1}^{\lambda_2} SR_D(\lambda)d\lambda\right] \tag{13}$$

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where transport factor f_i represents the mean probability that carriers cross the i-region without loss by recombination and capturing.

Open circuit voltage

The open circuit voltage of the cell can be presented as [1]

$$V_{oc} = \frac{kT}{q} ln\left(\frac{J_{sc}}{J_o} + 1\right) \tag{14}$$

where J_o is the reverse saturation current of the junction, V is the voltage appeared at the junction, k is the Boltzmann constant, T is the absolute temperature.

The reverse saturation current is the summation of two dark current components:

$$J_o = J_{s1} + J_{s2} \tag{15}$$

where J_{s1} is the current generated by minority carriers at the depletion layer edges and J_{s1} is the current sourced by the minority carriers inside the i-region due to thermal excitation [21, 22].

The dark current component J_{s1} is given by

$$J_{s1} = A\ exp\left(-\frac{E_{gB}}{vkT}\right) \tag{16}$$

Where E_{gB} is the energy band gap of GaAs, v is the ideality factor and

$$A = qN_C N_V \left(\frac{D_p}{N_D L_p} + \frac{D_n}{N_A L_n}\right) \tag{17}$$

with N_C and N_V are the effective density of states in GaAs conduction and valence band respectively, N_D and N_A are the donor and acceptor concentrations in the n-type and p-type regions, correspondingly.

Another current dark component J_{s2} is seen by

$$J_{s2} = A_{eff}\ exp\left(-\frac{E_{eff}}{vkT}\right) \tag{18}$$

where $A_{eff} = 4q\pi n^2 kT E_{eff}^2 / c^2 h^3$, and n is the average refractive index of *i*-region, and E_{eff} is the effective energy band gap of i- region which may be controlled by the band gap of GaAs E_{gB} and of InAs QD E_{tr} as

$$E_{eff} = [1 - n_D V_D]E_{gD} + n_D V_D E_{tr} \tag{19}$$

with E_{tr} is given in equation (5).

Conversion efficiency and fill factor

Following [1], we can easily calculate the conversion efficiency and fill factor. The efficiency of the cell at maximum power condition is

$$\eta = \frac{J_m V_m}{P_o} = \frac{kT}{q} \frac{t_m[J_{sc} - J_o(e^{t_m} - 1)]}{P_o} \tag{20}$$

Where $P_o = 116\ mW/\ cm^2$, is the incident power per unit area for 1 sun and AM 1.5 conditions, and the maximum power parameter t_m has to be determined from the equation

$$e^{t_m}(1 + e^{t_m}) = \frac{J_{sc}}{J_o} \tag{21}$$

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Fill factor may be measured by the relation

$$FF = \frac{J_m V_m}{J_{sc} V_{oc}}$$
(22)

RESULTS AND DISCUSSION

In this work, analytical investigations on spectral response, short circuit current density and open circuit voltage of QDSC have been carried out depending on the various device parameters. Spectral response $SR(\lambda)$, J_{sc} and open circuit voltage can be respectively measured from equations (12), (13) and (14). Integers n_x, n_x and n_z are taken 1, and the value of QD's base widths l_x and l_y are chosen 20 nm, and λ_1 is equal to 0.87 μm, and the value of λ_2 may be varied depending on the height of QDs. Variation of photon flux density with wavelength of incident light has been computed using the formula reported in [1]. Fig. 2. shows the variation of total spectral response of the cell versus wavelength of the incident photons for different values of QDs height. This is observed that spectral response for GaAs barrier regions abruptly falls, as wavelength of photons exceeds 0.87 nm. This means that GaAs material is unable to absorb the photons of wavelength larger than 0.87 nm. On the other hand spectral response contributions from QDs are significant at this condition because QDs have the ability to absorb the longer and longer wavelength photons by varying its height. In fact, confinement energies of electrons and holes in QDs reduce the effective band gap of QDs as dot height raises, which enhances overall the spectral response of the cell.

Short circuit current density of QDSC has been plotted in Fig. 3 as a function of width of the intrinsic region for various values of QD height. This is observed that as the intrinsic layer thickness changes at a particular value of QD, J_{sc} initially increases and then it remains almost constant [16]. On the other hand as QD's height changes from lower to higher values, J_{sc} significantly rises. This may be the reason that more and more photons are absorbed by the QDs at high value of QD height. Open circuit voltage of the considered cell is shown in Fig. 4 with intrinsic region thickness for different values of quantum dot height. It is evident from analytical observation that open circuit voltage strongly depends on quantum dot size. As QD size increases, open circuit voltage reduces. This can be explained in this way that reduction of the QD size implies enhancement of the effective band gap [12, 13] resulting larger open circuit voltage and smaller short circuit current density [16]. On the other hand open circuit voltage is almost independent of intrinsic layer thickness.

Finally power conversion efficiency and fill factor have been calculated based on the above results. As short circuit current density and open circuit voltage have reversible behavior on the variation of QD size. Hence the efficiency and fill factor can be optimized by changing QD size. Measured values of efficiency and fill factor reach respectively at 24.4 % and 84.5 % for 7 nm of QD height, 3 μm of intrinsic layer thickness under 1 sun and AM 1.5 conditions [1].

CONCLUSION

In this paper analytical work on the spectral response, short circuit current density and open circuit voltage of a QDSC has been done and the results obtained have been explained graphically. This is evident from Fig. 2 that the spectral response can be increased by tuning the quantum dot size. This is also noticed from Fig. 3 and Fig. 4 that the short circuit current and open circuit voltage are influenced conversely as QD size varies [12, 13]. On the other hand these parameters weakly depend on the intrinsic layer width [16]. Besides conversion efficiency and fill factor are also remarkably affected by quantum dot size and shape.

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Table 1. **The parameters used in this simulation [1].**

parameters	unit	value
surface recombination velocity $(S_n \, or \, S_p)$	cm/sec	3×10^3
diffusion length of electrons (L_n)	μm	2
diffusion length of holes (L_p)	μm	3
diffusion constant of electrons D_n	$cm^2 s^{-1}$	200
diffusion constant of holes (D_p)	$cm^2 s^{-1}$	10
volume density of QDs (n_D)	cm^{-3}	1.7×10^{17}
Surface reflection coefficient $[R(\lambda)]$		0.1
Band gap of GaAs (E_{gB})	eV	1.42
Band gap of InAs QDs (E_{tr})	eV	$0.36 + E_e + E_h$
Acceptor concentration (N_A)	cm^{-3}	1.4×10^{18}
Donor concentration (N_D)	cm^{-3}	1.7×10^{17}
p-region width (Z_p)	μm	0.8
n-region width (Z_n)	μm	2
QD base width $(l_x \, or \, l_y)$	nm	20
QD average height (l_z)	nm	$5 - 12$
transport factor(f_i)		1
ideality factor (v)		1.2

E_e and E_h are the confinement energy of electrons and holes
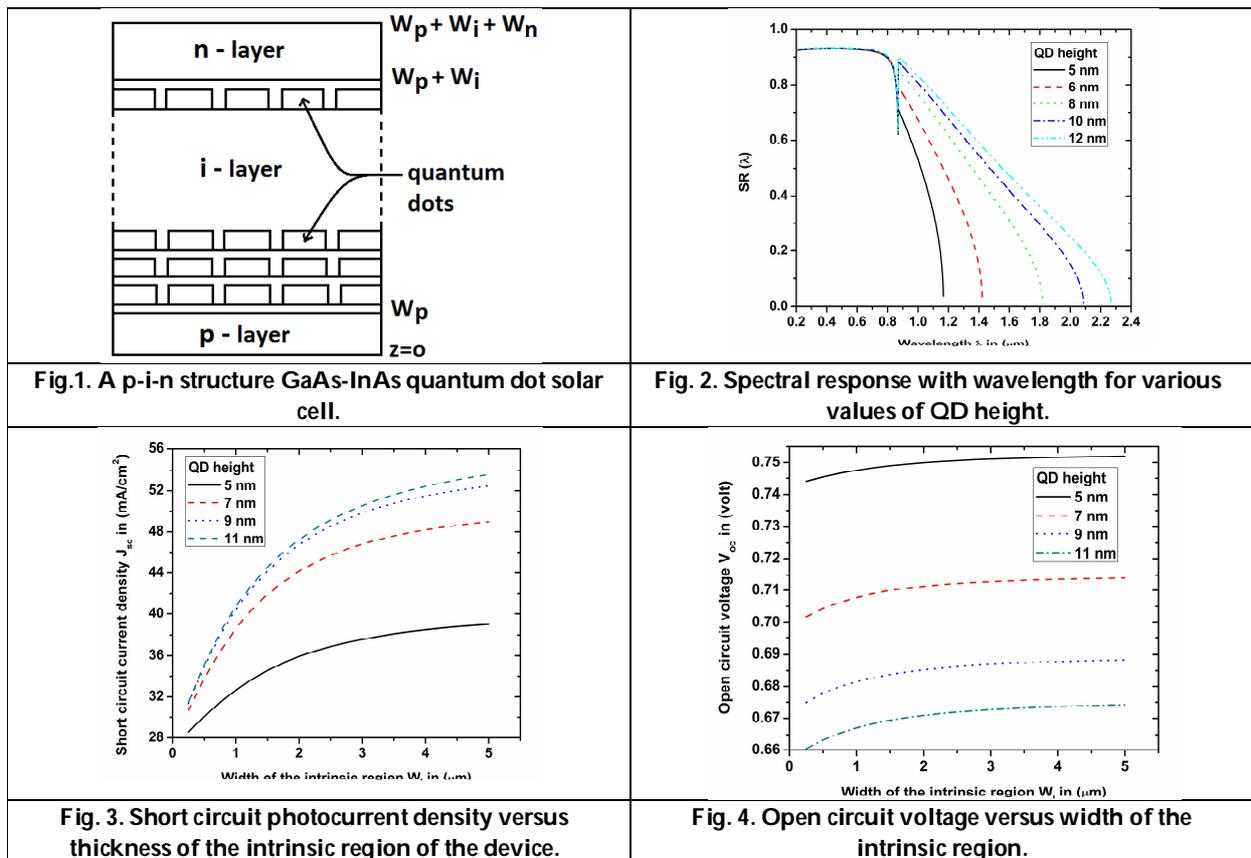

Fig.1. A p-i-n structure GaAs-InAs quantum dot solar cell.

Fig. 2. Spectral response with wavelength for various values of QD height.

Fig. 3. Short circuit photocurrent density versus thickness of the intrinsic region of the device.

Fig. 4. Open circuit voltage versus width of the intrinsic region.

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RESEARCH ARTICLE

Isolation, Characterization and Primary Screening of *Streptomyces* spp. for Antifungal Potential against Chilli (*Capsicum annuum* L.) Pathogens

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ABSTRACT

A total of 18 *Streptomyces* species were isolated from the Rhizosphere soil of Maize, collected from Harapanahalli (Taluk), Vijayanagar (District), Karnataka, India. Isolation was carried out by serial dilution. For isolation Starch Casein Nitrate (SCN), International *Streptomyces* Project-2 (ISP-2), Oatmeal agar media and Kenknight and Munaiers agar media were used. The isolates were characterized for their morphological and biochemical studies. The results revealed diversity of Actinomycetes with varying spore, aerial and substrate mycelium colors such as white, grey, pink, yellow and black. The colonies formed were discrete, powdery, raised and velvety colonies with brown, yellow and maroon pigmentations. The spore chain morphology studies showed different arrangements like rectus, flexibilis, retinaculum aperatum – open loops, hooks and spira – simple spirals. All the isolates were screened for antifungal activity by cross streak method. Among 18 isolates, SDSRO-13 showed strong inhibition against all the selected fungal pathogens of Chilli. The percentage inhibition of mycelial growth of all the fungal pathogens by the potent isolate SDSRO-13 were carried out by the formula. Primary screening for antifungal activity was determined by cross streak method against six fungal pathogens of Chilli. Dual culture assay was carried out for the measurement of rate of Percentage inhibition. SDSRO-13 showed inhibition against six selected fungal pathogens in the range of 79.74-89.95%. Actinomycetes especially members of the genus *Streptomyces* are fascinating biocontrol agents which exhibit safer alternative managements to control the fungal pathogens of Chilli.

Keywords: Antifungal activity, *Streptomyces* sp., Chilli, Dual culture assay, Percentage inhibition.

INTRODUCTION

Earth's soil is one of its most intricate and diverse environments. In order to function, reproduce, and survive in a dynamic environment with varied moisture, temperature, and chemical contents, soil organisms have evolved several strategies. Because soil conditions can change over relatively short distances as well as over time, soil organisms must be able to adapt quickly to various environments. In addition, plant roots have a significant impact on the majority of the topsoil. Thus, the region around the root where microorganisms and activities crucial for plant growth and health are found is known as the plant rhizosphere. Between roots and the surrounding soil is a layer called the rhizosphere that participates in significant nutrient flows. In addition, plant. Moreover, plant rhizosphere provides a special habitat that promotes higher microbial growth, abundance, and diversity [1]. Waksman and Henrici first introduced the genus *Streptomyces* in 1943 (Williams et al. 1983) [2]. The Streptomycetaceae family includes the genus *Streptomyces*. In general, the 16 SrRNA analysis, DNA-DNA hybridization, type of peptidoglycan, phospholipids, fatty acid chains, percentage of GC content, and physiological and morphological characteristics can distinguish members of the Streptomycetaceae family [3]. The genus Streptomyces is the only member of the Streptomycetaceae family, which is in the Actinobacteria phylum and Actinomycetales order within the class Actinobacteria [4]. *Streptomyces* is one of the largest taxonomic categories of known Actinomycetes in terms of the quantity and variety of described species. [5] *Streptomyces* are filamentous, Gram-positive bacteria that can be found in a range of soils, including compost, water, and plants. *Streptomyces* are able to produce secondary metabolites, including antibiotics, is its most distinctive feature. Making use of a large branching substrate and aerial mycelium is another trait of *Streptomyces*. They successfully colonise the rhizosphere because of the filaments they produce in the soil, which resemble threads. Rhizobacteria affect plant growth, combat plant diseases, and make nutrients available to the plants [6]. Actinomycetes are significant because they produce antibiotics and other beneficial chemicals of commercial significance in addition to degrading organic matter in the natural environment [7].

Actinomycetes exhibit a broad spectrum of biological properties, including those that are antibacterial, antifungal, antiviral, antiparasitic, immunosuppressive, anticancer, insecticidal, anti-inflammatory, antioxidant, enzyme inhibitory, and diabetogenic [8]. The primary impact of those that produce antibacterial and antifungal metabolites on their immediate environment is to prevent other microbes from proliferating or developing. The biological antagonistic types relate to these classes of actinomycetes. Due to their exploitation and the use of their metabolites in the production of antibiotics, they are of key significance [9]. One of the biological agents that is successful in preventing *Fusarium* wilt diseases in cotton plants is *Streptomyces* spp. *Streptomyces* sp. was efficient in suppressing the growth of *F. oxysporum* in tomato plants by 75% and was able to reduce the growth of *F. oxysporum* on red chilli peppers up to 82% [10]. One of the most important issues in commercial crops is fungal phytopathogens [11]. Major causes of crop loss are due to the soil borne diseases including grey mould, late blight, and anthracnose, which frequently inflict harm on a range of fruits and vegetables like tomatoes, strawberries, and peppers. Pepper (*Capsicum annuum* L.), is an important crop cultivated worldwide, can suffer large losses in both yield and quality due to anthracnose [12]. The aim of the present study was to evaluate antifungal activities of *Streptomyces* sp. to control fungal pathogens of Chilli like *Fusarium* sp. *Colletotrichum* sp. and *Alternaria* sp.

MATERIALS AND METHODS

Sample collection and isolation of *Streptomyces* sp. SDSRO-13
Streptomyces spp, were isolated from the rhizosphere soil of Maize plant. The soil was collected in a sterile polythene zip lock covers. Collected soil was brought to the laboratory and treated. Treatment was done by mixing 0.1 gm of $CaCO_3$ to 1 gram of dried soil sample. The treated soil was serially diluted with sterile distilled water till 10^{-6} and plating was done on solidified Starch Casein Nitrate agar medium (SCN), Actinomycetes Isolation Agar (AIA) (Himedia), Oat Meal agar and Kenknight and Munaier's medium. Streak plate method was used to purify the *Streptomyces* colonies. The media were supplemented with antibiotics Flucanozole and Griseofulvin to prevent

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fungal and bacterial contamination. All the plates were kept for incubation at 30±2° C for 7-14 days. Pure cultures were transferred on slants and preserved at 4° C for further analysis [13].

Characterization and Identification of *Streptomyces* spp.
Morphological Characterization
Morphological observations of the spore-bearing hyphae, spore chain, and spore morphology were made by using the cover slip technique. The cover slip method was performed by inoculating the pure cultures of the isolates on thin block of Starch Casein Agar. and placed on a clean glass slide. After inoculation, sterilized cover slip was placed on the agar block, the entire set up was then placed in a moist chamber and was incubated at 30±2ºC for 3-4 days. Moist condition was maintained by addition of sterile distilled water. After the incubation period, the cover slips were removed from the agar surface and were mounted on another slide by using crystal violet as staining reagent. The observation was done using binocular research microscope under oil immersion objective. All the isolates were subjected for Gram's staining and Acid-fast staining [14].

Biochemical Characterization
Various biochemical tests namely starch hydrolysis, casein hydrolysis, catalase test. gelatin hydrolysis, hydrogen sulphide production test, carbohydrate utilization test (dextrose, sucrose. lactose, maltose and starch) were performed [15].

Fungal pathogens used for antifungal activity of *Streptomyces* spp.
Colletotrichum capsici (ITCC No. 2041), *Fusarium oxysporum* (ITCC No. 6559), *Alternaria alternata* (ITCC No. 7025) were obtained from IARI, New Delhi. *Colletotrichum* sp., *Fusarium* sp., *Alternaria* sp. were isolated in the laboratory from infected chilli plant. All the fungal cultures were maintained on Potato Dextrose Agar (PDA) slants at 4° C for further assay.

Primary screening of *Streptomyces* isolates for antifungal activity
The primary screening of all the 18 *Streptomyces* isolates were carried out by cross streak method on SCN media. The media was amended with peptone and dextrose to facilitate fungal growth. The plates were prepared and the *Streptomyces* isolates were inoculated by a single line streak in the centre of the petriplate and were incubated for four days at 30±2°C. After 4 days the plates were then inoculated with the test organism's perpendicular to the growth of actinomycetes isolates and incubated for 72 hours for fungal growth. The absence of growth or a less dense growth of test organism near the actinomycete isolate was considered positive for production and secretion of antimicrobial metabolite by the isolates [16, 17, 18].

Screening of *Streptomyce*s spp. for antifungal potential by dual culture assay
Antifungal activity of *Streptomyces* spp. against chilli pathogens were evaluated by using dual culture assay. Actively growing fungal mycelia of all the six pathogens were inoculated on the modified SCN media at a distance of 1.5 cm. The *Streptomyces* isolate SDSRO-13 was inoculated 4 days prior to the fungal inoculation. All the plates were incubated at 25±2° C for 7-14 days [19]. After incubation, the zone of inhibition was measured and colony growth inhibition (%) was calculated by using the formula: $PI = C\text{-}T/C \times 100$, where PI is the percent inhibition, C is the colony growth of the pathogen in control, and T is the colony growth of pathogen in dual culture. [20]

RESULTS

Identification
Morphological Characteristics and staining characteristics of *Streptomyces* spp.
Streptomyces spp. colony morphology showed varied morphological characteristics, radiating powdery, granular, rugose and raised powdery. The color of aerial mycelia appears to be pinkish white, white, and gray color. Substrate mycelia showed brown, pink, white, yellow and light orange color. The spore arrangements of the isolates

was performed by cover slip method and are flexibilis, rectus, hooks, rectus straight, micromonospora and spiral in nature. All the isolates were found to be Gram positive and non acid fast. (Table-1)

Biochemical Characteristics
Biochemical characteristics of *Streptomyces spp.* showed positive results for starch hydrolysis, casein hydrolysis, catalase test and gelatin hydrolysis and showed negative result for hydrogen sulfide production. For Gram's staining tests the isolate showed Gram positive and non acid fast. The carbohydrate utilization test for *Streptomyces* spp. showed various results. The gas production was not observed and it is observed by the accumulation of gas in the Durham's tube. Acid production was observed by changing the color red to yellow in dextrose and showed positive results for alkali as it can be observed by changing color from red to dark pink in all the sugars except dextrose.

Morphological and Staining Characteristics of the *Streptomyces* isolates
The isolates were characterized for the biochemical and morphological tests [21]. The isolates were characterized on the basis of cultural characteristics (sporulation, color of the aerial and substrate mycelia and soluble pigment production in the medium) as per methods prescribed in International *Streptomyces* Project [22].

Characterization of the *Streptomyces* isolates
The isolates produced a diverse range of pigments. Majority of the isolates were secreted brown and yellow diffusible pigments. The spore morphology by coverslip method showed different arrays of spore arrangements differ fron rectus, flexibilis, retinaculum, spiral and hooks. (Table-1) All the 18 isolates showed varied biochemical characteristics. All isolates were negative for H_2S production, all the isolates were positive for starch hydrolysis, 10 isolates were positive for catalase test, 11 isolates were positive for casein hydrolysis, and 6 isolates were positive for gelatin hydrolysis. (Table 2) The carbohydrate utilization test showed diverse results of acid and alkali production by the isolates. The acid and gas production was observed by the colour change from red to yellow and accumulation of gas in the Duram's tube. The alkali production was observed by the change of colour from red to dark pink (Figure 3) 04 isolates were positive for acid production, 13 isolates were positive for alkali production, no gas production was observed in dextrose. Most of the isolates showed positive result for alkali production in all the sugars tested, alkali production was considerably high in disaccharides and polysaccharides. 03 isolates were positive for acid production, no gas production, 14 isolates produced alkali in sucrose. 02 isolates was positive for acid, 01 isolate was positive for gas production, 16 isolates were positive for alkali production in lactose. Maltose utilization was observed by acid production in 01 isolate, 01 isolates was positive for gas production and 17 isolates were positive for alkali production. 01 isolate was positive for acid production, 01 isolates was positive for gas production and 17 for alkali production in starch Antifungal activity of *Streptomyces* spp. was carried out against fungal pathogens. The activity of *Streptomyces* spp. was measured on the interaction between the *Streptomyces* spp. and test organisms (Table 3).

Among the 18 isolates tested against *Fusarium oxysporum*, the maximum inhibition was recorded with the isolates SDSRO-1, SDSRO-12, SDSRO-16 and SDSRO-13 is 74.4%. All the 18 isolates tested against *Fusarium* sp., where as the maximum inhibition was recorded with the isolates SDSRO-2, SDSRO-13 and SDSRO-16 is 71%. Similarly the isolates tested against *Colletotrichum capsici*, the maximum inhibition was recorded with the isolates SDSRO-2 and SDSRO-13 is 68.79%. Isolates SDSRO-13 and SDSRO-12 showed maximum inhibition ie 60.2%, when tested against *Colletotrichum* sp. All the isolates were tested against *A.alternata*, the inhibition was recorded with the isolates SDSRO-13 and SDSRO-16 is 65.52%. Isolates SDSRO-13 and SDSRO-15 showed inhibition of 62.85% against *Alternaria* sp. Isolates showed 10 least inhibition against *Fusarium oxysporum* and *Colletotrichum capsici* (23.25%). Whereas the Isolates SDSRO-3, SDSRO-4, SDSRO-6 and SDSRO-14 were ineffective against all the fungal pathogens tested. (Table 4; Fig 4). The isolate SDSRO-13 showed the inhibition of mycelial growth of all the 6 fungal pathogens of chilli which were tested after 7 days of incubation. Compared with the growth diameter of *F.oxysporum* (8.5±0.06), *Fusarium* sp.(9±0.01), *A.alternata* (7.8cm±0.010), *Alternaria* sp. (8.79cm±0.012), *C.capsici* (8.87cm±0.015), *Colletotrichum* sp. (8.96cm±0.014) centimeters in the control plate, the mycelial growth diameter of *F.oxysporum* (1.2cm ± 0.12),

Fusarium sp. (1.23cm±0.10), *A.alternata* (1.58cm±0.150), *Alternaria* sp. (1.21cm±0.128), *C.capsici* (1.34±0.154), *Colletotrichum* sp. (1.26±0.102) centimeters decreased markedly with the treatment of SDSRO-13 (Figure 5).
The isolate SDSRO-13 showed highest antifungal activity against six test fungi with inhibition rate in the range of 89.95 to 79.74% (figure 6). Highest Percentage (%) inhibition was shown by *F.oxysporum* (89.95%) and lowest by *A.alternata* (79.74%).

DISCUSSION

Many species of actinomycetes, particularly the genus *Streptomyces*, are well known as antifungal agents that inhibit several pathogenic fungi [23]. *Streptomyces* are of special interest in agriculture as PGP and BCAs, as they are commonly found in soil are able to colonize rhizosphere and root tissues. They have the potential to act as antagonist against a variety of plant pathogens. [24] Present study aimed to isolate *Streptomyces* spp. from the rhizosphere soil of Maize and screening them for the antifungal activity against chilli pathogens. Isolation of *Streptomyces* was done by serial dilution and plating on SCN media. A total of 18 isolates were obtained. Similar work was carried out [25]. The spore arrangement studies and biochemical characterization studies assists classification of majority of actinomycetes isolates as members belonging to the genus *Streptomyces*. The results of morphological and biochemical characterization are tabulated in Table no 1, 2 and 3. The results obtained in the present investigation are in similar with earlier studies [26].

Cross streak method is one of the important technique used for preliminary screening of antimicrobial activities for actinomycetes. This method determines the inhibition potential of any microbe by producing antimicrobial compounds. This method was selected in the present study for preliminary screening of *Streptomyces* spp. for their antifungal potential against fungal diseases of Chilli. Cross streak method has become one of the routinely used methods and has been employed by several Researchers to study antimicrobial potential of actinomycete isolates [27]. Dual culture assay has been commonly used for evaluating the antagonistic activity of actinomycetes against plant fungal pathogens [28]. In the present research work, we used to inuculate the *Streptomyces* isolates prior 4 days of fungal inoculation to allow them to produce the bioactive secondary metabolites and were capable of inhibiting the chilli fungal pathogens (Figure 5). Mycelial growth inhibition rate in the range of 81.74 to 89.95% (figure 6). *Streptomyces* are peculiar bacteria characterized by mycelial growth and particular life cycle, where the production of bioactive secondary metabolites coordinated with the switch to the formation of aerial hyphae and spores [29]. In case of fast growing fungi such as *S. sclerotiorum* it is observed a significantly higher inhibition when *Streptomyces* was inoculated 2-3 days before the pathogen, which was not confirmed for slower growing fungi and confirms that *Streptomyces* start to produce secondary metabolites later during their life cycle, and that, especially in the case of fast-growing fungal pathogens, they need to be applied prior the pathogen inoculation [30].

Streptomyces isolate SDSRO-13 along with biocontrol activity exhibited plant growth promoting attributes like, phosphate solubilisation, IAA production and Ammonia production. There are various mechanisms involved in the disease suppression, one of the primary mechanism of pathogen inhibition is used by plant growth promoting activity includes the production of antibiotics, lytic enzymes, volatile compounds and siderophores [31]. There are many reports which demonstrate the ability of rhizospheric soil *Streptomyces* sp. to produce Indole acetic acid and which promote the plant growth. [32] Actinomycetes are used as Plant Growth-Promoting agents, biocontrol tools, biopesticides agents and antifungal compounds [33]. They also produce many antibiotics including amphotericin, nystatin, chloramphenicol, gentamicin, erythromycin, vancomycin, tetracycline, novobiocin, and neomycin. Urauchimycins a member of antimycin class utilized as antifungal antibiotic against fungal pathogens and it act by hinders the electron flow in the mitochondrial respiratory chain [34].

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CONCLUSION

Now a days farmer became more and more dependent on agrochemicals but this increased use created lot of adverse effects. So, alternative approaches *viz.*, use of biocontrol agents for management of plant disease is very important. Among biocontrol agents *Streptomyces* is contributing for plant growth promotion activity and plant disease suppression by producing secondary metabolites. The success of a good biocontrol agent requires more than one parameter, such as, it should be effective for biocontrol over a long duration and if the biocontrol agent can improve plant growth, it will be an added advantage. *In vitro* antagonistic assay with SDSRO-13 reveals its potential to be utilized as biocontrol mechanism against fungal pathogens of chilli. The isolate also promotes PGP activity by producing IAA, Ammonia and Solubilization of phosphate. Therefore, *Streptomyces* are the valuable strains for the development as BCAs.

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Conflicts of Interest

The authors declare no conflict of interest.

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Table 1: Morphological characteristics of *Streptomyces* isolates

Sl. No.	Aerial Mycelium	Substrate Mycelium	Colony Morphology	Diffusible pigment	Spore chain arrangements
SDSRO-1	White	Brown	Granular	Brown	Rectus
SDSRO-2	Pink	Brown	Radiating Powdery	Brown	Flexibilis
SDSRO-3	White	White	Granular	-	Hooks
SDSRO-4	White	Pink	Granular	Brown	Rectus
SDSRO-5	Gray	White	Granular	-	Hooks
SDSRO-6	White	Pink	Radiating powdery	Brown	Rectus
SDSRO-7	White	Yellow	Granular	Yellow	Flexibilis
SDSRO-8	Pink	White	Raised powdery	-	Rectus
SDSRO-9	Gray	White	Granular	-	Rectus straight
SDSRO-10	White	Pink	Powdery	-	Flexibilis
SDSRO-11	White	Orange	Radiating granular	Brown	Micromonospora
SDSRO-12	Light gray	Orange	Granular	-	Rectus
SDSRO-13	Light gray	White	Granular	-	Flexibilis
SDSRO-14	Gray	White	Rugose	-	Hooks
SDSRO-15	White	White	Powdery	-	Flexibis
SDSRO-16	White	White	Powdery	-	Rectus
SDSRO-17	White	White	Radiating powdery	-	Flexibilis
SDSRO-18	White	Orange	Granular	-	Spiral

Table 2: Biochemical Characterization

Isolate No.	Biochemical tests				
	H_2S Production	Catalase Test	Casien Hydrolysis	Starch Hydrolysis	Gelatin Hydrolysis
SDSRO-01	-	++	+++	+	-
SDSRO-02	-	++	++	+	-
SDSRO-03	-	-	+	+	-
SDSRO-04	-	+	-	+	-
SDSRO-05	-	-	-	++	-
SDSRO-06	-	+	++	+++	+
SDSRO-07	-	+	+++	+	++
SDSRO-08	-	-	++	+	+
SDSRO-09	-	-	-	++	-
SDSRO-10	-	+	-	++	-
SDSRO-11	-	-	+	+++	+
SDSRO-12	-	+	++	+	++
SDSRO-13	-	+	-	+	++
SDSRO-14	-	-	-	++	-
SDSRO-15	-	-	+	+	-
SDSRO-16	-	+	++	++	-
SDSRO-17	-	-	+++	++	-
SDSRO-18	-	+	-	+++	-

'-' negative, '+' positive, '++' good, '+++' very good

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Table 3: Carbohydrate Utilization Test

Carbohydrate Utilization Test														
	Dextrose			Sucrose			Lactose			Maltose			Starch		
Isl.No.	Ac	G	Al	Ac	G	Al	Ac	G	Al	Ac	G	Al	Ac	G	Al
SDSRO-1	-	-	++	-	-	+++	-	-	++	-	-	+++	-	-	++
SDSRO-2	-	-	+++	-	-	+++	-	-	+++	-	-	+++	-	-	+++
SDSRO-3	-	-	++	+	-	-	-	-	++	-	-	++	-	-	++
SDSRO-4	-	-	+++	-	-	++	+	+	-	-	-	+++	-	-	+++
SDSRO-5	+	-	-	-	-	+	-	-	++	-	-	+++	-	-	++
SDSRO-6	-	-	++	+	-	-	-	-	+++	-	-	++	+	-	-
SDSRO-7	-	-	+++	-	-	++	-	-	++	-	+	++	-	+	++
SDSRO-8	-	-	++	-	-	+++	-	-	+++	-	-	++	-	-	+++
SDSRO-9	+	-	-	-	-	++	-	-	++	+	-	-	-	-	++
SDSRO-10	-	-	++	-	-	+++	-	-	++	-	-	+++	-	-	++
SDSRO-11	-	-	++	-	-	++	-	-	+++	-	-	++	-	-	+++
SDSRO-12	+	-	-	+	-	-	-	-	++	-	-	+++	-	-	++
SDSRO-13	-	-	+++	-	-	+++	-	-	+++	-	-	++	-	-	+++
SDSRO-14	+	-	-	-	-	++	-	-	+++	-	-	+++	-	-	++
SDSRO-15	-	-	++	-	-	++	-	-	++	-	-	+++	-	-	++
SDSRO-16	-	-	+++	-	-	+++	-	-	+++	-	-	++	-	-	+++
SDSRO-17	-	-	++	-	-	-	-	-	++	-	-	+++	-	-	++
SDSRO-18	+	-	-	-	-	+++	+	-	-	-	-	++	-	-	++

'-' negative, '+' positive, '++' good, '+++' very good

Table 4: Screening for Antifungal activity of *Streptomyces* sp.

Isl. No.	*F.oxysporum*	*Fusarium* sp.	*C. capsici*	*Colletotrichum* sp.	*A.alternata*	*Alternaria* sp.
SDSRO-1	++	+	+	+	++	++
SDSRO-2	++	+++	+++	++	++	+
SDSRO-3	-	-	-	-	+	-
SDSRO-4	+	-	-	-	-	-
SDSRO-5	++	++	++	++	+	+
SDSRO-6	-	-	-	-	-	-
SDSRO-7	++	-	++	++	+	+
SDSRO-8	++	-	+	-	+	++
SDSRO-9	++	+	+	+	++	++
SDSRO-10	++	+	++	+	+	++
SDSRO-11	++	-	+	++	+	+
SDSRO-12	+++	++	++	+++	++	++
SDSRO-13	+++	+++	+++	+++	+++	+++
SDSRO-14	-	-	-	-	-	-
SDSRO-15	++	++	+	-	++	+++

SDSRO-16	+++	+++	++	++	+++	++
SDSRO-17	++	++	+	+	++	-
SDSRO-18	++	+	+	++	-	++

Figure 1: Representatative of some *Streptomyces* isolates

Figure 2: Spore chain arrangements of *Streptomyces* isolates
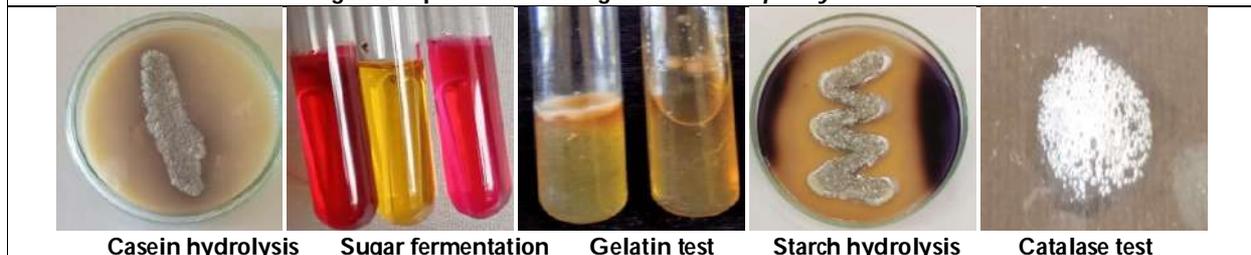
Casein hydrolysis　　Sugar fermentation　　Gelatin test　　Starch hydrolysis　　Catalase test

**Figure 3: Biochemical characterization of *Streptomyces* isolates**

SDSRO-13　　SDSRO-2　　SDSRO-16　　SDSRO-1

Figure 4: Antifungal activity of some *Streptomyces* spp. against fungal pathogens of Chilli


| **Figure 5: Antifungal potential of *Streptomyces* sp. SDSRO-13 against fungal pathogens**	**Figure 6: Percentage inhibition of fungal mycelial growth by *Streptomyces* sp. SDSRO-13**
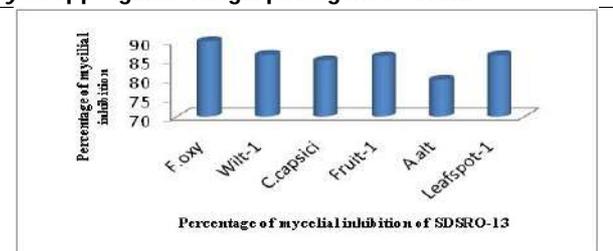
RESEARCH ARTICLE

Identification of Bioactive Components by Qualitative Phytochemical Analysis and Thin Layer Chromatography Profiling of the Whole Plant Extract of *Anisomeles indica (L)* Kuntze.

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ABSTRACT

Anisomeles indica, belonging to family *Lamiaceae*, is commonly found throughout the Deccan plateau and North Eastern India. The plant has varied ethno-medicinal importance, such as aerial parts that are used as stimulant, expectorant, diaphoretic and insecticide. Leaves are useful in chronic rheumatism, psoriasis and other chronic skin eruptions .Qualitative phytochemical screening of hexane, chloroform, acetone, ethanol, methanol extracts was performed to explore the scientific basis of the ethno- medicinal potential. It confirmedthe presence of many phytochemicals like alkaloids, flavonoids, phenols, terpenoids, etc. in various extracts. Alkaloids, phenols and flavonoids were mostly present in the methanol extracts. The hexane extract showed the predominant presence of terpenoids only and less number of alkaloids, while the chloroform extract gave a mild positive color for alkaloids, flavonoids and terpenes. The acetone extract gave a mild positive response for protein and flavonoids. Thin Layer chromatography (TLC) of the methanol extract of the whole pant of *Anisomeles indica (Linn.)*was performed for three important phytochemicals - alkaloids, flavonoids, and phenol in order to determine the best suited solvent for the development of their High Performance Thin Layer Chromatography fingerprint profile and further separation of the bio-actives using chromatographic techniques. These findings provide the evidence that *Anisomeles indica* is a potent source for some medicinally important phytochemicals, and this plant can be further investigated for the isolation and identification of active biochemical compound of medicinal value.

Keywords: *Anisomeles indica*, Bio-actives, Phytochemical screening, Thin Layer Chromatography (TLC).

Narayani Nivedhitha and Anita R. J. Singh

INTRODUCTION

Plants produce biologically active molecules called as phytochemicals/ metabolic intermediates which possess antibiotic, antifungal and antiviral properties. They help to protect the plant from pathogens and environment stress [1]The huge botanical riches must be identified, analyzed, and used by the pharmaceutical sector[2]. *Anisomeles indica* commonly known as 'Indian Catmint' is a traditional medicinal plant species of Tamilnadu and is distributed throughout India, China, Japan and southwards from Malaysia to Australia. *Anisomeles indica* (*Lamiaceae*) is a camphor-scented perennial woody shrub [3], Studies reveal that *Anisomeles indica* [Fig.1] is a source of medicinally active compounds and have various pharmacological effects like anti-oxidant, anti-microbial, anti HIV, anti-helicobacter pylori, anti-cancer activity and has an analgesic, anti-inflammatory activity .[4]. Aerial parts of the plant are valued as stimulant, expectorant, diaphoretic and insecticide. Leaves are considered useful in chronic rheumatism, psoriasis and other chronic skin eruptions. Bruised leaves are applied locally in snake bites [5].

Taxonomical Classification:
- Domain   : Eukaryota
- Kingdom   : Plantae
- Phylum   : Tracheophyta
- Class   : Magnoliopsida
- Subclass   : Lamiidae
- Order   : Lamiales
- Family   : Lamiaceae
- Genus   : Anisomeles
- Specific epithet : indica
- Botanical name   : *Anisomeles indica* (L.) Kuntze

2) **Synonym(s)**: Anisomeles ovata R.Br.
3) **Common name**: Indian Catmint
4) **Vernacular name**: Vattasadachi (Tamil)
5) **Habit**: Undershrub.

This knowledge is helpful for developing therapeutic sources and identifying new sources of economic materials like tannins, oils, and gums. [6].The majority of these biological components are extractable and are utilized as crude medicines. Qualitative chemical assays are used to identify the active principles in each category of phyto - constituents. Discovering the true worth of folklore remedies requires knowledge of the chemical components present in plants. In view of the fact that *Anisomeles indica (L)* has medicinal applications, we therefore propose to examine the range of phytochemical profiles that are accountable for the reported biological activities of this species. Numerous chromatographic techniques are available to isolate the individual phytoconstituents from   the crude plant extracts. TLC is a quick, sensitive, reproducible and inexpensive technique based on the principle of partition chromatography, which is used to determine the components in the mixture. It is used to confirm the identity and purity of a compound [7] as well as the solvent composition for preparative separations. However, choosing the right stationary phase and solvent system for the detection of secondary metabolites for a given phyto-constituent requires some trial and error. To find the chemical compounds that may be employed as markers for the quality assessment and standardization of the medicine in the near future, preliminary phytochemical screening and TLC profiling have been carried out in the current study.

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MATERIALS AND METHODS

Collection and Identification of Plant Material
Fresh plant samples of *Anisomeles indica* were collected from Dindigul district, TN, India, and were duly identified and authenticated by the taxonomist and Director, Plant Anatomy Research Centre, Chennai. The whole plant was washed thoroughly in tap water, shade dried and then ground to coarse powder by using by a mechanical grinder. This powder material was stored in air tight containers for further studies.

Preparation of Crude Extract
The extraction procedure was adopted from Harborne's 1984 [8]. About 50gms of the powdered sample of the whole plant was extracted with 400 ml each of 4 different solvents by sequential Soxhlet extraction method. Solvents used for extraction were of increasing polarity like hexane, chloroform, acetone and methanol. The process of extraction was carried out until the solvent in the siphon tube of the Soxhlet became colorless. At the end of the extraction, the solvent was evaporated using rotary vacuum evaporator, to obtain viscous semi-solid masses. This semi –dry crude extracts were used for phytochemical analysis and TLC.

Preliminary Qualitative Phytochemical Analysis
All of the plant extracts were investigated for qualitative screening of different phytoconstituents using standard tests. [9,10]

Detection of Alkaloids
Methanolic extract was diluted in acidic solution like 1-5% HCl or 10% acetic acid. This test solution was used for detection of alkaloid using various reagents.

Dragendorff's Test
1 to 2 ml of test solution was mixed with Dragendorff's reagent. Formation of bright orange precipitates confirmed presence of alkaloid in the sample.

Detection of Flavonoids
Extract dissolved in chloroform/methanol/n-hexane/ethyl acetate solvent can be used as test solution.

Shinoda Test
1 ml of test solution was mixed with magnesium powder and a few drops of concentrated HCl. Development of orange, pink, red to purple color with this test confirmed presence of flavonoid. By using zinc instead of magnesium, only development of deep-red to magenta color or weak pink to magenta color or no color at all indicated presence of flavonoid.

Alkaline Reagent Test
Crude extract was mixed with 2ml of 2% solution of NaOH. An intense yellow color was formed which turned colorless on addition of few drops of diluted acid which indicated the presence of flavonoids.

Detection of Steroids
Crude extract was mixed with 2ml of chloroform and concentrated H_2SO_4 was added sidewise. A red color produced in the lower chloroform layer indicated the presence of steroids. Another test was performed by mixing crude extract with 2ml of chloroform. Then 2ml of each of concentrated H_2SO_4 and acetic acid were poured into the mixture. The development of a greenish coloration indicated the presence of steroids.

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Detection of Phenols and Tannins
Ferric chloride Test: Test solution was mixed with 1 ml of 5% (w/v) FeCl3 in 90 % methanol. It was observed for blue, blue-green, red or purple color indicating the presence of phenols. A transient greenish to the black color indicated the presence of Tannins.

Detection of Saponin: Pinch of each extract was dissolvedin water and shaken well. Formation of foam indicated the presence of saponin in the test sample. Foam which was stable for 15 min or more then it was considered as positive.

Detection of Sugar: Extract dissolved in polar solvent like methanol/water/ethyl acetate/n-butanol can be used as test solution.

Benedict's test: Crude extract when mixed with 2ml of Benedict's reagent and boiled, a reddish-brown precipitate formed which indicated the presence of the carbohydrates.

Detection of Terpenoids:
Liebermann – Burchard Test: 1ml of extract was treated with chloroform, acetic anhydride and few drops of H_2SO_4 was added and observed the formation of dark green color indicates of the presence of terpenoids.

Detection of Glycosides:
Salkowski's Test: Crude extract was mixed with 2ml of chloroform. Then 2ml of concentrated H_2SO_4 was added carefully and shaken gently. A reddish-brown color indicated the presence of steroidal ring inglycone portion of the glycoside.

Detection of Proteins
Ninhydrin Test: Crude extract when boiled with 2ml of 0.2% solution of Ninhydrin, violet color appeared suggesting the presence of amino acids and proteins.

Screening of Methanol Extract using Thin Layer Chromatography
The analytic mode of Thin Layer Chromatography (TLC) was designed to identify the available phytochemicals in the crude methanolic extract of whole plant of *Anisomeles indica* (L.) Kuntze using suitable solvent systems and spraying reagents or visualizer.[11]. Samples were prepared by diluting the crude methanolic extract with respective solvent. It was then spotted (1-10μl) manually using a capillary tube on pre-coated silica gel 60 F_{254} (Merck) TLC plates (5X 3 mm thickness),at 2 cm,from the line of origin, on the TLC plate.

Development of Chromatogram:
The spotted TLC plates were developed in the chamber, pre-saturated withdifferent solvent systems,in order to detect a suitable mobile phase as per the method of Wagner *et al.* [12].Four different solvent systems used were, namely butanol: acetic acid: water (4:1:2), hexane: ethyl acetate (50:50),hexane: ethyl acetate (90:10) and chloroform: methanol (95:5)Elution was carried out using the aforementioned solvent systems. The plates were then dried when the elution was completed.

Detection of Compounds
The spots of separated compounds were detected by spraying the TLC plates with respective visualizing reagents namely:Dragendorff's reagent for Alkaloids, 5% Ferric chloride reagent for Phenols, and1% Ethanolic aluminium chloride reagent for flavonoids[13] so that the colored spots became visible. The plates were also observed under UV light at 254nm and 365 nm also. The spots were noted and their **Rf** values were determined by using following formula:

Rf = Distance travelled by the solute / Distance travelled by the solvent.

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RESULTS

Qualitative phyto-chemical analysis of the whole plant of *Anisomeles indica (L)* was   performed in four different extracts of varying polaritiessuch as Hexane, Acetone, Chloroform and Methanol. Different phyto-chemicals are detectable in various solvents. This study found that these extracts contained a variety of phytochemicals, and hence solvent systems with differing polarities were experimented to enable their maximal extraction. The alkaloids, phenols, and flavonoids were predominant   only in the methanol extract, proving the effectiveness of methanol in the extraction of polar compounds. The chloroform extract provided a mildly positive color for alkaloids, flavonoids, and terpenes, whereas the hexane extract showed the significant presence of terpenoids only and a lesser amount of alkaloids. Protein and flavonoids showed a mild and modestly good reaction respectively in the acetone extract. There were no saponins, tannins, carbohydrates, glycosides, or steroids in any of the extracts.

Results of preliminary phytochemical screening are summarized in Table 1. The methanol extract of the *Anisomeles indica* was subjected to Thin Layer Chromatography, in which solvent systems of varying polarities namely Butanol: acetic, acid :water [4:1:2], Hexane :ethyl acetate   [50:50],Hexane: ethyl acetate[90:10] and chloroform :methanol[95:5],were used as mobile phases to achieve the best separation of alkaloids, phenols and flavonoids. Solvent systems, visualizing agents used and the associated R_f values obtained for the phytochemicals detected in the methanol extract are listed in the Tables [2 -5]. The spots were developed by applying respective spraying reagents for alkaloids, flavonoids and phenols. One dark orange or brown colored spot was noted for alkaloids in each of the two different solvent systems namely - Butanol: Acetic Acid: Water [Fig2a:Table2]and Chloroform: Methanol. [R_F values 0.90 and 0.74 respectively]. The study revealed the development of yellowish brown colored band for flavonoids in the Chloroform: Methanol and Butanol: Acetic acid: water solvent systems with .R_f values 0.27 and 0.96 [Fig2b; Table 3]Dark yellow/ green and blue fluorescence, observed in UV light -254nm and 365nm [Fig 2e] respectively may indicate the presence of flavonoids. Purple colored band denoting phenols was identified in Butanol: Acetic acid: Water solvent system with an R_f value of 0.74 [Fig2c;Table 4].Up to 5 spots were visualized under UV light -254 nm for the Butanol: Acetic acid: Water solvent system [4:1:2], with an R_f value range of 0.24 – 0.96 whereas only one spot each could be seen for each of the other solvents [Fig2 d; Table5].

DISCUSSION

The study revealed that relatively high polarity solvents like (Butanol: Acetic Acid: Water) were more suited as mobile phases for the separation of bioactive compounds in the Methanol extract of the whole plant of *Anisomeles indica.* An idea of the R_f values of the bio-active compounds in specific solvents is an important factor, which serves as a useful tool in selection of appropriate solvent system for further separation of compound from the plant extract. [14].The therapeutic potential of medicinal plants is based on these bio-active phytochemicals, which are also helpful in the management of various diseases[15]. Previous reports state that terpenoids have analgesic and anti-inflammatory activities   [16] Numerous beneficial characteristics, such as anti-inflammatory, estrogenic, anti-bacterial, anti-allergic, antioxidant, vascular, and cytotoxic anticancer activity, have been attributed to flavonoids. [17]. Alkaloids weaken the performance of micro tubules and damage the integrity of the bio-membrane. They are also powerful ion channel inhibitors. At the cellular level, it also possesses anti-mitotic and allergic properties. They serve as a local pain reliever. [18]. Phenolic compounds function as chelators of metal ions that can catalyze the oxidation of lipids and as terminators of free radicals. They have been proven to have anti-inflammatory, antibacterial, and enzyme modulation processes that help them avoid the development of infectious and degenerative diseases, inflammation, and allergies. [19].

CONCLUSION

Preliminary phytochemical analysis revealed the presence of alkaloids, phenols, flavonoids and terpenes in the whole plant extract of *Anisomeles indica.* The TLC method is the most effective option for identifying secondary metabolites found in plants. The existence of potent, diverse biomolecules is confirmed by TLC profiling. Owing to the presence of rich variety of secondary metabolites, the whole plant extract of *Anisomeles indica* is expected to exhibit therapeutic properties. This report justifies the medicinal usage of this species by the rural people of the western districts of Tamil Nadu. Pure active chemical compounds should be isolated and identified using reference standards for future study.

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Table 1: Preliminary Phytochemical Analysis of Whole Plant Extract of *Anisomelesi ndica (L.) Kuntze*

S.No	Name of Extract	Alkaloids		Terpenoids	Flavanoids		Phenols	Protein
		Dragendorff's test	Mayer's test	Liebermann – Burchard Test.	Shinoda Test	Alkaline Reagent Test	Ferric chloride Test	Ninhydrin Test
1	Hexane	+	+	+ +	-	-	-	-
2	Chloroform	+	-	+	+	-	-	-
3	Acetone	-	-	-	++	+	-	+
4	Methanol	+++	+++	-	+++	++	+++	-

Note: + and **++** indicate intensity of presence and **–** indicates absence of Phytoconstituentsin sample

Table 2: **Results of Thin Layer Chromatography analysis of whole plant crude extract of *Anisomeles indica (L.) Kuntze* - Alkaloids**

Class Of Compounds	Crude Extract	Solvent System & the ratios used	Spraying Reagent/ Detecting reagent	Number of Spots Observed	Rf Values
Alkaloids	Methanol	Butanol: Acetic Acid : Water (4:1:2)	Dragendroff's Reagent	1	0.90
		Hexane: Ethyl acetate (90:10)		-	–
		Hexane: Ethyl acetate (50:50)		-	–
		Chloroform : Methanol (95:5)		1	0.24

Table3: Results of Thin Layer Chromatography analysis of whole plant crude extract of *Anisomeles indica (L.) Kuntze* - Flavonoids

Class of Compounds	Crude Extract	Solvent System & the ratios used	Spraying Reagent/ Detecting Reagent	Number Of Spots Observed	Rf Values
Flavonoids	Methanol	*Butanol : Acetic acid : Water (4:1:2)*	1% Ethanolic Aluminium Chloride Reagent	1	0.96
		Hexane : Ethyl Acetate (90:10)		–	–
		Hexane : Ethyl Acetate (50:50)		–	–
		Chloroform : Methanol (95:5)		1	0.27

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Table 4: Results of Thin Layer Chromatography analysis of whole plant crude extract of *Anisomeles indica (L.) Kuntze* **- Phenols**

Class Of Compounds	Crude Extract	Solvent System & the ratios used	Spraying Reagent/ Detecting Reagent	Number Of Spots Observed	Rf Values
Phenols	Methanol	*Butanol : Acetic Acid : Water (4:1:2)*	Ferric Chloride Reagent	1	0.74
		Hexane : Ethyl Acetate (90:10)		–	–
		Hexane : Ethyl Acetate (50:50)		–	–
		Chloroform : Methanol (95:5)		–	–

Table 5: Results of Thin Layer Chromatography analysis of whole plant crude extract of *Anisomeles indica (L.) Kuntze* **- Visualisation in UV light**

Crude Extract	Solvent System Used	Visualization	Number Of Spots Observed	Rf Values
Methanol	*Butanol: Acetic Acid: Water (4:1:2)*	UV light 254 nm	5	0.32; 0.64; 0.83; 0.93; 0.96
	Hexane: Ethyl Acetate (90:10)		–	–
	Hexane: Ethyl Acetate (50:50)		1	0.96
	Chloroform: Methanol (95:5)		2	0.24; 0.92
	Butanol: Acetic acid: Water (4:1:2)	UV light 365 nm	1	0.98
	Hexane: Ethyl Acetate (90:10)		1	0.34
	Hexane: Ethyl Acetate (50:50)		1	0.92
	Chloroform: Methanol (95:5)		1	0.94

Fig 1: View of *Anisomeles indica Plant* **Picture Courtesy: Wikimedia Commons.**

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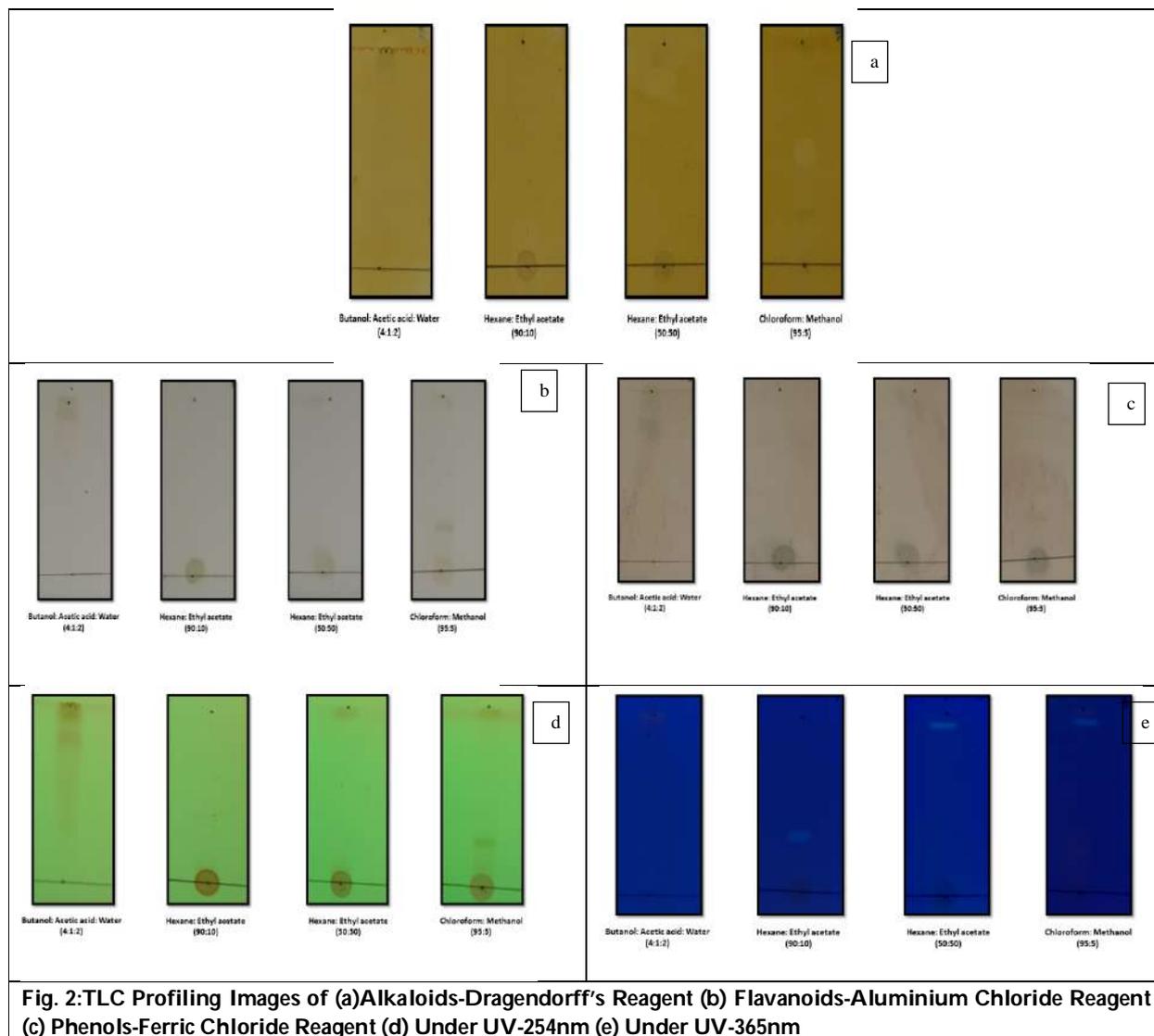
Fig. 2:TLC Profiling Images of (a)Alkaloids-Dragendorff's Reagent (b) Flavanoids-Aluminium Chloride Reagent (c) Phenols-Ferric Chloride Reagent (d) Under UV-254nm (e) Under UV-365nm

RESEARCH ARTICLE

Occupational Health Condition of Tobacco Processing Female Workers in Nippani Taluk, Belgaum District of Karnataka- a Study on Emic Point of View

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ABSTRACT

a research was conducted purposively in Nippani Taluk, Belgaum District of Karnataka to study the emic point of view of tobacco workers health condition. Random sampling method was employed to select the female tobacco workers working in the tobacco processing industries. The total sample size is n=345. The data were collected with the help of pretested structured interview schedule. The data was collected by the researcher himself. The collected data was compiled and analyzed statistically. The study reveals that Tobacco processing work is harmful to the health of the workers as they handle the tobacco flacks barehanded and inhale the tobacco dust in the long working hour. Tobacco workers face many health issues such as headache; pain in hand, nausea, loss of appetite, respiratory issues and dental problems. The female tobacco workers are socially and economically weak. Most of the female tobacco workers are illiterate and many of them are just studied till high schooling. The economic condition of the worker is vulnerable

Keywords: Tobacco workers, Health problems, Emic point of view, Occupational health, Tobacco processing.

INTRODUCTION

Tobacco is plant whose leafs are dried and used for preparation of various tobacco products such as beedi, cigarttes, cigar, chewing tobacco. It is generally known that tobacco use causes many health hazards. The use of tobacco products for a long years leads to many health problems and chronic diseases like cardiovascular diseases, cancers,

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strokes, tuberculosis, respiratory diseases, gastrointestinal disorders, dental problems, and nicotine and cotinine excretion rates increased in the tobacco industry workers (Ghosh et al., 2012). The tobacco products are prepared using the leaves of the tobacco plant. Tobacco leaves goes under many stages of processing to make it suitable for the manufacturing of tobacco products. The processing work is labour intensive task which involve many workers. The workers who process the raw tobacco are susceptible to many health issues caused by the exposure to the unburnt tobacco (Pattan & Puranik, 2019). The most often suffered health issues are cough, breathlessness, headache, acidity, loss of appetite, palpitation, respiratory impairment, hand pain and body pain are common health problems suffered by the tobacco processing workers. Green tobacco disease symptoms were reported by 53.29 percent of employees. Only subjects suffering from "green tobacco illness" had substantially higher rates of nicotine and cotinine urine excretion (Ghosh et al., 1986).As a result of occupational tobacco exposure, cotinine was found in the saliva of 19% of beedi rollers and 100% of tobacco processing plant workers who did not smoke (Bagwe & Bhisey, 1993). Tobacco workers are mostly illiterate or less educated; most of them have not even completed their study up to 10 STD which is minimum level of education to get a decent job. The low education level makes them to take the tobacco processing work for their earning. As the tobacco processing work does not require any education and on the other hand tobacco processing work is unskilled work that not needs any experience. Anybody can work in the tobacco processing field. Females make upto 70-80% of the total workforce of the tobacco processing industry. Tobacco processing workers handle tobacco flacks barehanded and eliminate the undesired parts of the tobacco. The working condition of the tobacco workers is bad, they inhale the raw tobacco at the workplace handling the tobacco barehanded make them to consume the tobacco unknowingly as many micro particles of the tobacco remain on the hands of the workers. Due to which the tobacco workers are more susceptible to the health problems caused by the tobacco.

Objectives
➢ To assess the occupational health problems faced by the tobacco processing female workers.
➢ To study the socio-economic condition of the tobacco processing female workers.

MATERIALS AND METHODS

The present study was conducted in Nippani Taluk, Belgaum District of Karnataka. The participants were selected by employing random sampling method. A pretested interview schedule was prepared to conduct the interview of the participants. The assessment of the health problems of the workers was investigated by considering the workers opinion to have an emic point of view in the assessment of the health problems. A total of 345 female workers working in tobacco factories were interviewed for the current study. The sample size for the study was 345. The data was computed and analyzed using various statistical techniques.

RESULT AND DISCUSSION

Table.1 reveals that there are 345 total participants were interviewed for the study and out of 345 participants, 253 respondents which is equal to 73.33 percent live in a nuclear type of family. 74(21.45 percent) participants live in a joint family and only 18 respondents which are equal to 5.22 percent live in an extended type of family. According to table.2, the majority of the respondents in the current study are Hindu, accounting for 95.07 percent of the total participants. Only 1 worker follows Buddhism, while 16 people (or 4.64 percent) are Muslim. Table.3 shows that the majority of the 345 participants are between the ages of 40 to 49, accounting for 36.52 percent. 30.43 percent participants are between the ages of 30-39. 15.94 percentrespondents are between the ages of 50 to 59. 10.43 percent respondents are between the ages of 60 to 69. There are 5.80 percent respondents are between the ages of 20 to 29, and only 0.87 percent respondents are between the ages of 70 to 79. The marital status of the respondents is shown in Table 4. According to the data, the majority of workers are married, accounting for 72 percent. Widows make up 25percent of the workforce, accounting for 86 workers. 5 workers are single or unmarried, and 1% out of all workers is divorced.

Table.5 depicts that out of 345 respondents, majority which is equal to 98.84 percent Respondents hold BPL (Below Poverty Line) card. Only 2, which is equals to 0.58 percent respondents hold APL (Above Poverty Line) card and remaining 2 respondents stated that they don't have any of the ration card. Education is a very essential part of human life. Education helps to upgrade the living standard of life. The table.6 explains the educational qualification of the female tobacco workers. From the data it is obvious that majority of the female tobacco workers are illiterate, Out of 345 workers, 31.88 percent respondents are illiterate. 22.32 percentrespondents finished their studies up to the 10th STD. After having completed high school, 17.97 percent respondents dropped out. 15.65 percentrespondents completed primary school. 12.17 percent respondents have finished their studies up to the 12th STD, but no one has studied all the way through to graduation.

According to Table.7, more than half of the respondents reside in a Thatched House which accounts to 57.39 percent. A single-family detached house is home to 24.64 percent of the population, or 85 people. Only 45 people reside in mud houses which accounts to 14.04 percent, whereas 4.93 percent workers live in chalas. Table 8 shows that of the 345 participants, Kannada speakers make up 55.36 percent of the total (191). Marathi speakers account for 39.71 percent of the population, whereas just 16 persons speak Hindi. Only 1 individual speaks the other language, tulu. Tobacco processing work is harmful to the health of the workers as the tobacco workers handle unburnt tobacco with bare hand and inhale tobacco dust at workplace. To avoid the health problems caused by the tobacco or to minimize it. Workers should use protective measures. From the table.9 it is observed that majority of the workers which are equals to 86.09 percent workers use protective measure but only 13.91 percent out of 345 workers don't use protective measures such as face mask and hand gloves.

Table.10 depicts the workers' perceptions of their personal health. The workers' response has been obtained without external interference to have an emic point of view on the workers' health situation. According to the above data, the vast majority of respondents that is 39.13 percent respondents believe their health are in very good condition. 36.81 percent workers stated that their health is in good condition. 12.17 percent respondents have rated their health to excellent condition. 8.70 percent respondents are suffering from health problems, and they have assessed their health as fair level. 3.19 percent respondents have rated their health as poor because they are experiencing several health issues.

The workers' dental health was evaluated from an emic approach. According to Table.11, 32.75 percent respondents believe their dental health is very good. 28.41 percent respondents said their dental health was excellent. 22.90 percent workers reported mild dental aches and evaluated their health as good. 13.33 percent workers have dental problems and are undergoing treatment; they have assessed their dental health as fair; the remaining 2.61 percent workers have major dental problems and have lost some teeth; they have rated their dental health as poor.

Table.12 shows the health issues of tobacco processing workers. There are several health risks that are likely to harm tobacco processing workers, and some of them have been addressed in this study. According to the data in the table above, lower back pain is the most prevalent health concern experienced by tobacco workers. Lower back pain affects around 64.35 percent of workers, or 222 out of 345 participants. As a result of working in and is comfortable posture. More than half of workers, or 53.62 percent, suffer from hand weakness. Another prevalent health concern experienced by 24.93 percent of workers is headache. 18.26 percent of employees have abdominal pain, which can lead to a loss of appetite. 12.75 percent of workers have dental problems. 14.49 percent of workers are facing breathlessness. Vision burning affects 10.43 percent of tobacco workers. 8.99 percent of workers have a cough. 4.93 percent of employees suffer from hyperacidity or epigastric discomfort. 2.90 percent of workers experience palpitation. 1.74 And 1.45 percent of workers suffer from nausea and skin problems, respectively.

CONCLUSION

The present study clearly reveals the situation of the female tobacco processing workers. The female tobacco workers are socially and economically weak. Most of the female tobacco workers are illiterate and many of them are just

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studied till high schooling. The economic condition of the worker is vulnerable; more than 90% workers are falls under BPL (Below Poverty Line). 57.39% workers live in a thatched house. More than half of the workers live in nuclear type of family. India is having many languages the same is depicted in the current study. Among them Kannada speaking population is more as compared to the others. Tobacco processing work is harmful to the health of the workers as they handle the tobacco flacks barehanded and inhale the tobacco dust in the long working hour. Tobacco workers face many health issues such as cancers, tuberculosis, and headache; pain in hand, nausea, loss of appetite and lower back pain as they work in discomfort posture for long working hours. The current study was focused on the emic point of view on the health condition of the tobacco workers. It is observed from the current study that despite facing many health issues. The workers feel that they are healthy and 135 workers rated their general health to very good level and majority (113) of workers rated their dental health to very good rating but medical examination shows that their general and dental health is at bad level.   Female tobacco processing workers face a variety of health issues, including lower back discomfort, which affects 64.35 percent of the workforce. Hand weakness affects 53.62 percent of workers. A headache affects 24.93% of workers. Abdominal pain affects 18.26% of workers. 14.49 percent experience breathing difficulties. 12.75 percent of the workforce has dental issues. Burning vision affects 10.43 percent of workers. Coughing affects 8.99% of the population. Acidity is 4.93 percent. Palpitation affects 2.90 percent of workers. 1.74 percent of workers have nausea, and 1.45 percent has skin diseases. It is suggested from the current study that tobacco workers should be taught about the health repercussions of working in tobacco industries and advised to take precautionary steps to avoid or reduce health issues.

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Table.1 Type of Family

Type of Family	No of Respondents	Percentage
Joint	74	21.45%
Extended	18	5.22%
Nuclear	253	73.33%
TOTAL	345	100%

Table.2 Religion of the Respondents

Religion	No. of Respondents	Percentage
Hindu	328	95.07%
Muslim	16	4.64%
Buddhism	1	0.29%
Total	345	100%

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Table.3 Age of the Respondents

Age Group	No. of Respondents	Percentage
20-29	20	5.80%
30-39	105	30.43%
40-49	126	36.52%
50-59	55	15.94%
60-69	36	10.43%
70-79	3	0.87%
Total	345	100%

Table.4 Marital status of respondents

Marital Status	No. of Respondents	Percentage
Single	5	1%
Married	250	72%
Divorced	4	1%
Widowed	86	25%
Total	345	100%

Table.5 Type of Ration card

Type of Ration card	No. of respondents	Percentage
BPL	341	98.84%
APL	2	0.58%
DON'T HAVE	2	0.58%
TOTAL	345	100%

Table.6 Educational Qualification

Educational Qualification	Respondents	Percentage
Illiterate	110	31.88%
Primary School	54	15.65%
High School	62	17.97%
10th STD	77	22.32%
12th STD	42	12.17%
Graduation	0	0%
Total	345	100%

Table.7 Type of House

Type of House	Respondents	Percentage
Mud or Hut House	45	13.04%
Single Family Detached House	85	24.64%
Chala	17	4.93%
Thatched House	198	57.39%
Total	345	100%

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Table.8 Mother Tongue

Mother Tongue	Respondents	Percentage
Marathi	137	39.71%
Hindi	16	4.64%
Kannada	191	55.36%
Others	1	0.29%
Total	345	100%

Table.9 Use of Protective Measure

Use Protective Measure	Respondents	percentage
Yes	297	86.09%
No	48	13.91%
Total	345	100%

Table.10 General Health

General Health	Respondents	Percentage
Excellent	42	12.17%
Very Good	135	39.13%
Good	127	36.81%
Fair	30	8.70%
Poor	11	3.19%
Total	345	100%

Table.11 Dental Health

Dental Health	Respondents	Percentage
Excellent	98	28.41
Very Good	113	32.75
Good	79	22.90
Fair	46	13.33
Poor	9	2.61
Total	345	100

Table.12 Health Problems

SL. NO.	Health Problems	Yes	No	Total	Percentage
1	Cough	31	314	345	8.99%
2	Breathlessness	50	295	345	14.49%
3	Headache	86	259	345	24.93%
4	Burning of Vision	36	309	345	10.43%
5	Lower back pain	222	123	345	64.35%
6	Weakness of hand	185	160	345	53.62%
7	Acidity/Epigastric pain	17	328	345	4.93%
8	Abdomen pain	63	282	345	18.26%
9	Nausea/Vomiting	6	339	345	1.74%
10	Skin Diseases	5	340	345	1.45%
11	Palpitation	10	335	345	2.90%
12	Dental Problem	44	301	345	12.75%

RESEARCH ARTICLE

Cross-Examination of the Life of Immigrated and Indigenous People Depicted in Kiran Desai's *the Inheritance of Loss* and Louise Erdrich's *Love Medicine*

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ABSTRACT

Louise Erdrich is a renowned novelist in the arena of Native American Literature. She is one of the notable tribal members of the Turtle Mountain Band of Chippewa Indians. Her novel *Love Medicine* won her the National Book Critics Circle Award in 1984 and would set the stage for her later works *The Beet Queen, Tracks* and *The Bingo Palace,* often noted as the North Dakota Quartets. The works of Erdrich often articulate the indigenous issues and subjects connected to Native Americans. Kiran Desai is an established diasporic writer acclaimed fame and name for her second novel, *The Inheritance of Loss*; for this novel, she won the Man Booker Prize in 2006. She is the youngest Indian woman writer to win the prestigious National Book Critics award in America and one of the three Indian writers to win this prize for fiction. Her first novel *Hullabaloo in the Guava Orchard*, also received some decent accolades.   *The Inheritance of Loss* shuttles between North-Eastern Himalayas, India and US, whereas *Love Medicine* in the Reservation of North Dakota, US. Regardless of the geographical difference in the setting, both novels shared some common themes like Home. Even the characters like June, Gerry and Lipsha Morrissey of Erdrich shared some resemblance with Jemu, Bijiu, Gyan and Sai. A modest attempt is being made in this paper to examine deep into the issue of both immigrated and indigenous people; and to portray their

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pain, problems and ordeal by comparing the theme of multiculturalism, hybridity, the quest for identity and homecoming in the novels as mentioned above.

Keywords: multiculturalism, Hybridity, Home, identity, geographical features

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Native American literature has always been an indispensable portion of American literature which describes a long history and versatile contents. Recently Native American literature has attained world acclaim from Native American writers like N.Scott Momaday, Leslie Marmon Silko, Louise Erdrich and Sherman Alexie. Louise Erdrich is a distinguished novelist in the arena of Native American Literature. She is one of the notable tribal members of the Turtle Mountain Band of Chippewa Indians. Her first novel *Love Medicine* considered to be her masterpiece, projects the life of Native Americans expelled from their land and the destinies of the following generation both at Home and abroad. It won her the National Book Critics Circle Award in 1984 and the Janet Kaufman Award for Best First Novel. *Love Medicine* would set the stage for her later works *The Beet Queen, Tracks,* and *The Bingo Palace,* often noted as the North Dakota Quartets. The works of Erdrich often articulate the indigenous issues and subjects connected to Native Americans.

South Asian Diasporic literature has played a pivotal role under the big label Indian Literature. Some renowned South Asian diasporic writers are Salman Rushdie, Rohinton Mistry, Jhumpa Lahiri, Arundhati Roy, and Kiran Desai. As scholars and critic argues that the ideology of Diaspora began with the expulsion of Adam and Eve from the Garden of Eden. The experience of exile, the tendency to remember the past, may induce an ambivalence, which determines a kind of writing that transcends geographical and national literature. This recreation represents an urge to look for an identity concerning the culture, the Home for the writer, which is reflected through the work. Desai has also focused on the identical recreation in her masterpiece *The Inheritance of Loss.*

Kiran Desai discusses the hardships faced by migrants between Home and abroad, thereby developing a search for identity. Kiran Desai is an established diasporic writer, daughter of Anita Desai, acclaimed fame and name from her second novel, *The Inheritance of Loss,* for which she won the Man Booker Prize in 2006. She is the youngest Indian woman writer to win the prestigious National Book Critics award in America and one of the three Indian writers to win this prize for fiction, including Salman Rushdie and Arundhati Roy. Her first novel *Hullabaloo in the Guava Orchard*, also received some decent accolades.

This paper cross-examines Kiran Desai's *The Inheritance of Loss and Louise Erdrich's Love Medicine;* both shares common post-colonial elements like multiculturalism, hybridity, Home, identity irrespective of their geographical settings. It also discusses the issues presented by the above-mentioned writers based on the following factors – loss of land, culture, identity and discrimination from the white society. The Native Americans are closely associated with the land; they considered their land as sacred which offers not only food and shelter but also something the link them with nature. The land gives a sense of belongingness to the native people. However, the arrival of the Whites brought damage to Native Americans, especially the Indian Removal Act by the Federal Government in 1830. As a result, the tribes are forced to move from the fertile east to the barren west. In *Love Medicine,* Lulu felt that their miserable fate could never be changed under the control of the white, so she once complained: "How many times did we move? The Chippewa had started off way on the other side of the five great lakes. How we were shoved out on this lonesome knob of prairie my grandmother used to tell. It is too long a story to get into now." (Erdrich, 1992, P.282). In *The Inheritance of Loss,* Gyan, the Nepali tutor of Sai, and his ancestors represent the loyalty of the Gorkhas to the Imperial Army and their rightful hold in the Indian mainland. Though they served in the Pre-independence, have been denied the rights and thwarted, which resulted in Gorkha National Liberation Front (GNLF) with the objective of demanding a Gorkhaland state within India. In both the novels, the writers deal with the sense of the loss of their land. The Federal government set out to undermine Native Americans' religion and traditions by

outlawing the practice of traditional religious ceremonies and by alienating Native American kids from their parents. Native Americans are forced to speak the English language and learn American culture. The white government set up a law to ask Indians to send their children to schools so that they could accept mainstream education from young age. In this way, the purpose of assimilation can be realized. Such schools instructed the Indian students – Science and Technology, and American Culture, eventually making them believe their Indian culture was uncivilized. The result of education makes the Natives prone to lose their own cultural identity and become confused in the clash of two societies.

Flavin (1989) holds that, in *Love Medicine*, Erdrich repeatedly emphasises that Uncle Eli is the only one in reservation who can hunt deer by using traps. The young generation has lost not only the ability of archery but also the knowledge of Chippewa vocabulary. Eli is hidden by his mother when he is young to avoid being taken by the white school, so he receives no education. That is why he is the only one in the second generation who cannot read or write. However, many years have passed, "Eli was still sharp, while grandpa's mind had left us, gone wary and wild." (Erdrich, 1992, P.19). In *The Inheritance of Loss,* Jemubhai Patel is an anglophile kind of personality and a retired judge living in north-east India in Kalimpong in the North ranges of the Himalayas at the foot of Kanchenjunga. He is educated in Cambridge and worked as a respected judge in Gujarat. He belongs to the class of persons "Indian in blood and color but English in taste, in opinion, in morals, and in intellect." (5) His attempt to behave like British makes him ridiculous as he has imitated the manner and culture of Europe.

English education is no way of providing opportunity for the Native People to lead a decent life after losing their culture and identity. The Native people encounter racial discrimination in the White Society; according to the Whites, all the Indian symbols like long hair, furs, archery and hunting are uncivilized and should be civilized. The white government builds many boarding schools and asked Indian children to accept American-style education. However, the fact is that though they have received education in neighbourhood schools as the government has required, Indians still have to face intense racial discrimination. Take Nector as an example; he accepts school education from a young age; after graduating from school, he once tries luck in movies but is frustrated by the fact that "death was the extent of Indian acting in the moving theatre."(Erdrich, 1992, P.119). He then becomes a model for a white artist. The only thing he needs to do is "stand still" and let the old woman paint his picture. In the picture, Nector is "jumping off a cliff, naked of course, down into a rocky river. Certain death." (Erdrich, 1992, P.120). According to Nector's experience, it can be concluded that the white never viewed Indians the same as them.

In *The Inheritance of Loss,* the retired judge Jemubhai Patel is a man disgusted at Indian ways and customs, so much so that he eats chapatis with a knife and fork, hates all Indians, including his father, whom he breaks ties with and his wife who he abandons at his father's place after torturing her, and is never accepted by the British in spite of his education and adopted mannerisms. However, he was not accepted by either the British or the Indians so he lost his faith and identity. His encounter with western culture blind's him. He became cynical, self-centred and frustrated. He desperately tries to be a very 'Englishman' by imitating the British lifestyle and speaking with a "fake English accent". He also tries to hide his Indian complexion by covering his dark brown face with pink and white powder. Jemu's encounter with Western culture confused him because of the strange feeling for the native land and the failure to mingle with the adapted land. Eventually, he feels of being a foreigner in his own country. He stands tragic figure at the end of the novel due to his detachment from wife, people and nation.

Apart from the factors that are discussed in the comparative study, there are some others like – political, economical and cultural factors play a significant in both *Love Medicine* and *The Inheritance of Loss.* They depict the tragedies of the first and the third-world country just liberated from colonialism. The novels also give the impression that the influence of the European powers among Native Americans in US, Migrants in India and how both Indians are hunted by the globalization policies. It leads to a loss of self-esteem; but, more importantly, it leads to a loss of connection. This is a more significant loss because the characters feel banished at state-nation. This leads to the loss of identity, and self-esteem makes voiceless to characters. The characters are compelled to negotiate new identities in order to realize the meaning of life.

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RESEARCH ARTICLE

Knowledge, Attitude and Practices of Pregnant Females Regarding Oral Health

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ABSTRACT

Good oral health is considered to be a fundamental component of general health. Oral health is often neglected by pregnant females, and physicians should evaluate and educate pregnant women regarding the routine dental checkups to prevent complications. Periodontitis is associated with preterm birth andlow birth weight babies, and high levels of cariogenic bacteria in the oral cavity of the mother leads to dental caries ininfants. Most of the pregnant women are unaware of periodontal diseases during pregnancy because of lack of knowledge. The aim of the study was to assess the oral health-related awareness and practice among pregnant Women. A descriptive cross sectional study was conducted in the outpatient department of Pravara Institute of Medical Sciences, Loni to evaluate the knowledge, attitude and practices of pregnant women regarding oral health. Permission to conduct this survey was taken from the concerned authorities. A total of 150 pregnant women regardless of age, financial status, social class or ethnic group were included in this survey.After taking consent, a self-structured questionnaire was filled by the principal investigator with each question having two responses as yes or No. Data was analyzed using IBMSPSS windows version2.0(SPSS Inc, Chicago 22.) Descriptive statistics

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were given in the form of percentage and frequency. A chi square test of association was also applied and p-value < 0.05 was taken as significant. Cross tabulation between sociodemographic variables such as gender, residency, education, income and Knowledge about oral health was measured. Mean age of the pregnant women was 28, SD± 3.218, among them 5% were illiterate, and 60.4% had less than50000 monthly income. Most common oral hygiene practice was cleaning through tooth brush and tooth paste 99%, and mostly do before breakfast almost 95%. Only 63.3% think it is important to visit dentist during pregnancy, 42.7% think treatment is safe during pregnancy, and 96.7% believed scaling can cause losing teeth. Primary prevention of oral diseases among pregnant ladies need to enhance to reduce burden of diseases.

Keywords: Oral Health Seeking Behavior, Dental Visit, Access To Dentist, Pregnant Women

INTRODUCTION

A sound oral health is considered to be a fundamental component of general health. Pregnancy is an important phase in the life of a female comprising of significant anatomical and physiological changes in the body. Any change in the levels of estrogen and progesterone hormones in pregnant women increases the risk for oral health issues as compared to their normal counterpart [1]. In addition, general factors, such as the general health or diet of an individual including other local factors, such as any qualitative or quantitative changes in saliva or certain local irritants (plaque and tartar accumulation, malocclusion, incongruous restoration, or prostheses) plays a major role. Psychological factors can also postpone dental care due to the fear that may hurt the unborn child during treatment.
 These conditions are substantially gingivitis, periodontitis, which have been reported to range between 36% to 100%and other being benign gingival lesions, tooth mobility, tooth erosion and dental caries [2]. Pregnant women do not always undergo preventive dental visits, but rather present the dentist with urgent clinical requirements. Due to insufficient information and knowledge there persist a risks for the oral health in both the pregnant woman and her unborn child. Multiple studies have shown that the maternal oral health has significant implications for birth issues and infant oral health [3,4]. Maternal oral flora is transmitted to the newborn infant, which in turn increases cariogenic flora in the infant leading to the development of caries [5]. Periodontal diseases provide a portal for hematogenous dissemination of oral microorganisms and their products which reach the fetal placental unit [6]. These microorganisms and their products could be an independent risk factor for preterm birth and low birth weight babies [7]. Maternal periodontitis may interact synergically with other maternal risk factors to induce preterm birth [8]. Proper nutrition along with a good oral hygiene practices play an important role in the general well-being of pregnant women [9] Hence, women should routinely be kept posted about the maintenance of ideal oral health care during whole of their lives as well as during pregnancy. This will minimize the risk of maternal transmission of diseases. The principle idea of the present study was to evaluate the knowledge, attitude, and practices of oral health in pregnant women in Western Maharashtra, India.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted in the outpatient department of Pravara Institute of Medical Sciences, Loni to evaluate the knowledge, attitude and practices of pregnant women regarding oral health. Permission to conduct this survey was taken from the Ethical Committee of the institution. A total of 150 pregnant women regardless of age, financial status, social class or ethnic group were included in this survey. Those who were uncooperative didn't respond or those who were not willing to participate were excluded from the study. After taking consent, a pre-structured questionnaire was filled by the principal investigator with each question having two responses as yes or No. Data was analyzed using IBMSPSS windows version 2.0 (SPSS Inc, Chicago 22.) Descriptive statistics were given in the form of percentage and frequency. A chi square test of association was also applied and p-

value < 0.05 was taken as significant. Cross tabulation between socio demographic variables such as gender, residency, education, income and Knowledge about oral health was measured.

RESULTS

A total of 150 pregnant women with a mean age of 28 years constituted the study population. The majority of the study participants completed high school (33.3%), Primary school (20.6%) education and Secondary education(14.6%) only. A few study subjects (6.6%) possessed a Graduation degree and 25.5% were illiterate(Table1). A comparable percentage of women were in the first trimester (31.0%), second (35.4%), and third trimester (33.6%) of pregnancy(Table1). Rural residents represented 59.4% of the study group and Urban residents represented 40.6% (Table1).Most of the pregnant women (74.7%) were housewives. Regarding knowledge and Attitude,100% of pregnant women think X-Rays are not safe during pregnancy and all of them clean their teeth with tooth brush and tooth paste(Table 2).None of the pregnant women use mouth wash and use dental floss and none of them brush after breakfast. About 99.3% of pregnant women think high sugary diet can damage their teeth (Table 2),51.3% of pregnant women clean their teeth after dinner. Eighty eight percent of pregnant women think extraction cannot be done during pregnancy(Graph 1) and 63.3% subjects think regular visit to dentist is important(Graph 2) and96.7of pregnant women think that scaling do not make teeth loose. Table 3 is depicting the cross tabulation between the demographic variables and knowledge about oral health. P value was found significant in relation to education and family income

DISCUSSION

In the present study the mean age of pregnant women was 28 which was similar to a study done by Khalaf SA *et al* in 2018 [10] and Gupta *et al.,* 2015 who reported that 80% of the pregnant women were aged 20-29 years old [11]. Regarding the place of residence in our study, 59.4% of the participated pregnant women were from rural area, whereas Amit *et al* reported that the majority of the studied pregnant women were belonged to urban area [12]. The results showed that 63.3% of pregnant women visiting at tertiary hospital of Pravara Institute of Medical Science, Loni, had good knowledge regarding oral health care. The response to the questionnaire regarding the knowledge of oral health care showed good results. Eight out of the thirteen questions asked was answered correctly by more than half of the respondents. This result might be because of much information on oral health received by these pregnant women. This result was similar to Gaffar *et al.* where most respondents have good knowledge of oral hygiene. According to Gaffar *et al*, the pregnant women receiving information about oral health are bound to have good oral hygiene [13]. However, this study was still found respondents with lack of knowledge of oral health, which could be related to the respondents' education level, whereas in this study, there were still 20.6% of respondents with low education level [13]. Education is needed to obtain information. The higher the education level, the easier it is to receive information. Apart from education, occupation is also a knowledge affecting factor. Employed women will have more knowledge than unemployed women because social interaction of employed women increases their knowledge [14]. However; this statement was not supporting the present study's result as the majority of respondents in the present study were unemployed.

The questionnaire referring 'The time for tooth brushing in the morning after breakfast' showed the lowest result. 99% of pregnant women disagreed with this statement. Which was similar to a study done by Azizah *et al* In 2021 [15]. According to Hiremath,[16] the proper frequency of daily tooth brushing is twice, namely in the morning after breakfast and at night before bedtime. The result of the present study shows that subjects did not received extensive information regarding oral health care. Information is also one of the factors that influences attitude. The respondents' oral health care attitude indicated that 63.3% of pregnant women had good attitude and no pregnant women had attitude in the poor category. This result was consistent with the research conducted by Chawla *et al.,* [17] who found that none of the pregnant women in their study had negative attitudes towards oral health care. Knowledge, thoughts, and emotions determine attitude formation. When a person thinks, the emotional and belief

components will form a tendency to act[18].   The good attitude that the respondents have in this study were expected to cause the intention to act; thus, practice to maintaining good oral health will be formed. The results regarding the oral health care practice showed unfavorable results. None ofthe pregnant women used dental floss or mouth wash. This is in agreement with the study done by Avula *et al.,* [9]and George *et al* [19], who found that most of the respondents have not used dental floss. Due to lack of information provided respondents did not understand the importance of using dental floss. The lack of visits to dentist by pregnant women to can be attributed to many factors, one of which is dental care costs. Pregnant women with higher household income are more likely to seek dental care than those with lower income. Also, time constraints can become another factor in the lack of visits by pregnant women to the dentist. It is better if health service providers provide more information to pregnant women about the importance of oral health care during pregnancy [20] High sugar diet can damage teeth, almost 99.3% of subjects agreed to this statement while the remaining were not in accordance with it. In a study conducted by Nogueira, it was reported that 42.17% respondent weren't aware of the affect of sugar on teeth [21]. About 63.3% believe that regular dental check up is important. On the contrary Gupta *et al* stated that majority of respondent didn't consider dental checkup to be important during pregnancy [22]. Regarding safety concern, in a study 57.3% of pregnant women believed that dental treatment during pregnancy may not be safe [23]. This was in contrast with the study done by Katherine *et al* stated that 84% pregnant ladies consider dental visits are safe during pregnancy [24].

CONCLUSION

Thus, the study concludes that we need to have an interdisciplinary approach including both gynecologists and dentist for maintenance of overall health of mother and unborn child . Intersectoral coordination between oral health care personnel and antenatal care provider personnel need to enhance for pregnant women. As mothers play an important role in demonstrating health habits to their children, pregnant women should be a target group for oral health education.

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Table 1: Sociodemographic characteristics of pregnant women (n=150)

Demographic characteristics	No.	Percentage
Education		
No education	38	25.5
Less than8 years education	31	20.6
8-12 years education	50	33.3
13-14years education	22	14.6
Greater than 14year education	09	06.0
Total	150	100
Financial Status		
Less than 15000 Rs	53	35.3
15000-50000 Rs	78	52.0
50001-80000 Rs	15	10.0
Greater than 80000 Rs	4	2.7
Total	150	100
Working status		

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House wife	112	74.7
Working women	38	25.3
Total	150	100
Trimester of pregnancy		
First trimester	48	31.0
Second trimester	53	35.4
3^{rd}trimester	49	33.6
Total	150	100.0
Residency		
Urban	61	40.6
Rural	89	59.4
Total	150	100.0

Table 2.Knowledge attitude and practices among pregnant women (n=150)

Do you think x-rays are safe during pregnancy?		
Response	Frequency	Percentage
Yes	-	-
No	150	100
How do you clean your teeth?		
Response	Frequency	Percentage
T/t	150	100
Do you use mouthwash?		
Response	Frequency	Percentage
Yes	-	-
No	150	100
Do you clean your teeth after breakfast?		
Response	Frequency	Percentage
Yes	-	-
No	150	100
Do you think high sugary diet can damage your teeth?		
Response	Frequency	Percentage
Yes	149	99.3
No	1	0.7
Do you clean your teeth after dinner?		
Response	Frequency	Percentage
Yes	77	51.3
No	73	48.7

Table 3.Cross tabulation between knowledge about oral health and Socio demographic variables pregnant women (n=150)

Variables	Knowledge about oral health			P value
Working status	**No**	**Yes**	**Total**	
House wife	7	105	112	**0.21**
Working women	2	36	38	
Total	9	141	150	

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Education				
uneducated	I6	22	38	**0.03 (S)**
Educated	1	111	112	
Total	17	133	150	
Family income				
Less than50000	29	102	131	**0.05(S)**
More than50000	2	17	19	
Total	31	119	150	
Residency				
Urban	3	58	61	**0.82**
Rural	4	85	89	
Total	7	143	150	
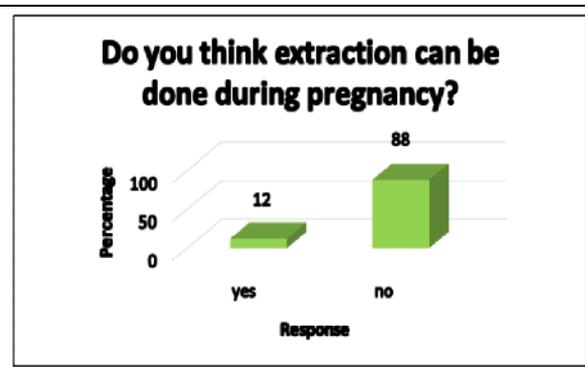
Graph 1.
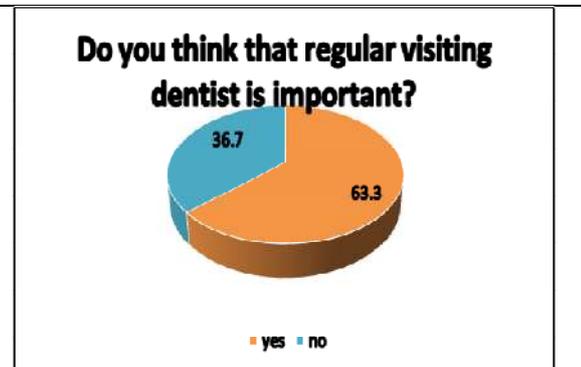
Graph 2

Graph 3

Graph 4

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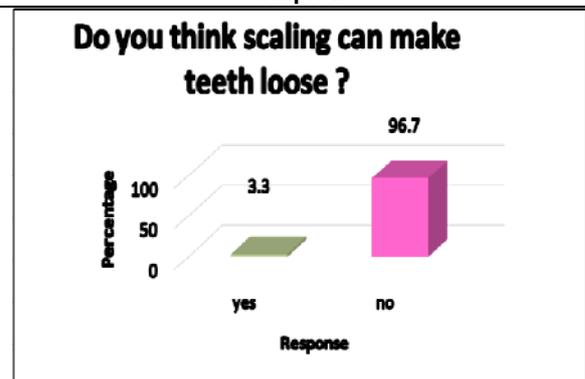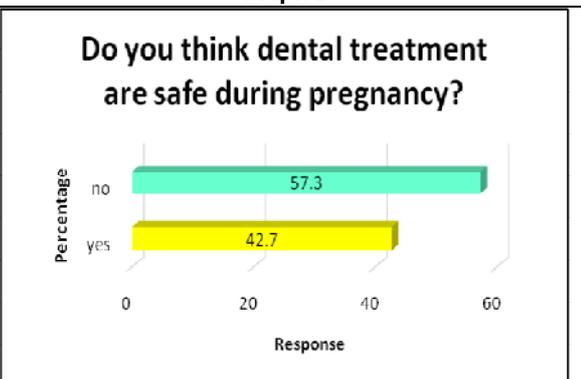
Development of Kashmir Economy through Tourism Industry with Special Reference to Srinagar District

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ABSTRACT

Development is the process of growth, progress, and advantageous change. Raising the standard of living for the populace is the aim of development, along with safeguarding the resources of the environment and boosting local and regional employment opportunities. Tourism, the largest and fastest-growing industry in the world, unquestionably contributes significantly to the expansion of the national economy. A prominent industry in the state of Jammu and Kashmir is tourism. Since it provides a variety of professions, including those for hotel managers, receptionists, tour guides, tour operators, travel agents, photographers, and other occupations, it is acknowledged as a multi-segmented industry. With a developing economy and a reputation for being a culturally diverse and rich location, the state of Jammu and Kashmir is currently supported by billions of dollars in annual tourism revenue. The primary industry of Jammu and Kashmir is tourism, which contributes 6.99% of the state's GDP. Because industrial growth is largely restricted to steep terrains, tourism is seen as an economic boon for the state of Jammu and Kashmir, particularly for the Srinagar area. The range of employment is relatively broad due to the industry's focus on development. The Srinagar district has excellent tourism potential and offers the region numerous commercial opportunities. The revival of violence in the state has had a negative impact on Jammu and Kashmir, one of the most popular tourist destinations in the world. The major goal of this essay is to examine whether the tourist sector in Jammu and Kashmir, specifically the Srinagar district, has the ability to contribute to the state's overall economic growth, development, and prosperity. The issues facing the tourism industry are also covered in this essay. It shows that the tourism

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industry is still in its infancy and that the valley is thought to have enormous potential. The study was qualitative in nature and used data from both primary and secondary sources. The study used a thematic software programme extensively for its qualitative analysis of secondary data in order to arrive at an objective result.

Keywords: employment, commercial, tourism, area, environment

LITERATURE REVIEW

The growth of the armed conflict has had a dramatic impact on tourism, which was formerly regarded to be Jammu and Kashmir's economic engine (Rafia Tabasum et al 2017). Because of its natural beauty, the State of Jammu & Kashmir has historically been one of India's most popular travel destinations. The state's economy has been severely harmed by terrorism. Due to the rise in violence, tourism has been drastically curtailed, which has caused major problems for the locals whose livelihoods are heavily dependent on tourism. Jammu and Kashmir is one of the most well-known destinations in the globe due to its long history as a renowned tourist destination. According to estimates, between 50 and 60 percent of the population of J&K works in some capacity related to tourism. 15% or so of the state's GDP is derived from the tourism industry. Despite its importance to the state's economy, significant efforts to gauge the impact of J&K's most significant industry have not yet been made (Rather, A.Y. 2022).

Today, tourism is a major force behind socioeconomic development, enhancing the interrelated processes in many different ways. The tourist sector is one that both spurs development and attracts foreign investment (M. Maqbool Bhat, 2018). Additionally helping the destination, it gives jobs to the locals. With a booming economy and a reputation for being a culturally diverse and rich location, the state of Jammu and Kashmir is currently supported by billions of dollars in annual tourism revenue. The primary industry of Jammu and Kashmir is tourism, which contributes 6.98% of the state's GDP. A significant driver in the world economy is tourism. There is hardly a day that goes by without a new declaration on the tourism industry's larger relevance (Gadoo, M. R. S., & Khan, F. A. G. 2012). International tourism is one of the fastest-growing industries, making up over half of all service trade and more than 10% of all international trade, making it one of the top earners of exports globally (WTO, 2010). In several nations, revenue from tourism outperformed that from all other industries combined.

INTRODUCTION

For personal, professional, or business reasons, people travel to places outside of their usual environment. The migration of people to these places is a social, cultural, and economic phenomenon known as tourism. These people are called tourists, and tourism describes the activities they engage in, some of which involve spending money on travel. Visitors can be locals or tourists, excursionists or non-excursionists. Today, tourism has grown into one of the largest and fastest-growing industries on the planet. One of the most fascinating and attractive tourist locations on the planet is frequently considered to be India. There are numerous justifications for this. She is first and foremost renowned for her breathtaking landscape. Additionally, some of the most stunning works of art ever created by civilised man may be seen in India's architecture, sculpture, and monumental buildings. (1978, A. K. Bhatia). For the purpose of this study's inquiry into the economic development of the tourism industry, the Srinagar district of Jammu and Kashmir was chosen. The valley of Kashmir is a traveller's dream destination. Because of its breathtaking scenery and mild year-round climate, it has the potential to: (Tourists Paradise). With its lakes and mountains, its opulent Chinars and popular tall cylinders, its delectable fruits, and its historic landmarks, this place has it all. It has positioned rivers and gurgling streams that are teeming with Himalayan trout as well as a plethora of other natural delights in countless quantities. According to the prophecy made by G.T. Vigne in 1885, Kashmir has evolved into an essential stop for any traveller heading east. The district of Srinagar, also known as the summer capital of India, will serve as the primary focus of this study. Because of the incredible natural beauty that can be

seen there, Srinagar is often referred to as "paradise on earth." The pashmina shawls have their own distinct culture and are renowned all over the world. Tourism, farming, and agriculture are the principal means by which people support themselves financially. In Srinagar, Muslims make up a large portion of the population. The district of Srinagar, which is located in the state of Jammu and Kashmir, has a higher potential to develop into a prominent tourism destination in various parts of the world. There has been a lot of discussion about how important tourism is to the growth of the economy in the Srinagar district (Bhat, Z. A.) (2013). huge amount of interest from a policy point of view (Asif Hussain 2016). The tourism business has seen great growth in recent years all over the world. It has also developed into an essential component of human recreation and exploration, which has helped to contribute to the expansion of the economy. (Junaid Aslam 2018).

The most significant component of the economic impact of these activities is their contribution to the accomplishment of three top economic priorities, namely the creation of income, employment, and foreign exchange earnings. When viewed from this angle, the tourism industry has the potential to play an important part as an important driving force of economic development. (Pablo Juan 2017) The tourism business contributes significantly to the production of income, employment opportunities, and gross domestic product in almost every economy in the world (GDP). Even in the state of Jammu and Kashmir, the tourist sector is significantly boosting the growth of the state's overall economy.

Some of the key attributes of the tourism industry in J&K areas follows:
- Virgin Areas
- Different Geographical Locations,
- Climate,
- Landscape,
- Architecture,
- Pilgrimage,
- Culture,
- Handicrafts,
- Hospitality,
- Historical Heritage, etc.

Research objectives
➢ To elucidate the significance of tourism and the part it plays in the expansion of the economy.
➢ To provide an explanation of and conduct an analysis of the role that the tourism development corporation plays in the promotion of the tourism industry in Jammu and Kashmir.
➢ To provide an illustration of the obstacles that stands in the way of the tourism industry and slow down its expansion.
➢ To identify steps that can be taken to further bolster the tourism industry in Jammu and Kashmir for the sake of the region's economic development.

METHODOLOGY

Two different research approaches were utilised in order to acquire the essential information that was required for the study to achieve its goals and targets. The documentary method was utilised in one approach, whereas analytical approaches were utilised in the other approach. I went out of my way to gather qualitative data and then analysed it so that I could provide an objective evaluation. Through the use of theme analysis software, secondary sources such as books, websites, newspaper articles, a variety of Indian reports, and a number of international journals and magazines were reviewed qualitatively. In addition, the findings of the study are supported by the researcher's own personal observations. Since he is a resident of Jammu and Kashmir, he is intimately familiar with the state's history and its ongoing growth.

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DISCUSSION AND RESULT

In common parlance, Jammu and Kashmir is said to as a paradise on earth. The translation of the couplet into English is as follows: "If there is paradise on earth, it is this, it is this, and it is this" (Amir Khusrau). The couplet drew the attention of numerous kings and queens who wanted to rule over Kashmir. Natural splendour and picturesque settings have contributed to the region's popularity as a travel destination among people from all over the world. Srinagar is a modern water world, dominated by Dal Lake and its winding water ways, tree-lined Nageen Lake, and the Jhelum River. Jammu is famous for its temples, while the Kashmir valley is known for its lakes and gardens. You may immerse yourself in the culture of the area by getting some exercise on the water and going on a cruise in a traditional wooden boat called a Shikara throughout the day or the evening. On land, take a stroll through the terresial hill sides of the 400-year-old Mughal gardens that Emperor Jahangir established for his wife. While you're there, be on the lookout for native products like as hand-woven silks and embroidered shawls.

For many years, Jammu and Kashmir has been a popular vacation spot, elevating it to the status of one of the most visited countries in the world. The arrival of tourists, who number in the millions on a yearly basis, has an effect on the social and economic environment of the region. It is estimated that somewhere between fifty and sixty percent of the people living in Jammu and Kashmir have jobs related to the tourism industry in the state in some way. The tourism industry is responsible for around 15 percent of the gross domestic product of the state.

In Jammu and Kashmir, Srinagar in particular and tourism hold a strategic position. Jammu and Kashmir receives economic benefits from tourism, including jobs, foreign currency, the improvement of infrastructure, and the growth of regional industries like handicrafts and looms. These advantages have aided in maintaining the Srinagar district's prominence on a national and international scale. It is clear that the tourist industry is playing a significant role in the economy of the state of Jammu Kashmir, as evidenced by the fact that the tourism sector contributes 5.92 percent to India's GDP and 8 percent to the economy of Jammu Kashmir. The Kashmir Valley, and particularly the Srinagar area, has a wealth of opportunities for the travel and tourism industry. The majority of Jammu and Kashmir's economy is made up of the service sector, which accounts for 56 percent of the total. Other two primary areas that make up the state economy are agriculture, which accounts for 16 percent, and industry, which accounts for 28.8 percent. The state's economy is substantially bolstered by the contributions made by the tourism industry. There are many different kinds of tourism available in Jammu and Kashmir, particularly in the Kashmir valley and with particular attention paid to the Srinagar area. These activities include rafting on water and skiing on snow, as well as adventure tourism, medical tourism, and pilgrimage tourism. The culture of Jammu and Kashmir is calm and collected. The intersection of art, religion, and philosophy results in a synergistic whole.

Many people have the chance to obtain employment in the tourism sector. With a growth in tourism, both the number of visitors and the production of cultural goods will rise. Guilders will have more opportunities, and they may be able to find job in the tourism sector. The largest service-based industry in the state, tourism contributes significantly to the GDP of the state, earns foreign exchange for the nation, creates a huge number of job possibilities, and pays taxes, among other advantages. Because it incorporates the outcomes of all economic subfields, the Gross Domestic Product is the most accurate gauge of how the economy is performing overall. The overall revenue made by the international tourism business in 2013 increased to a record high of $1,159 billion USD, according to forecasts given by the United Nations World Tourism Organization (UNWTO). A given year saw an increase in the number of foreign visitors from 25 million in 1950 to 278 million in 1980, 528 million in 1995, and 1087 million in 2013. By the year 2030, it is anticipated that there would be 1.8 billion foreign visitors to each nation annually. When compared to 2012, the number of tourists coming from foreign nations visiting India increased by roughly 4.1% in 2013. India welcomed 68.48 million tourists between January and December 2013, an increase from the 65.78 million who visited in 2012.

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The foreign exchange earnings from tourism in US dollars from January to December 2013 were US dollar 18.133 billion with a growth of 2.2 percent over the corresponding period of 2014, as opposed to US dollar 17.738 billion with a growth of 7.2 percent during the period of January to December 2012. However, after the repeal of Article 370 and in the wake of the COVID 19 outbreak, the tourism industry has been decimated; among the districts affected are the districts of: A survey by the local newspaper daily excelsior.com found that while there were 38 million people working in the tourism business nationwide, 21.5 million of them lost their jobs as a result. Additionally, Zee News.com reported on the claim that the COVID 19 epidemic had cost Kashmir's tourism sector Rs 1,500 crore in lost revenue.

According to information released by the Jammu and Kashmir Tourism Department, Kashmir is currently celebrating a tourism boom that has lasted for 10 years. Between March and April of 2022, more than 3.5 lakh tourists visited Kashmir. Over the coming months, it is expected that this number will increase even further. The expected number of tourists visiting the valley in 2021 would be 6.6 lakh, a huge rise over the 41,000 people that came to the valley in 2020. The number of tourists visiting Jammu and Kashmir has significantly decreased since 2019 when Article 370 was removed. The restrictions put in place by Covid further hastened the slide and dealt yet another blow to the area's burgeoning tourism industry. Hoteliers, travel agencies, and tour guides are all eagerly awaiting an improvement in the situation, as are the owners of Srinagar's famous Shikaras, or boats. If everything goes as planned, they said, we might notice some symptoms of healing. The research's next portion sheds light on the challenges facing Jammu and Kashmir's tourism industry, with special emphasis on the Srinagar district, which are impeding the sector's expansion. The report also analyses the role that Jammu and Kashmir's Department of Tourism played in the promotion of the travel industry in the section that follows. The study also aims to draw attention to Srinagar's well-known tourist attractions, which are largely to blame for the area's reputation as a magnificent and appealing travel destination.

Challenges of tourism industry in Jammu and Kashmir
The rate of economic expansion in the state of Jammu and Kashmir is quite low due to a number of different variables. The atmosphere of armed militancy, the absence of decent administration, and the lack of competent fiscal management have all contributed to the slow economic growth rate of the tourism industry in Jammu and Kashmir, which has been one of the state's primary sources of revenue. In this section, we looked at the role that the government plays in the administration of tourism in terms of the various duties that the state is responsible for, as well as specific management issues, such as issues pertaining to coordination and the form of state intervention. The ever-evolving facets of the central government's role in the tourism industry are also brought up for discussion. (Hall and Carol M. Hall 2005). The part that the government plays in the administration of tourism, both in terms of the public sector and tourism policy. The administration of tourism, pages 217–231.

It is generally agreed that the government should be involved in tourism and in the growth of the industry as a whole, but there is little room for argument in academic circles over the nature and extent of such involvement. This is especially the case where specialised aspects of state participation are implicated, such as support for human resource development (HRD) in the tourism industry for example. (There is still a dearth of appropriate guidance and direction within Kashmir's tourism business. The tourism business, rather than experiencing growth of any kind, has been showing signs of contraction recently. Tourists are also put off by the occasional civil instability, terrorist attacks, and criminal activity. It is quite regrettable that tourism, an industry that has the potential to generate a significant amount of revenue yet is currently being neglected, is instead experiencing a decrease. Seth and Bhat, P. N. Seth and S. S. Bhat (2003). The growth of economies all around the world is significantly influenced by the tourism industry. On the other hand, Kashmir's geopolitical standing has developed into one of the region's most impressive handicrafts. The year 1989 saw the beginning of unrest in Kashmir, and the region has since experienced the fallout of that conflict in a variety of aspects of life. The tourism sector, which is regarded to be the economic boon of Kashmir, has suffered greatly, and this sector is without a doubt the sector that has been the biggest causality of the continuing political instability and social unrest in Kashmir. (Hamid Mir 2016)

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Famous Tourist places of Srinagar District

Srinagar, the summer capital of the Indian state of Jammu and Kashmir, is home to the beautiful Lake Dal. Since "Dal" in Kashmiri literally means "lake," the lake should not be called "Dal Lake." Because of its significance to Kashmir's tourism and recreation industries, the urban lake has earned the nicknames "Jewel in the crown of Kashmir" and "Srinagar's Jewel." Fishing and the collection of aquatic plants are two additional lucrative industries that rely heavily on the lake.

Located to the west of Dal Lake in Srinagar, the Union Territory of Jammu and Kashmir is Hari Parbat, also known as Kooh-e-Maran. This Mughal structure was commissioned in the 18th century by the Afghan Governor Atta Mohammed Khan. Around later years, in 1590, Emperor Akbar oversaw the construction of a massive wall. This fort, which is perched on a hill and offers a breathtaking panorama of Dal Lake, is encircled by revered buildings representing all world religions. The Archaeological Survey of India (ASI) is in charge of maintaining this fort, which continues to look magnificent despite its age thanks to its many tall pillars and old rooms. The Makhdoom Sahib Shrine can be seen in its entirety from the vantage point provided by Hari Parbat.

Indira Gandhi Memorial Tulip garden is a tulip garden located in Srinagar. It was formerly known as Model Floriculture Center. On an area of approximately 30 hectares, this tulip garden is the largest of its kind in all of Asia. It has a view of Dal Lake and is located on the foothills of the Zabarwan Range. In 2007, the garden was established with the purpose of enhancing Kashmir Valley's floriculture as well as the region's tourism industry. The garden was constructed on the sloped terrain in a terraced pattern, and there are a total of seven terraces in the garden. In addition to tulips, several other kinds of flowers, such as hyacinths, daffodils, and ranunculus, have been included. The Tulip Festival is an annual event that is held with the purpose of showcasing the diverse array of flowers that can be seen in the garden as part of the efforts made by the Government of Jammu and Kashmir to promote tourism. The event takes place in the Kashmir valley just as the spring season is getting started.

Built in the UT of Jammu and Kashmir, India, not far from Srinagar is the terraced Mughal garden known as Nishat Bagh. To the east of Dal Lake is where you'll find the garden. The Kashmir Valley is home to the world's second-largest Mughal garden, located right here. The largest of these gardens is the Shalimar Bagh, which can be located along the Shore of Dal Lake. The Urdu word "Nishat Bagh" translates to "Garden of Joy," "Garden of Gladness," or "Garden of Delight." A Mughal garden, Shalimar Bagh may be found in Srinagar, Jammu & Kashmir, India. Is located on the right bank of Dal Lake and is linked to the left bank by a channel in the northeast. The neighbourhood of Shalimar Bagh may be found in the suburbs of Srinagar. This location is also known as Shalimar Garden, Shalimar Bagh, Farah Baksh, and Faiz Baksh. Nishat Bagh, another famous garden with a waterfront location, can be found not far away. The Bagh was commissioned by Mughal Emperor Jahangir in 1619 as a present for his wife, Noor Jahan. The Bagh is universally regarded as the peak of Mughal gardening. At the moment, it serves as a public park. Currently, it is being called the "crown of Srinagar."

The Pari Mahal, also known as The Angels' Abode, is a seven-tiered garden that can be found at the summit of the Zabarwan mountain range, south-west of Dal Lake, and overlooking the city of Srinagar. The building is an example of Islamic architecture, which was popular during the reign of the Mughal Emperor Shah Jahan, who was also a patron of the arts during that time. In the middle of the 1600s, Mughal Prince Dara Shikoh was responsible for the construction of the Pari Mahal. He used it as both a home and a place to store his books. It is reported that Dara Shikoh resided in this region in the years 1640, 1645, and 1654 respectively. After that, it served as an observatory, which was helpful for the education of astronomy and astrology. The Cheshmashahi Garden can be reached in a quick five-minute drive.

Role of Tourism Agency for the promotion of tourism industry in Jammu and Kashmir

In the state of Jammu and Kashmir, several field agencies and line departments are covered by the Department of Tourism, administrative umbrella.These field agencies and line departments are involved in both the preservation and dissemination of the state's extensive cultural heritage and the creation and improvement of tourist attractions.

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The two divisions that are shown below divide the department. The Department of Tourism, J&K is the most important development, promotion, and regulatory body in the state of Jammu and Kashmir. The state's primary source of economic activity is the hospitality and tourism industry. As a consequence of this, the Department of Tourism has a significant role to play in preparing the state of Jammu and Kashmir to become a popular tourist destination in the nation and projecting its image therein addition to its two provincial directorates, one in Jammu and the other in Srinagar, the Department has tourism offices in all of the state's popular vacation spots. In addition, outside of the state, there are six promotional offices: one each in New Delhi, Mumbai, Ahmadabad, Hyderabad, Chennai, and Kolkata, and one each in New Delhi and Mumbai. In addition, the state is home to twenty area-specific tourism development authorities, each of which is led by a chief executive officer and actively works to maximize the potential for tourism and build tourist infrastructure in the areas they are in charge of. The division likewise has regulatory obligation north of a couple of clubs and five unique social orders notwithstanding two organizations.

The general preparation and execution of projects for the turn of events, redesigning, and improvement of the travel industry framework in different segments of the state is one of the jobs and points of the travel industry. This is additionally one of the objectives of the travel industry. Assistance for private businesses in the form of financial incentives to establish a variety of tourism facilities and assistance with product promotion and marketing the marketing and promotion of a variety of state-produced goods and tourist attractions. The implementation of the requirements of the J&K Registration of Tourist Trade Act, which governs the travel industry.

➢ The establishment of infrastructure pertinent to tourism through the use of investment.
➢ The establishment of tourism-related infrastructure through the implementation of an incentive programme for private investment.
➢ Keeping the carrying capacity of Destinations in mind while regulating the development of Destinations in a systematic manner
➢ Keeping in mind the ecological balance as well as environmental issues.
➢ Teaching young people new skills that will make them more marketable for jobs in the tourism industry as service providers.
➢ Participating in travel marts, road shows, and Famous on both a national and worldwide level, in addition to organising and hosting a variety of festivals and events.

Tourism policy 2020
As a direct consequence of the dramatic rise in the total number of people travelling throughout the world, the tourism industry is one of the ones that is experiencing the most rapid growth right now. In 2018, tourism was responsible for 319 million jobs—equivalent to 9.9 percent of all employment—and 10.4 percent1 of the world's GDP.The total number of employed people serves as the foundation for this figure. In terms of the absolute direct contribution that the travel and tourism industries made to the country's gross domestic product (GDP) in 2017, India ranked eighth globally. This accomplishment was made conceivable by the way that India has one of the world's biggest populaces.2 in 2017, the tourism and hospitality industry in India made a direct contribution of 5.94 trillion rupees, or 91.27 billion dollars in the United States, to India's gross domestic product. This is anticipated to reach 12.68 trillion (US$ 194.69 billion) in 2028, representing a CAGR of 7.23 percent between 2012 and 2028.The third-highest amount of revenue in terms of foreign exchange is generated by the nation's tourism sector.

This project aims to make tourism in Jammu and Kashmir a pleasant experience for visitors, to establish Jammu and Kashmir as a leading all-season tourism destination in the nation, and to provide residents of Jammu and Kashmir with more employment opportunities as a direct result of these efforts' success. By ensuring that Jammu and Kashmir's natural surroundings, attitude, hospitality, experiences, and adventures are engaging and exciting, the goal is to make Jammu and Kashmir an appealing tourist destination. As long as this policy remains in effect ten years after the date it was issued, projects that are initiated, established, or expanded operationally during such a

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period will be eligible for benefits, exemptions, or concessions in accordance with the provisions of this Policy. After the date it was issued, this policy will remain in effect for a period of ten years. However, the rules of the policy that was in effect at the time will be applied to tourism projects that were already established or developed prior to the issuance of this policy, provided that that policy is still in use. This only applies in the event that the prior policy is still in use.

To the benefit of private financial backers, the Branch of The travel industry in Jammu and Kashmir will find different ways to work on the Simplicity of Carrying on with Work (EoDB) in the travel industry business there. Single-window permissions will be made available so that all necessary clearances can be obtained promptly. In order to encourage private investment in the development of Jammu and Kashmir's tourism infrastructure, this would be done. The Department of Tourism will be in charge of making certain that a variety of operational enhancements comply with the EoDB rules that have been made public by the Indian government.

Various tourism projects will be evaluated by the Department of Tourism to determine whether they meet the requirements for public-private partnership status. In addition, in order to maximize the utilization of the assets held by the Tourism Department, Corporations, and Tourism Development Authorities, the Department of Tourism will seek the assistance of the private sector. To guarantee that the assets are utilized to their full potential, this will be done. As a result, both the private developer and the Department will be able to benefit from time savings, economies of scale, and appropriate cross-subsidization.

Challenges of tourism industry in JK

The tourism industry, which requires a lot of workers, offers residents of Jammu and Kashmir a wide range of job opportunities. Tourism, which is a multi-segment industry, offers numerous employment opportunities, including those for hotel managers, receptionists, accountants, clerks, tour guides, travel agents, chefs, and transportation operators. In order to provide opportunities that focus on local communities, boost conservation projects, and integrate with enterprise development, policy officials, non-governmental organizations, and other stakeholders need to collaborate. JK has a good chance of becoming an internationally recognized tourist destination. Policymakers have been interested in the contribution of tourism to economic expansion for a significant amount of time. The significance of tourism to the J&K economy has been recognized for a significant amount of time. According to the Ministry of Tourism, the state of Jammu and Kashmir ranked 17th among India's top tourist destinations in 2012, behind only the state of Andhra Pradesh. If one is looking for a different way to achieve economic growth and job creation in the region, tourism is one option that can be considered as a potential source of economic development in the area. In addition to other kinds of infrastructure, Kashmir has a lot of tourist attractions that have a lot of historical significance and should be made more popular and developed. In these areas, it would also be beneficial to train young people to increase their capacity, so that the young people might work as guides or Khadims.

The tourism industry in Jammu & Kashmir State has grown a lot over the past two to three decades, but not all of its potential for growth has been realized. The state's growth of this industry has been constrained and unsatisfactory as a result of numerous obstacles. Jammu and Kashmir's tourism industry has been hindered by inadequate transit and road infrastructure. Problems at rest areas include inconsistent rates and prices, a lack of fundamental hygienic services, and abandoned rest areas. Insufficient capacity, a lack of dedicated and experienced professionals, security and harassment issues, fuel surcharges, poor flight planning, and inadequate infrastructure—such as filthy facilities, poor roads, communication issues, etc.—are all contributing factors to rising travel costs. All-too-oft occur incidents of security and safety breaches, visitor trespassing, and other forms of harassment. The rise of village tourism, a lack of understanding of the types of visitors, illiterate tour guides, and other issues indicate uneven development.

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Suggestions

Strengthening the Tourism Infrastructure the Department of Tourism will conduct a comprehensive study of the infrastructure gaps at each of the most important tourist destinations in order to develop a comprehensive 10-year action plan for the improvement of tourism infrastructure facilities at each of the most popular tourist destinations. In order to meet the requirements of the expanding tourism industry, this plan will be developed. To guarantee the long-term sustainable growth of important tourist destinations, the discovery, creation, and enhancement of new routes and circuits, and improved connectivity. Throughout the following quite a long while, the public authority of Jammu and Kashmir wants to continuously and relatively increment the yearly spending plan to support the improvement of Jammu and Kashmir's travel industry foundation. Inside a two-kilometre range of the most famous traveller areas, the Division of The travel industry will execute a thoroughly examined technique to further develop the travel industry foundation in unambiguous networks that are situated inside that sweep. To make it possible for high-quality tourist experiences, standard services like drinking water, toilets, a sewerage system, parking, paved roads, parks, street lighting, furniture, and improved communication will be provided. The Public-Business Partnership (PPP) model will be used to get businesses involved in the Department of Tourism's efforts to improve services and infrastructure at specific tourist attractions in Jammu and Kashmir. Better interdepartmental coordination for tourism activities involving horticulture, agriculture, apiculture, culture, youth services and sports, sericulture, handicrafts, and forests will be the responsibility of the Department of Tourism, which will also be in charge of handicrafts. Among these are the following:

During the process of developing tourism in the region, the department in charge of tourism development in Jammu and Kashmir will take into account both social and environmental concerns in order to guarantee the development of a tourism industry that is both eco-friendly and environmentally responsible. The administration of garbage, both strong and fluid, will step by step progress toward utilizing more logical methodologies. In addition, strict supervision and quality control would be applied to the level of cleanliness and sanitation in each tourist area. To ensure that all new construction and expansion projects at pilgrimage sites that are situated in ecologically fragile zones are carried out in accordance with the law, the Forest Conservation Act, the Environment Protection Act, and any other applicable laws and regulations that govern the subject will be adhered to. Important religious sites are located in these zones, too. Waterskiing, rafting, aero sports, sailing, canoeing, kayaking, water scooter racing, trips on ferries, cruise ships, Shikaras, and speed boats are among the recreational activities that the Department of Transportation intends to promote. In the state of Jammu and Kashmir, the Department will be in charge of mapping all of the sites that could potentially be used for aero sports and water sports.

In light of the existing and growing demand for tourists, hotel accommodations must be improved. Security of the entire tourist network must be prioritized; making tourists feel safe before and after their vacations is crucial to a destination's international competitiveness. In order to handle tourism-related tasks, such as working as a tour operator, tour escort, or tour guide, the workforce needs to be developed and trained. In order to promote Kashmir on a national and international scale, marketing strategies are required. By creating the best infrastructure for tourism, private players should contribute to the utilization of Kashmir's resources for tourists. Within the allotted time, the funds should be used appropriately for infrastructure development. In order to grow the tourist attraction, it is necessary to advocate for the local population. Last but not least, the valley ought to connect directly with the Middle East and the Far East by year. All attractions need to be connected by road Changes in tourism development in Kashmir.

CONCLUSION

Recent studies have shown that the tourism industry is the key driver of economic growth in the Jammu and Kashmir region. This was discovered in the state of Jammu and Kashmir. The development of new tourist destinations over the course of the last several decades has played a vital role in the progression of the region's urbanisation. It's possible that the state has a lot to offer because of the natural beauty and cultural landmarks that

can be discovered inside its borders. A recent study came to the conclusion that tourism is having a beneficial effect on the economy of Jammu and Kashmir, which the researchers found to be the case. The growth of a country's economy through an increase in the number of tourists visiting that country is one of the primary priorities of a substantial number of countries all over the world at the present time. It is becoming increasingly important for nations that have already developed economies as well as nations that are still in the process of constructing their economies to do research and studies on the growth of tourism and the myriad of effects that it has. This kind of event takes place only infrequently in Jammu and Kashmir, which is characterised by an unusually sluggish rate of industrial progress. Given the current circumstances, the expansion of the tourism industry is Jammu and Kashmir's one and only feasible alternative for economic development. The hospitality business, and notably the travel and tourist industry, is the state's primary engine of economic growth. When discussing Kashmir in the context of the travel and tourist industry, the phrase "Paradise on Earth" is frequently utilised. Because of this, the state of Jammu and Kashmir should make every effort to keep the region's tourism economy thriving, protect it from any threats, and grow it further. The tourism industry throws up brand new doors for resource opportunities, such as investment and the development of fresh revenue.

Because of this, new employment is created, incomes go up, and the state's socio economic climate improves as a whole as a result of the overall growth. According to the conclusions of an investigation, the tourism sector is the single most important contributor to the economy of the Indian state of Jammu and Kashmir, which can be found in the northern part of the country. Due to the fact that Jammu and Kashmir is widely regarded as one of the best tourist destinations in all of India, the state of Jammu and Kashmir (also known as J&K) has the potential to pull in a sizable number of visitors not only from other parts of India but also from countries all over the world. Over the course of a considerable number of years, the tourism industry has experienced significant expansion in terms of both employment and income, and it is projected that this trend will continue into the foreseeable future. It is possible that the number of visitors will continue to rise in a good manner, which will result in an increase in the amount of money that is made. This will be advantageous. Building up Jammu and Kashmir's tourist infrastructure is very necessary if the state is going to see an increase in the number of tourists it receives. This involves the development of huge highways, various forms of transportation such as air and rail, the refurbishment of existing hotels, and the enhancement of the infrastructure of popular tourist locations.

In order to satisfy the demand for enhanced connectivity, the development of alternative roadways in certain locations is required. In order to ensure that the historic places will continue to exist in the future, it is required to comply with a variety of different protocols. In order for the government of Jammu and Kashmir to be successful in enticing a considerable number of pilgrims to Jammu and Kashmir's three unique regions, it will need to give a higher priority to the fundamental infrastructure development that takes place there. To summarise, there is a need to use more contemporary tactics and instruments in order to provide assistance to tourists in a different manner. Because the data shows that tourism has a significant impact on the lives of people in the state, the industry has an incredibly bright future in the valley. This is because the valley is located in the centre of the state. This can be performed by fostering an appealing atmosphere and improving the numerous conveniences that were covered in the introduction. Both of these things can be done together. In order for the economic growth of the state to be a larger success, it is required for the state government to adopt more liberal policies. The implementation of these measures will lead to the generation of extra employment opportunities as well as an overall increase in the citizens' quality of life.

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CONFLICT OF INTEREST
The authors affirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research presented in this study.

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Table 01. Table of tourist in flow on employment from 2002 to 2020

Year	Additional Tourist Inflow (In lakhs)	Direct Employment (in lakhs)	In-Direct Employment (in lakhs)	Total employment col. (2)+(3)
1	2	3	4	5
2002	62.83	1.57075	7.85375	9.4245
2003	67.43	1.68575	8.42875	10.1145
2004	72.36	1.809	9.045	10.854
2005	77.66	1.9415	9.7075	11.649
2006	83.36	2.084	10.42	12.504
2007	89.48	2.237	11.185	13.422
2008	96.06	2.4015	12.0075	14.409
2009	103.13	2.57825	12.89125	15.4695
2010	110.73	2.76825	13.84125	16.6095
2011	118.91	2.97275	14.86375	17.8365
2012	127.7	3.1925	15.9625	19.155
2013	137.16	3.429	17.145	20.574
2014	147.34	3.6835	18.4175	22.101
2015	158.29	3.95725	19.78625	23.7435
2016	170.09	4.25225	21.26125	25.5135
2017	182.78	4.5695	22.8475	27.417
2018	196.46	4.9115	24.5575	29.469
2019	211.2	5.28	26.4	31.68
2020	227.08	5.677	28.385	34.062

Source: Santek Consultants Pvt. Ltd. New Delhi.

Figure 1. Impact of Tourist Inflow on Employment from 2002-2020

Table 02. SWOT Analysis for Tourism in Kashmir

STRENGTHS	WEAKNESSES
• Rich Culture, Heritage • Three distinct Regions with diversity • Ladakh, Jammu, Kashmir • Flora, fauna, lakes, mountains, pilgrimage places, springs, palaces, monuments, horticulture, handicrafts, shawls, • Kashmir The Heaven, Switzerland of India/ Asia • Kashmiris are hospitable, hospitality in their nerves • Various kinds of tourism available to be exploited • Local People experienced due to past tourism booms • High Awareness of J&K as Tourist Paradise	• No tourism Policy • Undeveloped Destinations • No proper/ Poor connectivity • Low awareness level • Low/ Poor promotional activities • Less Government Spending • Economy dependent on Tourism • Poor Coordination between departments • Stress only on few developed sites • Low time spending • No diversion of tourists from specific tourism to other type of tourism. • Less tourists diversion to new places • No Tourism research • No capacity building of stakeholders for better services • Lackadaisical Approach of Government • Complacency and non customer friendly. • No culture of Perspective Planning in State Department • No Accountability in Financial Matters & Services • Lack of Training Infrastructure & Hospitality Industry
OPPORTUNITIES	THREATS
• Can cater to almost all Tourist Tastes • High Returns from Tourism Industry • Development of Circuits • Un exploited Ladakh • Pilgrimage Circuits • Package Tours • Higher spending of people on recreation, entertainment • Linkage with specific circuits in other states • Professional approach • Governments role as Care taker and facilitator • Customer oriented and friendly	• Security • Competition • Diversion of tourists to other safer places • Better facilities from competitors • Low information dissemination, access and training • Non awakening of Government, complacency • Non treatment of tourism as service industry

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RESEARCH ARTICLE

Growing Media Influence on The Growth, Development, Flowering and Quality Features of Anthurium Plants Cv. Tropical.

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ABSTRACT

Anthuriums are tropical plants belongs to the family Araceae are slow growing perennials that requires shady humid condition are grown for their showy cut flowers and attractive foliage. Anthurium plants require good growing medium with good physical and chemical conditions for their proper growth and development. Research work was carried out to find out the best suited growing media for the production of Anthurium plants (*Anthurium andreanum*) cv. Tropical. The experiment was conducted with different growing mediain a combination of treatmentsusingCoir pith, coconut husk, brick pieces and leaf mould. All the treatments were grown under uniform shade level of 75% by using shade nets. The treatments were replicated thrice.Among the different treatments, growing media with coir pith + coconut husk + FYM envisaged maximum plant height, plant spread, number of flowers per plant, flower stalk length, spathe length and spathe breadth. Vase life and quality of flowers were also found improved in coir pith + coconut husk +FYM. Based on the performance of anthurium plants in the experiment it can be recommended that *Anthurium andreanum* cv. Tropical performed its best under the growing media combination of coir pith + coconut husk +FYM at 1:1:1 ratio.

Keywords: Growing media, Anthurium

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INTRODUCTION

Anthuriums are tropical plants grown for their showy cut flowers and attractive foliage. It has gained the importance as major cut flower of the modern world. Anthurium growing is a potential source of commercial farming and it makes best use of ready market for cut flowers with high returns both for its cut flower and whole plant. Anthurium is a slow growing perennial that requires shady, humid conditions as found in tropical forests. It includes more than 100 genera and about 1599 species, chiefly from tropics (Higaki *et al,* 1994). The Anthurium plant possesses an underground rhizome with adventitious roots, with low creeping habit of growth, using aerial roots for anchorage. Anthuriums are gaining popularity due to higher returns per unit area and their beautiful and attractive long lasting flowers. They have gained popularity as one of the most important commercial ornamental crop of the modern world. They are very popular with flower arrangers because of bold effect and lasting qualities of flowers. Under normal conditions, flower stay fresh without much deterioration for a period of about two weeks (Sheela, 2008). The cultivated anthurium species are erect plants, evergreen, bushy or climbing epiphytes with roots that can hang from the canopy all the way to the soil that have petiolated, lobed and cordate green leaves of variable size. Anthuriums are shade loving plants and grow best with about 70 to 85 per cent shade or an optimum light intensity of 18,000-25,000 Lux of light encourage their growth and development (ICAR report, 2013). They require 60 to 80 per cent relative humidity. The plant produces blooms throughout the year, one bloom emerging from the axil of every leaf. Flowers are usually harvested once a week at three quarters maturity. Anthurium plants require good growing medium with good physical and chemical conditions for their proper growth and development. Among the physical characteristics, aeration and water holding capacity are probably the most important factors while, among the chemical characteristics, nutritional status, salinity level and good drainage also have a crucial role on plant development (Dewayne *et al.,* 2003). Standardizationof growing media is most important to obtain higher yield and quality of the flowers. Therefore, the present work is carried out with a view to find the growing media influence on the growth, development, flowering and quality features of anthurium plants cv. tropical.

MATERIALS AND METHODS

The present study was carried out in Flora-tech floriculture unit at Kottarakara, kollam Dist, kerala state, India during 2018- 2021. The experiment was conducted with five growing media in different combinations. The treatments with three replications were carried out in completely randomized design. The Anthurium (*Anthurium andreanum*) cv. Tropical was used for the growing media study with 16 different treatment combinations. The colour of the spathe is red. Spathe is smooth, blistered, leathery and wavy in texture. The colour of the spadix is lemon yellow. Four months old tissue cultured plants were used. Plant height, plant spread, number of flowers per plant, flower stalk length, spathe length, spathe breadth and number of days taken for flower bud appearance were observed and recorded at 360 days after planting.

Sl. No.	TREATMENT DETAILS
T_1	coir pith
T_2	coconut husk
T_3	brick pieces
T_4	leaf mould
T_5	coir pith + coconut husk
T_6	coir pith + brick pieces
T_7	coir pith + leaf mould
T_8	coir pith +FYM
T_9	coconut husk + brick pieces
T_{10}	coconut husk + FYM
T_{11}	coconut husk + leaf mould
T_{12}	leaf mould +FYM

T_{13}	leaf mould +brick pieces
T_{14}	brick pieces + FYM
T_{15}	coir pith + coconut husk + FYM
T_{16}	soil media

RESULTS AND DISCUSSION

The results significantly influenced in overall performances of Anthurium plants due to the effect of growing media combinations. Among the different treatment combinations, the maximum plant height (37.14 cm), plant spread (59.21cm), number of flowers per plant (5.92), flower stalk length(45.77 cm), spathe length(9.71 cm) and spathe breadth(9.93 cm) were recorded in T_{15}(coir pith + coconut husk + FYM), this was followed by (T_5) coir pith + coconut husk with plant height of 33.49 cm, plant spread of 53.70 cm, 4.72flowers per plant, Flower stalk length of 40.21 cm, Spathe length of 8.88cm and 9.06 cm of spathe breadth. Days taken for flower bud initiation were also early in coir pith + coconut husk + FYM with 92.92 days, followed by $T_6$with 100.42 days. The increased results may be due to appropriate shade and growing media comprising of coir pith + coconut husk + FYM. For optimal growth of plants, media must contain enough water and air, mainly depends on the physical properties of medium. Most of the light weight, soilless media are combinations of two or more components formulated to achieve desirable physical and chemical properties. The present results are inline with the following results. Early flowering in Dendrobium was recorded with coconut fibre was also reported by Cibes *et al.* (1957). Savithri and Khan (1994) find out the growth promotive effect of coir pith was reported in a series of annual crops and same findings were done by Mirzaev (1988) in carnation. coir pith in combination with tree fern is most suitable due to optimum water holding capacity, better drainage and aeration (Griffis *et a,l*1983).

The anthurium requires a well drained media with sufficient moisture retention capacity, which favours the faster rate of growth. The media with good anchorage, root aeration, water holding capacity and favourable physical and chemical properties lead to better metabolic activities of anthurium plants especially with the production of photoassimilitates which would have favoured the maximum vegetative growth. Smitha (1999) observed the growth parameters like leaf area, number of leaves per plant, petiole length, petiole thickness, number of roots and suckers were the maximum in coir pith medium compared to different ratio of coir pith in *Anthurium andreanum*. Chaudhary and Das (1996) noted that the application of composted coir pith increased the plants growth. Khalaj *et al.*, (2011) confirmed that the selection of appropriate growing medium for cut flower was very important for their effective growth. The medium must ensure the production of their required growth on cost effective basis. The treatment combination of coir pith + coconut husk + FYM recorded the best values such as longer flower remaining in the plants (41.99 days)vase life of 10.07 days with a visual scoring range of very good (9.22 grade).This might be due to the internal carbohydrate content of the flowers, which is responsible for the vase life of flowers and other quality parameters. Mngcweliso and Paul (2010) observed that the highest quality of cut flowers in terms of flower diameter and cut flower stem mass were obtained in carnations under optimum shade and good growing media.

Agasimani *et al.*, (2011) revealed that the plants under shade house recovered from the adverse climatic conditions. According to Sekar and Sujata (2001), flower produced on coir pith showed more vase life compared to other media. Vase life was considerably increased in the flower produced in coconut fibre medium followed by brick pieces (Arumugam and Jawaharlal, 2004). Similar results were also obtained by Beaver (1986) and (Suman *et al.,*2004).Considering the above facts and results of the present investigation it could be concluded that the treatment combination of growing medium with coir pith + coconut husk + FYM has resulted as the best for the growth and yield of Anthurium plants (*Anthurium andreanum*) Cv. Tropical.

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Table 1. Growing media influence on the growth, development, flowering and quality features of anthurium plants

Treatments	Plant height (cm)	Plant spread (cm)	Number of leaves per plant	Number of flowers per plant	Flower stalk length (cm)	Spathe length (cm)	Spathe breadth (cm)	Spadix length (cm)
T_1 - coir pith	31.69	50.13	6.98	4.30	36.87	8.27	8.43	5.08
T_2 - coconut husk	29.87	46.63	6.63	3.89	33.67	7.67	7.82	4.70
T_3 - brick pieces	28.28	43.46	6.34	3.51	30.69	8.12	7.26	4.35
T_4 - leaf mould	29.67	40.25	6.04	4.12	37.68	7.56	6.69	4.02
T_5 - coir pith + coconut husk	33.49	53.70	7.31	4.72	40.21	8.88	9.06	5.48
T_6 - coir pith + brick pieces	31.39	52.34	6.77	4.12	39.01	8.14	8.91	4.37
T_7 - coir pith + leaf mould	31.72	50.18	6.99	4.30	36.91	8.28	8.44	5.09
T_8 - coir pith +FYM	30.18	47.10	6.70	3.93	34.01	7.74	7.90	4.75
T_9 - coconut husk + brick pieces	36.41	49.85	5.98	4.09	27.41	6.50	7.63	4.96
T_{10} - coconut husk + FYM	36.38	49.81	5.97	4.09	37.38	7.49	7.62	3.96
T_{11} - coconut husk + leaf mould	34.83	46.72	5.68	4.72	34.48	6.96	7.08	4.62
T_{12} - leaf mould +FYM	32.16	41.13	5.21	4.01	29.02	5.98	6.08	2.99
T_{13} - leaf mould +brick pieces	31.69	50.13	6.98	4.30	36.87	8.27	8.43	2.16
T_{14} - brick pieces + FYM	29.87	46.63	6.63	3.89	33.67	7.67	7.82	2.34
T_{15} - coir pith + coconut husk + FYM	37.14	59.21	7.76	5.92	45.77	9.71	9.93	5.97
T_{16} - soil media	21.67	33.25	4.04	2.62	17.68	3.56	3.69	1.70
SE (d)	1.33	1.74	0.16	0.15	1.35	0.26	0.16	0.12
CD (p=0.05)	2.86	3.48	0.23	0.34	2.84	0.43	0.54	0.25

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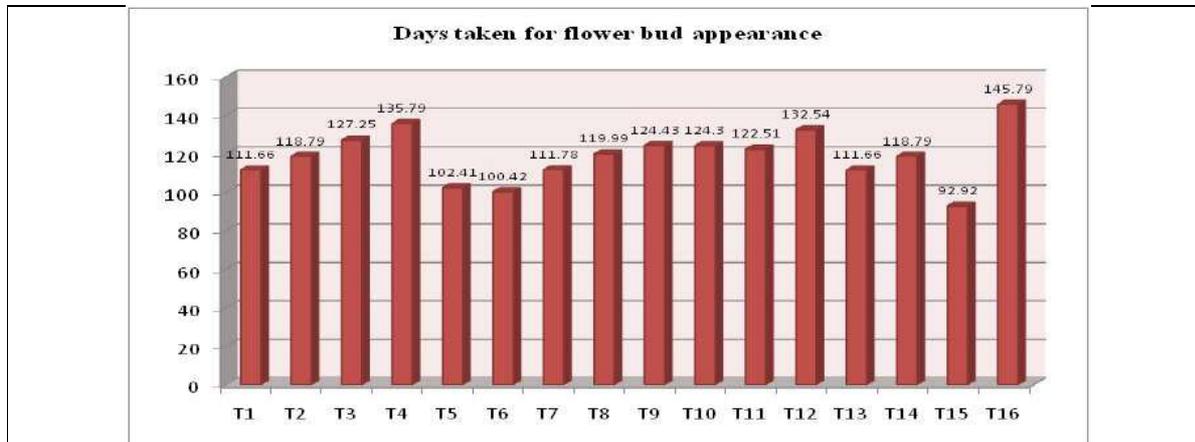
Fig. 1. Growing media influence on the growth, development, flowering and quality features of anthurium plants on days taken for flower bud appearance
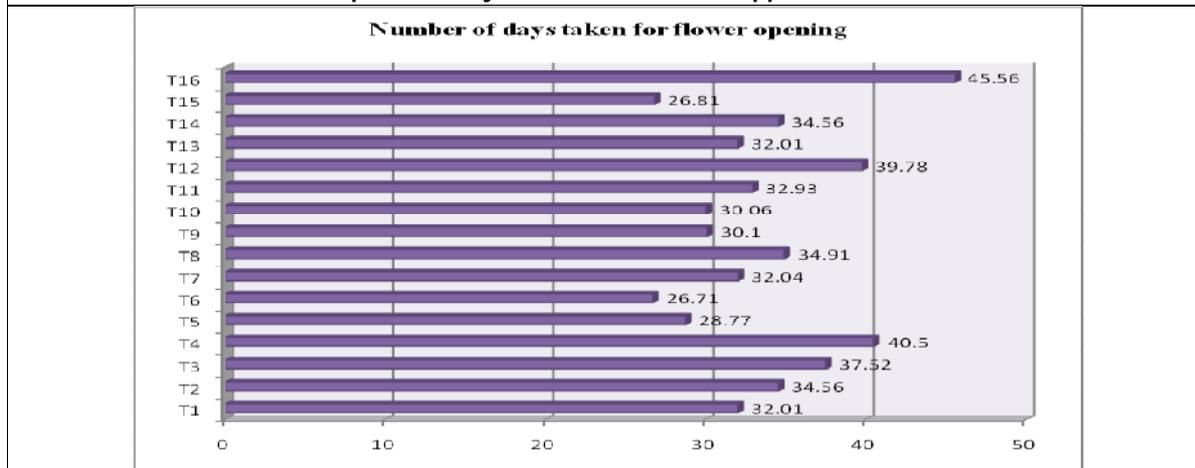

Fig. 2. Growing media influence on the growth, development, flowering and quality features of anthurium plants on number of days taken for flower opening
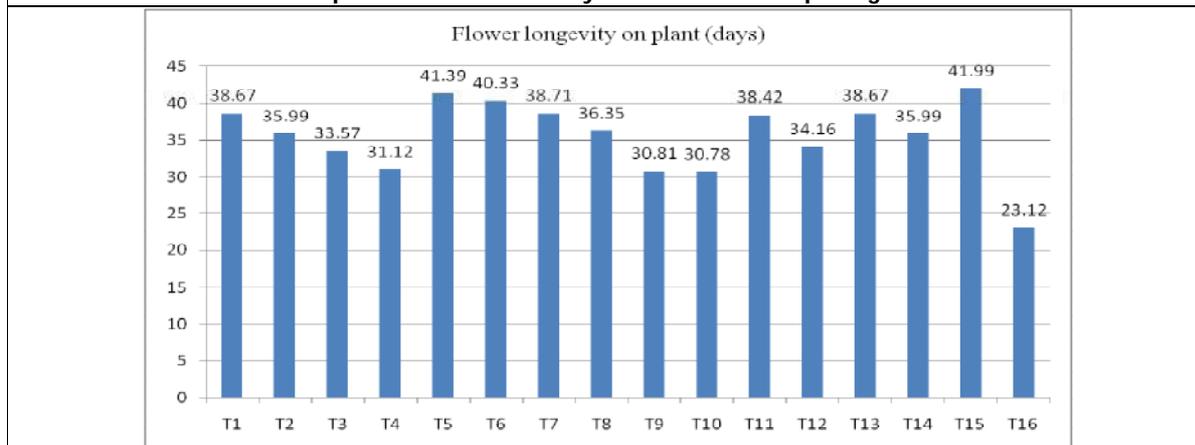

Fig. 3. Growing media influence on the growth, development, flowering and quality features of anthurium plants flower longevity on plant (days)

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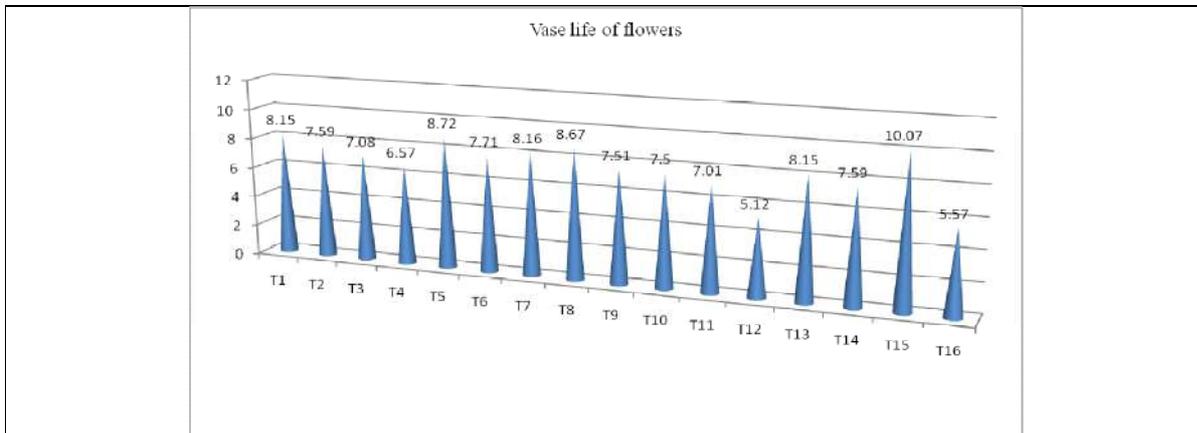
Fig. 4. Growing media influence on the growth, development, flowering and quality features of anthurium plants on vase life
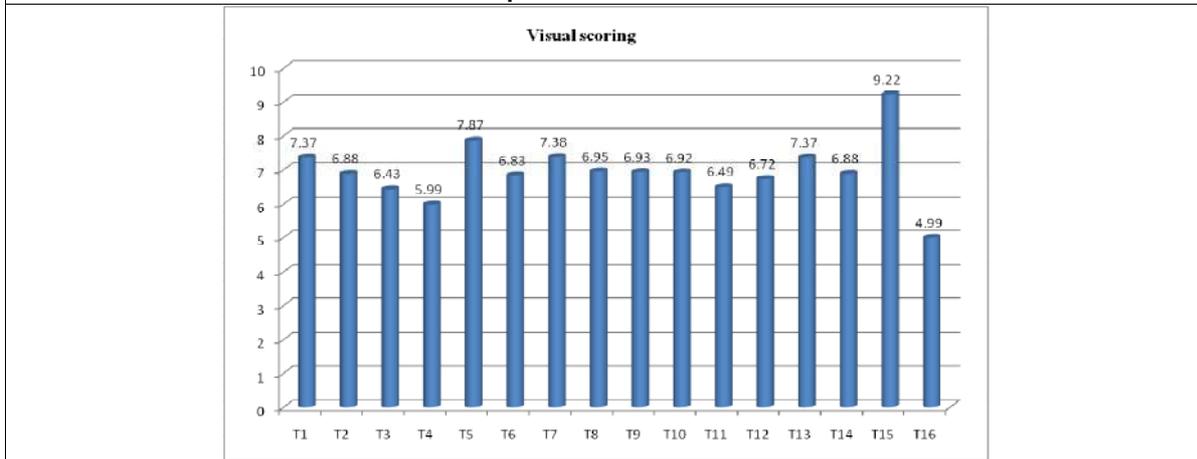
Fig. 5. Growing media influence on the growth, development, flowering and quality features of anthurium plants on visual scoring

RESEARCH ARTICLE

Process of Average Mixing and Filtering for Gaussian Noise Clearing

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ABSTRACT

We employed image de-noising, the most crucial image technique for processing images, to lessen noise in an unclear picture. The practice of restoring noisy photographs is known as image restoration. Recently, technological advancement has greatly improved picture analysis. This is a phase we are currently going through. In our research, we offer a method that can clear an image by removing Effective Gaussian noise. We've seen in this part that different types of filters have used to get rid of various types of a noise in photographs. To eliminate Utilizing Pick the relationship between signal to noise and the root mean squared error, efficiency is dependent on the accuracy of the error image (PSNR). MATLAB analysis is the end result. Unclear picture can Noise free by different methods but our proposed methods can check different parameter, removing border and produces a clear picture. unclear picture makes clear by different filter that available in different source.

Keywords: Root Mean Square Error, Average Hybrid Filter, Effective Gaussian Noise, Image De-noising and Restoration

INTRODUCTION

The goal of the picture noise clearing approach is to improve the photographs output. Picture noise is actually a specific change in clarity [1]. Digital cameras can be used to reduce image noise and is essentially "Unwanted Signal" [2]. In the Gaussian distribution, this type of noise is regulated by the probability density function and is identical to the normal distribution [3]. Salt & Pepper Noise is the term used to describe the noise that is frequently found on pictures. The item has both pepper and impacts of salt noise (There are dark pixels in areas of greater brightness, and there are brilliant pixels in areas of greater darkness.) [4]. Medical applications of sporadic noise include the processing of back-scattered signals from numerous distant targets. Nowadays, doctors prefer photos with speckle

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noise over fully sophisticated smooth versions of images because the latter can distort some legitimate image IDs [5]. The Gaussian distribution is used to remove noise since it is identical to the normal distribution and is controlled by the probability density function. Gaussian Noise is a visual noise that is produced at random. So, we decide to use the strategy we've suggested to remove the Gaussian Noise.

Related Works

We have examined a lot of publications on image restoration. For picture de-noising methodology, a variety of process that are employed with varying degrees of success. We're going to create a filter to get rid of the Gaussian noise [6, 7]. Our suggested approach performs better at removing noise. In order to eliminate the particular noise, we must properly arrange a mathematical calculation. There are numerous methods for de-noising photographs that have suffered from Gaussian noise damage, consisting of (SMF) [8] filter presented by V.R. Vijaykumar [9] or others filers etc. [10]. That are a few examples. Average pixels in the neighborhood is used to modify the pixels in the MF [11]. The side-by-side window's median in the SMF changes the pixels [12]. Low density impulse noise can be removed using both mean and median filters. In essence, the Wiener filter reduces the mean square error for impacted photos [13, 14].

Through in noise addition [15], However, Real-time images cannot provide the "a priori" information of the original signal and noise spectra required by this filter to determine the appropriate threshold value. C. Tomasi introduces the bilateral filter to solve the drawback of earlier filters [16]. Even so, pictures with high noise densities exhibit false edges and staircase effects. After that, Garnett [17] suggests a trilateral filter to eliminate various noises, however it is not effective against Gaussian noise [18]. Additionally, more contemporary filters, such as adaptive window median filter (AWMDF)[19] and an output filter from V.R. Vijaykumar [20], have made an effort to reduce the execution time required to eliminate Gaussian noise while maintaining edge quality, however the results are inadequate at levels of excessive noise density.

Suggestive Method

Take into account that (i, j) is P and represents the brilliant level concentration value of a noise-free image X's pixel spot (i,j) (M,N). For the two-part method, 1. Part of Detection 2. Removal utilizing Average Hybrid Filtering Techniques(AHFT), X_1 (MN), the Gaussian noisy picture is taken into consideration.

Part of detection

To determine if an image pixel is noisy or not, we created a 5×5 matrix with the center (G, H) and a set threshold value of 3. We employ the four-direction image pixel detection. If the threshold value (calculate) is higher than 3, the picture is fuzzy; otherwise, it is noise-free.

Left Side

$$m_1 = \frac{\left[\left| \sum_{s=l-2}^{t+2} \left|(G_{s+1,l} - H_{s,l-1})\right| - \sum_{s=l-2}^{t+2} \left|(G_{s,l-1} - H_{s,l-2})\right| \right|\right]}{5} \tag{1}$$

Right Side

$$m_2 = \frac{\left[\left| \sum_{s=l-2}^{t+2} \left|(G_{s,l+1} - H_{s+1,l})\right| - \sum_{s=l-2}^{t+2} \left|(H_{s,l+2} - G_{s,l+1})\right| \right|\right]}{5} \tag{2}$$

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Top Side

$$m_3 = \frac{\left\| \left[\sum_{p=l-2}^{l+2} \left| \left(G_{l,p+1} - H_{l-1,p} \right) \right| - \sum_{p=l-2}^{l+2} \left| \left(G_{l-1,p} - H_{l-2,p} \right) \right| \right] \right\|}{5} \qquad (3)$$

Down Side

$$m_4 = \frac{\left\| \left[\sum_{p=l-2}^{l+2} \left| \left(G_{l+1,p} - H_{l,p} \right) \right| - \sum_{p=l-2}^{l+2} \left| \left(G_{l+2,p} - H_{l+1,p} \right) \right| \right] \right\|}{5} \qquad (4)$$

Equation (1) – (4) are to evaluate m_1, m_2, m_3 and m_4, and verify the threshold value. We must use our suggested Removal component of AHFT to clean the noisy image if m is bigger than the cut-off value of 3.

Removal Component

The removal is carried out using the AHFT algorithm, which produces a noise-free image from an input image that is noisy. The mean and median operations are combined in the average hybrid filter approach. The Average (+) Operation is the process by which an unclean pixel picture locates selects the nearest noise-free pixel, taking its noise as a replacement. Therefore, we referred to every operation as using a hybrid approach.

Response and Conversation

On the basis of the method we suggested[22 – 26],in this session, we talk about our findings. Any typical PC, MATLAB R2011a is used to do the analysis (2 GB RAM, i3 processor and additional factors). The evaluation is conducted using a standard deviation-based image range (The range is 10to 50 with such a variance of 10). Utilize of equation (5) and (6) below for measure the MSE (mean square error) &&PSNR (peak signal to noise ratio) as well. The table below shows the PSNR results for an image with polarizing filters used at distinct standard deviations (σ).

$$MSE = \left(\sum_{F,J} \frac{\left(I(f,j) - S(f,j) \right)^2}{FXJ} \right) \qquad (5)$$

Where,

I = True Picture
S = Picture that has been reduced in noise
F = Size of the Rows
J =Size of the Columns

$$PSNR = 10\log_{10} \frac{255^2}{MSE} \qquad (6)$$

We used our Method and clear the Noise as compare between the different Filter With variation of standard deviation (SD (σ)) based image range (10-50 with a standard difference of 10).

CONCLUSION

This is how we get rid of the Gaussian Noise that our suggested method, AHFT, had an impact on the photos. This method uses two distinct components: identifying and eliminating noise using the AHFT method. Filtering and maxing operation can produce a clear picture. With help of Low operating and Area median process create a noise

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free photo. The study of the results shows that the PSNR ratio drops as the standard deviation rises. So, in our opinion, it is a more effective approach for reducing image noise. Maximum and Neighborhood Mean Operation is most important idea to find out the noisy pixel that located in in to noise free pixel. Our suggested method creating more unclear picture in different standard deviation-based image range that is defined in our experimental table.

ACKNOWLEDGMENTS

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Table 1. The PSNR results for an image with polarizing filters used at distinct standard deviations (σ)

| SD (σ)	MF[12]	WF[21]	AT [14]	BF[16]	TF[17]	V. R. Vijaykumar [20]	AWMF [19]	SM
10	26.32	31.88	30.91	30.88	29.93	32.91	32.58	**33.54**
20	25.41	28.15	28.92	29.01	28.61	31.27	29.21	**31.83**
30	24.56	25.83	26.63	28.75	27.66	28.41	27.55	**29.29**
40	23.26	24.09	24.47	25.94	24.51	26.36	26.41	**27.99**
50	21.19	22.32	21.11	23.90	22.87	25.49	25.55	**26.82**

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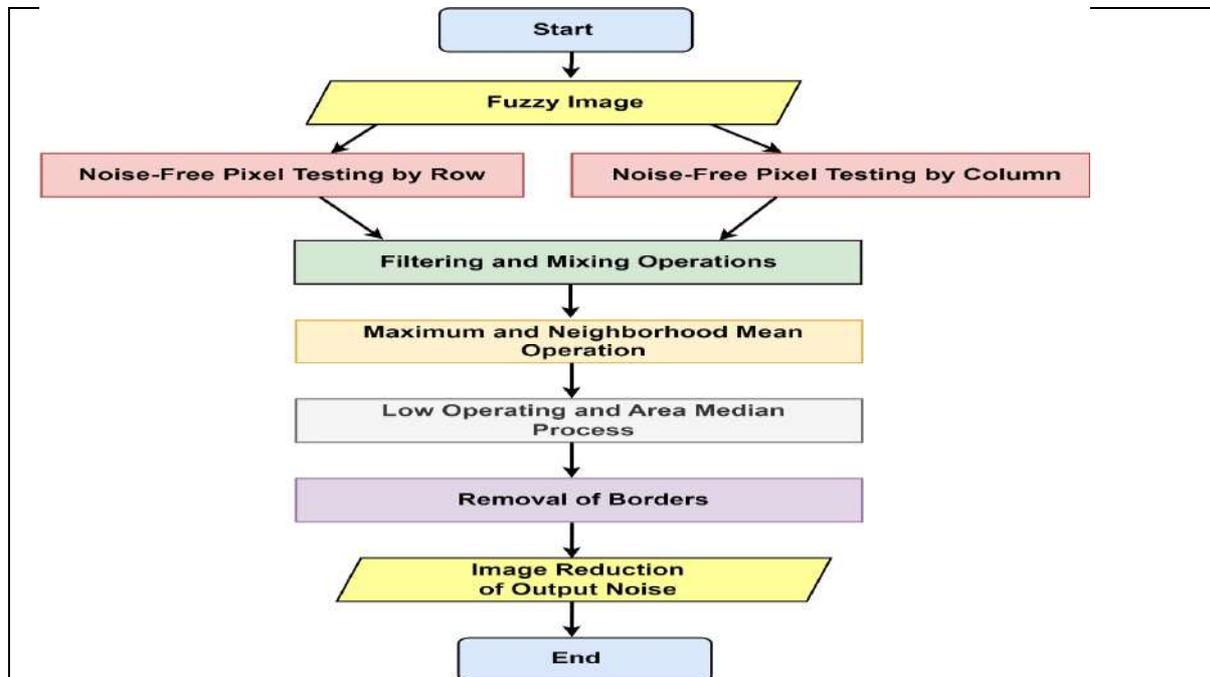

Fig. 1.Flowchart of proposed method

Fig. 2. (a) True Picture (b) Un smooth Picture (c) Average filter (d)Alpha Trimmed (e) Wiener filter (f) TF (g) BF (h) V.R. V. filter (i) AWMDF (j) Proposed Method

RESEARCH ARTICLE

Screening of Phytochemicals and Antioxidant Activity of Leaf Extracts of *Azadirachta indica* A. Juss. (Neem)

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ABSTRACT

The present study was undertaken to evaluate the novel phytochemicals present in *Azadirachta indica*and its antioxidant activity. The aqueous, ethanolic, methanolic and acetone extracts of the plant were prepared for phytochemical analysis and the methanolic extract was used for testing antioxidant activity. The process of extraction continued for 24 hours using Soxhlet apparatus. The extract then used to perform the qualitative tests. The antioxidant activity was measured using DPPH free radical scavenging assay.The different tests performed showed the presence of various novel phytochemicals and also the antioxidant efficiency of the plant which can be proved helpful in the synthesis of more potential drugs in the near future.

keywords: *Azadirachta indica*, phytochemicals, antioxidant activity, potential drugs

INTRODUCTION

Azadirachta indica A. Juss. (Neem) is an evergreen tree, cultivated in various parts of Indian subcontinent. Since ancient times, every part of the tree has been employed as a traditional medicine for household remedies against a variety of illness. The medicinal practises of Ayurveda, Unani and Homeopathy, all make substantial use of neem. The Neem tree is remarkable plant that has been named the Tree of the 21st century by the United Nations [1]. It is referred to as 'Divine Tree', 'Life giving tree', 'Nature's drugstore', 'Village Pharmacy', and 'Panacea for all diseases' in India [2]. It is a broad-leaved evergreen tree with a height of up to 30m and is a member of the family Meliaceae, also known as the Mahogany family. It is frequently cultivated and has naturalised throughout the arid regions of tropical and subtropical nations like Nepal, India, Pakistan, Sri Lanka, Thailand, and Indonesia. It has long been

valued for its therapeutic and ethnomedicinal properties [3,4]. The medium to large sized plant has dense, rounded, pinnate leaves and a brown to dark grey bark [5]. Almost every part of the neem tree, including the fruit, seeds, oil, leaves, roots and bark, is bitter and contains substances with proven antiviral, anti-inflammatory, anti-ulcer, antifungal, antiseptic, antipyretic, and anti-diabetic properties [6]. Azadirone, promeliacin, limonoids, gedunin, vilasinin, C-secomeliacins, azodirachtin, nimbin, salanin, and other non-isoprenoids are among the numerous biologically active substances found in *A. indica*. Other active compounds include protein/amino acids, polysaccharides, sulphurous compounds, polyphenolics like flavonoids, their glycosides, coumarins, tannins, dihydrochalcone, aliphatic compounds etc. [4]. Azadirachtin is the most bioactive compound which is an authentic mixture of seven isomeric compounds labelled as azadirachtin A-G, with azadirachtin E being the most effective [7]. Neem oil also demonstrated spermicidal activity and slowed sperm movement, highlighting its immune-contraceptive qualities [8,9]. The ability of neem oil to both inhibit fertility and activate cell-mediated immunity has been demonstrated. Neem's immune contraceptive abilities, anti-implantational effects, and abortifacient effects are allwell-known [9,10]. Neem also exhibits a wide range of other pharmacological effects, including those that make it effective as an abortifacient, analgesic, anthelminthic, antibacterial, anti-yeast, antiulcer, antifertility, antifilarial, antifungal, antifungal, anti-hyperglycemic, anti-inflammatory, antiviral, antimalarial, antinematodal, antipyretic, antispasmodic, insecticidal, antispermatogenic, antitumor, hypercholesteremic, hypoglycaemic, immunomodulator [11,12].

Polyphenolic chemicals, which are relatively widespread in the plant family Meliaceae, are known to have excellent antioxidant and antibacterial properties [13]. In the past, it has been customary to use solvents like methanol, ethanol, and acetone to extract phenolic/antioxidant compounds from fresh plants at various concentrations while containing water [14]. This practise has a significant impact on the precise quantification of antioxidants. But generally speaking, solvents like methanol, ethanol, and acetone have different polarities, vapour pressure, and viscosities. Solvents with low viscosity have low density and high diffusivity, which can easily allow them to diffuse into the pores of the plant materials to leach out the active ingredients [15]. Therefore, to determine the potential protective benefits of this plant against free radical induced degenerative reactions, the phytochemical analysis of aqueous,ethanol, methanol and acetoneextracts as well as the antioxidant activity of the methanol extract of *A. indica* leaf extractswere examined in this study.

MATERIALS AND METHODS

COLLECTION AND IDENTIFICATION OF PLANT SAMPLES
The leaves of *A. indica* were collected from Gandhia Gaon, Tengakhat, Dibrugarh, Assam during 2019 during their full growing season and was identified.

PREPARATION OF PLANT EXTRACT
After adequately washing the collected leaves under running water, they were allowed to air dry for more than 4 weeks in the shade at room temperature. The dried samples were then grounded into a fine powder using kitchen blender and stored in an air-tight container. Using Soxhlet apparatus, the powered sample was successively extracted with water, ethanol, methanol, and acetone. About 20 gm of the powered samples were placed in 250 ml of various solvents, each for 24 hours. Solutions were filtered using filter paper after 24 hours. The obtained filtrates were then completely dried by evaporation before being dissolved in DMSO (Dimethyl sulfoxide) to create the final concentration. The resulting extracts were then kept at a low temperature (4℃) until they were used.

QUALITATIVE ANALYSIS OF PHYTOCHEMICALS
The extracts were examined using the following standard protocols to determine whether alkaloids, terpenoids, coumarins, flavonoids, phenols and tannins, reducing sugars, glycosides, proteins, anthocyanin, betacyanin and saponins were present. The appropriate reagent was added to the proper volume of the extract after the powered leaf was extracted using the necessary solvent. Then a record of every observation was made.

TEST FOR ALKALOIDS (MAYER'S TEST)
Few ml of extract was added with 1-2 drops of Mayer's reagent (1.358gm of mercuric chloride was dissolved in 60ml of distilled water and poured into the solution of 5gm potassium iodide in 10ml of distilled water). Appearance of a creamy white or yellow precipitate indicates the presence of alkaloids [17,18,19].

TEST FOR TERPENOIDS (SALKOWSKI TEST)

3ml of the plant extract was taken and 1ml of chloroform and 1.5ml of concentrated H_2SO_4 were added along the side of the test tube. Areddish browncolour in the interface indicates the presence of terpenoids [20].

TEST FOR FLAVONOIDS (ALKALINE REAGENT TEST)
1ml of the extract was added with 2ml of diluted NaOH and then 2-3ml of diluted HCl was mixed. Formation of a yellow solution that turns colourless indicates the presence of flavonoids [21,22,23].

TEST FOR COUMARINS
2ml of the plant extract was mixed with 3ml of 10% NaOH. Formation of yellow colour indicates the presence of coumarins [20].

TEST FOR GLYCOSIDES
1ml of the extract was mixed with 0.4ml of glacial acetic acid and one drop of $FeCl_3$ and 0.5ml of concentrated H_2SO_4 was also added to the solution. The appearance of blue colour indicates the presence of glycosides[20].

TEST FOR PHENOLS AND TANNINS
Plant extract was mixed with 2ml of 5% $FeCl_3$ solution. A dark blue green colour indicates the presence of phenols and tannins [17,18].

TEST FOR SAPONINS
3ml of the extract was mixed with distilled water and shaken vigorously. Appearance of steady foam indicates the presence of saponins [24].

TEST FOR REDUCING SUGAR (FEHLING'S TEST)
1ml of the extract was added with 1ml each of Fehling's solution A & B and then boiled in water bath. Appearance of brown colour indicates the presence of reducing sugar [17,22].

TEST FOR PROTEINS (MILLON'S TEST)
2ml of plant extract was mixed with 2ml of Millon's reagent. Formation of white precipitate indicates the presence of proteins [25,17].

TEST FOR ANTHOCYANINS AND BETACYANINS
2ml of plant extract was mixed with 1ml of 2N NaOH and heated for 5 min. Formation of bluish green colour indicates the presence of anthocyanin while yellow colour indicates the presence of betacyanin [26].

EVALUATION OF ANTIOXIDANT ACTIVITY BY 1,1-DIPHENYL-2-PICRYL-HYDRAZYL (DPPH) FREE RADICAL SCAVENGING METHOD
The extracts were taken in different concentrations and placed in separate test tubes. With the addition of methanol, the volume was adjusted to 100μL.Then 5ml of 0.1mM methanolic solution of DPPH was added to each test tube and shaken vigorously. Then these tubes were allowed to stand at room temperature (27℃) in the dark for 20 minutes. Without any extract, the control was made as described above, and methanol was used for baseline correction. At 517 nm, changes in the sample's absorbance were monitored using spectrophotometer [27]. The amount of extract required to reduce the initial concentration of DPPH by 50% (IC_{50}) under the specified experimental conditions was

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used to express the radical scavenging activity as the inhibition concentration (IC_{50}). The percentage of scavenging activity was calculated using the following formula

% of scavenging activity $=[(A_a - A_x)/A_a] \times 100$
Where,
A_a is the absorbance of the DPPH/ DPPH reading
A_x is the absorbance of the sample

RESULTS

PRELIMINARY PHYTOCHEMICAL ANALYSIS
The initial phytochemical screening of *A. indica* leaf extracts in water, ethanol, methanol, and acetone revealed the presence of a number of secondary metabolites. The most prominent bioactive components found in *A. indica* leaf extracts included alkaloids, terpenoids, coumarins, flavonoids, phenols and tannins, reducing sugars and glycosides. The results of phytochemical tests were summarised in Table 1. A significant group of chemicals that function as main antioxidants or free radical scavengers includes flavonoids, alkaloids, and phenolic compounds. The systematic production of drugs using it in the future could result in the treatment of a variety of diseases [13].

DPPH FREE RADICAL SCAVENGING ACTIVITY
The DPPH free radical scavenging activity of *A. indica* is shown in Figure 1. At various concentrations (10-200µl), the amount of DPPH radical scavenging by *A. indica* extract was measured. The outcome showed that 200µl extract of *A indica* had the highest inhibition activity of 83.33% followed by decreasing inhibition activity at lower concentrations.10µl extract had the lowest inhibition activity of 46.46%.

DISCUSSION

According to the findings of this study, extracts of *A. indica* leaves contain a variety of phytochemical compounds in significant amounts that can expertly protect the body against oxidative stress brought on by free radicals and may therefore be used as a source of powerful natural antioxidant compounds. *A. indica* has the ability to combat pathogens that are resistant to numerous drugs. The creation of novel bioactive antibacterial and antioxidant chemicals is anticipated to be aided by further study of plant active components. Both conventional and modern medicines can be derived from medicinal plants, which are a powerful and efficient source. Antioxidant activity by DPPH assay revealed that the plant under investigation has some potential antioxidant components. When a higher concentration of plant extract was employed, it was discovered that the percentage inhibition of the DPPH free radical was higher, indicating greater antioxidant activity. This might be brought on by the high concentration and high amount of antioxidant chemicals present. This antioxidant activity may be caused by flavonoid content, as revealed by phytochemical analysis of plant extract [28,29]. According to the aforementioned findings, it is recommended that future research on *A. indica* be focused on identifying and quantifying the active compounds that are responsible for treating skin conditions, as well as patenting the results to make them available to the general public [30].

CONFLICT OF INTEREST
Authors declare that there is no conflict of interest.

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Table 1: Phytochemical analysis of leaf extracts of *Azadirachta indica* A. Juss. using ethanol, methanol, acetone and water as solvent.

SI.No.	Phytochemicals	Plant extracts of *A. indica*			
		Ethanol	Methanol	Acetone	Water
1.	Alkaloids	+	+	+	_
2.	Terpenoids	+	+	+	_
3.	Coumarins	+	+	+	_
4.	Flavonoids	+	+	+	+
5.	Phenols and Tannins	+	+	+	_
6.	Reducing sugars	+		+	+
7.	Glycosides	+	+	+	+
8.	Proteins	_	_	_	_
9.	Anthocyanins	+	+	_	_
10.	Betacyanins	_	_	+	+
11.	Saponins	_	+	_	_

Table 2: % Scavenging Capacity of the plant methanol extract

Sample Concentration	Absorbance of the sample	% Scavenging capacity	DPPH Reading
S_1 (10µL)	0.485	46.46%	
S_2 (25µL)	0.474	47.68%	
S_3 (50µL)	0.435	51.98%	0.906
S_4 (100µL)	0.355	60.81%	
S_5 (200µL)	0.151	83.33%	

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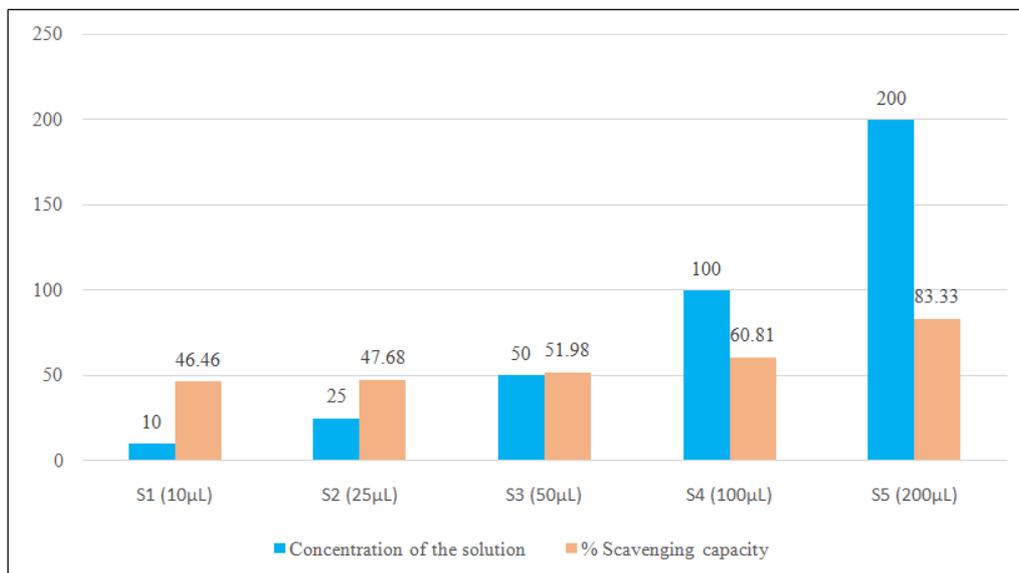
Figure 1. Antioxidant activity by DPPH assay

REVIEW ARTICLE

A Review on Antioxidant and Antimicrobial Properties of Some Medicinal Plants of Indian Himalayan Region

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ABSTRACT

One of the main issues in both wealthy and underdeveloped nations is infectious illnesses. Due to their abundant supply of antibacterial action and low cost, traditional medicinal herbs are frequently employed to treat microbial infections. Different solvents, including ethanol, methanol, chloroform, acetone, petroleum ether, alcohol, and ethyl acetate, were used to extract the various plant components, including seed, fruit, root, bark, stem, leaf, and even the entire plant. To determine these extracts' antibacterial activity, gram positive, gram negative, and fungus were tested against them using the diffusion technique. This study presents clear information on a few traditional medicinal plants with antimicrobial activity, which creates the possibility for additional investigation of medicinal plant extracts to create potent antibacterial and antioxidant medications. The current review supports the most recent body of knowledge about the usage of herbal medicines and the chemical components that provide them its antibacterial activity.

Keywords : Essential oil, Antimicrobial, Genus, Traditional, Humans.

INTRODUCTION

The wide variety of bioactive chemicals that plants generate makes them a great source of several sorts of medications. The majority of medications on the market today are derived from natural sources or from partially synthesized natural materials that were once employed in conventional medical practices. Therefore, screening conventional natural compounds makes sense in the drug development process. A substantial percentage of new

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antibiotics supplied to the market are derived from natural or semi-synthetic resources, and about 20% of plants found in the globe have been subjected to pharmaceutical or biological testing [1]. Pharmaceuticals, cosmetics, and nutraceuticals are all incorporating medicinal plants into their products. Because of the broad variety of chemicals found in plants that have been used to treat both infectious and chronic ailments, medicinal plants are frequently exploited in the pharmaceutical industry [2] The notion that some plants had healing properties or even included what we would now refer to as antimicrobial principles was widely believed long before humans learned about the presence of bacteria. Plants have been utilized by humans to cure common infectious diseases since the dawn of time, and some of these folk remedies are still used consistently to treat a variety of ailments [3]. Given that medication safety is still a major global concern, the current treatments for infectious diseases offer cause for concern. The majority of synthetic medications have negative effects, and the majority of bacteria have evolved resistance. To alleviate this problem, antimicrobial compounds from potential plants should be explored. These drugs from plants are less toxic, side effects are scanty and also cost effective. They are effective in the treatment of infectious diseases while simultaneously mitigating many of the side effects that are often associated with synthetic antimicrobials [4]. The swiftly transforming and possibly harmful external environmental variables are continually interacting with plants. Being immobile species, plants have developed sophisticated alternative defensive mechanisms that use a wide range of chemical compounds as coping mechanisms for stressful situations [1] .

By combining, contrasting, and developing the gene products necessary for secondary metabolite biosynthetic pathways, plants are able to perform combinatorial chemistry, which opens up an infinite supply of chemical compounds that humans have used to their advantage. Therefore, the utilization of plants by humans in both conventional and contemporary therapeutic systems greatly takes use of this idea [5].

Bioactive Compounds

Plants have medical relevance because they contain certain chemical compounds known as phytochemicals that have a specific physiological effect on humans. Herbal and homoeopathic medications contained these phytochemicals to treat the illness [6]. These compounds, which are not nutritious, have anti-infectious or disease-preventive qualities[1].Screening medicinal plants for bioactive chemicals become necessary and serves as a foundation for subsequent pharmacological research. Many of the medicinal plants' active ingredients have been identified and presented as useful drugs in contemporary medical systems thanks to advancements in phytochemical methods. Among these bioactive substances, alkaloids, flavonoids, tannins, and phenolic compounds are the most significant [7].

Genus Artemesia

There are 400 varieties of Artemisia, which are found in temperate climates all over the world [8]. These plants are mainly fragrant shrubs and herbs. Indigenous societies employ numerous species of the genus as traditional remedies, and many of them exhibit biological activity such as antimalarial, cytotoxic, antihepatotoxic, antibacterial, and antifungal effects . *A. absinthium* L., the main ingredient in the infamous notorious spirit drink absinthe , *A. annua* L., the effective antimalarial medication qinghaosu , *A. dracunculus* L., the flavouring herb tarragon and *A. tridentate* Nutt., the "big sagebrush" of western North America are some of the more notable members of the genus [9]. The Himalaya is home to 19 species of Artemisia, some of which have had their volatile constituents and bioactivity examined. These species include *A. absinthium, A. biennis, A. brevifolia, A. desertorum, A. dracunculus, A. dubia, A. gmelinii, A. indica, A. japonica, A. lacinata, A. macrocephala, A. maratima, A. nilagarica, A. parviflora, A. roxburghiana, A. scoparia, A.sieversiana* and *A.vulgaris*[10].

A.dracunculus: The herb *A.dracunculus*, sometimes known as tarragon, is utilized as a food flavouring agent all throughout the world, particularly in the Himalayan region. Additionally, the herb has ethnobotanical uses. Native peoples in the Lahaul Valley (Himachal Pradesh) and the Kibber Wildlife Sanctuary (Himachal Pradesh) [11] use a paste made from the leaves to treat wounds on the legs of donkeys and yaks; To cure dysentery, intestinal worms, stomachaches, toothaches, fever, and stomachaches, a whole plant extract is utilized. A. dracunculus from the Himalayas is a rich source of the diacetylene capillene and the monoterpene (Z)- -ocimene [12], and it differs

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significantly from "French tarragon," which is predominated by estragole (up to 74%), or "Russian tarragon," which is predominated by elemicin (up to 57%), or other cultivars of *A. dracunculus* [13].

A.dubia: Villagers in the Dolpa district of Nepal and the Newar community in Kathmandu, Nepal use the leaf juice of *A. dubia* as an antiseptic to treat cuts and wounds, and the leaf extracts are employed as pesticides. According to research, Chrysanthenone (29.0%), Coumarins (18.3%), and Camphor (16.4%) are all abundant in *A. dubia's* essential oil. The leaf oil was ineffective against the germs *Bacillus cereus, Staphylococcus aureus, Escherichia coli*, and *Pseudomonas aeruginosa*, although having in vitro cytotoxic action against MCF-7 human breast carcinoma cells and antifungal activity against *Aspergillus niger* [14]. *A. dubia's* antibacterial properties must thus be a result of non-volatile plant elements. The entire fresh plant of A. gmelinii is mashed into a paste and administered externally to treat headaches, boils, and pimples in the Humla district of northwest Nepal [15].

A.indica: Wide variations have been observed in the essential oil makeup of *A. indica.* Ascaridole (15.4%), isoascaridole (9.9%), trans-p-mentha-2,8-dien-1-ol (9.7%), and trans-verbenol (8.4%) made up the majority of the leaf essential oil from Nepal. Davanone (30.8%), _- pinene (15.3%), and germacrene D (5.8%) were abundant in the essential oil from the aerial portions of a sample from Uttarakhand, India, in contrast to Artemisia ketone (42.1%), germacrene B (8.6%), and borneol (6.1%) in a sample from Kashmir [14] .When the oil from Kashmir was tested for antibacterial action, it shown exceptional activity against *Penicillium chrysogenum* and *S. aureus* (MIC = 16 _g/mL). The Kashmir oil also demonstrated impressive cytotoxic action against the human tumour cells THP-1 (leukaemia), A-549 (lung), HEP-2 (liver), and Caco-2 (colon). The Nepali A. indica oil showed neither antibacterial (*B. cereus, S. aureus, E. coli, P. aerugino*sa), antifungal (*A. niger*), nor cytotoxic (MCF-7 breast tumor) activities [16].

A.japonica: The leaves of Artemisia japonica are used as an insecticide and an incense in the Garhwal Himalaya in Uttarakhand , and in ethnoveterinary medicine, the herb is used to cure internal parasites like roundworms [17].
A.maritima: Many Himalayan tribes use Artemisia maritima to cure digestive issues and to get rid of intestinal worms [14]. A. maritima essential oil from Malari (Garhwal area, India) was discovered by Mathela and colleagues to be high in _-thujone (63.3%), sabinene (7.8%), and 1,8-cineole (6.5%) [18]. High amounts of _-thujone in various A. maritima essential oils may explain why this plant is used ethnopharmacologically to remove intestinal parasites because _-thujone has demonstrated anthelmintic action . However, the substance is a strong neurotoxic and a GABA-gated chloride channel modulator [19]. Commercial *A. maritima* oil from Pakistan also included high levels of camphor (20.3%) and 1,8-cineole (41.1%). Contrarily, camphor has been demonstrated to lack anthelmintic properties despite being harmful to humans and potentially causing seizures when consumed. 1,8-Cineole may play a significant role in the traditional use of 1,8-cineole-containing herbal medicines for stomach issues because it has been demonstrated to inhibit castor oil-induced diarrhoea in rats , prevent ethanol-induced gastric injury in rats, and attenuate trinitrobenzene sulfonic acid-induced colitis in rats [14].

A.nilagirica: Northern India's hilly regions are home to a large population of *Artemisia nilagirica*, which is utilized as an insecticide . Altitudinal variation has been seen in the essential oil compositions of A. *nilagirica. A. nilagririca* from lower altitudes in Uttarakhand (500 m asl) contained _-thujone (36.9%) as the major component, the oil from intermediate elevation (1200 m asl) had mequinyl p-nitrobenzoate (22.1%), cadina-1,4-diene (17.7%), and _-eudesmol (12.4%) as the major components, and the sample from higher elevation (2000 m asl) had linalool (32.5%) and isopulegyl acetate (20.7%) as the major components [20]. The *A. nilagirica* essential oil from Himachal Pradesh, which has the following major constituents: camphor (12.6%), artemisia ketone (10.2%), caryophyllene oxide (7.4%), and borneol (5.3%), exhibited antifungal activity against the plant pathogenic fungi *Colletotrichum acutatum, Colletotrichum fragariae,* and *Colletotrichum gloeosporioides* but did not show antimicrobial activity against *S. aureus, E. coli, S. abony, P. aeruginosa, or C. albicans* [14]. In order to stop bleeding, residents of the Parvati valley in Himachal Pradesh, India, make a paste from the leaves and apply it to cuts and wounds.

A.parviflora: In the Himalayas, between 900 and 3500 metres above sea level, *Artemisia parviflora* is extensively spread [21]. The leaves of *A. parviflora* are used to treat skin conditions, burns, cuts, and wounds in Kumaun

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Himalayan traditional medicine, while the plant's volatile oils are used to ward off insects. The plant is also employed as an anthelmintic in ethnoveterinary medicine; stock animals (such as horses, mules, sheep, and buffaloes) are given a decoction of the plant's leaves and buds to treat roundworm [22]. *A. parviflora's* aerial parts were used to make the essential oil, which was discovered to include _-caryophyllene (15.3%), germacrene D (14.7%), camphor (11.4%), artemisia ketone (7.8%), and 1,8-cineole (5.8%) in Pauri, Pauri Garhwal (Uttarakhand, India). Although there are subsequently no reports on the bioactivities of Himalayan *A. parviflora* essential oil, *Candida* and Cryptococcus species have been shown to be sensitive to oil from southern India [23].

A.roxburghiana: The presence of Artemisia roxburghiana is related to elevation. The major components of the essential oil of *A. roxburghiana* from Bhaldana, Uttarakhand (850 m asl) were _-caryophyllene (18.4%) and eugenol (16.2%), whereas the oil from Bhatwari, Uttarakhand (1218 m asl) had _-caryophyllene (16.3%) and _-thujone (12.0%) as major components [80], and the major components of the essential oil from Mussoorie, Uttarakhand (2205 m asl) were borneol (21.2%), linalyl acetate (7.4%), and _-humulene (6.7%)[24].An extract of the entire plant is used to treat fever by residents of the Kedarnath Wildlife Sanctuary in the western Himalayan region of Chamoli-Rudraprayag (Uttarakhand), India. The plant extract is also applied topically to the skin to treat allergic responses. Skin conditions are also treated with *A. roxburghiana* in Jammu and Kashimir, India [14].

A.scoparia: All over southwest Asia and central Europe, *Artemisia scoparia* (syn. *A. capillaris*) is a widespread and common plant. *A. scoparia* produces an essential oil from its aerial parts that has been shown to have medical benefits, including insecticidal, antioxidant, antibacterial, anticholesterolemic, antipyretic, antiseptic, cholagogue, diuretic, purgative, and vasodilator effects [25]. Capillene (60.2%), -terpinene (11.1%), and 1-phenyl-2,4-pentadiyne (1.0%) made up the *A. scoparia* leaf oil that was gathered from Milam Glacier in Uttarakhand, India. Capillene (82.9%) and 1-phenyl-2,4-pentadiyne (2.6%) constituted the root essential oil. On the other hand, the main ingredients of the essential oil extracted from the aerial portions of A. scoparia grown in New Delhi were myrcene (24.4%), -terpinene (18.3%), p-cymene (17.4%), and neral (12.5%) [14]. The leaf powder is used to cure diabetes, colic, coughs, colds, gastrointestinal ailments, and as a blood purifier. Capillene is probably responsible for the biological activity of A. scoparia and its essential oils. This substance has demonstrated antifungal and antibacterial properties [14].

A.vulgaris: In Nepal, numerous illnesses are treated using *Artemisia vulgaris*. To halt bleeding from the nose, crushed leaves are placed inside the nose. Treating allergic reactions involves soaking in a bath made from crushed leaves. Oral ulcers can be treated by chewing on raw leaves [26]. An extract of the leaves is used to cure ocular conditions in Sudhan Gali, Kashmir, Pakistan. The _-thujone (30.5%), 1,8-cineole (12.4%), and camphor (10.3%) concentrations of the A. vulgaris leaf essential oil were discovered in Hetauda Makwanpur, Nepal. Antimicrobial activity of this essential oil against *B. cereus, S. aureus, E. coli, P. aeruginosa*, and *A. niger* was tested, but it was shown to be ineffective (MIC = 2500 _g/mL). Another *A. vulgaris* essential oil sample from Nepal did exhibit antibacterial activity against *Streptococcus pyogenes* and *Propionibacterium acnes* [14].

Genus Cympogon

One of the main sources of essential oils is aromatic grasses. There are over 140 species in the genus Cymbopogon, 45 of which have been documented to occur in India. One of the most significant genera of the Poaceae family that produces essential oils is Cymbopogon. Different types of essential oils, such as palmarosa oil (*C. martinii* var. motia), lemongrass oil (*C. citratus, C. flexuosus*), citronella oil (*C. winterianus, C. nardus*), ginger grass oil (*C. martinii* var. sofia), or rusa oil (*C. martini* var. motia) are produced by the most common economic species viz., C. winterianus Jowitt ex Bor, *C. flexuosus* (Nees ex Steud.) Will. Watson, *C. martinii* var. motia Bruno, *C. martinii* var. sofia Bruno, *C. nardus* var. nardus (L.) Rendle, *C. citratus* (DC.) Stapf, *C. pendulus* (Nees ex Steud.) Will. Watson, *C. jwarancusa* (Jones) Schultz, and *C. khasianus* (Munro ex Hack.) Stapf ex Bor [27]. The most prevalent species that are widely cultivated for their essential oils of commercial importance used in perfumes, soaps, cosmetics, toiletry, tobacco products, and other related industrial products are three *Cymbopogon grasses*: Java citronella (*C. winterianus*), East Indian lemongrass (*C. flexuosus* and *C. pendulus*), and palmarosa (*C. martinii* var. motia) [28]. The cultivation of these aromatic grasses covers more than 40,000 hectares of land in India, with the majority of that land located in Assam,

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Kerala, Madhya Pradesh, South Gujarat, Karnataka, Maharashtra, and Uttar Pradesh. Numerous Cymbopogon species exhibit significant anthelmintic, anti-inflammatory, analgesic, anti-aging, pesticidal, antimicrobial, mosquito repellant, and larvicidal activities and are utilized in traditional medicine to treat a variety of illnesses The Cymbopogon species have excellent chances of producing high-quality essential oils, and they are strongly attributable to the perfumery sector, which benefits humanity economically [14].

C.flexuosus: Two distinct species of lemongrass, *C. flexuosus* (also known as East Indian lemongrass) and *C. citrates* (common name: West Indian lemongrass), are used to make lemongrass oil . The main constituents of C. flexuosus have been identified as geraniol (30.5%), citronellol (24.1%), neral (10.3%), and geranial (13.6%) [29]. In several soaps and detergents, lemongrass oil is employed. Lemongrass oil's antifungal, antibacterial, and antioxidant qualities have been widely used [14].

C.pendulus: The untamed regions of northern India, including Saharanpur (in the state of Uttar Pradesh) and western Nepal, are where the North Indian lemongrass oil (*C. pendulus*) grows. It is typically rich in geranial (48%) and neral (33%) [30].

C.martinii: Geraniol makes up a majority (71%–89%) of the palmarosa oil that is extracted from *C. martinii* var. motia and is thought to be of higher quality. Gingergrass oil is the name given to the essential oil extracted from the C. martini Stapf sofia variety. The wild strain of *C. martinii* var. sofia growing in the Kumaon hills has been reported to contain limonene (20%) and monoterpene alcohols, as well as the cis and trans forms of p-menth-2,8 diene-1-ol, p-menth1(7),8 dien-2-ol, carveol, and piperitol [31].

C.jwarancusa: Piperitone (45%–67%) and elemol (7%–29%) make up the majority of the ingredients in *C. jwarancusa* oil. The leaf essential oil from *C. jwarancusa* (Jones) Schult. is rich in piperitone, imparting a characteristic odor.

C.distans: With respect to growing environments and geographic areas, *C. distans* essential oils contain different chemical components. For instance, citral (neral + geranial) (35.0%), geranyl acetate (15.0%), and geraniol (9.5%) were the main components of the essential oil from Munsyari (Uttarakhand). Similar to this, the main constituents of the essential oil grown in Pantnagar, Uttarakhand were geranial (22.8%), neral (16.9%), geraniol (14.8%), and geranyl acetate (19.5%). However, the essential oil from C. distans var. Loharkhet was rich in the sesquiterpenoids eudesmanediol (34.4%) and 5-epi-7-epi- -eudesmol (11.2%),but the oil from Nainital (Uttarakhand) was dominated by _-oxobisabolene (68%)[14].

Genus Junipers

The Juniperus genus (Cupressaceae) contains over 75 species and has a wide range of habitats, from below sea level to above the timberline. *J. communis*, the common juniper used to flavour gin, *J. drupacea* from the eastern Mediterranean, *J. monosperma* from southwestern North America, *J. oxycedrus*, the heartwood from which oil of cade is made, and *J. virginiana*, which is used in Native American traditional medicine in eastern North America are important medicinal species[14].

There are at least six native Juniperus species in the Himalaya of Nepal and northern India: *J. communis* L., *J. indica* Bertol.*, J. macropoda* Boiss (syn. J. excelsa M. Bieb.), and J. pseudosabina Fisch. Additionally, J. wallichiana Hook. f. and Thomson ex E. Brandis, J. recurva Buch.-Ham. Ex D. Don (syn. *J. squamata* Lamb.), and C.A. Mey [32].

J.communis: The most common Juniperus species, *J. communis*, is found all throughout the globe, including the Himalayas from Kashmir to Bhutan. In the Himalayas, *J. communis* is employed in traditional medicine. *J. communis* essential oils are abundant in limonene and _-pinene, both of which have been demonstrated to produce antinociceptive effects in rodents. In addition to being used to treat gout, chronic arthritis, and rheumatism, J. communis is also used as a tonic, a diuretic, and to treat urinary tract infections as well as skin conditions [33][34].

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J.indica: A decoction made from *Juniperus indica's* leaves and berries is used to treat coughs and colds in the Humla district of western Nepal; a paste made from the berries is used to treat skin conditions. Sabinene and terpinene-4-ol are often abundant in the leaf and berry essential oils of *Juniperus indica* . In addition, terpinen-4-ol has been shown to inhibit the growth of human melanoma (M14 WT) cells [14]. Terpinen-4-ol has demonstrated antibacterial activity against a number of bacteria, including methicillin-resistant Staphylococcus aureus (MRSA), respiratory tract pathogens Haemophilus influenza, and penicillin-resistant Streptococcus pneumonia [35]. The growth of human melanoma (M14 WT) cells has also been shown to be inhibited by terpinen-4-ol. Terpinen-4-ol has demonstrated antifungal activity against a number of dermatologically significant fungi, including *Candida albicans*, which causes *Cutaneous moniliasis*, *Candida parapsilosis*, which causes onychomycosis, and a number of dermatophytes, which cause tinea in humans (*Trichosporon* spp., *Rhodotorula rubra*, *Epidermophyton floccosum*, *Microsporum canis*, and *Trichophyton mentagrophytes*); the compound was also active against the potential pulmonary fungal pathogens *Aspergillus niger*, *Aspergillus flavus*, and *Aspergillus fumigates* [36].

J.macropoda: The resin from *Juniperus macropoda* is applied topically to ulcers in Himachal Pradesh, where the berries are used to cure colic, cough, chest colds, diarrhoea, impotence, and indigestion. The needles are used as incense in the Ladakh area in northern Jammu and Kashmir and in Tibet. In Ladakh, tablets prepared from the wood are used for irregular menstrual cycles, amenorrhea, or dysmenorrhea , and tablets made from *J. macropoda* berries, mixed with several other plants, are taken for kidney and urinary disorders. In Tibet, the needles are used medically to treat kidney diseases [37]. J. macropoda's leaf essential oils exhibit a wide range of chemical compositions. The three main components of a sample of leaf oil from Chamba, Himachal Pradesh were sabinene (27.5%), cedrol (14.1%), and terpinen-4-ol (9.4%). This oil does exhibit larvicidal and antifungal properties against fungi [14].

Genus Nepeta

About 250 species of flowering herbs, small shrubs, and very seldom trees belong to the genus Nepeta (Lamiaceae), which frequently has quadrangular stems, glandular, and aromatic leaves that are arranged progressively at right angles to one another. Six of the 31 species reported in the Himalayan region are found in the Uttarakhand Kumaun region: *N. ciliaris* Benth. , and *N. connata* Royle ex Benth., *N. distans* Royle ex Benth., *N. elliptica* Royle ex Benth., *N. leucophylla* Benth., and *N. spicata* Wall ex Benth. Nepeta is native to Nepal in eleven different species, including *N. cataria* L., *N. ciliaris*, *N. coerulescens* Maxim., *N. discolour* Royle ex Benth., *N. elliptica*, *N. hindostana* (Roth) Haines, *N. laevigata* (D. Don) Hand.-Mazz., *N. lamiopsis* Benth. ex Hook. f., *N. leucophylla*, *N. nepalensis* Spreng., and *N. staintonii* Hedge Additionally, *N.campestris* Benth. and *N. eriostachys* Benth. are endemic to Kashmir, India [38].

Traditional uses for nepeta species include antispasmodic, diuretic, febrifuge, diaphoretic, antibacterial, and antiseptic properties, as well as the treatment of dysentery, tooth problems, kidney, and liver ailments. Some Himalayan Nepeta essential oils, such as those from *N. elliptica* and *N. juncea*, are particularly high in nepetalactones, which are typically thought of as biochemical markers for the genus. These essential oils' antibacterial properties are probably brought on by high nepetalactone concentrations [39]. Some Nepeta species, such as *N. discolour* , *N. laevigata,* and *N. royleana*, have high levels of 1,8-cineole. In a double-blind, placebo-controlled research, 1,8-cineole was found to be effective in treating acute rhinosinusitis and to reduce headache, nasal obstruction, and rhinological secretion while not having antitussive effects. Numerous additional Nepeta samples have been shown to be abundant in sesquiterpenoids, including _-caryophyllene, caryophyllene oxide, and germacrene *D. Caryophyllene* has demonstrated anaesthetic and anti-inflammatory properties. In mice, caryophyllene oxide has demonstrated analgesic and anti-inflammatory effects [14].

Genus Origanum

Most species of *Origanum* L. are perennial herbs that are part of the mint family (Lamiaceae). It is widely dispersed in the Mediterranean, Euro-Siberian, and Irano-Siberian regions and has been categorised into 10 sections with 43 species, 6 subspecies, 3 variations, and 18 naturally occurring hybrids. 75% of the genus' members are only found in the eastern Mediterranean, which is where it is most widely distributed [41]. The genus contains some commercially

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significant culinary herbs, such as marjoram (*Origanum majorana* L., syn. *Majorana hortensis* Moench) and oregano (*Origanum vulgare* L.), which are widely used to flavour foods and alcoholic beverages.

***O.vulgare*:** In most European nations, *Origanum vulgare* is referred to as "oregano," and in India, "Himalayan marjoram" or "Indian oregano." This is the sole species known from the northwest Himalaya, and it can only be found in the Kumaon and Garhwal regions of Uttarakhand Himalaya at elevations between 600 and 4000 m. There are numerous chemotypes of *O. vulgare*, Verma and co-workers have defined six in Himalayan India: (1) –terpinene / thymol, (2) thymol/ocimene, (3) thymol/-terpinene, (4) -terpinene/carvacrol, (5) carvacrol/-terpinene, and (6) linalool. Lukas and co-workers have generalized European O. vulgare monoterpene chemotypes as (a) cymyl-type (rich in p-cymene, thymol, and/or carvacrol), (b) acyclic-type (rich in myrcene, ocimene, linalool and linalyl derivatives), and (c) sabinyl-type [42]. The thymol- and carvacrol-rich chemotypes of *O. vulgare* should be helpful in treating bronchial and pulmonary diseases (coughs, colds, etc.); both thymol and carvacrol have antibacterial, antitussive, antihistamine, and many other pharmacological properties, which are in line with this plant's historical uses [43].

Genus valeriana

Around 200 species of *Valeriana* L. (Caprifoliaceae), which is one of the most significant traditional herbal medicines, are found around the world in temperate and subtropical regions. The underground parts of *Valeriana officinalis* L., including the rhizome, root, and stolons, are used to make the herbal medicine valerian. The phytomedicines derived from valerian have been used to treat a variety of ailments, including nerve tension, emotional difficulties (as a tranquillizer or sedative), epilepsy, insanity, snake envenomation, eye problems, skin illnesses, relaxants, and carminatives [44]. One of the ten most popular herbal supplements in North America is valerian [14]. It has also been recommended as the ideal herbal tranquillizer and was used for this purpose in the First World War to treat troops who had suffered from shell shock and to calm civilians who had been subjected to air attacks in the Second World War [45].

***V.jatamansi*:** The Indian medical traditions of Ayurveda and Unani have long utilized Valeriana jatamansi Jones (syn. *Valerianawallichii* DC.) to treat various ailments, including epilepsy, mania, and snake bites. It is also thought to have amazing calming effects on nerve tension, stress, and neuralgia. According to a review of the literature, V. jatamansi contains lignans, iridoids, and flavonoid glycosides. Scientific studies have supported the anti-inflammatory, anti-anxiety, anti-diarrheal, and bronchodilatory effects of *V. jatamansi* extracts [46]. Additional in vitro cytotoxic and antileishmanial properties of the plant have been observed. The essential oil of *V. jatamansi* has demonstrated antibacterial activity against harmful bacteria as well as antifungal activity against a variety of human and plant fungal infections [14]. Six chemically different chemotypes of *V. jatamansi* can be seen in the chemical compositions of root / rhizome essential oils. (a) a maaliol-rich (40%-60%), (b) a patchouli alcohol-rich (> 40%), (c) a patchouli alcohol/ -bulnesene, (d) a patchouli alcohol/viridiflorol, (e) a seychellene-rich, and (f) a kanokonyl acetate chemotype [195, 196, 196]. Methyl linoleate, valeracetate, bornyl acetate, and cuparene were the primary components of the root oil of V. himalayana from the Talle valley in Arunachal Pradesh [47].

CONCLUSION

One of the most researched properties of plant extracts, significant for both food preservation and management of human and animal diseases of microbial origin, is anti-microbial activity together with the anti-oxidant effectiveness. The majority of the target species demonstrate strong anti-oxidant properties and a wide range of antibacterial properties against the reference strains, particularly bacterial strains. It has been proposed that these species' extracts could be employed as natural antioxidants to lessen illnesses caused by free radicals, as a self-preserving agent for their processed products, and as a source of active molecules against disease-causing pathogens. According to this review, some medicinal plants in the Himalayan region have chemicals that have antibacterial properties and could be employed therapeutically as antimicrobial agents. Additionally, greater research on the isolation and

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identification of active chemicals that can be synthesized into antimicrobial medications is beneficial for scientists, research scholars, and scientific companies.

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RESEARCH ARTICLE

Super Capacitor Based Energy Storage for EV Systems

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ABSTRACT

It is necessary to preserve a greener, as well as much more secure, atmosphere by gradually decreasing carbon dioxide discharges coming from our planet. Carbon dioxide emissions are typically reduced by a significant reduction in fossil fuel-powered cars as well as a shift to electric vehicles, which use created electrical power as gas and produce fewer discharges compared to conventional cars and are zero-discharge if the electrical power used is sustainable. Super capacitors are actually commonly utilized nowadays. These high-pressure, high-efficiency power-storing gadgets are actually likewise referred to as ultra-capacitors or even electrochemical double-layer capacitors (EDLC). Their advantageous residential or commercial properties make them ideal for use in power storing bodies, including the ability to be charged as well as discharged quickly without losing efficiency over time. A supercapacitor load could be utilized in HESS (battery-supercapacitor system), which integrates different power-storing innovations along with a specific command technique that makes the most of the advantages of each power resource utilized to accomplish general efficiency. This research will certainly provide a short summary of the advantages, functions, benefits, as well as drawbacks of crossbreed power bodies based upon electric batteries as well as supercapacitors.

Keywords: Super Capacitor, Electric Vehicles, Hybrid Energy Storage System

INTRODUCTION

In contemporary-day shipping, progressively electric- powered cars (EV) of different kinds might show up daily: electric-powered vehicles, electric-powered buses, electric-powered mobility scooters, electric- powered motorbikes, and so on. The intentions of expanding the number of EVs when driving depend on each eco-system as well as their efficiency. Therefore, in spite of being actually more elegant to purchase,EVs feast on a lot less energy as well as

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being actually less expensive in exploitation. It is critical to impose extreme carrying out of power storing components in terms of their life time, energy thickness, power thickness, pattern efficiency, expense, size, and much better garage general efficiency. Integrating eachelement-electric battery as well as to form a cross bed power storing body (HESS) that might expand the basic general efficiency of electric vehicles throughthe implication of keeping the power coming fromvelocity proficiencies to the slowdown of the car. It is actually understood that in traditional HESSs, the electric battery is actually straight associated with the DC hyperlink, whilst in a 1/2-connect DC/DC converter, the electric battery is actually located amongst the super capacitor as well as the DC hyperlink. In comparison to electric batteries, the main advantage of super capacitors is the ability to charge and discharge continuously without degradation, as well as the performance for operating extreme power racks. In order for this method to provide power storage for electric vehicles, both fee-maintaining and plug-in designs must use super capacitors in combination with electric batteries. In a battery- capacitor power body, the galvanic electric battery functions as an electrical power source for long- distance exploring simultaneously as the supercapacitor load is actually utilized as a top energy source, offering electric battery life time enhancements, energy for velocity, as well as the chance for finish regrowth of power throughout stopping, which enhances power efficiency as well as use of electrical power. The requirement for general efficiency of super capacitors depends on the chosen product for the electrode, electrolyte, separator, as wellas modern collection agency. The supercapacitors. Electrolytes require to be very carefully chosen to decrease their interior protection.

Literature Survey

The trip with a problem implies a demand for a large quantity of energy for the brief opportunity period. For a minority of 2 seconds of your time, our team can easily utilize supercapacitors. Within this particular report, the writers presented the integrated functioning of a supercapacitor and battery utilizing MATLAB Simulink and fundamental equipment. To summarize, supercapacitor and electric battery collaborate to improve body efficiency [1]. Made a proposal technique is actually executed on a microcontroller for a 2 dc/dc converter topology. There is an examination of two DC/DC converter topologies as well as a polynomial command technique. Supercapacitors are energy-storing devices that allow us to source the peak of energy for electric vehicles during transient conditions. Under stable conditions, electric batteries will certainly offer thepower asked for [2]. This paper provides detailed information on supercapacitors and electric batteries. The final thought coming from that report is that the supercapacitor overcomes the electric batteries quickly. The use of capacitors to replace batteries is discussed [3] due to their fundamentally higher energy capability and lengthy charge/discharge pattern. From this paper, our team examined supercapacitors and their requests in electric cars in position or even ina mix of electric batteries, which is actually provided in this report. In the end, cars utilizing the SCAP possessed much better efficiency compared to those utilizing batteries. Likewise, examination information is actually revealed for crossbreed supercapacitors [4].

It is expected that, in the future, electric vehicles will play an important role in the emerging modern car body. Among the significant issues to be dealt with in the electrical car standard is its own power-storing capability improvement. Scientists around the world are actually functioning to improve the capability of electric batteries to store power with little dimension, value, and expense. The gas needs are actually constantly increasing along with the variety of cars. India depends on various other nations for gassupplies. Likewise, there certainly are no centers offered for billing or even changing the electric batteries throughout the lengthy trip. It is actually required to enhance the capability of batteries or even style a brand-new body as an option. A double power storing body made up of a capacitor and an electric battery aids in the development of a modern E-vehicle as mentioned in this report to ensure long-term performance as well as reduce the expense of transportation centers. Because of their superior capability in small dimensions, Li-on batteries are expected to be used in all E-vehicles in the future. Thisreport develops and provides information on how to control these batteries with the help of supercapacitors [5].

The disparity between the massive promotion of electric vehicles and the lagging construction of billingposts is becoming increasingly popular. Emergency situation billing innovation for electrical car requirements to make a proposal quickly. Furthermore,energy batteries will certainly quickly usher in the country's first retired life top. How

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to effectively and also environmentally manage the aforementioned issues has become a hot research study topic. This report forecasts the combined tip usage of energy electric batteries and capacitors after retirement and also develops a detachable power storing and billing body. For the issues of reduced current as well assluggish billing in the usage of current energy electric batteries, the combined energy source setting ofdecommissioned energy electric batteries as well as very capacitors is actually a proposal to enhance the billing effectiveness [6].

Power Web is a location of research study and also method in the field of power both at home and abroad. DC energy circulation innovation is actually an essential aspect of the power web. When developing the best power conversion path in the power web, particularly in the DC circulation system, it is important to consider how to approach the type and capability of power storing body (ESS).The appropriate kind and capability of ESS can easily reduce DC voltage flicker as well as boost body procedure security and error going across capability. In this particular report, the crossbreed power storing plan of power storing electric batteries as well as capacitors is actually embraced in the DC circulation system, as well as the distinct Fourier range evaluation of energy need example information is actually performed to acquire the fundamental energy in radio frequency as well as varying energy in higher regularity [7].

Within this particular report, body combination as well as crossbreed power storing administration formulas for a crossbreed electrical car (HEV) possessing several electric sources of power made up of Lithium- Ion electric battery financial institutions as well as very capacitor (SC) financial institutions exist. The power storing body (HESS) incorporates an ideal command formula as well as a vibrant guideline- located style utilizing a Li-ion electric battery and also based on the super-capacitor's Condition of Charge(SOC).The electric battery financial institution provides greater power thickness, whilesupercapacitors have a lot better energy thickness to satisfy the vibrant efficiency of the steer. The bidirectional two-quadrant front-end dc-dc converter (BDC) is the critical component for controlling thepower flow between the battery and the supercapacitor. With appropriate command as well as the establishing of essential specifications, great velocity and slowdown, relatively easy-to-fix steering, as well as stopping qualities are actually acquired. To conquer the deterioration of life cycle in an electric battery because of constant velocity as well as de- acceleration triggered by higher current because of regenerative stopping setting, very large capacitors are actually utilized in making a proposal for HESS [8].

Proposed System
In our proposed System, the topologies for electric battery energy administration utilizing boost converters and very capacitors have been modeled as well as discussed, along with various advantages. This electric battery energy administration topology is developed in HEV utilizing a DC motor-generator collection that is linkedto the tires of the car, which will certainly turn the tiresregardless of the rate and also unexpected jerks in the body, making it a better and also more precise car body compared to the current one. One can easily utilize this body in sustainable energy-based car bodies, which makes it lower in expense as well as more beneficial.

The Benefits of the Proposed System
•   Increase Efficiency
•   Increase billing potential
•   Multi-functionality
•   Inexpensive
•   Lower maintenance costs

Working Principle
The proposed system has various converter topologies as well as the manner in which they are actually long- lasting for the bodies. In terms of multi-complete connect topology, the increase converter design is considered for simplicity as well as costconsiderations. It allows the body's energy administration to run smoothly. The complete connect converter topology, however, is actually suitable for changing the variety of accessibility voltages to the DC web link. Because of its own higher cost and decreased effectiveness, the end connect converter is actually much less

appropriate for higher current as well as reduced voltage demands, such as very capacitors. The primary elements in the building of supercapacitors are actually 2 billed electrodes, a present collection agency, and a separator that enables the movement of ions as well as avoids guide electric get in touch with. When an electrical fee is actually acquired between the main electrode as well as electrolyte, the equivalent number of fees along with contrary polarity may be precipitated on the 2nd electrode, developing billed levels with minimal divided range.

When a quick fee is required to provide temporary power, supercapacitors are the correct service. Simultaneously, electric batteries are actually routinely chosen to provide long-term power as they can becharged extremely rapidly. They are also appropriate and more durable for connecting energy spaces, lasting from a few seconds to a few minutes. To make up for the difficulty found in battery-powered EVs, SCs are actually utilized together with the electric battery, resulting in a crossbreed ESS (HESS). Their extreme energy thickness as well as their prospective defines the SCs' ability to deal with a large range of temperature levels as well as their prospectiveto react rapidly. The common qualities of each electric battery as well as SCs are actually offered. Thus, crossbreed ESS (HESS) topologies were proposed, along with eachelectric battery and SCs.

In addition, depending on the tissue setup or even power storing body, electrical dual-level capacitors,crossbreed uneven capacitors, as well as pseudo capacitors are prominent. In addition to significance to EDLC capacitors, power storage is accomplished through fee splitting up in Helmholtz double-level serving as a limit between the conductor and electrolyte. Pseudo capacitors have chemical substance carrying electrodes or even steel chemical substances mainly based upon electrodes integrating the fixed as well as pseudo capacitance charge-storage procedure. Crossbreed capacitors have unequal electrodes made up of a dual-level capacitor electrode as well as a pseudo capacitive electrode, integrating one of the absolute simplest choices of each innovation. Compared to an EDLC capacitor, Li-ion capacitorsutilize one electrostatic conductor as well as one chemistry electrode, allowing greater power thickness as well as self-discharge, particularly compared to an EDLC capacitor, and extra charge-discharge cycles compared to a Li-ion electric battery, certainly not the prospective for dangerous thermal runaway

Lots of topologies of HESS are actually best-known, like supercapacitor/electric battery, electric battery/ supercapacitors, half-bridge, full-bridge, as well as several input converter topologies that have been examined, designed, developed as well as analyzed over the last twenty years. As discussed above, the mix of an electric battery as well as a supercapacitor is a HESS. Development of the powertrain's overall effectiveness and development of its electrical power capability properly designed HESSand its own general efficiency trust the potential to satisfy the energy demand explained with the assistance of utilizing the private general efficiency specifications of the electric battery as well assupercapacitor packs as well as extended functional versatility.

Cordless billing has actually begun as an option for billing electrical equipment. As billing of electric battery toss cordless innovation for electric cars (EVs) occurs, various problems like the energy pad, roll organization plan's as well as most significant is actually the billing opportunity for electric batteries of an electric-powered vehicle, energy converters for extreme reoccurrence stamina alter, and electro- magnetic area safety and safety. Because of the cutting-edge energy digital gadgets that are going to be available in every energy age group and condition,inductive combining bodies generally run in the kHzband. However, this radio frequency necessitates a large size roll as well as heavy ferrite products, which may not be the most preferred in terms of payload effectiveness when utilizing cars. The vibration combining bodies functions at greater running regularities within the megahertz band. It is intended to become a guarantee for the factor of the cordless vehicle bill being obligated to repay for the following advantages.

The cordless power move recommends the electrification of vehicles may prolong on the edge, providing electrical power as well as altering it into power with the onboard electric batteries of fixed cars. In particular, the cordless billing of relocating cars on- demand as well as in the time period (i.e., vibrantbilling) will lead to a standard change in the requirements for transportation. The cordless billing ofelectric vehicles can easily reduce the need for onboard electric batteries or even customize battery- free vehicles. Thinking about the requirement for fast as well as regular

cordless billing, another range of electrical power storing gadgets, supercapacitors, could be extra suitable compared to batteries thanks to their marvelous qualities for car onboard use:

- Function electrostatically, despite the fact that chemical responses are not easily fixed
- Unlimited pattern lifestyle (use pattern a thousand times) quick as well as more cost-effective fee/discharge due to a small amount of interior protection along with around 97–98% effectiveness.
- There is no need to use heavy products, making it eco-friendly.

HESS

The very initial topology is actually a partially- decoupled HESS. Within this particular setup, the supercapacitor is actually connected instantly to a bidirectional DC/DC converter. The electric battery is actually connected to the inverter (DC/AC converter). The DC hyperlink voltage can easily have little voltage changes since the battery is actually linked to the DC hyperlink. However, right below, the electrical power thickness of the supercapacitor might be completely discharged to zero volts. The risks of this particular setup are that the DC/DC converter needs to customize the stamina fast, which enhances the application intricacy. Another HESS topology is the intermittent partly decoupled form. The electric battery is actually connected to a bidirectional DC/DC converter. The supercapacitor is actually associated with the terminals of the DC hyperlink, operating as a reduced pass filter. The energy that chooses to wander might be effectively managed. The supercapacitor can easily operate in a much larger range, as well as the DC hyperlink voltage can easily expose extreme changes.

CONCLUSION

The SCs, as opposed to electric batteries, due to their characteristics, can provide an instant response to an altering need request, as well as carry out severe ecological problems. It, in hybridization along with the electric battery, can easily enhance the battery's presence as well as prolong the electric battery's alternative period. The SCs can easily launch as well as saturate extra power, as well as deal with energy digital converters as well as changes, as well as deal with variable voltage procedures concurrently, providing one of the most significant profits of each ESS within the HESS.

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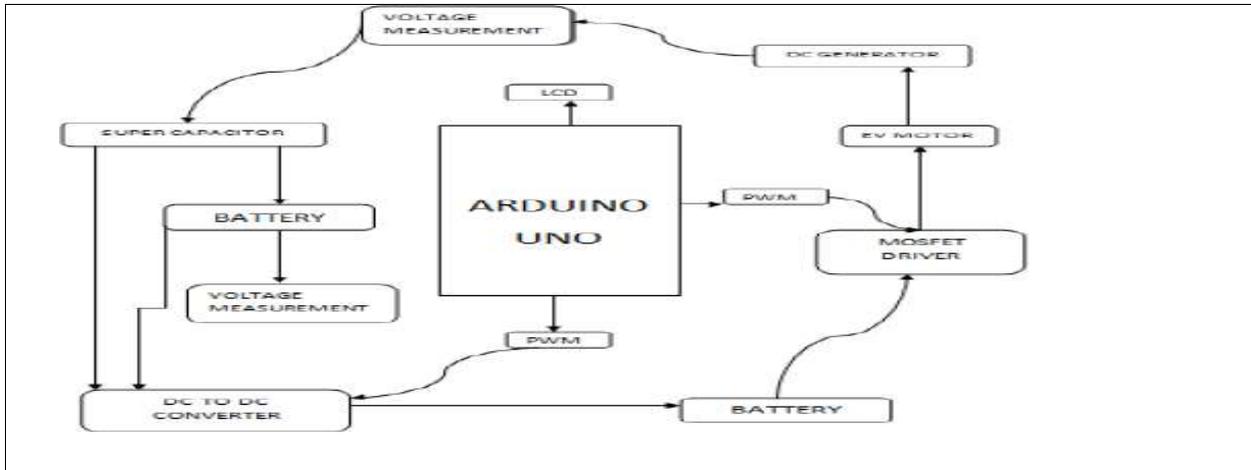
Fig 1 - Block Diagram
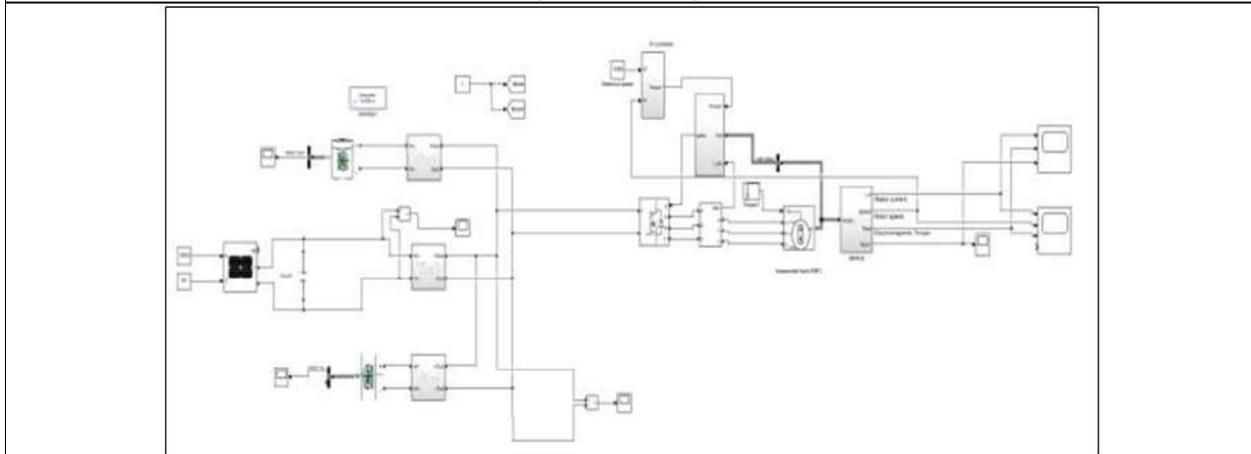
**Fig. 1.1 Battery With Super Capacitor System**
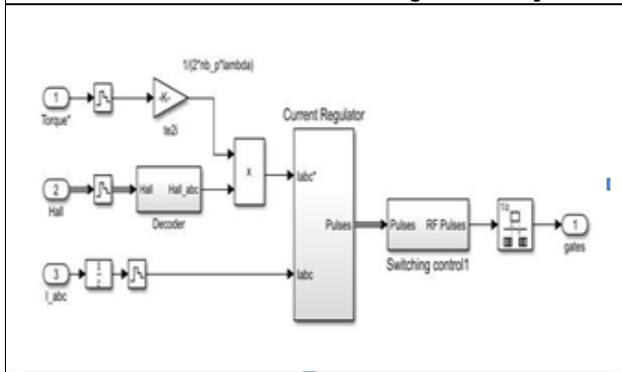
Fig 2 - Simulation Diagram
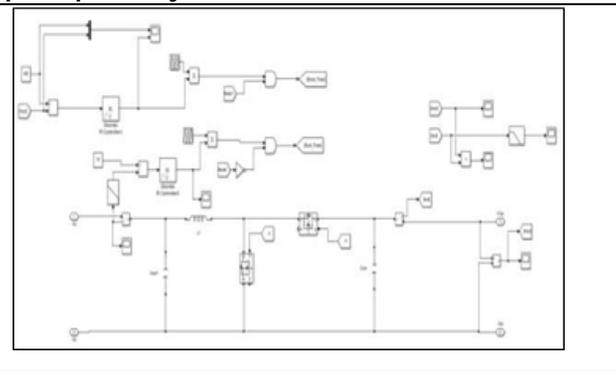
Fig 2.1 - Simulation Diagram
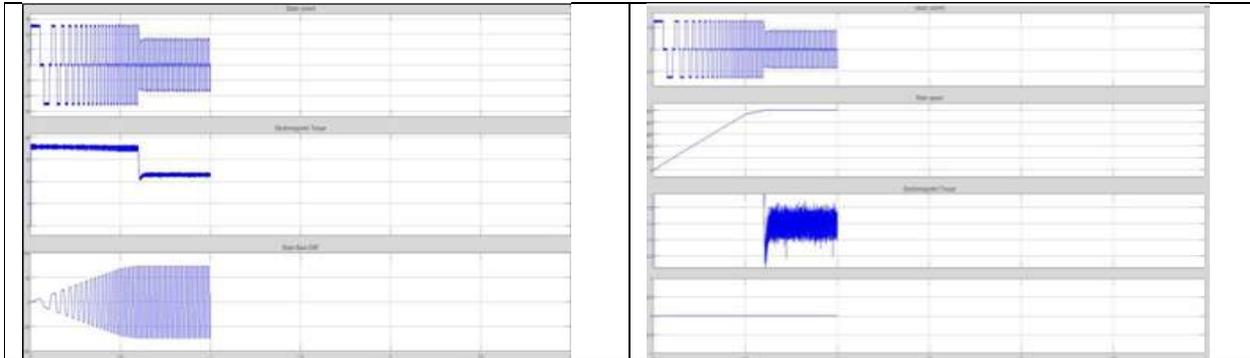
Fig. 3. Simulation Results

**Fig. 3.1. Simulation Results**
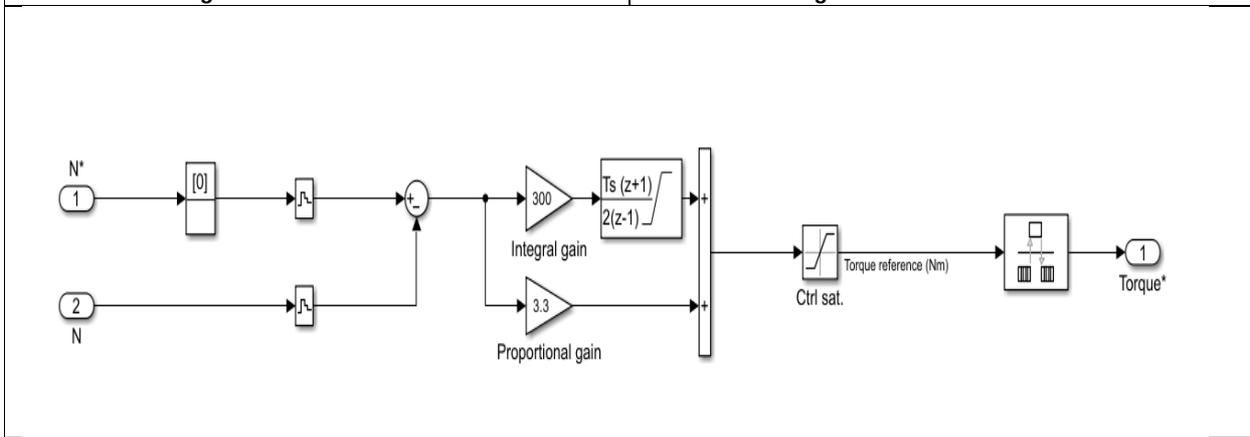
Fig. 4. Hybrid Energy Storage System

RESEARCH ARTICLE

A Study on the Food and Feeding Habits of the Chocolate Mahseer from Jiyabharali River of Sonitpur District, Assam, India

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ABSTRACT

This paper embodies to investigate the food and feeding intensity of Chocolate mahseer (*Neolissochilus hexagonolepis*) with respect to season, maturity stages and length of the fishes. The diet composition of *Neolissochilus hexagonolepis* during different season were determined based on the analysis of 60 specimens, collected from Jiya Bharali River. The fish are found to be an omnivore with higher feeding preference for plant material than for animal material and high values of its gastro-somatic indices species to be a voracious feeder. The feeding activity of the fishes found to be increased with the increase in size of fish.

Keywords: Chocolate mahseer, food, feeding and Jiya Bharali

INTRODUCTION

*Neolissochilus hexagonolepis*is widely recognized as a sport fish due to its tremendous size and strength facilities but this species is facing tremendous ignorance in terms of its habitat loss and over fishing, and becoming near threatened in IUCN Red list Data book. Originating from the Tawang border district in Arunachal Pradesh, Jia Bhoroli or Jia Bharali is a habitat of many coldwater fishes of species. However, the population of different fish species is in decreasing mode over the years due to various anthropogenic factors. The study of the food and feeding habit of fishes provide keys for the selection of culturable species and necessary information for successful fish farming [1]. The present study deals with food and feeding habits of *Neolissochilus hexagonolepis* from Jia Bharali River.

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MATERIALS AND METHODS

The specimens collected during the one year of investigation of the rivers from October 2021-October 2022 were brought to laboratory for the purpose of performing different experiments of the food and feeding habits of the fish. Fishes were collected once in every two months for dietary analysis. The collected fishes were preserved in a plastic container with 10% formalin to prevent further digestion of food. The abdomen of each fish specimen was opened by a ventral incision along the keel and gut was removed.The gut content of the fishes was studied based on the method byNikolsky [2]. The Gastro somatic Index (GSI) was determined by method of Bhatnagar and Karamchandani[3]. The Relative Length of the Gut (RLG) has been assessed by dividing the gut length by total length of the body [4].

RESULTS AND DISCUSSION

The gut contents of comprise of Algae, Protozoa, Rotifers, Nematods, Insects, Crustaceans, unidentified vegetable matter, unidentified animal matter, and sand particles. The vegetable matte and algae are found to form the primary food of the fish which is covering most of the stomach content. The animal matter, insects larvae, Protozoa, Rotifera, Nematoda, and Crustacea constituted the secondary food but found in smaller amounts. Sand particles were also observed in some examined fishes and therefore, considered as incidental food.It may be noted in this context that food and feeding habit of *Neolissochilus hexagonolepis* studied in Simsang river of Meghalaya was found to be omnivore and considered as voracious feeder subsisting mainly on algae and vegetable matter [5]. The occurrence of sand and mud in the gut of different developmental stages the fish showed that the fish is column to bottom dweller and occasionally rise near to the surface for nibbling the flowing food items [5]. In the present study a change in the diet with increase in size was also observed. The smaller specimens consumed more of animal matter however large specimens are found to consumed more of vegetable matter.Similar informationhas also been made by Dasgupta [5.6&7].

The seasonal GSI of Chocolate Mahseer during the period of study has been presented in Fig. 1.GSI data showed there is a rise in the feeding intensity of the fish. It was found out that GSI was lowest during the breeding period (June to August) and highest during the pre-breeding period (March to May). Dasgupta [8] reported that the species breeds during the April/May October/November signifying that the period of low feeding intensity matches with the spawning period. The low feeding during thebreeding season may be due to the completely developed gonads, permitting limited space in the abdominal cavity for intake of food. Further, the intensity in food intake increased ensuing spawning and for their growth. Dasgupta[5] informed that the species is avoracious feeder in natural condition. The present study on revealed high values of its gastro-somatic indices species to be a voracious feeder.

The present study indicates that RLG. values increase with increasing total length of the fishes. The RLG values show a gradual increase from 1.75 in length (7-10 cm) to 2.13 in length (46-62cm).It is also reported that R.L.G. value has aclose relationship with the nature of food fish has taken[5]. A close relationship with the nature of food taken by the fish was observed with the relative gut length of the fishes of different feeding categories [9]. In omnivorous fishes, the RLG values were lower than herbivorous fishes because the vegetables matter requires more time for digestion [10]. The presentfinding indicates average RLG value of *Neolissochilus hexagonolepis* was 1.69 (Table 1). Gut content analysis consequences supported the studied species to omnivorous.

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Table 1: GSI and RLG of *Neolissochilus hexagonolepis* in different maturing stages

Maturing stage	Seasons	No. of fish	GSI	RLG
Stage I (Imature stage)	June-Feb	20	1.73	1.75
Stage II (Maturing stage)	March-May	20	1.98	1.89
Stage III (Mature stage)	June-August	20	0.53	2.13
Stage IV (Spent)	Sept-Dec	20	1.1	2.01
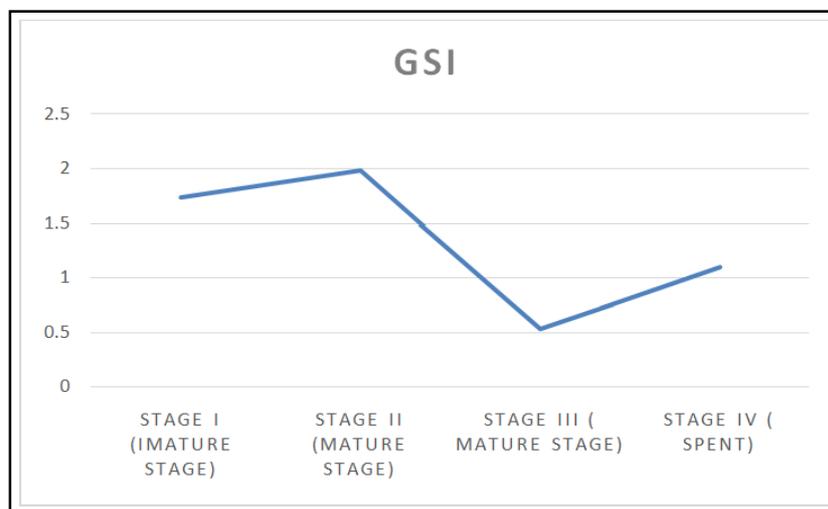
Fig. 1: Seasonal variation of GSI in *Neolissochilus hexagonolepis*

RESEARCH ARTICLE

Effectiveness of One Leg Squat on Gluteus Medius Strength in Normal Healthy Individuals Randomized Clinical Trial

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ABSTRACT

A major hip abductor, the gluteus medius (GM) muscle keeps the pelvis stable in the frontal plane while walking and performing other functional tasks. It is crucial for the stability's mediolateral control. An adaptation of the upper body will be initiated in an effort to move the centre of gravity closer to the centre of hip rotation if weight overload or muscular weakening occur. Strengthening the gluteus medius may be essential for both injury prevention and healing. Devices like a hand-held dynamometer are used in clinical examinations to improve accuracy. Total 20 college going healthy individuals were recruited as pr selection criteria, all subjects collected from Parul university. Gluteus medius (right and left) strength was measured a single examiner using a belt-stabilized hand-held lower limb dynamometer placed on the knee of the individuals positioned in lateral decubitus. Three measurements were recorded with the rest interval, and only the highest value measured for each limb was used for analysis. There is significant percentage increase in the strength of the gluteus medius between pre and post treatment of both the groups on the right and left side , but group 1 has better strength compared to group 2 , the "t" test values are 5.0179 hence the p value is ($p<0.05$). Hence, by analyzing the numbers it is evident that group 1 has more increased strength as compared to group 2.

Keywords: Gluteus medius, one leg squat, walking

INTRODUCTION

During walking and other functional tasks, the gluteus medius (GM) muscle, a main hip abductor, stabilizes the pelvis in the frontal plane [1, 2]. The medio-lateral control of stability is assumed to be significantly influenced by the gluteus medius (GM). In response to medio-lateral perturbations while walking, there has been evidence of increased activity of the stance and swing leg GM. [3,4]. According to in vivo research, the hip abductors need to exert a force that is roughly 2.5 times their subject's body weight in order to support the pelvis. Hence, the combined strength of the abductor muscles must be more than the person's body weight [4]. The gait pattern and joint function are normal when there is sufficient strength to sustain the person's weight. An adaptation of the upper body will be triggered in an effort to move the centre of gravity closer to the centre of hip rotation if weight overload or muscular weakening occurs [5,6,7]. There are a variety of factors that might contribute to GM weakening, including changing lifestyle choices, age-related weakness, trauma, and congenital conditions. The vulnerability of GMs can be caused by various things. In terms of medicine, they can include hip rotator cuff injuries and congenital hip dislocation [8,9]. Lifestyle issues may also contribute to GM deficiency. Examples include lying on one's side with the top leg flexed and adducted over the bottom leg, or standing with the body weight primarily on one leg as the pelvis sways sideways and the hip joint is adducted [10,11]. Strengthening of the gluteus medius may be essential for both injury prevention and rehabilitation. The use of hand-held dynamometers in clinical examinations can improve accuracy (HHD). HHD can be used as a substitute instrument since it is a reliable, portable, and reasonably priced way to measure strength. A rapid instrument for providing objective values in clinical and experimental settings is one of the benefits of HHD [12].

Hip strengthening exercises have varying degrees of success in reducing symptoms and enhancing quality of life in patients with clinical disorders. Exercises to strengthen the hips are proven to improve knee issues, but outcomes for conditions like hip osteoarthritisare less convincing and show only modest short-term improvements [13]. One of the most often utilised hip-strengthening exercises is the single-leg squat [14]. To reduce excessive contralateral pelvic drop and boost hip adduction torque, it has been suggested that the single leg squat be performed with the gluteus medius muscle activatedon the side that is supporting the weight [15,16].

MATERIALS AND METHODOLOGY

- SOURCE OF DATA: Subjects are collected from Parul University Campus
- STUDY POPULATION : Normal individuals
- STUDY DESIGN: A Comparative study
- SAMPLING METHOD: Random sampling through chit method
- SAMPLE SIZE : 20

INCLUSION CRITERIA

- Individuals age between 18 to 25years.
- Person who has normal BMI.
- Includes both males and females.
- Individuals who Co-operative individual
- Individuals who are willing to participate

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EXCLUSION CRITERIA

- Individuals with any neurological conditions or neuromuscular deficient.
- Individuals having hormonal imbalance disorders.
- Individuals with any lower limb injury or surgery within last 1 year.

Individuals who don't wish to participate in the study

<u>Materials</u>

- Mat
- Hand held dynamometer

Participants were taken from Parul University, total 20 participants were selected according to inclusion criteria. They were provided with a form which includes demographic details and consent of the participants. All of them were screened for GM muscle strength via hand held dynamometer. Participants were divided into two groups of 10 participants in each group. Groups were divided as following-

GROUP 1- participants in group 1 were allotted with one leg squatting exercise for 3 times a week for 4 weeks.

GROUP 2 – participants in group 2 were asked to perform 60 mts walk.

After 4 weeks all the participants were re-analyzed for GM muscle strength using hand held dynamometer

RESULT AND DISCUSSION

Data was analyzed using SPSS software version 20.0 and Microsoft excel 2019. Prior to the statistical analysis, the data was screened for normal distribution using Shapiro Will Test. After that Paired T-Test was used for two sample between group 1 and group 2. Each group has 10 records by not considering population standard deviation. We have calculated the percentage increase in Gluteus Medius strength between pre and post treatment for right and left lower limb. Using Percentage increase in right for two groups as the data in hand, running T-Test gavethe following results:

For Group -1

T statistics = 5.0179P value = 0.000

For Group – 2

T statistics = 4.2946P Value = 0.000

There was no significant difference in strength for group 2 while assessed on Lower limb hand held dynamometer pre and post treatment. But there was significant difference instrength of Group 1 while assessed on lower limb hand held dynamometer in strength of gluteus medius. Thus, suggesting that statistically and clinically adding one leg squat to the treatment inventions in gluteus medius strengthening shows significant improvement in the strength. Hence, one leg squat is more effective in improving the strength of Gluteus Medius muscle among normal healthy individuals.

CONCLUSION

The current study demonstrates that addition of one leg squat to a standard rehabilitation, an optimal rehabilitation program for strengthening the gluteal muscles for pelvis stabilization and determines an increase in muscle strength improves the functional performances. Further studies will be necessary to evaluate the possible

changes in biomechanics during walking through the use of gait analysis in order to understand if the increase in strength of abductor muscles.

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Ethical approval
Ethical approval was obtain from The Institutional review board from Parul Institute of Physiotherapy, Waghodia, Vadodara.

Conflict of interest
Non

Consent for publication
All individuals participating in this research singed a informed consent form prior to theirinclusion in the study

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Fig. 1. T-Test

REVIEW ARTICLE
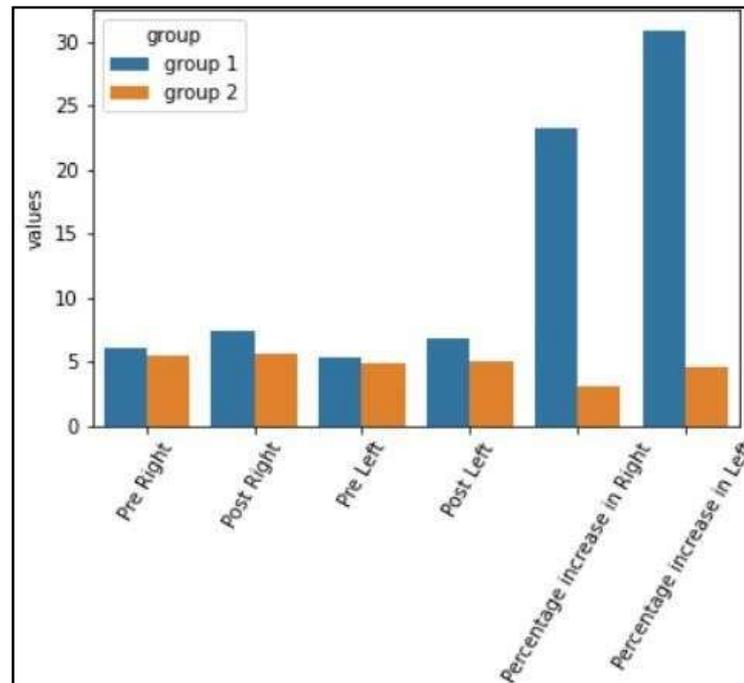
Current Trends in Bone Grafts and its Substitutes in Periodontics: A Literature Review

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ABSTRACT

A variety of bone grafts and substitutes are available for clinical use; the problem of effective regeneration treatment remains extremely challenging. A variety of products are available in the market to be used for bone replacement procedures. After tooth loss, bone resorption is irreversible, leaving the scope for successful periodontal regenerative treatment. B one repair and regeneration enhances new technologies to overcome shortcomings of bone replacement grafts and fill clinical gaps in a wide spectrum of applications. Bone regenerationtreatments are performed using autografts, allografts, xenografts, and artificial scaffolds. A bone graft is a living tissue capable of promoting bone healing, either alone or in combination with other materials. A bone substitute is a natural or synthetic material, often containing only a mineralized bone matrix with no viable cells act as a scaffold, to achieve the same purpose. Careful review of all research for each graft is essential when considering its use. This review will help us to know the different bone graft materials, their properties, and selection of a graft for different procedures.

Keywords: Bone replacement grafts, autografts, allografts, xenografts, synthetic grafts.

INTRODUCTION

The ideal outcome of periodontal therapy is the regeneration of lost periodontal tissue including alveolar bone, cementum, periodontal ligament, and arrest of periodontal disease progression [1]. Bone grafting materials also contains a variable capacity to promote formation of bone, cementum and periodontal ligament. Historically, autogenous as well as allogenic bone grafts have been used with some success. Allogenic bone is obtained from a different person and it provides an alternative to autogenous bone. Several other bone grafts have been developed for use in periodontal therapy to promote bone formation and defect fill. Synthetically derived (alloplastic or synthetic) or procured from other species (xenogeneic), are biocompatible organic materials and their purpose is to substitute for autogenous bone as sometimes sufficient autogenous bone is unavailable, or harvesting would require additional surgical sites, increasing patient morbidity and clinician chairside time. The present review describes the various types of bone graft material used in the periodontal regeneration.

Classification of Bone Graft Materials
Based on the source of graft [2]
A. **Autografts** (derived from the same individuals)
B. **Allografts** (derived from different individuals of the same species)
C. **Xenografts** (derived from different species)
D. **Alloplasts** (synthetically derived grafts)

Based on source and composition [3]

A. **Human Bone: Autogenous grafts**
   Allogenous grafts: Fresh frozen bone,Freeze dried bone allografts (FDBA), Demineralized freeze-dried bone allograft. (DFDBA)
B. **Bone substitutes: Alloplastic grafts:** Polymers, Hydroxyapatite, Bioceramics, Bioactive glass,   Tricalcium Phosphate
C. **Non-Human Bone: Animal (**Calf bone, Kiel bone, Ospurum, Equine) **Natural (**Natural coral)

Based on bone graft substitutes [4]
A. **Allograft-based bone graft substitute involve** allograft bone, used alone or in combination with other materials (e.g., Grafton, Ortho Blast).
B. **Factor-based bone graft substitutes** are natural and recombinant growth factors used alone or in combination with other materials such as transforming growth factor-beta, platelet-derived growth factor, Fibroblast Growth Factors, and Bone Morphogenetic Protein.
C. **Cell-based bone graft substitutes** use cells to generate new tissue alone or are added a support matrix, for example, mesenchymal stem cells.
D. **Ceramic-based bone graft substitutes** include calcium phosphate, calcium sulphate, and bioglass used alone or in combination (e.g., Osteo Graf, Pro Osteon, Osteo Set).
E. **Polymer-based bone graft substitutes** uses degradable and nondegradable polymers alone or in combination with other materials.
F. **Healos** is a natural polymer-based product, a polymer-ceramic composite consisting of collagen fibers coated with hydroxyapatite and indicated for spinal fusion.
G. **Cortoss** is an injectable resin-based product with applications for load-bearing sites.

Autogenous Bone Graft
It functions as osteoinductive or osteoconductive agent, which are harvested from the patient's own body. It is consideredas gold standard to which other grafting materials are compared because it contains viable cells participating in osteogenesis, tissue reaction is induced without inducing immunological reactions, presence of

minimal inflammatory reaction, rapid revascularization around the graft particles and potential release of growth and differentiation factors sequestered within the grafts. Disadvantages of autogenous bone grafts arehigh morbidity, second operation site, difficulty in obtaining enough graft material, potential resorption, and high cost.

Types of autogenous bone graft
Intra oral Autografts: Cortical bone chips, Intra oral cancellous bone marrow graft, Osseous coagulum, Blend of cortical and cancellous bone, Bone Swaging.

Cortical bone chips: The impetus for the modern-day use of periodontal bone grafts can be traced to the work of **Nabers and O' leary (1965) [5].** They reported that shavings of the cortical bone removed by hand chisels during osteoplasty/ ostectomy from sites within the surgical area could be used successfully to increase bone height. Due to large particle size (1,559.6 x 183 μm) and potential for sequestration, Cortical chips were replaced by autogenous osseous coagulum and bone blend techniques. There is evidence of new bone, cementum, and periodontal ligament following this type of graft. The sources of cortical bone chips include mandibular lingual ridges, exostoses, edentulous ridge, bone distal to a terminal tooth, bone removed by osteoplasty or ostectomy, bone trephined from within the jaw without damaging the roots.

Intra oral cancellous bone marrow graft: The cancellous bone has higher regenerative potential and it is used to replace the cortical plate back to assist in better healing. This graft is procured by using trephine burs which are available in different sizes. Sources of intraoral cancellous bone marrow includehealing bone wounds, healing extraction sockets, edentulous ridges, maxillary retromolar area, maxillary tuberosity, mandibular ramus, mandibular symphysis.

Osseous Coagulum: Robinson (1969) [6] described a technique using a mixture of bone dust and blood that he termed as osseous coagulum. The bone dust is obtained by using rotary instruments such as carbide bur no. 6 and 8, at speeds between 25,000-30,000 rpm with coolant, then mixing the particles of bone with patients' blood in a sterile dappen dish. Whenever possible, patients own blood and saliva are used to lubricate the surfaces being cut. The size of the graft particle; thin bone chips of 100 μm, as found in the osseous coagulum technique provided for a sooner and greater osteogenic activity than the thick particles of ten times bigger size. "overpacking" may result in delay or failure in holding up the formation of the necessary granulation tissue.

Bone Blend: It is the combination of cortical and cancellous bone that is procured usingtrephine bur or rongeurs. The technique was introduced by Diem, Bowers and Moffitt (1972) [7] Forum et al (1975) [8] have demonstrated regeneration of bone and cementum and both parallel and functional orientation of periodontal ligament fibers in a 6 to 13 human block specimens following osseous coagulum-bone blend grafting procedures. The bone fragment particle size in range of 100-200 μm to a workable, plastic-like osseous mass, similar in consistency to amalgam that can be packed or molded into bone defects.

Bone Swaging: The bone swaging procedure was first described by Ewen and renamed Contiguous Autogenous Transplant by Ross et al. The process of repair of contiguous autogenous transplant may includeankylosis, new attachment and transplant resorption utilized for the formation of new bone. In this procedure, swaging the bone adjoining the defects of periodontal disease, constructive use is made of the deformed bone wall adjacent to the periodontally involved teeth. This technique requires the existence of an edentulous area adjacent to the defect in which the bone is pushed into contact with the root surface without fracturing the bone at its base.

Extra oral Autografts
Iliac cancellous bone and marrow: Extraoral cancellous bone and marrow from the iliac crest offering the greatest osteogenic potential to regenerate a functional attachment apparatus has been depicted by several investigators in humans. The disadvantage is an additional surgical insult to the patient.

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Allogenous bone grafts

The allografts include grafts obtained from other individuals of same species but disparate genotypes. An allogenic source or substitute for autogenous bone arose from the need for a supply of donor material to fill the material or deep bone defects within the same patient, shortage of material in the case where multiple surgical sites are involved, morbidity accompanying a second surgical site to procure donor bone. Boiled cow bone powder, Anorganic bone, boplant and other preparations have been tried with less than satisfactory results. Surface decalcified bone and Kiel bone graftshave shown promising results in human pilot studies [9,10]. Some advantages of using allogenous bone grafts such asradially available, elimination of the need for a patient donor site, reduced anaesthesia and surgical time, and decrease blood loss. Some disadvantages such as the use of tissue from another individual, cadaveric bone may also undergo rejection, quality and subsequent health of the recipient depending on the medical history of the donor, the risk of disease transfer specially HIV with a fresh frozen bone allograft (approximately 1: 1,60,000) of the tissue bank use exclusionary techniques. Most bone banks adhere to the guidelines of the American Association of Tissue Banks with respect to procurement, processing, and sterilization of bone grafts [11].

Types of allogenous bone grafts

Freeze dried bone allograft (FDBA): It was introduced by Navy Tissue Bank in the 1940s. Mineralized FDBA was introduced to periodontal therapy by Mellonig et al.in 1976 [12]. FDBA is the only graft material that has undergone extensive field testing in the treatment of adult periodontitis. Freeze drying removes more than 95% of the water content from the bone by a process of sublimation in a vacuum. Although freeze-drying destroys all cells, the morphology, solubility, and chemical integrity of the original specimen are maintained relatively intact. Freeze drying also markedly reduces the antigenicity and vacuum sealing in a glass container protects against contamination and degradation [13]. FDBA, works primarily through osteoconduction, a process in which the graft does not activate bone growth but instead acts like a scaffold for the patient's own natural bone to grow from and within. Overtime, the graft is resorbed and replaced by new bone.

Decalcified freeze-dried bone allograft (DFDBA): Libin et al (1975) [14] were the first to report the use of cortical and cancellous decalcified FDBA (DFDBA) in humans.Demineralization of a cortical bone graft enhances osteogenic potential. Demineralization with hydrochloric acid exposes the bone inductive proteins called bone morphogenetic protein, which stimulates the formation of new bone by osteoinduction. The demineralized graft induces host cells to differentiate into osteoblasts, whereas an unmineralized allograft is felt to function by osteoconduction as it affords a scaffold for new bone formation [15]. Particles in the range of 125 to 1,000μm possess a higher osteogenic potential than do particles below 125 μm. DFDBA is now being provided in sheets of various thickness from 20 to 100 microns to 100 to 300 microns and as blocks of ileum.

Types of DFDBA: Allogenic Autolysed, Antigen Extracted (AAA) bone, demineralized bone powder, demineralized bone, and demineralized bone gelatin can be thought of an synonymous with differences in preparation of these materials.

Autolysed, Antigen Extracted, Allogenic (AAA) bone [15]: It is a type of DFDBA, processed according to the methods of Urist et al. with minor modifications. In comparison to DFDBA, the procedure of AAA bone preparation includes the extraction of cell-surface glycoproteins, which represent the major antigens responsible for bone allograft reactivity. In addition, the collagen matrix of AAA bone is shrunken during preparation, allowing better diffusion of bone BMP.

Demineralized bone matrix (DBX) [16]: DBX paste and putty are particulate demineralized bone matrices in a 2% or 4% hyaluronate carrier, respectively. The belief is that 2% or 4% sodium hyaluronate is biocompatible and can effectively carry and stabilize the allogenic bone matrix in the recipient site. It is processed from cadaver long bones by aseptically processing the bone to remove lipid, blood, and cellular components before it is frozen. Cortical bone is milled into elongated fibres of 0.5 mm in diameter or pulverized into particles of 100 to 500 micrometers. Glycerol

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carrier added to stabilize the proteins and improve the graft handling. It can be used in flex, putty or as matrix plugs. Using damp sterile gauze material is condensed into defect sites, however, heavy pressure causes extrusion of the material out of the defect site. Materialtend to lose its paste or putty consistency in sites with poor hemorrhage control.

Frozen iliac cancellous bone & marrow: It is procured from "living" cadavers and cryogenically stored has shown similar potential as iliac autografts to correct osseous defects,furcation defects, and crestal defects in appropriately crossmatched recipients. The early work done by Hiatt (1970) and by Schallhorn & Hiatt (1972) [17]., attempted to avoid graft rejection either by treating the recipient with an immunosuppressive drug or by histocompatibility cross-matching of donor and recipient. Excluding tissue typing and having banked material available, the technique is identical to that described for stored iliac autografts. However, the formulation of a bank of frozen iliac material free of pathogens and with various profiles of human lymphocyte antigens (HLA) and blood group types may pose logistical problems. Due to decalcification, only organic content remains causing exposure of factors like TGF-β enhancing their action on bone formation. Mineral matrix purported to remain more intact because the water content is removed rather thanfreeze-drying. Libin et al [18] (1975) was the first to conduct a study to evaluate the effect of to report the use of cortical and cancellous decalcified FDBA (DFDBA) in humans. Three sites with intra-bony periodontal defect were chosen for placement of the graft. The three grafted sites responded with 4 to 10 mm of new bone formation.

Xenograft: Xenografts are procured from different species. They are osteoconductive in their nature of bone deposition. Both sources, through different processing techniques, provide products which are biocompatible and structurally like human bone. Commercially available bovine bone is processed to yield natural mineral bone which is without organiccomponents. Advantages such as osteoconductive nature, readily available, risk free of disease transmission, biocompatible products.[7]Disadvantages are possibilities of developing bovine spongiform encephalopathy or mad cow disease [7].

Types of Xenograft
Anorganic Bovine –derived bone xenograft (BDX): Calf Bone (Detergent Action), Kiel Bone (Denatured with 20% H_2O_2 dried with Acetone, Ospurum (Defatted, Potassium Hydroxide, Acetone, Saltsolution), Equine Bone

Anorganic Porcine – derived bone xenograft

Natural coral (Coralline calcium carbonate - Biocoral®)

Anorganic Bovine –derived bone xenograft (BDX): It is the hydroxylapatite "skeleton" that retains the macroporous and microporous structure of cortical and cancellous bone remaining after chemical or low-heat extraction of the organic component. The BDX is a xenograft consisting of deproteinized, sterilized bovine bone with 75–80% porosity and 10mm crystal size in the form of cortical granules [19]. BDX possesses excellent osteoconductive properties and it acts as a scaffold for new bone formation. The large-mesh interconnecting pore system facilitates angiogenesis and migration of osteoblasts. Differences in the purification and manipulation methods of bovine bone exist, leading to commercially available products with different biologic behaviour. It is available in different particle sizes or as block grafts.

Commercially available Xenografts
Bio-Oss®(Osteohealth Co., Shirley, NY): It is a natural, nonantigenic, porous bone mineral matrix produced by the removal of all organic components from bovine bone.It is available in cancellous and cortical granules and blocks. Bio-Oss undergoes a low-heat (3,000°C) chemical extraction process by which all organic components are removed, but maintains the natural architecture of bone. This material is essentially carbonate-containing apatite with few hydroxyl groups, and possesses a crystalline architecture and calcium: phosphate ratio like natural bone minerals in

humans. Chemically, Bio-Oss is a low crystalline apatite (size approximately 100 × 200 × 500 Å) with a 7% content of carbonate [20]. Synonyms are Deproteinized bovine bone mineral, Porous Bone Mineral, Natural Bone Mineral.

Bio-Oss Collagen® (Osteohealth Co., Shirley,NY): It consists of Bio-Oss Spongiosa granules (0.25–1 mm) with the addition of 10% highly purified porcine collagen. As with Bio-Oss, the mineral structure of Bio-Oss Collagen is highly porous, possesses a large internal surface area, and functions as a scaffold (osteoinductive) for bony ingrowth. The collagen component enables convenient handling and simple application but does not function as a barrier. The collagen component allows Bio-Oss Collagen to be easily adapted into the defect. The cohesion of the particles is ensured, even without a membrane. The collagen component is resorbed within 4–6 weeks [21].

Osteo Graf/N® (Cera Med Dental, LLC, Lakewood, CO): It is a pure, natural form of hydroxylapatite, the major mineral component of tooth enamel and bone. It is completely biocompatible and remodels to vital bone at the same rate as host bone. OsteoGraf/N is the only xenograft that meets all ASTM standards for "Composition of Anorganic Bone for Surgical Implants". The product is hydrophilic – cohesive consistency when hydrated. It is manufactured as radiopaque, rounded particles and is available in two particle sizes: OsteoGraf/N-300 (250–420 mm) packaged in 1-g and 3-g vials and OsteoGraf/N-700 (420–1,000 mm) packaged in 1-g and 3-g vials.

Pep Gen P-15®(Dentsply Friadent, Mannheim, Germany): a calcined bovine bone (1,100°C; hydroxyapatite) coated with a pentadecapeptide (P-15). It is available as granulate with a particle size of 0.25–0.42 mm and used in dental applications. The P-15 peptide is a synthetic clone of a 15 amino acid sequence of the α chain of Type I human collagen (residues 766-780). The P-15 sequence of amino acids is a biologically active segment of collagen that facilitates cell migration and binding. The P-15 peptide is adsorbed to ABM to enhance bone growth in the defect site. Pep-Gen P-15 combines 200 nanograms of P- 15 with 1 gram of ABM and is available in particulate and gel form [22].

Anorganic Porcine – Derived Bone Xenograft: A natural replicate of autologous bone and and presents a high osteoconductive activity. Commercially available as OsteoBiol®, Gen-Os (Tecnoss Dental, Turin, Italy). Gen-Os must always be hydrated and thoroughly mixed with a few drops of sterile physiological solution to activate its collagen matrix and to enhance its adhesivity; it can also be mixed either with OsteoBiol Gel or with the patient's blood. If necessary, it can as well be mixed with the drug selected for surgery. The particle sizes are 250–1,000 mm and its porosityis 33% [23].

Coralline Calcium Carbonate - Biocoral®: Natural coral graft substitutes are derived from the exoskeleton of marine madreporic corals and the structure is similar to that of cancellous bone. Polyps absorb the calcium ions and carbonic acid present in the seawater to produce aragonite crystals of calcium carbonate, representing 97–99% of the coral exoskeleton. The remaining balance is made up of various elements, such as oligoelements comprising 0.5–1%, magnesium varying from 0.05% to 0.2%, sodium in quantities of 0.4–0.5%, amino acids representing 0.07% and the remainder consisting of traces of potassium (0.02–0.03%), strontium, fluorine and phosphorous in the phosphate form. The oligoelements found in corals are known to play a critical role in the bone mineralization process and in the activation of enzymatic reactions in osteoid cells.
It is commercially available as Biocoral (Inoteb, Saint Gonnery, France).

Alloplast: It is a biocompatible, inorganic synthetic bone grafting material,marketed for periodontal regeneration avaliable into two broad classes: ceramics and polymers. The fate of an alloplastic bone grafting material is dependent primarily on its chemical composition, structure, and physical properties [24].

Types of Alloplast
Polymer-based bone graft substitutes: Polymers can be divided into natural polymers and synthetic polymers and further divided into degradable and non-degradable types [25]. Polymer-based bone graft substituteinclude a non-resorbable, calcium hydroxide coated copolymer of poly-methyl-methacrylate (PMMA) and poly-hydroxylethyl-

methacrylate (PHEMA) which is referred as HTR (hard tissue replacement) (e.g. HTR™ Bioplant Inc. New York, NY, US) and a resorbable polylactic acid (PLA) polymer.

Bioplant™ HTR polymer is composed of microporous (300-350 μm) beads in three concentric layers: Inner of PMMA, Middle of PHEMA, Outer of the calcium hydroxide-carbonate layer. It act as a scaffold for new bone formation. The inner hard PMMA layer gives the particle an adequate mechanical resistance, while PHEMA is soft and hydrophilic, and its negative charge favors adhesion to the surrounding tissues and enhances clotting. The calcium hydroxide layer is bioactive and forms calcium carbonate after its introduction into the osseous bleeding surgical site. Sulfate is added to make the implant radiopaque. It is a clinically beneficial, biocompatible, osteophilic, and osteoconductive alloplastic bone substitute. Provides an environment that is favourable to bone regeneration.It is available in two particle sizes, HTR 40 (small, 500 microns) for infrabony pocket filling and HTR 24 (large, 750 microns) for ridge preservation and augmentation.

Demineralized dentin matrix: The organic component of dentin, which accounts for approximately 20% of dentin weight, is mainly type I collagen, a component of bone. Dentin also contains bone morphogenetic proteins, which promote the differentiation of mesenchymal stem cells into chondrocytes, and thus enhance bone formation, noncollagen proteins such as osteocalcin and osteonectin, which have been implicated in calcification and dentin-specific proteins including dentin phosphoprotein, also known as phosphophoryn, and dentin sialoprotein [26].

Hydroxylapetite (HA): It is the primary mineral component of bone. Synthetic hydroxyapatite has been marketed in a variety of forms. This has a calcium to phosphate ratio of 1.67,like that found in bone. Investigators have concluded thatin the stress bearing areas rounded particles are clinically more suitable for implantation in the oral cavity.

Types of hydroxylapetite

The polycrystalline ceramic form of pure densely sintered hydroxylapetite: Non-resorbable,osteoconductive has a low microporosity and acts primarily as inert biocompatible fillers. It is prepared in relatively large particle size (18–40 mesh). Commercially available as Calcitite, Calcite (Carlbad, CA), OsteoGraf/D300, OsteoGraf/D700, CeraMed Corp (Lakewood, CO).

The Coralline Porous Non-resorbable Hydroxylapatite: Is a replica of a marine coral skeleton, Porites. After the organic components of the coral have been removed, the aragonite of the coral skeleton is converted to HA by treatment with ammonium phosphate at elevated temperature and pressure. This HA is formed as small crystals in contrast to the large fused crystals found in the sintered or ceramic-like forms of artificial HA [26]. It can facilitate osteogenesis within the porous structure of the implant when placed in human periodontal defects.Commercially available as Interpore 200 (Interpore International, Irvine, CA), Pro-Osteon 500R (Interpore Cross International, Irvine, CA, USA).

Resorbable Nonceramic Hydroxylapatite: Highly microporous, non-sintered, composed of small particles measuring 300–400 mm (35–60 mesh), with a controlled, predictable rate of resorption. As the material resorbs, it acts as a mineral reservoir and predictably induces new bone formation via osteoconductive mechanisms. The material appears to be very biocompatible in both hard and soft tissues. It is commercially available Osteogen (Impladent, NY, USA), OsteoGraf/LD-300 (particle size 250 and 420 mm), CeraMed (Corp., Lakewood, CO), Cerabone® (Coripharm GmbH & Co. KG, Dieburg, Germany).

Nanocrystalline Hydroxyapatite (NHA): It provides the benefits of traditional hydroxyapatites, complete resorption, and improved osseointegrative properties. Advantages aregood biocompatibility, promoted proliferation, osteogenic differentiation, and bone regeneration.
Commercially available products of NHA:

Ostim™ (Heraeus Kulzer, Hanau, Germany): It is available as ready-to-use paste in a syringe form containing 65% water and 35% nanostructured apatite particles. The average crystallite size is 100 nm/20 nm/3 nm, the atomic ratio of calcium phosphorus is 1.67. It is characterized by a large bioactive specific surface area of 106 m2/g. The Ostim syringe in the double-sterile pack can be directly applied to the bone defect.Close contact with surrounding tissues, quick resorption characteristics, and large number of molecules on the surface are certain advantages [27].

Fluorohydroxyapatitic (FHA) Biomaterial. It is developed as a biomaterial as its natural architecture offers similarity to natural bone. FHA includes materials produced by calcifying marine algae or those produced by sintering together HA and TCP.

Commercially available products are
Frios® Algipore® (Friadent GmbH, Mannheim, Germany): It is manufactured from calcifying marine algae. The particles contain a pore system with a mean diameter of 10 µm, that is, periodically septate (mean interval 30 mm) and interconnectively microperforated (mean diameter of perforation 1 mm). Every pore is limited by one layer of small FHA crystallites with a size of 25–35 nm.

Biostite® : It is a mixture of synthetic HA (88.0%, granulometry of 160–200 mm, total porosity of 60%), equine type I collagen (9.5%) and chondroitin sulphate (2.5%). Chemically, Biostites particles demonstrated a major phase represented by polycrystalline synthetic HA (³99%), little presence of b-tricalcium phosphate and CaO (£1%) and a Ca–P ratio ranging from 1.665 to 1.697 (Scabbia and Trombelli 2004). Biphasic alloplastic materials include Calcitec® Inc. (Austin, TX), Osteogen® (Impladent Ltd, Holliswood, NY), Tricos® (Baxter, Bern, Switzerland), MBCP (Biomatlante, Vigneux de Bretagne, France), Ceraform® (Teknimed SA, Vic-en Bigorre, France), Bone Ceramic® (Straumann, Basel, Switzerland).

Calcium Phosphate: Calcium phosphate cements are gaining special interest due to its biomimetic nature and potential use as controlled release systems. These cements are prepared by mixing a liquid phase with a solid phase to create a workable paste that sets into a solid material. Due to the ability of prolonged setting time and inability to set in,the presence of blood led to advances in this group. Resorption of calcium phosphate occurs by dissolution or is cell mediated. They follow the osteoconductive theory of bone formation. They have an important percentage of porosity within the nano-/ submicron size range. While porosity can be a limitation for the use of these materials in high-load-bearing applications. Porosity is sought to enhance a material's resorbability and the extent of bioactivity by increasing the surface area available for reaction. Inherent porosity makes it good carriers for controlled\ drug delivery systems. They have been used as carriers for biologically active peptides, such as antibiotics and growth factors.

Types of CPC
According to Ca2+ and P compounds
1. Materials which contain high levels of Ca^{2+} ions have alkaline pH and therefore show low resorption ability as Hydroxyapatite (AP)
2. Materials with low levels of Ca2+ ions have acid pH and show high resorption properties as dicalcium phosphate forms.

According to their preparation
1. High temperature (ceramics of TCP, hydroxyapatite, and biphasic calcium phosphate)
2. Low temperature (calcium phosphate).
Ceramics are presented in porous; granular and block forms and they are difficult to reshape. The granules have a size range between 0.2 mm and 1mm. The lack of adaptability of calcium phosphate ceramics was solved when calcium phosphate cement developed [28]. This cement is a mixture of calcium phosphate powders that upon reacting with aqueous phase produce new calcium phosphate. The chemical reaction that produces this new phase is termed setting reaction and the consistency of the cement is progressed from paste-like to solid structure by the

entanglement of the setting product. This enables the cement to be moulded, adapt intimately to the bone defect borders, and permits the development of an injectablepreparations for minimally invasive surgery. Cements are biocompatible, degradable, and osteoconductive.

According to the setting reaction end-product: Hydroxyapatite, Brushite cements.

β–Tri-Calcium Phosphate: Tricalcium phosphate is a porous calcium phosphate compound available in two forms as follows:

Alpha tri calcium phosphate [29]: Crystal structure is monoclinic and consists of columns of cations. It is less stable than beta and forms the stiffer material calcium-deficient hydroxyapatite when mixed with water. It is formed by heating the beta tricalcium phosphate above 1,180°C and quenching in air to retain its structure.

Beta tri calcium phosphate [30]: It is a porous form of calcium phosphate, with similar proportions of calcium and phosphate to cancellous bone. However, the compressive strength reaches only 1/20 of the cortical bone. It is a resorbable material with 99% phase purity, total microporosity, and a homogeneous ceramic sintered structure occurring within 24 hrs. This faster rate of resorption harmonizes with the bone formation and remodeling process and results in displacement of the material to bone. Ca/P ratio is 1.5 and is more resorbable than hydroxyapatite. This higher degradability is related to higher solubility that aids phagocytosis to induce biomaterial replacement with new bone. It is biocompatible and osteoconductive.

Commercially available TPC products [31]
- **Bioresorb®**: porous granulate (particle size: 0.5–2 mm)for dental applications.
- **Chronos®** and **Ceros®** (Mathys, Bettlach, Switzerland): granular materials with a particle size of 0.5–1.4 mm and pore size of 100–500 mm.
- **Cerasorb®(Curasan, Kleinostheim, Germany)**: porous granulate (pore size >5 mm) in particle sizes of 0.05–2 mm (grain sizes: 50–150 mm, 150–500 mm, 500–1,000 mm, 1,000–2,000 mm) for dental application and as machined macroporous blocks for orthopedic applications.
- **Vitoss®**: porous granulate (pore size 10–1,000 mm; porosity approx. 90%; particle size 3–5 mm) for dental application
- **SynthograftTM (Bicon, Boston, MA, USA)**: available in two particle sizes: 50–500 mm and 500–1,000 mm.

Commercially available alloplastic combinations with β-TCP
- **OsteonTM (Genoss Co., Ltd., Suwon, Korea) [33].** composed of 70% HA and 30% b-TCP. HA coated with b-TCP establishes an interconnected scaffold with a porosity of 300–500 nm\
- **Ceraform®**: It is manufactured by Teknimed SA (Vic-en Bigorre, France). This material is a synthetic biphasic ceramic made of 65% HA and 35% TCP. The material is available as a block or granular form and sterilized by gamma radiation. The mean granular diameter is between 900 and 1,200 mm.
- **BoneCeramic®** is a composite of medical purity biphasic calcium phosphate: a mixture of 60% hydroxyapatite, which is 100% crystalline, and 40% of the b form of TCP in particulate form. The graft material is 90% porous with interconnected pores 100–500 mm in diameter. Nery et al. (1992) [34] suggested that higher HA ratios showed accelerated new bone formation and new attachment levels and demonstrated the superiority of using a composite of these two materials over the use of either material alone. This grafting material was used in periodontal, peri-implant and various types of bone defects.
- **Fortoss® Vital (Biocomposites, Staffordshire, UK)** is such a mixture of b-TCP and calcium sulphate. Osteoconductive behavior might be superior to conventional calcium phosphate. use a proprietary process (Zeta Potential Control, Biocomposites) to establish a negative zeta potential due to which the surface of the material will be charged negatively in an aqueous environment. Zeta potential is an effective predictor of biomaterial attraction to osteoblasts and bone, providing a useful *in vitro* method for predicting such interactions [35].

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Calcium phosphate can be bound to collagen carriers or mixed with fibrin. The concept is that collagen and fibrin form a network from which minerals can crystallize. Collagen can also bind to extracellular matrix proteins of importance in the mineralization process.

Commercially available products showing combination with collagen
- **Healos® (Orquest, Mountain View, CA)** is a mixture of hydroxyapatite and bovine collagen
- **Collagraft® (Zimmer Corp., Warsaw, IN)** is composed of 65% hydroxyapatite and 35% TCP combined with bovine collagen [36].
- **Tricos®** is a mixture of hydroxyapatite, TCP, and fibrin.

Calcium Sulphate
Calcium sulfate, generally known as plaster of Paris, or gypsum, is perhaps the oldest ceramic bone substitute material. Calcium sulfate hemihydrate ($CaSO_4 \times 1/2H_2O$) powder is hydrated to form calcium sulphate dihydrate ($CaSO_4 \times 2H_2O$), undergoing a slight exothermic reaction to set to a solid form [39]. It functions as a resorbable osteoconductive scaffold that provides the structural framework necessary for angiogenesis and osteogenesis while preventing soft tissue invasion by acting as a space filler Calcium sulfate resorbs quickly, over a period of 12 weeks, by a process of dissolution and is substituted by new bone [37]. The rapid resorption rate can pose a potential problem because the volume of the graft may not be maintained for a sufficiently long period of time to yield reliable grafting results in the esthetic zone. Significant loss of its mechanical properties occurs upon its degradation; therefore, it is a questionable choice for load-bearing applications. Calcium Sulphate has been shown superior results when used as a binder and barrier to DFDBA, as evidenced by reductions in probing depth, gains in clinical attachment level, and defect fill and resolution when used in bony defects [38].

Commercially available products
- **Capset®, Lifecore Biomedical, Chaska, MN**
- **CalFormaTM Calcium Sulfate Bone Graft Barrier** - modification of Lifecore Biomedical's Capset® Calcium Sulfate Bone Graft Barrier. The modification is the addition of a small amount of an excipient, HPMC (hydroxypropyl methylcellulose or hypromellose), to the accelerated calcium sulfate to improve the handling characteristics of the device when used as a barrier over bony defects in dental applications [31].
- **CalMatrix (Lifecore Biomedical CalMatrix Calcium Sulfate Bone Graft Binder)** – resorbable surgical grade plaster of Paris with approximately 10% of a pharmaceutical grade sodium carboxymethylcellulose.
- **Allomatrix® (Wright Medical Technology, Inc)** - calcium sulfate (CS)/ CMC blend, except that Allomatrix is provided with human demineralized bone matrix (DBM) already mixed in.
- **CalMatrix** is to be mixed with DBM or other bone graft material by the clinician prior to application.
- **Osteoset® Wright Medical Technology, Arlington, TN, USA** - medical grade calcium sulfate impregnated with tobramycin.

Bioactive Glass: Bioactive glass particles were first developed by Dr. L. Hench (1971) [39]. It shows the concept of "bioactivity" due to their capacity to form a carbonated hydroxyapatite layer on their surfaces once exposed to simulated body fluids or implanted in vivo. The original composition of bioactive glass approved by the FDA, designated 45 S5, was composed of 46.1 mol% SiO_2, 26.9 mol% CaO, 24.4 mol% Na_2O, and 2.5 mol% P_2O_5. The original composition and fine structure have been extensively modified in an attempt to further enhance the bioactive glass as a bone replacement graft. Bioglass shows osteoconduction and osteogenesis. It also has an osteostimulatory effect showing bone growth within eroded particles. Bioactive glass particles of a narrow size range (300-355 pm) have been shown to undergo a series of chemical transformations that result in focal points of osteogenesis in the center of the surgical site [40]. The narrow size range bioactive glass granules also have exhibited more extensive bone growth compared to larger (425-800 pm), smaller (212- 300 pm), or wide size range (100- 710 pm) granules. Advantages are easy to manipulate, hemostatic, can be conveniently packed into extraction sockets or periodontal defects, and ability to bond to connective tissue and bone without intervening fibrous connective tissue. Different forms of bioactive glasses are as follows-

Perioglass ® (Block Drug Co., NJ, USA) is a synthetic absorbable osteoconductive bone graft substitute composed of a calcium phosphosilicate bioactive glass. The device is in a particulate form with a size range 90–710 mm. It is supplied sterile, packaged either in a Tyvek-sealed PET-G cup or in a filled syringe within a second sterile barrier package. It is mixed with sterile water, saline, the patient's own blood or marrow, or with autogenous or allograft bone to form a wet sandy paste that is applied to the defect.

PerioGlass® Plus (Block Drug Co., NJ, USA) is a synthetic resorbable osteoconductive bone graft substitute composed of a calcium phosphosilicate material and a calcium sulfate binder. The inorganic calcium and phosphorous components are thermally incorporated in a sodium silicate network (PerioGlass®) designed specifically for its absorbability and osteoconductive nature. The calcium sulfate component binds the PerioGlass® particles together at the time of implantation and is absorbed from the graft site over the first several weeks following implantation. On absorption of calcium sulfate, the PerioGlass® particles remain in the graft site and are progressively absorbed and replaced by the host bone during the healing process [41].

Biogran™: Itis a resorbable bone graft material made of bioactive glass granules of 300 to 355 µm size range, which has been reported to be advantageous for guiding osteogenesis.Formation of hollow calcium phosphate growth chambers occurs with this particle size because phagocytosing cells can penetrate the outer silica gel layer by means of small cracks in the calcium phosphorous layer and partially resorb the gel. This resorption leads to the formation of protective pouches where osteoprogenitor cells can adhere, differentiate, and proliferate. This material is hydrophilic and slightly haemostatic; it stays in place in the defect when bleeding occurs. When wetted with sterile saline, it can be shaped to fill the defect. Bone transformation and growth occur within each granule. This osteogenesis, guided by bioactive glass particles occurs at multiple sites, rapidly filling the osseous defect with new bone that continuously remodels in a normal physiologic manner.

Unigraft®: The bioactive glass (CaO, Na_2O, P_2O_5, and SiO_2) used in Unigraft® is manufactured as irregular-shaped synthetic granules, sized from about 200 mm to about 420 mm. It is supplied sterile in foil-sealed polyolefin vials. The product is to be mixed with sterile saline or with the patient's blood to form a sandy paste that is to be applied to the defect intended for use in repair of oral/maxillofacial and dental intraosseous defects.

Oily Calcium Hydroxide Suspension : It is marketed as **(OCHS; Osteoinductal®, Osteoinductal GmbH, Munich, Germany)** contains, apart from $CaOH_2$, liquid and solid carbohydrate chains andvarious fatty acids (e.g., oleic, palmitoleinic, gadoleinic,margarine, pentadecane, myristic, linolenic,stearic, arachidic, lauric) esterified with glycerol, while the oily part consists of a natural product of porcine origin, oleum pedum and vaselinum album [42]. Topical subgingival application of an oily calcium hydroxide suspension after nonsurgical periodontal therapy improves early periodontal wound healing, gingival bleeding, and gingival inflammation.

Porous Titanium Granules: It is a non-resorbable, osteoconductive bone substitute. It is used in clinic situations requiring augmentation of the sinus floor or in conjunction with dental implants.Irregularly shaped and porous granules were manufactured using commercially pure titanium. The granules are between 0.7 mm and 1.0 mm. When they are mixed with the patient's blood or with a saline solution, the granules attach to each other due to the capillary force. The titanium surface is very thrombogenic, which facilitates the formation of stabilizing blood clots around the granules. The granules that have a porosity of about 80% and an osteoconductive surface structure, imitate the properties of human bone and create a scaffolding for bone generation that stimulates osteoblast colonization and osseointegration. The granules are non-resorbable and keep their volume during the operation and the entire healing period which ensures mechanical stability and a desired aesthetic result.

Commercially available product includes Tigran™ PTG : When osseointegration is completed, common drilling techniques are used when an implant has to be placed in the treated area, The titanium granules do not set (i.e., no risk of heat injury to the bone) and can be handled without time pressure during surgery with superior

microstructural properties, cell viability and proliferation rate compared to both Straumann BoneCeramic and Geistlich Bio-Oss [43].

Teeth as Bone Graft Material

Autogenous bone grafts are considered the gold standard for bone replacement and is known to have certain disadvantages. Hence, human tooth is considered as one of the intraoral donor sites due to its chemical similarity to bone. Autogenous bone tooth graft material (Auto BT) was developed and has been in clinical use since 2008 in Korea. The mechanisms involved in the osteogenesis of Autogenous demineralized dentin matrix include endochondral and intramembranous bone formation. The particle size ranges from 75 μm to 500 μm. AutoBT consists of low-crystalline hydroxyapatite and other calcium phosphate minerals such as tricalcium phosphate, octacalcium phosphate, amorphous calcium phosphate which are components like those of human bone [44].

Composite Grafts: A composite graft combines an osteoconductive matrix with bioactive agents that provide osteoinductive and osteogenic properties, potentially replicating autograft functionality. The osteoconductive matrix becomes a delivery system for bioactive agents, requiring less chemotaxis and less migration of osteoblast progenitor cells to the graft site. The direct infusion of progenitor cells should lead to more rapid and consistent bone recovery. When an osteoconductive scaffold is seeded with bone morphogenetic proteins, for example, the composite graft may become both osteogenic and osteoinductive, providing a competitive alternative to autografts. Alloplasts can be mixed with autogenous grafts or allografts in the management of large structural defects.

Commercially available composite grafts are Healos® (Orquest, Mountain View, CA), Collagraft® (Zimmer Corp, Warsaw, IN), Tricos® (Baxter BioSciences BioSurgery), Ceramics (Biomatlante manufacturer, Vigneux de Bretagne, France).

CONCLUSION

Periodontal bone grafts have the potential to regenerate the periodontium. Due to the variable physical and chemical properties of bone replacement grafts, the goal of reproduction of the lost periodontal structure has been met with varying degree of success or failure [3]. There is substantial clinical and histological evidence that supports the concept that extraoral and intraoral autogenous bone grafts and DFDBA are effective regenerative materials. Moreover, long-term evaluations can help to achieve clinically stableregenerative gains. Synthetic grafts may result in improved probing depth and clinical attachment levels but have yet to demonstrate the ability to initiate or enhance the formation of a new attachment apparatus.

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RESEARCH ARTICLE

Animal Detection in the Vicinity of Crop Field using different Machine Learning Approaches

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ABSTRACT

Animal attacks on farmland are considered the greatest concern, as they lower crop yield. This is primarily due to the growth of cultivated land. Crop raiding is a prevalent cause of human-animal conflicts in the modern era. Due to natural disasters, animal assaults, etc., India's farmers suffer enormous losses. The farmers' use of antiquated techniques is inefficient. It is nearly impossible to assign guards to the farm's perimeter. Crop raiding is becoming one of the most vexing human-animal conflicts as a result of the extension of agricultural land into once wild areas. There are two enemies of farmer in India.First one is the natural disasters in the form of heavy rain or drought and second by pests or animal assault in the crop field. Both of these factors govern the quality and quantity of harvests. Due to the importance of both human and animal safety, it is necessary to protect crops from animal assault and divert animals without harming them. To resolve the issue a smarter and intelligent way of keeping animals away from the crops is required. Thus, this paper aims to study methods of machine learning used in detection of animals' attack from crop field.

Keywords: deep learning, CNN, Animal intrusion system, machine learning.

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INTRODUCTION

Wild animal damage to agricultural crops is a pressing social issue today. The problem of wild animals encroaching on farmland has persisted for a long time. Deer, wild boar, moles, elephants, monkeys, and other animals are just a few of the pests that can ruin a farmer's harvest. Without the farmer to prevent them, these animals may destroy crops by eating them or simply running amok in the field. This, in turn, could lead to a major drop in yield and the need for supplementary financial safeguards to deal with the fallout of the harm [1]. While every farmer deserves to enjoy the fruits of his labour, he also has a responsibility to safeguard the well-being of the creatures who share the planet with him. There is a pressing need to address this issue and come up with and implement a workable solution. That's why we're doing this study: to review the available techniques and find an effective solution [2]. Wild boar, deer, wild buffalo, elephants, tigers, monkeys, and others pose a threat to agricultural output. These creatures may be attracted to the crops and then wander throughout the field without a rancher, causing harm to the crops and resulting losses in production [3]. As a result, this could lead to a significant drop in yield and the need for additional financial protection to deal with the fallout. However, it's common knowledge that plants grown to attract fewer pests and other creatures have lower yields overall. Thus, efforts have been made to cultivate programmed frameworks appropriate for identifying wild animals in the harvest without needless interruption of the cultivating activity [4].

The destruction of the forest for human survival has harmed wildlife and their habitats because of human-animal conflict and population growth [5]. Since the rate of industrialization in forested areas increased so rapidly, animals have begun to invade neighbouring settlements. Due to lack of water and food, they go crazy and pretend to attack farms, herds of livestock, and even people. When farmers need to keep animals out of their fields, they often resort to an electric fence because the effects of electrocution on animals (cramping) can be somewhat unpredictable. Human and animal lives have equal value. An intelligent monitoring system is needed to automatically check for animal ingress, identify it in photographs, and provide a warning signal to humans. This document compiles information from a wide range of wired and wireless apps that serve to warn people of potential animal intrusion. Studies of animal imagery have proven useful in a wide variety of contexts. The Internet of Things (IoT) is a new and promising technology that is gaining popularity around the globe [6]. While its capabilities have many potential uses, only a small fraction of those are currently relevant to our culture.

Wireless applications, such as those for emergency responses, intelligent control, and military purposes, would undoubtedly enhance the quality of our daily activity in various domains and environments. There are a number of methods available for detecting animal infiltration, such as the Internet of Things (IoT), a sensor unit, a communicating device to perform preliminary steps, the diversion of animal, and the sending of alarm to farmers [7]. There are a number of strategies and techniques that can be used to increase the level of protection against animal incursion. In this study, we give a systematic literature review on machine learning techniques for detecting animals. Numerous practical uses for sensor-based technologies can be found in the world today. Cost, robustness, reliability, ease of access for farmers, ease of remote monitoring, and reduced energy use are all possible benefits of adopting this device. For animal entrance detection, try one of the below methods.

Deep learning
Artificial neural networks, algorithms whose structure and function are modelled on the human brain, provide the basis of deep learning, a subfield of machine learning. Deep learning is more potent than ever before thanks to the vast amount of data available and the increasing processing power of computers [8]. Image categorization and object detection are two popular uses of computer vision. The goal of image classification is to assign a category to each pixel in the input image, a method typically employed for pictures of single objects. Object detection is commonly employed when there are a large number of objects in the scene since it can both identify and pinpoint their location [9].

Convolutional neural networks

It's no secret that CNN, a popular tool in the field of computer vision, has improved in precision over the years [10]. A CNN has three layers: the input layer, the output layer, and the hidden layers in between. Mathematically speaking, convolution is a crucial operation for CNNs [11]. A convolution of images can be used to convey how well one set of data corresponds to another. If the second source is a small matrix—a kernel—it can be slid over the entire image to create a filtered version of the original. Only the parts of the image that are in agreement with the filter will be used to create the final image [12].

Definitions

Functions of the network's behaviour must be set in order to configure a neural network. The terms "optimizers," "loss functions," and "activation functions" all belong to this category. During model training, the weights and biases are optimised by minimising the penalty associated with a given prediction and the real annotation. Loss functions assess this penalty. Combining classification loss and localization loss is a popular strategy when it comes to object detection [13].

Activation functions

The output of a neuron is typically modelled as a function of its input using an activation function.

Classification loss functions

The distance of a model's predicted class from the true class is quantified by the classification loss. Loss computation typically use either the Sigmoid or SoftMax classification function. With its ability to estimate probabilities with ease, the Sigmoid function is frequently employed in two-class classification problems. Its output is constrained to lie between 0 and 1, the values of which are easily interpreted by humans [14].

Localization loss

If the network can localise an object in a picture, then it can pinpoint its precise location. The localization loss is the estimated discrepancy between the true and predicted regions of interest.

Regularization loss

The regularisation loss method is used to reduce the influence of outsized weights. In order to improve the model's generalisation abilities, it slightly adjusts the learning algorithm. As a result, the effectiveness of the model on new data is enhanced.

Optimizer

In order to reduce the loss, an optimizer revises the model based on the results of the loss function.

Transfer learning

To prevent over fitting, CNNs need a lot of training data. To rephrase, if the prediction model is too similar to a specific dataset, it won't be able to accurately predict future observations[15]. Generalization is the ability to perform effectively on inputs that have not been observed before, and transfer learning is a helpful learning strategy for achieving this. The term "transfer learning" refers to the process of gaining proficiency in a new activity by applying knowledge gained through mastery of a previously learned but related one. Early layers of deep neural networks commonly display the feature of learning to detect simple patterns, such as edges, when trained on image data sets [16]. It is possible to transfer information by initialising the weights from a pre-trained model with these patterns because they are not dataset- or task-specific. In addition, fine-tuning layers, which recognise patterns more particular to the dataset, are typically added as the last layers to a network after the initial layers have been frozen.

Deep learning for camera traps

Motion actuated cameras, also known as "camera traps," are stealthy and relatively cheap monitoring options. As camera traps can generate millions of photos, it can be a time-consuming procedure to sift through them all and get

the information you need. Luckily, computer vision, and CNNs in particular, may be used to automatically extract relevant information[17].

Edge machine learning

In most cases, machine learning is executed on the server, although this is beginning to shift to edge devices. Such examples as voice-activated device control and self-driving cars would benefit greatly from the incorporation of sensors. The lower processing power, restricted memory, and eventual battery limits are typical difficulties with deployment on such devices [18].

Efficient detection models

The network's architecture is determined by its intended function. The complexity of a network is proportional to the number of computations it must perform, and some models are created with efficiency in mind rather than precision [19]. Two components make up a detection model: the "base network" and the "classifier head." Quantization is another technique used to boost a model's efficiency. It can lessen wait times by streamlining inference computations, albeit this simplification may come at the cost of precision. One way that quantization can be put to use is by rounding down the numbers used to represent a model's parameters. As a result, the resulting model is more compact and calculation time is reduced.

SSD - Single Shot multiple detector

When it comes to efficient detection of objects of varying sizes, the SSD is one of the first attempts to use the CNN's pyramid feature hierarchy. To that end, it employs the vgg-16 model for feature extraction, and then builds upon it with a series of convolution layers of ever smaller sizes [20].

MobileNet V2

As a lightweight architecture, MobileNet V2 minimises the number of computations by employing shortcut connections between layers and depth-wise convolutions. The model is composed of a cluster of three convolution layers [21].

Inception V2

Another lightweight architecture that can serve as the foundation of a detection model is Inception [22]. The goal of Inception V1, which was released in May of this year, was to boost deep CNN performance without increasing network size or computational cost [23]. Their design decision to make filters of many sizes function on the same network level allows them to focus on extracting acceptable features notwithstanding the object's size [24].

Literature reviews

The author proposed a model that uses a Convolutional Neural Network (CNN) to train on a dataset containing images of monkeys, boars, and elephants. The captured model will be used in conjunction with the driver code to evaluate how well the trained images perform in comparison to the newly captured test images. The horrible noise is played through the speakers in case the one trained animal is spotted during the live capture [25]. The authors suggested creating an algorithm to identify the wildlife in the reserve. This software can categorise animals from photographs, allowing for more precise animal monitoring. Vehicle-animal collision avoidance, animal tracking, and theft deterrence are just a few of the many potential benefits of improving animal detection and classification. All of these targets can be assisted by efficient deep learning techniques [26]. The authors suggested a convolutional neural network based on AlexNet to sort pictures of wild animals. A multiclass Support Vector Machine (SVM) classifier is then fed the collected features to make a classification. The accuracy and classification rates of this approach are very good [27]. The study's authors presented a system that uses a height-based side-view technique to differentiate between photos of humans and animals. Similarly, a human-crawl would likely be categorised as an animal prediction on LITE (Light Intrusion Detection system named LITE) with a CNN-based classification algorithm. According to the data collected, there is little difference between the success rates of classifying human-crawl versus animal and classifying person-with-item [28].

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The researchers advocated for the use of computer vision methods and automatic animal detection on roads to reduce the number of animal-vehicle collisions. About 2200 positive and negative photos and video clips of animals crossing highways at different speeds were used to train the system. Our proposed solution can alert the driver when the vehicle's speed reaches 35 km/h, which is in compliance with the two-second rule. Above that speed, the driver has no chance of avoiding a collision even if the animal is correctly identified. Our proposed method has an approximate 82.5 percent detection accuracy. Additionally, we suggest a method for determining the actual distance that the animal is from the vehicle equipped with the camera [29]. The study authors proposed a UWB-powered wireless sensor network. Examining Ultrawide Band (UWB) signals, the gathered signal is recreated in the performance space to showcase its feature to organise interference identification. Referring the features into various classifiers on a regular basis for intrusion detection leads to roughly 16 percent higher correctness compared to standard feature extraction [30].

Using an in-house developed sensor tower platform in the shape of a Passive Infrared (PIR) sensor, the team was able to identify animal infiltration (STP). The typical signals are modelled. These signals used the feature's selection criteria to implement a reliable chirplet count, energy signature, and cross-correlation parameter. This data was gathered while running an animated simulation. Using the generated data as a guide, an evaluated the optimal collection of features for classification. An SVM is used to assign a label to the feature vector that was created. Testing this classification strategy with real data obtained through the STP showed that the STP architecture and the sorting algorithms were quite effective. Overall, the rate of correct classification was above 94% on average. The impact of external influences on the input image can be mitigated by the application of a variety of pre-processing techniques. Animal faces in the newly created animal database have been discovered using the anticipated CNN and SVM classification methods. The performance of Convolution Neural Networks, a subset of Neural Networks, in identifying animal faces exceeds that of SVM classifiers [31]. The researchers recommended using convolutional neural networks (CNNs) to identify different species. Implemented There were many different approaches tested in MATLAB and C++/Python, but in the end, it was the accuracy of CNNs that proved to be the highest [32].

A system was developed by the researchers using image processing techniques to identify animal incursions. Animal photos are segmented using a watershed technique, and numerous objects are extracted and checked for danger. Extracting a text-rich region and identifying facial emotions at different frequencies are common applications of the Gabor filter. As a supervised learning algorithm, Linear SVM is utilised to train the dataset and label texts and hyperlinks. This algorithm only creates a boundary, or contour, when the selected region intersects with other markers. The overall success percentage of this method for detecting animal invasion is 54.32% [33]. The authors proposed a study on picture classification using Deep Learning, which makes use of the Tensor Flow framework and a Deep Neural Network (DNN). Five distinct types of flowers are given as examples in the input data for this article. A deep neural network (DNN) was selected as the optimal learning mechanism because to its great precision. Tensor Flow, a framework for deep learning, was also used with successful outcomes. It can model up to 90% accuracy in classifying five different types of flowers through simulation, training, and categorization. The results include a percentage representing the reliability of the image classification. The typical rating for roses is 90.58%, and the typical rating for all other flower types is between 90% and 100% [34]. A system with live video investigation cameras mounted in strategic locations was proposed by the researchers. This system is built in layers. You can determine whether or not elephants frequent a given area by following these three simple procedures. The image is extracted from video frames as the first layer. The next step is to use machine learning techniques to pinpoint the location of that elephant. Using a pre-trained Convolution Neural Network model, the third layer validated the presence of an elephant. The accuracy of the proposed approach is calculated to be 99.1 percent [35].

CNN are presented for image classification, and the researchers suggest using images from handwritten MNIST data sets. Approximately 98% of the time, it is correct. In training, we use low-resolution grayscale photos. This method employs the Digits of MNIST data set as a benchmark for grayscale image categorization. More computing power is needed to properly categorise the grayscale images included in the training data set. By training the images with a CNN network, this system achieves a 98 percent accuracy rate in the experimentation phase. The time required to

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process these images is very high when compared to regular JPEG shots. More accurate results of image classification can be achieved by stacking the model with more layers and training the network utilising more image data via clusters of GPUs [36].

Applications in detection of animals

In Figure 1, a use case diagram consists of all requirements for crop protection in a graphical way. an idea for supervising cum recommendation system for crop protection from monkey near the crop field, an alert to farmer about the animal attack, a sound wave is activate when detected the animal or the animal runaway from the crop field without harm the crop and itself.

Agent node or Admin, farmer and monkey are actors of the system. Admin and farmer have authorization id and password for enter into the system. Admin have the power of controlling the supervision Phase with all use case. Farmer only views the activation action and crop area information. Relationship between actors and use case or each other depicted as an arrow in figure. Include and extend is use for parent and child relationship. Agent node supervises any animal activity during Supervising Phase. After detection of such activity recommendation phase is activated and particular alarm or information can trigger. Other existing algorithm for animal detection is mention in following tables. Table 1 shows the existing work related with animal recognition including the different classifiers. Table 2 shows the different feature extraction with classifier accuracy for animal intrusion system. And Table 3 includes the existing Microcontroller based animal intrusion detection system. These sensor based system provides the early warning or alert for intrusion detection.

CONCLUSION

The ability to identify animals before they enter human habitat and provide audible and visual warnings is crucial for reducing the likelihood of accidents involving humans and other animals. This aids in protecting agricultural produce from animals. Wildlife in their natural habitats must be monitored effectively and reliably. Identifying animals by hand may be challenging due to the wide variety of species. Wildlife and humans are constantly at odds for scarce resources like land and food, leading to a rise in property damage, lost revenue from crop assaults and cattle predation, and sometimes even death. The killing of wildlife for defensive or retaliatory purposes might weaken public support for conservation efforts. Conflict between humans and other forms of nature occurs all around the world. Developing a secure strategy for coexisting with local fauna is essential. Machine learning was observed to the most efficient method for this job. Deep learning, a part of machine learning, uses CNN, AlexNet, etc, methods for programming devices for sensing and identifying animals which are threat to the crops. It was also observed that machine learning has been proved as the best method used for animal detection and has a huge scope for further development.

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Table 1: Existing animal recognition system

Classifier	Objectives	Year	Ref
CNN(Convolutional Neural Network), SVM Classifier	Animal recognition	2017	[37]
Alex Net, SVM Classifier	Animal recognition	2019	[33]
CNN(Convolutional Neural Network)	Animal classification and recognition	2018	[38]
SVM Classifier	Animal Intrusion Detection	2015	[39]
CNN (Convolutional Neural Network)	Animal recognition	2020	[40]

Table 2: Existing animal intrusion system

Objectives	Feature Extraction	Classifier/Technique	Accuracy	Year	Ref
Intrusion detection	Chirplet-based decomposition & Cross Correlation	SVM (Support Vector Machine)	Accuracy 82.93%	2015	[41]
Animal recognition	LBP (Local Binary Pattern) & SIFT (Scale- invariant Feature Transform)	(SVM) Support Vector Machine.	Accuracy 82.09%	2013	[42]
Recognize animal	W-CoHOG	LIBLINEAR	Accuracy 91.62%	2017	[43]
Animal intrusion detection	Gabor Filter	(SVM) Support Vector Machine	Accuracy 85.07%	2018	[44]
Intrusion detection	CNN	CNN	Accuracy of 91%	2017	[45]

Table 3: Existing Sensor based animal intrusion detection system

Objectives	Sensors/Alarm	Microcontroller	Year	Ref
IOT- based intrusion detection system	Passive infrared sensor	Arduino Uno & Arduino IDE	2018	[46]
Animal intrusion early warning system	early warning	Arduino Uno	2019	[47]
Low-cost alert system	alert	Raspberry Pi	2016	[48]
Intrusion recognition	Motion sensor	Arduino	2018	[49]
Intrusion detection in Agriculture field	PIR &Ultrasonic	AVR Advance Virtual RISC	2015	[50]

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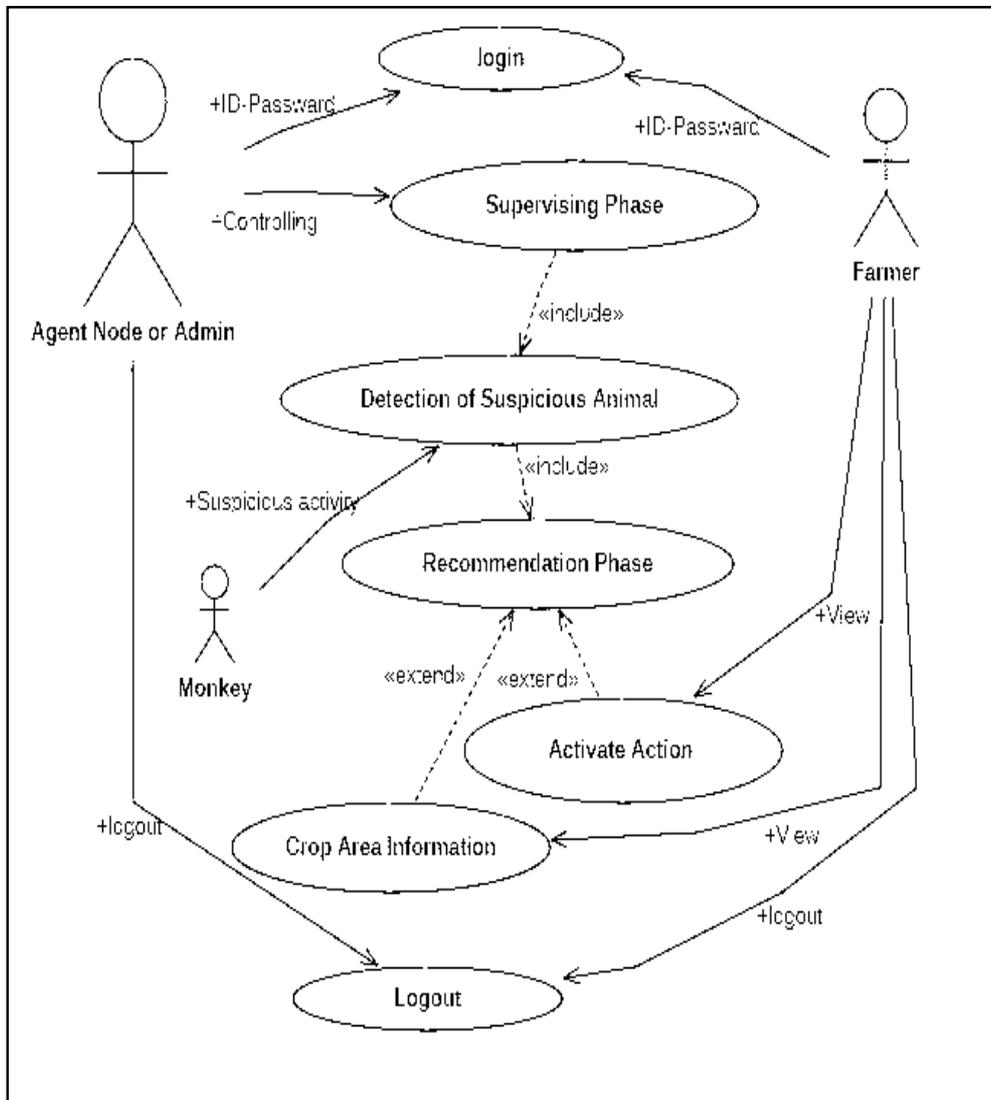
Figure 1: Use Case Diagram of crop protection idea

RESEARCH ARTICLE

Comparative Clinical Study of Interactions of Various Drug Eluting Stents Along with Prescribed Medication in Patients with Coronary Artery Disease

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ABSTRACT

Drugs that inhibit platelets will lessen cardiac episodes without raising the danger of bleeding. The majority of patients undergoing Percutaneous coronary intervention (PCI) are advised to take aspirin since it is a commonly used anti-platelet medication that is efficient, safe, and affordable. In combination with Drug eluting stents (DES), aspirin has a positive effect that increases patient survival. It has been demonstrated that clopidogrel lowers the frequency of cardiac incidents. After PCI, atorvastatin lowers thrombin production. In this study total of 118 patients who underwent percutaneous coronary intervention with different DES were enrolled. 56 were treated with sirolimus DES, 26 were treated with everolimus DES and 36 were treated with zotarolimus DES. Baseline clinical characteristics, angiographic and procedural characteristics, mostly used medications and Drug- DES interactions were compared. Out of 118 patients, Patients treated with Sirolimus drug eluting Stents shows 0.85 %, Patients treated with Everolimus drug eluting stents shows 2.54 %, and Patients treated with zotarolimus drug eluting stents shows 1.69 % Drug- DES interactions. Aspirin, Atorvastatin and Clopidogrel were the mostly prescribed drugs to maximise benefits and reduce the complications in patients who underwent Percutaneous

Coronary Intervention with various DES. According to this study Sirolimus drug eluting stent was found to be more efficient and safe when compared to Everolimus drug eluting stent and Zotarolimus drug eluting stent.

Keywords: Coronary artery disease, Drug eluting stents, interactions, drug therapy.

INTRODUCTION

Coronary artery disease (CAD) has been remaining the first killer and the major cause of public health problems in the world [1]. Coronary artery disease also called as coronary heart disease (CHD), coronary atherosclerosis or Ischemic heart disease (IHD), which is a branch of coronary vascular disease (CVD) and a common form of heart disease. And, it is considered insidious and dangerous disease in the world [2]. Coronary artery disease is the narrowing or blockage of the coronary arteries, usually caused by atherosclerosis [3]. An estimated 17.5 million people died from CVDs in 2012, representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke. CAD as of 2010 was the leading cause of death globally resulting in over 7 million deaths. This is up from 5.2 million deaths in 1990 [4]. It may affect individuals at any age but becomes dramatically more common at progressively older ages, with approximately a tripling with each decade of life. Males are affected more often than females [5]. Treatments for coronary heart disease include heart-healthy lifestyle changes, medicines, medical procedures and surgery(Coronary interventions as angioplasty and coronary stent, Coronary artery bypass grafting (CABG)) and cardiac rehabilitation [6]. Drug eluting stents (DESs) have been widely used for the coronary artery disease since Food and Drug Administration approved use of first DES in April 2003 [7]. Drug-eluting stents (DESs) have been dominant for the treatment of CAD in the interventional cardiology world owing to their efficacy in significantly reducing restenosis, A drug-eluting stent (DES) is a peripheral or coronary stent (a scaffold) placed into narrowed, diseased peripheral or coronary arteries that slowly release a drug to block cell proliferation [8]. but may be associated with the hazard of late stent thrombosis. Antineoplastic, anti-inflammatory and immune modulators are the major agents used in drug eluting stents. Local delivery of drugs using DES provides both biological and mechanical solution and has emerged as a very promising approach effective in management of ISR. For local drug delivery to be successful, challenges to be addressed include [9] decision on the most appropriate agent to be use, [11] determination of the proportion of the systemic dose needed locally and [10] identification of a biocompatible vehicle that can deliver drug for the required therapeutic window [12,13]. Four classes of drugs (anti-inflammatory, antithrombogenic, antiproliferative and immunosuppressive) are candidate drugs to be used in DES. These drugs inhibit one or more biochemical pathways leading to restenosis.

METHODS

The present retrospective- prospective observational study included coronary artery disease patients treated with various DES in two clinical centers (Vivekanandha Medical Care Hospital Elayampalayam and Sri Gokulam Hospital, Salem) from the beginning of February 2016 to June 2016. Ethical approval was gained through the main center's human ethical committee (IEC). In this study we used 3 groups, Patients with Sirolimus eluting stent (42M + 14F), Patients with Everolimus drug eluting stent (14M + 12F) And Patients with Zotarolimus drug eluting stent (25M + 11F). The selection criteria included a history of unstable angina (UA), chronic stable angina (CSA), myocardial infarction (MI) or the presence of high-risk factors for coronary artery disease (CAD) etc. Patients with pregmancy and lactation etc were excluded. The patient who met inclusion criteria was included in the study. A number of variables that play a vital role in stent therapy were analyzed. These included baseline patient characteristics, angiographic and procedural characteristics, stent characteristics, mostly prescribed medications and drug- DES interactions. The patients case reports and drug chart were reviewed in patient who underwent percutaneous coronary intervention. And also the details are collected via phone calls.

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Inclusion criteria
• Age: From 30 to 80 years.
• Gender: Male & Female.
• Patients underwent Angioplasty
• Patients underwent Angioplasty with or without hypertension.
• Patients underwent Angioplasty with or without diabetes.
• Patients prescribed with or without oral hypoglycemic agents.
• Patients prescribed with or without Anti-hypertensive drugs.

Exclusion criteria
• Age <30, >80.
• Pregnancy.
• Lactation.
• Critically ill patients.
• Patients with life style modification alone.

Statistical Analysis
Statistical analysis was done by using graph pad instant software version 7.01. Results were expressed as mean±SEM for numerical variables and as percentage for categorical variables. Column statistics followed by student t test was used to compare statistical difference of various groups. $P < 0.05$ was considered as significant.

RESULTS

A total of 118 patients were included in the study. Fifty-six were treated with Sirolimus DES; twenty-six were treated with Everolimus DES and thirty-six were treated with Zotarolimus DES. The clinical baseline characteristics, angiographic and procedural characteristics, mostly prescribed medications and Drug-DES interactions were compared with three groups. The clinical baseline characteristics are shown in table 1, the angiographic and procedural characteristics are shown in table 2, mostly prescribed medications are shown in table 3 and the DRUG – DES interactions are shown in table 4.

Gender Wise Distribution of the Study Population
In this study population, patients treated with sirolimus DES include 75% males and 25% females, in patients treated with everolimus DES include 53.84% males and 46.15% females, and in patients treated with zotarolimus DES includes 69.44% males and 30.55% females.

Age Wise Distribution of the Study Population
In this study, age is categorized to 6 variables and each group is compared with each variable. Among 118 populations, the incidence of coronary artery disease is mostly occurred in patient in the age of 51-60.

Cad Background of the Study Population
The CAD background of the study population of 118 patients was grouped into patients with the history of CAD and patients without the history of CAD. Among this population patients without the history of CAD were more (Sirolimus DES: 78.47%, Everolimus DES: 92.30%, Zotarolimus DES: 88.88%).

Social Habits Wise Distribution of Study Population
In this study, social habits of 118 population were analyzed and categorized to smoker, alcoholic, Both, none. In patient treated with sirolimus DES: smoker (25%), alcoholic (21.43%), both (14.29%), none (39.28%). In patient treated with everolimus DES: smoker (7.69%), alcoholic (7.69%), both (11.54%), none (73.08%). In patient treated with zotarolimus DES: smoker (13.88%), alcoholic (8.34%), both (2.78%), none (75%).

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Patients with Target Vessel Diseases
In this study, CAD was categorized into single vessel disease and multivessel disease. In Patient treated with sirolimus DES 28.57% had single vessel disease and 30.35% had multi vessel disease, in patient treated with everolimus DES 26.92% had single vessel disease and 23.07% had multi vessel disease, and in patient treated with zotarolimus DES 19.44% had single vessel disease and 33.33% had multivessel disease.

Patients with Myocardial Infarction
In this study, the myocardial infarction is categorized into IWMI, ASMI, AWMI, IPMI. In Patient treated with sirolimus DES 25% had IWMI, 30.35% had ASMI, 17.86% had AWMI and 1.79% had IPMI, in patient treated with everolimus DES 19.23% had IWMI, 15.38% had ASMI, and 19.23% had AWMI, and in patient treated with zotarolimus DES 30.55% had IWMI, 16.66% had ASMI, and 13.88% had AWMI.

Patients with Angina Pectoris
In this study population angina pectoris is categorized into stable angina and unstable angina. In Patient treated with sirolimus 44.64% had stable angina and 10.71% had unstable angina. In Patients treated with everolimus 76.92% had stable angina 23.08% had unstable angina. In Patients treated with zotarolimus 77.78% had stable angina and 19.44% had unstable angina.

Pattern of Co-Morbidities Prevalent Among Study Population
Out of 118 patients, 95 patients had one or more co morbid condition and 23 patient did not have any co morbidity. In the 95 patients with co morbidities, in patients treated with sirolimus 23.21% had diabetics, 32.14% had hypertension, 3.57% had hyper cholestrimia, 3.57% had congestive heart failure, 1.79 had arrhythmia and 1.79% had hyperthyroidism. In patients treated with everolimus 42.31% had diabetics, 38.46% had hypertension, 3.84% had hyper cholesterolemia, and 7.69% had arrhythmia. And in patients with zotarolimus 36.11% had diabetics, 33.33% had hypertension, 13.88% had hyper cholesterolemia, 2.77% had renal insufficiency, 2.77% had congestive heart failure and 5.55% had arrhythmia.

Angiographic Features
In this study population, distribution of the lesions was comparable with three groups: lesions were more often occurred in the left artery descending (LAD) coronary artery. And all the lesions were treated with sirolimus DES (44.64%), everolimus DES (46.15%), and zotarolimus DES (58.33%).

Study Population Based on the Route
In this study, the route by which the stents are introduced were analyzed and categorized into by right radial artery route and by right femoral artery route. Right femoral route was mostly preferred in all groups.

Patients Treated with Different Number of DES
In the study of 118 cases one DES and two DES are used. out of 118 cases, 57.5% single and 12.5% double sirolimus DES , 88.46% single and 11.54% double everolimus DES, and 94.44% single and 5.55% double zotarolimus DES were used.

Mostly Prescribed Drugs in the Study Population
In the study population of 118 patients , among the three groups the mosly prescribed drugs are aspirin, atorvastatin, clopdogrel, pantoprazole, nicrandil, alprazolam, ramipril, telmisartan, glyceryl tri nitrate and isosorbide dinitrate. Aspirin is more prevalent in patient with sirolimus DES (94.64%) and everolimus DES (80.76%). But in case of patient with zotarolimus DES atorvastatin(100%) is more prevalent.

Drug- DES Interactions
Out of 118 patients, Patients treated with Everolimus drug eluting stents showed 1.69 %, and Patients treated with zotarolimus drug eluting stents showed 0.84 % Drug- DES interactions.

DISCUSSION

Baseline Patient Characteristics

Groups were well matched. Males are more in all groups. The incidence of coronary artery diseases are mostly occurs in the age group of 51-60. Among the study population patients without the history of CAD were more. Smokers and alcoholics were more prevalent in Sirolimus DES. Higher proportion of the patients with Sirolimus DES and Zotarolimus DES had multivessel coronary disease. And higher proportion of the patients with zotarolimus DES had single vessel disease. In this study population myocardial infarction were categorized into IWMI, ASMI, AWWMI, and IPMI. ASMI had higher prevalence in patients with sirolimus DES. AWMI had higher prevalence in patient with everolimus DES. And IPMI had higher prevalence in patient with sirolimus DES. Higher proportion of the all the three groups had stable angina. Diabetics, Hypertension, Arrhythmia were more prevalent in Everolimus DES.

Angiographic and Procedural Characteristics

Few significant differences existed between treatment groups with respect to lesion characteristics. Lesions were located in the Left anterior descending, Left circumflex or Right coronary arteries. Lesions were comparable with three groups: lesions were more often occurred in the left artery descending (LAD) coronary artery. And all the lesions were treated with sirolimus DES, everolimus DES and zotarolimus DES. Right femoral route was mostly preferred in all groups to introduce the DES into the body. One stent was mostly used in all groups.

Mostly Prescribed Medications

Aspirin, Atorvastatin and Clopidogrel are the majorly used drugs in patients with DES. Aspirin is more prevalent in patients with Sirolimus DES and Everolimus DES. But in case of patients with Zotarolimus DES Atorvastatin is more prevalent.

Drug- DES Interactions

Drug- DES interactions were analyzed to monitor the effect of drugs in patient with drug eluting stents. Out of 118 patients, Patients treated with Sirolimus drug eluting Stents does not showed any interactions with prescribed medications, Patients treated with Everolimus drug eluting stents showed 1.69 %, and Patients treated with zotarolimus drug eluting stents showed 0.84 % Drug- DES interactions. In this study, Sirolimus drug eluting stent was better when compared to other stents.

CONCLUSION

Based on the study carried out, Aspirin, Atorvastatin and Clopidogrel were the mostly prescribed drugs to maximize benefits and reduce the complications in patients who underwent Percutaneous Coronary Intervention. Anti- platelet drugs will reduce the cardiac events without increasing the risk of bleeding. Aspirin is widely used anti-platelet agent, is effective, safe and inexpensive and is recommended for most of patients undergoing PCI. Aspirin produces beneficial action with DES, patient will survive more. Clopidogrel has been shown to reduce the rates of cardiac events. Atorvastatin reduces the thrombin generation after PCI. The totality of evidence available to date does not support a clinically significant impact of any pharmacokinetic and pharmacodynamics major interactions between Drug eluting stents and Prescribed medications (Anti-platelet drugs, Anti diabetic drugs, Antihypertensive drugs etc.). In this study Drug eluting stents with prescribed medications does not associated with any major interactions like Bleeding, Increased/ decreased blood concentration, Stent thrombosis, Restenosis, Cardiovascular related death and other clinical manifestation. Sirolimus drug eluting stent does not show any interactions with prescribed medication. In few patients with Everolimus drug eluting stent and Zotarolimus drug eluting stent shows chest pain and increased blood flow, it might be a suspected interaction of Calcium channel blockers or Aspirin. According to this study Sirolimus drug eluting stent was found to be more efficient and safe when compared to Everolimus drug

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eluting stent and Zotarolimus drug eluting stent. Further study is required at multicentre level in order to verify the observed results.

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Table 1: Baseline patient characteristics

Base line patient characteristics	Patients treated with sirolimus DES(n=56)	Patients treated with everolimus DES(n=26)	Patients treated with zotarolimus DES(n=36)	p value
Age	56.17±8.79	58±11.33	58.11 ± 8.15	-
Male	75 %	53.84 %	69.44 %	0.0091
Female	25 %	46.15 %	30.55 %	0.0411
Patient with the history of CAD	21.43 %	7.69 %	11.11 %	0.0832
Smoking	25 %	7.69 %	13.88 %	0.0920

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Alcoholic	21.43 %	7.69 %	8.34 %	0.1080
Single vessel disease	28.57 %	26.92 %	19.44 %	0.124
Multi vessel disease	30.35 %	23.07 %	33.33 %	0.0109
IWMI	25 %	19.23 %	30.55 %	00168
ASMI	30.35 %	15.38 %	16.66 %	0.0468
AWMI	17.86 %	19.23 %	13.88 %	0.088
IPMI	1.79 %	0	0	0.4226
Stable angina	44.64 %	76.92 %	77.78 %	0.029
Unstable angina	10.71 %	23.08 %	19.44 %	0.0402
Diabetics	23.21 %	42.31 %	36.11 %	0.0265
Hypertension	32.14 %	38.46 %	33.33 %	0.0031
Hypocholesteremia	3.57 %	3.84 %	13.88 %	0.1716
Renal failure	0	0	2.77 %	0.4226
Congestive heart failure	3.57 %	0	2.77 %	0.1899
Arrhythmia	1.79 %	7.69 %	5.55 %	0.1009
hyperthyroidism	1.79 %	0	0	0.4226

Table 2: Angiographic and procedural characteristics

Angiographic and procedural characteristics	Patients treated with sirolimus DES(n=56)	Patients treated with everolimus DES(n=26)	Patients treated with zotarolimus DES(n=36)	p value
ISR location as a unit				
Left anterior descending	44.64 %	46.15 %	58.33 %	0.0075
Left circumflex	33.92 %	7.69 %	33.33 %	0.1154
Right coronary artery	26.78 %	42.30 %	22.22 %	0.0708
Others	0	7.69 %	8.33 %	16.02
Stent as a unit				
Patient with One DES	87.5 %	88.46 %	94.44 %	0.006
Patient with Two DES	12.5 %	11.54 %	5.55 %	0.0453

Table 3: Mostly prescribed medication

drugs	Patients treated with sirolimus DES(n=56)	Patients treated with everolimus DES(n=26)	Patients treated with zotarolimus DES(n=36)	p value
Aspirin	94.64 %	80.76 %	83.33 %	0.0024
Atorvastatin	87.50 %	73.07 %	100 %	0.0079
Clopidogrel	91.05 %	69.23 %	80.55 %	0.0061

Table 4: DRUG – DES interactions

Groups	DRUG – DES Interactions
Patients treated with Sirolimus drug eluting stents (N = 56)	0 %
Patients treated with Everolimus drug eluting stents (N = 26)	1.69 %
Patients treated with Zotarolimus drug eluting stents (N = 36)	0.84 %

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RESEARCH ARTICLE
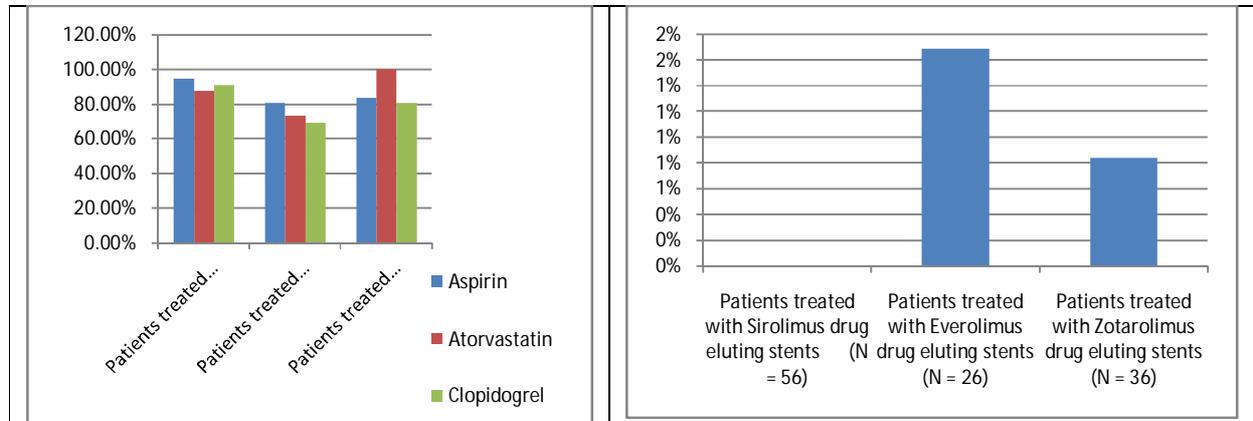
A Study on Zooplankton Diversity and Some Physicochemical Parameters of Gobli Lake, Mysuru

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ABSTRACT

Zooplanktons are microscopic, free floating animals which play a vital role in aquatic ecosystem. They are highly sensitive to environmental variation. Zooplanktons are one of the important faunas in water body which act as bio-indicators of pollution and play a direct role in food chain of fishes. It is rich source of nutrients and used as live feeds to fishes. The diversity study carried out on zooplanktons at Gobli lake located near foot of Chamundi hills, Mysuru, Karnataka. It is a perennial lake with water variations in water level during different seasons of the year. The present study was carried out to investigate physico-chemical conditions and zooplankton diversity during middle of summer (April) to onset of monsoon (July), 2022 by following standard methods. The physico-chemical parameters like Atmospheric and Water temperature, pH, Electrical conductivity, turbidity, Free CO_2, Dissolved oxygen showed observable variations throughout the study period. A total of 30 species of zooplanktons were recorded of which, Rotifers were dominated with 26 species followed by cladocerans with 4 species.

Keywords: Diversity, zooplanktons, Physico-chemical parameters, Gobli lake, Mysuru

INTRODUCTION

Shaping of the ecosystem is mainly influenced by the regional fluctuations in biotic and Abiotic factors (Shurin *et.al.*, 2000). The coexistence of groups of organisms and their reproductive fitness depends on microclimatic conditions on different time scales (interannual, seasonal or daily fluctuations (D'Odorico *et.al.*, 2008). Limnological studies paves

path to understand structural and functional variations influenced by abiotic factors (Adoni *et al.*, 1985). Abiotic and Biotic status of a water body are analyzed by Physico-chemical, biological and microbiological parameters which throws light on water quality (IAAB, 1998; Kulshrestha and Sharma, 2006; Mulani *et al.*, 2009). The energy flow in an aquatic ecosystem through food chain and food web reflects the diversity, coexistence and reproductive fitness of organisms inhabiting the ecosystem. Extreme events such as droughts, storms and heat waves have become more common in recent decades (Karl *et.al.* 1995; Easterling *et.al.* 2000). Such environmental variations present a major challenge for distribution and existence of diverse organisms (Walther *et.al.* 2002; Parmesan 2006).Zooplanktons are one of the major biotic factor which act as good indicators of health of freshwater ecosystem (Ahmad, 1996; Murugan *et.al.*, 1998; Dadhich and Sexena, 1999; Contreras *et.al.*, 2009). Even though a plenty of reports are available on zooplanktons and their ecological role in freshwater bodies, present study was aimed at throwing light on the diversity of zooplanktons and physico-chemical conditions of a perennial fresh water body at the foot of Chamundi hills in which the water level in the pond varies seasonally.

MATERIALS AND METHODOLOGY

Study Area
The present study was carried out at Gobli lake ($12^0 17^1 23.0^{11}$ N, $76^0 39^1 52.5^{11}$E**)** located near foot of Chamundi hills, Mysuru, Karnataka (Fig 1), which is a lentic water body. The lake is surrounded by large flora and visited by grazing of animals. In addition dense algal growth was noticed at times caused by surge in nutrients level whenever there was a rainfall. The anthropogenic activities such as washing clothes, vehicle cleaning and cleaning animals etc was observed in and around the study area.

Collection of Samples
The pond survey was carried out from April 2022 to July 2022 which comprised of two seasons (middle of summer through onset of monsoon). Water samples were collected periodically in each Saturday from the selected pond, during the early hours between 7.00 to 10.00 am. The plankton samples were collected by filtering 50 litters of water through standard plankton net (77 mesh bolting silk) and the concentration samples were fixed in 4% of formalin.

Physico-Chemical Parameters
Environmental variables such as Atmospheric and water temperature, pH, Electrical conductivity, Turbidity, Free CO_2 and Dissolved oxygen were analyzed by following the standard methods of Trivedy and Goel (1984), APHA (1995).

Biological Analysis
The zooplanktons observed in the sample were captured using microscope attached with camera using suitable objectives for further analysis zooplanktons. Zooplankton species identification was done with the help of standard references (Alfred *et al.*, 1973; Adoni *et al.*, 1985)(Fig. 2 and 3).

RESULTS AND DISCUSSION

Physico-Chemical Parameters
The temperature is an important factor in any aquatic environments affecting on biological processes, in this study, air temperature was varied from 22 to 36^0C and water temperature was found to be in the range between 27 to 32^0C. Water temperature ranging between 13.5 and 32^oC is reported to be suitable for the development of the planktonic organisms (Kamat, 2000; Gaikwad *et al.,* 2008) . The maximum pH values of 7.50 was observed during the month of July 2022 while the minimum (6.13) recorded during April 2022. The pH was affected by temperature, Salinity and alkalinity (Hemalatha *et. al.*, 2016). In the present study, pH of the water body was alkaline (Table.1) in most of the

months which may be due to low levels of water and high levels of carbon dioxide produced as a result of photosynthesis by floral community (Trivedy, 1989; Shiddamallayya and Pratima, 2008).

Electrical conductivity is found to be good indicator of the water quality (Abbassi *et al.*, 1996; Gaikwad *et al.*, 2008).The EC was found to be maximum (2.73mS) during the month of April 2022 while minimum (1.34mS) was observed during May 2022 (Hemalatha *et. al.*, 2016). In the present study. species diversity of Zooplanktons showed a positive correlation with EC. Rajgopal *et.al.*, (2010) reported similar observation of correlation of zooplankton production with EC. Turbidity is an indicator of various biological, physical and chemical processes, depending on the origin, concentration and type of suspended particles (Lind *et.al.*, 1997; Boenigk and Novarino, 2004). High turbidity is indicative of low water transparency and a limited euphotic (productive) zone, and it can significantly affect the feeding efficiency, development and abundance of filter-feeding zooplankton (Kirk & Gilbert, 1990; Kirk, 1992). In the present study maximum Turbidity (10.8NTU) was observed during the month of May 2022 while the minimum (2.8NTU) was observed during April 2022. Turbidity showed a negative correlation with zooplankton species diversity. The values of CO_2 in water varied from 46.2 to 90 mg/l. Maximum CO_2 was noticed during July 2022 and minimum during May 2022 which did not show any correlation with that of zooplankton species diversity in the study pond. The primary source of oxygen for a pond is from microscopic algae (phytoplankton) or submerged plants. In the present investigation, the values of dissolved oxygen in water varied from 0.3 to 3.64 mg/l during the study period. In the month of April 2022 Maximum dissolved oxygen was recorded which is correlated with high number of zooplankton species in the water body and minimum during July 2022.

Zooplankton Diversity

In the present study 38 species of zooplankton were identified. 26 species belonged to Rotifers and 4 species to Cladocera and 8 species were of copepods (Table 2). Among a total of 1700 species of rotifers, about 500 species have been described from Indian water bodies (Arora and Mehra, 2003; Kiran *et al.*, 2007). In the present investigation, among rotifers population *Brachionus* species were found to be the dominant with 5 spp, which are more frequently found in tropical environment (Nogueira, 2001; Mulani *et al*, 2009). According to Harikrishnan, 1995; Sharma and Sharma, 2001, about 46 species of Genus *Brachionus* is recorded in India and is one of the most ancient genus of monogonont rotifers. Our observations indicate that, there was a variation in the zooplankton diversity with the changing climatic conditions. In the month of April, 2022 the water temperature was approximately 30^0C with minimum turbidity value (2.8NTU) (Table.1) and species diversity was found to be more (26 Spp) when compared to that of other months of the study period (Table.3). This relatively high zooplankton species density may be due to eutrophication effect. The present investigation throws light on the fact that the Gobli Lake is polluted due to contamination by sewage as witnessed by the high diversity of rotifers (Table.2)(Fig.2).

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Table 1: Physico-chemical Parameters during study period

Sl.no	Physico-chemical parameters	April	May	June	July	Average
		2022				
01	Atmospheric temperature	32^{0}C	36^{0}C	23^{0}C	22°C	28.25
02	Water temperature	30^{0}C	32^{0}C	27^{0}C	28^{0}C	29.2
03	pH	6.13	7.14	7.25	7.50	7.0
04	Electrical conductivity	2.73mS	1.34mS	1.51mS	1.65mS	1.80
05	Turbidity	2.8NTU	10.8NTU	3.1NTU	3.0NTU	4.9
06	Free CO2	88mg/l	46.2mg/l	88mg/l	90mg/l	78.0
07	Dissolved oxygen	3.64mg/l	3.24mg/l	0.4mg/l	0.3mg/l	1.8

Table 2: Checklist of zooplanktons recorded at Gobli lake, Mysuru district, Karnataka

	Zooplankton groups	Order	Family	Scientific name	No.of species
1	Rotifera	Ploimida	Asplanchnidae	*Asplanchna priodonta (Gosse,1850)*	26 species
2				*Asplanchna sieboldi (Leydig,1854)*	
3			Brachionidae	*Brachionus angularis (Gosse,1851)*	
4				*Brachionus plicatalis (O F Muller,1786)*	
5				*Brachionus quadridentatus (Hermann,1783)*	
6				*Brachionus urceolaris (Muller, 1773)*	
7				*Brachionus pterodinodies (Pleallas,1766)*	
8				*Keratella sps (Bory de saint:Vincent, 1822)*	
9				*Anuraeopsis fissa (Gosse, 1951)*	
10			Lecanidae	*Lecane bulla (Gosse,1851)*	
11				*Lecane curvicornis (Murray,1913)*	
12				*Lecane furcata (Murray,1913)*	
13				*Lecane luna (Muller,1776)*	
14				*Monostylus sps (Edmondson,1935)*	
15			Lepadellidae	*Lepadella ovalis (Muller,1776)*	
16				*Lepadella patella (Hauer,1952)*	
17				*Colurella uncinata (Muller,1773)*	
18			Synchaeta	*Ploesoma sps (Bogaert,1989)*	
19				*Polyarthra vulgaris (Carlin,1943)*	
20			Euchlanidae	*Pseudoeuchlanis (Dhanapathi,1978)*	
21			Trichocercidae	*Trichocerca pusilla (Lauterborn,1898)*	
22		Bdelloida	Philodinidae	*Rotaria sps (Scopoli,1777)*	
23				*Philodina sps (Ehrenberg,1830)*	
24		Floscular iacae	Testudinellidae	*Testudinella patina (Hermann,1783)*	
25			Trochosphaeridae	*Filinia longiseta (Ehrenberg,1834)*	
26				*Monogononta sps (Cuvier,1798)*	
27	Cladocera	Cladoceae	Daphniidae	*Daphnia sps (Muller,1785)*	4 species
28				*Moina micrura (W Baird,1850)*	
29				*Moina macrocopa (Straus,1820)*	
30				*Moina recticorostris (Leydig,1860)*	
31	Copepoda	Calanoida	Diaptomidae	*Heliodiaptomus viduus*	8 species
32			Pseudodiaptomidae	*Pseudodiaptomus speciosus*	
33			Acartiidae	*Acartiella sinensis*	

34				*Mesocyclops leuckarti*	
35				*Cyclops strenuus*	
36		**Cyclopoida**	**Cyclopidae**	*Microcyclops varicans*	
37				*Mesocyclops hyalinus*	
38				*Thermocyclops hyalinus*	

Table 3: Month wise occurrence of zooplanktons at gobli lake, Mysuru, Karnataka

Sl. No	Zooplankton species	April	May	June	July
		Summer (2022)		**Monsoon (2022)**	
1	*Asplanchna priodonta*	+	-	-	+
2	*Brachionus plicatalis*	-	-	+	-
3	*Brachionus quadridentatus*	+	+	-	-
4	*Brachionus pterodinodies*	-	-	-	+
5	*Brachionus urceolaris urceolaris*	+	-	+	-
6	*Colurella uncinata*	+	-	-	+
7	*Filinia longiseta*	+	-	-	-
8	*Keratella sps*	-	+	-	+
9	*Lecane bulla bulla*	+	-	-	-
10	*Lecane curvicornis*	-	-	+	+
11	*Lecane furcata*	+	-	-	-
12	*Lecane luna*	+	-	+	-
13	*Lepadella ovalis*	+	+	-	-
14	*Polyarthra vulgaris*	-	+	+	-
15	*Rotaria sps*	+	-	-	-
16	*Testudinella patina patina*	-	-	+	+
17	*Trichocerca pusilla*	+	-	-	-
18	*Asplanchna Sieboldi*	+	-	+	-
19	*Monostylus sps*	+	+	-	-
20	*Pseudoeuchlanis*	-	+	+	-
21	*Lepadella patella*	+	-	-	-
22	*Brachionus angularis*	+	+	-	-
23	*Ploesoma sps*	+	-	-	-
24	*Philodina sps*	+	-	-	+
25	*Monogononta sps*	+	+	-	-
26	*Anuraeopsis fissa*	-	-	+	+
27	*Daphnia sps*	+	+	+	-
28	*Moina micrura*	-	-	+	-
29	*Moina macrocopa*	-	+	+	-
30	*Moina rectirostris*	-	-	+	+
31	*Heliodiaptomus viduus*	-	+	+	+
32	*Mesocyclops leuckarti*	+	+	+	+
33	*Cyclops strenus*	+	+	+	-

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34	*Microcyclops varicans*	-	+	+	+
35	*Mesocyclops hyalinus*	+	+	-	+
36	*Thermocyclops hyalinus*	-	-	+	+
37	*Pseudodiaptomus speciosus*	+	+	+	+
38	*Acartiella sinensis*	+	-	-	+
	Total	**23**	**16**	**19**	**16**

Note: + =Present, - = Absent
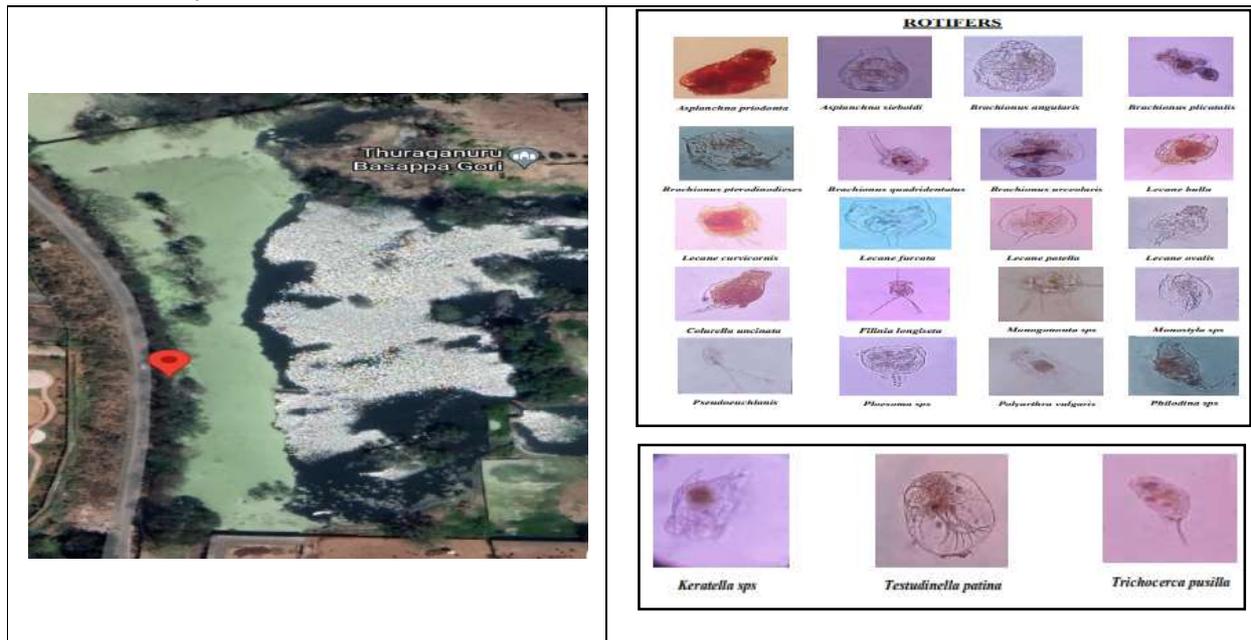
Fig. 1: Map showing the study area of Mysuru, Karnataka

Fig. 2. Rotifers
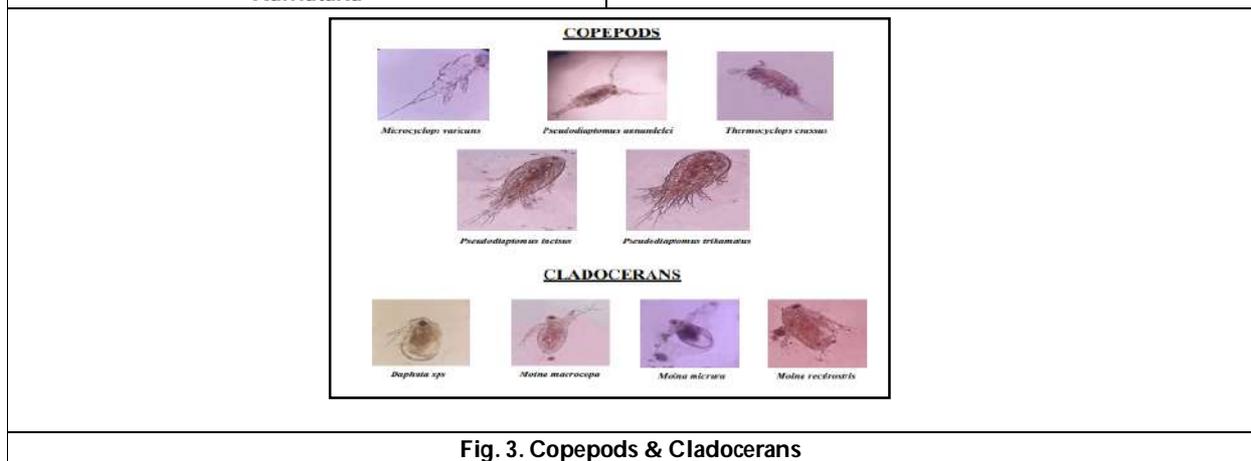
Fig. 3. Copepods & Cladocerans

RESEARCH ARTICLE

A Constraint Analysis on Production, Processing and Marketing of Sesame Cultivation in Tamil Nadu

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ABSTRACT

Sesame is one of the major cash crops and also a very popular crop among rural farmers for its seed and oil. The present research observes the constraints in the production, marketing and processing of sesame in the Kallakurichi District of Tamilnadu with the following specific objectives: i) To identify the constraints in the production, marketing and processing of sesame for the study area and ii) To suggest the policy recommendations based on the study's findings. In Tamil Nadu, the Kallakurichi district was selected purposively and from that, the two top-ranking blocks were selected based on the Sesame area. Five top-ranking villages were selected from the selected block and by using probability proportionate sampling, 120 sample farmers were selected for the study. For processing, 30 sesame processing units were randomly selected from the entire district for the study. The constraint analysis was carried out by using Response Priority Index (RPI). The study found that irregular rainfall was the major problem in sesame production followed by a lack of labour availability. In marketing, high commission charges were the major problem followed by more middlemen. In processing, most of the processors felt that irregular electric supply was the major problem. Finally, the study suggested that Government Institutions and Agriculture Departments should provide adequate training and technology to increase production. The study also recommended that public and private partners, NGOs, entrepreneurs processing units and farmers joined together to achieve self-sufficiency in the oil seed sector.

Keywords: Production, Marketing, Processing, Constraints, RPI.

INTRODUCTION

Sesame is one of the major cash crops and they are also a very popular crop among rural farmers for its seed and oil. Sesame production has gained attention in the country because of its huge foreign exchange for our economy. Industrially, most sesame is processed directly into the oil, but can also be sold at various stages of processing, for various uses such as meal, paste, confections, and bakery products. In recent years, the world has experienced some fluctuation in the price of sesame seeds, however, generally, prices have continued to rise despite increasing supply. The sesame prices vary based on factors including colour, quality (including the oil content grades mentioned above), origin, moisture content, and purity (admixture). The present research observes the constraints in the production, marketing and processing of sesame in the Kallakurichi District of Tamilnadu with the following specific objectives:i) To identify the constraints in the production, marketing and processing of sesame for the study area and ii) To suggest the policy recommendations based on the study's findings.

RESEARCH METHODOLOGY

Sampling
Kallakurichi district was selected purposively based on the first rank in the area and production of sesame among all the districts of Tamil Nadu. From the district, two top-ranking blocks namely Tirukoilur block and Ulundurpet block were selected purposively taking into consideration the concentration of area under Sesame. From the selected block, according to acreage under Sesame cultivation, five top-ranking villages were selected. By using Probability proportionate sampling, 120 sample farmers were selected from each block and in total 240 sample farmers were selected for the study. For processing, the sesame processing units, located in the entire Kallakurichi district, were considered in which the thirty units were selected randomly for the study.

Tools of Analysis
Response Priority Index
To assess the constraints uttered by the farmers in the Production, Marketing and Processing of sesame, there was a problem, whether importance was supposed to be given to the number of answers to a particular main concern or to the maximum number of answers to a constraint in the first priority. To determine this, a Responses Priority Index ith (RPI) was built as a creation of Proportion of Responses (PR) and Priority Estimate (PE), where PR for the constraint gives the ratio of the number of responses for a particular constraint to the total responses as per equation (Rao, 2011):

$$\text{RPI} = \frac{\sum_{j=1}^{k} f_{ij} X|(k+1)-j|}{\sum_{i=1}^{1}\sum_{j=1}^{k} f_{ij}} \quad 0 \le RPI \ge 5$$

Where,
RPI$_i$= Response Priority Index for ith constraint
f$_{ij}$= Number of responses for the jthpriority of the ithconstraint
　　　(i=1,2……I, j= 1,2,3……k)
$\sum_{j=1}^{k} f_{ij}$ = Total number of responses for the ith constraint
k = Number of priorities (1. Strongly agree; 2. Agree; 3. Moderate; 4. Disagree; 5. Strongly disagree)
$X_{|(k+1)-j|}$= Scores for the jth priority
$\sum_{i=1}^{1}\sum_{j=1}^{k} f_{ij}$ = Total number of responses to all constraints
In the present study, larger the RPI, higher would be the importance for the constraints.

RESULTS AND DISCUSSION

Constraints faced by Sesame Farmers:
An effort was made to find out the constraints faced by the sesame farmers during production, marketing and processing were ranked based on Response Priority Index.

Problems faced by Farmers in the Production of Sesame
The constraints faced by the sample farmers in sesame production were elicited and investigated to determine the constraints' significance and priority. The outcome of the study is given in table 1. The Response Priority Index indicated that Irregular Rainfall (Short/Long) was given maximum Priority in sesame production and ranked first with a mean score of 0.6190 followed by Lack of Labour Operation (0.5434), Infestation of Pest and Disease (0.5131), Lack of technical knowledge (0.4637), Limited access to credit (0.4429), Weed control problem (0.4226) and Shortage ofavailability of inputs in time (0.3833).

Problems faced by Farmers in Marketing of Sesame
The constraints faced by the sample farmers in sesame marketing were examined to determine the constraints' importance and priority. The result of the study is detailed in table 2. The Response Priority Index showed that High commission chargeswere given maximum Priority in sesame marketing and ranked first with a mean score of 0.6312 followed bythe Existence of more middlemen (0.6130), Delayed payment(0.5692), Seasonal fluctuation in market prices(0.5479), High transport (0.5182), Poor marketing link age cost (0.4786),Malpractices in grading (0.4479) and Limited access to market information(0.3932).

Problems faced by processors in Sesame oil processing
The constraints faced by the sample farmers in sesame processing were obtained and studied to determine the constraint's impact and priority. The result of the study is specified in table 3. The Response Priority Index showed that Irregular Electric supply was given maximum Priority in sesame processing and ranked first with a mean score of 0.7142 followed by Unavailability in raw materials (0.6476), Labour scarcity(0.5714), High cost of transport(0.5429), Insufficient of storage facilities(0.4380), Lack of finance(0.4190) and Lack of knowledge about Government policy(0.3857).

CONCLUSIONS

Sesame is the cash crop that earns foreign exchange for the country, hence, continuous reduction in sesame production due to the numerous problems plaguing its farming could spell doom to the nation's GDP. Farmers should pay attention to improving the quality of sesame to get market share in not only domestic but also international market by overcoming current constraints. The Government Institutions and Departments should provide adequate training and technology to increase production, fulfill the requirement of domestic consumption and achieve export earnings. The study recommended that public and private partners, NGOs, entrepreneurs processing units and farmers joined together to achieve self-sufficiency in the oil seed sector.

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Table 1 Problems faced by Farmers in the Production of Sesame

S. No	Constraints in the Production of Sesame	No. in respective priorities					Total responses	RPI	Rank
		I	II	III	IV	V			
1.	Irregular Rainfall (Short/Long)	65	39	83	17	36	240	0.6190	I
2.	Lack of Labour Operation	12	85	46	38	59	240	0.5434	II
3.	Infestation of Pest and Disease	17	48	74	22	79	240	0.5131	III
4.	Lack of technical knowledge	11	36	42	63	88	240	0.4637	IV
5.	Limited access to credit	16	22	29	76	97	240	0.4429	V
6.	Weed control problem	5	23	41	59	112	240	0.4226	VI
7.	Shortages of availability of inputs in time	9	5	13	87	126	240	0.3833	VII
Total							**1680**		

Table 2 Problems faced by Farmers in Marketing of Sesame

S. No	Constraints in Marketing of Sesame	No. in respective priorities					Total responses	RPI	Rank
		I	II	III	IV	V			
1.	High commission charges	87	25	9	51	68	240	0.6312	I
2.	Existence of more middlemen	21	63	35	114	7	240	0.6130	II
3.	Delayed payment	42	37	16	62	83	240	0.5692	III
4.	Seasonal fluctuation in market prices	13	44	27	94	62	240	0.5479	IV
5.	High transport cost	18	12	46	75	89	240	0.5182	V

6.	Poor marketing linkage	6	15	24	82	113	240	0.4786	VI
7.	Malpractices in grading	9	7	6	71	147	240	0.4479	VII
8.	Limited access to market information	3	1	2	16	218	240	0.3932	VIII
Total							1920		

Table 3 Problems faced by processors in Sesame oil processing

S. No	Constraints in Processing of Sesame	No. in respective priorities					Total responses	RPI	Rank
		I	II	III	IV	V			
1.	Irregular Electric supply	14	10	1	2	3	30	0.7142	I
2.	Unavailability in raw materials	7	12	3	6	2	30	0.6476	II
3.	Labour scarcity	5	9	3	7	6	30	0.5714	III
4.	High cost of transport	4	7	6	5	8	30	0.5429	IV
5.	Insufficient of storage facilities	2	1	4	13	10	30	0.4380	V
6.	Lack of finance	1	4	2	8	15	30	0.4190	VI
7.	Lack of knowledge about Government policy	1	2	1	9	17	30	0.3857	VII
Total							210		

RESEARCH ARTICLE

Effect of Structured Teaching Programme on Knowledge Regarding Early Detection and Prevention of Myopia in Children among School Teachers, Guwahati, Assam

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ABSTRACT

Our understanding of the dynamic interaction between the eye's growth and its ability to adapt to maintain vision has shown that childhood myopia is a significant prediction of progressive myopia and the potentially severe ocular co morbidities associated with it. It is important for us to better understand this process and its risk factors in order to better develop a prevention and treatment strategy. This article will discuss the epidemiology, risk factors, prevention and current therapeutic regimens for reducing myopic progression. Pre-experiment on group pre-test post-test research design and quantitative evaluative research approach was undertaken among school teachers in Glacier school and Bal Bhartis Public School, Guwahati, Assam. The sample consisted of 60 school teachers and convenience sampling technique was adopted to select the samples. The tool used for data for data collection was demographic variables and self structured knowledge questionnaire regarding early detection and prevention of myopia in children. The result showed that there was increased in post-test knowledge In knowledge , the mean post-test knowledge score (27.10) was higher than the mean pre-test knowledge score (18.83) and mean difference between pre-test and post-test score was 8.27. The calculated "t value" was 16.95 and p value was 0.001** at 0.05 level of significance. This indicates that the structured teaching programme regarding early detection and prevention of myopia in children was effective in improving the knowledge of school teachers. The present study concluded that the structured teaching programme (STP) regarding early detection and prevention of myopia in children has an effect in improving the

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knowledge among school teachers. Hence, the structured teaching programme can be utilized by school teachers to suggestion and advice parent to take children to hospital if any sign of myopia occur in children to reduce the incidence of myopia in early stage.

Keywords- Myopia, Early detection, Prevention, Children and school teachers

INTRODUCTION

Myopia nearsightedness is an inability's to accommodate for objects at a distance. It causes light ray to be focused in front of the retina. Myopia may occur because of excessive light refraction by cornea or lens or because of an abnormally long eye. Myopia is the most common refractive error [1]. Myopia is one form of refractive error, placed at the opposite end of the distribution of this quantitative trait to hypermetropia. As it arises as a consequence of ocular growth Severity and timing of onset of myopia (childhood versus adult-onset) are related [2]. childhood-onset myopia generally has a clear familial/hereditary basis, is progressive into adulthood and often of greater severity [3]. Myopia is one of the most prevalent eye diseases and a worldwide public health burden [4]. Globally, there are approximately 1950 million (28.3% of the global population) with myopia (defined as −0.50 diopters [D] or less) and 277 million (4.0% of the global population) with high myopia (HM) (defined as −5.00 D or less) [5]. Refractive Error Study in Children surveys of 12-year-old children have shown that the prevalence of myopia is higher in urban Asian cities, such as Singapore (62.0%), Hong Kong (53.1%), and Guangzhou, China (49.7%) than in the United States (20.0%), Australia (11.9%), urban India (9.7%), Nepal (16.5%) and Cambodia (6.0%) [6]. Vision 2020, the right to sight; Global initiatives for elimination of avoidable Blindness after the realization the unless Blindness will double by 2020 AD, WHO along with an international partnership committee launched the vision 2020 initiative in 1995. Under global initiative for the elimination of all avoidable blindness by 2020 Ad. The disease identified for elimination includes: Avoidable causes of childhood blindness refractive error and low vision, the target have been set for each of the component disease for next 20 years. Elimination of all avoidable blindness by 2020 AD [7]. In a study conducted by Lim et al. children (aged 6–18 years) with two myopic parents had a mean refractive error of −2.33 D and the odds ratio of having myopia in childhood with two myopic parents was 2.83, compared with no parental myopia [8].

Both environmental and genetic factors play a role in the development of myopia. Environmental factors have recently contributed to the increase in myopia over the past few decades in populations with a stable genetic pool and thus are the main contributors to myopia. The major environmental risk factors are less outdoor time and more near-work, including reading, writing, and screen time [9]. With regard to genetic factors, a consistent finding is that children with myopic parents have a higher prevalence of myopia. In addition, some genetic loci associated with myopia and HM have been identified previously [10]. A less hyperopic refraction at a young baseline age has been considered as the most significant predictor of myopia [11]. In another study, it was found that for every year of delayed stabilization, there was an increase in the total amount of myopia (overall 0.27 diopters (D) more myopia per year of delay [12].

A Child is a human being between the stages of birth and puberty or between the development period of infancy and puberty. A child vision development is a critical period as vision impacts the learning ability. As children spend most of their time in schools, primary teachers, knowledge and awareness of eye health issues are essential to influence the provision of better eye health-care practices among their students. This can help in creating awareness about eye health among children, their parents and communities and well-being of the children [13]. Management of myopia is typically treated with glasses or contact lenses. Refractive surgery such as LASIK is typically used in adult once the refractive error has stabilized. For progressive myopia aimed at slowing the rate of progression or worsen.

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Multiple treatment options have been attempted and researched. Using 0.01% atropine eye drops have been shown to most effectively slow myopia progression. With fewer side effect And another method of slowing myopia progression has been orthokeratology, which involves using rigid gas permeable contact lenses every night to reshape the cornea (the clear front part of the eye) [14]. A descriptive survey study conducted on awareness of primary school teachers regarding refractive error and its early identification among primary school children in selected schools, Mysore. Convenient sampling was used to obtain the sample of 60 primary school teachers. The data was collected using structured questionnaire to assess the awareness of primary school teachers regarding refractive errors and its early identification among primary school children. Results shows that majority of primary school teachers (60%) were in the age group of less than 30 years and majority (91.67%) were females. 33.33% of them had their educational qualification as B Sc B. Ed. 71.67% of them had less than 10 years of experience. None of them had previous experience of identification of visual problems in children. Majority (80%) of primary school teachers had adequate awareness regarding refractive errors in children, but none of them had previous experience of identifying visual problems in school children. This study concluded that childhood visual impairment due to refractive errors is a significant problem among school children and has a considerable impact on public health. Early detection of the refractive errors is very much important to prevent blindness and other complications. Therefore the knowledge regarding the refractive errors among school teachers is very much important to detect any manifestations of refractive errors in school children [15].

Childhood myopia is progressive from of short-sightedness (myopia) that occur during a child's growing years and worsens throughout childhood. In fact, about 9% of kids' ages 5-17 are nearsighted kids with this condition can usually see things close up, but struggles to see things far away [16]. The objective of study is to assess the pre-test and post-test knowledge regarding early detection and prevention of myopia in children among school teachers and to evaluate the effect of structured teaching programme and to find out the association pre-test knowledge regarding early detection and prevention of myopia in children among school teachers. Hypotheses are formulated for the study are H_1: There is a significance mean difference in the pre-test and post-test level of knowledge scores of the school teachers after the structured teaching programme regarding early detection and prevention of myopia in children. H_2: There is a significance association between the pre-test knowledge score regarding early detection and prevention of myopia in children among school teachers with their selected demographic variables and it is tested in the level all   the hypotheses will be tested at the level of significant 0.05.

MATERIAL AND METHODS

A descriptive survey study conducted on awareness of primary school teachers regarding refractive error and its early identification among primary school children in selected schools. Convenient sampling was used to obtain the sample of 60 primary school teachers. The data was collected using structured questionnaire to assess the awareness of primary school teachers regarding refractive errors and its early identification among primary school children. The research designed selected for this study was a pre –experimental research design (one group pre-test and post test research design) is adopted. As the study fulfils the criteria such as non randomization, the investigator has selected the pre- experimental design. Quantitative evaluative research approach was undertaken among school teachers of Glacier school and Bal Bhartis Public School, Guwahati, Assam. The total sample for the study is 60 schools teachers were selected using convenience sampling technique. Written consent were taken from the participant who are willing to participate in the study and before study, the ethical approval was obtained from the ethical committee Assam Down Town University, Guwahati to conduct study and formal permission for data collection was taken from concerned school authorities.

Pre-test was conducted on the first day by using self structured knowledge questionnaire on early detection and prevention of myopia in children. Further followed by 45 mins structured teaching programme regarding early detection and prevention of myopia in children among school teachers. Post test were conducted after 7 days of structured teaching programme by administered using the same self structured knowledge questionnaire.

RESULTS

In this study paired 't' test is used to compare the pre –test and post –test knowledge score of the school teachers regarding the early detection and prevention of myopia in children among school teachers. And Chi-square used to find the associated between the mean pre -test knowledge scores in selected socio demographic variables among schools teachers in selected schools. The result showed that there was increased in post-test knowledge, the mean post-test knowledge score (27.10) was higher than the mean pre-test knowledge score (18.83) and mean difference between pre-test and post-test score was 8.27. The calculated "t value" was 16.95 and p value was 0.001** at 0.05 level of significance. This indicates that the structured teaching programme regarding early detection and prevention of myopia in children was effective in improving the knowledge of school teachers.

Analysis and interpretation of data is the most important phase of research process, which involves the computation of the measures along with searching for patterns of relationships that exist among data groups. Quantitative evaluative research analysis of data is done through statistical analysis, which includes simple procedures e.g. computing and average. The purpose of analyzing that data collected in study is describe the data in meaningful terms. The data were systematically analyzed so that trends and patterns of relationship can be detected. Table for frequency distribution. Table A.1 depicts that out of 60 (sixty) school teachers, 25(42%) were in the age group of 21-40 years, 17 (28%) were in the age group of 31-40 years and16(27%) were in age group of 41-50 years and 2(3%) were in age group of above 50 years and 46 (77%) of the school teachers were female and 14 (23%) of the school teachers were male and majority of school teachers were graduate 25(42%), 21(35%) were post graduate, 7(12%) were B.Ed, 2 (3%) were from M.Ed and 5(8%) were from others and 19(32%) of school teacher were from science stream, 33(55%) were from Arts stream and 28(13%).were from commerce. 32 % of the school teacher were having 6-10 years of experience, 30% were having 1-5years of experience, 28% were having 11-20 years and 10% were having 21 and above years of teaching experience. All samples have received a information regarding myopia 60(100%) and 34(57%) have information received from magazine, mass media where as 24(40%) have received from mass media, internet and 2(3%) from any other and school teachers have not any attended eye camp programme 60 (100 %).

Table A.2 depicts the frequency and percentage distribution of pre-test and post-test level of knowledge regarding early detection and prevention of myopia in children among schools teachers**.** Results revealed that in pre-test majority 40(67%) of participants had moderate knowledge and 20(33%) of participants had adequate knowledge while in post-test all the participants 60(100%) had adequate knowledge regarding early detection and prevention of myopia in children. Table A.3 depicts the effect of structured teaching programme on knowledge regarding early detection and prevention on myopia among school teachers which was tested by using paired t test. Findings showed that pre-test mean knowledge score was 18.83±3.158 and post-test mean knowledge score was 27.10±1.902 with mean difference was 8.27with obtained (t=16.95) at df = 59 was statistically significant at p<0.05 level. Findings showed that structured teaching programme was effective in improving the knowledge regarding early detection and prevention on myopia among school teachers.

Hence, findings concluded that there was significant difference in pre-test and post-test knowledge scores of school teachers regarding early detection and prevention on myopia after structured teaching programme was statistically significant at 0.05 level of significance, H_1 hypothesis was accepted.

Table 4.1 depict that the there is significant association between found between the pre-test level of knowledge with selected demographic variables I,e. the stream during higher secondary at 0.01 level of significance. Hence, it is concluded that the level of knowledge regarding early detection and prevention of myopia in children dependent on the stream during higher secondary.

DISCUSSION

The findings of the study have been discussed with reference to the objective' hypotheses and finding from other studies. The following are the major findings of the study-.

To assess the pre-test and post-test knowledge regarding early detection and prevention of myopia in children among school teachers in selected schools.
The statistical findings of the present study revealed that in pre-test majority 40(66.7%) of participants had moderate knowledge and 20(33.3%) of participants had adequate knowledge while in post-test all the participants 60(100%) had adequate knowledge regarding early detection and prevention of myopia in children. So post –test knowledge score higher than the pre- test knowledge score. The present study is supported by the study conducted by S.Iiavarasi. (2010) [18] study to assess the effectiveness of structured teaching programme regarding eye disorder in terms of knowledge and practice among adolescent children in selected schools at Dharapuram. Study revealed that the pre test 74(37%) of adolescent children had moderately adequate practice . Results shows that the highest percentage of 155(77%) adolescent children were adequate knowledge after the structural teaching programme. The present study supported by SM V, Baby AA, Mathew A and Ginson AJ. (2019) [19] conducted a descriptive analytical study was done to assess knowledge and practice regarding vitamin A prophylaxis among mothers of under five children in selected communities of Aikkaranadu Grama Panchayath. Quantitative research approach with a descriptive survey design was adopted for the study. Convenient sampling method was used for sample selection. Data collection was done from 100 subjects by using structured knowledge questionnaire. Study findings revealed that, out of 100 subject's six (06%) subject's possessed adequate knowledge, 43 (43%) subjects had moderate knowledge and 57 (57%) subjects had poor knowledge. There was significant association between knowledge level and occupation of parents and there is no significant association between age of mother, education of parents, number of children, type of family and monthly income.

To evaluate the effect of structured teaching programme regarding early detection and prevention of myopia in children among school teachers.
Findings of the present study showed that pre-test mean knowledge score was 18.83 ± 3.158 and post-test mean knowledge score was 27.10 ± 1.902 with mean difference was 8.27 with obtained (t =16.95) at df = 59 was statistically significant at p<0.05 level. Findings showed that structured teaching programme was effective in improving the knowledge regarding early detection and prevention on myopia among school teachers. The present study is supported by the study conducted by Panchal S, Batra N. (2018) [20] effectiveness of structured teaching programme regarding early detection and prevention of visual impairment among older people. An evaluative research approach was adopted under the study. Results revealed that the mean post test knowledge score (29.98 ± 2.81) of experimental group was higher than the mean post test knowledge score of control group (17.88 ± 3.12). It was found to be statistically significant (p< 0.000). It was found to be statistically significant (p< 0.000).Structured Teaching Programme (STP) is an effective strategy in improving knowledge and attitude of older people regarding early detection and prevention of visual impairment.

To find out the association between selected socio demographic variables among school teachers with their knowledge level regarding early detection and prevention of myopia in children
The findings of the present study shows that the there is significant association between found between the pre-test level of knowledge with selected demographic variables I,e. previous exposure to the topic at 0.01 level of significance. Hence, it is concluded that the level of knowledge regarding early detection and prevention of myopia in children dependent on the stream during higher secondary. The present study is supported by the study conducted by Sreelatha DM, Leela MK, Rani DPS. (2019) [21]. A study to assess the knowledge on refractive error and related risk factors of school children in selected Government School, Tirupati. Results revealed that there is significant association between knowledge regarding refractive errors and related risk factors of school children with

some of the variables like age in years, standard of class, educational status of father and occupational status of the father, occupational status of the mother, at p< 0.01 level. Whereas, Family income per month, residence, source of information were significance at   p< 0.05 level. Remaining variables like Gender, religion, educational status of the mother and type of the family were not significant.

The present study supported by D.G Vishakantamurthy, M Chandrasekhar et al. (2016) [22] conducted a pre-experimental study to assess the effectiveness of structured teaching programme on refractive errors among high school children (12-15 years) in selected schools at Mysuru. The research approach adopted for this study is evaluative approach. The research design adopted for this study was one group pre test and post test design. The sample consists of 60 high school children in selected schools at Mysuru district. Results shows that there is a significant association between pre-test knowledge score of high school children and findings of the study. A statistically significant association was between the level of knowledge and income per month of high school children. Hence study conclude that the hypothesis of the study is well accepted as the knowledge levels of the high school children were increased after the structured teaching programme.

CONCLUSION

The present study was conducted to assess the effect of structured teaching programme on knowledge regarding early detection and prevention of myopia in children among school teachers at selected schools, Guwahati, Assam. The study reveals that total post –test knowledge score was significantly higher than of pre-test knowledge score I,e 27.10±1.902 and pre-test mean score is 18.83±3.158 Hence the structured Teaching Programme (STP) is an effective strategy in improving knowledge of school teachers regarding early detection and prevention of myopia in children. More educational strategies can be undertaken to mobilize and motivate the school children and help them to acquire knowledge and correct practice regarding myopia.

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Table 1: Frequency and Percentage distribution of demographic variables.

n=60

SL NO	DEMOGRAPHICAL VARIABLES	FREQUENCY (f)	PERCENTAGE (%)
1.	**AGE IN YEARS** a.21-30 years b.31 -40 years c.41-50 years d. Above 50 years	17 25 16 2	28 42 27 28
2.	**GENDER** a. Female b. Male	46 14	77 23
3.	**EDUCATIONAL QUALIFICATION** a. Graduate b. Post Graduate c. B.Ed	25 21 7	42 35 12

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	d. M.Ed e. Any other	2 5	3 8
4.	**STREAM DURING HIGHER SECONDARY** a. Science b. Arts c. Commerce	19 33 8	32 55 13
5.	**YEARS OF EXPERIENCE** a.1-5 years b.6-10 years c.11-20 years d.21 years and above	18 19 17 6	30 32 28 10
6.	**HAVE YOU RECEIVED ANY INFORMATION REGRADING MYOPIA** a. Yes b. No **IF YES, SOURCE OF INFORMATION** a. Mass Media. Internet b. Magazine, Textbook c. Any others	60 0 24 34 2	100 0 40 57 3
7.	**HAVE YOU EVER ATTENDED ANY EYE CAMP PROGRAMME** a. Yes b. No	0 60	0 100

Table 2: Frequency and percentage distribution of level of knowledge regarding early detection and prevention of myopia in children among schools teachers.   n=60

Level of knowledge	Pre-test		Post-test	
	f	%	f	%
Inadequate knowledge	0	0	0	0
Moderate knowledge	40	67	0	0
Adequate knowledge	20	33	60	100

Table 3: Effect of structured teaching programme on knowledge regarding early detection and prevention on myopia among school teachers   n=60

Comparison knowledge score	Mean	SD	Mean Difference	t test value	df	p value	Inference
Pre-test	18.83	±3.158	8.27	16.95	59	**0.001****	S**
Post-test	27.10	±1.902					

*P<0.05 level of significance   NS-Non significant
S**= Highly significant at, p<0.005

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Table 4.- Association between pre-test level of knowledge regarding early detection and prevention of myopia in children among school teachers with selected demographic variables.

n=60

S. No	Demographic variables	Pre-test knowledge		χ^2 value	df	'p' value	Inference
		Moderate	Adequate				
1	Age in years a. 21-30 years b. 31-40 years c. 41-50 years d. Above 50 years	11 16 11 2	6 9 5 0	1.141	3	0.767	NS
2	Gender a. Male b. Female	30 10	16 4	0.186	1	0.666	NS
3	Educational qualification a. Graduate b. Post graduate c. B.Ed d. M.Ed e. Any others	17 15 4 2 2	8 6 3 0 3	3.120	4	0.538	NS
4	Stream during higher secondary a. Science b. Arts c. Commerce	5 27 8	14 6 0	21.33	2	**0.001***	S*
5	Years of experience a. 1-5 years b. 6-10 years c. 11-60 years d. 21 years and above	9 17 9 5	9 2 8 1	8.889	3	0.031	NS
6	Source of information a. Mass media, Internet b. Magazine, Textbooks	38 2	20 0	1.034	1	0.309	NS
7	Have you ever attended any Eye Camping programme a. Yes b. No	-- 40	-- 20	NA	NA	NA	NA

*P<0.05 level of significance   **NS-Non significant**
NA- Not applicable

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RESEARCH ARTICLE

Morphometric Analysis of Sub-Watersheds in The Bandalli Watershed Area of Hanur Taluk, Chamarajanagar District Karnataka, India Using Remote Sensing, and GIS Techniques.

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ABSTRACT

When evaluating different hydrogeological properties, drainage morphometry studies of watersheds are quite important. Studying the watershed's numerous qualities, including its geology, climate, morphological features, structural development, and other factors, is made simpler by having a solid understanding of geohydrological issues. The study area is 400 sq.km and contains 6 sub-watersheds (PrakashPalya (BSW1), Balagunase (BSW2), Chinchalli (BSW3), Changavadi (BSW4), Halgapuram (BSW5) and Devarabetta (BSW6). The drainage network of these 6 sub-watersheds was identified using remote sensing data at a scale of 1:50,000 and SOI topo maps as a guide. The Morphometric analysis of 6 sub-watersheds was conducted using GIS software's 10.8 versions to estimate and comprehend the various morphometric characteristics in the study area. The drainage network demonstrates that the study area terrain exhibits dendritic to sub-dendritic drainage patterns. The second-order stream is the highest-order one currently in existence. In this study, various stream orders were classified using the Strahler method. The drainage density ranges from 1.50 to 2.15 km/km^2, and the drainage texture is coarse to coarse. The range of the relief ratio is 0.005 to 0.024. The standard basin group is represented by a mean bifurcation ratio of 1.43 to 1.94. According to the elongation ratio, the Balagunse sub-watershed is circular, whereas the other sub-watershed has an elongated pattern. Therefore, it might be inferred. According to the study, remote sensing methods are an effective tool for morphometric analysis.

Keywords: Bandalli Watershed, Morphology, Drainage density, Arc-GIS

INTRODUCTION

Earlier attempts at morphometric analysis utilizing remote sensing methods have been made by Srivastava and Miter 1995; Srivastava, 1977; Nag, 1998; and Agarwal, 1998. All of these studies have resulted from remote sensing methodology has become a potent tool in recent years. Analysis of drainage morphometry benefits significantly from the ability of satellite remote Sensing to capture an overview of a broad area all at once. The study area is situated in the southwestern part of Karnataka state between 12°09'56.3" North latitude and 77°21'06.5" East longitude. The study covers an area of 400 km2. Except for certain hydrogeological information reported by the Department of Mines and Geology, no literature has been published. Accessible on morphometric analysis (Reddy and Ramaswamy, 1989). Consequently, the current investigation has been started. The region experiences a mild monsoon in the winter and a semi-arid environment with hot summers, little rainfall, and dry winters. The temperature ranges from 20.5 °C to 35.2 °C. The average rainfall of the area is 800 mm the year. Clay loamy black and red soil, varying in thickness from 0.50 to 2 meters, is present in the area.

Geologically, the region is a portion of Chamarajanagar district Hardrock terrain and contains the sorts of rocks gneissic and granite (GSI, 1981). Some dolerite dykes that mark the borders of some of the sub-watersheds in the basin pierce the gneisses. Dharwar Craton is split into Western and Eastern blocks by the northern extension of closepet granite batholiths, composed of granite. The western portion of the study region is made up of a distinct narrow series of hills that stretch north to south. The significant role of morphometry is to measure the configuration of the earth's surface, shape, and Size of the landforms, through mathematical analysis (Clarke, 1966; Agarwal, 1988; Babar and Kaplay, 1998; Obi Reddy *et al.,* 2002; Hajam and Hamid et al. 2013).The morphology of drainage basins from the quantitative analysis as input by Horton (1945). Much morphometric research has shown that a drainage basin is a fundamental unit in the morphometric analysis since all hydrologic and geomorphic processes occur inside an area of the watershed where the denudation and aggradation process is most clearly demonstrated. (Horton 1945; Strahler 1952, 1964; Muller 1968; Shreve 1969; Evans 1972,1984; Chorley *et al.,* 1984; Ohmori 1993; Cox 1994; Hurtrez *et al.,* 1999). Understanding the ground slope, channel network, structural control, geology, and geomorphology of a draining basin is easier by studying drainage patterns and morphometric analysis (Strahler 1964). It might be done by calculating the basin's linear, areal, and relief characteristics. For evaluating various morphometric and hypsometric parameters utilizing the drainage basin, remote Sensing, and a geographic information system (RS-GIS) approaches are popular (Gangalakunta 2004; Grohmann *et al.* 2007; Korkalainen et al. 2007; Yu and Wei 2008; Hlaing et al. 2008; Javed et al. 2009; Umrikar 2016). Drainage systems are identified systems in the interior of basins or sub-basins that were done using conventional methods and topographic maps before the development of remote Sensing and GIS tools (Verstappen, 1983; Mark, 1983; O'Callaghan *et al.,* 1984; Rinaldo *et al.,* 1998; Macka 2001). Drainage provides a foundation for understanding starting slopes, differences in rock hardness, structural controls, geological and geomorphological history (Kale and Deshmukh, 2020). Using information from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and the Shuttle Radar Topographic Mission (SRTM), GIS-based analysis has given an accurate, rapid, and affordable method of assessing water resources systems (Smith *et al.,* 2003; Grohmann 2004). The properties useful for morphometric calculations depend on subsurface structure, geomorphological features, and hydrological factors (Murkute and Solanki, 2019). Additionally, it is significant because it can be used to explain geological processes like erosion, flooding, and others. Understanding a drainage basin's quantitative characteristics can aid watershed prioritization, geo-hydrological behavior and soil susceptibility to land degradation (Varade 2018). Implementing management methods in a watershed and engaging in sustainable groundwater development activities require a thorough understanding of the watershed. This study applied remote Sensing (R.S.) and geographic information system (GIS) methodologies. It benefits watershed research in terms of the execution of the work's design and implementation, as well as the expansion of groundwater management methods (Shrivatra 2021). Furthermore, it helps academics who are engaged in relevant research projects across a variety of fields. The groundwater development and basin management plans in the Hanur taluk in the Chamarajanagar District, Karnataka, would benefit from the analysis findings.

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METHODOLOGY

In the current study region, maps illustrating drainage features have been generated and digitized from the Arc GIS 10.8 edition using topographic sheets at a scale of 1:50,000. Strahler's (1957, 1964) approach was used to evaluate the parameters applied in the study region. The defined formulas were used to calculate a linear feature: the Length of the streams, the number of streams, the Length and area of the watersheds, and the altitude ranges that were used to calculate the bifurcation ratio, length ratio, and other metrics. Areal features such as stream frequency and drainage density in the sub-watersheds. Basin shape, Length of overland flow in the sub-watershed, infiltration number, etc. The present study was conducted based on a thorough morphometric assessment of the sub-basin using remote Sensing and a geographic information system (GIS). As a geographical feature, the digital elevation model (DEM) is used to calculate morphometric characteristics (Joshi, 2013). The interpolation approach in ArcGIS has been used to create thematic maps of morphometric characteristics.

RESULT AND DISCUSSION

The outcomes of the current study are given below. It strongly emphasizes using Analyzing morphometric data with satellite remote Sensing.

Watershed Delineation

A watershed is an organic hydrological structure from which surface runoff travels to a designated drain, channel, stream or river at a specific location. Based on AIS & LUS recommendations (1990). The mean area of the watershed is less than 500 km^2 (± 50%). Watershed is further classified into sub-watershed (± 30-50 km^2), mini-watershed (± 10-30 km^2), and micro-watershed (± 5-10 km^2) according to IMSD Technical Guidelines (NRSA, 1995). Hence, the present study watershed has been divided into 6sub-watersheds (PrakashPalya, Balagunse, Chinchalli, Changavadi, Halgapuram, and Devarabetta). The sub-watersheds have been referred to by their names, tanks, and villages at the retailer.

Morphometric Analysis

Morphometry is the measurement and mathematical analysis of the Earth's surface arrangement and its landforms' shape and measurements (Clarke 1966). This study can be accomplished by measuring the linear, aerial, and relief features of the contribution from the basin and slope (Nag and Chakraborty 2003). The morphometric analysis for the parameters, such as stream order, stream length, bifurcation ratio, stream length ratio, basin length, drainage density, stream frequency, elongation ratio, circularity ratio, form factor, relief ratio, etc., has been performed in the current study area using the mathematical formulae provided in Table 1. The results are summarized in Table 2.

Linear Aspect

When analyzing the topological properties of the stream orders in terms of active connections between network systems and linear aspects of the basins concerning the drainage's channel patterns. An aspect of linear morphometric analysis of a research area includes stream order (U), stream number (Nu), stream length (Lu), mean stream length (Lsm), stream length ratio (R1), and Bifurcation ratio (Rb) that were determined, with the outcomes shown in Table 2.

Stream Order

According to Strahler's stream (1957), the order is the standard by which stream segments are categorized following the tributaries upstream. Therefore, it is the primary method for analyzing watershed morphometry. In the current study, we classified several stream orders using Strahler's (1964) approach (Table 1). The order-wise stream numbers, area, and stream Length of the 6 sub-watersheds are given in Table 2. Out of these sub-watersheds, Balagunse (BSW2) and Chinchalli (BSW3) are of the fifth order, while the remaining sub-watersheds namely

PrakashPalya (BSW1), Chngavadi (BSW4), Halgapuram (BSW5) and Devarabetta (BSW6) are of sixth order. From Table 2, it can be shown that second-order streams have the highest frequency. The frequency of the streams likewise decreases as the stream order increases.

Stream Length

In linear aspects, one of the most critical processes is the stream length (Lu). The Length of all the streams in a specific order is how it is defined. The Harton-proposed law implemented the stream length (1945). In first-order streams, the overall Length of the stream section is often at its maximum and gets shorter, increasing stream order. For example, the maximum stream length (Lu) in the study region is 73.12km, while the average stream length is 30.50km. However, in the sub-watersheds of PrakashPalya and Balagunase, the stream segments of different orders differ from what is often observed (Table 2). These fluctuations might represent the flow of streams from high elevations, lithological variety, and relatively steep slopes (Singh 1997).

Mean Stream Length

The mean stream length (Lsm) is a characteristic property of the drainage network and its associated basin surface (Harton 1945; Strahler 1964). It might be determined by splitting the sum of all order streams by the sum of all stream segments. The mean stream length of the study area varies from 0.34km to 11.9km, with an average of 2.42km. According to the researchers (Vittala *et al.,* 2004; Chopra *et al.,* 2005; Rudraiah *et al.,* 2008), the variation in the mean stream length of a sub-basin is due to the topography and slope of the area. According to Harton's (1945) second law of stream lengths, the average length of streams of all varying arrangements in a drainage basin tends to be very similar to the first term of a straight geometric series, which is the typical length of first-order streams.

Stream Length Ratio

The definition of stream length ratio (R1) is the ratio of one order's mean Length of streams to those of the following stream segments in lower order (Harton 1945). The stream length ratio of the study area ranges between 0.24 to 1.24 (Table 2). When the length ratio increases from lower order to higher order, a sub-watershed is said to be at a mature geomorphic stage. However, in some sub-watersheds, there is a decreasing trend. Changes in stream length from one order to another order indicate their geomorphic evolution at its late-youth stage in the stream of the study area (Singh and Singh, 1997; Singh *et al.,* 2014; Rai *et al.,* 2014).

Bifurcation Ratio

The bifurcation ratio (Rb) is the comparison of the number of streams in one order by the number of streams in the next higher order (Schumm 1956) (Table 1). It is a property without dimensions that describes the degree of integration between streams of different orders in a drainage basin (Strahler 1964). Rb levels below a certain threshold indicate sub-watersheds with fewer structural disruptions (Strahler 1964). Additionally, the structural instabilities have not caused the drainage patterns to change (Nag, 1998). While smaller values infer sub-watershed that are not impacted by structural disturbances, greater values of Rb in the current study imply considerable structural control over the drainage pattern. If the mean bifurcation ratio of a basin ranges between 3 to 5, then the area has not been influenced much by structural alterations (Strahler 1957).

Relief Aspect

Table 2 lists the measurements of relief, including the total relief, relief ratio and basin size.

Relief Ratio

The total relief of a sub-watershed is the elevation difference between the highest and lowest places on the valley floor. The relief ratio (Rh) of maximum relief to horizontal distance along the longest dimension of the basin parallel to the primary drainage line is referred to as the relief ratio (Schumn 1956) (Table 1). He asserts that the gradient of the canal and the relief are directly related. Additionally, a drainage basin's relief ratio and hydrological characteristics are correlated. The Rh often rises when the Size of the drainage area of a certain drainage basin sub-

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watersheds decreases (Gottschalk 1964). The range of Rh values, from 0.006 to 0.022, is shown in table 2. As can be seen, high Rh values suggest steep slopes and great relief (405m), whereas low Rh values may point to the availability of basement rocks that are revealed as minor hills, mounds, and ridges with a gentler slope (GSI 1981).

Aerial Aspect

Aerial features define the general layout and Size of drainage basins. The analysis using morphometrics of a research area's aerial features includes drainage density (Dd), drainage texture (Rt), Elongation ratio (Re), Circulatory ratio (Rc), Stream frequency (Fs), Form factor (Rf), Length of overland flow (Lo) and constant channel maintenance (Cm).

Drainage Density

As described by Harton (1945), the drainage density is the ratio of the stream's entire Length to its total drainage area. According to numerous experts, one of the morphometric measures with the highest sensitivity and variability, the drainage density, directly correlates with rainfall intensity (Chorley 1957 a,b; Chorley *et al.,* 1962), rock resistivity (Zavoianu 1985; Gardiner 1996; Sangireddy *et al.,* 2016), average annual runoff (Morisawa 1962), and an inverse relationship with the degree of development of a drainage network within a sub-basin (Harton 1945), infiltration capacity (Harton 1945; Melton 1957), permeability (Strahler 1956; Zavoianu 1985), vegetation cover (Chorley 1957 a,b) and texture of landscape dissection and spacing of stream (Chorley 1969). Under the dense vegetative cover and low relief, the area is likely made up of extremely resistant and very permeable subsoil material, as evidenced by the low drainage density. In addition, the area's steep relief, scarce vegetation, and high drainage density suggest the land is made up of impermeable subsurface material. When drainage density is low, the drainage texture is coarse, and when drainage density is great, the drainage texture is fine.

Stream Frequency

The watershed's stream frequency is calculated by splitting the basin's total stream volume by the region of the watershed (Gardiner 1975). From the analysis, it shows that stream frequency varies from 1.45 Devarabetta (BSW6) to 9.91 Balagunase (BSW2). In Devarabetta, Halgapuram and Changavadi sub-watersheds the stream frequency is low (Table 2) whereas stream frequency is high in other watersheds of the study area. The degree of dissection, total runoff and mean annual rainfall, are related to stream frequency in a watershed. The low degree of dissection and low water flow is observed in the regions which have low stream frequency.

Drainage Texture

It is "the total number of stream segments of all kinds to the perimeter of a river basin," as stated (Sangireddy et.al 2016). One of the key ideas in geomorphology is drainage texture (Rt), which refers to the distance between drainage lines. Over impermeable terrain, there are more drainage lines than over-permeable ones. According to Horton (1945), Rt is the sum of all the stream segments along the area's perimeter (Table 1). He acknowledged that infiltration capacity is the only significant variable affecting Rt and considered drainage texture, which comprises drainage density and stream frequency. Smith (1950) has classified drainage density into five different textures. The drainage density of less than 2 indicates very coarse, between 2 and 4 is related to coarse, between 4 and 6 is moderate, between 6 and 8 is fine, and greater than 8 is very fine drainage texture. In the present study, the drainage density (Table 2) is of a very coarse to coarse drainage texture. The Drainage density ranges from 2.16 to 4.83 km^2/km (Table 2). In this instance, the land has very permeable subsoil and a thick vegetative cover because of the low drainage density.

Form Factor

The basin area to the square of the basin length ratio is known as the Form factor (Rf), according to Horton (1932). Table 2 shows that the Rf ranges from 0.28 (Devarabetta) (BSW6) to 0.81 (Balagunase) (BSW2), indicating that the Balagunase sub-watershed is circular with a higher value (0.81) whereas the other sub-watersheds are elongated with lower values of form factor.

Circularity Ratio

According to Miller (1953), it is the basin's area concerning a circle whose diameter matches the basin's perimeter (Table 1). The circularity ratio (Rc) is influenced by factors such as Stream Length and Frequency, Geological formations, land use and land cover (Lu/Lc), temperature, relief, and basin slope. In the present study, the Rc ranges from 0.32 to 0.60 (Table 2). High Rc 0.60 in Chinchalli (BSW3), Balagunase (BSW2) indicates that they are more or less circular and are characterized by high to moderate relief and the drainage system is structurally controlled. The remaining sub-watersheds have less than 0.44 indicating that they are elongated.

Elongation Ratio

The primary characteristic of a region is the Elongation ratio. According to Schumm (1956), it is the ratio of the largest Length of the basin to a circle whose diameter has an area equal to that of the basin. A circular basin discharges runoff more effectively than an extended basin (Singh and Singh 1997). According to Strahler (1964), In between 0.6 and 1.0, the Elongation ratio is related to a wide range of geology and climatic conditions. Values close to 1.0 are typical of regions of very low relief, whereas values in the range of 0.6-0.8 are usually associated with high relief and steep ground slopes (Strahler 1964). These values can be grouped into four categories namely (a) circular (>0.9), (b)oval (0.9 to 0.8) and (c) less elongated (<0.7). the Re of sub-watersheds of the study area varies from 0.60 to 1.01 (Table 2). The lowest Re (0.60) in the case of Devarabetta (BSW6) sub-watershed indicates high relief and steep slope, while very high values of 1.01in Balagunase (BSW2) indicate that plain land with low relief and low slope.

Length of Overland Flow

It is the amount of time that water spends above the earth before it is focused on defined stream courses. (Horton, 1945). This element strongly correlates negatively with the average channel slope and largely corresponds to sheet flow length. Approximately, the reciprocal of drainage density (D) and the Length of overland flow (Lg) are equal (Horton, 1945). Table 2 reveals that the Lg is less in Balgunase(BSW2) and Chinchalli (BSW3) sub-watersheds as Drainage density is high in these two sub-watersheds. The computed value of Lg for all sub-watersheds varies from 0.10 to 0.23.

CONCLUSION

The present work has shown Remote Sensing and GIS to be effective methods for drainage delineation and updating, and this updated drainage has been employed for morphometric analysis. The drainage networks of all 6 sub-watersheds show a dendritic to sub-dendritic drainage pattern, and changes in slope and topography may cause variations in stream length ratio. It is also concluded from the study that the mature stage of streams in PrakashPalya (BSW1), Changavadi (BSW4), and Devarabetta (BSW6) sub-watersheds and late youth stage of geomorphic development in remaining sub-watersheds. The difference in topography and geometric development is blamed for the variation in bifurcation ratio values among the sub-watersheds. The Stream frequencies for each of the study sub-watersheds show a positive connection with the Drainage density values, indicating that stream populations have increased in response to rising Drainage densities. The texture of Drainage density is very coarse to coarse. The Elongation ratio shows that Balagunase (BSW2) sub-watershed possesses a circular shape, while the remaining marks elongated pattern. The steep slopes in the area make it possible for water to move quickly and easily, lowering the infiltration rate. Most sub-watersheds exhibit changes in the sub-slope watersheds and terrain. As a result, the study offers a crucial tool for locating areas where groundwater management, soil erosion control and Soil conservation measures can be planned.

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Conflict of Interest

The author there is no conflict of interest.

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Table 1: Methodology Adopted For Computations of Morphometric Parameters.

Sl. No.	Morphometric Parameters	Formula	Reference
1	Stream Order (U)	Hierarchical rank	Strahler (1964)
2	Stream Length (Lu)	Length of the Stream	Horton (1945)
3	Mean Stream Length (Lsm)	$Lsm = Lu / Nu$ Where Lsm = Mean Stream Length Lu = Total stream length of order 'u' Nu = Total no. of stream segments of order 'u'	Strahler (1964)
4	Stream Length Ratio (R.L.)	$RL = Lu / Lu - 1$ Where R.L. = Stream Length Ratio Lu = The total stream length of the order 'u' Lu – 1 = The total stream length of its next lower order	Horton (1945)
5	Bifurcation Ratio (Rb)	$Rb = Nu / Nu + 1$ Where, Rb = Bifurcation Ratio Nu = Total no. of stream segments of order 'u' Nu + 1 = Number of segments of the next higher order	Schumn (1956)
6	Mean bifurcation ratio (Rbm)	Rbm = Average of bifurcation ratios of all orders	Strahler (1957)
7	Relief Ratio (Rh)	$Rh = H / Lb$ Where, Rh = Relief Ratio H = Total relief (Relative relief) of the basin in Kilometers Lb = Basin length	Schumm (1956)
8	Drainage Density (D)	$D = Lu / A$ Where D = Drainage Density Lu = Total stream length of all orders A = Area of the Basin (km2)	Horton (1932)
9	Stream Frequency (Fs)	$Fs = Nu / A$ Where Fs = Stream Frequency Nu = Total no. of streams of all orders A = Area of the Basin (km2)	Horton (1932)
10	Drainage Texture (Rt)	$Rt = Nu / P$ Where Rt = Drainage Texture Nu = Total no. of streams of all orders P = Perimeter (km)	Horton (1945)

11	Form Factor (Rf)	$Rf = A / Lb^2$ Where, Rf = Form Factor A = Area of the Basin (km2) Lb^2 = Square of Basin length	Horton (1932)
12	Circularity Ratio (Rc)	$Rc = 4 * Pi * A / P^2$ Where Rc = Circularity Ratio Pi = 'Pi' value i.e., 3.14 A = Area of the Basin (km2) P^2 = Square of the Perimeter (Km)	Miller (1953)
13	Elongation Ratio (Re)	$Re = 2 \sqrt{(A / Pi)} / Lb$ Where, Re = Elongation Ratio A = Area of the Basin (km2) Pi = 'Pi' value i.e., 3.14 Lb = Basin length	Schumn (1956)
14	Length of Overland flow (Lg)	$Lg = 1 / D * 2$ Where, Lg = Length of Overland flow D = Drainage Density	Horton (1945)

Table 2: Results of Morphometric Analysis of 6 Sub-Watersheds around Bandalli Watershed.

Sl No	SWSD Name	Stream Order	Basin Area (Km2)	Stream order						Stream length in Km (Lu)						Perimeter (P) (Km)	Basin Length (Km)
				I	II	III	IV	V	VI	I	II	III	IV	V	VI		
1	BSW1	VI	93.99	210	279	69	54	75	1	73.12	69.32	55.40	43.20	26.10	11.90	51.74	11.78
2	BSW2	V	45.27	183	142	58	49	17	-	71.80	55.62	42.70	38.90	9.8	-	34.77	7.47
3	BSW3	V	47.44	154	119	49	37	29	-	68.20	43.50	37.30	29.31	14.5	-	31.33	8.59
4	BSW4	VI	68.20	103	53	28	13	9	1	63.40	48.30	30.50	19.81	24.60	9.5	48.69	13.49
5	BSW5	VI	74.68	84	38	16	11	8	1	71.90	36.20	31.30	21.93	18.60	4.5	52.02	12.28
6	BSW6	VI	54.17	37	17	13	6	5	1	58.41	19.81	23.81	11.41	-	3.9	45.41	13.81

Sl no	SWSD Name	Mean Stream Length in Km (Lsm)						Stream Length Ratio (R.L.)					Elongation Ratio (Re)	Texture Ratio (Rt)
		I	II	III	IV	V	VI	II/I	III/II	IV/III	V/IV	VI/V		
1	BSW1	0.34	0.38	0.80	0.81	0.34	11.90	0.94	0.79	0.77	0.60	0.45	0.92	11.36
2	BSW2	0.39	0.40	0.73	0.79	0.57	-	0.77	0.76	0.91	0.25	-	1.01	12.91
3	BSW3	0.44	0.36	0.76	0.79	0.50	-	0.63	0.85	0.78	0.49	-	0.90	12.38
4	BSW4	0.61	0.91	1.08	1.52	2.73	9.5	0.76	0.63	0.64	1.24	0.38	0.69	4.25
5	BSW5	0.85	0.95	1.95	1.99	2.32	4.5	0.50	0.86	0.70	0.84	0.24	0.79	3.02
6	BSW6	1.57	1.16	1.83	1.90	-	3.9	0.33	1.20	0.47	-	-	0.60	1.73

Sl no	SWSD Name	Bifurcation Ratio (Rb)				Mean Bifurcation Ratio (Rbm)	Drainage Density (D) (Km/Km2)	Stream Frequency (Fs)	Form Frequency (Fs)	Circularity Ratio (Rc)	Length of Overland Flow(Lg)
		I/II	II/III	III/IV	IV/V						
1	BSW1	1.17	2.59	1.27	0.72	1.43	2.96	6.25	0.67	0.44	0.16
2	BSW2	1.28	2.44	1.18	2.88	1.94	4.83	9.91	0.81	0.47	0.10
3	BSW3	1.29	2.42	1.32	1.27	1.57	4.06	8.17	0.64	0.60	0.12
4	BSW4	1.94	1.89	2.15	1.44	1.85	2.87	3.03	0.37	0.36	0.17
5	BSW5	2.21	2.37	1.45	1.37	1.86	2.46	2.11	0.49	0.34	0.20
6	BSW6	2.17	1.30	2.16	1.20	1.70	2.16	1.45	0.28	0.32	0.23

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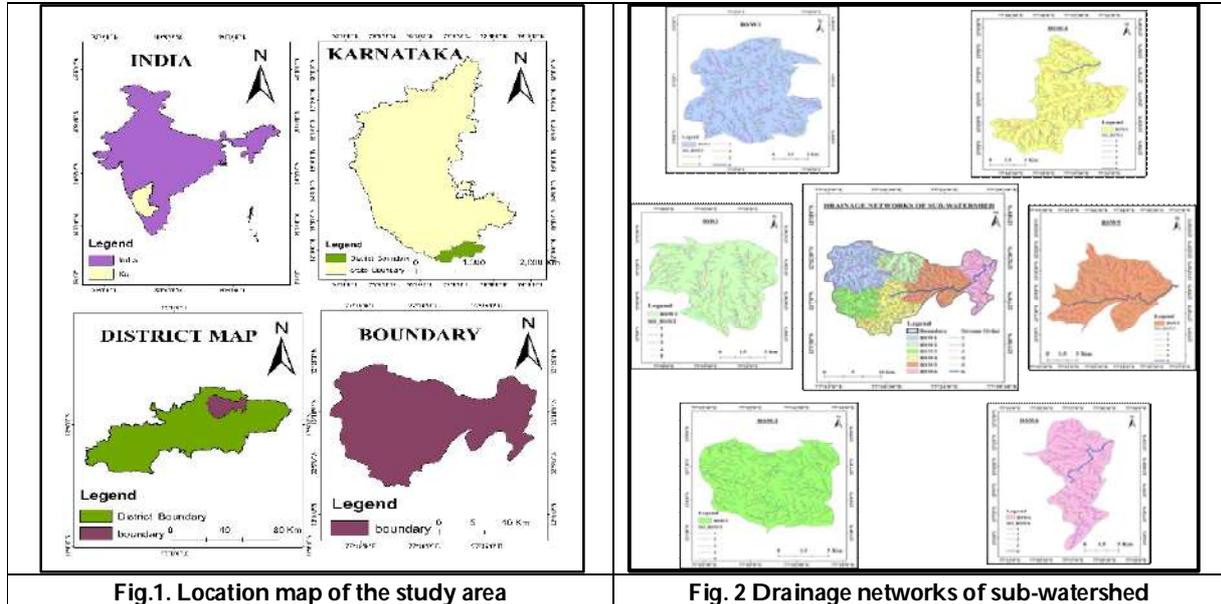
Fig.1. Location map of the study area	**Fig. 2 Drainage networks of sub-watershed**

REVIEW ARTICLE

Plant Materials from Assam in the Treatment of Jaundice: A Review

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ABSTRACT

Jaundice is characterised by a yellowish colouring of the skin, sclera, and mucous membranes. The conventional treatments used for neonatal hyperbilirubinemia are mainly phototherapy and blood exchange transfusion which may damage DNA, interfere with maternal-infant bonding, and trigger intestinal hypermotility. Blood exchange transfusion is generally performed after failure a phototherapy failure, and is reported to cause blood-related or cardiorespiratory complications. These limitations show that new therapies by natural plants for neonatal hyperbilirubinemia are required because plant materials are a source of numerous effective and dominant drugs as they synthesize hundreds of phytoconstituents for therapeutic purposes like defense against insects, fungi, diseases, etc. The obtainable data were collected via search engines like Firefox, Google Chrome, different journals and data bases available. Approximately, 60 journals, several books and online sources were reviewed. The primary source of data collection was research and review articles published by reputed publishers such as Elsevier, Informa, Springer, Taylor and Francis, and several others; online databases such as PubMed, Google scholar, Science hub, Research gate, Scopus and Science Direct. About 22 species were found to utilized potentially for the treatment of jaundice in different regions of Assam. These includes *Amaranthus spinosus, Alternanthera philoxeroides, Achyranthes aspera, Alseodaphne petiolaris, Dillenia indica, Garcinia pedunculata,* etc. containing several important phytoconstituents such as Rutin, Quercetin, Chlorogenic acid, Norchlorogenic acid, β- carotene, α- Spinasterol, Stigmasterol, β-sitosterol, Cycloeucalenol, Phytol, Oleanolic Acid, Ecdysterone, Bisdesmosidic Saponins, Aporphines, etc. **Conclusion**- This study enumerates an overview of plant materials from Assam, India for treatment of jaundice by activating the enzyme uridine-diphosphate glucuronyl transferase (UDP) in the HEME

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metabolic pathway that is useful to researchers for further scientifical analysis as well as formulation development.

Keywords: Jaundice, neonatal jaundice, plant materials, uridine-diphosphate glucuronyl transferase (UDP), Assam

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INTRODUCTION

The French term jaune, which indicates yellow, is where the name "jaundice" first appeared. Bilirubin, a yellowish-orange coloured bile, causes jaundice, which is characterised by a yellowish colouring of the skin, sclera, and mucous membranes. Heme ring degradation produces bilirubin, which is often derived from digested red blood cells. Once the serum bilirubin level exceeds 3 mg per dL (51.3 per L), the discoloration is often seen clinically. Adults rarely report of jaundice as a presenting symptom. Its presence may be a sign of a major issue [1]. Neonatal hyperbilirubinemia, characterized by raised up serum bilirubin contents above the standard range, is one of the most prevalent clinical disorders in neonates, occurring in approximately 60% of full-term and 80% of preterm neonates in the initial 7 days of life [2]. Although jaundice in newborns is recognized to subside spontaneously and harmless in most cases, the elevated unconjugated bilirubin (U-Bil) in serum can penetrate blood-brain barrier (BBB) and produce serious damage to the immature nervous system, leading to acute bilirubin encephalopathy, called as kernicterus [3].

The causes of neonatal hyperbilirubinemia can be classed as physiological or pathological. Disruption of the production, uptake, conjugation, excretion and/or reabsorption of bilirubin could lead to an excessive accumulation of bilirubin in the blood [4]. Aging red blood cells undergo phagocytosis and release hemoglobin, which is broken into globin and heme. Heme oxygenase (HO-1) converts heme to biliverdin, and biliverdin reductase (BR) converts biliverdin to U-Bil. The U-Bil binds with albumin in the circulation, is transported into the liver, forms conjugated bilirubin (C-Bil) with glucuronic acid by UDP-glucuronosyltransferases (UGTs), and finally secreted into the bile and intestine [5]. β-glucuronidase deconjugates colonic bilirubin which is then decreased by bacteria to form bilinogen, the majority of which is oxidized and excreted into the feces, whereas a small portion is reabsorbed from the intestine into the enterohepatic circulation. It should be noted that newborns have more reabsorption of U-Bil due to a paucity of gut flora [6]. The low rate of bilirubin glucuronidation by the liver is thought to be the key factor causing neonatal hyperbilirubinemia. Additionally, newborn hyperbilirubinemia can be linked with pathological factors, such as infection, hemolysis, interior bleeding, hypoxia, hypoglycemia and genetic factors [6, 7].

The conventional treatments used for neonatal hyperbilirubinemia are mainly phototherapy and blood exchange transfusion [8]. Although phototherapy is widely used by number of countries, may damage DNA [9], interfere with maternal-infant bonding [10], and trigger intestinal hypermotility [11]. Blood exchange transfusion is generally performed after failure a phototherapy failure, and is reported to cause blood-related or cardiorespiratory complications [10, 12]. These limitations show that new pharmaceutical therapies for neonatal hyperbilirubinemia are required.

The bilirubin content in serum higher than 2.5 to 3 mg per dL (42.8 to 51.3 per L) in association with a clinical appearance of yellow skin and sclera is the traditional definition of jaundice [13]. The metabolism of HEME causes the body to create 4 mg of bilirubin per kg every day. The catabolism of RBCs accounts for around 80% of the HEME moiety, with the remaining 20% coming from inefficient erythropoiesis and the metabolism of muscle myoglobin and cytochromes. Plasma supplies bilirubin to liver for conjugation and excretion. Bilirubin that has not been conjugated is soluble in lipids but insoluble in water. As a result, it can easily pass through the placenta or the blood-brain barrier. The glucuronosyltransferase converts unconjugated bilirubin to conjugated bilirubin in the hepatocyte,

which is then soluble in aqueous bile and excreted out [13]. HEME is degraded by enzyme heme oxygenase to form biliverdin with the utilization of NADPH and oxygen. Biliverdin reductase then reduces biliverdin to bilirubin using NADPH again, iron (Fe2+) and carbon monoxide (CO) are released. Bilirubin is taken up by the liver and conjugated to a monoglucuronide then a diglucuronide by the action of uridine-diphosphate glucuronyl transferase. This allows for excretion in the stools. Some of the conjugated bilirubin can be modified by bacterial flora to be reabsorbed and circulated in the serum (Figure 1).

MATERIALS AND METHODS

Literatures review were done through search engines like Firefox, Google Chrome, different journals and data bases available. Approximately, 60 journals, several books and online sources were reviewed. The primary source of data collection was research and review articles published by reputed publishers such as Elsevier, Informa, Springer, Taylor and Francis, and several others; online databases such as PubMed, Google scholar, Science hub, Research gate, Scopus and Science Direct.

RESULTS

Plant materials are a source of numerous effective and dominant drugs as they synthesize hundreds of phytoconstituents for therapeutic purposes like defense against insects, fungi, diseases, etc. Although jaundice in adult is recovered after few days, however the appearance of which can cause pathological changes to occur severe disorder. After the literatures review a number of plant materials from Assam (India) were found which are potentially utilized for the treatment of jaundice for the presence active phytoconstituents (Table 1).

DISCUSSION

Jaundice is characterized by yellowish colouration of the skin, sclera and mucous membranes. In adults, it can be recovered, but the appearance of increased bilirubin content can cause pathological changes to occur severe disorders. Jaundice is very common to newborn babies about 80% in the initial weeks of their life. Neonatal jaundice is treated using phototherapy, which can damage cells and brain, ultimately can lead to cancers. Thus in this study, many of the plant materials utilized by the people of Assam (India) for treating jaundice are highlighted (Table 1). Out of so many plant materials, few of them are mentioned in the study which have potential activity against jaundice, preparing them as juice, paste, pills, liquid solutions, etc. either alone or in combination with other plant materials or pharmaceutical aids. The plant materials contains many potential phytoconstituents such as Rutin, Quercetin, Chlorogenic acid, Norchlorogenic acid, β- carotene, α- Spinasterol, Stigmasterol, Campesterol, Phaeophytin, Oleanoic acid, β-sitosterol, Cycloeucalenol, Phytol, L-Ascorbic acid, 2, 6-hexa-decanoate, N, N-dimethylglycine, 17-Octadecynoic acid, Anthocyanins, Ascorbic acid, Maleic acid, Hibsicic acid, etc. (Table 1).

As the bilirubin formation and its excretion takes place by degradation of HEME to biliverdin to bilirubin with the help of enzymes. That bilirubin is then taken up by the liver and conjugated to a monoglucuronide then a diglucuronide by the action of uridine-diphosphate glucuronyl transferase (UDP), which is easily excreted out (Figure 1). So, Jaundice is appeared when the action of uridine-diphosphate glucuronyl transferase (UDP) is blocked in the HEME metabolic pathway. Thus conjugated bilirubin is not formed and free bilirubin raised up in the serum. So, the plant materials are believed to be act by activating the enzyme uridine-diphosphate glucuronyl transferase (UDP) and thus free bilirubin in the serum are again converted to conjugated one which is easily excreted out from the body.

CONCLUSION

Jaundice is characterized by yellowish colouration of the skin, sclera and mucous membranes. It is very common to newborn babies. The appearance of increased bilirubin content can cause pathological changes to occur severe disorders in adults. Traditionally, many of the plant materials utilized by the people of Assam (India) for treating jaundice due to presence of highly potent phytoconstituents by activating the enzyme uridine-diphosphate glucuronyl transferase (UDP) in the HEME metabolic pathway. This can be studied further to scientifically analyze the traditional utilization and development of suitable formulation.

CONFLICTS OF INTEREST
The authors declare no conflict of interest for publication of the review article.

CONFLICTS OF INTEREST
Nill.

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Table 1. Plant Materials used in the Treatment of Jaundice

Family	Name of plant	Local name	Part(s)	Phytoconstituents
Amaranthaceae	*Amaranthus spinosus* [14]	Kotakhutura	Stem, Leaf	Rutin, Quercetin, Chlorogenic acid, Norchlorogenic acid [31]
	Alternanthera sessilis [15]	Matikanduri	Leaf, Root	β- carotene, α- Spinasterol, Stigmasterol, Campesterol [32]
	Alternanthera philoxeroides [16]	Panikaduri	Leaf	Phaeophytin, Oleanoic acid, β-sitosterol, Cycloeucalenol, Phytol [33]
	Achyranthes aspera [17, 18]	Apamargo	Stem	Oleanolic Acid, Ecdysterone, Bisdesmosidic Saponins [34]
Lauraceae	*Alseodaphne petiolaris* [19]	Gojua	Stem, Root	Aporphines, dihydoisoobtusilactone, Bisbenzylisoquinoline alkaloid [35]
Dilleniaceae	*Dillenia indica* [19]	Outenga	Bark, Seed	Dillenetin, Rhamnetin, Betulinic acid, Mallic acid, Isorhamnetin, Lupeol, Myricetin [36]
Clusiaceae	*Garcinia pedunculata* [19]	Borthekera	Fruit	Hydroxycitric acid, Garcinol, Cambogin [37]

Table 2. Plant materials used in the Treatment of Jaundice

Family	Name of plant	Local name	Part(s)	Phytoconstituents
Urticaceae	*Dendrocnide sinuata* [19]	Churaat	Root	Cardiac glycoside, Flavonoid, Terpenoid, Tannin [38]
Onagraceae	*Ludwigia octovalvis* [19]	Longbon	Whole plant	Daucosterol, Tormentic acid, Apigenin, Luteolin, Maltol, Luteolin [39]
Rutaceae	*Aegle marmelos* [20]	Bel	Leaf	Aeglemarmelosine, Skimmianine, Xanthotoxin, Scopoletin, marmisin [40]
Liliaceae	*Aloe vera* [21]	Salkuwori	Leaf	Aloesin, neoaloesin A, aloeveraside A & B, aloeresin A, E, J, K [41]
Apocynaceae	*Alstonia scholaris* [22]	Satiana	Stem	*19, 20-E*-alstoscholarine, *19, 20-Z*-alstoscholarine [42]
Papaveraceae	*Argemone Mexicana* [23]	Siyalkata	Leaf	β-amyrin, Rutin, Mexitin, Phenylalanine, Cysteine [43]
Meliaceae	*Azadirachta* indica [24]	Neem	Leaf	Hydroxy pivalic acid, Phytol, 4-Cycloocten-1-ol, 1,3-Diphenyl-2-azafluorene, Germanicol [44]

Table 3. Plant Materials used in the Treatment of Jaundice

Family	Name of plant	Local name	Part(s)	Phytoconstituents
Leguminosae	*Cajanas cajan* [25, 26]	Rahar	Leaf	Cajanine, Longistyline A, Pinostrobin, Orientin, Vitexin, Cajanol, Prunetin, Cajanin [45]
	Cassia fistula[27]	Sonaru	Seed	Chrysophanol [46]
Zingiberaceae	*Curcuma longa* [28, 29]	Halodhi	Rhizome	Curcumin, Termerone, Curlone, Curcuphenol [47]
Rubiaceae	*Coffea benghalensis* [30]	Sagoliphul	Root	5-Caffeoylquinic acid, Caffeine, A-2-Furfurylthiol, 4-Vinylguaiacol [48]
Malvaceae	*Hibiscus sabdariffa* [30]	Khaseng-tenga, Mesta-tenga	Calyx And Fruit	Phytosterols, Polyphenols, Anthocyanins, Ascorbic acid, Maleic acid, Hibsicic acid [49]
Lamiaceae	*Leucas aspera* [30]	Durun	Leaf	U-Farnesene, X-Thujene, Menthol [50]
Anacardiaceae	*Mangifera indica* [30]	Aam	Bark of Stem	Mangiferin, Isomangiferin, Protocatechic acid, Catechin [51]
Salicaceae	*Xylosma longifolia* [30]	Mota-koli	Leaf	L-Ascorbic acid, 2, 6-hexa-decanoate, N, N-dimethylglycine [52]
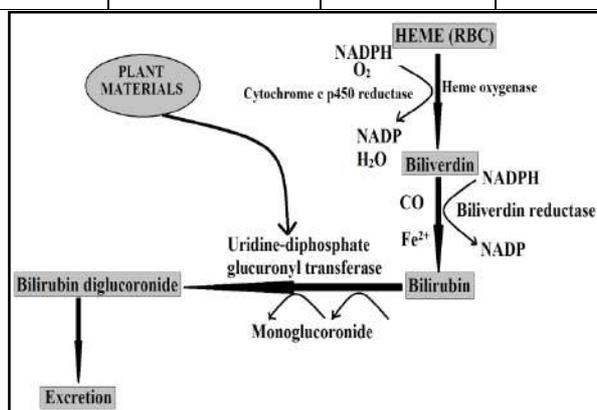
Fig 1: HEME metabolic pathway

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RESEARCH ARTICLE

Advanced Smart Vehicle Monitoring System

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ABSTRACT

Vehicle monitoring is used to keep track of stolen vehicles from robberies. Vehicle theft is a common occurrence in which every one hour in India, about five vehicles are stolen. During the year 2021, a total 44,518 vehicles were stolen. We design a prototype biometric system that merges faces and fingerprints since automatic identification systems based on fingerprint and face recognition frequently fail to meet system performance. Speed breakers are responsible for over half of all accidents. We employ an ultrasonic sensor to avoid this mishap. It exhibits one of the most cost-effective digital distance measurement systems, which detects an object approaching in front of car to avert an accident. The suggested biometric system overcomes the limitations of individual system while simultaneously meeting the requirements for reaction time and accuracy.

Keywords: Face recognition, fingerprint, ultrasonic, vehicle security, authentication.

INTRODUCTION

Vehicle monitoring system consists of an electronic devices or number of sensors installed in a vehicle to prevent from theft. There were numerous well-known biometrics-based identification and verification techniques. Fingerprints, facial features, and iris have all been used in security applications in the past. Face recognition is a popular biometric approach for security and alarm system since it is based on human facial feature and can function variety of conditions. The majority of facial recognition algorithms were created in order to attain a high rate of discriminating. Fingerprint recognition is an automated way of identifying or verifying an individual's information. One of the most well-known, biometric solution for vehicle authentication is fingerprint recognition. The key is

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required to unlock the vehicle. These enhancements are dependent on the vehicle's owner and the requirements of police workstations. They are concerned not only with the theft of car goods, but also with the automobiles and the vehicle owner's personal security needs. The goal of this project is to keep motorcycles safe from unauthorized users to keep them from being stolen.

EXISTING METHODOLOGY

Biometric authentication is the automated verification or identification of persons based on their unique physiological traits such as fingerprint, iris, and face recognition. For authentication, a fingerprint sensor is employed in this system. The fingerprint of the owner should be programmed first. The car is freely accessible to those who have registered. This prevents an unauthorised individual from starting the car without the permission of the owner. Finger impression yields are obtained for both authorised and illegal people. If the finger is placed on the sensor, it validates and compares data, and the vehicle is turned on if the fingerprint imprint coordinates are accurate. The engine cannot be started if the finger impression does not match.Sound waves are used to determine distance with ultrasonic sensors. The sound wave is emitted by the sensor head, and the echo wave is received by the speed breaker. Ultrasonic sensors asses the distance to the speed breaker and control it.

Drawback of Existing Methodology
The greatest embedded solution is voice recognition, but the most difficult obstacle in speech recognition is the loud environment. Face recognition is used to address this difficulty.

PROPOSED METHODOLOGY

Face Recognition
Any device capable of digital photography can create and get the copy and data required to construct and record the facial image of the individual to be identified for the face recognition operation. It employs a face detection and identification system that automatically recognizes and verifies people by extracting unique facial traits from an image or video acquired by the camera. The computer vision security system is implemented on a microcomputer using MATLAB in the personal computer and an ARM 7 microprocessor as the controlling unit. Computer algorithms are used in facial recognition software to recognize specific, distinctive traits on the face of the person. These properties, such as eye distance or chin shape, are then mathematically represented and compared to data from other faces in a face recognition database. A face template is data on a specific face that may be used to distinguish one face from another. This gives a level of vehicle protection that is crucial in today's world of better theft strategies.

Ultrasonic Sensor
Operation of sensors an ultrasonic sensor sends out ultrasonic waves and subsequently receives reflected ultrasonic waves from its sensor head. It detects the distance and thus the position of the item by measuring the time between transmission and receipt of the ultrasonic pulse. Ultrasonic waves are similar to audible sound waves, except they have far higher frequencies. Our ultrasonic transducers use piezoelectric crystals that resonate at a specific frequency and transfer electric energy to acoustic energy and back. The diagram below depicts how sound waves delivered in a conical shape are reflected back to the transducer by a target. As a result, an output signal is generated to perform an indicating or control function. To interpret the "echoes," a specified minimum distance from the sensor is required to provide a temporal delay. Target surface angle, reflective surface roughness, and temperature or humidity fluctuations are all factors that can affect the operation of ultrasonic sensors. Any reflecting form can be

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used as a target. Even spherical items can be used as targets. Ultrasonic sensors are utilized to determine whether or not the passage is clear.

Fingerprint Sensor

The fingerprint sensor collects fingerprint images, compares them to those stored in its module or local system database, and confirms that each print read by the sensor is idiomatic. We are achieving the same results with the same competence and precision in the ignition of vehicles using a dactylogram sensor and a liquid crystal display by lowering the cost factor, allowing us to extensively distribute and deploy safeguard in a range of sectors. In criminal investigations, biometric identification based on an impression of the ridges in a finger's skin is frequently used as validation. The two parts of fingerprint processing are fingerprint enrolment and fingerprint equivalent. The user must double-insert his or her finger upon enrolling. The technology will examine the double-time finger photographs , develop a finger prototype based on the outcomes of the processing, and save the prototype. When a user uses an optical sensor to input a finger, the system builds a finger prototype and matches it to prototypes in the library. The technology will search the whole library of fingers for the matched finger for 1: N matching, or searching. The system will produce the same result in both circumstances, whether success or failure. Among other things, the sensors have picture archiving and chip processing. The size of the fingerprint reader can be lowered and set.. Power utilization is low, performance is greater, size is tiny, and cost is low across a variety of end products and chip processing. The size of the fingerprint reader can be lowered and set Power usage is low in a variety of end products, which is preferable. It is better performance, small in size, low cost.

Working Principle

Face recognition can be accomplished using feature-based or model-based methods. In real-time security systems, feature-based algorithms are commonly utilized. For face recognition, the viola jones algorithm is utilized. MATLAB is used to pre-program the faces of the vehicle users. The webcam records your face and trains it into it. When the vehicle starts, the webcam recognizes the users' faces, and the input face is compared to the taught face. Once the faces match the trained face, the process continues. The route clearance is checked using an ultrasonic sensor. When the road is clear, the fingerprinting process begins. The two parts of fingerprint processing are fingerprint enrolment and fingerprint equivalent. The user must double-insert his or her finger upon enrolling. The technology will examine the double-time finger photographs, develop a finger prototype based on the outcomes of the processing, and save the prototype. When a user uses an optical sensor to input a finger, the system builds a finger prototype and matches it to prototypes in the library. The technology will search the whole library of fingers for the matched finger for 1: N matching, or searching. The system will produce the same result in both circumstances, whether success or failure. Among other things, the sensors have picture archiving

RESULT

The device can be used to combat rising vehicle theft by   allowing the owner to identify the intruder and reclaim control of the vehicle. The findings trusted to ensure vehicle safety. When a face is detected, the sensor checks and proceeds on to the next step of the procedure, which is to check the ultrasonic sensor. If any barriers block the vehicle's progress, the ultrasonic sensor will prevent it from starting, and if it does not, the vehicle will go to the next step in the process to check the fingerprint. The engine is turned on if the fingerprint matches. The engine cannot be started if the finger impression or face recognition does not match.

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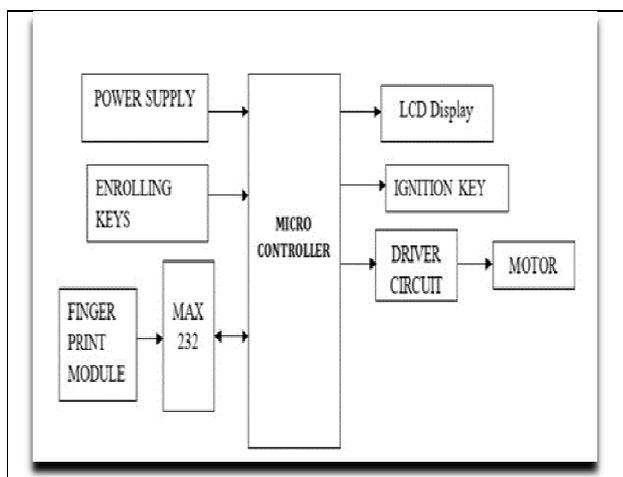
Figure 1: Block Diagram For Existing Method	**Figure 2: Block Diagram For Face Recognition.**
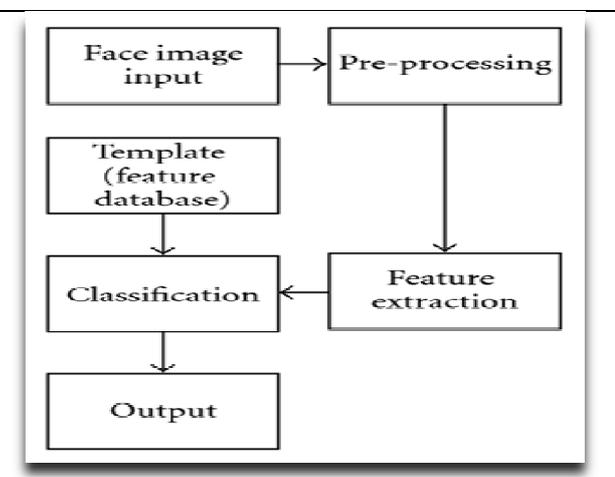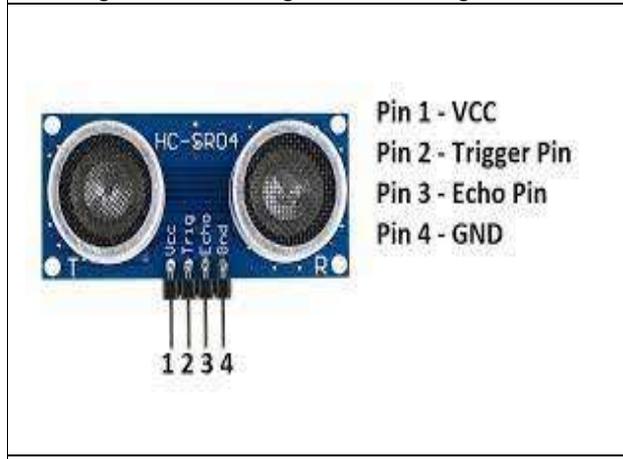
Figure 3: Block Diagram of Fingerprint Sensor.	**Figure 5: Block diagram for advanced smart vehicle monitoring system.**
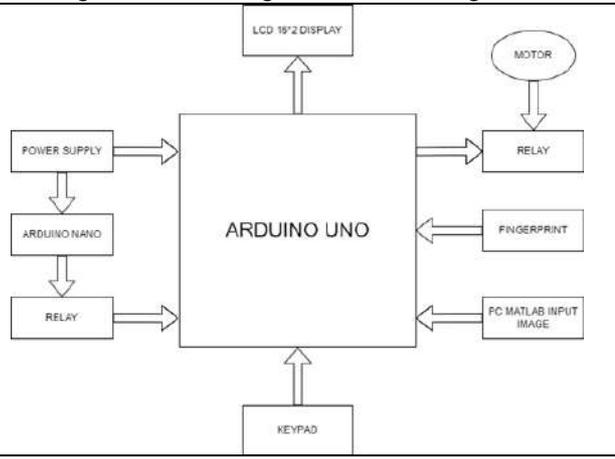
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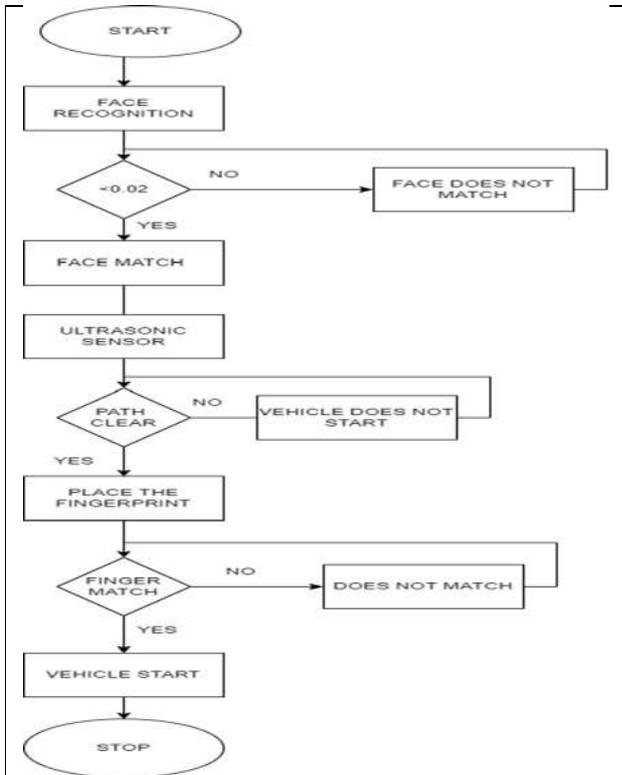
Figure 6: Flow chart of advanced smart vehicle monitoring system.

Figure 7: Input face
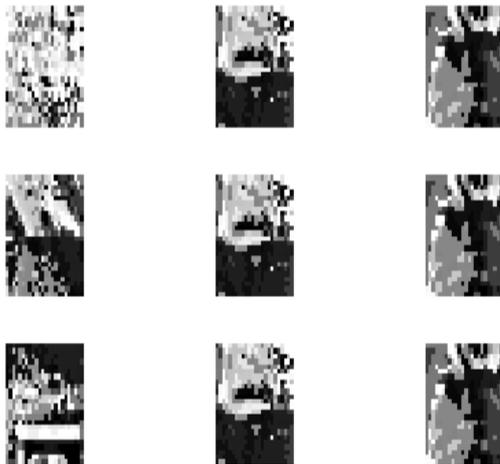
Figure 8: Pixel representation of an image.

Figure 9: Pixel representation of a gaussian filter image.
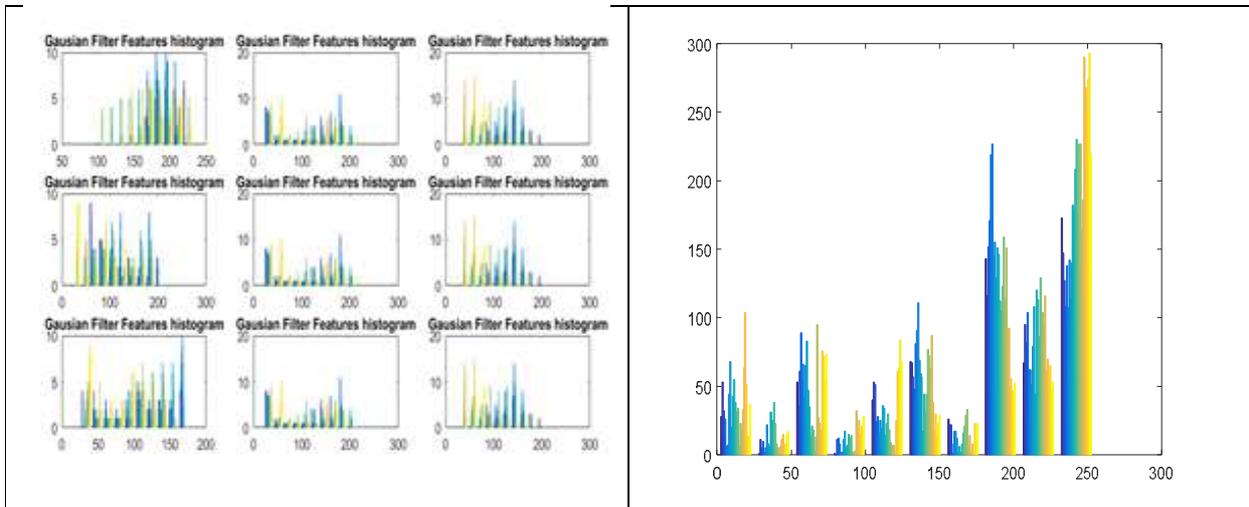
Figure 10: Gaussian filter histogram.

Figure 11: Histogram of output image.

Figure 12: Output of an ultrasonic sensor.
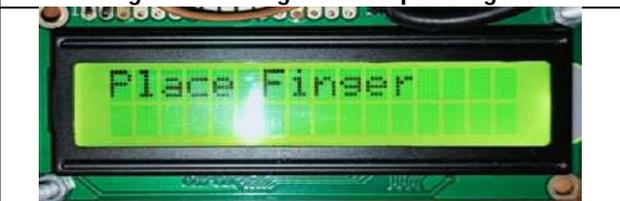
Figure 13: Output of fingerprint sensor.

Figure 14: Output of advanced smart vehicle monitoring system.

RESEARCH ARTICLE

Isolation and Identification of Protease from Soil Bacteria and Assessing Its Antibacterial Activity and Cytotoxic Effect on Cancer Cell Line A549.

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ABSTRACT

Microbes are famous source of industrially important enzymes which can easily be modified by biotechnological methods. Soil is a rich and bio diverse source of a huge number of microorganisms. The objective of present study was to isolate protease producing bacteria from soil samples and Screening of the bacteria was done by employing skim milk agar plating technique at 37°C and observed after 24 hours. Proteolytic activity of the crude protease extract from the bacteria was detected by using azocasein as substrate. The samples showed clear zone around the colony indicating protease activity. The isolated yellow bacteria were identified by 16s rRNA sequencing as Pseudomonas species. The isolated protease producing bacteria also having antibacterial activity against different bacterial pathogens and we have evaluated protease producing bacteria against the human lung cancer cell line A549 during *in-vitro* assays of growth inhibition. Overall, this study shows clearly that the potential and exploration of protease producing bacteria can be used as a biocontrol agent against bacterial pathogens and therapeutic use in A549 lung cancer cell line.

Keywords: Soil bacteria, Protease, Effect of pH, Antibacterial and Anti-cancer activity.

INTRODUCTION

Proteases are used by microorganisms in many processes, including stress response, nutrient acquisition, and protein maturation for cell division. Likewise, pathogens use these enzymes as important virulence factors in both direct and indirect damage of the host to gain access to nutrients, destroy host cells and tissues to facilitate invasion and dissemination, degrade host immune molecules for defense evasion and process self-molecules for pathogenicity.

Such roles promote the development of protease-based therapies for pathogen-related diseases, including fungal meningitis, HIV/AIDS, candidiasis, aspergillosis, and COVID-19 [1].

Proteases are generated by a variety of microorganisms, yeast, bacteria, fungus, and plants. The process of destroying or suppressing disease-causing bacteria is referred to as antimicrobial activity. This is accomplished using a variety of antibacterial drugs [2]. The microbial production of proteases is preferred more than others sources because microbes can be grown and cultivated in a very small space. They grow faster and can be genetically modified easily and they have wide industrial applications [3,4]. The variety of different bacterial microorganisms was known to produce maximum amount of protease commercially [5]. Although protease production is an inherent property of all organisms, only those microbes that produce a substantial amount of extracellular protease have been exploited commercially. They also include species which can degrade many macromolecules such as lipids, starch, chitin, pectin, and proteins [6].

Proteolytic enzymes are highly required where proteins need some sort of alteration either structurally or functionally and they can destroy the cell components such as lipoprotein membranes and immunoglobulins [7]. Proteases are involved in normal and pathophysiological processes or conditions. This involvement of proteases may lead them to produce a therapeutic agent against deadly diseases, such as cancer and AIDS [8]. The cytotoxic study of the culture filtrate of *Stenotrophomonas maltophila* caused vigorous endocytosis in cancer cell lines like Vero and HeLa cells [9]. Based on this concept, The present study was aimed at the isolation of protease inhibitor producing bacteria from soil and finding new strains of microorganisms. We have screened bacteria for protease property and identified bacterium by 16s rRNA sequencing method as protease isolated from soil bacterial species and assessing its antibacterial activity and cytotoxic effect on cancer cell line (A549).

MATERIALS AND METHODS

Soil Sample
Soil sample was collected from the areas of Dr. NGP College of Arts and Sciences (Coimbatore, Tamilnadu), India, in a sterilized bag and carried to the laboratory for further analysis.

Isolation and Screening of Bacteria
1gm of the soil sample was weighed and serially diluted (10^{-1} to 10^{-6}). 0.1ml of the aliquots were spread plated on Skimmed Milk Agar and incubated 24 hours at 37°C. Caseinolytic activity of the bacteria was noted by the hydrolytic zones formed on the plates. Colonies showing higher zones were streak plated on Nutrient Agar which was stored at 4°C for further studies.

Cell Lysate Preparation
Bacteria were grown in Nutrient broth which was centrifuged at 6000rpm for 10 mins. The pellet was dissolved in 200mM lysis buffer (containing TRIS-Cl and EDTA; pH=8), lysozyme (20mg/ml) and protease inhibitor cocktail and incubated for 1 hour at 37°C.

Partial Purification of Crude Enzyme
Partial purification of the enzyme by Zambare method in which the cell lysate was precipitated with ammonium sulfate (at 40% saturation) and at 5000rpm for 20 minutes at 4°C. After the centrifugation was done, the protease precipitate was loaded in dialysis bag for dialysis which was dipped in 100ml of 200mM phosphate buffer (pH=8) for 6 hours with a change of buffer after every 2 hours. After this the partially purified protease was collected and protease activity and its molecular weight were determined.

Estimation of Protein Concentration by Lowry's Method

Samples were incubated with TRIS-Cl buffer, Reagent-A (2% of sodium carbonate mixed with 0. 1N sodium hydroxide), Reagent-B (1.56% Copper sulfate with mixed 2.37% sodium potassium tartrate) and 2 ml Folin-Ciocalteau reagent in dark for 30 minutes and the amount of the tyrosine released was measured calorimetrically at 660nm.

Estimation of Protease Activity by Using Azocasein as Substrate

Protease activity of the cell lysate or extract after ammonium sulphate precipitation was measured by azocasein assay (degradation of azo group from azocasein in per unit time can be detected by monitoring absorbance at 405 nm). 0.1 ml of the crude enzyme was incubated with 0. 25 ml of azocasein (2% azocasein in 0. 1M Tris HCl buffer; pH=7) for 60mins at 37°C and the reaction was stopped by the addition of 0. 2ml of TCA (5%).

Effect of Temperature and pH on Protease Activity

The effect of temperature and pH on protease activity was measured using protease assay using azocasein described above at the temperature range of 4–80^{0}C, at pH 7 with 10^{0}C interval. The influence of pH on protease activity was measured at optimum temperature obtained previously, and range of pH 4-10.

Identification of Protease-Producing Bacteria

Molecular characterization: Using the DNA extracted from the high-yield, protease-producing bacteria as a template, the 16S rRNA gene in the bacterial genomic DNA were amplified using the bacterial universal primers 27F and 1492R. PCR was performed at 94°C for 5 minutes, followed by 35 cycles of denaturation at 94°C for 30 seconds, annealing at 55°C45 seconds, and extension at 72°C for 1.5 minutes. Finally, repair and extension at 72°Cwere performed for 10 minutes, and the sample was stored at 4°C. A 50μL PCR amplification solution was prepared, and the amplification results were detected using 1% agarose electrophoresis to observe the specific products and their relative molecular masses. The amplified products were sent to applied biosystem 3500 Genetic analyzer for sequencing. The sequence obtained was searched against Genbank database to identify the organism. The sequences from the BLASTn result were obtained and used for phylogenetic tree formation. Phylogenetic tree was obtained by using phylogeny.

Extraction of Bioactive Compounds

10ml of overnight culture of the isolate protease was transferred into conical flask containing 500ml of Bennet medium (sterilized with steam explosion) individually and incubated for 7 days at 24°C at 200rpm and pH (7.0±0.2). Further the mass cultured broth was filtered through cheese cloth to get clear filtrate. Further, equal volume (1:1) of ethanol was added & mixed with the help of vortex and kept without disturbance. The organic phase was collected & evaporated at 70°C in an incubator. The obtained residue was stored at -20°C for antibacterial and cytotoxicity assay.

Antibacterial Activity of Protease Against Bacterial Pathogens

The antibacterial activity of purified fractions of isolated protease was evaluated against bacterial species using Agar well diffusion method. Sterile Muller-Hinton agar plates were prepared. The plates were allowed to solidify for 5 minutes and wells of 6 mm were punctured using a well borer. 0.1% inoculum suspension of each test organisms (*Escherichia coli, Klebsiella pneumonia* and *Pseudomonas aeruginosa*) was swabbed uniformly over the surface of the agar. About 20μl of PI fraction was added onto the well. All the plates were incubated at 37°C for 24 hours. Zone of inhibition around the well was measured after incubation and recorded [10].

Anticancer Activity of Protease as Potential Tool Against Human Lung Cancer A549 Cell Line
Cell Culture

The human lung cancer (A549) was procured from the National Centre for Cell Sciences (NCCS), Pune, India. The selected cancer cells were maintained in Dulbecco's modified eagle's medium (DMEM) supplemented with 2mM L-glutamine and balanced salt solution (BSS) adjusted to contain 1.5gL^{-1} Na$_2$CO$_3$, 0.1mM nonessential amino acids,

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1mM sodium pyruvate, 2mM L-glutamine, 1.5gL^{-1} glucose, 10mM (4-(2-hydroxyethyl)-1-piperazineethane sulfonic acid) (HEPES) and 10% fetal bovine serum (GIBCO, USA). Penicillin and streptomycin (100 IU/100μg) were adjusted to 1ml. The cells were maintained at 37°C with 5% CO_2 in a humidified CO_2 atmosphere.

MTT Assay

To evaluate the cytotoxicity of protease producing bacteria, the following experiments were carried out. The confluent monolayers of A549 cells were grown in 96-well tissue culture plates. Cells were incubated with different concentrations of protease. Then, we examined cell viability, as the ability of the cells to cleave the tetrazolium salt MTT [3-(4,5-dimethylthiazol-2ol)-2,5 diphenyl tetrazolium bromide), Sigma Chem. Co. St. Louis, USA], by the mitochondrial enzyme succinate dehydrogenase which develops a formazan crystal. Each concentration was replicated three times. The 50% inhibitory concentration (IC$_{50}$) was needed as the test compound concentration required for reduction of cell viability by 50% and IC$_{50}$ values were calculated by regression analysis. The OD value was used to calculate the percentage viability using the following formula.

% Of viability = OD value of experimental sample / OD value of experimental control × 100:

Morphological Study

The selected Human cancer cells that were grown on cover slips (1 × 10^5 cells/cover slip) were incubated for 24 hrs with protease at different concentration (25 μg/ml, 50 μg/ml, 100 μg/ml), and they were then fixed in an ethanol: acetic acid solution (3:1; v/v). The cover slips were gently mounted on glass slides for the morphometric analysis. Three monolayers per experimental group were micrographed. The morphological changes of the cells were analyzed using Nikon (Japan) bright field inverted light microscopy at 40x magnifications.

Fluorescence Microscopic Analysis of Apoptotic Cell Death

1μl of the dye mixture (100 mg/mL acridine orange (AO) and100 mg/mL ethidium bromide (EtBr) in distilled water was mixed with 0.9mL of the cell suspension (1×10^5 cells/mL) on clean microscope cover slips. The pre-treated cancer cells with different concentrations of protease were collected, washed with phosphate buffered saline (PBS) (pH 7.2), and stained with 10μL of AO/EtBr. After incubation for 2 min, the cells were washed twice with PBS and visualized under a fluorescence microscope (Nikon Eclipse, Inc, Japan) at 40x magnification, with a 480 nm excitation filter. Besides, the cells were placed on a glass cover slip in a six-well plate and treated with different concentrations of protease for 24h. The treated cells were fixed with methanol: acetic acid (3:1, v/v) and then washed with PBS. The cells were subsequently stained with 10μL of DAPI for 20 min in the dark and were observed under fluorescence microscopy (Nikon Eclipse, Inc, Japan).

Data Analysis

SPSS software package 16.0 version was used for all analyses. Cell apoptosis/growth inhibition data were analyzed by probit analysis, calculating IC$_{50}$, respectively. All cell viability data were transformed into arcsine H-proportion values then analyzed using ANOVA.

RESULTS AND DISCUSSION

Isolation and Screening of Bacteria

The strains of bacteria were screened among others which showed clear zones on the Skimmed Milk Agar plate indicating caseinolytic property of proteases (Figure 1). These strains were isolated and allowed to grow on nutrient agar media. Pure colonies were obtained with distinct morphological features.

Characterization of Bacteria

After sub-culturing on the Nutrient agar plates from the milk agar plates by streak plate method, the following characteristics of the yellow colonies and shape and size of small and round were observed in Figure 2.

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Protein Concentration of Bacterial Extract

Yellow bacterial cell lysates were high protein concentration as determined by Lowry's method using BSA standard curve. Figure 3 showed that bacterial colony has 1. 41 mg/ml protein.

Determination of Protease Activity by Using Azocasein As Substrate

Estimation of the protease activity was estimated quantitatively by using azocasein substrate. Degradation of azo dye was measured by absorbance at 440nm.

From the equation, enzyme activity was determined: -

Enzyme activity = (Δ Absorbance/min) / $\mathbb{C}$

($\mathbb{C}$ is the molar extinction coefficient and $\mathbb{C}1\%$ of azocasein is 37 liters g-1 and cm-1

Effect of Temperature on Protease Activity

A standard protein assay using azocasein was carried out at constant pH 7 for 1 hour by varying the temperatures (4-80℃). The purified protease has optimum activity at 60℃, shows in Figure 4. The optimum temperature of this protease was similar to protease obtained from*Geobacillus spp*. YMTC 10492, *Bacillus spp.* [11], *Bacillus* brevis [12], Thermoacidophiles [13], and Bacillus licheniformis Lbbl-11 [14].

Effect of pH on Protease Activity

The important aspect of enzyme catalyzed reaction is the effect of pH and temperature on the enzyme. For any purpose use of an enzyme the effect these parameters should be determined. A standard protease assay using azocasein was carried out by varying pH (4-10) for 1 hour at 37℃. The optimum pH of the protease enzyme was found to be 8. 5. Protease from bacteria showed higher activity (Figure 5). The optimum pH for this protease activity was similar to protease from Bacillus brevis and Bacillus sp JB-99 [15].

16s rRNA Sequencing Analysis of The Isolate

The 16s rRNA sequencing, one of the most useful and effective methods for identifying organisms and tracing phylogenetic relations as shown in Figure.6. 16s rRNA has both conserved and variable regions. While the conserved regions are made use in finding the evolutionary background of the species, the variable regions are of more interest when it comes to identification. The Small subunit ribosomal ribonucleic acid (ribosomal SSU) exists universally among bacteria and includes species-specific variability which is unique to each bacteria and is used for identifying the organism by comparing it with public domain databases [30]. From the sequencing, the organism was identified as *Pseudomonas otidis*. Commonly, protease produced by Pseudomonas genus [16,17], Bacillus genus [11,15,18].

Antibacterial Activity of Protease Against Bacterial Pathogens

Antibacterial activity of the protease inhibitor fractions was assessed against the bacterial pathogens on MHA plates compared with a standard fluoroquinolone drug ofloxacin. During the analysis, the zone of inhibition measured in millimeters for Protease and ofloxacin was calculated in triplicates and presented in Mean ± Std deviation. The bacterial pathogens organisms *Escherichia coli, Klebsiella pneumonia* and *Pseudomonas aeruginosa* showed highly inhibitory zones of 20.1±0.85mm, 18.9±0.44mm and 18.3±0.38 mm. Similar difference in the susceptible pattern was evident for the fluoroquinolone ofloxacin (Table 1). The obtained results revealed that the protease participate in the defense response of pathogens. It was reported that protease could also act synergistically with other classes of antibacterial drugs [19], antifungal drugs [20] and antiviral drugs [21]. Recently, protease inhibitors have received new interest due to their potent ability to prevent carcinogenesis in a wide variety of in vivo and in vitro systems [22].

Anticancer activity of Protease as potential tool against human lung cancer A549 cell line
Cytotoxic Assay

The effect of Protease on the Human cancer cells by using the MTT assays. Protease was examined for cytotoxicity effects on A549 human lung cancer with MTT bioassay in a 24-hours examination (Figure. 7) and the IC_{50} value is shown in Table 2. Figure 7 shows that Protease can inhibit the growth of A549 human lung cancer at certain doses,

which demonstrated that IC$_{50}$ values were, respectively 31 μg/ml, whereas 18μg ml in MCF -7 cells for doxorubicin (standard). The Protease had higher inhibitory activity against cell proliferation as compared to the doxorubicin.

Morphological Analysis
The morphological change of A549 cells was observed after treatment for 24 hrs with the IC$_{50}$ concentration of the Protease (Figure 8). The change in the morphology of treated cells can be seen in a dose dependent way. Cytotoxicity was increased with increase Protease. This extract incited cell shrinkage, adjusting of the cell and reducing the number of feasible cells. These progressions demonstrate that Protease actuated apoptosis in A549 cells (Figure 8b, c & d). On the other hand, untreated control cells did not show any adverse effect (Figure 8a).

Fluorescence microscopic analysis of nuclear fragmentation – AO / EtBr Staining
The fluorescence microscopic analysis was carried out to the effect of apoptogenic activity of the Protease on cancer cells. No aggregation of Protease was observed during the assay because most of the Protease was dissolved at these low concentrations. After the treatment with IC$_{50}$ concentration of Protease, the induction of apoptosis was assessed for A549 cells by fluorescence microscopy stained with acridine orange/ ethidium bromide (AO/EtBr). These results showed that the live cells had green color fluorescence and dead cells had acridine orange fluorescence. The untreated control cells revealed large numbers of live cells (Figure. 9 (a)). On the other hand, the treated A549 cells with Protease depicted more apoptotic cells and apoptotic bodies observed a nuclear shrinkage, nuclear damage and blebbing as orange-colored bodies (Figure. 9(b, c & d)).

Fluorescence microscopic analysis of nuclear fragmentation - DAPI Staining
Furthermore, we evaluated the Protease using the DAPI staining method. Fluorescence microscopic description of the cells stained with DAPI after 24 h in the absence and presence of Protease are shown in Figure10. Figure 10 (a) shows that cells did not prove any significant changes whereas Protease treated cells (Figure. 10 b, c & d) bright fetches, indicating the configuration of condensed chromatins and nuclear fragmentations in the A549 cells. Thus, from the results of fluorescence microscopic analysis, conclude that Protease can be used as an effective therapeutic agent against cancer. It isevident from the present investigation that proteases showed significant cytotoxiceffects on A549 cancer cell line. Earlier research has reported cytotoxic activity in *Stenotrophomonas maltophilia* [23]. The bacterial isolate showed IC$_{50}$ value 17.2μg/ml, 26.5μg/ml and 35.5μg/ml in EAC, SiHa and Hep G2 cancer cell lines, respectively. Another research has reported that the IC$_{50}$ values less than 30μg/ml in cancer cell lines can be considered as potent for anticancer drug development [24]. Similarly reported that bacteriocin produced by Lactococcus lactis have cytotoxic effect on MCF7 breast cancer cell lines [25].

CONCLUSION

Over all in this research concludes that the protease enzyme obtained from has optimum temperature at 60°C and optimum pH for its activity at 8.5 and bacterium as protease producer identified as *Pseudomonas otitidis*. And, we have found protease shows a potential antibacterial effect against different pathogens. Furthermore, our studies found that extract of protease possess excellent inhibitory activity against the proliferative and migration of human lung cancer (A549) cell line and inhibits the growth of cancer cells.

Conflict of Interest
Authors have no conflict of interest to declare

ACKNOWLEDGEMENT

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Table 1: Antibacterial activity of protease against bacterial pathogens

S.No	Test organism	Zone of inhibition (mm)	
		Protease	STD (Ofloaxin)
1	*Escherichia coli*	20.1±0.85	21.8±1.30
2	*Klebsiella pneumoniae*	18.9±0.44	19.9±0.70
3	*Pseudomonas aeruginosa*	18.3±0.38	20.6±0.28

*Mean ± Standard deviation

Table 2. Cytotoxic activity of Complexes (μg/ml)

Extract	A549 (IC$_{50}$)
Protease	27± 1.2
Dox	23± 0.7

IC$_{50}$ – Values of respective Compounds (at 24 hrs)
Standard Used: Dox'
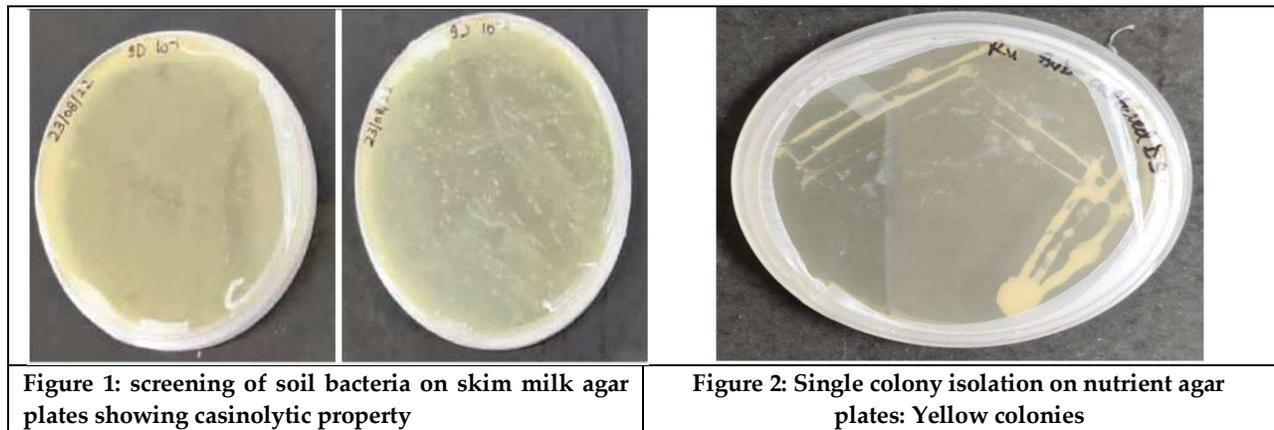
| Figure 1: screening of soil bacteria on skim milk agar plates showing casinolytic property | Figure 2: Single colony isolation on nutrient agar plates: Yellow colonies |
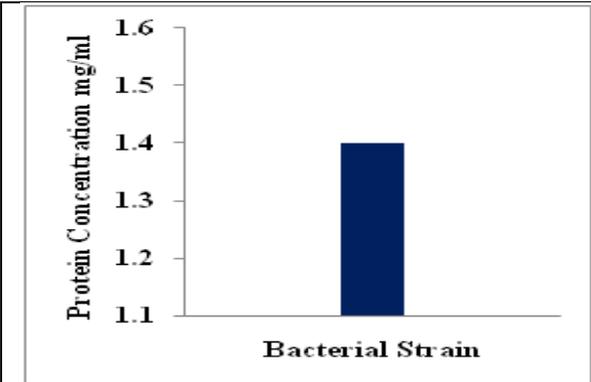
Figure 3: Protein concentration in different crude extract
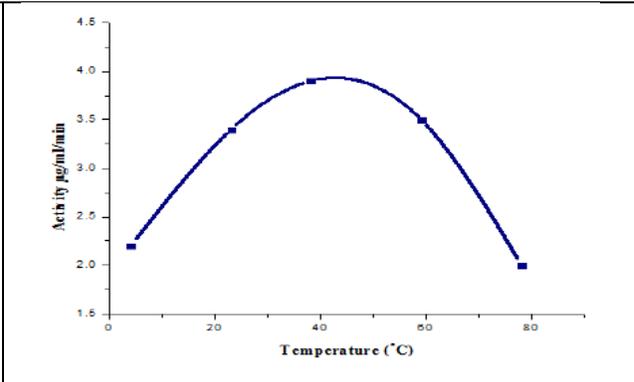
Figure 4: Effect of temperature on protease activity
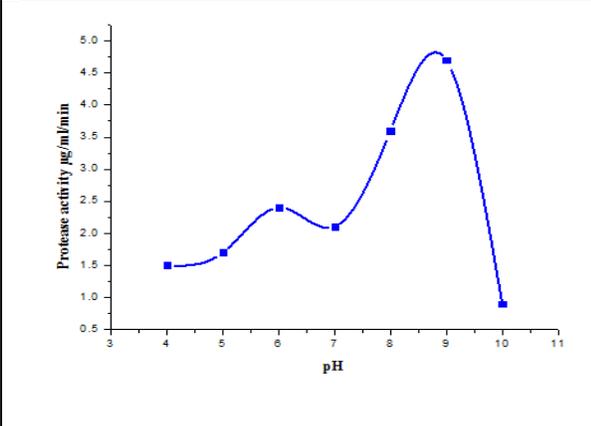
Figure 5: Effect of pH on protease activity
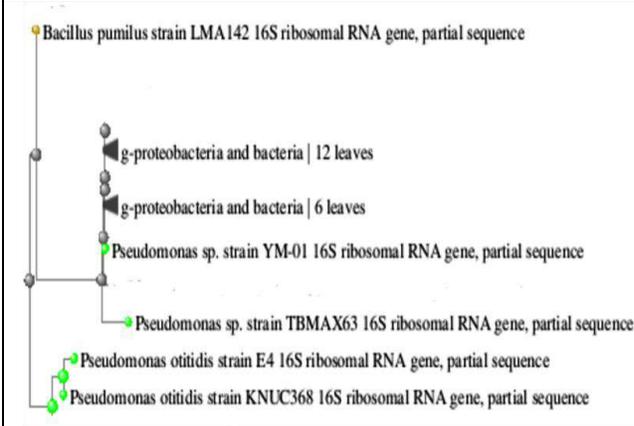
Figure 6: Phylogenetic tree based on 16s rRNA gene sequence showing the Pseudomonas sp. strain which is *Pseudomonas Otidis*.
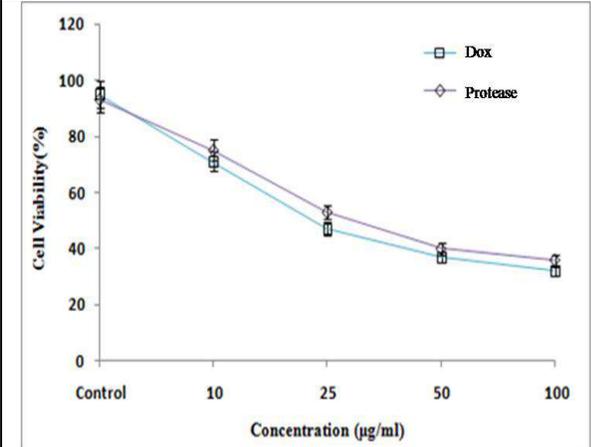
Figure 7: MTT analysis of Protease
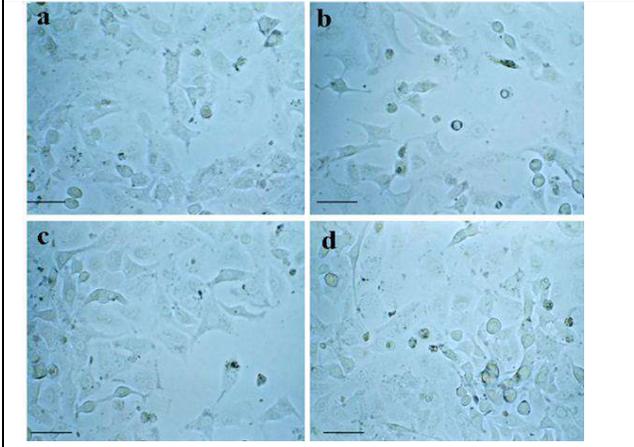
Figure 8: Morphological analysis of Protease-treated A549 cells for 24 hrs (a) Control (b) 25 μg/ml (c) 50 μg/ml (d) 100 μg/ml
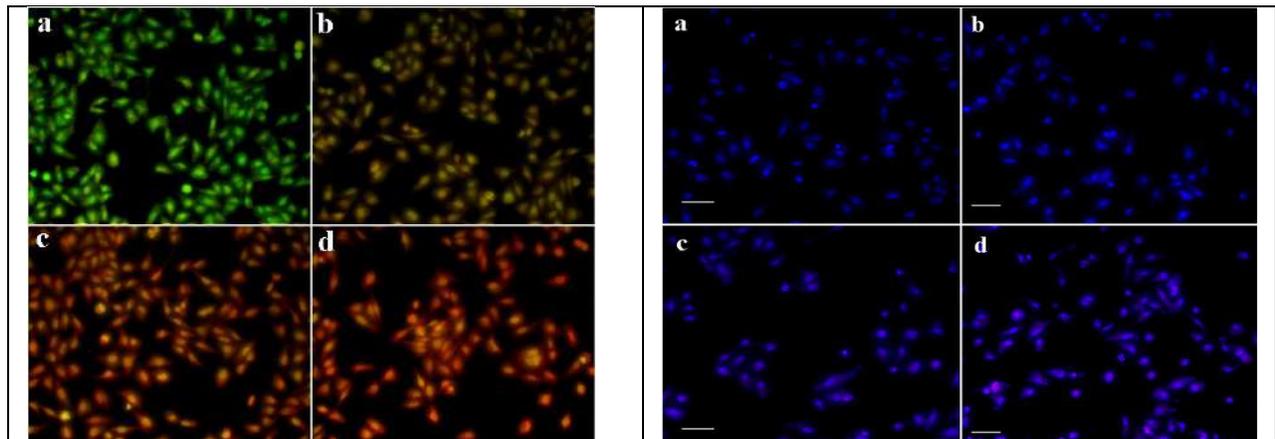
Figure 9: AO/EtBr staining assay of Protease- treated A549 cells Control (b) 25 µg/ml (c) 50 µg/ml (d) 100 µg/ml

Figure 10: DAPI staining assay of Protease- treated A549 cells (a) Control (b) 25 µg/ml (c) 50 µg/ml (d) 100 µg/ml

REVIEW ARTICLE

A Case Study on the Incredible Role of Telematics in the Field of Logistics

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ABSTRACT

The rapid growth of smart devices has resulted in a shift in how telematics is used and how the vast amounts of data it collects is processed. Today's vehicles are the most technologically advanced, enabling safer and easier driving. High-tech sensors and automatic operation also ensure a more comfortable driving experience. As a result of corporate demand and regulatory obligations, vehicle telematics continues to gain popularity in Logistics sector. Telematics is a term that has become increasingly common over time. It brings together automotive technology and computer science to open up new possibilities in the logistics industry. Though, Telematics can be effectively used in various industries such as agriculture, forestry, construction, manufacturing, freight, delivery, retail, finance/insurance, mining, etc. Telematics emergence in the Logistics sector has marked a watershed moment in fleet efficiency and safety. Monitoring vehicle location, fitness, and performance has been one of the most important concerns that logistics companies have had to deal with. The emerging telematics era can help organizations overcome this barrier. The capacity to collect information on a vehicle's route, fuel level, position, amount of engine idle and delivery status makes telematics invaluable to the logistics business.

Keywords: Telematics, Auto Insurance, Fleet Tracking, Insurance sector, Logistics.

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INTRODUCTION

The word 'telematics' is a compound term. It combines 'tele' – a prefix denoting remote communications (the prefix is derived from the Greek for 'far-off' or 'at distance') and 'informatics', a discipline incorporating the practice of information processing[1].Telematics is a game-changing automobile technology that uses information technology and communication protocols to send, receive, and store data from remote vehicles. The data is securely delivered over a wireless network, and remote connectivity is established using an in-vehicle electronic device or smartphone. Telematics is the combination of two advanced technologies: Telecommunication and informatics. Telematics combines navigation, safety, security and communication into one convenient piece of technology that fits in a vehicle's dashboard [2]. Wireless data is received by automotive telematics systems and transmitted through a crash-resistant box. Trucking telematics systems have proved to be highly useful to fleet owners and managers. These systems play a crucial role in Transportation Management Systems Vehicle Maintenance [5].

Telematics has become more and more important to the industry, making fleets interconnected in ways that were impossible before. The technology is so useful that it simply can't be ignored. Telematics is here to stay and the industry is marching toward universal adoption[3].

Automobile insurance firms, fleet management businesses, and others use telematics devices to track a vehicle's position and activity. Telematics Control Unit (TCU), telematics cloud server, and the front end-based vehicle telematics system are the three main components of a vehicle telematics solution.

OBJECTIVES

The specific objectives of this research were to:
- To estimate the size of the global Telematics market.
- To provide an overview of the top global key players, value of Telematics in Logistics and global market share of telematics. Also includes a strategic overview of how Telematics helped logistics industry during Pandemic as well as an in-depth analysis of their growth strategies.

HISTORY OF TELEMATICS
1978: In a technology development report to the French prime minister in 1978, the term "telematics" is coined.
1988: The European Commission launches major research programmers to test car telematics with the goal of increasing road safety and lowering environmental impact.
1993: The US government provides consumers complete GPS access in 1993, bringing GPS technology to the consumer market.
Early 2000s: Telematics technologies are being used enterprise-wide in Web-based fleet management systems with real-time data updates to remote networks. Slow tracking rates of one or two incidents per hour are limited. The consumer market was swamped with GPS- based automobile navigation systems in the mid-2000s.
Late 2000s: Advances in cloud and M2M technologies allow for super-fast and precise tracking of GPS data and other sensor characteristics, which may then be reported in real time.
Present: Unprecedented innovation in IoT and M2M telematics data management capabilities for the enterprise and consumer markets.

WORKINGS OF TELEMATICS

Telematics systems perform a range of functions by gathering vehicle location and activity data and turning this into business insight[4]. Telematics is based on the following principles:
Using a GPS-enabled gadget installed in a car to capture vehicle location data. Sending collected data across secure cellular networks. Presenting and visualizing vehicle location and driver activity data using a web-based software platform.

TYPES OF TELEMATICS

- **Smartphone/Mobile**

Smartphones are the most convenient and cost-effective way of telematics solutions [6].The advantages of smartphone telematics and Behavior-Based Insurance (BBI) programs are fairly obvious: insurance providers can identify and understand risks by gaining a more accurate glimpse of how their clients actually behave behind the wheel [7].

- **Bluetooth-Enabled Self-Powered Devices**

The Bluetooth-enabled devices are united with smart phone apps. The devices are directly fixed in the vehicle. Many pre-1996 vehicles are implemented with this technology. The device collects all the data and transfers it into understandable information. This information is used to improve the driving experience. This device is also known as household telematics. It is commonly used by low-risk drivers, new learners, young drivers who use the vehicle for non-commercial or personal use.

- **Bluetooth Assisted Devices**

These are self-powered fixed vehicle devices that use your smart phone's network to relay driving data to the insurer[6]. It's primarily employed by high-risk drivers. Mileage is one of the key elements used to determine the premium cost in many insurance contracts. This is a mileage-focused rating that focuses on the vehicle.

- **OBD (On Board Diagnosis)**

This is an on-board computer that keeps track of everything in the vehicle, including driver behavior, vehicle maintenance, emissions and soon. The device is connected to the vehicle's OBD connection and can send data through the cellular network.

- **Hard-wired Telematics Device**

The main component of the Hard-wired devices is the Telematics Control Unit (TCU)[6]. Hard-wired telematics devices, unlike OBDII and smart phone based fleet telematics devices are very secure as they are hard fitted into a vehicle [8]. They are connected to the vehicle's electrical connections by using the vehicle's battery.

- **Black Box**

A black box is a small box fitted inside the vehicle. It measures the various aspects of the vehicle and transfers them to the insurance companies [6].The black box is a more dependable and adaptable device. Low-mileage insurance is encouraged. Because it is technically complex, it is simple to install in the vehicle.

THE NEED FOR TELEMATICS IN LOGISTICS

Monitoring vehicle location, fitness, and performance has been one of the most important concerns that logistics companies have had to deal with. The new telematics era can help organizations overcome this barrier by giving a wealth of data on these aspects, allowing them to increase operational efficiency.

- **Lower Operational Costs and Greater Efficiency**

The use of Fleet Telematics and other intelligent AI-based tools can greatly improve business performance and lower operating costs. The fundamental idea is to turn massive amounts of data into usable and actionable information. This data can be compiled and used to develop new strategies and algorithms. They can help agencies make accurate predictions about how deliveries will be made based on driver behavior, traffic and weather conditions.

- **Employee Safety Has Improved**

In discussing how telematics affects all sections of the logistics system, we should also consider worker safety, keeping in mind that telematics collects data on vehicle health and driving behavior and provides it to the operators. A thorough evaluation of the driving is possible by capturing the vehicle's speed, harsh braking, swerves, and a wide range of street Conditions.

- **Cut fuel costs by better fuel management**

Thankfully, the telematics system's fuel management systems can assist in improving a Vehicle's fuel efficiency. Transporters can gain insights into gasoline usage as well as corresponding map position and time by equipping their fleet with a fuel management system. Reports on fuel transactions by kind of fuel, distance travelled, quantity spent and cost.

- **Increase vehicle longevity and improve vehicle performance**

The Telematics technology aids fleet managers in keeping track of their car's health. It helps to reduce unnecessary mileage, while telematics data can also help to eliminate engine idling (through being caught in traffic jams, for example) and thereby reduce engine run time while also helping to improve fuel efficiency.

According to a study by NHTSA, more than 94% of collisions are attributable to driver error, and of those incidents, a majority stem from risk factors that include distracted driving, speeding, tailgating and improper turns [14].

INDUSTRIES THAT ARE BENEFITED BY TELEMATICS

In addition, the consumer telematics market is categorized by end user, such as car (owned and rented), healthcare, insurance, media and entertainment, vehicle manufacturers/dealers, government agencies and soon.

THE MAIN GLOBAL BY USERS OF TELEMATICS

Transportation and Logistics

Global Commercial Telematics Market is expected to reach US$ 130.15 Bn. By 2027, at a CAGR of 14.35% during the forecast period [12]. Real-time engine diagnostics, GPS tracking, fatigue alert, and drive lane assist are among the technological breakthroughs that are transforming the existing driving experience, and the adoption of such technologies in mid-range vehicles is likely to enhance the market.

Insurance Industry

Global Automotive Telematics Insurance Market size is expected to reach US$ 161.91 Bn. By 2027, at a CAGR of 15.6% during the forecast period [13]. GPS- enabled telematics is essential for keeping a construction site operating by locating and Tracking construction equipment

Government Fleets

County and municipal fleets are comprised of different types of vehicles: from street sweepers to public work vehicles, from refuse and recycling trucks to emergency service vehicles, just to mention a few GPS fleet tracking software, often known as AVL, has been widely adopted by government fleets (Automatic Vehicle Location)[9]. This mainly includes state and municipal fleets throughout North America. GPS tracking is used to track most, if not all, of the vehicles in each department [11].

MAJOR PLAYERS

Key Companies in Commercial Telematics Market are
Geo tab Inc. (Oakville, Canada),
Trimble Inc.(U.S.),
Tom Tom Telematics BV(Netherlands),
Verizon Telematics, Inc.(U.S.),
Mix Telematics International (Pty)Ltd(South Africa),
Zonar Systems, Inc. (U.S.),
Octo Telematics Ltd. (U.K.),
Omnitracs LLC (U.S.),

Masternau tLimited. (U.K.),
Microlise Group Ltd. (U.K.),
Inseego Corporation (U.S.),
Volkswagen Commercial Vehicles (U.K.),
Continental AG(Germany),and Others[18]

The global commercial telematics market was valued at $3.53 billionin2020,andis projected to reach $30.05 billion by 2030, registering a CAGR of 24.5% from 2021 to2030.North America region is leading the market presently in terms of revenue and foreseen to grow considerably over the forecast period.

Growth of Telematics in Indian Market
The government is investing 12,000 crores ($2.4 billion) in improving the police force, including the consolidation of security grids in key cities. The government initiates 12,000 crores, i.e., 2.4 dollars billion investment in upgrading the police force, including the consolidation of the key cities' security grids [15]. India will become 'toll plaza free' in the next two years: 2023 [16]. The administration has chosen to keep toll plazas as seamless as possible for all vehicles. Rising Number of Road Accidents, Vehicle Thefts and Social Factors Driving the Market for Telematics Devices in India [17].

The Indian market is expected to grow at a CAGR of 31.2 % (From 2015-2020) and CAGR of 38.3 %(from 2020-2025).

Telematics and Its Market Size

This graph divides the market into four categories: service, form, vehicle type, aftermarket, components, connection, service type (fleet management), and geography North America, Asia Pacific, Europe, and the Rest of the World are the regions covered. Major actors in the telematics solutions ecosystem are included in the above analysis. Robert Bosch GmbH (Germany), AT&T INC. (US), Continental AG (Germany), LG Electronics (South Korea), Verizon (US), and a total of 26 key players are among the major players covered.

Role of Telematics in Logistics During Covid-19 Pandemic
- **Upgrade Driver Safety**

First and foremost, it's important that managers keep their team healthy. Social distancing is easier with the right tech. Live GPS maps and communication tools decrease the need for drivers to check-in with managers in person. GPS data can also be used for tracing purposes, providing vital information about who a driver may have been in contact with. Get ETA boards to monitor multiple routes, their status, route percentage completed, and traffic conditions on the road [21].

- **Inventory Management**

As for inventory management-pharmaceutical manufacturing businesses, health care organizations, clinics, hospitals, health charities and non-governmental organizations, food retail and wholesale companies are being helped to manage a workflow overload, inventory tracking, stolen goods, and robbery issues[22].

- **Improves Efficacy**

Telematics helps fleets where it matters most – reduced fuel use, lower labor expenses, and savings on cost, time and miles driven and improved vehicle fleet efficiency. All of this, of course, ties up neatly into higher revenues and profitability. No wonder then that fleets are continuing to ramp up investments in telematics technologies [22].

CONCLUSION

In the automotive business, telematics has experienced exponential expansion. Telematics is also assisting industry and society in adapting to the on-going issues that large cities face. Telematics has come a long way from mere GPS

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tracking to Big Data analytics, and here is more to come [19]. High-end telematics systems, complete with a telematics gateway unit, are now used by enterprises that manufacture heavy vehicles and luxury passenger automobiles. Overall, we believe that telematics will become an intrinsic feature of all future automobiles, and that this will result in a paradigm shift in the automotive industry. With the widespread of IoT and Artificial Intelligence, telematics continues to improve and gets better by the day. As owners look beyond the basic needs in order to achieve 'increasing integrations into the broader scope of the enterprise, including with mobile workforce management, ERP software, and business management software, telematics will become an integral component of all modern fleet operations [20].

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Table 1. Growth of Telematics in Indian Market

Expected Growth of Indian Telematics Market	
Year	**Revenue (Billions)**
2015	0.4
2017	0.7
2019	1.2
2021	2.2
2023	4.8
2025	8.1

Source: https://www.geotab.com/blog/telematics-growth-the-golden-age/

Source:https://www.carinsurance.org/telematics-and-car-insurance/
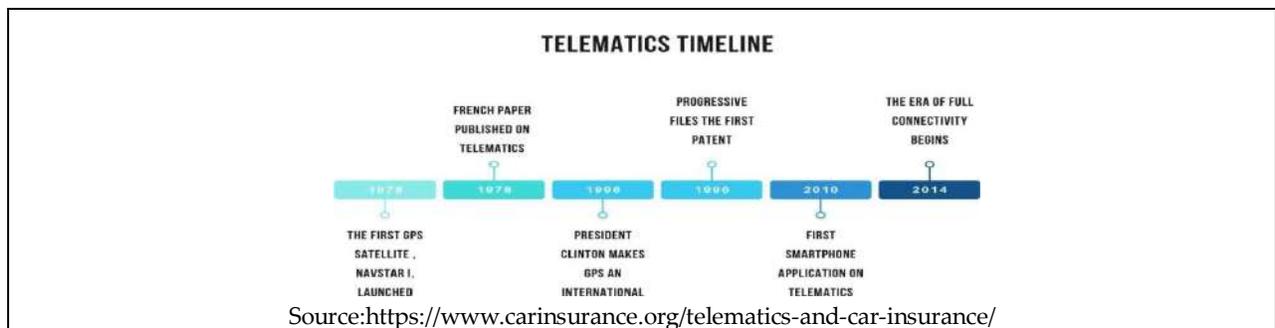
Fig.1. Telematics timeline

Source: https://www.verizonconnect.com/resources/article/what-is-telematics/

Fig.2. Working Softelematics

Source:https://blog.fleetcomplete.com/the-true-roi-of-telemati
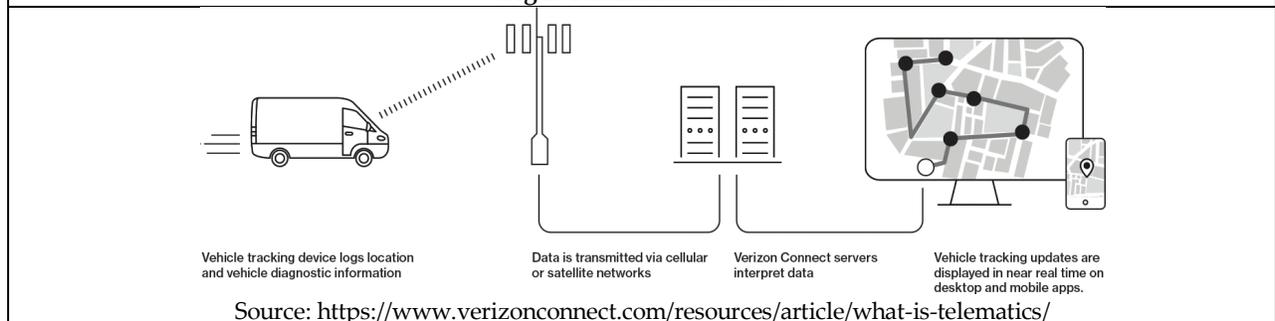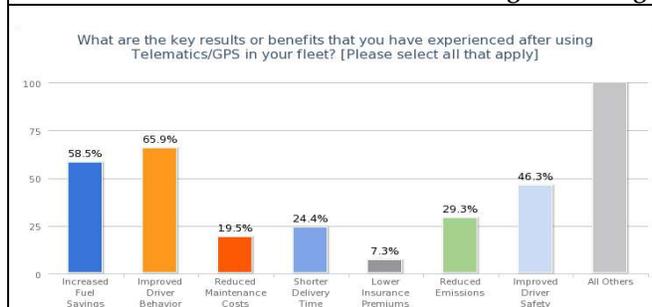
Fig. 3. Vehicle Performance

Source:https://www.alliedmarketresearch.com/commercial-telematics-market
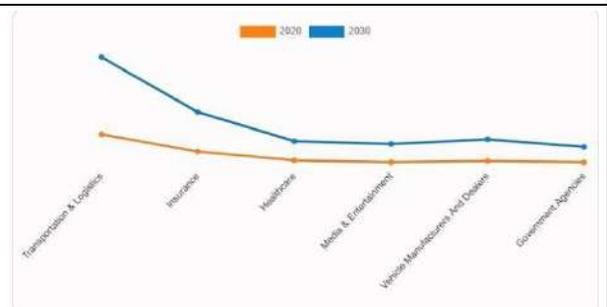
Fig.4. Industries that are benefited by telematics

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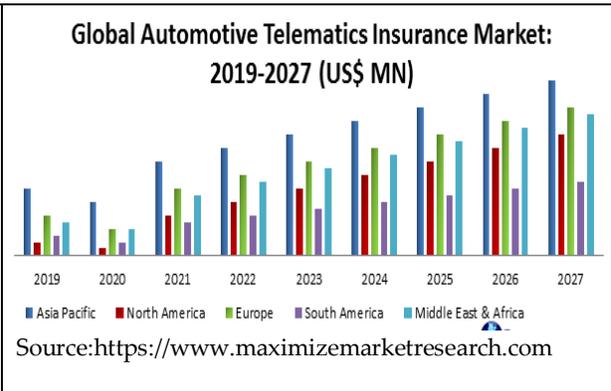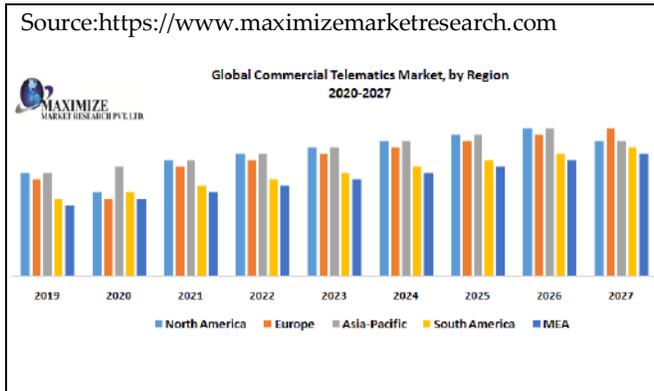
Fig.5. Transportation and Logistics

Fig.6. Global Automotive Telematics Insurance Market

Fig.7. Major Players
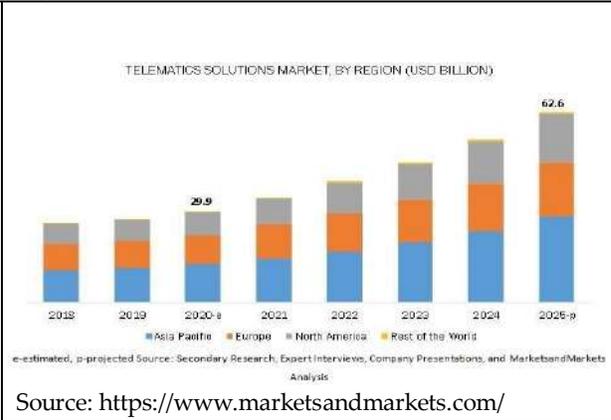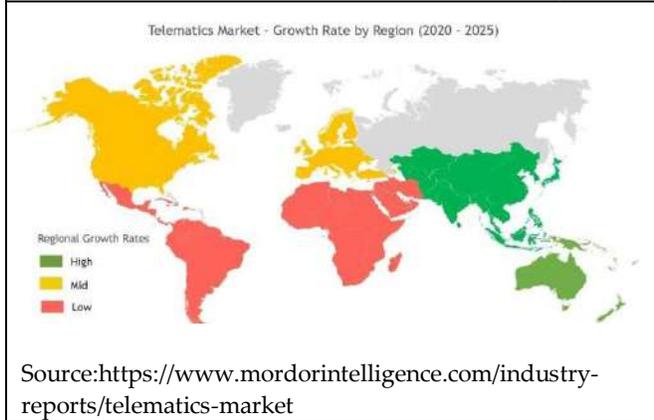
Fig. 8. Telematics and Its Market Size

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RESEARCH ARTICLE

Modification of PVC – Poly (Butyl Acrylate) Blends by Incorporation of Nano CaCO$_3$

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ABSTRACT

In the recent years, the incorporation of nano materials in polymers have set a new milestone to scientific research and development in the area of Polymer Science and Technology. Polyvinyl chloride (PVC) is one of the polymers which play a large role in the area of consumer products. However, some of the problems which are associated with the most widely used polymer PVC are poor impact strength, difficult processibility and poor thermal stability. These confinements can be overcome by polymeric or non-polymeric modifiers which are often referred to as impact modifiers or processing aids. However, one of the properties of the polymer is enhanced but it induces deterioration in the other properties of the same when a non-polymeric modifier is used. So, by incorporating a polymeric modifier like polybutyl acrylate (PBA) in PVC, it has been observed that the mechanical properties of the latter are largely modified by increased elongation at break and toughness. However, the strength parameters of modulus and ultimate tensile strength seems not to be improved by the influence of PBA. Taking this problem into consideration, the present study aims at improving the strength properties of PVC in terms of modulus and ultimate tensile strength by incorporating nano calcium carbonate (nano CaCO$_3$) while maintaining the balance of improved elongation at break and toughness within it and estimate the dynamics of the incorporated system over a range of added nanofiller.

Keywords: Poly (vinyl chloride), Poly(butyl acrylate), Nano calcium carbonate, Mechanical properties, Toughness

INTRODUCTION

Synergism in properties of materials is an inspiration to the scientists towards the formation of nanocomposites in the arena of Polymer Science and Technology. Incorporating multifunctional nanomaterials into polymers provides an effective approach towards enhanced performance and creation of new functionalities [1]. The resulting polymer nanocomposites benefit from the advantages of both the polymer matrix and reinforcement phase [2]. With this conception, a nanofiller, nano $CaCO_3$, has been incorporated in poly(butyl acrylate) blended PVC matrix to observe the dynamics of mechanical properties with variation in the proportion of the nanofiller, nano $CaCO_3$[3]. '

Several studies have been reported about incorporating various nanofillersin PVC to enhance its properties [4]. A study reveals that increased hardness and decreased smoke production is exhibited in PVC composites containing well dispersed nanoclays [5].The antimicrobial property and photostability of PVC is influenced by introduction of copper or silver nanoparticles in it [6]. Cen *et.al.* [7] estimated the effect of nano $CaCO_3$ on the mechanical properties of PVC and PVC/ Blendex. . It was observed that the properties like impact strength, flexural modulus, Vicat softening point enhanced appreciably on addition of 0 – 15 phrnano $CaCO_3$ incorporation. Dzhardimalieva *et.al.* estimated the preparation of metal – polymer nanocomposites by chemical reduction of metal ions [8]. The assessment of structural, thermal, dielectric and catalytic properties on silver nanoparticle incorporated PVC films was reported by Ganesh *et. al.*[9]. He analysed that the properties exhibited improved performance on incorporation of the nanoparticles. In another study, the catalytic activity of polymer inorganic composite materials were estimated in a silver nanoparticle loaded matrix by Yan et. al [10]. Also, the antifouling properties and desalination performance by incorporation of magnetite nanoparticles within PVC microfiltration membrane was significantly studied by Alghamdi *et.al* [11].

Despite abundant usage of PVC, the properties of the polymer demands further improvement when several application factors set in. To overcome these drawbacks of properties, polymeric or non polymeric modifiers may be used which are often referred to as impact modifiers or processing aids [12]. However, by the usage of a non polymeric modifier, one of the properties of the polymer is enhanced but it induces deterioration in the other properties of the same [13, 14]. The incorporation of acrylates in PVC behaves as equivalent to rubber toughening of glassy polymers [15, 16]. So, if an acrylate polymer (polybutyl acrylate) (PBA) is blended with PVC, the mechanical properties of the latter are largely influenced by increased elongation at break and toughness. With this basic observation, the present study aims at improving the properties of PVC even further in terms of modulus and ultimate tensile strength for effective environmental stability by incorporating nano calcium carbonate within it and estimate the dynamics of the incorporated system over a range of added nanofiller. In the present study, an endeavour has been made to enhance the mechanical properties of poly(butyl acrylate) incorporated PVC in terms of its modulus, ultimate tensile strength, elongation at break and toughness by using nano calcium carbonate ($CaCO_3$) as the nanofiller. The nanofiller has been added in varying proportion (from 3 to 15 phr) in 75:25 PVC – Poly (butyl acrylate) blended system. It is proposed that the enhancement in the property parameters subsequently leads to the superior applications of PVC material in versatile sectors.

EXPERIMENTAL

MATERIALS

PVC resin (grade K 67) was procured from M/s Kalpana Industries Ltd. and was used as the major matrix resin. Dioctyl phthalate (DOP) from M/s Burgoyne (India) and tribasic lead sulphate (TBLS) procured from M/s Kalpana Industries Ltd. (Daman, India) were used as suitable plasticizers and stabilizers respectively. Poly(butyl acrylate) from LobaChemie was used as polymeric modifier of PVC. Nano calcium carbonate which was used as the nanofiller

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was supplied from ReinsteNanoventures Pvt. Ltd. Benzoyl peroxide also from LobaChemie(India) was used as initiator for acrylic polymerization.

METHODS

PVC resin (75 parts by weight) was taken in an air tight dry blender and mixed with 30 parts by volume ofdioctyl phthalate (DOP) plasticizer and 2 parts by weight of tribasic lead sulphate (TBLS) heat stabilizer with respect to the amount of PVC resin taken. The butyl acrylate monomer (25 parts by weight) premixed with benzoyl peroxide initiator (2 parts by weight) was added to the PVC mix along with the nano calcium carbonate filler and mixed thoroughly in the blender at a slightly elevated temperature unless a thoroughly mixed powder was obtained. A number of batches were prepared varying the dose of the nanofiller from 3, 6, 9, 12 and 15 parts by weight. The mixes was then moulded by compression in a compression moulding machine into sheets under heat and pressure which was then subjected for mechanical testing in Instron Universal tester. Initially, the mould (0.95 m x 0.65 m x 0.001 m) with the mixed powdery content was heated at a temperature of 80^0C to initiate and propagate acrylatepolymerisation. This was allowed to continue for 30 min. Subsequently, the temperature was raised to 160^0C while a pressure of 15 tons/cm^{2}was maintained. The mould was then cooled down to 100^0C and kept for 30 min to ensure complete polymerization of butyl acrylate and nanomaterial dispersion. Consequently, the mould was allowed to cool down to the room temperature and the moulded sheet ejected [17].

Characterization
An Instron Universal Testing Machine (Model 4204) was used for measuring the tensile properties like modulus, ultimate tensile strength, elongation at break and toughness. In the process of measurement, ASTM D638 method was followed.

RESULT AND DISCUSSION

The effect of nanomaterial (nano CaCO$_3$)incorporation on the blended PVC – polybutyl acrylate (75:25 ratio) was analyzed in terms of modulus, ultimate tensile strength, elongation at break and toughness. The ratio of 75:25 has been opted according to the derived values of the mechanical parameters obtained from the blended ratio of 80:20 and 70:30 of PVC and polybutyl acrylate respectively as shown in Table 1. As already reported in literature [18], the optimum level of modulus and ultimate tensile strength was reached at the concentration ratio of 80:20 of PVC and polybutyl acrylate and that of elongation at break and toughness was reached at the concentration ratio of 70:30 of the same. Consequently, the ratio of 75:25 of PVC and polybutyl acrylate was chosen in the present investigation to extract the utmost optimum values within which nano calcium carbonate was incorporated for further modification of the mechanical parameters. The dynamics of mechanical behavior of nanofiller incorporated PVC – polybutyl acrylate blends was reflected in terms of modulus, tensile strength, elongation at break and toughness.

Variation of Modulus
The change of modulus of the nano calcium carbonate incorporated PVC with gradual increase in the nanofiller dose is depicted in figure 1. The significant rise in modulus with increasing content of nanofiller is clearly explicit in the depicted plot. This is indicative of the fact that the nanoparticles get well distributed within the PVC matrix with enhanced surface area and amplifies the interaction between itself and PVCconsequently modifying and improving the mechanical parameter. The rise in modulus over a range of 3 to 15 phrnanofiller incorporation as explicit in the curve reveals that the value rises from 393 MPa to 446 MPa. When poly (butyl acrylate) is incorporated within the major matrix PVC, there is molecular interaction between the polar entities of the two participating polymers. The secondary valence force due to the formation of H bonds through the strongly electronegative chlorine in PVC and the α hydrogen of the ester groups present in polybutylacrylate are considered to influence the compatibility of the two polymers and subsequently enhance the initial strength parameters of unmodified PVC.This force predominates over the weakening dipolar forces between the adjacent PVC chains owing to the incorporation of PBA within the

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interstices of the PVC chains. Thus, the properties exhibited by the blending may be considered as an effect of two opposing forces operating simultaneously. The modulus of 75:25 PVC:PBA blend have been further augmented by the incorporation of the nanofillernano calcium carbonate and a significant rise over 3 to 15 phr range is observed. It is perceived that the plasticization effect of the polybutyl acrylate tends to be compensated by the presence of the dispersed nano calcium carbonate which helps to increase the rigidity modulus parameter. The reinforcing influence of the nanofiller exerted on the PVC-PBA blended system aids in uplifting the modulus of the system well above the base reference compound [20]. However, the values tend to level off beyond 15 phrnanofiller incorporation which is indicative of reaching the optimization point of modulus in the entire system under consideration.

Variation of Ultimate Tensile Strength
Figure 2 represents the rise in Ultimate Tensile Strength (UTS) and it is found to be in corroboration with the rise in modulus as observed, on increasing nano calcium carbonate. The incorporation of nano calcium carbonate from 3 to 15 parts by weight reflect the dynamical changes in the Ultimate Tensile Strength throughout the range of the nanofiller.A gradual rise is exhibited from 9.8 MPa of unmodified PVC-PBA blend to about 31.9 MPa at 15 parts of nano calcium carbonate incorporation. PVC-PBA blend is substantially modified by the superior properties of the nanomaterials which has been revealed by the significant rise. The strength properties show a gradual rise with increasing doses of nano $CaCO_3$ and tends to level off at 15 phr. Here again, the effect of nano $CaCO_3$ on PVC acting as the reinforcing filler to enhance the strength parameter of PVC is evidenced and at the later stages, the saturation effect is reached. This parameter value which increases more than three folds of the base compound. This establishes the fact that nano calcium carbonate as nanofillers are very effective in modifying PVC and is also highly compatible with it. So nano calcium carbonate can contribute enormously to the modification of the base polymer compound PVC.

Variation of Elongation at Break
The changes in elongation at break as depicted in figure 3 corroborates with the changes in the strength parameters like modulus and ultimate tensile strength. The elongation at break decreased from 192% to 159% which was higher than the base reference material PVC and revealed that the nanomaterial improved the modulus and ultimate tensile strength of PVC not at the compensation of deteriorated values of flexible parameter like elongation at break.

The reduction in the values of percentage elongation at break from 192 to 159 reveals that the reduction is quite well compensated by the use of nanofiller calcium carbonate. So, it evident that the nano calcium carbonate acts as the nanofiller by raising the strength parameters of PVC with its increasing dose not at the cost of the flexibility parameters namely the elongation at break. Moreover, there is an overall rise compared to the base reference compound of PVC-PBA which again reveals that the nanofiller has the potential of modifying PVC along with PVC-PBA blend and contributes to the overall improvement of the mechanical properties of PVC. Thus, the combined influence of the polybutyl acrylate polymer and nano calcium carbonate on PVC is simultaneously explicit within the range of nano $CaCO_3$ incorporation within the blend under study.

Variation of toughness
The variation in toughnessof the PVC-PBA blend with varying concentration of the nanofilleris depicted in figure 4.The marginal decrease in value from 6.1 to 5.4 MPaexplicitly indicates that there is an overall rise compared to the base reference PVC-PBA compound of 75:25 composition. Although there is a decreasing trend in the toughness values due to the increasing concentration of the rigid nanoparticles within the blended matrix, there is no significant reduction due to the presence of the nanofiller. Evidently, the nano calcium carbonate acting as the nanofiller, augments the strength parameters of PVC-PBA blend and consequently PVC with its increasing dose but not at the cost of the flexibility parameters namely the elongation at break and toughness. So, it is significantly manifested that both polybutyl acrylate and the nanofillernano calcium carbonate has a directing modifying influence on PVC and contributes to the overall improvement of the mechanical properties of PVC. Thus the influence of the polybutyl acrylate polymer and nano calcium carbonate on PVC in modifying the mechanical chatracteristics and creates a

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balance in all the parameters which aids in the overall improvement in the properties of PVC as is widely explicit within the range of the nanofiller incorporation under study.

CONCLUSION

The modification in the mechanical properties of PVC by way of blending with polybutyl acrylate (PBA) incorporating nano calcium carbonate as the nanofiller in varying ranges, is estimated in the present study. The mechanical parameters of modulus, ultimate tensile strength, elongation at break and toughness displayed an overall rise well above the values of unmodified PVC under the directing influence of the nanofiller supported by the 75:25 PVC:PBAblend composition. Thus mechanically modified PVC compound has been achieved wherein the strength properties of the polymer such as the modulus and ultimate tensile strength rise not at the compensation of the flexibility parameters like elongation at break and toughness and hence yielding mechanically improved PVC compounds in all aspects.

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Table 1: Comparative study of PVC:PBA blends

Properties	PVC:PBA 100:0 (Base reference compound)	PVC:PBA 80:20	PVC:PBA 70:30
Modulus (MPa)	35.18	408	214
Ultimate tensile strength (MPa)	7.8	12.2	6.5
Elongation at break (%)	130	123	256
Toughness (MPa)	6.9	5.2	6.8
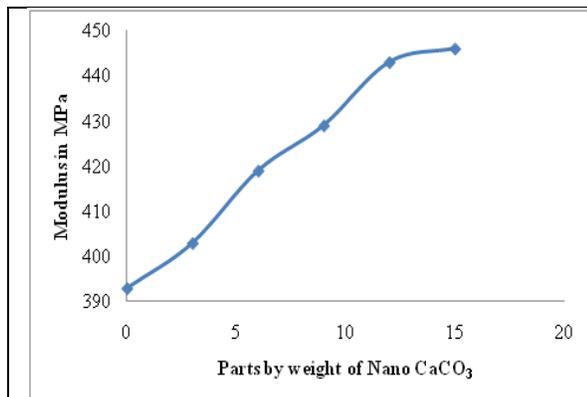
Figure 1: Variation of Modulus w.r.t Nano CaCO₃ dose
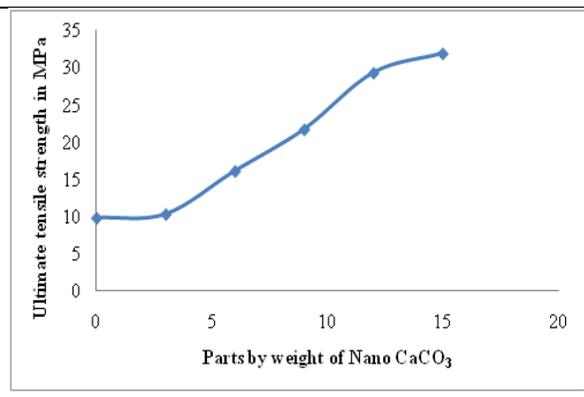
Figure 2: Variation of Ultimate Tensile Strength w.r.t. Nano CaCO₃ dose
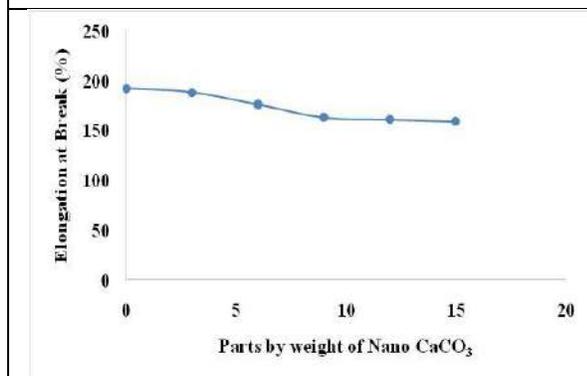
Figure 3: Variation of elongation at break w.r.t. Nano CaCO₃ dose
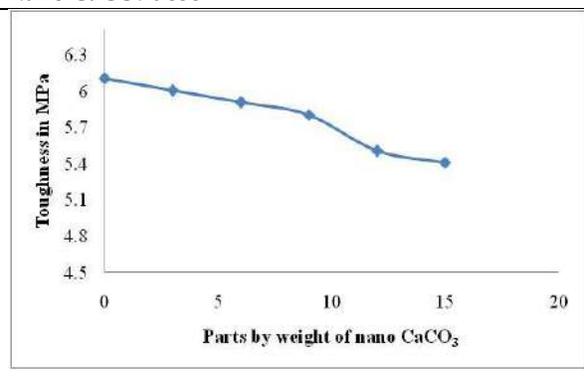
Figure 4: Variation of toughness w.r.t. Nano CaCO₃ dose

RESEARCH ARTICLE

Efficient Load Balancing and Optimal Resource Allocation using Hybrid Genetic Algorithm with Firefly Optimization Algorithm

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ABSTRACT

Grid computing wherein a community of computers is integrated to create a very rapid digital laptop. It's far the future computing paradigm for organization packages. Efficient allocation of resources with load balancing is critical goals in computational grid environments. Load balancing is improve the performance of computational grid. Inside the current gadget, the load balancing isn't ensured correctly and velocity of the system is decreased because of convergence troubles.. To overcome the above referred to problems Hybrid Genetic algorithm with FireFly Optimization (HGAFF) algorithm is proposed to enhance the weight balancing as well as optimum aid allocation on grid. The proposed device include main stages together with machine version, load balancing, resource allocation and path and node-stage fault tolerance. Load balancing is carried out by moving obligations from over-loaded nodes to underneath-loaded nodes. The useful resource allocation is accomplished with the aid of using HGAFF algorithm that is used to choose extra premiere assets correctly. It additionally focused to lessen the price metric and boom the VM performance in grid.

Keywords: Grid computing, Hybrid Genetic Algorithm with Fire Fly Optimization (HGAFF) algorithm, load balancing, resource allocation, fault tolerance

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INTRODUCTION

Grid computing is an surroundings that utilizes computing assets which might be geographically dispensed. Grid computing affords a digital environment to users, integrating facts, and computing assets to perform solutions for numerous sorts of problems. Customers can utilize computing sources transparently without thinking about place and operating surroundings constraints. With the emergence of grid computing technology, sequential applications can be parallelized and executed on unutilized heterogeneous sources that are possessed by means of organizations everywhere in the international. Grid computing may be used to remedy issues associated with computation in depth applications related with one-of-a-kind regions. Grid computing permits researchers to use the grid resources unfold across the world to solve issues related to the earth observation, marine, and environmental sciences [1]. The performance of job scheduling without delay impacts the performance of the whole grid environment. In the subject of grid computing device, a lot of evaluation and research work has been accomplished on task scheduling hassle. The ideas of computing energy, load and bandwidth awareness is in process scheduling to enhance scheduling overall performance. Scheduling approach primarily based on ant colony algorithm, which regards reaction time as the primary criterion of scheduling method, but the scheduling approach ignores the time required to go back the task results. Ant colony algorithm is used for computing grid process scheduling. This algorithm combines ant colony system and max-min ant machine technology. Load balancing plays a good position in the grid computing with the utilization of grid assets that are globally allotted. Grid computing stocks assets among the consumer for execution of the obligations. Without using green load balancing mechanism, some assets may be overloaded and some resources can be idle for a protracted time period. Aid allocation is an important element of Grid computing. There is several research methodologies introduced but the load balancing isn't always ensured drastically. The present method has drawback with balanced hundreds and much less pace of the technique. To triumph over the above stated problems Max-Min Heuristic (MMH) and Hybrid Genetic algorithm with FireFly Optimization (HGAFF) algorithm is proposed to progress the overall grid machine performance.

RELATED WORK

In [10], Shah et al (2014) discussed that grid computing is substantial effect within the field of scientific research as well as within the realms of software world. The online presence of reliability and simplicity of bendy operations are the primary features. The evolution of allotted computing with virtualization of numerous forms of grids is the important thing to the understanding its software. In [1], Ren et al (2019) introduced agent-based technique to optimize the reliability of a gadget inside the restoration system. A modified recovery approach primarily based on reinforcement getting to know, Wolf % set of rules (WPA) is used to multi-agent framework and conversation architecture. First, remember the limitations of the grid community and the dynamic load of the device. Numerous types of marketers are described and abstracted to mimic bodily entities. In [2], Li et al (2009) deal with the weight balancing hassle by supplying a hybrid technique to resolve load balancing for sequential responsibilities below grid computing environments. The principle goal is to reach project assignments that might attain minimum execution time and maximum node usage.

In [3], Kfatheen et al (2015) brought a brand new scheduling set of rules named as Min-Max based on renowned task scheduling algorithms. On this algorithm the drawbacks were rectified by way of the use of combined usage of two algorithms. The experimental final results indicates that the set of rules improves the Makespan. The want for powerful and efficient scheduling algorithms is essential to use the abilities of massive distributed structures optimally. In [4], Shu et al (2007) objectives at resolve the trouble of optimally allocating resource at the grid to maximise the grid carrier reliability. Grid computing device isn't like traditional disbursed computing structures via its awareness on huge-scale useful resource sharing and open architecture for services. Based totally on useful resource allocation in grid computing, we broaden an optimization model and a Quantum Chromosomes Genetic algorithm (QCGA) to efficiently clear up it. In [5], sources in grid structures are heterogeneous, geographically distributed, belong to one-of-a-kind administrative domains and apply exceptional control rules. The role of process scheduling mechanisms are to pick out and allocate the most suitable assets for a given set of jobs. This paper

affords an smart metaheuristics approach primarily based on firefly algorithm for scheduling jobs in grid computing. This method is to dynamically create an top of the line agenda to complete the jobs within minimal makespan. The simulation consequences illustrate that the mechanism carried out better than different scheduling mechanisms.

PROPOSED METHODOLOGY

In this work, load balancing is completed with the aid of the usage of Max-Min Heuristic (MMH) set of rules and useful resource allocation is done with the aid of the use of Hybrid Genetic algorithm with FireFly Optimization (HGAFF) algorithm .It is focused to improve the grid computing overall performance drastically. The proposed work entails the formation of gadget model, load balancing, premier resource allocation and fault tolerance gadget.

System model

In this paintings, don't forget the range of sources, wide variety of tasks and wide variety of grid users over the grid computing. A grid system is designed to complete a hard and fast of programs and applications to finish sure tasks. Executing the ones packages need some sources in the grid. The fundamental elements that constitute a aid allocation problem within the grid environment includes mission of grid users, grid sources, and the strategy of aid allocation. At distribution system level, grid operators normally use a shared communication infrastructure with a certain QoS stage furnished through communication network operators through provider degree agreements a good way to change statistics. It includes periodic undertaking T_i and absolutely diagnosed by way of a couple (C_i, T_i) . The request for T_i is periodic with the consistent c programming language T_i among every consecutive requests and t_i's first request occurs at time zero. The worst case execution time for all endless requests of t_i is regular and same to C_i.

Given n impartial periodic tasks $t_{(1,)} t_{(2,…)} t_n$ and set of equal processors within the scheduling trouble. To find an order in which all the periodic requests of the responsibilities are carried out by means of the processor so that you can satisfy the subsequent scheduling situations. Every challenge is carried out by using one processor at a time and no processor executes more than one challenge at a time. Every request of task should be completely achieved before the subsequent request of the equal mission. By using the give up of time the variety m processors is minimized. Fig 1 suggests the overal block diagram of the proposed device.

Efficient load balancing using Max-Min Heuristic (MMH) algorithm

In this work, green load balancing is achieved with the aid of the usage of Max-Min Heuristic (MMH) set of rules. Load balancing entails dispensed obligations a few of the to be had sources to make sure that no aid is underutilized or over-applied. In grid computing load balancing sources are in particular statistics facilities, bodily machines, VM or any application software program [19].

Need for load balancing in grid computing

In grid computing, tasks and other undertakings to the VM are referred to loads.
These loads are categorized into three categories
• Under-loaded
• Over-loaded
• Balanced

Load balancing algorithms are accountable for try to equalize the overall workloads in the grid computing surroundings [6]. It's miles achieved by using shifting responsibilities from over-loaded nodes to below-loaded nodes and maximize the device throughput. A load is the range of jobs in the ready queue and may be light, slight and heavy in keeping with their work. Load balancing is a process to enhance the overall performance of computational grid gadget. The grid are uniformly applied as lots as feasible so that the throughput are improved and the execution time are minimized.

The modern load may be computed for all of the sources shared in VM of grid servers. Once the load index is computed for all of the assets and load balancing operation might be initiated to the assets. Dynamically the

technique of assigning sources to the corresponding node to lessen the burden price. Within the grid computing environment, the converting load of real-time reveal server nodes and assigns sources to the corresponding node dynamically to meet some wishes. Such as high utilization of assets, notable overall performance and speedy reaction. The topology of the server group nodes that worried inside the grid useful resource scheduling can be defined inside the following Fig 2.

The topology can be described as an G (V,E) undirected graph, G represents the node set and E represents the set of connection between those nodes. Ci represents cluster manage server node. CN_(i)represents node controller which is separate physical device. Every Ci node manages m node controller N_(i) and run k VMs on every CN_(i) and use Vi to symbolize VM. So the node so as to be mentioned in this look at is Vi . In the grid provider environment software, database management machine and different software program are deployed in several Vi nodes to run. The proposed method triggers a way for producing an effective load balancing within the grid system to schedule the nodes. Max-Min heuristic algorithm starts with a fixed made of unmapped tasks. The scheduling procedure is preferred to set of nodes with least amount of load possession. The set of rules later selections the duties with the best (most) make span and allocates it to the subsequent available VM.

The least load are favored for enticing extra technique through the grid community. Each node describe attributes described via the scheduling manner. The group of nodes is served with the aid of the grid system as per the request from the users to the server. Because the request comes to the server fetches the node free and severed to the user. This method is mapped on the premise of the nodes and in line with their processing time a scheduling list is generated. The techniques of selecting the node with least load are inspired from the MMH set of rules. The distance calculation between the nodes inside the scheduling queues. Earlier than intending to the calculation to discover the node with least load values. The node with least load is taken into consideration for the queue to calculate least awesome nodes.

The distance values of the node are calculated based on the Cartesian distance, that is given by using:

$$Dist = \sqrt{\sum_{(j=1)}^{okay}\left((n_i - n_j) ^2 \right)}$$ (1)

The gap is supplied using the expression dist and n_i is the selected node and n_j is the evaluating node. As soon as all the distance values were calculated between the node values are rearranged consistent with the least awesome node to the pivot node. The top queue in the agenda listing is considered because the maximum applicable scheduling queue. In the end, in step with grid load balancing, carrier useful resource might be assigned to the excellent server node.

Algorithm 1: MMH algorithm for load balancing

1.   *Start*
2.   *For all the tasks in the set G; Ti*
3.   *For all the resources ; Rj*
4.   *Cij=Eij+rj*
5.   *While the tasks set G has tasks*
6.   *Select a task Tk with the highest completion time.*
7.   *Find the distance between nodes using (1)*
8.   *sort the resources in the order of completion time*
9.   *Allocate that task to a resource (Rj), which will give the minimum execution time*
10.   *Empty the task Tk from set U.*
11.   *Repeat steps 1 to 7 until the set U is empty*
12.   *Equalize the loads in grid*
13.   *End*

From the above pseudo code rj represents the resource Rj which is ready to execute the assignment. Cij represent the predicted final touch time and Eij the execution time [2]. It maximizes the utilization of the VM and the CPU. As a consequence the MMH set of rules offers equalization masses to the grid device correctly and additionally it offers more balanced load across all of the machines in the grid computing considerably.

Hybrid Genetic Algorithm with FireFly Optimization (HGAFF) algorithm is proposed for optimal resource allocation

On this paintings, most fulfilling resource allocation is carried out with the aid of the usage of Hybrid Genetic algorithm with FireFly Optimization (HGAFF) set of rules. Firefly algorithm [21] is inspired by way of biochemical and social components of actual fireflies. Real fireflies produce a quick and rhythmic flash that helps to attract (speaking) their mating companions and also serves as shielding caution mechanism. This mechanism normalizes few of the firefly capabilities and may be proven as given beneath: Every firefly is interested in a exceptional irrespective of their companion. The brightness formed through the firefly is openly comparative to its attractiveness and it is amongst two fireflies.

The firefly in conjunction with better brightness draws the only which has lesser brightness. A firefly shifts arbitrarily if it isn't always succesful to discover a brighter nearest firefly. In the statistical form, firefly's brightness depends on the objective function. Fig 3 shows the basic mechanism of the firefly algorithm

Firefly set of rules is chosen for its potential of giving satisfactory solutions to multi objective troubles. For a maximization hassle the brightness can actually be proportional to the objective feature.It's miles assumed that the elegance of a firefly is decided by using its brightness or mild depth which in flip is related to the encoded goal characteristic. The fireflies constitute the requested challenge and the mild depth corresponds to the grid wherein the utility is accomplished. It is associated with a unique identifier and the grid broker pals responsibilities with assets to be had using HGAFF. These phases are repeated iteratively until the convergence criteria are satisfied

A) beauty and mild intensity at the supply: The mild intensity adjustments based at the inverse rectangular regulation as follows

$$I(r) = \frac{I_0}{r^2} \tag{1}$$

Step 4 (Mutation): Mutation refers back to the alternate (growth) in the genome of chromosome, flipping of bit strings (genes) of chromosome.

Step 5 (health assessment): Analogous to "survival of fittest", chromosomes with a sure stage of fitness will live to tell the tale for subsequent generation at the same time as the others whose fitness is much less than the edge price might be discarded

$$T_{dc}(M_{dc}) \leq ResT_{dc} \tag{2}$$

Assume that M_{Rc} is the minimum response time of the computing instances

$$T_c(M_{Rc}) = \frac{(M_{Rc})^{-1}}{1 - \frac{E_c}{M_{Rc}}} \tag{3}$$

Tc is the maximum response time

The mathematical model for resource allocation is as follows:

$$Maximize\ T_{dc}(M_{Rdc}), T_c(M_{Rc}) \tag{4}$$

$Completion\ time\ =\ CT\ max\ [i,j]$ 　　　　　　　　　　(5)

Where CT denotes maximum time for complete Task i on VM$_j$. n and m denote the number of tasks and VM respectively.

Therefore, to reduce the completion time which can be denoted as CT$_{max}$, the execution time of each task for each virtual machine must be calculated for the scheduling purpose. If the processing speed of VM is PS$_j$, then the processing time for task P$_i$ can be calculated by equation (13)

$P_{ij} = \frac{c_i}{PS_j}$ 　　　　　　　　　　(6)

Where, the processing time for task P_i on VM_j and c_i computational complexity of task P_i

The processing time of each task in the VM can be calculated by equation (14)

$P_j = \sum_{i=1}^{n} P_{ij}$ 　　　　　　　　　　(7)

The fitness value of each VM is calculated in the population. In the first generation, the number of tasks in a batch is randomly allocated to the open VM. The fitness value of each firefly is calculated. Then, the selection procedure is used to decide on two selected fireflies [23]. Firefly along with higher brightness has the highest fitness value which is selected for the next generation (resource allocation)

$p_i(S) = \frac{f_i(S,T)}{\sum_{i=1}^{D} f_i(S,T)}$ 　　　　　　　　　　(8)

Where, $f_i(S,T)$ stands for the fitness of member and i in the population; D stands for the scale of the population.

Where, t is the number of generations; D is the scale of the population; and M is the number of VMs

Algorithm 2: HGAFF algorithm for optimal resource allocation

Begin

Objective function (x), x = (x1,...,)T consider lower makespan time and higher throughput as objective function

Produce initial population of fireflies xi (i = 1, 2, . . . , n)

Light intensity Ii at xi is found via (xi)

Describe light absorption coefficient γ

while (t < MaxGeneration)

for i=1:n all n fireflies

for j=1:i all n fireflies

if (Ij > Ii), Move firefly i towards j in d-dimension;

end if

Evaluate the fireflies based on fitness function

Do

I = 0

{

Compute the fitness of each individual

Select the individual according to their individual

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Compute crossover probability

Perform mutation probability

Population =selection of tasks after crossover and mutation

Compute the distance of each firefly from the best (6)

Update the firefly's positions using (7)

Attractiveness changes along with distance r via exp[$-\gamma r$]

Compute resource allocation using (11) and (12)

Compute fitness of fireflies using (15)

Estimate new solutions and update light intensity using (4)

Minimize the makespan time using (10)

Update the optimal task

End for j

End for i

Rank the fireflies and find the current best

End while

A firefly i shifts to a more attractive

End

SIMULATION RESULT

Which will confirm the effectiveness of grid resource allocation and cargo balancing set of rules primarily based on optimized goal selection, a comparative check is carried out. Firstly, aid allocation choice making plans model is mounted for a sure equal resource requirement. As compared with the performance and accuracy of aid allocation control inside the aid allocation management method, on the way to make certain the accuracy of the test before the test detection, the experiment detection parameters are first acquired and determined [26], and the unique parameter statistics is shown inside the following table 1

In this research work, performance of the proposed HGAFF+FF algorithm is compared with the existing PSO–GELS, Multi-Task Target Decision (MTTD) and APSO+FF approaches in terms of accuracy, time complexity, cost complexity and error rate. Table 2 shows the comparison metrics of existing and proposed system

Accuracy
Accuracy is the most intuitive overall performance degree and it is genuinely a ratio of efficaciously predicted commentary to the overall observations.

$$Accuracy = \frac{(TruePositive \ + TrueNegative \ )}{(TrueP \ ositive + FalseNegative \ + FalsePositive \ + TrueNegative \ )}$$

From the above Fig 6, it is able to be determined that the evaluation metric is evaluated using existing and proposed approach in phrases of accuracy. For x-axis the techniques are taken and in y-axis the accuracy price is plotted. The existing strategies are which include PSO–GELS, MTTD and APSO+FF algorithms offer decrease accuracy while proposed HGAFF+FF set of rules offers higher accuracy. In this proposed research work, most appropriate resources are decided on by using APSO+FF set of rules thru satisfactory fitness function values.

Error rate

From the above Fig 7, it could be found that the comparison metric is evaluated using existing and proposed approach in phrases of error rate. For x-axis the techniques are taken and in y-axis the error price fee is plotted. The existing strategies are which include PSO–GELS, MTTD and APSO+FF algorithms provide higher mistakes rate whereas proposed HGAFF+FF set of rules presents lower blunders charge.

Time complexity

The system is better when the proposed algorithm executes in less time consumption. From the above Fig eight, it may be found that the comparison metric is evaluated the use of current and proposed method in phrases of time complexity. For x-axis the methods are taken and in y-axis the time complexity fee is plotted. The existing techniques are consisting of PSO–GELS, MTTD and APSO+FF algorithms provide better time complexity whereas proposed HGAFF+FF set of rules provides decrease time complexity. The MMH ensures that every one the obligations are completed quick, therefore minimizing the entire make span of the virtual device in use.

Cost complexity

From the above Fig 9, it may be observed that the assessment metric is evaluated the usage of present and proposed method in phrases of value complexity. For x-axis the techniques are taken and in y-axis the cost complexity cost is plotted. The prevailing strategies are which include PSO–GELS, MTTD and APSO+FF algorithms offer higher price complexity whereas proposed HGAFF+FF algorithm gives lower cost complexity. Load balancing is enhancing the performance of computational grid machine

CONCLUSION

With the rapid improvement in huge area networks and occasional cost, powerful computational sources, grid computing has gained its popularity. On this work, Hybrid Genetic set of rules with Fire Fly set of rules and in shape First (FF) heuristic algorithm is proposed to decorate the overall grid gadget performance. First of all the gadget model is constructed with numbers of assets, users, duties and servers over the grid computing. Then the load balancing is achieved by means of using MMH set of rules that's targeted to equalize the whole workloads over grid computing surroundings. The resource allocation is finished the use of HGAFF set of rules is used to provide gold standard answers by means of enhancing the time and fee complexity metrics. Route and node-level fault tolerance technique for better development the usage of FF heuristic set of rules which reduces the failure prices and blunders charges substantially. The proposed approach is used to growth the overall performance the usage of powerful algorithms over grid computing. The results proves that the proposed HGAFF+FF algorithm presents higher overall performance through extra accuracy, decrease mistakes rate, price complexity and time complexity than the present APSO+FF, PSO–GELS and MTTD algorithms. Inside the destiny work, overall performance evaluation parameters such as wide variety of venture migrations among VMs the usage of efficient algorithms can be advanced over the grid computing.

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Table 1 Experimental Test Parameters

Resource capacitymb	allocation capabilities %	memory GB	Maximum detection time（s）
1300	35	110	18
1200	50	140	26
1600	78	220	38
1400	64	210	20
1500	75	156	60
1300	48	230	57
1200	65	170	40

Table 2 Comparison metrics of existing and proposed system

Methods/Metrics	PSO–GELS	MTTD	APSO+FF	HGAFF+FF
Accuracy (%)	87.04	91.03	93.08	94.34
Error rate (%)	23.76	20.47	16.13	11.01
Time complexity (sec)	45	38	29	18
Cost complexity (GB)	0.13	0.1	0.08	0.04

Fig. 1. Overall block diagram of the proposed system	Fig. 2. Simple grid system

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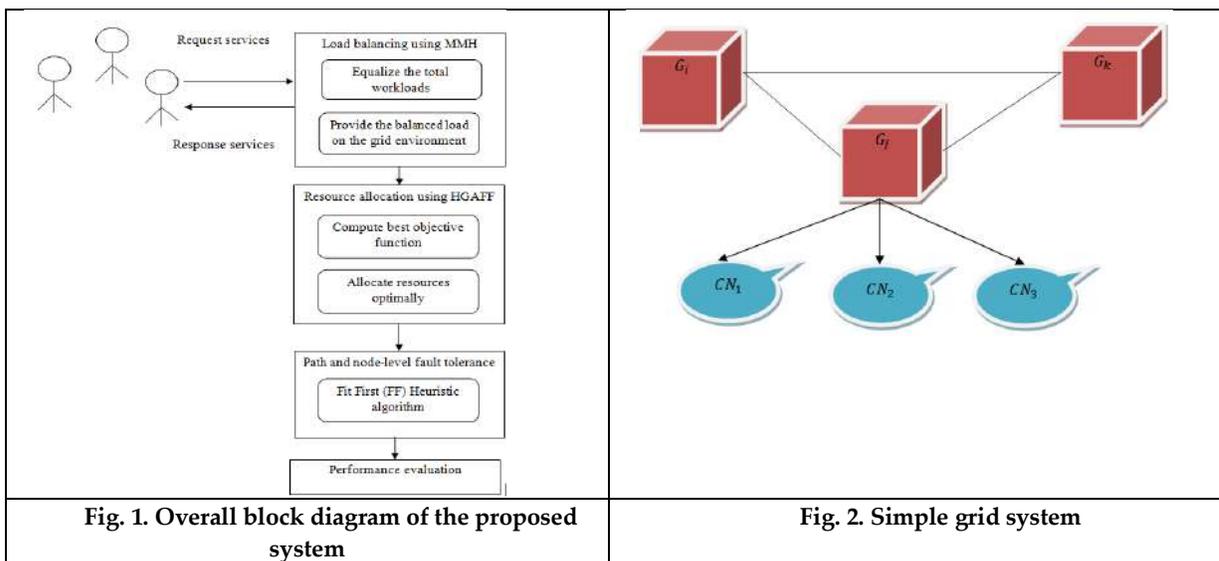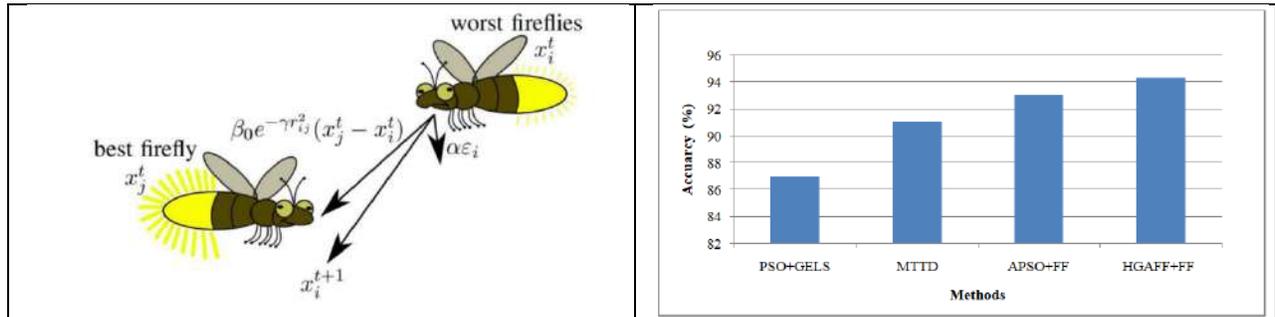
Fig.3. Basic Mechanism of the Firefly Algorithm

Fig. 4. Accuracy Comparison
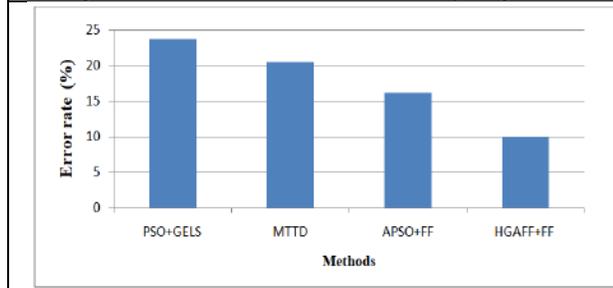
Fig.5. Error Rate Comparison
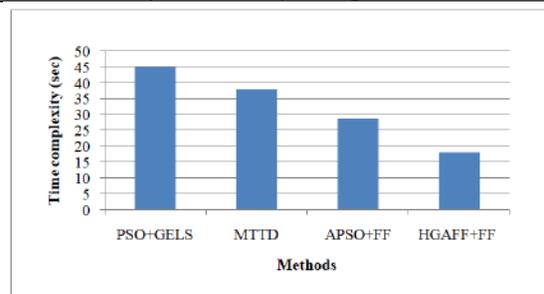
Fig. 6. Time Complexity
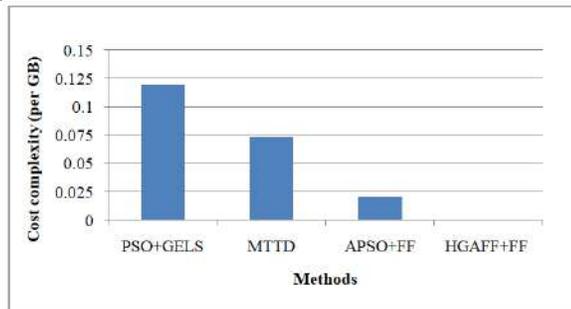
Fig. 7. Cost Complexity

RESEARCH ARTICLE

Service Quality Perception of Customers towards Food Delivery App in Coimbatore City

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ABSTRACT

In a decade of advanced technological era, a greater number of people have used food delivery applications which have broken into the conventional practices and have offered a convenient solution to a problem of busy work schedule not letting people go out for getting a delicious food. The requirement of these apps increases day-by-day and largely driven by millennials. So, the research is necessary to examine the customers perception towards the services offered by the food delivery apps particularly in Coimbatore city. For this, the researchers have selected 140 customers who have used various food delivery apps at least minimum of 6 months. A structured questionnaire has been framed and collected the opinion of the customers through direct and through online by using google forms. The population is unknown and so the respondents could identify through food delivery people. The collected details were subdued into tables and graphs by using SPSS 22.0 and MS-Excel. For examining the relationship of the selected variables, a hypothesis has been framed and tested by using ANOVA analysis and correlation analysis. Also, percentage analysis and mean score analysis have been used. The research found that most of the respondents have experienced the better perception towards food delivery apps who belong to above 50 years age category, female customers, businessmen, using Swiggy App, using app for 1-3 times in a week and expensing Rs.3001-5000 monthly through food delivery app.

Keywords: Service Quality Perception, Food Delivery App, Online Food Ordering, Online Ordering System.

INTRODUCTION

The recent development of the internet in India, it has augmented the e-commerce industries. E-commerce development has made online food ordering services seamless for people who want to get food delivered at their doorstep. Although consumers continue to go out for the meals, consumers feel very convenient to order food online since it frees the customer from personally visiting the restaurants. In today's world service sector contributes 64.80% in GDP. Zomato, Swiggy, Ubar Eats, etc., are the most popular applications that provide services to the user to discover restaurants. The rise of digital technology is reshaping the industries. With the increased use of technology, the number of people engaging into the digital sector are rapidly increasing. Even Consumers are accustomed to shopping or even ordering online through apps or websites, with maximum convenience and transparency, expecting the same experience that they would get from the outlet itself. To match up with the consumer's expectations apps are providing increased facilities and services to the customers. This scenario doesn't exist only in one country but all across the globe. Being up to date with the customers' expectations helps firm retain customers to a greater extent.

REVIEW OF LITERATURE

In this research, the researchers are coated solely some relevant studies for reviewing the past literature. According to Aditya Tribhuvan (2020) showed that a most of people use food apps as it's the best way to save time and convenient. Also, the most of participants preferred food app was Swiggy and cash on delivery was the safest and most secure form of payment. Moreover, the results obtained that all age and income groups used food apps and they were happy with the service quality, hygiene and packaging system, which made people order from food apps. The author Merry Borgohain (2019) indicated that the main influencing factors of highest respondent were found to be ease and convenience of using the food applications and ordering food sitting at home followed by the influencing factor to be time saving. In addition, the most preferred mode of payment as Cash on delivery while the issues faced by the respondents while ordering food through applications was mostly regarding non-availability of food items/dishes they wish for. They confirmed that the overall satisfaction regarding services of the food application were responded as they were satisfied with the service provided followed by neutral responds too. Result from Gawande *et al*. (2019)explored that online food ordering system was new method and many of the users specifically above 40 years of age were not familiar with the ease of ordering food online. Further, mostly students preferred to order food online instead of going out for lunch and they felt ease of placing orders and time efficiency as main reason to prefer it. The study of Aparna Anib *et al*. (2019) divulged that there was significant relationship between usage and satisfaction of services of Swiggy, there was significant relationship between usage and preference over other food ordering apps. Also, there was no association between age and frequent usage of Swiggy app whereas there was no association between gender and convenience of Swiggy app.

The researcher Ardhana M Prabhash (2020) found in this attempt that most youngsters were well aware about online services on online food delivery system. Also, the most influencing factor was offers provided by online food apps and fast food was fancied by most respondents in their choice of cuisines. Moreover, the results indicated that a major proportion of respondents utilized Swiggy and least uses Potafo. In case of Jeganathan Gomathi Sankar and Naveenkumar (2020)noted that the main concerns of the customers were the safe food delivery and customer safety in this pandemic condition. Thus, factor affecting customer perception in online food delivery were delivery problem, preventive and secure, safety service. It was observed that safety service factors were major influenced the customer perception at the time of covid among the factors. The research from Mehathab sheriff and Shaik Mohamed (2019) assessed that youngsters were mostly poised to use online food ordering services and also price of the product, discounts and special Offers had the most influencing factor on online food ordering. Further, the second most influencing factor was the convenience, followed by On-time Delivery. Moreover, a major proportion of respondents used both Uber Eats and Swiggy to order their food online. The results obtained that there was

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significant relationship between monthly family income of the respondents and their level of satisfaction towards online food ordering services. It could be observed from Jeneefa and Rajalakshmy (2019) that perceived control and convenience were keys to customer use of online ordering which led to higher satisfaction. Also, young customers were more likely to use online, mobile or text ordering whereas young customers placed a greater value on convenience and speed than older users do. Besides, almost all users felt safe paying online and the Service rendered by the food ordering app was the major factor behind its success.

Statement of the Problem

The popularity of online food ordering and delivering services is steadily growing and the expectations of the users are also increasing. In this connection, the perception of the customers about Online Food Ordering and about the services of the Online Food Ordering companies gains significance. In this fast-changing tech landscape, when more and more diners are migrating online, restaurants have realized that if they fail to provide a robust, seamless and efficient online ordering platform, they will quickly be left out of the race. Now-a-days, the customers have faced number of problems while using food delivery apps like selection of restaurants, payment methods, delay in delivery, quality and quantity of food, packaging issues and unpleasant behaviour of delivery persons. Owing to these problems, the customers have faced numerous problems and frequently changed the food delivery app. So, all the food delivery apps companies have not able to maintain loyal customers. Based on the discussion, the researchers have raised a question that how the food delivery apps companies have given proper service to their customers and what extend the customers have experienced the service quality of the food delivery apps in Coimbatore city. For finding the solution of the questions, the researchers have planned to conduct the study.

Objectives of the Study

- To identify the demographic profile and purchase behaviour of the customers of food delivery apps in Coimbatore city.
- To examine the service quality perception of customers towards services offered by the food delivery apps.
- To evaluate the degree of relationship of the service quality of food delivery apps with their customers.

Hypothesis of the Study

- There is a significant mean difference in perception on service quality of food delivery app with regard to age of the customers.
- There is no significant mean difference in perception on service quality of food delivery app with regard to gender of the customers.
- There is no significant mean difference in perception on service quality of food delivery app with regard to using food delivery app of the customers.
- There is no significant mean difference in perception on service quality of food delivery app with regard to frequency of using food delivery app.
- There is no significant mean difference in perception on service quality of food delivery app with regard to monthly expenses through food delivery app.
- There is no significant mean difference in perception on service quality of food delivery app with regard to mode of payment.
- There is no significant mean difference in perception on service quality of food delivery app with regard to period of using.
- There is a positive association on service quality perception of food delivery app among the selected variables.

RESEARCH METHODOLOGY

In nature, this study is descriptive research design. The researcher has aimed to collect the necessary sample data or immediate survey regarding service quality perception of customers towards food delivery app in Coimbatore city.

For this, the researchers have selected 140 customers who have used various food delivery apps at least minimum of 6 months. A structured questionnaire has been framed and collected the opinion of the customers through direct and through online by using google forms. The population is unknown and so the respondents could identify through food delivery people. The structured questionnaire has included customer profile and their service quality perception on food deliver app. This research has been performed in Coimbatore, Tamilnadu. For analysis of this study, the statistical techniques namely percentage analysis, mean score analysis, Standard deviation, ANOVA and Correlation analysis have been carried out. The details of analysis have been furnished in the following table.

RESULTS AND DISCUSSION

An online food delivery app enables a customer to order their food requirements from any preferred providers located locally through some mobile applications using the internet. The socio-economic profile of the participants has been evaluated in detail in this section and also analysis has been divided into two segments. Further, this section examined that the relationship between the variables viz. age, working department, designation, period of experience and dependent variable influence of transactional leadership on employee performance.

- From the above analysis, it is indicated that 23.6% of the customers belong to below 30 years of age segment, 29.3% of the customers came into age group of 30-40 years, 35.0% of the customers belong to 41-50 years and 12.1% of the customers belong to above 50 years of age group.
- The analysis found that 63.6% of the customers are male and 36.4% of the customers are female.
- From the analysis, it is explored that 20.0% of the customers are private employees, 29.3% of the customers are government employees, 31.4% of the customers are businessmen, 9.3% of the customers are professional and 10.0% of the customers are belong to others like housewives, students, retired persons, etc.
- From the analysis, it is assessed that 5.0% of the customers are using Swiggyappfor food delivery, 7.9% of the customers are utilizing Zomato, 18.6% of the customers as Ubar Eats, 10.0% of the customers as Foodpanda, 12.9% of the customers as Domino's, 17.1% of the customers as Pizza Hut, 10.7% of the customers as JustEat, 3.6% of the customers as Faaso's, 8.5% of the customers as TastyKhana and 5.7% of the customers are utilizing FoodMingo for food deliver.
- It is determined that 30.0% of the customers are using food delivery app for 1-3 times in a week, 40.7% of the customers are utilizing for 1-5 times in a fornight, 17.9% of the customers as 1-10 times in a month and 11.4% of the customers are using food delivery app occasionally.
- It is explored that 18.6% of the customers are expensing upto Rs.1000 monthly through food delivery app, 23.5% of the customers are spending Rs.1001-3000 for food delivery, 35.0% of the customers are expensing Rs.3001-5000 and 22.9% of the customers are spending above Rs.5000 monthly.
- It is surmised that 32.9% of the customers are using credit card for payment of food delivery app, 16.4% of the customers are utilizing debit card, 10.7% of the customers are making payment as cash on delivery and 40.0% of the customers performing online payment channels for payment of food delivery app.

Table 1 :Customers' Profile and their Opinion towards Service Quality Perception on Food Delivery App

S.No.	Variables	No. of Respondents	Percentage	Mean Score
	Age (Years)			
1	Below 30	33	23.6	3.84
2	30 – 40	41	29.3	3.86
3	41 – 50	49	35.0	3.52
4	Above 50	17	12.1	3.89
	Total	**140**	**100.0**	
	Gender			
1	Male	89	63.6	3.67
2	Female	51	36.4	3.86

S.No.	Variables	No. of Respondents	Percentage	Mean Score
	Total	140	100.0	
	Occupational Status			
1	Private Employee	28	20.0	3.67
2	Government Employee	41	29.3	3.82
3	Business	44	31.4	3.84
4	Professional	13	9.3	3.54
5	Others (Housewife, Student, Retired, etc.)	14	10.0	3.71
	Total	140	100.0	
	Using Food Delivery App			
1	Swiggy	7	5.0	3.97
2	Zomato	11	7.9	3.94
3	Ubar Eats	26	18.6	3.78
4	Foodpanda	14	10.0	3.73
5	Domino's	18	12.9	3.44
6	Pizza Hut	24	17.1	3.87
7	JustEat	15	10.7	3.72
8	Faaso's	5	3.6	3.30
9	TastyKhana	12	8.5	3.88
10	FoodMingo	8	5.7	3.46
	Total	140	100.0	
	Frequency of Using Food Delivery App			
1	1-3 times in a week	42	30.0	3.82
2	1-5 times in a fortnight	57	40.7	3.79
3	1-10 times in a month	25	17.9	3.49
4	Occasionally	16	11.4	3.74
	Total	140	100.0	
	Monthly Expenses through Food Delivery App			
1	Upto Rs.1000	26	18.6	3.66
2	Rs.1001-3000	33	23.5	3.42
3	Rs.3001-5000	49	35.0	3.89
4	Above Rs.5000	32	22.9	3.90
	Total	140	100.0	
	Mode of Payment			
1	Credit Card	46	32.9	3.79
2	Debit Card	23	16.4	3.34
3	Cash on Delivery	15	10.7	3.98
4	Online Payment Channels	56	40.0	3.79
	Total	140	100.0	
	Period of Using the			

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S.No.	Variables	No. of Respondents	Percentage	Mean Score
	Food Delivery App			
1	Less than a Year	15	10.7	3.63
2	1-2 Years	35	25.0	3.89
3	2-3 Years	23	16.4	3.77
4	Above 3 Years	67	47.9	3.68
	Total	**140**	**100.0**	

Table 2: Service Quality Perception of Customers towards Food Delivery App

No.	Statement	Mean	SD
1	The app is user friendly	3.89	1.13
2	Prices of goods are updated	3.78	1.29
3	Prompt acknowledgement to customer's transactions	3.78	1.16
4	App respond to the customer's requests is quick	3.84	1.22
5	It has appropriate design	3.59	1.25
6	It is understood by all types of customers	3.75	1.13
7	The app makes customers' feel safe and secured	3.39	1.41
8	The information displayed in the app are trust worthy	4.02	1.27
9	The app gets personal attention to their customers	3.83	1.22
10	The app is able to communicate effectively with customers	3.53	1.19

Table 3: Age and Service Quality Perception on Food Delivery App

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	3.539	3	1.180	4.120	0.008*
Within Groups	38.937	136	0.286		
Total	42.476	139			

Note: * - Significant at 1% level

Table 4: Gender and Service Quality Perception on Food Delivery App

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	1.170	1	1.170	3.910	0.050**
Within Groups	41.306	138	0.299		
Total	42.476	139			

Note: * - Significant at 1% level

Table 5: Using Food Delivery App and its Service Quality Perception

	Sum of Squares	Df	Mean Square	F	'p' value
Between Groups	4.675	9	0.519	1.786	0.077[NS]
Within Groups	37.801	130	0.291		
Total	42.476	139			

Note: * - Significant at 1% level

Table 6: Frequency of Using Food Delivery App and its Service Quality Perception

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	1.956	3	0.652	2.188	0.092[NS]
Within Groups	40.520	136	0.298		
Total	42.476	139			

Note: NS - Not Significant

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Table 7: Monthly Expenses through Food Delivery App and its Service Quality Perception

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	5.372	3	1.791	6.563	0.000*
Within Groups	37.104	136	0.273		
Total	42.476	139			

Note: * - Significant at 1% level

Table 8: Mode of Payment and Service Quality Perception on Food Delivery App

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	1.261	3	0.420	1.387	0.249^{NS}
Within Groups	41.215	136	0.303		
Total	42.476	139			

Note: * - Significant at 1% level

Table 9: Period of Using the Food Delivery App and Its Service Quality Perception

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	4.779	3	1.593	5.747	0.001*
Within Groups	37.697	136	0.277		
Total	42.476	139			

Note: * - Significant at 1% level

Table 10: Degree of Relationship between selected variables and Service Quality Perception on Food Delivery App

No.	Independent Variables	'r' value	'p' value
1	Age	0.413	0.000*
2	Frequency of Using Food Delivery App	-0.131	0.123^{NS}
3	Monthly Expenses through Food Delivery App	0.248	0.003*
4	Period of using Food Delivery App	0.377	0.000*

Note: * - Significant at 1% level; NS - Not Significant
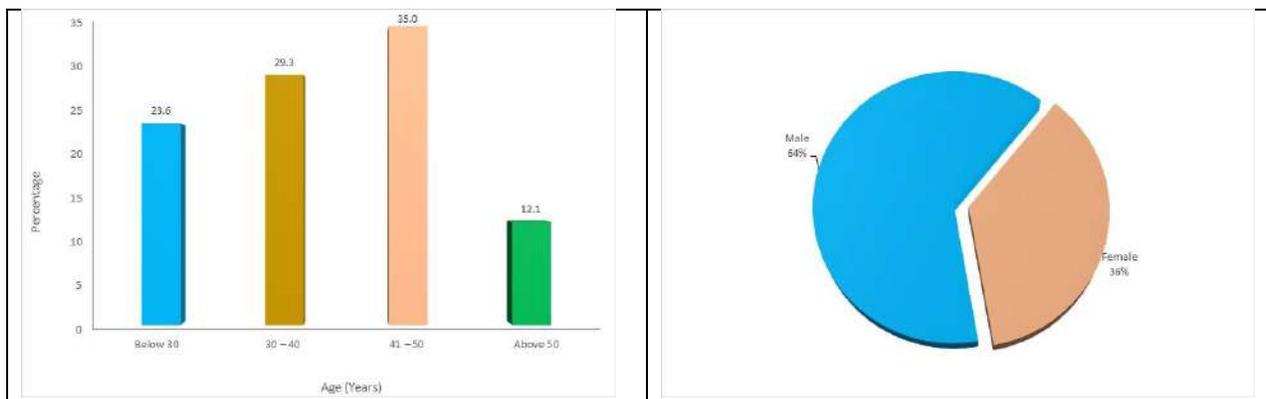
Prabhu and Surya Subam
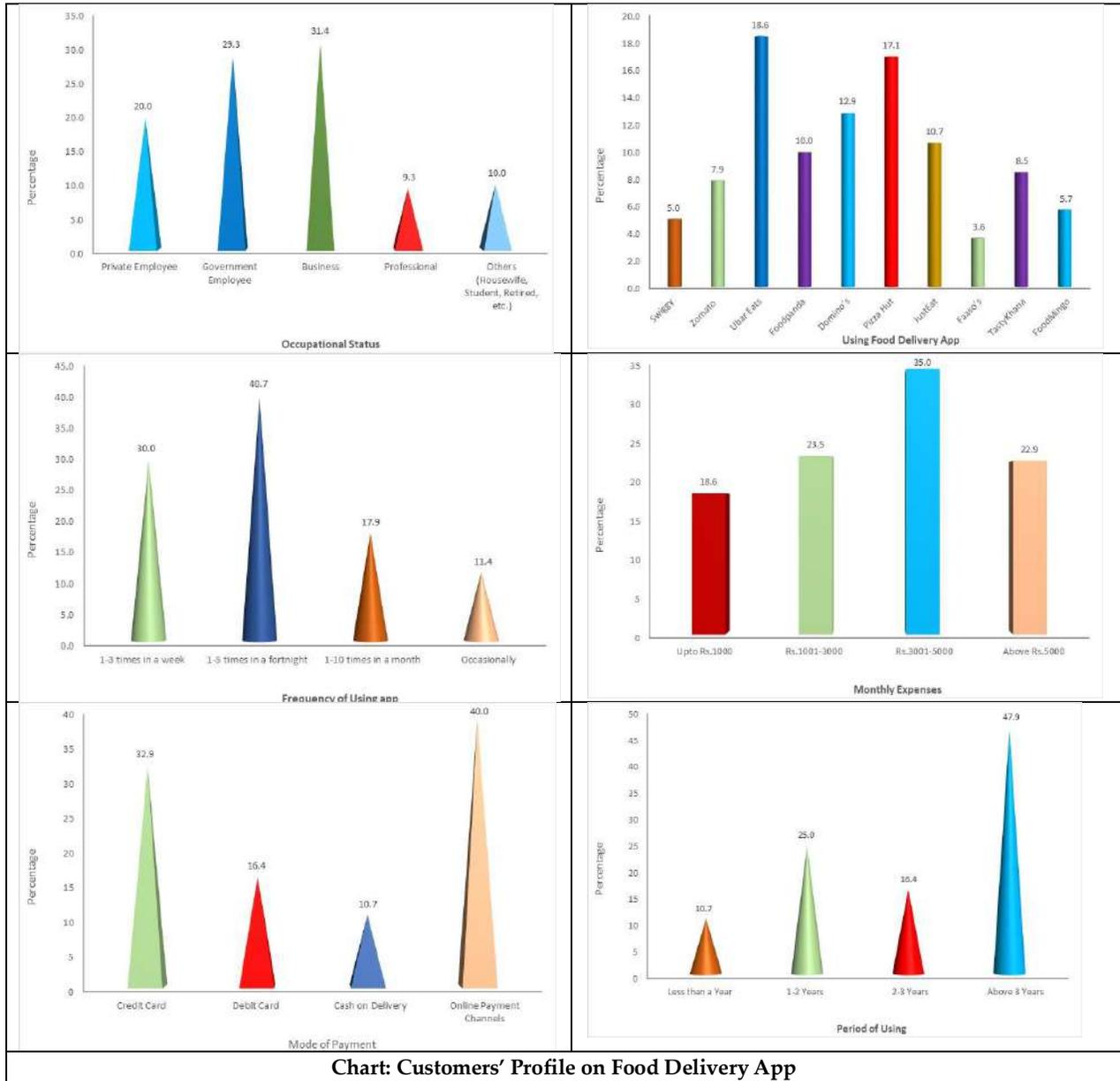
Chart: Customers' Profile on Food Delivery App

RESEARCH ARTICLE

An Exploratory Study on Digital Financial Inclusion and Development in India

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ABSTRACT

The economic and social progress of a nation can't progress without a robust financial system. It's an essential component in the process of channelling savings into investments in productive assets. The Government of India and the Reserve Bank of India have adopted a variety of policy steps to bring the massive unbanked masses into the financial mainstreams, recognising the significance of financial inclusion as a facilitator of inclusive growth. There has been a lot of progress made in communication technology recently that can be utilised to include the unbanked in the digital financial system at low cost. To promote economic growth that benefits all segments of society, digital financial services may be a powerful tool in promoting financial inclusion.

Keywords: Financial Inclusion, Digitization, Mobile Banking, Inclusive development.

INTRODUCTION

The health of a country's economy depends in large part on its financial system. Sufficient resources are essential to the health and efficiency of the financial system. A financially inclusive society guarantees that all of its residents have access to and are able to make use of basic financial services. Financial knowledge is the forefront in making wise use of these resources. A person who is financially literate has the informational and psychosocial tools at their disposal to handle their own finances wisely and successfully. Gaining financial literacy is seen as an investment in human capital since it helps to moderate spending over accounted for the importance of financial literacy in the context of an individual's pursuit of maximisation of lifetime value subject to constraints imposed by the model's underlying time horizons and budget constraints. Financial Education in the Digital Age (DFL)appears to be an

important part of the modern digital environment as a form of financial literacy. It is the process of learning how to use digital services for monetary transactions and expanding one's comfort zone with these tools. The individual's degree of literacy and familiarity with digital gadgets and technology both play a role in the formation of this habit. Learning about personal finance encourages a broad variety of actions, from establishing a bank account to purchasing insurance and investing. On the other side, being financially illiterate can lead to bad choices regarding debt accumulation, stock market involvement, and borrowing. Governments may do more to foster economic and social inclusion by raising digital literacy, which in turn boosts civic participation, strengthens public safety, and broadens citizens' access to public-sector services. While this is great for consumers, it also helps firms build cloud-enabled infrastructure, which is a key factor in the birth of any innovation-based sector.

Even though India's recent economic growth has been impressive compared to other developing countries, a large portion of the population still can't use banking services. A World Bank report from 2017 says that more than half of India's people don't have bank accounts. This makes India the second largest country in the world, after China. It is one of the primary goals of the current NDA administration (in office since May 2014) to facilitate economic and social growth via the use of technology-enabled financial inclusion. The creation of PMJDY is the initial stage of this initiative, which ultimately aims to open a bank account for every resident of India. Through the use of modern technology, it is able to supply the economically disadvantaged with services such as remittance facilities, pension benefits, and insurance coverage. Digital India and Aadhaar, two additional government programmes, have been integrated. The former seeks to rapidly increase people's access to mobile phones and the internet, while the latter creates a unique digital identifier for each resident. With the use of Aadhaar cards, it is straightforward to track down the rightful recipients and deposit the funds into their bank accounts. The PMJDY, Aadhaar, and Mobile triangle was dubbed the J-A-M trinity because of its role in spreading digital financial education. A considerable portion of government subsidies are lost due to intermediary costs, corruption, and inefficiency; the government expects that the JAM trinity would help them rein in these losses.

In addition, the government and the Reserve Bank of India (RBI) have launched a number of initiatives aimed at improving citizens' familiarity with and ability to use digital financial tools. One such initiative, the Digital Saksharta Abhiyan (DISHA), was launched by the Ministry of Electronics and IT to give one crore rural residents with training in digital financial literacy and access to such tools. VittiyaSaksharta Abhiyan (VISAKA) has been re-introduced by the Ministry of Human Resource to educate over a million college students (Prasad and Meghwal, 2017). During the course of the training, participants will learn how to register a bank account, link a mobile number and Aadhaar card number to a bank account, use a mobile wallet, make a transaction using the Unified Payments Interface (UPI), and so on.

India's government has taken the following steps
The widespread use of computers in India increased when the country's economy was liberalised in 1991 and 1992. Several Indian commercial banks have begun providing digital consumer services in an effort to maintain relevance in the increasingly globalised banking industry. The deployment of new technology also benefits financial institutions. Since the advent of online banking, banks have significantly cut their operating expenses. Indian banking sector reforms are about to enter their second phase. The greater the degree to which the Indian economy is integrated with the global economy, the larger the influence of global economic risk on the Indian economy. Even in the corporate sector, the government is narrowing its safety net for employees. A lack of these programmes would lead to greater financial insecurity among the populace at large. Therefore, it is crucial to increase financial literacy among Indian individuals to ensure their economic security. Though residents have access to and can utilise many forms of technology, they lack the expertise to make the most use of it, particularly when it comes to managing their finances. The Indian government announced the demonetization programme in 2016 with the goals of making India a paperless digital economy and eliminating black money. The widespread use of e-wallet apps and websites can be attributed in part to the demonetization policy. Even though more people have access to bank accounts online as a result of demonetization, physical currency is still widely used. This is because most individuals lack basic skills when it comes to managing their finances online.

When looking at India's development of its digital financial service infrastructure, two distinct stages of expansion are evident. The first phase spans from before August 2016 (the beginning of the demonetization process) and until the end of that month. In the first stage (beginning in early 2014) the volume of digital financial transactions increased at a rate of 2% per month (USAID, 2019). For the purpose of providing access to financial services for India's underprivileged population, the Indian government launched the Pradhan Mantri Jan-Dhan Yojona (PMJDY) in 2014. The initiative was bank-led and sought to provide Indian adults with access to a bank account. Over the next year and a half, 38.22 billion people will deposit a total of Rs. 1,17015.5 crore into bank accounts, most of which will be held by huge public sector banks (PMJDY website). Though there is considerable debate about the precise number, both in terms of new account creation and account dormancy, the fact remains that it has helped make financial services more accessible to the hitherto excluded majority of the people. Direct Benefit Transfers (DBT) and Government-to-person (G2P) payments have been integrated into PMJDY to ensure that the benefits of government programmes reach the people who need them most. The government now faces the issue of fostering financial inclusion beyond the passive "access" stage. Debit cards using the RuPay network were supplied to PMJDY account holders to facilitate digital transactions and discourage the use of paper checks.

The push for a cashless economy in India has been gathering steam in recent years, with the number of digital transactions increasing dramatically. Undoubtedly, users are finding banking and payments more convenient than ever because to the widespread use of UPI and other digital advancements. The Reserve Bank of India (RBI) has reported that 29.20 billion RuPay debit cards have been distributed to the recipients, representing the total number of digital transactions. How Things Are Now, Where We Want to Go, and What We Face with Digital Financial Transactions in India Debit and credit card issuance in India's scheduled commercial banks has increased dramatically during the past several years. Commercial bank debit card issuance in India increased from 55.4 in 2014 crore to 92.4 crore in 2019, a CAGR (Compound Annual Growth Rate) of 14 percent. With the same time frame, the number of credit cards has increased from 2.1 crore in 2014 to 4.7 crore in 2019. a rate of increase of 25.7% in 2018-2019 over 2017-2018. The total amount of money exchanged via digital means has quadrupled from 8.56 million to 24.13 million rupees. The research also notes that in March of this year, the amount of UPI transactions hit a record high of $799.5 million, which is 405% more than the volume in March of 2018. The fact that many individuals in India, especially the elderly and those living in rural areas, still prefer to use physical bank branches is a major obstacle to the growth of internet banking there. Concerns about security prevent many people from making electronic financial transactions. There is a significant barrier to widespread adoption of e-banking due to the general public's insufficient familiarity with the technology. Training for new information technology trends is also necessary for bank workers to adapt to the ever-evolving technological landscape. External dangers, such as hacking, sniffing, and spoofing, are also a concern. Furthermore, the development of AI poses a significant threat to the Indian financial sector.

Inclusion in digital financial markets and economic growth
If more people are able to access and use financial services, the economy will flourish. Bank account maintenance costs, ATM and branch expansion rates, and transaction times all fall under the "supply side" category, while illiteracy, poverty, and job insecurity all fall under "demand side" categories because they reduce people's ability to save money and put it towards things like credit and insurance (D'Souza, 2018). Financial inclusion helps those with lower incomes achieve economic security and break the cycle of poverty. A person shouldn't have to go on debt only to deal with an unexpectedly large bill or to put money away for retirement. The proliferation of smartphones, the internet, and other digital technology has facilitated the digitization of data gathering, analysis, and distribution. Availability to mobile phones is far higher in a developing country like India than access to other basic necessities like clean water or medical care. Most people in India who don't have bank accounts or who don't use their accounts regularly have mobile phones, therefore the country's limited bank branch network and the Business Correspondent (BC) model may be overcome through digital financial inclusion (Demirguc-Kunt, Klapper, Singer, Ansar, and Hess 2018). Providing financial services to the poor, especially the unbanked masses, has become more easier because to the proliferation of mobile networks in developing countries. Financial information such as micropayments, recurring savings, and micro-credit might be communicated cheaply using mobile communications (Claessens,

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Glaessner and Klingebiel 2002). The widespread use of online banking has decreased the price of customer data while simultaneously expanding its accessibility (World Bank, 2016). Access to digital financial services is beneficial for all societal strata, including individuals, businesses, and governments.

Consumers

About half of all people in developing nations now have access to a mobile phone, making it possible to deliver easy, inexpensive, and secure banking services to the underserved (World Bank, 2014). Expanded access to financial services benefits the economy by creating new jobs and increasing disposable income. Financial organisations can save money thanks to digital financial transactions since they require less paperwork, fewer bank branches, and shorter wait times at those locations (IFC, 2017). Because customers may switch banks in a matter of minutes if they receive subpar service, banks are motivated to improve their efficiency by providing superior products and services. Financial services have a low marginal cost, hence the law of growing returns at larger scale encourages the development of innovative business models. When more people utilise online banking and other forms of electronic payment, it helps the government reduce the amount of cash in circulation, which is a powerful weapon for lowering high inflation (GPFI, 2016). The government's capacity is expanded as a result, allowing for simpler delivery of essential services. Increasing the speed and decreasing the cost of distribution are two ways in which digital G2P (Government to person) payments may boost payment efficiency. This method also improves the openness of monetary transactions and minimises leakage between the payer and the payee. On top of that, it strengthens the safety of financial transactions and decreases the likelihood of fraud. Digital payments can aid in women's economic empowerment by increasing the safety of transactions and giving recipients more discretion over the money they receive.

LITERATURE REVIEW

Delivery of financial services has seen gradual but continuous development over the past few decades. There has been a lot of shift due to the development of digital technology. In this new era, information is processed more quickly and more connections are made, both for the benefit of the consumer and for internal operations. The financial services sector has been the major target of digitization as a result of the proliferation of potentially lucrative digital business models and prospects in recent years. Digital finance, in its most basic sense, describes the many cutting-edge options available from FinTechs and other forward-thinking financial service providers. This has prompted researchers in fields like finance and IT to examine the implications of these shifts for the economy. This study thus examines the present level of research in Digital Finance that focuses on such innovative business strategies. As an added bonus, it reveals prospective growth areas for the market. An instrument for this sort of research is the Digital Finance Cube. There are three key components that make up digital finance and fintech: the associated commercial operations, the underlying technology and technological principles, and the associated institutions. Working from a shared conceptual framework that allows researchers and practitioners to group studies by similar themes, sort studies by how they were conducted, and uncover research gaps is essential for navigating the rapidly expanding area of digital finance. (Gomber P., 2017)

It would be hard to foresee how quickly the global economy is developing right now if not for the extensive use of digital technologies, which are transforming whole areas of the economy. The advent of the "digital economy" may be traced back to the widespread adoption of digital technology. So much so that it requires a sizable population to adopt cutting-edge methods of electronic communication and computer usage. The Russian Federation's Digital Economy State Program was officially adopted that year (2017). It lays forth the government's plans and priorities for expanding the country's digital economy. The initiative's primary objective is to develop and distribute tools for managing and analysing massive data sets. One of the world's top financial centres is the Russian Federation. A large amount of information has accumulated during their lengthy history, and this must be combed through and examined before anything further can be done. This research analyses the current state of big data and identifies promising solutions for the Russian market. As part of our analysis, we also considered the state of the Russian big data market financially, its existing and prospective market leaders, and the dynamics and development rates of the

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Russian big data industry. We analysed the financial market for big data in Russia's banking and financial sector, looked at how Russian financial organisations accepted and utilised big data, and identified use cases for these technologies. The article investigated why Russian financial institutions have been slow to adopt big data analytics.(A.V., 2018)

There has been remarkable expansion among Thailand's SMEs in the manufacturing sector. Their very life is at stake, and this success can only be ensured by strictly adhering to well-established supply chain procedures. Although trade digitalization and supply chain finance are potentially useful tools for improving the performance of small and medium-sized firms (SMEs), it is crucial to consider other elements before drawing firm conclusions. This research investigated the potential moderating role of supply chain financing and negotiation in the context of trade digitalization, with a particular focus on the effects of digitalization on the performance of small and medium-sized enterprises. We employed structural equation modelling to analyse survey responses from about 35 SMEs in Thailand's manufacturing sector, including both management and workers in the production department. The findings demonstrate that trade digitization significantly modifies the relationships between supply chain agreements, finance, and SMEs' performance. This study stands out because it is one of the few to investigate how trade digitalization influences the correlation between SME performance and supply-chain negotiations (SMEs). The findings of this study have important consequences for the administration of Thai government and for Thai small and medium-sized enterprises.(Somjai S., 2019)

Understanding the meaning of "Industry 4.0" requires a look at the informational backbone of a modern digital enterprise. Keeping up with the exponential rise of data flows produced by modern digital technologies necessitates a digital transformation for a conventional firm. The demand for alternative methods of managing digital enterprises has become pressing in light of the proliferation of new business models and network architectures based on community-based approaches to production and consumption. Most individuals believe that if firms adopted cutting-edge information and communication technology, they would be more productive and profitable (mobile; sociality; BPM; electronic document management system ERP finance and accounting; Big Data Analytics, business analytics). Indications are that technological advancements have made it feasible for all business activities to be optimised in a consumerization-driven fashion. In addition, they provide effective collaboration between businesses operating in specialised manufacturing fields. There is a systematic breakdown of the present trends in the expansion of digital businesses, as well as the prerequisites for the widespread adoption of digitalization. When all the components of a digital organization's information infrastructure have been developed, a model of how to manage it may be displayed. The digital infrastructure aids in achieving the aims of speeding up decision making, increasing process flexibility to meet the ever-evolving demands of consumers, and decreasing the number of people involved in the process. When it comes to managing the information infrastructure of a digital organisation, "Industry 4.0" fortifies the methodological underpinnings. (Andriushchenko K., 2019)

Interest in the intersection of accounting and technology has resurfaced in light of recent developments in digital technology. Still, there is a dearth of literature on the topic of how management accountants' roles are affected by the rise of digital technologies. Management accountants play an essential part in the modern economy, and this article employs the concept of "jurisdiction" to describe the value of management accountants' specialised expertise and technology resources. The results indicate that management accountants appear to be engaged in a power struggle with other groups inside an organisation. Management accountants at the division level were found to have less responsibility and authority compared to those in business-focused jobs at the team level. As a result, management accountants at the group level have different objectives to meet than those at the division level. The essay presents several salient arguments concerning the roles and responsibilities of management accountants by using a case study from the technologically-focused banking sector. The article begins by discussing the ways in which computers might facilitate specialised work. The essay then moves on to its second point, which is the possibility that increased professional competitiveness would result from the increased usage of digital technology. Finally, it describes how management accountants' responsibilities and the expectations of their superiors have evolved in light of the widespread adoption of digital technologies. Finally, it discusses how management accountants may need to adapt

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to the new digital landscape. Finally, a factual analysis of how the rise of digital technology is altering the responsibilities of accounting supervisors is presented.(R.-I., 2020)

The evolution of Uzbekistan's digital economy and banking industry over the past few years is the primary focus of this essay. Learn about the state of the digital economy in Uzbekistan's banking industry after reading this article. The example of PJSCB "RAVNAQ-BANK" is shown. This research aims to encourage more academics to participate in developing the digital economy in a range of developing countries. This is for the good of the national and business economies. This research may be broken down into four sections. Part one of this article explores the impact of the digital economy on the financial services sector. Our second topic is the potential benefits of mobile banking technologies to the banking industry. Third, we analyse how PJSCB "RAVNAQ-BANKevolving "'s financial infrastructure is contributing to the reorganisation of the digital economy. We'll wrap off by discussing how the expansion of the digital market and the digitization of government services are intertwined.(Khusanov N.A., 2020) The Chinese manufacturing sector is keen to adopt a service-oriented business model. The rapid expansion of digital financial services has facilitated progress in many fields. We examined the impact of digital finance on manufacturing outsourcing using data from listed businesses and the Digital Financial Inclusion Index from Peking University. The findings demonstrated that digital finance significantly aids the servitization of China's industrial sector. We also explored the idea that the increased levels of innovation and digitalization enabled by digital banking would promote manufacturing servitization. In addition, we discovered that digital finance's promotion of servitization benefitted the most firms located in the country's central and western regions, in labor-intensive sectors, in high-tech industries, and that were privately held. Finally, we discussed the degree to which companies are prepared to adopt manufacturing servitization and the evolving nature of the associated repercussions. While the operation of digital currency is compatible with the law of diminishing marginal utility, a distinct superimposing impact is seen in the past three periods.(Chen S., 2021)

Financial inclusion is a method of reducing economic inequality by facilitating transactions through established financial institutions such as banks. Poor and marginalised individuals may benefit from a more accessible financial system if traditional banking is converted into a digital system, allowing them to more easily access services such as inexpensive healthcare, equal education and work opportunities, and equal income. In order to assess the extent to which India's socioeconomic potential has been realised, we studied the impact of digitalization-led financial inclusion on public sector Indian banks and the socially excluded segment of the country's population. Banks have improved financial inclusion by making financial services more accessible, but we found that digitalization has had little effect on this. On the other hand, banks' financial situations have greatly improved. The findings provide light on inclusion as a multidimensional term comprised of several indicators of socioeconomic well-being and have policy implications for India's public banks and central bank.(Kanungo R.P., 2021)

Using the impact of Islamic and conventional banks' basic accounting and market analysis IFIs on financial inclusion in their respective home countries, this research aims to provide a snapshot of the global landscape of fintech solutions as it is now. Using data from Bloomberg Financial, the top 10 conventional US banks and top 10 Islamic banks are compared based on Total Asset and Market Capitalization. Data study by Bloomberg demonstrates that Islamic banks have a greater risk-return than conventional US banks, with the exception of the ROE Market statistic that we provide. The result was a period of rapid expansion for Islamic banking from 2006 to 2021. We find that Islamic financial institutions, in contrast to their US counterparts, place a greater focus on credit. In fact, loans account for more than 70% of their net income. The authors claim that the development of fintech and digitalization are what are allowing Islamic finance to flourish during these trying economic times. How we may and cannot use

The results of future studies
No one in the financial business has any idea what FinTech is, and there hasn't been any in-depth study of the many shifts taking place in the sector. Practical wisdom Islamic banks are always on the lookout for new methods to better serve their customers, and FinTech presents a fantastic opportunity to do so. Those in academia and the business sector interested in the evolution of Islamic and conventional banking may find this research instructive. The

authors' comparison of the American banking system to the Islamic banking system may be instructive for consumers. Originality/value: For this study, the authors analysed Risk-Return, Growth, and Business Model using accounting and market data from Bloomberg for the top 10 Islamic and top 10 US conventional banks from 2006 to 2021. Another method of weighing the potential benefits and costs is provided. Market volatility and the potential for loss vs potential gain (Sidaoui M., 2022)

This research examines 57 emerging economies between 2006 and 2018 to determine if there is a correlation between Internet penetration and the emergence of innovative enterprises and user-friendly financial services. The authors employ a generalised least squares estimator-based approach to compare the impact of improved and diminished access to capital on the expansion of startups in developing countries with high and low Internet penetration. Financial markets and financial institutions are not the same thing. More access to financial markets is found to be detrimental to the emergence of new enterprises, whereas more ease of access to financial institutions increases the likelihood that individuals would go into company ownership. In addition, the authors discover that the marginal effect of access to financial institutions rises as the Internet user base expands. In terms of the stock market, this influence will quickly fade. Implications for the field and potential roadblocks to further study: The fact that new companies may only be tallied in the traditional entrepreneur sector is a major issue. Therefore, it is impossible to accurately account for the unofficial economy or for lone owners. Policymakers are dedicated to expanding the ICT industry and their digitalization efforts, and as a result, they aim to make it simpler for individuals to access financial resources. This research is substantial because it demonstrates how, when combined with improved access to capital, technology may make it simpler for new enterprises to launch. The paper provides an in-depth analysis of the function of banking structures and market forces in this setting.(Haini H., 2022)

In order to better understand global digital trends and identify new business prospects across all sectors, this article employs a co-word analysis. The rapid speed of technical progress and digital transformation has led to a more complex and dynamic industrial environment. Strategic planning and investment plans at the corporate and regional levels rely heavily on identifying emerging industry trends. This research analyses CrunchBase data from 2016-2018 to determine which subsectors in education, finance, healthcare, and manufacturing are targeted by early-stage firms from around the world. In example, we employ word co-occurrence analysis to learn how frequently certain terms are used in various industries and digital tools. Network analysis is also used to draw up maps of company ecosystems and identify trends in the digitization of various sectors. According to the data, personalised and competitive learning are gaining popularity in the classroom. Transactions, payments, insurance, venture capital, the stock market, and risk management are just some of the areas where digital technology has been put to use in the financial services industry. Data study also reveals that healthcare diagnostics and senior care are the frontrunners in the industry's push towards digitization. The importance of smart networked manufacturing and the automation of industrial processes in the context of manufacturing start-ups is growing. Finally, implications for strategic planning and management are discussed.(Bzhalava L., 2022)

Because of the rise of digitization and technical advancement, CCIs have shifted to accommodate new methods in which individuals access assistance. Businesses in CCIs employed reward-based crowdfunding between 2015 and 2019, and this research will analyse how the cultures and regulations of 12 European nations influenced their usage of this financing method. We discovered that the demand for cultural and creative crowdfunding is significantly impacted by country cultural attributes and legislation. Countries with high rates of avoiding ambiguity, hedonism, and a focus on the short term are also likely to have high rates of crowdfunding success. We also discover that the Southern European welfare model, which is based on a weak and inefficient state, increases the use of crowdfunding in the CCIs, as does the liberal welfare state model, which is characterised by minimal government involvement, market orientation, privatisation, and a focus on individual responsibility. More often than not, crowdfunding is successful in CCIs where the central ministry has a firm grasp on local customs. Our findings reveal a wide variety of demand for crowdfunding across Europe, with the level of interest fluctuating in relation to the number of people actively engaged in a certain sector. We also find evidence that the EU acts as a moderator between cultural characteristics and crowdfunding adoption, suggesting that the strength of this relationship relies on the availability

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of EU funds in a nation. To ensure the accuracy and consistency of our primary findings, we conduct a battery of correlated random effects (CRE) Poisson regressions.(Cicchiello A.F., 2022)

Objectives

1. The goal of this study is to take a look at where digital financial inclusion stands in India right now..
2. The purpose of this research is to better understand the significance of digital financial literacy in fostering India's inclusive growth.
3. Understanding the Relationship Between Access to Digital Financial Markets and Economic Development

METHODOLOGY

The current research uses a descriptive analytic approach. RBI and other financial and non-financial entities' public reports were utilised as inputs. In addition, articles from a variety of reputable journals, websites, and periodicals have been included.

FINDINGS AND CONCLUSION

In the future years, digital transactions will replace traditional methods of doing financial business. Yet not everyone has been able to reap the benefits of digital financial inclusion. There is a large gap between the availability and functionality of technical advancements for digital transactions throughout the country, which has to be bridged. Expanding access to things like banking and internet services isn't enough to eliminate the systemic barriers that poor people experience. If digital financial literacy projects are to support human development and poverty reduction, they need to be structured in a way that takes into account the interconnected demands of the underprivileged classes. Together with other supplementary resources, it may help make financial literacy in the digital age a central focus of schooling at all grade levels. The potential success of this endeavour may hinge on the accessibility of online services to the underprivileged sector of the population. Training programmes offered by private and non-profit organisations can also play an important role in boosting individuals' digital literacy across all age groups.

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REVIEW ARTICLE

Snake Venom: Panpharmacon for Cancer

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ABSTRACT

Cancer has been an ever-present fatality in the pharmaceutical world. In this article, research conducted over the years on the anticancer properties of snake venom have been reviewed. It is common knowledge that snake venom has neurotoxic and haemotoxic effects on the human somatic cells. But these effects are also responsible for making snake venom into an antidote instead of a poison. It was observed that this antitumour property of cancer is mainly due to the presence of disintegrins, enzymes and peptides. This study is another step towards the discovery of a new cure for cancer. Numerous research has been conducted in the avenues of venom extraction, purification and capacitation for the treatment of cancer. Since chemotherapy is highly selective, this new methodology is the next breakthrough in the field of cancer technology. The first angiotensin converting enzyme inhibitor was obtained from the Brazilian Pit Viper. It was named Captotril. Disintegrins are peptides that lack enzymatic activity but have a high affinity for integrins and trans membrane receptors, which link the component of the cell with the extracellular matrix. They act as anticoagulants, allowing the venom to circulate more freely throughout the body of the target. Disrupting the last stage of platelet aggregation causes this anticoagulant action. Disintegrins block fibrinogen binding by tying to the integrins themselves. This review article's objective is to provide an overview of the extensive research done from 2015 to 2022 on the viability of snake venom as an anticancer drug agent due to its inhibitory effects on cancer progression, including cell locomotion, cell seizure, colony genesis, and its impact on the phenotypic and genotypic levels in cancer cell lines [1].

Keywords: Tumour, Phospholipase, Viperidae, drug, oncogenes, apoptosis

Akanksha Tarafdar and Swati Bhatt and Manikantan

INTRODUCTION

One of the most leading causes of deaths as listed under the World Health Organisation is cancer. Loss of normal metabolic functions and the ability to differentiate by the somatic cells and their uncontrolled multiplication leads to cancer. Cancer cells have a novel way of growing called neoplasm. If cancer cells are present in a particular location, it is called benign. If cancer cells invade other parts of the body, it is known as malignant. The risk of cancer increases dramatically, with an increase in age, and various forms of cancer are prevalent in developed countries [35]. With the increase in the number of senior citizens and the drastic changes observed in our lifestyle, cancer has been quite an exasperating occurrence in the developing world. The total global economic cost of cancer was estimated at US$2.21 trillion per year in 2016 [10]. Approximately 45% of all the new cancer cases observed each year include non-melanoma skin cancer cases.

Lung, prostate, colon, and stomach cancer, are commonly seen in men while the most common in females are breast and cervical cancer. Acute lymphoblastic Leukaemia and Astrocytomas are commonly observed in children under the age of 15. The main causes of cancer include smoking and the practise of an imbalanced diet [51]. Presence of carcinogenic substances in smoke, food, and the environment causes mutations in genes and interferes with cell differentiation. When protooncogenes are activated, tumour suppressor genes are inactivated, causing cancer. Until now, there have been three methods for the treatment of cancer: surgery, radiotherapy, and chemotherapy [13]. The combination therapy is much more effective because it has different mechanisms of action. Bone marrow cells are totipotent in nature. Hence, accumulation of anti-cancer drugs occurs faster in these cells, leading to a negative side-effect. Chemotherapy is highly selective and specific to biomolecular targets that are overexpressed in the cell. The most common anticancer drugs as of 2019 are Rituxan (rituximab), Revlimid (lenalidomide) and Avastin (bevacizumab). In recent studies, snake venoms have shown remarkable anti-cancer properties. Snake venoms are intricate mixtures of proteins such as neurotoxins, hemotoxins, cytotoxins, and bungarotoxins; minerals such as Zinc, Calcium, Sodium, and Magnesium. Phospholipases A2, Ancarrid, toxins in cobra, cytodoxes CD1, CD2, and crytoxin acid, and amino toxin are also important components. Diseases like Cancer, Rheumatoid arthritis, Neurological disorders, Muscular disorder, Myocardial infarction can be treated by snake toxins [5]. Many studies have been conducted on snake venom measures in tumour culture and are currently undergoing clinical trials in two phases [44]. Venom is a pre-digestant. It helps in the commencement of digestion and assimilation [41,12]. Most of the snake venoms contain enzyme hyaluronidase, which warrants the swift diffusion of the venom. Most people confuse the terms, "poisonous" and "venomous". Poisons are ingestible and inhalable, whereas venoms are injected directly into the blood flow.

Taxonomically, venomous snakes belong to two families- Elapidae consist of cobras, kraits, African mambas, copperheads, aquatic snakes and coral snakes [41]. Viperidae consist of vipers, cottonmouths, bushmasters, and rattlesnakes. Some Colubridae such as boom slangs and tree snakes are also venomous [41, 37]. Snake venoms are highly toxic. Hence, they are an appropriate choice for the production of antitumour agents. The development of today's advanced screening systems has led to the discovery of latest biotoxin-derived therapeutic compounds, such as the venom of many snakes, which show display potential in the fight against cancer. Increasing understanding of the molecular mechanism also helps in this direction [50].

GENESIS OF CANCER
A pharmaceutical agent is referred to be a "drug" if it has the necessary biological impact on the body of a person or another living thing. A drug can be either futile or dangerous. Futile drugs cause no unwanted side effects, whereas dangerous drugs have toxic effects. Along with physical and chemical mutagens which are found to be carcinogenic, there are few viruses and bacteria that are responsible for causing cancer. Epstein Barr virus is the cause of Burkitt's lymphoma. Human papilloma viruses are sexually transmitted and can cause cervical cancer. Hepatitis B is responsible for liver cancer. HIV (Human immunodeficiency virus) can cause Kaposi's sarcoma and lymphoma. The bacterium *Helicobacter pylori is* responsible for many stomach ulcers which may progress to cancers.

Genes called proto-oncogenes generally produce proteins that regulate cell development and division. If a mutation takes place, it interferes with the cell's normal function. If this occurs proto-oncogenes are called oncogenes and are in their activated form. For example, Ras genes- abnormal production of Ras protein affects the cell's ability to self-regulate and stay active, leading to continuous cell division [34].

When DNA is damaged, cellular policemen detect them and block DNA replication. If this does not happen, cell commits suicide (apoptosis). There are two routes of apoptosis: Extrinsic and Intrinsic. Tumour suppression genes code for proteins that monitor the processes of cell checking, repair, and suicide. For example, TP53 gene that codes for p53 protein. If the cell becomes cancerous, apoptosis does not occur. Due to these kinds of genetic defects such as activation of proto-oncogenes and inactivation of tumour suppression genes, abnormalities in cell cycle regulation are observed. The cells become insensitive to growth inhibitory signals, following abnormal signalling pathways, leading to tissue invasion and metastasis. Cells become totipotent in nature, develop the ability to form new blood cells (angiogenesis) and cell division is limitless.

Cell cycle is the basis of life. Its function is to divide the mother cell into two genetically identical cells. There are four stages total—G1, S, G2, and M. In response to several growth stimuli, the cell is actively expanding in size and getting ready to duplicate its DNA during the G1 phase [34,60]. DNA replication takes place during the S phase. The cell prepares for cell division during the subsequent period known as Gap-2 phase after the chromosomes have been replicated [34]Cell division occurs during the last phase (mitosis), resulting in two daughter cells, each of which possesses complete sets of chromosomes [24]. In tumour cells, the restriction point becomes abnormal, thus losing control of the cell cycle. Cyclin proteins and cyclin dependent kinases regulate the uninterrupted flow of the cell cycle [8]. In cancerous cells, this activity is disrupted [3].

ANTICANCER DRUGS AND THEIR MECHANISM OF ACTION
In cancer treatment, combination therapy is considered more effective, which means that the usage of various anticancer drugs with different mechanisms of action is considered productive. Chemotherapy is highly selective and specific to cellular target molecules that are over expressed in the tumour cell. Most conventional anticancer drugs work by disrupting the functioning of DNA and are termed as cytotoxic [20]. ome act on DNA directly, while others act indirectly by inhibiting enzymes involved in DNA synthesis. A new era of chemotherapy called molecular targeted therapeutics is emerging as a more effective remedy of cancer. The development of kinase inhibitors such as imatinib, is a much-heralded illustration of this approach [34]. Knowledge of the cell cycle is important in chemotherapy. Specific drugs are sensitive towards specific parts of the cell cycle. For example, drugs like Paclitaxel (Taxol), which affect microtubules, target the mitotic phase. Some drugs like Cisplatin are utilised regardless of the phase.

Transport proteins bind to a specific guest molecule, but sometimes it attaches to the drugs being provided. Examples of drugs that bind to transport proteins include cocaine and tricyclic antidepressants, which stop neurotransmitters like noradrenaline and dopamine from reentering nerve cells [34]. This has a similar impact to adding medications that imitate neurotransmitters, basically raising the amount of neurotransmitters at neuron synapses. Paclitaxel inhibits tubulin depolymerization and is an important anticancer agent. The majority of anti-cancer medications are anti-proliferative, which means that they also impact quickly dividing healthy cells. As a result, they are likely to inhibit growth, slow healing, and depress bone marrow [36]. The majority are teratogenic, sterile, and induce hair loss (reversible alopecia) (abnormality caused by drugs in foetus). Alkylating chemicals have chemical groups that may interact with DNA and other nucleophilic components of cells to produce cross-bridge covalent connections [36]. The N 7 position of guanine is a major site of alkylation in DNA [11]. Antimetabolites block or reroute one or more of the metabolic routes used to synthesise DNA [36]. Polyglutamates are changed by dihydrofolate reductase into FH2 and FH4. An important co-factor for the production of purines is FH4. Dihydrofolate reductase enzyme is inhibited by antimetabolites like methotrexate. Plant compounds like vinca alkaloids bind to tubulin and prevent it from polymerizing into microtubules, which prevents the production of spindles and results in metaphase arrest [36,2]. Since, they have inhibitory effects on lymphocyte proliferation,

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glucocorticoids like prednisolone and dexamethasone are utilised to treat leukaemia [36]. Analogues of the gonadotropin-releasing hormone are used to treat breast and prostate cancer by inhibiting the release of gonadotropin. Antibiotics that directly affect DNA include the class of substances known as cytotoxic antibiotics [36]. Doxorubicin inhibits topoisomerase II activity by forming complexes with DNA via guanine in both DNA strands [36]. Cell disruption and cell death are the outcomes of this DNA intercalation process. Immunoglobulins made by hybridoma cells that respond with certain target proteins expressed on cancer cells are known as monoclonal antibodies [36]. The drug rituximab is used to treat lymphomas. B-lymphocytes are killed when it attaches to the CD20 protein, which helps generate calcium channels. Along, with a combination of other chemotherapeutic agents it can cause apoptosis.

SNAKE VENOM: ANTICANCER PROPERTIES

The evolutionary archives of venomous snakes can be tracked previously to as far as 27 million years ago. Venomous snakes belong to the sub order Serpentes and are capable of producing venom, which is used to kill prey and as a self defence mechanism. The venom is injected using hollow or grooved fangs, although some snakes do not have well developed fangs. The families of Elapidae, Viperidae, Atractasipididae, and Colubridae.

Snake venom is essentially modified saliva which is secreted through specialised hollow fangs directly into the blood stream or the tissue of the prey leading to its immobilization [42]. The virulence of venom is majorly indicated by murine LD_{50}. Snake venom has both neurotoxic and hemotoxic effects. It is an amalgamation of many bioactive molecules. The most abundant component of snake venom includes phospholipase A2, metalloproteinases, lyases, and endonucleases, serine-proteinases, hydrolases, alpha-neuro toxins, protease inhibitors, cardio toxins, dendrotoxins, and disintegrins. Enzyme and non-enzyme components are the two types of typical venom components [29,6,16]. L-amino acid oxidases (LAAO), metalloproteases (SVMP), (SBSP), phospholipase (PLA2), esterases, proteases, and hyaluronidase are among the enzymes found in enzymatic snake venom [28,14].

Disintegrins are peptides that lack enzymatic activity but have a high affinity for integrins and trans membrane receptors, which link the component of the cell with the extracellular matrix [24]. Disintegrins attach to the integrins on the cell surfaces of platelets and other cells in a particular manner. They act as anticoagulants, allowing the venom to circulate more freely throughout the body of the target. Disrupting the last stage of platelet aggregation causes this anticoagulant action. Disintegrins block fibrinogen binding by tying to the integrins themselves. Disintegrins were commercialised as Eptifibatide and Tirofiban, two medicinal drugs, as a result of this feature [40]. Eptifibatide (Integrilin) is a disintegrin that was isolated from the barbourin-containing venom of the pygmy rattlesnake (Sistrurusmiliarius barbourin) [40,26]. Echistatin, a synthetic version of the disintegrin called tirofiban, is found in the venom of the saw-scaled viper (Echiscarinatus) (Aggrastat). These antiplatelet medications are used during acute coronary syndrome [40]. For integral-mediated cell attachment, signal transduction mechanisms including cell migration and dissemination are crucial. Integrins aid in the angiogenesis, metastasis, and proliferation of cancer cells [40,57]. Trans-membrane receptors called integrins connect the cytoskeleton to specific extracellular matrix substances such vitronectin, laminin, fibronectin, and collagen [40]. Upon attachment to the ECM, integrins start signal transduction inside the cell matrix. Proliferation and survival of cancer cells are significantly impacted by integrin-mediated cell attachment. Integrins are heterodimeric complexes made up of one alpha and one beta subunit when they are in their active state [40]. Their capacity to interact with membrane-associated proteins is influenced by the presence of a persistent tripeptide motif called the Arg-Gly-Asp (RGD) motif, which is composed of the amino acids arginine, glycine, and aspartate [58]. Eight integrin dimers are capable of recognising the RGD motif in natural ligands [49,15]. A richer spatiotemporal context for the micro environment may be provided by analysis of cell type-specific integrin expression patterns. Important controls on the integral function include structural diversity and conformational alterations. An inactive or low affinity state, a ligand-bound or occupied state, and a primed or activated high affinity state are the three main conformational states that are visible [46]. These conditions make the integrin structure more complicated. The discovery of RGD-containing disintegrins from snake venom is significant because they compete with the RGD motif and have anti-cancerous action.

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Non-enzymatic peptides called disintegrins were found in the disulphide-rich venom of snakes. Alternative tripeptide domains, including MGD, MLD, and ECD, are present in several disintegrins. These domains affect the high affinity of disintegrins for many physiological and pathological processes. The majority of disintegrins are monomeric, while just a small number are dimeric. The RGD motif-containing motile eleven amino acid loop that extends from the polypeptide core and the appropriate pairing cysteine residues, which are responsible for the disintegrin fold, are both essential for the binding activity of disintegrins [31]. By analysing their crystal structures and using NMR spectroscopy, this activity has been researched. In cancer cells and angiogenic endothelial cells, disintegrins favour the activated conformation of integrins. These integrins are the focus of disintegrins because they act as an alluring trap for malignant tissues.

In 1987, the *Trimeresurus gramineus* venom was used to isolate the first disintegrin. Both crude and purified snake venom proteins have shown cytolytic action on Yoshida tumour cells and Keratin-forming (KB) tumour cells. Crotalase is an enzyme that can be isolated from the venom of *Crotulus adamanteus* and has been shown to have anti-tumor properties in 36 melanoma cells [55]. In the study, Essex et al. administered various amounts of intravenous injections of rattlesnake venom to 15 white rats having tumours [29]. The venom of a cobra might kill the sarcoma cells of the Fujinami rat. Kurotchkin found that for this action to occur, tumour cells and venom have to come into intimate touch. In 1963, Macht conducted a clinical investigation of cobra venom as an analgesic [17]. The presence of cholinesterase in several forms of snake venom was investigated by Zeller and Jynegar. In 1963, Duran- Reynals discovered hyaluronidase activity in snake venom [43].

SNAKE VENOM FOR CANCER TARGET THERAPY

In the 1940s, efforts to isolate and characterise snake venom started. In 1950, Singer successfully isolated and characterised LAAO from the venom of a moccasin snake. LAAO, an enzyme that uses flavin adenine dinucleotides (FADs), changes L-amino acid into alpha-keto acid, H_2O_2, and NH_3 [29]. Snake venom containing multiple PLA2 isoenzymes is difficult to purify. Eight PLA2, for instance, were identified and sequenced from the venom of *Pseudechis austrailis.* Bjarnson and Tu's separation of SVMPs from the venom of the western diamond rattlesnake (*Crotalus atrox*) revealed that each SVMP's zinc content was around 1:1 to the corresponding protein [27]. The proteolytic and hemorrhagic effects of SVMP were caused by zinc.

Neovascularisation provides the essential nutrition and oxygen required for tumour growth. Angiogenesis promotes distinct metastasis by favouring tumour cell extension and invasion. Angiogenesis inhibitor favoured by FDA include Bevacizumab, Sorafenib, and Sunitinib. Disintegrins purified from snake venom showed anti-angiogenesis effects. Apoptosis is a process of planned cell death used to get rid of useless cells in tissues that are not malignant and to keep cellular hemostasis in check [29]. Unbridled growth of cells causing cancer is majorly influenced by defects in apoptotic process [47]. Some haemorrhagic snake venoms are responsible for inducing apoptosis of vascular endothelial cells, this was studied by Araki in 1993. Suhr and Kim characterised LAAO from the venom of *Agkistrodon halys.* Venomous snake bites may result in serious local tissue damage, shock, paralysis, haemorrhage, acute renal injury, and other acute medical crises. Cytokines are proteins that function as signals for the immune system's effector and stromal cells to develop, differentiate, and become active. They recognise cancer cells easily at tumour sites. FDA approved cytokines for cancer treatment are Interleukin 2 (IL2) and Interferon (IFNα).

Snake venom liquor is a traditional medication in China. The FDA originally authorised captopril as an angiotensin converting enzyme inhibitor in 1989 [29]. The bradykinin-potentiating pentapeptide BPP5a, which was discovered from the venom of the Brazilian pit viper *Bothrops jararaca*, served as the basis for its creation [53]. Cancer cell inhibitors called atroporin and koatree have been discovered in the venoms of *Crotaluxatrox* and *Najakouthia,* respectively [30,52]. They were extracted by fractionation using high pressure liquid chromatography because they had molecular weights of 35 kDa and 6 kDa [30]. These may suppress the development of ascitic tumours in BalB/C mice by myeloma cells at doses as low as 0.5 g/ml (albino laboratory bred house mice). Anti-cancer drugs' cytolytic action is primarily brought about by their ability to stop cancer cells' DNA replication and synthesis [30]. We are entering a new era of medicine as new proteins and polypeptides are being isolated from snake venom. Venom is

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used to make a variety of medications that are used to treat human illnesses. Additionally, as commercial manufacture and recombinant expression of peptides get more efficient and affordable, more of these complex peptide medications may be created, increasing the likelihood that snake venom may one day be used to treat cancer.

RECENT ADVANCES IN THE FIELD OF ANTINEOPLASTY

Disintegrins, such as Contortrostatin isolated from Agkistrodon contortrix venom, gained popularity in 2015. Contotrostatin inhibits cell contact with extracellular tissue and stops cells from sticking to one another [9]. Contortrostatin (CN) has anticancer capabilities due to its strong affinity for interacting with the integrins found in malignant cells. In 2004, delivery system for CN was described to be more effective in accumulating liposomal CN in tumour site and curtail tumour metastasis. This liposomal CN was isolated by Lin et. al. from *Najaatra*. By deactivating the PI3K/Akt signalling pathways, down regulation of the metalloproteinase MMP-9 prevents cell migration and invasion, which is seen in breast cancer [54]. As a consequence, cell mobility and invasiveness are decreased. Numerous researchers have attempted to create various chemotherapeutic medications based on the cytotoxic properties of snake venom, according to a 2018 study [32]. DeWys et al. were the first to describe the defibrination process. They saw after administering Ancrod, a polypeptide from *Agkistrodon rhodostoma,* followed by cyclophosphamide [32]. He observed the increase in fibrinolysis and the decrease in tumour rate. Braganca et al. conducted the first investigations on the effects of snake venom on sarcoma cells. They examined the effects of the king cobra's (*Najanaja*) venom on sarcoma cell cultures and named it cobra venom factor (CVF) [32]. Yang et al. investigated the mechanism of CTX-3, a cardiotoxin, on tumour suppression. They claimed that in K562 cells, bax and endocuclease G expression rose following apoptosis whereas Bcl-X expression dropped. It was also shown that CTX-3 has apoptotic effects via inducing calcium ion influx, which raises cytosolic calcium concentration, and activating the JNK pathway and caspase 12 [32,45].

Chien et al. performed two experiments on the antiproliferative properties of CTX-3 on leukaemia cells. According to research, the increase of the sub-G1 population and activation of c-JUN-N-terminal kinase cause apoptosis. A greater amount of protein-78 and calcium is produced as a consequence of the stimulation of the endoplasmic reticulum pathway and the mitochondrial apoptotic pathway, which both contribute to the induction [32]. Loss of mitochondrial membrane potential and the accumulation of sub-G1 population in human breast cancer cells (MDA-MB-231 cells), which occurred in the first cell type, were evidence of apoptosis [32]. According to reports, CTX-3 caused apoptosis and suppressed growth in the second cell type [32]. Cytotoxins found in *Naja* species acts against HL60 cells (promyelocytic leukaemia) and A549 cells (lung adenocarcinoma in humans). Lectins are one of the main substances that have the capacity to thwart cancer cells (polyvalent carbohydrate binding proteins) [56]. According to P. Bittencourt et al., BJcuL has an inhibitory impact on eight cancer cell lines [21]. This lectin was identified from the pit viper venom. The most notable effects were seen with 50% inhibition on CFPAC-1, Caki-1, and A-498 [32]. The anti-integrin activity of a C type lectin from the venom of Turan blunt-nosed viper, inhibited the adhesion and invasion of tumour cells [38]. In 2016, study was conducted to test the viability of snake venom isolated from the Caspian cobra (*Najaoxiana)* as an anticancer agent. Conducted by Strizhkov et.al. in 1994, this study revealed an element called neurotoxin II isolated from this venom to be responsible for the induction of apoptosis in the the human erythroleukaemic cell lines. Two more elements called cytotoxin I and II were also observed to penetrate into the living tumour cells and cause aggregation of lysosomes leading to lysosomal damage and apoptosis. After further investigation, significant effects of this venom were observed against another three cell lines- MCF7, HepG2, and DU145.

According to a research paper published in 2015, snake venom components which were tagged with gold nano particles were found to be more easily by tumour cells. Silica nano particles were also an alternative [18]. This was subsequently shown in studies done on snake venom extracted from *Walterinnesia aegyptia* by Al-Sadoon et al (WEV) [39]. He mixed the venom with silica nanoparticles (NP) and showed that the apoptosis and suppression of human breast cancer cell lines' growth occurred without having a significant impact on MCF-10A cells that are typical for the breast epithelium [29,33,59]. They also confirmed WEV+NP's therapeutic efficacy in mice with multiple myeloma.

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In 2016, research showed that the snake venom disintegrinLebein inhibits the growth of melanoma cells and induces a differentiated phenotype by inhibiting the phosphorylation of extracellular signal-regulated kinase and the overexpression of the microphthalmia associated transcription factor [22]. After exposure to lebein, melanoma cells split and E-cadherin was shown to be upregulated. Less invasive melanoma cells were found. A Caspase-independent apoptotic programme using apoptosis inducing factor produced Lebein induction, which resulted in downregulation of BCL-2, overexpression of Bim and BCL-2-associated X-protein (BAX), and downregulation of BCL-2. Depending on the cell line status, which may be either wild type or mutant, this caused a distinct reaction in ROS (reactive oxygen species) formation and p53 levels [22]. Proteins in snake venom have an impact on thrombocyte and blood coagulation capabilities [23]. Drug development for angiogenesis, tumour metastasis, arterial thrombosis, and other integrin-related disorders depends on integrins that include these receptors. By using X-ray crystallography, ligand receptor docking, and an understanding of the physical and pathological functions of integrins, anticancer therapeutic drug development may be investigated. The toxicity of raw snake venoms in cultured cervical cancer cells SiHa and HeLa was investigated in 2016 study on the pit vipers [7]. The DAPI experiment demonstrated that both BJ and BE venoms may suppress the growth of tumour cells by encouraging nuclear condensation, fragmentation, and the production of apoptotic bodies.[7] Additionally, these venoms cause Rhodamine-123-mediated mitochondrial damage and disrupt the G1 and G0 phases of the cell cycle. They might be employed successfully against cervical cancer cells since they were not harmful to healthy 3T3 fibroblast cells. [7]

CONCLUSION

Theranostics is a combination term for denoting diagnostics and therapeutics simultaneously. It usually involves bubbles, particles, nano capsules or tubes which mainly focus on cancer cells. We have already discussed that snake derived disintegrins are capable of recognising different cancerous cells and metabolic processes, which becomes an incentive for the application of theragnostic in anti-cancer studies.

Leong-Poi et al. provided an explanation for the great capability of echistatinconjugated micro-bubbles (MBE) to image activated endothelium in subcutaneously inserted Matrigel plugs augmented with FGF-2. The increased abundance of the integrin receptor V3 on endothelial cells that line neocapillaries as compared to mature capillaries has led researchers to consider it as a possible marker for tumour angiogenesis [4]. The clinical application of disintegrins is faced with a lot of complexity due to the nature of the notorious cancerous cells.[19] Cancer involves different integrins, making it difficult to recognise the specific integrin involved in the cancer. On the plus side, this diversity of integrins suggests additional possibilities for the use of specialised inhibitors with less negative effects. This goes one step beyond the majority of the currently used anticancer treatments, which generally target both somatic and malignant cells and are non-specific, like radiation and chemotherapy. New therapies often concentrate on suppressed tumor-specific angiogenesis. Disintergrins enable us to access a therapeutic potential, but because to the difficulties of instability and immunogenicity, the majority of trials have not advanced beyond the early clinical stage [4]. Natural resources are also basically limited, necessitating the development of artificial production or heterologous expression techniques [4]. New strategies have been explored to lessen the immunogenicity and instability of disintegrins [4]. Daily administration of Salmosin (disintegrin isolated from Korean snake *Agkistrodon halysbrevicaudus)* is responsible for suppression of tumour progression [48, 33]. The difficulty faced with Salmosin is that its therapeutic levels in blood is constantly changing and has to be maintained with systemic administration. This can be improved by using complexes of cationic liposomes through non-viral gene delivery. Tirofiban (aggrastat) and eptifibatide (integrilin) are FDA approved drugs which are commercially available as anti-coagulants responsible for treating myocardial infarction and refractory ischemia as result of cancer. Ever since disintegrins were discovered, it received immediate appreciation as they were naturally occurring proteins causing a significant effects in biochemistry [4]. Disintegrins are useful tools in pharmacology and help in understanding mechanisms related to cancer [4]. In this review article, we have highlighted the importance of the components present in snake venom that make it viable as a diagnostic technique for the screening and treatment of cancer, putting to light the various researches conducted throughout the years in the same field.

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The results obtained so far are enriching in spite of the complications faced during clinical trials. However, in the following years, many of them will be successful due to the emergence of advanced technologies in the field of cancer biology. Up till now, only 10% of the venom from snakes belonging to Atractaspids, Elapids, Viperids, and Colubrids has been examined for the existence of disintegrins in the area of cancer research. Hence, these molecules are yet to be scrutinized and acclaimed for its ability to cure cancer.

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Table 1. Predicted pharmaceutical impact of snake venom proteins

Family	Scientific name/ Common name	Protein present	Research cell lines	Declaration
Viperidae	1. South American rattlesnake	Cro-toxin	squamous carcinoma cell lines found in human lungs	p-JNK and p17 expression increase observed during apoptosis
	2.Bothrox jararaca	Jararhagin	Skin cancer cell lines in humans	Increased expression of cell cycle and apoptosis
	3.Cryptelytrops purpureomaculatus	L-amino acid oxidase	Human colon cancer cell lines (SW480, SW620)	Increased activity of caspase 3 and Bcl2 level reduction Autophagy, and signalling pathways, apoptosis
	4.Bothrox pauloensis	L-amino acid oxidase	Human mammary gland cancer cell lines	
Elapidae	1. Najaoxiana	Cytotoxin I and II	Human breast tumour, hepatocellulocarcinoma , prostate tumour and leukaemia cell lines	Signalling apoptotic pathways
	2.Naja najaatra	Cardiotoxin III	Human mammary gland cancer cell lines	EGF induced cell invasion suppression

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Table 2. Anticancer Drugs and their chemical structures

Anticancer drug derived from snake venom	Chemical structure
Rituxan (rituximab)	$C_{6416}H_{9874}O_{1987}S_{44}$
Revlimid	
Avastin(bevacizumab)	$C_{6638}H_{10160}N_{1720}O_{2108}S_{44}$
Eptifibatide	$C_{35}H_{49}N_{11}O_{9}S_{2}$
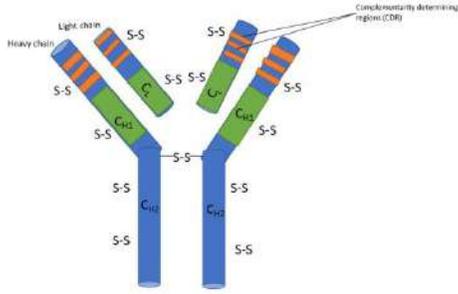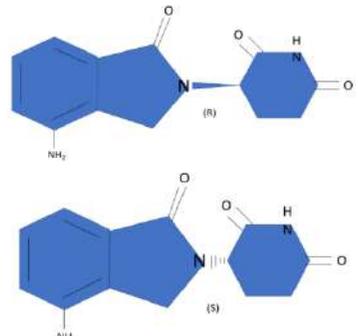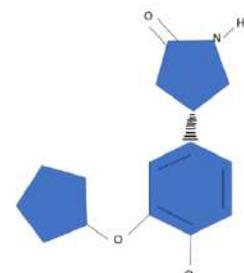
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Tirofiban	 $C_{22}H_{36}N_2O_5S$
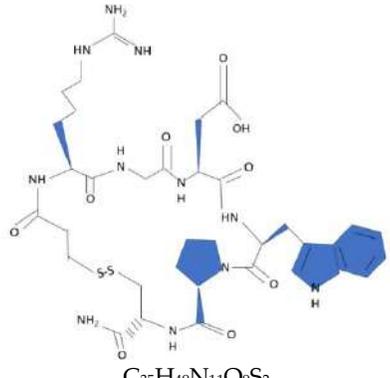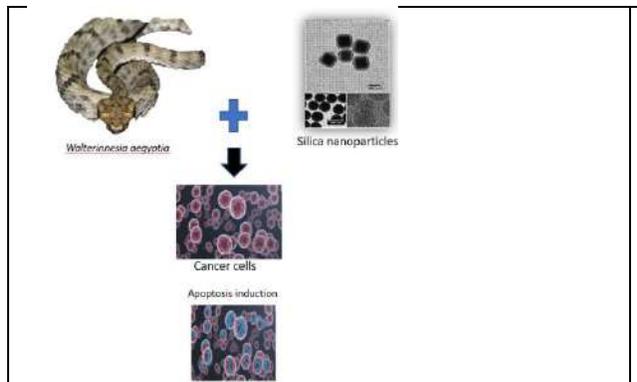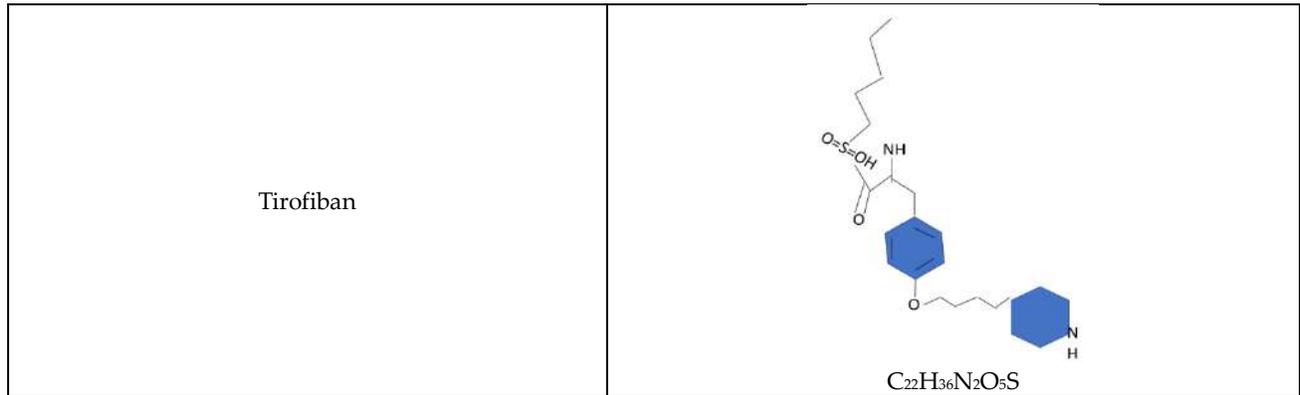
Fig.1 Combination of snake venom and nanoparticles for breast cancer
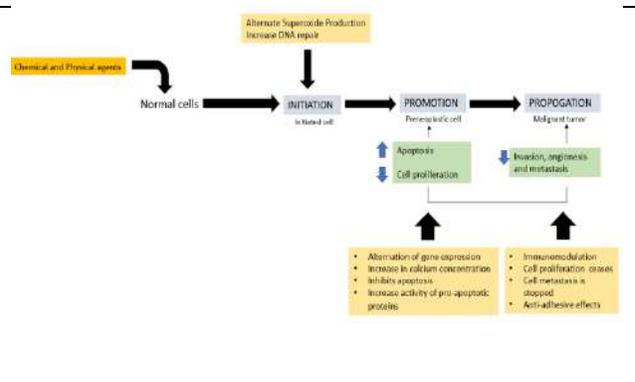
Fig 2. Carcinogenesis
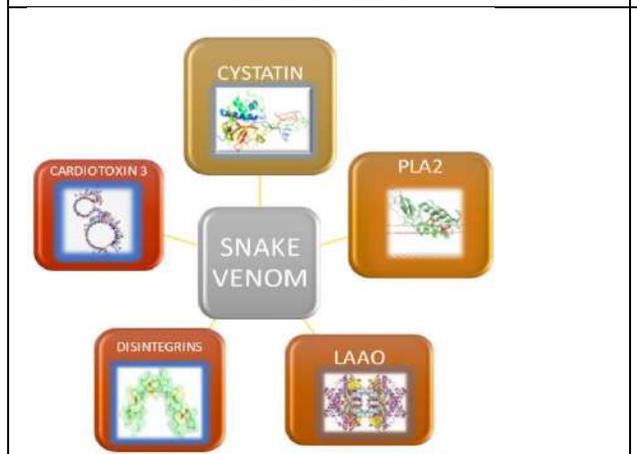
Fig 3. Snake venom and its components
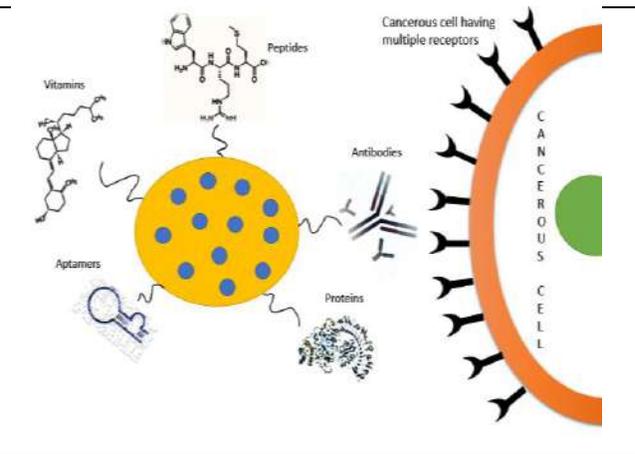
Fig 4. Usage of silica nanoparticle as a venom carrier

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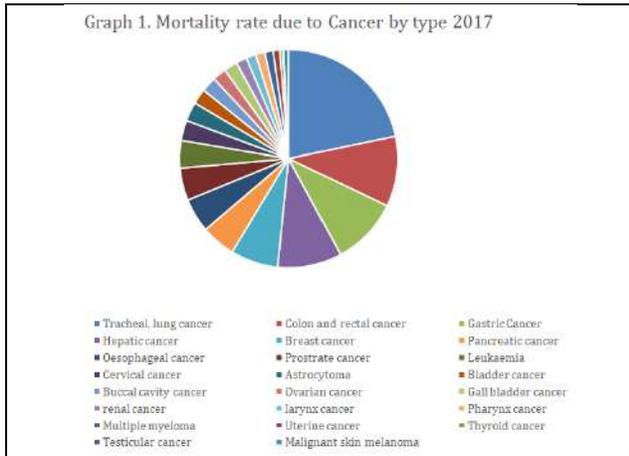
Graph 1. Mortality rate due to Cancer by type 2017	**Graph 2. Mechanism of action for anti-cancer drug approvals untill 2020**
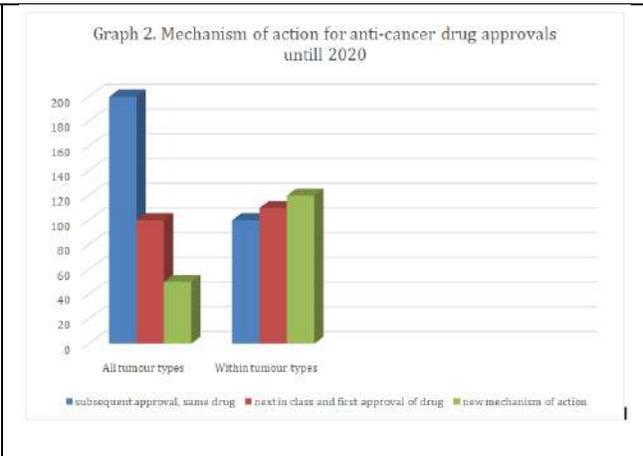
RESEARCH ARTICLE

Human Health Risk Assessment Associated with Potentially Toxic Elements via the Ingesting of Freshwater Fish (*Oreochromis mossambicus*) of Bhima River, Karnataka, India

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ABSTRACT

The Bhima River, which lies in the northern part of the state of Karnataka, receives a significant quantity of untreated agricultural and domestic effluents from the surrounding areas, making it very susceptible to heavy metal poisoning. This study aims to determine the levels of six Potentially toxic elements (PTEs) in the muscle of highly eaten fish species (*Oreochromis mossambica*), as well as to estimate the possible harm to local consumers' health. An atomic absorption spectrometer (AAS) was used to detect the heavy metal concentration. The highest concentration was found in Fe (49.54 mg/kg dry weight), followed by Zn (38.55 mg/kg dry weight), Cu (6.17 mg/kg dry weight), Pb (0.79 mg/kg dry weight), Mn (0.76 mg/kg dry weight), and Cd (0.062 mg/kg dry weight). According to a calculation of the number of fish ingested by adult persons, the average daily dosage of PTEs was computed using a mean fish consumption rate of 19.5×10^{-3} kg/day. The considered fish species do not carriage any non-carcinogenic and carcinogenic risk for human consumption, but as the obtained HI values are half close to 1, indicates initiation of adverse health effects on the consumers.

Keywords: Atomic absorption spectrophotometer, Bhima River, Health risk assessment,*Oreochromis mossambica*, Potentially toxic elements.

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INTRODUCTION

Heavy metals (HMs) have emerged as a global problem in recent decades due to their propensity to persist in the environment, their capacity to bioaccumulate in organisms, and their toxicity to humans, animals, and plants (Cui *et al*., 2015). In contrast to other potentially harmful compounds, metals are neither produced nor eliminated by humans. Since they are dormant in the environment if not disturbed, they are typically regarded as conservative contaminants (Ahmed *et al*., 2019). The UN predicts that by 2050, there will be a roughly 50% rise in the global population. More people will need to be fed, which will increase the demand for food and change consumption patterns. The projected protein demand is particularly intriguing because, based on projections, by 2050 there will be a greater demand for animal-derived protein than plant-derived protein worldwide (Henchion *et al*., 2017). Aquatic meals are regarded as full-protein diets for humans because they contain all nine essential amino acids. Coastal communities also significantly rely on aquatic foods as their main source of proteins, minerals, and vitamins because fish have low fat and calorie content. Most individuals are bare to hazardous substances, habitually through their food (Javed and Usmani, 2016). In research, the phrase "heavy metal" has remained used frequently for a long time. However, the phrase "potentially toxic element(s) PTEs has recently gained more popularity, especially in studies on the effects of pollution (Chinmalli and Vijaykumar, 2022). Several studies on metal pollution in innumerable edible fish species have been conducted because fish make up a significant portion of the ordinary person's diet (Javed and Usmani, 2016, Ahmed *et al*., 2019, and Shindhe *et al*., 2020).

Quantitative research does not adequately account for the bioavailability and ecotoxicity of PTEs in water, which may change the ecological balance of the populace in the aquatic environment. As a result, fish are now used as bioindicators in aquatic ecologies, and the quantity of metal they accumulate may now be used to determine the degree of metal contamination in certain environments. Fish up-take both beneficial and detrimental metals in the aquatic ecosystem, so regular fish tissue contamination monitoring is essential for spotting associated water quality issues (Gyimah *et al*., 2018). Studies on PTEs using fish analysis can often be significant in two ways. First, from the perspective of public health, where it has highlighted the importance of measuring the build-up of PTEs, particularly those that pose major health risks to people, such as Arsenic (As), Lead (Pb), and Mercury (Hg). Second, from the perspective of the aquatic environment, the key challenge has been to stop biological deterioration and pinpoint the factors that endanger ecological balance. In this sense, more common metals like copper (Cu), zinc (Zn), and manganese (Mn) may occasionally provide a larger risk than lead, and cadmium (Asharf*et al*., 2012). There is a lack of a thorough regional study of PTEs in nutriment and an evaluation of the risk to the general populace. The amounts of manganese (Mn), iron (Fe), copper (Cu), lead (Pb), and zinc (Zn) in freshwater fish (*Oreochromis mossambica*) that were exposed to heavy metals from the Bhima River were measured in the current study. Adult males and females were given estimates of the non-carcinogenic and carcinogenic risks of ingesting contaminated fish due to PTEs.

MATERIALS AND METHODS

Study Area
The present study was performed on the Bhima River flowing through the district of Kalaburagi, Karnataka (Fig. 1) which is in the Northern region of Karnataka state (76º– 04" to 77º– 42" Longitude and 16º – 12" to 17º – 46" Latitude) located 454 meters above mean sea level (MSL). Bhima river is one of the tributaries of the river Krishna. It has its origin in Bhimashankar hills in the Western ghats of Maharashtra and flows along the common state border of Karnataka and Maharashtra for a length of about 75 km then enters Karnataka near the village Sheshgiri and flows through a length of about 294 km entirely in Karnataka and joins the Krishna River near Yadgir district. The study area covers Aflazpur and Jewargi talukas of the Kalaburagi district through which the Bhima River passes. Eight sampling locations were chosen for the assessment of heavy metal concentration.

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Sample Collection

Fish samples were collected from local fishermen from October 2020 to September 2021 from the eight sites. Over the course of a year, the sample species were gathered at eight segmental sampling sites along the Bhima River (Fig. 1). To keep the fish's natural qualities from eroding, the specimens were stored in an ice box with dry ice cubes nearby. After that, samples were kept frozen at -20 °C while being delivered to a lab for analysis. The samples were defrosted at room temperature after being properly washed with distilled water. With stainless steel scissors, the samples' edible muscles were removed.

Digestion of sample

1 gram of fish muscle ash was weighed and digested on a hot plate for 1 hour at room temperature, 1 hour at 40°C, and then 3 hours at 140°C with a mixture of 10 ml concentrated HNO_3 and H_2O_2 (3:1). After that, the samples were cooled to room temperature. Following dilution with deionized water to a final capacity of 100 ml and filtering using Whatman filter paper no. 42, samples were kept at 4°C in the refrigerator for additional analysis (Shinde *et al*., 2020).

Assessment of the health risks of fish consumption

The US Environmental Protection Agency (USEPA) human risk assessment model for heavy metals was used to estimate non-carcinogenic and carcinogenic risks for heavy metals with concentration over Food and agricultural organization of United Nation (FAO) tolerable level (USEPA 2011, FAO, 1983). Even though contaminants may still create health issues even if they are below the limits that are deemed safe for consumption, a health risk assessment is a crucial part of a complete water body examination (Sarikar and Vijaykumar, 2022). To compute the risk quotients (RQ), risk index (RI), and cancer risk (CR) individually for adult male and female individuals, the values of heavy metal accretion in muscle were employed.

Average Daily Dosage (ADD)

Estimating the risks to human health associated with consuming PTEs in food comes first. To achieve this, ADD is calculated, which is dependent on both the degree of PTE concentration in foods and the daily consumption of those foods. The following equation was used to determine the ADD.

$$ADD = C \times IR / BW \times 10^{-3} \qquad (1)$$

Where C is the PTE content of the fish muscle (measured in mg/kg dry weight). The ingestion rate, or IR, which was used in health risk assessment, is computed as 19.5×10^{-3} kg/day. In India, the average body weight (BW) of a man is 57 kg, while that of a woman is 50 kg (Javed and Usmani, 2016 and Shindhe*et al*., 2020).

Risk Quotient (RQ)

To determine the risk to human health from consuming fish contaminated with heavy metals. The following equation is used to determine the RQ, which is an estimate of the non-carcinogenic risk level due to pollutant exposure.

$$RQ = C \times IR \times 10^{-3} \times EF \times ED / (RfD \times BW \times AT) \qquad (2)$$

C is the metal content of the fish muscle (measured in mg/kg dry weight). EF stands for exposure frequency, which is 365 days per year. ED stands for exposure duration, 65 years for men and 68 years for women [World Health Organization (WHO) 2012]. RfD is the abbreviation for reference dosage for each specific metal represented in Table 1. USEPA (United States Environmental Protection Agency, 2011), AT is the average time, which is 365 days.

Risk Index (RI)

The RI of each metal is added together to create a risk index, which is a measure of the overall possible health danger that multiple metals pose due to fish consumption. The Risk quotients of each metal can be added to determine the RI.

$$RI = RQ_{Zn} + RQ_{Cu} + RQ_{Mn} + RQ_{Pb} + RQ_{Cd} + RQ_{Fe} \qquad (3)$$

The non–carcinogenic risk for adult males and females was calculated for each of the seven heavy metals for which RfD standards were accessible. Health risks may be experienced at HI ≥ 1, which calls for the implementation of treatments and preventative measures. HI < 1 denotes the absence of any potential health problems (Javed and Usmani, 2016 and, Shindhe *et al.*, 2020).

Carcinogenic risk (CR)

The carcinogenic risk is assessed as a result of exposure to significant carcinogens to determine the likelihood of acquiring cancer over the course of a lifetime. The risk limit's permissible range is 10^{-6} to 10^{-4}. It is anticipated that CRs greater than 10^{-4} will increase the probability of a carcinogenic risk effect. The following is the standard equation to evaluate the CR (Javed and Usmani, 2016, Ahmed *et al.*, 2019, and Shindhe *et al.*, 2020).

$$CR = ED \times EF \times ADD \times CSf / AT \times 10^{-3} \qquad (4)$$

Where CSf carcinogenic slope factor (mg/kg/day). Accessible CSf values for Pb and Cd are 0.0085 and 6.3 mg/kg/day, respectively (Ahmed *et al.*,2019).

RESULTS

Concentration of Potential toxic elements in Fish Muscle

The concentrations of different PTEs (Zn, Cu, Mn Pb, Cd, and Fe) in fish that were caught in the Bhima River's edible part (muscle) are shown in Table 2. The average highest concentration of Fe was found in dry weight (49.54 mg/kg), followed by Zn (38.55 mg/kg), Cu (6.17 mg/kg), Pb (0.798 mg/kg), Mn (0.76 mg/kg), and Cd (0.062 mg/kg).

Human health risk assessment
Average Daily Dosage (ADD)

Table 3 represents and summarises the findings on ADD in adult males and females. Adult women demonstrated comparable levels of ADD to adult men. The ADD was determined in the following order for both groups: Fe > Zn > Cu > Pb > Mn > Cd.

Risk quotient and Risk index for non-carcinogenic risk.

Table 3 shows the calculated Risk quotient for the fish under investigation. RQ was 0.043, 0.052, 0.001, 0.136, 0.021, and 0.024 in the adult male group exposed to Zn, Cu, Mn, Pb, Cd, and Fe, respectively, while it was 0.050, 0.060, 0.002, 0.155, 0.024, and 0.027 in the adult female group. Additionally, the order of the elements RQs was Pb > Cu > Zn > Fe > Cd > Mn. While adult males and females were, respectively, 0.280 and 0.320 for the cumulative RI scenario. The investigated RI, however, did not go beyond the suggested limit.

Carcinogenic risk

Pb and Cd metals have been classified by the IARC as carcinogenic elements. These two metals' potential carcinogenic risk was carefully considered. Pb and Cd were calculated to have carcinogenic risks of 2.31×10^{-6} and 1.34×10^{-4} for adult men, respectively, and 2.64×10^{-6} and 1.52×10^{-4}, respectively, for adult females. The findings indicated that females were more exposed than males to greater CRs (Table 3).

DISCUSSION

PTEs are ecologically regarded as one of the major issues in the aquatic ecosystem, due to their persistence, toxicity, and bioaccumulation, which can negatively affect both the aquatic ecosystem and living species (Pandey and Madhuri, 2014). Both natural and manmade sources of PTEs are typically more hazardous. In addition to being

poisonous to the aquatic environment, PTEs also negatively affect the health of aquatic creatures through their accumulation (Pandey and Madhuri, 2014). As the top consumer in the food chain, humans may be at risk for health problems if they ingest fish that are high in PTEs. PTEs may result in a variety of biological and metabolic malfunctions as well as illnesses (Abbas *et al.*, 2017). Muscle was specifically chosen for heavy metal analysis in the current investigation since it is the only fit for human consumption and the concentration of toxicants in it is of concern (Javed and Usmani, 2016). Fish muscle typically has the lowest metal concentrations since it is not typically thought of as an active region for metal accumulation and biotransformation, according to (El Bahgy*et al.*, 2021).Fe was found to have the highest concentration of metal in the muscle tissue, followed by Zn, Cu, Pb, Mn, and Cd.Individuals who intake too much iron from fish food have symptoms such as constipation, nausea, diarrhoea, and vomiting. Gastric and oesophageal ulcers in people have been connected to long-term Fe exposure (Shindhe*et al.*, 2020). Nevertheless, throughout the year, the levels of all heavy metals were within the FAO permitted limits (FAO, 1983). The same trend of metal concentration in fish*(Oreochromis mossambicus)* muscle (Fe> Zn > Cu > Mn) was observed by Shindhe *et al.*, 2020 in the Ujjan reservoir, which receives water from the Bhima River of the state of Maharashtra. This observation is in conformity with the findings of Shivkumar *et al.*, 2014 in *Etroplus maculates* and *Ompokbimaculatus* fish species of Bharda river. The PTEs deposition in fish was documented in the current investigation. Fish tissues from the Bhmia River contained moderate concentrations of PTEs, notably the metal Fe was higher compared to others. PTEs enter the river through anthropogenic activities including fishing boats, fisherman's excrement, and the direct discharge of their waste effluents into it, even though there are no direct sources of PTEs contamination in the river. Additionally, the river is polluted by mining, bridge building, agricultural, and household activities (Chinmalli and Vijaykumar, 2022). The low metal concentrations in fish species' muscles are a result of the lower levels of binding proteins there compared to other organs. As a result, along the pathway for metal absorption and storage, muscle is seen as a transient tissue. In contrast to muscle, other organs like the liver and gills serve as the principal organs for metabolism and respiration, and as such, they are assumed to be the target organs for pollutant accumulation (Yap *et al.*, 2015).

Several measures, including Average daily dosage (ADD), Risk quotient (RQ), and Risk index (RI), are used to determine the risk assessment of heavy metals for humans associated with fish eating. These variables are affected by pollutant intake amount, regularity and interval of acquaintance, average body mass, and oral reference dose (RfD). The ratio between the concentration of heavy metals in fish muscle and RfD is known as RQ and is referred to as a dimensionless quantity. The maximum RQ limit value should not be greater than 1, as doing so may expose the populations to non-carcinogenic dangers. It is also crucial to remember that RQ simulates the amount of anxiety rather than measuring risk. Even though contaminants may still create health issues even if they are below the limits that are deemed safe for consumption, a health risk assessment is a crucial part of a complete water body examination (Sarikar and Vijaykumar, 2022). PTEs like Cd and Pb are classified as carcinogenic agents by IARC and may cause an effect on organism even when they are at their low concentration, whereas PTEs like Zn, Cu, Mn, and Fe which are included in the present study does not pose any carcinogenic risk at a low and moderate level, but could pose non-carcinogenic effects when they surpass their desirable limits. The Cd and Pb can disturb human health even when they are at a lower concentration. So, it is important to know the source and effective status of Cd, and Pb by measuring carcinogenic risk.

In the current investigation, except at some locations, almost all fish samples tested positive for all six heavy metals with RQ values below 1. Additionally, females had RQ values that were generally greater than males for all the relevant heavy metals. There will not be much of a risk if the heavy metal's ADD to RfD ratio is equal to or less than the RfD. Even the HI values for both groups did not cross the unit value 1. CR for Pb, and Cd in the present work was 2.31×10^{-6}, 1.34×10^{-4}, in males and 1.34×10^{-6}, and 1.52×10^{-4}, for females, respectively. Lead and cadmium pollution of the environment comes from mining, smelting, and reprocessing activities, phosphate fertilizers, paints as well as combustion by-products of lead and cadmium additives in gasoline (Dinis and Fiuza, 2011, andMahurpawar, 2015). Excess intake of lead results in Encephalopathy, Peripheral Neuropathy, Central Nervous Disorders, and Anemia(Mahurpawar, 2015). Cadmium has cancer-causing effects on both humans and aquatic life. It is widely distributed in the environment at low concentrations and is not required for humans, animals, or plants to

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survive(Krishna *et al.*, 2014). Cd levels in the muscle throughout the current experiment were 0.062 mg/kg. Cadmium cause Proteinuria, Glucosuria, Osteomalacia, Aminoaciduria, Emphysemia in humans (Mahurpawar, 2015).

CONCLUSION

These fish, which are commonly consumed by people, are the chief causes of fishery resources in the study area. The suitability and safety of the natives' edible fish must therefore be determined. The goal of this study was to assess the toxicological status and risk assessment of edible fishes in humans. Iron was the metal that was most frequently discovered in fish, and it was then followed by zinc, copper, lead, magnesium, and cadmium. The least abundant metals discovered, lead and cadmium, are nonetheless present in safe concentrations, they could cause health effects even at their low concentration. Therefore, care should be taken to avoid exceeding the authorized limits for metal concentrations. Heavy metal contamination affects other aquatic species in addition to influencing fish and humans. Therefore, heavy metals in effluent and municipal trash must be properly detoxified before being released into the water body.

ACKNOWLEDGMENT

Conflict of Interest
The authors declare no conflict of interest

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Table.1: Reference dosage and Carcinogenic Slope factor values for Heavy metals.

Heavy metals	RfD (mg/kg/day)	CSF (mg/kg/day)
Zn	0.3	-
Cu	0.04	-
Mn	0.14	-
Pb	0.002	0.0085
Cd	0.001	6.3
Fe	0.7	-

Table.2:Average heavy metal concentration in fish muscle (mg/kg)

Sites / Metals	S1	S2	S3	S4	S5	S6	S7	S8	Average	FAO
Zn	22.79	25.23	26.53	33.77	43.89	50.11	54.62	51.49	38.55	100
Cu	6.25	6.36	4.77	6.93	6.32	6.78	4.17	7.81	6.173	10
Mn	0.71	0.53	0.58	0.83	0.91	0.87	0.87	0.85	0.768	1
Pb	0.98	0.68	0.71	0.91	0.98	0.61	0.75	0.77	0.798	2.5
Cd	0.097	0	0.079	0.098	0.108	0.116	0	0	0.062	0.2
Fe	44.04	34.16	29.27	45.13	54.71	62.31	63.95	62.75	49.54	100

S1-Gangapur, S2-Sagnur, S3-Chinamalla, S4-Nelogi, S5-Harwal, S6-Rasangi, S7-Saradgi-B, S8-Jevargi, FAO – Food and Agricultural Organization of United States.

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Table.3:Calculated ADD, RQ, RI, and CR for the selected groups.

Heavy Metals	ADD (mg/kg BW/day)		RQ		RI		CR	
	Male	Female	Male	Female	Male	Female	Male	Female
Zn	1.31×10^{-2}	1.50×10^{-2}	0.043	0.050				
Cu	2.11×10^{-3}	2.40×10^{-3}	0.052	0.060				
Mn	2.67×10^{-4}	3.04×10^{-4}	0.001	0.002				
Pb	2.73×10^{-4}	3.11×10^{-4}	0.136	0.155	0.280	0.320	2.31×10^{-6}	2.64×10^{-6}
Cd	2.13×10^{-5}	2.42×10^{-5}	0.021	0.024			1.34×10^{-4}	1.52×10^{-4}
Fe	1.69×10^{-2}	1.93×10^{-2}	0.024	0.027				
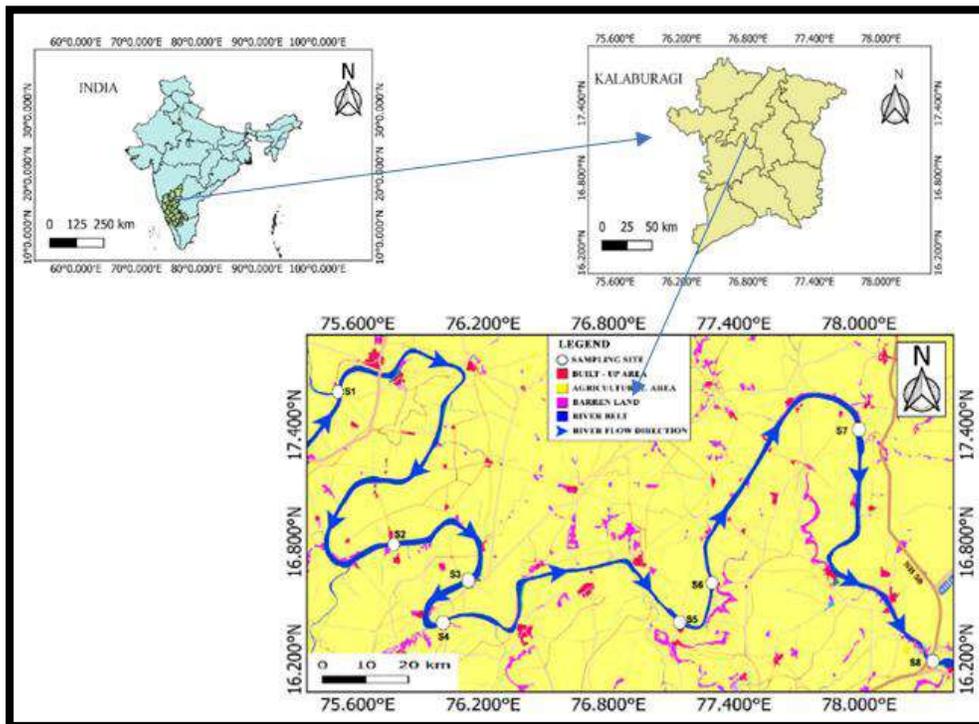
Fig.1: Map of Kalaburagi district showing eight different segmental sampling sites

RESEARCH ARTICLE

Binary α-Generalized Closed Sets in Binary Topological Space

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ABSTRACT

In this paper, we propose to introduce the new classes of binary $g\alpha$-closed sets and binary αg-closed sets in binary topological spaces and certain properties of these investigated. We also investigated the notion of binary $g\alpha$-interior and closer in binary topological spaces. Further, we have given an appropriate examples to understand the abstract concepts clearly

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Keywords and phrase : binary αg-open, binary $g\alpha$-open, binary $g\alpha$-interior and binary $g\alpha$-closure

INTRODUCTION AND PRELIMINARIES

In 1970 Levine [3] gives the concept and properties of generalized closed (briefly g-closed) sets and the complement of g-closed set is said to be g-open set. Njasted [11] introduced and studied the concept of α-sets. Later these sets are called as α-open sets in 1983. Mashhours et.al [6] introduced and studied the concept of α-closed sets, α-closure of set, α-continuous functions, α-open functions and α-closed functions in topological spaces. Maki et.al [4, 5] introduced and studied generalized α-closed sets and α-generalized closed sets. In 2011, S.Nithyanantha Jothi and P.Thangavelu [7] introduced topology between two sets and also studied some of their properties. Topology between two sets is the binary structure from X to Y which is defined to be the ordered pairs (A, B) where $A \subseteq X$ and $B \subseteq Y$. In this paper, we have introduced a new class of sets on binary topological spaces called binary α-generalized closed sets and binary generalized α closed sets and the relation of these new sets with the existing sets.

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Let X and Y be any two nonempty sets. A binary topology [7] from X to Y is a binary structure $\mathcal{M} \subseteq \mathbb{P}(X) \times \mathbb{P}(Y)$ that satisfies the axioms namely
1. (ϕ, ϕ) and $(X, Y) \in \mathcal{M}$,
2. $(A_1 \cap A_2, B_1 \cap B_2) \in \mathcal{M}$ whenever $(A_1, B_1) \in \mathcal{M}$ and $(A_2, B_2) \in \mathcal{M}$, and
3. If $\{(A_\alpha, B_\alpha) : \alpha \in \delta\}$ is a family of members of $\mathcal{M}$, then $(\bigcup_{\alpha \in \delta} A_\alpha, \bigcup_{\alpha \in \delta} B_\alpha) \in \mathcal{M}$.

If $\mathcal{M}$ is a binary topology from X to Y then the triplet $(X, Y, \mathcal{M})$ is called a binary topological space and the members of $\mathcal{M}$ are called the binary open subsets of the binary topological space $(X, Y, \mathcal{M})$. The elements of $X \times Y$ are called the binary points of the binary topological space $(X, Y, \mathcal{M})$. If $Y = X$ then $\mathcal{M}$ is called a binary topology on X in which case we write $(X, \mathcal{M})$ as a binary topological space.
Throughout this paper, (X, Y) denote binary topological spaces $(X, Y, \mathcal{M})$

Definition 1.1 *[7] Let X and Y be any two nonempty sets and let (A, B) and $(C, D) \in \mathbb{P}(X) \times \mathbb{P}(Y)$. We say that $(A, B) \subseteq (C, D)$ if $A \subseteq C$ and $B \subseteq D$.*

Definition 1.2 *[7] Let $(X, Y, \mathcal{M})$ be a binary topological space and $A \subseteq X$, $B \subseteq Y$. Then (A, B) is called binary closed in $(X, Y, \mathcal{M})$ if $(X \backslash A, Y \backslash B) \in \mathcal{M}$.*

Proposition 1.3 *[7] Let $(X, Y, \mathcal{M})$ be a binary topological space and $(A, B) \subseteq (X, Y)$.*
Let $(A, B)^{1*} = \cap \{A_\alpha : (A_\alpha, B_\alpha)$ is binary closed and $(A, B) \subseteq (A_\alpha, B_\alpha)\}$ and $(A, B)^{2*} = \cap \{B_\alpha : (A_\alpha, B_\alpha)$ is binary closed and $(A, B) \subseteq (A_\alpha, B_\alpha)\}$. Then $((A, B)^{1*}, (A, B)^{2*})$ is binary closed and $(A, B) \subseteq ((A, B)^{1*}, (A, B)^{2*})$.

Proposition 1.4 *[7] Let $(X, Y, \mathcal{M})$ be a binary topological space and $(A, B) \subseteq (X, Y)$. Let $(A, B)^{1*} = \cup \{A_\alpha : (A_\alpha, B_\alpha)$ is binary open and $(A_\alpha, B_\alpha) \subseteq (A, B)\}$ and $(A, B)^{2*} = \cup \{B_\alpha : (A_\alpha, B_\alpha)$ is binary open and $(A_\alpha, B_\alpha) \subseteq (A, B)\}$.*

Definition 1.5 *[7] The ordered pair $((A, B)^{1*}, (A, B)^{2*})$ is called the binary closure of (A, B), denoted by $b\text{-}cl(A, B)$ in the binary space $(X, Y, \mathcal{M})$ where $(A, B) \subseteq (X, Y)$.*

Definition 1.6 *[7] The ordered pair $((A, B)^{1*}, (A, B)^{2*})$ defined in proposition 1.4 is called the binary interior of of (A, B), denoted by $b\text{-}int(A, B)$. Here $((A, B)^{1*}, (A, B)^{2*})$ is binary open and $((A, B)^{1*}, (A, B)^{2*}) \subseteq (A, B)$.*

Definition 1.7 *[7] Let $(X, Y, \mathcal{M})$ be a binary topological space and let $(x, y) \subseteq (X, Y)$. The binary open set (A, B) is said to be a binary neighbourhood of (x, y) if $x \in A$ and $y \in B$.*

Proposition 1.8 *[7] Let $(A, B) \subseteq (C, D) \subseteq (X, Y)$ and $(X, Y, \mathcal{M})$ be a binary topological space. Then, the following statements hold:*
1. $b\text{-}int(A, B) \subseteq (A, B)$.
2. If (A, B) is binary open, then $b\text{-}int(A, B) = (A, B)$.
3. $b\text{-}int(A, B) \subseteq b\text{-}int(C, D)$.
4. $b\text{-}int(b\text{-}int(A, B)) = b\text{-}int(A, B)$.
5. $(A, B) \subseteq b\text{-}cl(A, B)$.
6. If (A, B) is binary closed, then $b\text{-}cl(A, B) = (A, B)$.
7. $b\text{-}cl(A, B) \subseteq b\text{-}cl(C, D)$.
8. $b\text{-}cl(b\text{-}cl(A, B)) = b\text{-}cl(A, B)$.

Definition 1.9 *A subset (A, B) of a binary topological space $(X, Y, \mathcal{M})$ is called*
1. a binary semi open set [10] if $(A, B) \subseteq b\text{-}cl(b\text{-}int(A, B))$.
2. a binary pre open set [2] if $(A, B) \subseteq b\text{-}int(b\text{-}cl(A, B))$,
3. a binary regular open set [9] if $(A, B) = b\text{-}int(b\text{-}cl(A, B))$.

Definition 1.10 *[8] Let $(X, Y, \mathcal{M})$ be a binary topological space. Let $(A, B) \subseteq \mathbb{P}(X) \times \mathbb{P}(Y)$. Then (A, B) is called binary g-closed if $b\text{-}cl(A, B) \subseteq (U, V)$ whenever $(A, B) \subseteq (U, V)$ and (U, V) is binary open in $(X, Y, \mathcal{M})$.*

Definition 1.11 *[12] Let $(X, Y, \mathcal{M})$ be a binary topological space. Then $(A, B) \subseteq (X, Y)$ is called binary gs-closed if $b\text{-}scl(A, B) \subseteq (U, V)$ whenever $(A, B) \subseteq (U, V)$ and (U, V) is binary open.*

Definition 1.12 *[1] A subset (A, B) of a binary topological space $(X, Y, \mathcal{M})$ is called binary α-open if $(A, B) \subseteq b\text{-}int(b\text{-}cl(b\text{-}int(A, B)))$.*

Definition 1.13 *[2] A subset (A, B) of a binary topological space $(X, Y, \mathcal{M})$ is binary β-open in (X, Y) if $(A, B) \subseteq b\text{-}cl(b\text{-}int(b\text{-}cl(A, B)))$. The set of all binary β-open sets of (X, Y) is denoted by $b\beta O(X, Y, \mathcal{M})$.*

2 Binary $g\alpha$-closed sets and binary αg-closed sets

Definition 2.1 *A subset A of $(X, Y, \mathcal{M})$ is called an binary generalized α-closed set (briefly binary $g\alpha$-closed) if $b\text{-}cl(A, B) \subseteq (U, V)$ whenever $(A, B) \subseteq (U, V)$ and (U, V) is binary α-open in $(X, Y, \mathcal{M})$. The complements of binary generalized α-closed set is binary generalized α-open set in $(X, Y, \mathcal{M})$.*

Definition 2.2 *A subset (A, B) of $(X, Y, \mathcal{M})$ is called a binary α-generalized closed set (briefly binary αg-closed) if $b\text{-}\alpha cl(A, B) \subseteq (U, V)$ whenever $(A, B) \subseteq (U, V)$ and (U, V) is binary open in $(X, Y, \mathcal{M})$. The complements of binary α-generalized closed set is binary α-generalized open set in $(X, Y, \mathcal{M})$.*

Theorem 2.3 *If (A, B) is binary closed set in $(X, Y, \mathcal{M})$, then it is binary $g\alpha$-closed set but converse is not true.*
Proof. Let $(A, B) \subseteq (U, V)$ and (U, V) be a binary open in $\mathcal{M}$. Since, (A, B) is binary closed and $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B)$. Also, $b\text{-}cl(A, B) = (A, B)$. Thus $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B) = (A, B) \subseteq (U, V)$. Since every binary open set is binary α-open set. Hence, $b\text{-}\alpha cl(A, B) \subseteq (U, V)$. Therefore, (A, B) is a binary $g\alpha$-closed set. The converse of the above theorem is need not be true as seen from the following example.

Example 2.4 *Let $X = \{1,2\}$, $Y = \{a, b\}$ and*
$\mathcal{M} = \{(\phi, \phi), (\{1\}, \{a\}), (\{2\}, \{a\}), (\{1\}, \{b\}), (X, \{a\}), (\{1\}, Y), (\phi, \{a\}), (\{1\}, \phi), (X, Y)\}$. *Then $(X, \{a\})$ is a binary $g\alpha$-closed set, but it is not a binary closed set.*

Theorem 2.5 *If (A, B) is binary closed set in $(X, Y, \mathcal{M})$, then it is binary αg-closed set but converse is not true.*
Proof. Let $(A, B) \subseteq (U, V)$ and (U, V) be a binary open in $\mathcal{M}$. Since, $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B)$ and (A, B) is binary closed. Since, $b\text{-}cl(A, B) = (A, B)$. Thus $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B) = (A, B) \subseteq (U, V)$. Hence, $b\text{-}\alpha cl(A, B) \subseteq (U, V)$. Therefore, (A, B) is a binary αg-closed set. The converse of the above theorem is need not be true as seen from the following example.

Example 2.6 *Let $X = \{1,2\}$, $Y = \{a, b\}$ and $\mathcal{M} = \{(\phi, \phi), (\{1\}, \{a\}), (\phi, \{b\}), (\{1\}, Y), (X, Y)\}$. Then $(\{2\}, \{a\})$ is a binary αg-closed set, but it is not a binary closed set.*

Theorem 2.7 *If (A, B) is binary g-closed set in $(X, Y, \mathcal{M})$, then it is binary $g\alpha$-closed set.*
Proof. Let (A, B) be binary g-closed set, then $b\text{-}cl(A, B) \subseteq (U, V)$ whenever $(A, B) \subseteq (U, V)$ and (U, V) be a binary open in $\mathcal{M}$. Also since, $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B)$ and every binary open set is binary α-open set. Then $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B) = b\text{-}cl(A, B) \subseteq (U, V)$. Hence, $b\text{-}\alpha cl(A, B) \subseteq (U, V)$. Therefore, (A, B) is a binary $g\alpha$-closed set.

Theorem 2.8 *If (A, B) is binary g-closed set in $(X, Y, \mathcal{M})$, then it is binary αg-closed set.*
Proof. Let $(A, B) \subseteq (U, V)$ and (U, V) be a binary open in $\mathcal{M}$. Since, $b\text{-}cl(A, B) \subseteq (U, V)$. Also since, $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B)$ and (A, B) is binary closed set. Thus $b\text{-}\alpha cl(A, B) \subseteq b\text{-}cl(A, B) = b\text{-}cl(A, B) \subseteq (U, V)$. Hence, $b\text{-}\alpha cl(A, B) \subseteq (U, V)$. Therefore, (A, B) is a binary αg-closed set.

Theorem 2.9 *If (A,B) is binary αg-closed set in $(X,Y,\mathcal{M})$, then it is binary $g\alpha$-closed set.*

Proof. Let $(A,B) \subseteq (U,V)$ and (U,V) be an binary open in $\mathcal{M}$, then $b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Since, every binary open set is binary α-open set. Therefore, (U,V) is binary α-open in $\mathcal{M}$ and $(A,B) \subseteq (U,V)$. Hence $b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Therefore (A,B) is a binary αg-closed set.

Theorem 2.10 *If (A,B) is binary $g\alpha$-closed set in $(X,Y,\mathcal{M})$, then it is binary generalized semi closed set.*

Proof. Let (A,B) be a binary $g\alpha$-closed set and $(A,B) \subseteq (U,V)$; (U,V) is binary open in (X,Y). We have $b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Also for $(A,B) \subseteq (U,V)$ and (U,V) is binary open, we have $b\text{-}scl(A,B) \subseteq b\text{-}\alpha cl(A,B)$. Then $b\text{-}scl(A,B) \subseteq (U,V)$ as $b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Hence $b\text{-}scl(A,B) \subseteq (U,V)$ whenever $(A,B) \subseteq (U,V)$, (U,V) is binary open. So (A,B) is binary generalized semi closed set.

Theorem 2.11 *The Union of two binary $g\alpha$-closed sets in $(X,Y,\mathcal{M})$ are also binary $g\alpha$-closed set in $(X,Y,\mathcal{M})$.*

Proof. Assume that (A,B) and (C,D) are two binary $g\alpha$-closed sets in $(X,Y,\mathcal{M})$. Let (U,V) be a binary open in $(X,Y,\mathcal{M})$ such that $((A,B) \cup (C,D)) \subseteq (U,V)$. Then $(A,B) \subseteq (U,V)$ and $(C,D) \subseteq (U,V)$. Since, (A,B) and (C,D) are binary $g\alpha$-closed sets in (X,Y). $b\text{-}\alpha cl(A,B) \subseteq (U,V)$ and $b\text{-}\alpha cl(C,D) \subseteq (U,V)$. Hence, $b\text{-}\alpha cl((A,B) \cup (C,D)) = b\text{-}\alpha cl(A,B) \cup b\text{-}\alpha cl(C,D) \subseteq (U,V)$. That is $b\text{-}\alpha cl((A,B) \cup (C,D)) \subseteq (U,V)$. Hence $((A,B) \cup (C,D))$ is an binary $g\alpha$-closed set.

Remark 2.12 *The intersection of two binary $g\alpha$-closed sets in $(X,Y,\mathcal{M})$ are also binary $g\alpha$-closed set in $(X,Y,\mathcal{M})$ as seen from the following example.*

Example 2.13 *In Example 2.4, then the binary $g\alpha$-closed sets are $\mathbb{P}(X,Y)$. Hence the intersection of two binary $g\alpha$-closed set is binary $g\alpha$-closed set.*

Theorem 2.14 *The Union of two binary αg-closed sets in $(X,Y,\mathcal{M})$ are also binary αg-closed set in $(X,Y,\mathcal{M})$.*

Proof. Assume that (A,B) and (C,D) are two binary αg-closed sets in $(X,Y,\mathcal{M})$. Let (U,V) be a binary open in $(X,Y,\mathcal{M})$ such that $((A,B) \cup (C,D)) \subseteq (U,V)$. Then $(A,B) \subseteq (U,V)$ and $(C,D) \subseteq (U,V)$. Since, (A,B) and (C,D) are binary αg-closed sets in (X,Y). $b\text{-}\alpha cl(A,B) \subseteq (U,V)$ and $b\text{-}\alpha cl(C,D) \subseteq (U,V)$. Hence, $b\text{-}\alpha cl((A,B) \cup (C,D)) = b\text{-}\alpha cl(A,B) \cup b\text{-}\alpha cl(C,D) \subseteq (U,V)$. That is $b\text{-}\alpha cl((A,B) \cup (C,D)) \subseteq (U,V)$. Hence $((A,B) \cup (C,D))$ is an binary αg-closed set.

Remark 2.15 *The intersection of two binary αg-closed sets in $(X,Y,\mathcal{M})$ are not binary αg-closed set in $(X,Y,\mathcal{M})$ as seen from the following example.*

Example 2.16 *Let $X = \{a,b,c\}$, $Y = \{1,2,3\}$ and $\mathcal{M} = \{(\phi,\phi),(\{a\},\{1\}),(\{b\},\{2\}),\ (\{a,b\},\{1,2\}),(X,Y)\}$. Take $(A,B) = (\{a\},\{1,3\}$ and $(C,D) = (\{c\},\{1,2\})$. Then (A,B) and (C,D) are binary αg-closed but $(A,B) \cap (C,D) = (\phi,\{1\})$ is not a binary αg-closed set.*

Theorem 2.17 *If a set (A,B) is binary $g\alpha$-closed set then $b\text{-}\alpha cl(A,B) - (A,B)$ contains no non-empty closed set.*

Proof. Suppose that (A,B) is binary $g\alpha$-closed set. Let (P,Q) be a binary α-closed subset of $b\text{-}\alpha cl(A,B) - (A,B)$. Then, $(A,B) \subseteq (P,Q)^c$, $(P,Q)^c$ is open and hence binary α-open. Since, (A,B) is binary $g\alpha$-closed set, $b\text{-}\alpha cl(A,B) \subseteq (P,Q)^c$. Consequently, $(P,Q) \subseteq (b\text{-}\alpha cl(A,B))^c$. Since, Every binary closed set is binary α-closed set. Hence, (P,Q) is binary α-closed set. Therefore $(P,Q) \subseteq b\text{-}\alpha cl(A,B)$. $(P,Q) \subseteq b\text{-}\alpha cl(A,B) \cap (b\text{-}\alpha cl(A,B))^c = \phi$. Hence (P,Q) is empty.

Theorem 2.18 *Let (A,B) be a binary $g\alpha$-closed subset of (X,Y). If $(A,B) \subseteq (C,D) \subseteq b\text{-}\alpha cl(A,B)$ then (C,D) is also a binary $g\alpha$-closed subset of (X,Y).*

Proof. Let (U,V) be a binary α-open set of (X,Y) such that $(C,D) \subseteq (U,V)$. Then $(A,B) \subseteq (U,V)$. Since, (A,B) is a binary $g\alpha$-closed set $b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Also, $(C,D) \subseteq b\text{-}\alpha cl(A,B)$. Then $b\text{-}\alpha cl(C,D) \subseteq b\text{-}\alpha cl(A,B) \subseteq (U,V)$. Hence (C,D) is also a binary $g\alpha$-closed subset of (X,Y).

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3 Binary $g\alpha$-interior and binary $g\alpha$-closure

Definition 3.1 *Let (X,Y) be a binary Topological space and let $(i,j) \in (X,Y)$. A subset (A,B) of (X,Y) is said to be binary $g\alpha$-neighbourhood of (i,j) if there exists a binary $g\alpha$-open set (P,Q) such that $(i,j) \in (P,Q) \subseteq (A,B)$.*

Definition 3.2 b-$g\alpha$-$int(A,B) = \cup \{(C,D): (C,D)$ *is binary $g\alpha$-open set and $(C,D) \subseteq (A,B)\}$*

Definition 3.3 b-$g\alpha$-$cl(A,B) = \cap \{(C,D): (C,D)$ *is binary $g\alpha$-closed set and $(A,B) \subseteq (C,D)\}$*

Theorem 3.4 *If (A,B) be a subset of (X,Y). Then b-$g\alpha$-$int(A,B) = \cup \{(C,D): (C,D)$ is binary $g\alpha$-open set and $(C,D) \subseteq (A,B)\}$.*
Proof. Let (A,B) be a subset of (X,Y). $(i,j) \in b$-$g\alpha$-$int(A,B) \Leftrightarrow (i,j)$ is a binary $g\alpha$-interior point of (A,B).
$\Leftrightarrow (A,B)$ is a binary $g\alpha$-neighbourhood of point (i,j).
$\Leftrightarrow$ there exists binary $g\alpha$-open set (C,D) such that $(i,j) \in (C,D) \subseteq (A,B)$.
$\Leftrightarrow (i,j) \in \cup \{(C,D): (C,D)$ is binary $g\alpha$-open set and $(C,D) \subseteq (A,B)\}$.
Hence, b-$g\alpha$-$int(A,B) = \cup \{(C,D): (C,D)$ is binary $g\alpha$-open set and $(C,D) \subseteq (A,B)\}$.

Theorem 3.5 *Let (A,B) and (C,D) be subsets of (X,Y). Then*
1. b-$g\alpha$-$int(X,Y) = (X,Y)$ and b-$g\alpha$-$int(\phi,\phi) = (\phi,\phi)$.
2. b-$g\alpha$-$int(A,B) \subseteq (A,B)$.
3. If (C,D) is any binary $g\alpha$-open set contained in (A,B), then $(C,D) \subseteq b$-$g\alpha$-$int(A,B)$.
4. If $(A,B) \subseteq (C,D)$, then b-$g\alpha$-$int(A,B) \subseteq b$-$g\alpha$-$int(C,D)$.
5. b-$g\alpha$-$int(b$-$g\alpha$-$int(A,B)) = b$-$g\alpha$-$int(A,B)$.

Proof.
1. Since, (X,Y) and (ϕ,ϕ) are binary $g\alpha$-open sets, by theorem 3.4 b-$g\alpha$-$int(X,Y) = \cup \{(C,D): (C,D)$ is binary $g\alpha$-open and $(P,Q) \subseteq (X,Y)\} = \cup \{(A,B): (A,B)$ is a binary $g\alpha$-open set$\} = (X,Y)$. That is, b-$g\alpha$-$int(X,Y) = (X,Y)$. Since, (ϕ,ϕ) is the only binary $g\alpha$-open set contained in (ϕ,ϕ), b-$g\alpha$-$int(\phi,\phi) = (\phi,\phi)$.
2. Let $(i,j) \in b$-$g\alpha$-$int(A,B) \Rightarrow (i,j)$ is a binary $g\alpha$-interior point of (A,B). Then (A,B) is a binary $g\alpha$-neighbourhood of (i,j). Thus $(i,j) \in (A,B)$. Hence, $(i,j) \in b$-$g\alpha$-$int(A,B) \subseteq (A,B)$.
3. Let (C,D) be any binary $g\alpha$-open sets such that $(C,D) \subseteq (A,B)$. Let $(i,j) \in (C,D)$, then since, (C,D) is a binary $g\alpha$-open set contained in (A,B), (i,j) is a binary $g\alpha$-interior point of (A,B). That is (C,D) is a b-$g\alpha$-$int(A,B)$. Hence, $(C,D) \subseteq b$-$g\alpha$-$int(A,B)$.
4. Let (A,B) and (C,D) be subsets of (X,Y) such that $(A,B) \subseteq (C,D)$. Let $(i,j) \in b$-$g\alpha$-$int(A,B)$. Then (i,j) is a binary $g\alpha$-interior point of (A,B) and so (A,B) is binary $g\alpha$-neighbourhood of (i,j). This implies that $(i,j) \in b$-$g\alpha$-$int(C,D)$. Thus we have shown that $(i,j) \in b$-$g\alpha$-$int(C,D)$. Hence, b-$g\alpha$-$int(A,B) \subseteq b$-$g\alpha$-$int(C,D)$.
5. Let (A,B) be any subset of (X,Y). By definition of binary $g\alpha$-interior, b-$g\alpha$-$int(A,B) = \cap \{(A,B) \subseteq (E,F) \in b$-$g\alpha cl(X,Y)\}$, if $(A,B) \subseteq (E,F) \in b$-$g\alpha cl(X,Y)$, then b-$g\alpha$-$int(A,B) \subseteq (E,F)$. Since (E,F) is a binary $g\alpha$-closed set containing b-$g\alpha$-$int(A,B)$. By(3), b-$g\alpha$-$int(b$-$g\alpha$-$int(A,B)) \subseteq (E,F)$. Hence, b-$g\alpha$-$int(b$-$g\alpha$-$int(A,B)) \subseteq \cap \{(A,B) \subseteq (E,F) \in b$-$g\alpha cl(X,Y)\} = b$-$g\alpha cl(A,B)$. That is, b-$g\alpha$-$int(b$-$g\alpha$-$int(A,B)) = b$-$g\alpha$-$int(A,B)$.

Theorem 3.6 *If a subset (A,B) of a space (X,Y) is binary $g\alpha$-open then b-$g\alpha$-$int(A,B) = (A,B)$.*
Proof. Let (A,B) be binary $g\alpha$-open subset of (X,Y). We know that b-$g\alpha$-$int(A,B) \subseteq (A,B)$. Also (A,B) is binary $g\alpha$-open set contained in (A,B). From theorem 3.5(3), $(A,B) \subseteq b$-$g\alpha$-$int(A,B)$. Hence, b-$g\alpha$-$int(A,B) = (A,B)$.

Theorem 3.7 *If (A,B) and (C,D) are subsets of (X,Y), then b-$g\alpha$-$int(A,B) \cup b$-$g\alpha$-$int(C,D) \subseteq b$-$g\alpha$-$int((A,B) \cup (C,D))$.*
Proof. We know that $(A,B) \subseteq (A,B) \cup (C,D)$ and $(C,D) \subseteq (A,B) \cup (C,D)$. We have by theorem 3.5(4), b-$g\alpha$-$int(A,B) \subseteq b$-$g\alpha$-$int((A,B) \cup (C,D))$ and b-$g\alpha$-$int(C,D) \subseteq b$-$g\alpha$-$int((A,B) \cup (C,D))$. This implies that b-$g\alpha$-$int(A,B) \cup b$-$g\alpha$-$int(C,D) \subseteq b$-$g\alpha$-$int((A,B) \cup (C,D))$.

Theorem 3.8 *If (A,B) and (C,D) are subsets of space (X,Y), then $b\text{-}g\alpha\text{-}int((A,B) \cap (C,D)) = b\text{-}g\alpha\text{-}int(A,B) \cap b\text{-}g\alpha\text{-}int(C,D)$.*

Proof. We know that $(A,B) \cap (C,D) \subseteq (A,B)$ and $(A,B) \cap (C,D) \subseteq (C,D)$. We have, by theorem 3.5(4), $b\text{-}g\alpha\text{-}int((A,B) \cap (C,D)) \subseteq b\text{-}g\alpha\text{-}int(A,B)$ and $b\text{-}g\alpha\text{-}int((A,B) \cap (C,D)) \subseteq b\text{-}g\alpha\text{-}int(C,D)$. This implies that

$$b - g\alpha - int((A,B) \cap (C,D)) \subseteq b - g\alpha - int(A,B) \cap b - g\alpha - int(C,D). \qquad (1)$$

Again, let $(i,j) \in b\text{-}g\alpha\text{-}int(A,B) \cap b\text{-}g\alpha\text{-}int(C,D)$. Then $(i,j) \in b\text{-}g\alpha\text{-}int(A,B)$ and $(i,j) \in b\text{-}g\alpha\text{-}int(C,D)$. Hence, (i,j) is a binary $g\alpha$-interior point of each sets (A,B) and (C,D). It follows that (A,B) and (C,D) is binary $g\alpha$-neighbourhood of (i,j), so that their intersection $(A,B) \cap (C,D)$ is also binary $g\alpha$-neighbourhood of (i,j). Hence, $(i,j) \in b\text{-}g\alpha\text{-}int((A,B) \cap (C,D))$. Therefore,

$$b - g\alpha - int(A,B) \cap b - g\alpha - int(C,D) \subseteq b - g\alpha - int((A,B) \cap (C,D)). \qquad (2)$$

From (1) & (2), we get $b\text{-}g\alpha\text{-}int((A,B) \cap (C,D)) = b\text{-}g\alpha\text{-}int(A,B) \cap b\text{-}g\alpha\text{-}int(C,D)$.

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REVIEW ARTICLE

Functionalized Polysaccharides Based Hydrogels: Application in Tissue Engineering and Regenerative Medicines

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ABSTRACT

Hydrogels have become a very popular trend in interdisciplinary research owing to their versatile characteristics and applicability in a diverse array of healthcare sectors. They have been extensively utilized as contact lens materials, wound dressing materials, and filler materials in soft tissue augmentation, where the backbones of polymers such as hydroxyethyl methacrylate (HEMA) are commonly used. Polysaccharides have recently drawn the attention of researchers as a potential material of construction for extracellular matrices (ECMs). In particular, in the fields of tissue engineering and regenerative medicine, alginate, pullulan, chitosan, dextran, and hyaluronic acid are the preferred choices of polysaccharides, and precise chemical functionalization is very essential for obtaining appropriately functionalized hydrogels from these polysaccharides. This review provide an overview of convergent and divergent cross linking techniques, as well as biofunctionalization strategies for polysaccharides. In a nutshell, this article reviews functionalized polysaccharide-based hydrogels and their biomedical applications, particularly in tissue engineering and regenerative medicine.

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Keywords: Polysaccharides;Hydrogels; Dextran, Pullulan, Tissue engineering; Scaffolds; Regenerative medicine

INTRODUCTION

Over the last ten years, Hydrogels have gained a lot of attention, and they've been used for a variety of purposes, from making contact lenses to treating minor wounds. The concept of hydrogel dates back to 1894 when the first evidence of water absorption on copper particles was discovered[1].A hydrogel is a three-dimensional network that has the ability to absorb water without being solvated[2].In the invention of clinical uses, hydrogels have widely been known as a target material because of the aforementioned property. For example, hydrogels are used in contact lens materials and hydroxyethyl methacrylate (HEMA) is the polymer of choice for it[3].Polysaccharides are excellent scaffold substances for making hydrogels, which are utilized to enclose cells[4]. Polysaccharides have lately been investigated asdrug-delivery vehicles in the area oftissue engineering and regenerative medicine[5].For artificial cells' extracellular matrix (ECM), these polysaccharides are excellent choices. Natural extracellular materials are a complex mixture of extracellular substances released by cells that give the cells in their vicinity biochemical and structural stability. In order to accommodate cells, tissue engineers have been looking for ways to replace natural ECM with synthetic biomaterials. These biomaterials' physiologically active elements give them the appearance of a synthetic in-vivo environment with complex and dynamic interactions with the surroundings, such as stem cell regulation.

The creation of artificial organs and transplantation are crucial in the tissue engineering field. In addition to naturally occurring substances like fibronectin and collagen, non-human ECM can also be created from synthetic or natural polymers and could be further utilised in tissue engineering [6].To produce gels *in-situ*, a crude extracellular matrix mixture, relevant cells, additives, or medium are precisely inserted in the desired location. *In-vitro* gel formation and incubation, on the other hand, permit cells such as cardiomyocytes to replace the artificial ECM if certain conditions are met. Artificial heart tissue transplantation could be developed in this manner. This review article highlights and briefly discusses recent advances in producing functionalized and chemically modified designs for polysaccharides that will permit the production of hydrogels to act as artificial ECM in tissue engineering. Herein, we are particularly interested in synthetic approaches for preparing hydrogels on demand and further functionalizing them with small molecules to provide them new biological capabilities. The design strategies of polysaccharide-based drug delivery systems (Figure 1).

Methods for Functionalizing Polysaccharides and Cross-Linking

When developing hydrogel materials for clinical uses, the limitations of hydrogel formation and the toxicity of cross-linking agents were taken into consideration. Variety of methods can be used to covalently cross-link polymers to generate a three-dimensional network with hydrogel-like properties. Glutaraldehyde is the cross-linking agent that has been extensively used. It is, however, difficult to deal with, and concerns regarding the cross-linked compounds and their toxicity have yet to be addressed. The multifunctionality of polysaccharides provides a variety of ways for semi-synthetic derivatization. Chemical derivatization is particularly applicable to the carboxylate found in salicylic acid and the amino group of chitosan, hyaluronic acid, and alginate. Furthermore, cross-linking the two polysaccharide strains was achieved using the 1,2-diol moieties found in hyaluronic acid, pullulan, and dextran. In general, there are two methods for making hydrogels via a chemical reaction. For convergent modification, a polysaccharide is treated and cross-linked with epi-chlorohydrin or glutaraldehyde. Although it is a widely used method, but it is limited in its flexibility because it is dependent on the selected hydroxyl groups present in the polysaccharide or carboxylic acid residue.

Biodegradable hydrogels shown remarkable potential for cell and drug delivery systems, enabling for simple and uniform cell or drug distribution inside any fault shape or size[7–12].Biodegradable hydrogels have been made using

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a variety of approaches during the last decade[13–20]..Traditional hydrogel fabrication methods are limited by the use of cytotoxic reagents, operational complexity, the possibility of side reactions, and low coupling efficiency. A prominent example is the azides with alkynes catalysed copper (I)- reaction; which has been used in recent advancements to make biodegradable hydrogels with specific association processes [21–27]. The diversity of click reactions has been widely exploited. However, there are various challenges in converting these methodologies into biological applications, with the intrinsic toxicity of the synthetic techniques being one significant limitation. Simple, fast, and highly efficient conjugation chemistries that can be applied to a diverse range of biodegradable hydrogels while retaining their full bioactive functionality for biomedical applications are still required.

There has been a lot of interest in making self-crosslinking in-situ formable hydrogel a component of a tissue engineering construct. Various cross-linking methods and polymers are being tested in order to create a functional self-cross-linkable mucilaginous substance for cartilage tissue synthesis. In this sense, hyaluronic acid, gelatin, alginate and their combinations appear to be more effective. It is generally possible to create a composite scaffold from these polymers by combining them and crosslinking them with calcium chloride. However, this framework has several practical drawbacks. To start with, alginate is a non-biodegradable polymer that may cause reactions in foreign body cells and the immune system can be activated by calcium ions produced by this structure which increases the risk of defective bone formation in the cartilage and leads to chondrocyte death. The above problems are successfully resolved by self-crosslinking of gelatin and partially oxidized polysaccharides without the application of exogenous crosslinking agents[1–6,8–10,28].Self-crosslinking alginate, gelatin, and hyaluronic acid hydrogels have been developed and tested in research. According to reports, it was the first method of connecting the aforementioned polymers into a network that was covalently crosslinked and formed in place.The most popular modification strategies for polysaccharides functionalization are listed in Table 1.

Using damaged chitosan and thiol derivatized hyaluronan, Michael's addition reaction was employed[29,30]. The hydrogels were characterized using oscillatory rheology, swelling ratio, antibacterial activity. As per the outcomes of FT-IR and SEM post 15 minutes, *in-situ* hydrogels with promising strength were formed with various molar ratios. The porosity and swelling ratio can be decreased with an increase in vinyl content. Additionally, the hydrogels have shown antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*, which is crucial for biomedical applications. A few research developments and progressions of popular polysaccharide-based DDSs are presented in Table 2.

Functionalized Polysaccharide-based Hydrogels and their Medical Applications

In physiological conditions, a polysaccharide-based hydrogel is created with variable biodegradable properties. Hyaluronic acid, a cross-linked polysaccharide, is one prominent example. It can be functionalized to contain anesthetics such as lidocaine or lignocaine to relieve pain when applied to any soft tissue[31,32]. Drug delivery vehicles can also be made from polysaccharide-based hydrogels[33]. The development of mixed materials was influenced by the search for synthetic ECMs in tissue engineering, with the aim of producing a more robust and effective man-made extracellular matrix[34]. These mixed materials are usually made up of a polysaccharide and an artificial polymer like poly-lactic acid (PLA) or*polyethylene glycol* (PEG). They are mechanically robust and can be further functionalized[35,36].The patent literature on these types of mixed materials has been rapidly expanding in recent years[37].

Nicoll and Chou *et al*., reported that cross-linked alginate hydrogels based on nucleophilic reactions differ from ionically produced hydrogels implied for cartilage regeneration. Both hydrogels were cell-friendly and elicited no immunological reactions. Hydrogels were formed when alginate was cross-linked with calcium cations, but due to cation leaching, they tend to become fluid again after a short period of storage. Importantly, the equilibrium may change the mechanical properties of the hydrogels produced. However, a comparable photochemically cross-linked covalent network has been used as a scaffold for cartilage regeneration because it is more stable over time[38,39].

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To combine both modified polysaccharides, researchers employed a crosslinking approach based on adipic acid dihydrazide and alginate aldehyde as a linker[40]. In addition, Amedee *et al.*, have effectively used apatite blends comprising a pullulan or dextran mixture for bone tissue development to replace the injured bone tissue[41].

In a different study strategy, Two alginates which are modified were infused into the heart muscle to form the hydrogels. In this investigation, both commercially available RGD-modified alginate and pure alginate were employed. There were favorable effects on left ventricular remodeling after *in-vivo* gelation and tissue shape retention in the infarcted area[42].Administering the injections of alginate allowed the same team to successfully restore the left ventricle (LV) after a previous myocardial infarction. The *in-vivo*-produced hydrogels aided in the regeneration of infarcted and scarfed areas[43].In current progressions, chitosan-based polymers have acquired prominence in the field of cardiac tissue synthesis in addition to alginate. Herein, for the said purpose, the researchers used a multi-layered scaffold to cover cardiac patches. As a result, the scaffold has enough mechanical strength to keep cardiomyocyte viability intact and long-lasting[44,45].

Chemical Analysis of Polysaccharides Based Hydrogels

The qualitative and quantitative examination of functionalization is a major difficulty for chemically derivatized polysaccharides. Nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry are the two common structural analytical tools that can be used. These methods provide a general idea of how functionalized a polysaccharide is, but do not provide an exact number of derivates. These analytical techniques, on the other hand, provide information about the precise location of functional derivatization and any changes in the polysaccharide backbone. In some circumstances, data from combustion and gravimetric analysis can be used to supplement these findings. Traditional titration techniques can be used to assess the quantity of reactive functional groups prior to crosslinking and to gauge the extent of the post-crosslinking alteration[46,47]. Thiols are frequently used as functional groups in adjustable reactivity crosslinking[48].Ellman's reagent is one such chemical compound that can be used both qualitatively and quantitatively to determine whether or not disulphide bonds have formed on the backbone of the polysaccharide[49,50]. Derivatization chemistry using appropriately blocked monosaccharides is one way to learn about a regioselectivity of a derivatization method, which is been widely adopted nowadays[51].

Polysaccharide-Based Hydrogel Preparation
Preparation of Polysaccharide-Based Hydrogel Using the Hydroxy Decanoic Acid(HDA), Alginate Dialdehyde(ADA), And Gelatin:

HDA, gelatin and ADA solutions can be manufactured and combined in a mass ratio for the production of hydrogels. Gelatinis dissolved in deionized water, whereas HAD and ADAwere dissolved in borax solution.The samples created and their final respective compositions are given in Table 3.

Preparation Of Polysaccharide-Based Hydrogels

Regardless of the presence of two or three free hydroxyl groups, the graphical schemes often indicate only one mechanism of attachment between two monosaccharide units of the polysaccharide strands. This is done to keep things simple. Individual hydroxyl groups have varied reactivity in monosaccharide synthetic carbohydrate chemistry ($C_6 > C_3 > C_2 > C_4$) for the gluco-configuration. Axial hydroxyl groups, such as those in the fourth position, show significantly less reactivity in galactic-configured monosaccharides than the equatorial epimer[52].There is yet no generalizable hydroxyl group reactivity pattern in polysaccharides[53].

Convergent Approaches

Dextran is a historically significant polysaccharide because it was a pioneering polymer in elucidating the research limitations, and hazards. Dextran is an excellent starting point.Because it is non-adhesive and biodegradable, it is ideal for medication administration and tissue engineering applications[54].
Cross-linked dextran's (11) and (12) prepared using epi-chlorohydrin as a bifunctional crosslinking agent:(Figure 2).

Cross-linked dextran (14) hydrogel formation using dithioerythritol (det) as a crosslinking agent (for reasons of schematic simplification only 3rd position of the dextran ring is functionalized, similarly at 2, 4th positions also serve as points of cross-linking)[55]:(Figure 3).

Photoactivation reaction used to crosslink methacrylate-modified hyaluronic acid (15) and form a hydrogel (16):(Figure 4).
A different convergent crosslinking method that uses ultraviolet (UV) irradiation as a crosslinking trigger was used to create hydrogel (16) from methacrylate hyaluronic acid (15)[56]. While the convergent method is a simple chemical technique, it has a few synthetic flexibility limitations. Intramolecular cross-linking is unavoidable within a single polymer strand, resulting in a gel with poor definition. By joining two polymeric strands from various polysaccharide sources, this technique avoids the production of hetero-cross-linked products. Additionally, the presence of an unreacted crosslinking agent renders it inappropriate for *in-vivo* gelation as it may cause unfavorable side effects including an immunological response or inflammation[57–59].

Alginate derivative (17) converging crosslinking with dihydrazideof adipic acid results in the creation of hydrogel (18):(Figure 5).

Synthesis of crosslinked hyaluronic acid (21) was achievedvia a copperfree "click" a divergent method:(Figure 6). The inclusion of thio-Michael is a critical step in the formation of a hydrogel between pullulan and Dextran:(Figure 7).
The above schemes provide a variety of approaches for connecting two polysaccharide strands. The approach has got a copper-free advantage. It can also overcome the cyclooctyne-based copper-free approaches fundamental limitation[60].

Applications Of Polysaccharide-Based Hydrogels [61]
Self-healing hydrogels
By joining two polymeric strands from various polysaccharide sources, this technique avoids the production of hetero-cross-linked products. Additionally, the presence of an unreacted crosslinking agent renders it inappropriate for in-vivo gelation as it may cause unfavourable side effects including an immunological response or inflammation.
Sensors
Under particular conditions or in any reaction to specific stimuli, hydrogels may drastically change their volume. Hydrogels are attractive candidates for sensors because this behavior can change into a variety of output signals, including, electrical, physical, chemical properties. The quantity variations from input to output have the most influence on the sensor's sensitivity.
Energy storage and conversion
Hydrogels are commonly found in energy conversion and storage devices like batteries and supercapacitors. Because of its cross-linked 3D network with internal voids filled with aqueous electrolytes and high stability, hydrogel provides electrochemical activity and versatility in energy storage devices. Electrolytes and electrodes are commonly used in energy storage systems. Furthermore, hydrogels contain a variety of functional groups, such as carboxyl acid groups, that allow them to co-ordinate with cations as anchoring points and increase the electrolyte's ionic conductivity.
Biological applications:
Because of its fascinating features in bio-medical applications like drug administration, wound dressing, tissue engineering, and bio-imaging, polysaccharide-based hydrogels generated from renewable resources have piqued the interest of many researchers. In hydrogel-based drug delivery systems, swelling behaviour and pH sensitivity are critical issues.

Minimally Invasive Surgery for Regenerative Medicine

Polysaccharide-based hydrogels are particularly appealing as a matrix for the repair and regeneration of a variety of organs and tissues because of recent developments in tissue engineering. The optimum cell scaffold should enable effective nutrition transfer and waste product elimination while simultaneously offering adequate mechanical support for cell growth. The therapy of cartilage regeneration uses hydrogels made of polysaccharides. Like other polysaccharides, hyaluronan is one of the most widely utilised polymers for treating osteoarthritis. In order to maintain the joints' ability to function, HYAL modifies the viscoelastic properties of synovial fluid[61].

Interpenetrating Hydrogels as Three-Dimensional Cell Scaffolds

Polysaccharide-based hydrogels are a viable substitute for surgical implantation because of their thixotropic properties and ensuing injectability. The mixed hydrogels are typically made by chemically connecting two different polymers. The quantity, kind, and reactivity of the chemical groups in the two different polymers influence their respective proportions in the final hydrogel. A novel class of predictable injectable hydrogels can be created by blending two different thixotropic hydrogels. The two thixotropic hydrogels are freely mixed after being crushed. Physical entanglement or non-covalent interactions between the molecules in polymeric chains hold the resulting network, known as an interpenetrating hydrogel(IPH). Compared to native hydrogels, IPH has different mechanical, biological, and physicochemical properties. This strategy forecasts and controls the IPH's attributes based on the kind and proportional distribution of each distinct native component. CMT-CHT, GG, and HYAL IPHs were created using hydrogels made of hyaluronic acid, gellan gum, chitosan, and carboxymethylcellulose (CMC, CHT, GG, and CHT)[61].

CONCLUSION

Polysaccharides have gained significance as a polymeric base for the creation of biomedical hydrogels, particularly as a synthetic ECM for tissue engineering. Hyaluronic acid hydrogels are frequently used in soft-tissue augmentation as a filler material. This is a remarkable example because it highlights the safety and biocompatibility of modified polysaccharides generally, as well as their immense potential in other biological areas like tissue regeneration and related regenerative medicinal applications. A well-defined and physiologically durable synthetic chemistry is necessary for successfulfabrication of hydrogels *in-vitro* and *in-vivo* with certain biological characteristics. It must be capable of carefully controlling the crosslinking and functionalization of polysaccharide backbones. When an additional bioactive ligand, like any antibiotics or adhesion factors has to be added, then the second functionalization process is essential. Recently, biorthogonal reactions that satisfy Sharpless's criteria for "click" chemistry have been discovered. These synthetic methods enable the modular and combinatorial functionalization of polysaccharide backbones and leads to the synthesis of hydrogels.Overall, we could say that functionalized polysaccharides will have a bright future in biomedical research.

Ethics approval and consent to participate

This review has not involved studies such as human participants, human data, or human tissues

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Table1: Most usual types of approaches and methods used for polysaccharide functionalization

Functional categories	Methods of modification	Developed Features
Functional group modification	Schiff base is created through the modification of aldehydes. Targeting ligand modification	pH-responsiveness, tumour ability of targeting cells
Grafting of molecular chains	Grafting hydrophobic segment	Amphiphilicity
The addition of cleavable bonds	Forming disulphide bonds and pH sensitive groups	Responsiveness to the reducing microenvironment

Table 2: Research advances have made of a few of the most common polysaccharide-based DDSs.

Names	Various methods of functionalization	Strategy for Design	Characteristics of DDS	*In-vivo* Model/ Cell Lines
Hyaluronic Acid (Ha)	Functional molecule alterations (cholesteryl moiety and methacrylate)	Hydrogels based on polysaccharides that include drugs are produced.	CD44 receptor targeting as well as biodegradability	Cells (A549)
Hyaluronic Acid (Ha)	Functional molecule modification (HA itself as a functional molecule)	The crosslinking of the polymeric electrolyte and the ions (between HA and DOX)	Targeting the CD44 receptor	HK2 and B16F10 cells
Chitosan (CS)	Functional group modification (CS itself as functional molecules)	Creating polysaccharide-drug conjugates (NCTD)	improved antitumor activity and decreased systemic toxicity	Cells BEL-7402
Chitosan (CS)	Functional molecule modification (Lactobionic acid)	Creating polysaccharide-drug conjugates (self-assembly of hydrophobic polysaccharides)	pH-responsiveness	SMMC-7721 and HepG2 cells

Table 3:The created samples and their respective compositions

Sample ID	Final concentration of the polymer HDA (w/v) %	Final concentration of the polymer ADA (w/v) %	Final concentration of the polymer G (w/v) %
ADA–G–HDA 3	2.5	5	10
ADA–G–HDA 2	2.5	5	7.5
ADA–G–HDA 1	2.5	3.75	7.5

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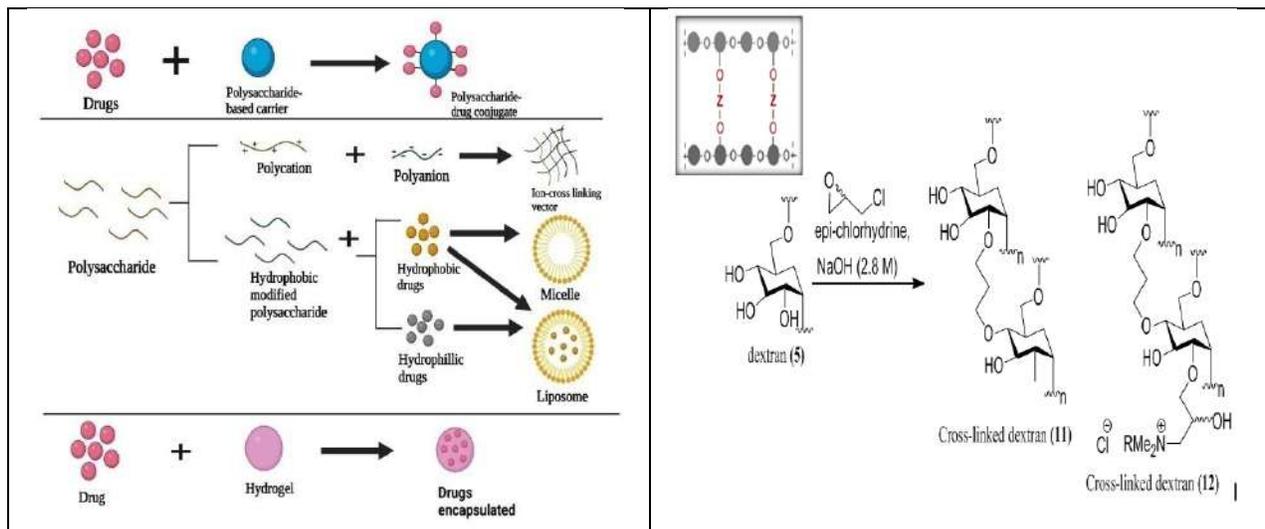
Figure 1: The design strategies of polysaccharide-based drug delivery systems (DDSs).
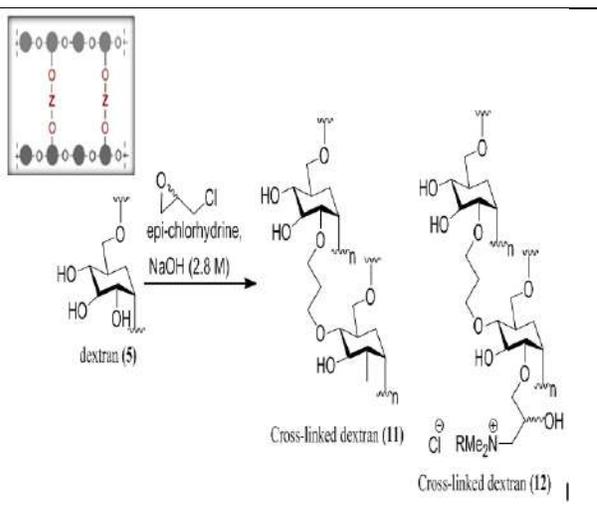
Figure 2: Convergent synthesis of cross linked dextran's (11)and (12)
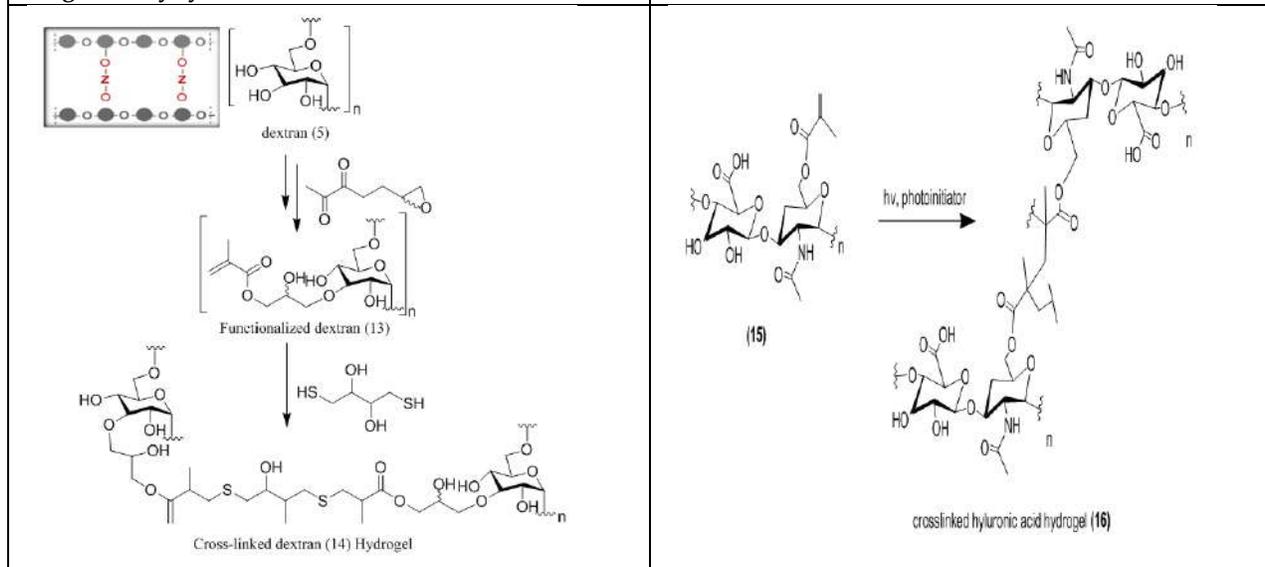
Figure 3: Convergent synthesis of Cross-linked dextran14
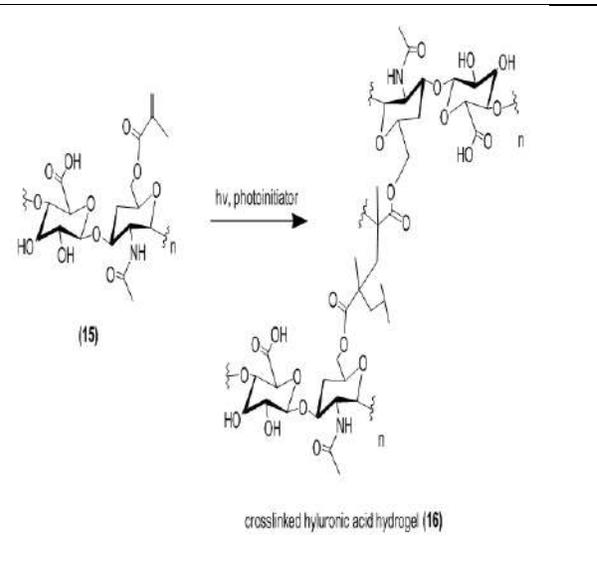
Figure 4: crosslinkingh ofh methacrylateh modified hyaluronic a**acid (15) and** a**formation** a**ofa hydrogel (16) via** a**Photoactivation**a**reaction**A

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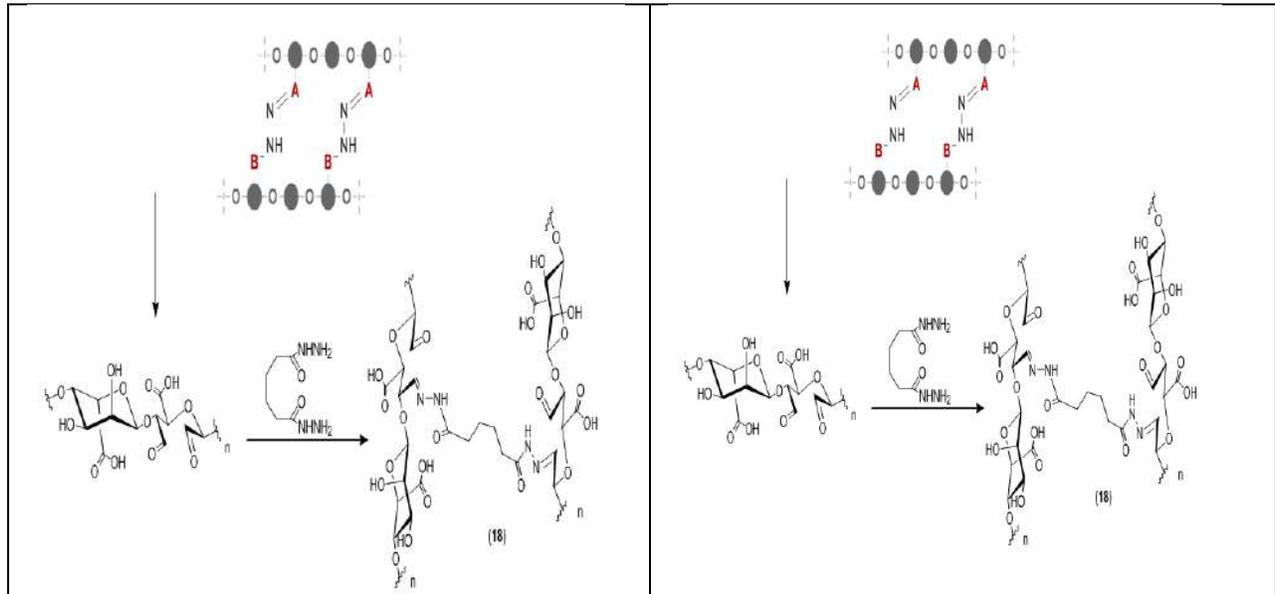
| **Figure 5:** Alginate derivative (17) converging crosslinking with adipic acid dihydrazide results in creation ofhhydrogelh(18) | **Figure 6: synthesis of cross linked hyaluronic acid (21)** |
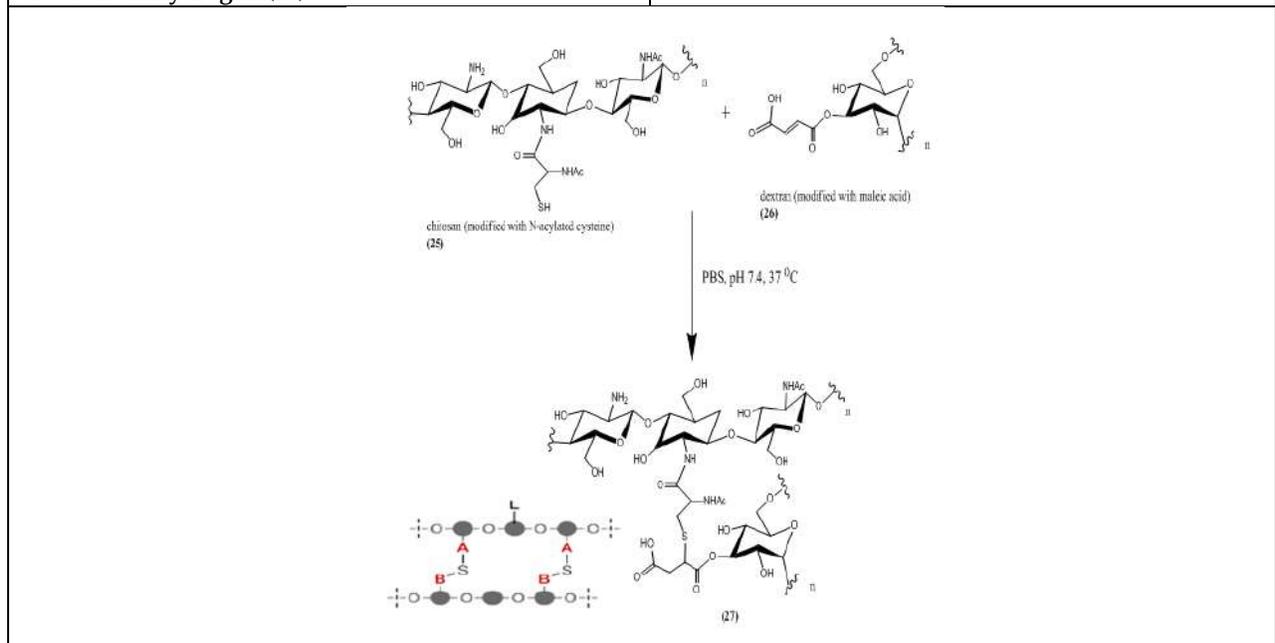
Figure 7: Development of a hydrogel between pullan and Dextran

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RESEARCH ARTICLE

Design Development and Evaluation of Pulsatile Drug Delivery System of Orciprenaline Sulfate for the Treatment of Nocturnal Asthma

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ABSTRACT

The primary goal of this study is to create and test a pulsatile Orciprenaline sulphate drug delivery system for the treatment of nocturnal asthma and symptomatic relief from acute asthma attacks. Pulsatile release tablet comprises a drug containing core and pH sensitive polymeric coating capable of delaying drug release and providing gastric resistance. The core tablets of Orciprenaline sulphate were prepared for the treatment of nocturnal asthma. The core tablets were prepared by direct compression method using different disintegrating agents. The coating was given using pH sensitive polymers (Eudragit S-100, Eudragit L100) at different coating levels to develop a suitable dosage form which should show minimum drug release in upper regions of gastrointestinal tract. To evaluate prepared formulations for physical parameters like weight variation, color, shape, disintegration, dissolution etc. A prompt attempt was made to develop pulsatile release tablets using pH sensitive polymers and evaluated for *In vitro* characterization. From the results obtained in the present research work, it can be concluded that-From IR, Studies and physical observation it was observed that there was no significant Drug- Excipient interaction. So, it can be concluded that drug and other excipients are compatible with each other. Based on disintegration time, Sodium starch glycolate 5% (F6) was selected as a disintegrant in the formulation

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of core tablets and found satisfactory in terms of hardness, thickness, weight variation, *In-vitro* disintegration, *in vitro* drug release and content uniformity.

Keywords: Orciprenaline sulfate, Nocturnal asthma, P^{H} Sensitive polymers, Pulsatile, Dissolution unit.

INTRODUCTION

Chronopharmaceutics is a new concept in which research is devoted to the design and evaluation of drug delivery systems that release a therapeutic agent at a rhythm that ideally matches the biological requirement of a given disease therapy [1]. Diseases that require a pulse of therapeutic concentration in a periodic manner rather than a constant drug level act as a push for the development of "Pulsatile Drug Delivery Systems." In these systems, a certain amount of drug molecules are released quickly and transiently within a short time period immediately following a predetermined off release period [2]. The most effective treatment for asthma is to identify and avoid triggers such as cigarette smoke, pets, or aspirin. If avoidance of triggers is insufficient, medication is recommended. Pharmaceutical drugs are chosen based on a variety of factors, including the severity of the illness and the frequency of symptoms [3]. Specific asthma medications are divided into two categories: fast-acting and long-acting. The presence of different counter-ions in the medium can influence the pulsatile delivery system by changing the membrane permeability and water uptake of acrylic polymers with quaternary ammonium groups [4]. on the basis of this ion exchange, several delivery systems have been developed. The polymer of choice for this purpose is reported to be Eudragit RS 30D. The polymer side chain typically contains a positively polarised quaternary ammonium group, which is always accompanied by negative hydrochloride counter-ions [5]. Because the ammonium group is hydrophilic, it facilitates polymer interaction with water, changing its permeability and allowing water to permeate the active core in a controlled manner [6]. This property is essential to achieve a precisely defined lag time. The cores were prepared using theophylline as model drug and sodium acetate. These pellets were coated using Eudragit RS30D (10% to 40% weight gain) in four different layer thicknesses. A correlation between film thickness and lag time was observed [7,8]. It was found that even a small amount of sodium acetate in the pellet core had a dramatic effect on the drug permeability of the Eudragit film [9]. After the lag time, interaction between the acetate and polymer increases the permeability of the coating so significantly that the entire active dose is liberated within a few minutes [10]. Bronchodilators are recommended for short-term relief of symptoms, other medications are not required for those who have occasional attacks [11]. If there is mild persistent disease (more than two attacks per week), low-dose inhaled corticosteroids or an oral leukotriene antagonist or mast cell stabiliser are recommended [12]. A higher dose of inhaled corticosteroids is used for those who have daily attacks. Oral corticosteroids are added to these treatments during a moderate or severe exacerbation.

METHODS

Tablets of Orciprenaline sulphate were made by direct compression method. All ingredients were weighed accurately and blended homogeneously for 15 minutes by trituration using glass mortar and pestle. Microcrystalline cellulose was used as direct compressing agent [14]. Crospovidone, Croscarmellose Sodium and Sodium Starch Glycolate were used as disintegrating agents. Magnesium stearate and Talc were used as lubricants. Tablets were compressed in Minipress Tablet Compression Machine using 10mm round concave punches [15]. Coating was made by using different pH sensitive polymers like EudragitS-100 and Eudragit L-100 with concentration of 2.5%, 5% and 10% and the tablets are coated by dip coating technique.

Compatibility Analysis
Compatibility studies of pure drug Orciprenaline sulphate with polymers were carried out prior to the preparation of tablets. I.R spectra of pure drug Orciprenaline sulphate and that with polymer were obtained, which are depicted.

All the characteristic peaks (-NH (3347 cm^{-1}), -OH (3467 cm^{-1}) -CH (2871 cm^{-1}), Aromatic (1682 cm^{-1}) of Orciprenaline sulphate were present in spectra at respective wavelengths, indicates compatibility between drug and Polymer. It shows that there was no significant change in the chemical integrity of the drug.

Formulation of Core Tablets by Direct Compression

Tablets of Orciprenaline sulphate were made by direct compression method. All ingredients were weighed accurately and blended homogeneously for 15 minutes by trituration using glass mortar and pestle. Microcrystalline cellulose was used as direct compressing agent. Crospovidone, Croscarmellose Sodium and Sodium Starch Glycolate were used as disintegrating agents. Magnesium stearate and Talc were used as lubricants. Tablets were compressed in Minipress Tablet Compression Machine using 10mm round concave punches. Coating was made by using different pH sensitive polymers like EudragitS-100 and Eudragit L-100 with concentration of 2.5%, 5% and 10% and the tablets are coated by dip coating technique. Formulation of Orciprenaline sulphate tablets shown in table. 1

Evaluation of Tablets

All the prepared tablets were evaluated for average weight, hardness, friability, assay, drug content uniformity, in vitro disintegration time, and in vitro dissolution.

Dissolution Rate Studies Of Core And Coated Tablets

The *in vitro* release of Orciprenaline sulphate from the pulsatile tablets was determined by using a dissolution apparatus according to USP method II (paddle). This apparatus is placed in a water bath thermostated at 37^{0}C (+/-) 0.5^{0}C and stirred at a rate of 75 rpm. Sink conditions were maintained throughout the study. The tablets were glued to a metallic disk and placed at the bottom of the vessels, thereby allowing drug release only from the upper side and edges. The dissolution medium was 900ml of 1.2 pH HCl medium for first 1 hour, followed by 7.4 pH Phosphatee buffer and phosphate buffer pH 6.8. At fixed time intervals (1, 2,3,4,5,6,7,8,9,10 hr) 5ml samples were withdrawn and replaced with fresh buffer solution. Samples were filtered and analysed using UV-spectrophotometer at 276nm. Released drug contents were determined from the calibration curve.

RESULTS AND DISCUSSION

Compatibility Analysis

The characteristic peaks from IR spectra of the drug are shown in Fig. 1, and a physical mixture of the drug and polymers used is shown in Figs. 2-5. Evaluation of blends and tablets of immediate release cores. The flow and compressibility properties of the blends of all the formulations of the core tablet are given in Table 4. The tablet characteristics of the prepared core tablets are shown in Table 5. The results of the dissolution profiles of all the formulations are represented graphically in Fig.1 to 6.

Pre-Compression Parameters

The formulations were subjected for precompressional evaluations such as angle of repose, bulk and tapped density, compressibility index and Hausner's Ratio. Parameters performed on the blend for batchF1 to F9 are tabulated. Angle of repose values for batches from F1 to F9 were found to be in the range 28.94 to 30.64.Compressibility index was found to 13.29, to 15.25. The results of Hausner's ratios were found to be in the range, 1.16 to 1.17, for batch F1 to F9. The results of angle of repose (<30) indicate good flow properties of the powder based on (Table No.2). This was further supported by lower compressibility index values. Generally, compressibility index values up to 15%results in good to excellent flow properties. Results shown in Table-2.

Post-Compression Parameters

The formulated tablets were subjected for evaluation according to official specifications for shape, thickness, hardness, friability, weight variation, drug content and *in vitro* disintegration time. Results are shown in table 3.

DISCUSSION

Drug – Excipient Compatibility Studies
Compatibility studies of pure drug Orciprenaline sulphate with polymers were carried out prior to the preparation of tablets. I.R spectra of pure drug Orciprenaline sulphate and that with polymer were obtained, which are depicted. All the characteristic peaks (-NH (3347 cm^{-1}), -OH (3467 cm^{-1}) -CH (2871 cm^{-1}), Aromatic (1682 cm^{-1}) of Orciprenaline sulphate were present in spectra at respective wavelengths, indicates compatibility between drug and Polymer. It shows that there was no significant change in the chemical integrity of the drug.

Pre-Compressional Parameters
The formulations were subjected for precompressional evaluations such as angle of repose, bulk and tapped density, compressibility index and Hausner's Ratio. Parameters performed on the blend for batchF1 to F9 are tabulated in (Table No.7.3). Angle of repose values for batches from F1 to F9 were found to be in the range 28.94 to 30.64.Compressibility index was found to 13.29, to 15.25. The results of Hausner's ratios were found to be in the range, 1.16 to 1.17, for batch F1 to F9. The results of angle of repose (<30) indicate good flow properties of the powder based on (Table No.2). This was further supported by lower compressibility index values. Generally, compressibility index values up to 15%results in good to excellent flow properties.

Post-Compressional Parameters
Physical appearance: Tablets were white in color, having concave surface with circular shape.
Uniformity of thickness: The results of thickness for tablets are tabulated in (Table No.3). The mean thickness of tablets of the batches F1to F9 was found to be in the range of 3.87±0.12 to4.17±0. 34. The standard deviation values indicated that all the formulations were within the range.

Weight Variation Test
The weight variations of all formulations are tabulated in (Table No.3).All the tablets passed the weight variation test, i.e., average percentage weight variation was found within the pharmacopoeial limits of ±7.5%.

Hardness Test
Hardness or crushing strength of uncoated tablets for all the formulations was found to be in the range 4.2 to 4.6 kg/cm^2 and for coated tablets the hardness was found to be in the range 5.1 to 5.4 kg/cm^2 which is tabulated in Table No.3. The low standard deviation values indicated that the hardness of all the formulations was almost uniform and the tablets possess good mechanical strength with sufficient hardness.

Friability Test
Friability values for batch F1 to F9 were found to be in the range 0.244±0.10, to 0.374±0.13, respectively. The obtained results were found to be well within the approved range (<1%) in all the prepared formulations. That indicated tablets possess good mechanical strength. The results are tabulated in Table No.3.

Drug Content
The formulated tablets were assayed in triplicate. The average value and standard deviations were calculated. The tablets of batch F1, to F9 showed drug content in the range of 97.31±0.42 to 99.62±0.96, The results are tabulated in Table No.3.The results were within the limit(90% to 110%) specified in pharmacopoeia. The cumulative percentage drug released from each tablet in the *in vitro* release studies was based on the average drug content present in the tablet.

***In vitro* Disintegration time**
In vitro disintegration for batch F1 to F9 was found to be in the range as follows: -in pH 1.2 it was 6.39±0.04 to 7.89±0.06

-In pH 6.8 it was 3.12±0.17 to 4.92±0.04 and
-in 7.4pH it was 4.38±0.03 to 5.79±0.03 min.
Batch F6 showed least disintegration time. The results are tabulated in (Table No.4).

In vitro Drug release studies

The in vitro drug release of all formulation before coating (F1 to F9) was carried out in pH1.2 HCl medium. F6 as mentioned before not only having he least disintegration time but also released the drug in just 20mins which is containing SSG 5% concentration as super disintegrant. Hence F6 is coated with pH sensitive polymers (Eudragit S-100, Eudragit L-100). The formulation showed small amount of drug release in the first two hrs in the gastric environment. Formulation F6 coated with Eudragit S 100 as pH sensitive polymer of different concentrations and the formulations were named as F6S1, F6S2, F6S3. At 2.5% Coating (F6S1) a slight drug release was observed & within 7hrs completes drug release was seenie.99.73%. At 5% coating concentration the formulations F6S2, The complete drug release was observed 99.56% after 8 hrs and around 4% drug was released within 3hrs. This concentration is not enough to elicit pharmacological action (concentration less than therapeutic range).At 10% coating concentration i.e. Formulation F6S3, the complete drug released was observed within 8 hrs i.e., 98.79% respectively. It has shown the necessary lag period of 4 hrs and drug release is seen at 5th hour which is within the acceptance criteria. Hence F6S3 is chosen as the best formulation in the study. Formulation F6 coated with Eudragit L 100 as pH sensitive polymer of different concentrations and the formulations were named as F6L1, F6L2, F6L3. At 2.5% Coating (F6L1) a slight drug release was observed & within 6 hrs completes drug release was seen ie. 96.09%. At 5% coating concentration the formulations F6L2, the complete drug release was observed 96.73% after 7 hrs and around 6% drug was released within 3hrs. This concentration is not enough to elicit pharmacological action (concentration less than therapeutic range).At 10% coating concentration i.e., Formulation F6L3, the complete drug released was observed within 8 hrs i.e., 99.07% respectively. But the formulations coated with Eudragit L 100 did not show the necessary lag period. Results shown in Table no 5&6.Cumulative Drug released from all the core tablets related plot Taken time on X-axis and % Cumulative Drug released core & coated tablets Graphical representation shown in fig.7 and 8.

Release Kinetics Study

The data from the in vitro drug dissolution studies were fitted into various mathematical models to find out the best fit model. The formulations from F1 to F6 followed First order kinetics basing on the r^2 regression coefficient value. The coated formulations have shown good linearity with Korsemeyer peppas model and said to follow non-fickian diffusion by analyzing the release exponent values (n<0.5). Results shown in Table no 7.Zero order, first order, Higuchi and Korsemeyer peppas plots of Eudragit S and L coated formulations are shown in fig.9, 10, 11 and 12.

CONCLUSION

The aim of this study was to explore the feasibility of time and pH dependent colon specific, pulsatile drug delivery system of Orciprenaline sulphate to treat Asthma. A prompt attempt was made to develop pulsatile release tablets using pH sensitive polymers (Eudragit S100, Eudragit L100) and evaluated for *In vitro* characterization. From the results obtained in the present research work, it can be concluded that-From IR, Studies and physical observation it was observed that there was no significant Drug- Excipient interaction. So it can be concluded that drug and other excipients are compatible with each other. Based on disintegration time, Sodium starch glycolate 5% (F6) was selected as a disintegrant in the formulation of core tablets and found satisfactory in terms of hardness, thickness, weight variation, *In-vitro* disintegration, *in vitro* drug release and content uniformity.

ACKNOWLEDGMENT

Conflict of Interest

The authors declare that they have no conflict of interest.

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Table.1. Formulation of Orciprenaline sulphate tablets

INGREDIENTS (mg)	F1	F2	F3	F4	F5	F6	F7	F8	F9
	Crosscarmellose sodium [CCS]			Sodium starch glycolate [SSG]			Crosspovidone [CPV]		
Orciprenaline sulphate	20	20	20	20	20	20	20	20	20
CCS	7.5	10	12.5						
SSG				7.5	10	12.5			
CPV							7.5	10	20
Starch	20	20	20	20	20	20	20	20	20
Microcrystalline	192.5	190	187.5	192.5	190	187.5	192.5	190	187.5
Talc 2%	5	5	5	5	5	5	5	5	5
Magnesium stearate2%	5	5	5	5	5	5	5	5	5

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Table-2: Precompression studies of orciprenaline

Formulation code	Bulk Density	Tapped Density	Carr's Index	Hausner's Ratio	Angle of Repose
F1	0.2346±0.001	0.273±0.001	14.065±0.3	1.1636±0.01	29.84±0.1
F2	0.2396±0.003	0.281±0.003	14.733±0.2	1.1727±0.01	29.23±0.2
F3	0.2393±0.004	0.276±0.002	13.297±1.0	1.15336±0.01	29.99±0.5
F4	0.2383±0.003	0.275±0.001	13.345±1.3	1.1540±0.02	29.67±0.2
F5	0.2366±0.007	0.276±0.001	14.275±0.5	1.16652±0.03	28.94±0.4
F6	0.2336±0.002	0.275±0.001	15.054±0.6	1.1772±0.02	29.85±0.2
F7	0.2373±0.003	0.280±0.002	15.250±0.4	1.17994±0.01	30.64±0.6
F8	0.2346±0.002	0.271±0.003	13.431±0.8	1.1551±0.02	29.37±0.7
F9	0.2343±0.006	0.272±0.005	14.065±1.0	1.16368±0.01	29.71±0.2

Table-3: Postcompression studies of orciprenaline Sulphate

BATCH	Uniformity of thickness (mm)	Weight variation uncoated Tablet	Weight variation of coated Tablet	Hardness of uncoated Tablet	Hardness of coated Tablet	Friability (%)	% Drug Content
F1	4.12 ±0.1	252.12±1.2	253.45±2.1	4.3±0.4	5.1±0.2	0.312±0.11	97.31±0.4
F2	3.87 ±0.1	251.34±1.3	252.18±1.4	4.4±0.3	5.1±0.1	0.244±0.10	98.14±0.3
F3	4.09±0.2	249.19±1.5	251.19±2.4	4.2±0.2	5.3±0.2	0.361±0.15	97.46±0.4
F4	3.89±0.1	251.56±1.3	251.71±1.8	4.4±0.2	5.1±0.3	0.424±0.12	98.74±0.4
F5	3.84±0.4	249.09±1.7	250.89±1.2	4.5±0.4	5.2±0.4	0.347±0.09	97.69±0.2
F6	4.17±0.3	251.37±1.5	251.87±1.1	4.3±0.2	5.4±0.4	0.268±0.12	99.06±0.3
F7	4.10±0.2	249.15±1.2	250.90±1.5	4.2±0.2	5.3±0.2	0.374±0.13	98.17±0.7
F8	4.19±0.7	251.65±1.5	252.09±1.7	4.4±0.3	5.1±0.3	0.341±0.14	99.62±0.9
F9	3.98±0.2	251.49±1.7	251.83±1.8	4.6±0.2	5.4±0.2	0.361±0.16	98.44±0.8

Table 4. Disintegration time study of core tablet

DISINTIGRATION TIME (min)	FORMULATION CODE								
	F1	F2	F3	F4	F5	F6	F7	F8	F9
1.2 P^H	6.54	7.61	6.87	7.19	6.59	6.39	7.26	7.74	7.89
6.8 P^H	4.47	3.86	4.67	3.24	4.92	3.12	3.87	4.53	3.19
7.4 P^H	5.06	4.95	5.31	5.69	4.98	4.07	5.79	5.71	4.38

Table 5. In vitro Dissolution study of core tablets

Time	F1	F2	F3	F4	F5	F6	F7	F8	F9
0	0	0	0	0	0	**0**	0	0	0
5	11.96	14.19	16.52	17.69	19.88	**21.47**	13.58	16.54	18.71
10	29.18	30.25	32.45	42.13	46.87	**49.07**	36.74	39.16	42.19
15	57.19	58.93	61.23	69.36	71.27	**76.78**	61.11	65.49	70.12
20	79.16	80.17	83.19	89.07	92.1	**98.71**	79.87	83.17	89.09
30	86.74	88.36	90.17	94.18	99.72	**--**	90.76	91.29	99.06
45	96.37	97.14	99.19	99.86	--	**--**	97.13	98.17	--
60	99.89	--	--	--	--	**--**	--	--	--

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Table6: *In vitro* **Drug release from coated Eudragit S and L coated tablets**

Time (Hrs)	F_6S_1	F_6S_2	F_6S_3	F_6L_1	F_6L_2	F_6L_3
0	0	0	**0**	0	0	0
1	2.3	1.27	**0.87**	3.17	2.24	1.26
2	3.7	2.36	**1.12**	5.86	4.78	2.59
3	5.9	3.87	**2.54**	8.9	6.81	3.67
4	7.4	4.67	**3.31**	33.17	24.56	16.74
5	67.8	58.7	**42.3**	74.16	68.97	52.41
6	79.4	71.34	**68.79**	96.09	79.01	74.97
7	99.73	87.9	**83.56**	--	96.73	88.63
8	--	99.5	**98.79**	--	--	99.07

Table 7. Release kinetics study of Eudragit S and L coated formulations

Formulation CODE	Zero Order Plot		First Order Plot		Higuchi Matrix		Korsmeyer-Peppas Model	
	K	R^2	K	R^2	K	R^2	n	R^2
F_6S_1	11.22	0.724	0.624	0.564	36.64	0.587	0.307	0.911
F_6S_2	10.64	0.777	0.196	0.670	37.72	0.649	0.345	0.907
F_6S_3	9.920	0.756	0.164	0.629	35.81	0.627	0.347	0.913
F_6L_1	12.32	0.761	0.454	0.664	35.83	0.607	0.322	0.969
F_6L_2	11.61	0.806	0.189	0.611	37.14	0.663	0.336	0.965
F_6L_3	10.83	0.821	0.039	0.684	38.01	0.689	0.343	0.951
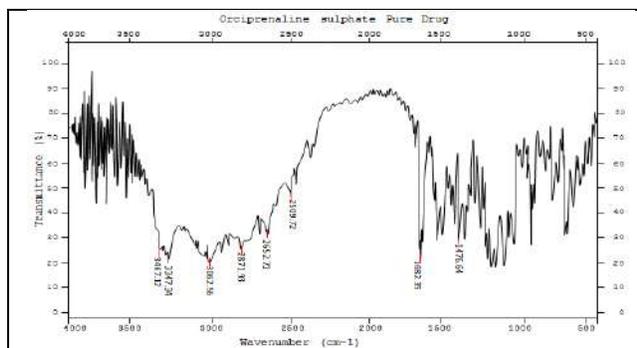
Fig. 1: FTIR Spectrum of pure drug Orciprenaline sulphate
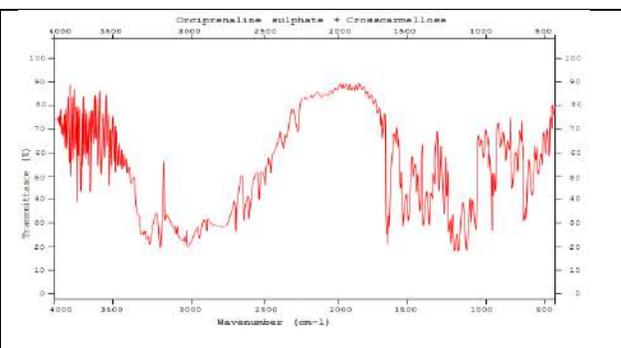
Fig. 2: FTIR Spectrum of pure drug + Crosscarmellose
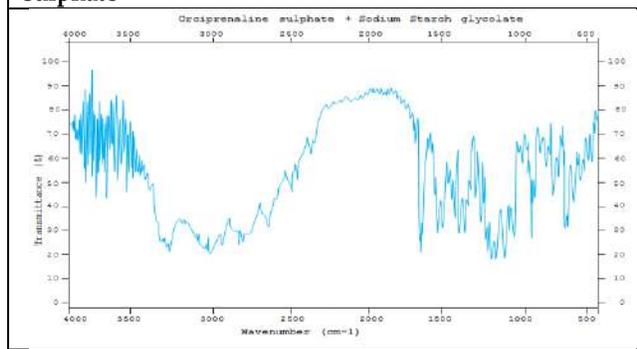
Fig. 3: FTIR Spectrum of pure drug + SSG
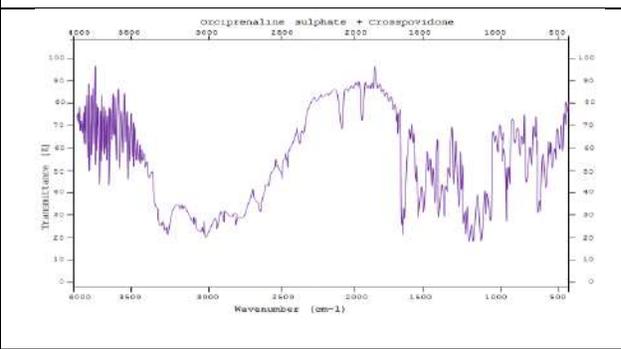
Fig. 4: FTIR Spectrum of pure drug + CPV

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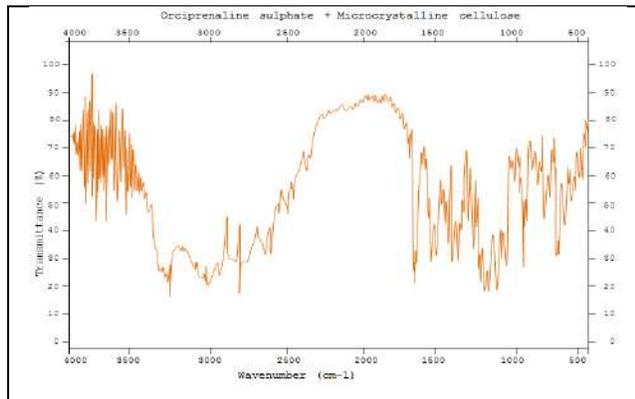
Fig. 5: FTIR Spectrum of pure drug + MCC
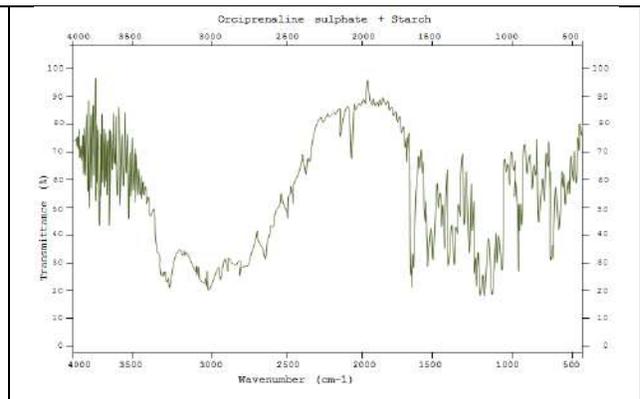
Fig. 6: FTIR Spectrum of pure drug + Starch
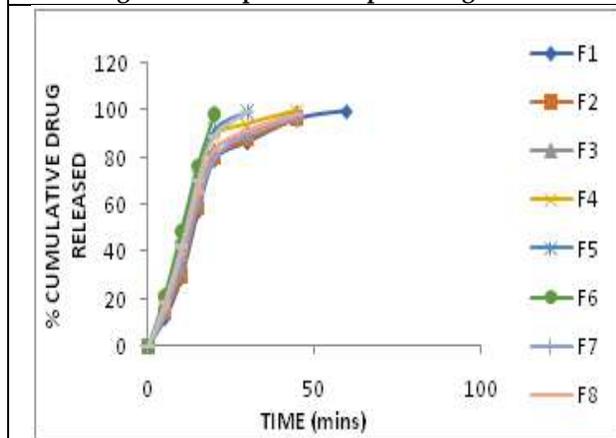
Fig. 7. % Cumulative Drug released from all the core tablets
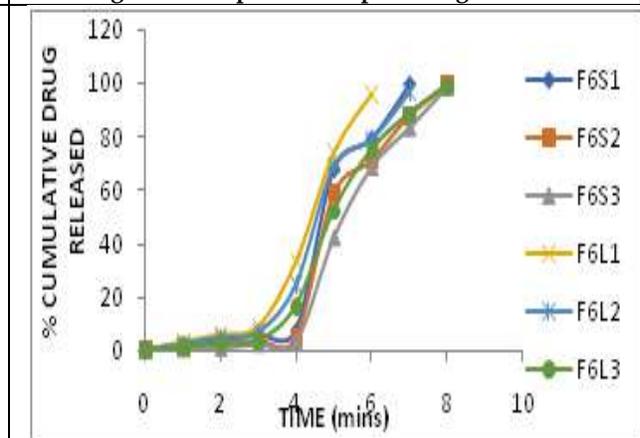
Fig. 8: % Cumulative Drug release plots of Eudragit S and L coated formulations
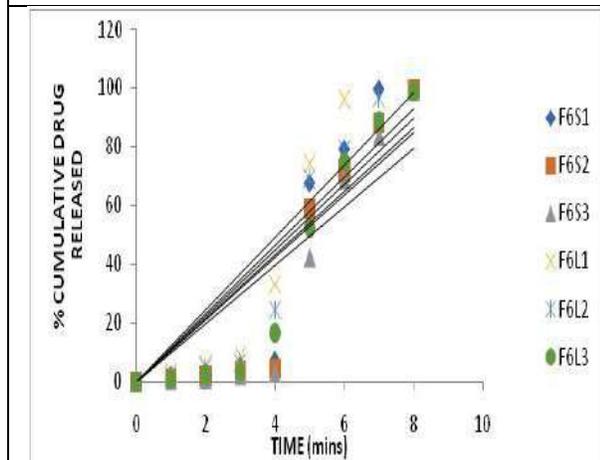
Fig. 9. Zero order plots of Eudragit S and L coated formulations
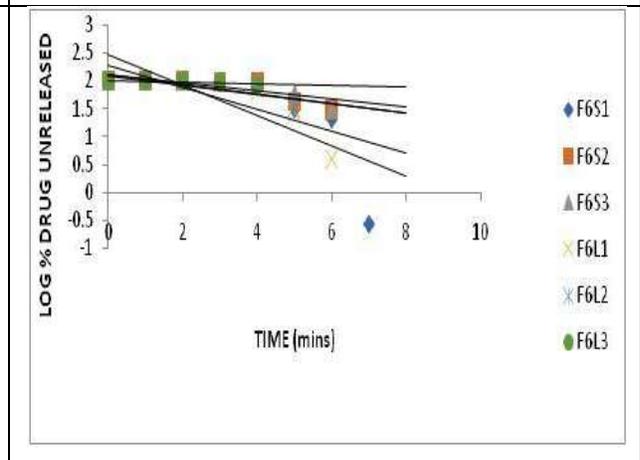
Fig. 10. First order plots of Eudragit S and L coated formulations

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Fig. 11. Higuchi plots of Eudragit S and L coated formulations	Fig. 12.Korsemeyer peppas plots of Eudragit S and L coated formulations

RESEARCH ARTICLE
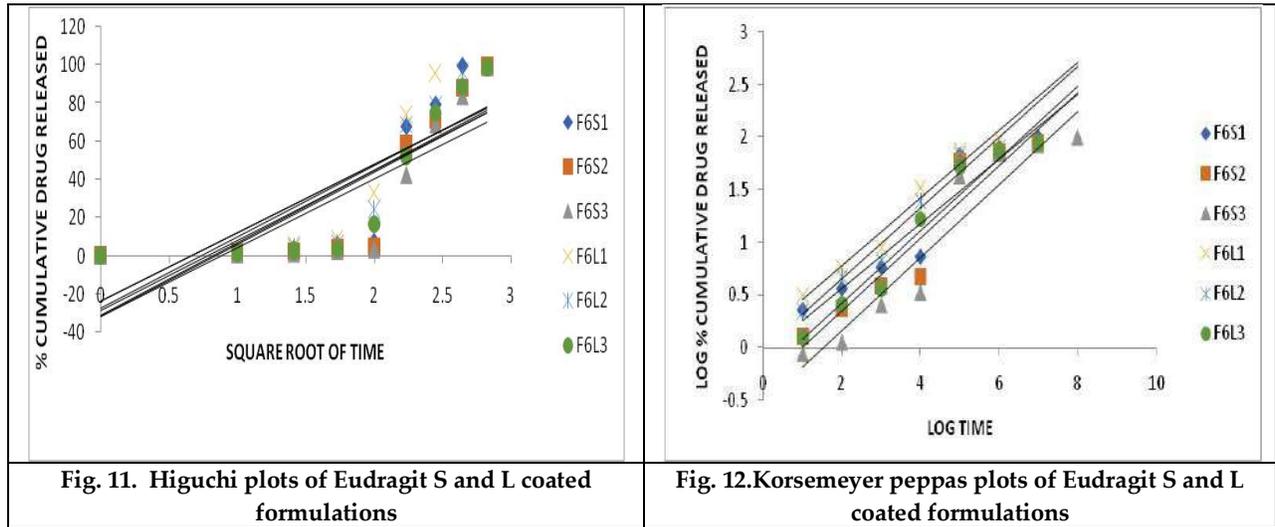
Efficacy of Heel Stretcher Exercise and Foot Strengthening Exercises in School Going Children with Flat Foot

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ABSTRACT

The prevalence of flat feet declines with age, being higher in children with ligament laxity, and the early shoes wearing impairs longitudinal arch development. The aim of the study is to find the effect of heel stretcher exerciser and foot strengthening exercises for school children with flat foot of age group 8 to 15 years. The study includes 50 samples who fulfilled the inclusion criteria. The pedographic pattern test done to measure the angle of arch and medial longitudinal arch and navicular drop pre- test was done. whereas group A students are treatedwith heel stretcher exerciser and stretching exercises and group B are treated with minimal strengthening exercises. After completion of 8 week of study post-test value are recorded. Comparing the pre test and post values of both group A and B the mean values of Arch angle of group A is 0.33 and for groupB is 0.08 , the mean value of Medial Longitudinal Arch for group A is 0.37 and for group B is 0.14 and the mean value of Navicular Drop test for group A is 0.18 and for group B is 0.8. (p< 0.0001) The study concludes that the outcome measures is significant difference in the pre-test and post-test value of angle of arch, medial longitudinal arch and navicular drop test.

Keywords: Flat foot, pedographic pattern, navicular drop test, arch of foot

INTRODUCTION

The prevalence of flat feet declines with age, being higher in children with ligament laxity and the early shoes wearing impairs longitudinal arch development [1,3]. Flat feet or pes planus is a postural deformity in which the arches of the foot collapses, with the entire sole of the foot coming into complete or near-complete contact with the ground [2]. There is a functional relationship between the structures of the foot and the biomechanics of the lower leg [1,5]. The arch provides an elastic, springy connection between the forefoot and the hind foot [4]. Human foot is the region most affected by anatomical variations in the entire human body, and one of the most important characteristics presenting the highest level of variability is the medial longitudinal arch, and an arch index provides a quantitative measurement of the plantar arch, which can be compared to other measurements [3]. The flatfoot occurs when the Medial Longitudinal Arch is decreased because of the arch is increased or it is been relaxed more and excessively pronated, so the eversion of the heel takes place so that the weight load is fall over and it compress the Medial Longitudinal Arch[6,7]. When the medial longitudinal arch is completely lost it leads to structural or functional deformity [8]. The ability of arch is to absorb the impacts such as shock and sense is decreased [11]. Probably the balance lost and decreases in stability during walking, running and hence endurance is decreased and the players prone to injury and their sports performance may reduce [15]. The Structural deformation of the feet leads to lesions in the ankle joint, feet and lower limb and it leads to early fatigue and pain due to excessive actions of the intrinsic and extrinsic muscles, and it ends in the decrease in the balance and stability [6,9]. Flatfoot is classified as congenital or acquired[3]. It occurs, when there is any abnormality in supporting structure of medial longitudinal arch[15]. Years of wear and tear can weaken the tendon and mostly affects the performance level16. It is also known as fallen arches and a postural deformity in which the arches of foot collapse [10]. The arches provide the elastic, springy connection between the forefoot and hind foot. It is usually a painless condition [19].

The appearance of flat feet is normal and common in infants, partly due to "baby fat" which masks the developing arch and partly because the arch has not yet fully developed [21]. The human arch develops in infancy and early childhood as part of normal muscle, tendon, ligament and bone growth [16]. Training of the feet, especially by foot gymnastics and going barefoot on varying terrain, can facilitate the formation of arches during childhood, with a developed arch occurring for most by the age of four to six years [15]. Flat arches in children usually become proper arches and high arches while the child progresses through adolescence and into adulthood [29]. Flexible flat foot in which the arch is visible during sitting or standing in tip toe but disappears during standing [26]. Height of the navicular bone is important for maintain the integrity of the entire medial longitudinal arch, as it is situated at medial side of the tarsus between talus and cuneiform [17]. Navicular drop is defined as the change in navicular bone when the foot moves from subtalar neutral non weight bearing to relaxed weight bearing stance is valid and reliable[28]. Therefore, paediatric flat foot remains a controversial topic in the clinical community[31]. Substantial knowledge gaps still exist in the field. In particular, the controversy around whether or not and when it is necessary to treat a non-developmental asymptomatic flat foot in children is yet to be resolved30. Also, there is a dearth of research on the prevalence of flat foot among school-aged children[19].

Aim of the Study
The aim of the study is to find the effect of heel stretcher exerciser and foot strengthening exerciser for school children with flat foot of age group 8 to 15 years.

Objective of the Study
- To analyse the effect of heel stretcher exerciser technique to reduce the flat foot deformity.
- To improve the range of motion for the flat foot patients with the effectiveness of foot exercise.
- To improve the joint mobility and functional ability.

METHODOLOGY

Study design	:	Experimental study
Study type	:	Pre and Post-test type
Sampling method	:	Convenient sampling
Sample size	:	50 students
Study duration	:	8 weeks
Study Setting	:	Schools in and around Chennai

Inclusion Criteria
- Age group 8 to 15 years.
- Gender both boys and girls with flat foot.
- Co-operative children's.
- Navicular drop test positive students.
- Foot pain students.
- Pedographic flat foot positive students.

Exclusion Criteria
- Participation in another study
- History of disc pathology
- Congenital foot deformities
- Any other congenital deformities of knee & ankle
- Strain and Sprains in lower limb
- Soft tissue injuries of lower limb within 3 months
- History of spinal surgery in past two years
- History of any fractures in past two years

Outcome MeausresArch Assessment
1. Angle of arch - Pedograph pattern
2. Medial longitudinal arch – Pedograph pattern
3. Navicular drop test

Tools Used
1. Foot print stamp
2. A2 sheet
3. Measurement scale

Outcome Measures
Arch Assessment Pedographic Print Test
The subjects wear asked to wash their both legs. The subjects are made to place their foot in the footprint stamp and asked to place it in an A2 sheet. The impression of the foot can be seen in the sheet. Angle of arch and medial longitudinal arch of foot is marked and values are noted.

Navicular Drop Test
The subjects with presence of flat foot were assessed using Navicular DropTest. The subjects were made to sit in the neutral relaxed position in a chair with the knee flexed and ankle flexed at 90°. The prominent position in the navicular tubercle is marked with a pen When the subtalar neutral position is maintained, the index card is placed from the ground in a vertical position that passes the level of the navicular bone and protruding point of tubercle is

pointed on the card. Navicular tubercle's prominent position is again marked. Then the difference between the initial heights of the navicular tubercle is measured in the relaxed position of the non-weight bearing and the position of weight bearing.

Procedure

The subjects are selected based on the inclusion and exclusion criteria. Informed written consent was obtained from the subjects. The subjects underwent an exercise regimen as 45 mins in a day for consequetive 5 days in a week since 8 weeks. The arch of the foot is measured by using two methods Pedographic pattern for angle of arch and medial longitudinal arch and Navicular drop test. 50 subjects were selected based on Inclusion and Exclusion Criteria and randomly divided in to two groups. Group - A and Group - B. Each group consists of 25 samples. The Group A participants were given to perform with heel stretcher machine exerciser and foot corrective exercise protocol for the of duration of 8 weeks of period. The heel stretcher exerciser was done for the duration of 10 mins in every day session and Exercise Protocol includes, Calf rise, Step stretch, Toe curl, Short foot exercise with and without weight-bearing, Toe pick up, Intrinsic muscle strengthening, Single leg hops, Double leg hops. This protocol was asked to perform for the period of 8 weeks. The post-test value of Angle of Arch and Medial Longitudinal Arch were measured by using pedograph pattern test and Navicular Drop Test. The Group B participants were teaches to perform with minimal heel stretching exercises for the duration of 8 weeks of period. Then the post-test value of Angle of Arch and Medial Longitudinal Arch were measured by using pedograph pattern test and Navicular Drop Test.

Exercise protocol
Heel stretcher foot exercise
Group A - After pre -test assessment the Exercise Protocol was taught for Group-A subjects with respective rest period for 8weeks. Group A students are made to sit in a back supported chair and a single foot is placed on a foot holder and griped with a strap in a heel stretcher machine for the duration of 10 mins for the period of 8 weeks. Followed by the exercise protocol of

Calf-Rise The subjects were asked to stand on the ground and knee should be straight ahead and the heels should drift towards the floor.

Toe-Curl The subjects were asked to sit and then the towel should be placed under the feet curl the towel by using their toes and should bunch the towel and release.

Toe-Pick up The subjects should place their feet on the floor and should place their toes flat on the ground and pick up the objects or they could raise their toes.

Step-Stretch The subjects were asked to stand on their feet at first and then they are asked to take a big step forward using their left foot and place it over the step or step stool so that the subjects are in a staggered stance.

Double Leg Hops The subjects were asked to stand in both their feet at the same time and arms should be placed straight and in front they are asked to jump upward and forward.

Single Leg Hops The subjects were asked to stand on their feet on floor and then one leg in extension of knee and arms straight out in front and jump upward and forward.

Intrinsic Muscle Strengthening Toe Lift The subjects are asked to stand and then they should lift their big toe upward and other toes and heel should be on the ground for few seconds and then they should lift their other four toes whereas their big toe and heel on the ground.

Big Toe Stretch The subjects were asked to sit with legs straight out, and should pull back the big toe and hold.

One Foot Balance The subjects were asked to stand with feet flat on the ground, pull the toes towards the heel, and then they should lift one leg while the opposite foot in ground and balance.

Short Foot Exercise with Weight Bearing The subjects are asked sit and then to lower the toes not the arch, and should hold this raised arch for a minute, and this position is Short foot position and knee should point the centre of foot.

Short Foot Exercise without Weight Bearing The subjects are asked stand and then to lower the toes not the arch, and should hold this raised arch for a minute. The above protocols are done for the dosage of 5 sets for 10 rep with 30 sec

of rest intervalsbetween each exercise. The above exercise protocol has been performed after the pre-test andthen the post-test values are calculated.

Group B : subjects received heel and foot stretching exercises for 10 mins for the period of 8 weeks. The above exercise protocol has been performed after the pre-test and then thepost-test values are calculated

Statistical Analysis

Descriptive statistical analysis was carried out in the present study. Outcome measures are presented as mean and mean values are used to compare the outcomes within thegroups. Significance assessed at 5% of significance with p value was at alpha =0.05 (p value < 0.05) less than this is considered as statistically significant difference. The statistical softwareSPSS 25.0 were used to statistically analysis of data. Microsoft word and excel have been usedto generate the graphs and tables.

- Intra group analysis - Paired sample t- test
- Inter group analysis - Independent sample t- test

Table [1] shows the baseline characteristics of the gender of students with flat foot treated with heel stretcher exerciser and stretching exercises for group A and basic strengthening exercise for group B

Table [2] shows the baseline characteristics of the age of students with flat foot treated with heel stretcher exerciser and stretching exercises for group A and basic strengthening exercise for group B

Descriptive Statistics of all measures – Group A

Table 3 shows that the mean value of group A the angle of arch, pre test values is 5.74 and the post values is 6.07 and the standard deviation of group A the pre testvalue is 0.86 and post test value is 0.87 and P value is 0.0001. Table 4 shows that the mean value of group A the navicular drop test, pre test values is 1.55 and the post values is 1.37 and the standard deviation of group A thepre test value is 0.22 and post test value is 0.21 and P value is 0.0001.

Descriptive Statistics of all measures – Group B

Table 5 shows that the mean value of group B the angle of arch, pre test values is 5.9 and the post values is 6.04 and the standard deviation of group B the pre test value is 0.81 and post test value is 0.82 and P value is 0.0001. Table 6 shows that the mean value of group B the angle of arch, pre test values is 5.9 and the post values is 6.04 and the standard deviation of group B the pre test value is 0.81 and post test value is 0.82 and P value is 0.0001. Table 7 shows that the mean value of group B the angle of arch, pre test values is 1.50 and the post values is 1.42 and the standard deviation of group B the pre test value is 0.23 and post test value is 0.22 and P value is 0.0001.

Inter-Group Analysis (Between Group Analysis)

Table 8 shows that the mean value of group A and B the angle of arch the difference betweenthe mean values of group A are 0.33 and group B are 0.08. The value of standard deviation of group A are 0.12 and for group B are 0.05. P value is 0.0001. **Table 8** shows that the mean value of group A and B the navicular drop test the difference between the mean values of group A are 0.33 and group B are 0.08. The value of standard deviation of group A are 0.12 and for group B are 0.05. P value is 0.0001.

RESULTS

Comparing the experimental group A pre and post-test values, it is shown thatthe foot's angle of arch increased in mean value from 5.74 to 6.07. Medial longitudinalarch increase in mean value from 4.64 to 5.01 and Navicular Drop test decreases from 1.55 to 1.37 among preliminary -test and post-test. The table presents a substantial rising in the foot arch angle and medial longitudinal arch and a decrease navicular droptest value. Comparing the control group B pre and post values showed an Arch of Foot angle, the mean value increased from 5.95 to 6.04. Medial Longitudinal Arch increasesin mean value from 4.92 to 5.06 between pre-and post-test and Navicular Drop test decreases in mean value from 1.50 to 1.42. The table demonstrated a substantial increase Arch Angle and Medial Longitudinal Arch and decrease in Navicular Drop testvalue. Comparing the post values of both group A and B the mean values of Arch

angle of group A is 0.33 and for group B is 0.08 , the mean value of Medial Longitudinal Arch for group A is 0.37 and for group B is 0.14 and the mean value of Navicular Drop test for group A is 0.18 and for group B is 0.8. Experimental and Control group, flat foot school students showed a increase in the angle of Arch of Foot and Medial Longitudinal Arch and decrease in the navicular drop test. But comparatively the group A participants with heel stretcher exerciser and foot strengthening exercises shows a significant improvement in this study than the group B participants who undergone with minimal stretching exercise.

DISCUSSION

This study was done to find the effect of heel stretcher foot exerciser and foot strengthening exerciser for school children with flat foot. The values of angle of arch, medial longitudinal arch and navicular drop test are compared with both the groups. The result showed a significant effect in increase of angle of arch and medial longitudinal arch and decrease in the navicular drop test. The treatment protocol for group A of heel stretcher foot exerciser and foot strengthening exercises and stretching exercise for group B showed a significant improvement in flat foot students. However the group A students showed a more significant effective result in this study than group B students. Primarily, a stretching function was implemented. Following manual stretching by a physical therapist, the foot is dorsiflexed till the end of the ankle ROM. Subsequently, the therapist applies an additional load on the foot and maintains the foot in this posture(33). Stretching is a major treatment for restoring the ankle range of motion while decreasing the ankle stiffness and to treat flat foot. stretching machine can provide long-term continual stretching at home(21). S Sivachandiran and Dr. G Vinod Kumar et.al., is their study states that the corrective exercises programme among athletes with flat feet on foot alignment factors are effective. The study concludes that, 12 weeks of corrective physical exercises programme for experimental group is significantly improved in angle of arch foot (AAF), navicular height (NAH) and medial longitudinal arch (MLA). The experimental group compare with control group better significant improvement on angle of arch foot (AAF) and Navicular height (NAH) of the flat feet players when compare to control group (CG). Shiraishi, Y., Okamoto, S., Yamada, N. et al. Pneumatically-driven stretching machine for ankle dorsiflexion: safety concepts and effectiveness test involving healthy young subjects A few studies have investigated the effect of static stretching on the decrease in the muscle strength. Further, the effectiveness was verified for healthy young participants to confirm that the machine achieved the stretching effect. The machine was used to stretch the plantar flexors, and it was observed that the passive resistance significantly decreased after stretching.The results indicated that the stretching machine was effective for healthy young people.

This study revealed that the post test value of pedographic pattern of angle of arch, medial longitudinal arch and navicular drop test were showed a significant improvement (<0.05) than the pre test value for the group A students who undergone the intervention of heel stretcher foot exerciser and foot strengthening exercises than the group B students who have undergone with basic stretching exercises. So, from the above study the effectiveness of heel stretcher exerciser and foot strengthening exercises there is significantly improved arch of foot (angle of arch, medial longitudinal arch) and navicular drop for the students with various level of flat foot. This study experience many difficulties in the initial stage to follow up the protocol for the students later turns the students more involvement to perform the protocol with motivation.

Limitations
- Small sample size
- Duration of study is small

Recommendation
- In future studies the large samples size can be included.
- The duration of the study can be increased for complete recovery of flat foot.
- Other intervention can be added.

CONCLUSION

The intra-group analysis showed that both the treatments are effective However, the inter-group analysis showed that Treatment A is significantly effective than Treatment B in terms of improvement in the values of a measure namely NAVICULAR DROP TEST & MEDIAL LONGITUDINAL ARCH. Hence, we conclude that Treatment A (HEEL STRETCHER EXERCISER) is significantly effective than Treatment B (STRENGTHENING EXERCISE) **.**

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Table 1- Summary of baseline characteristics

CHARACTERISTICS	GROUP A	GROUP B
MEN: WOMEN	12 : 13	10 : 15

Table 2 - Summary of baseline characteristics

CHARACTERISTICS	GROUP A	GROUP B
AGE(Y)	10.83 ±11.23	32.1 ± 32.72

Table 3 shows that the mean value of group A the angle of arch, pre test values is 5.74 and the post values is 6.07 and the standard deviation of group A the pre testvalue is 0.86 and post test value is 0.87 and P value is 0.0001.

GROUP A	MEAN		STANDARDDEVIATION		T VALUE	p VALUE
	PRE TEST	POSTTEST	PRE TEST	POSTTEST		
ANGLE OF ARCH	5.74	6.07	0.86	0.87	13.66	0.0001

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Table 4 shows that the mean value of group A the medial longitudinal arch, pre test values is 4.64 and the post values is 5.01 and the standard deviation of group A the pre test value is 1.23 and post test value is 1.26 and P value is 0.0001.

GROUP A	MEAN		STANDARD DEVIATION		t VALUE	p VALUE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
MEDIAL LONGITUDINAL ARCH	4.64	5.01	1.23	1.26	15.85	0.0001

Table 4 shows that the mean value of group A the navicular drop test, pre test values is 1.55 and the post values is 1.37 and the standard deviation of group A thepre test value is 0.22 and post test value is 0.21 and P value is 0.0001.

GROUP A	MEAN		STANDARD DEVIATION		t VALUE	p VALUE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
NAVICULAR DROP TEST	1.55	1.37	0.22	0.21	-19.47	0.0001

Table 5 shows that the mean value of group B the angle of arch, pre test values is 5.9 and the post values is 6.04 and the standard deviation of group B the pre test value is 0.81 and post test value is 0.82 and P value is 0.0001.

GROUP B	MEAN		STANDARD DEVIATION		t VALUE	p VALUE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
ANGLE OF ARCH	5.95	6.04	0.81	0.82	8.89	0.0001

Table 6 shows that the mean value of group B the angle of arch, pre test values is 5.9 and the post values is 6.04 and the standard deviation of group B the pre testvalue is 0.81 and post test value is 0.82 and P value is 0.0001.

GROUP B	MEAN		STANDARD DEVIATION		t VALUE	p VALUE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
MEDIAL LONGITUDINAL ARCH	5.9	6.04	0.81	0.82	11.96	0.0001

Table 7 shows that the mean value of group B the angle of arch, pre test values is 1.50 and the post values is 1.42 and the standard deviation of group B the pre testvalue is 0.23 and post test value is 0.22 and P value is 0.0001.

GROUP B	MEAN		STANDARD DEVIATION		t VALUE	p VALUE
	PRE TEST	POST TEST	PRE TEST	POST TEST		
NAVICULAR DROP TEST	1.50	1.42	0.23	0.22	-8.72	0.0001

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Table 8 shows that the mean value of group A and B the angle of arch the difference betweenthe mean values of group A are 0.33 and group B are 0.08. The value of standard deviation of group A are 0.12 and for group B are 0.05. P value is 0.0001.

TOPIC	MEAN DIFERRANCE		STANDARD DEVIATION		T VALUE	P VALUE
	GROUP A	GROUP B	GROUP A	GROUP B		
ANGLE OF ARCH	0.33	0.08	0.12	0.05	-9.51	0.0001

Table 8 shows that the mean value of group A and B the medial longitudinal arch the differencebetween the mean values of group A are 0.37 and group B are 0.14. The value of standard deviation of group A are 0.12 and for group B are 0.06. P value is 0.0001.

TOPIC	MEAN DIFERRANCE		STANDARD DEVIATION		T VALUE	P VALUE
	GROUP A	GROUP B	GROUP A	GROUP B		
MEDIAL LONGITUDINALARCH	0.37	0.14	0.12	0.06	-9.05	0.0001

Table 8 shows that the mean value of group A and B the navicular drop test the difference between the mean values of group A are 0.33 and group B are 0.08. The value of standard deviation of group A are 0.12 and for group B are 0.05. P value is 0.0001.

TOPIC	MEAN DIFERRANCE		STANDARD DEVIATION		T VALUE	P VALUE
	GROUP A	GROUP B	GROUP A	GROUP B		
NAVICULAR DROP TEST	0.18	0.08	0.05	0.04	8.40	0.0001

Fig. 1 Foot print	**Fig.2 Navicular drop test in sitting**

Fig. 3 Navicular drop test in standing

Fig. 4 foot stretcher exerciser
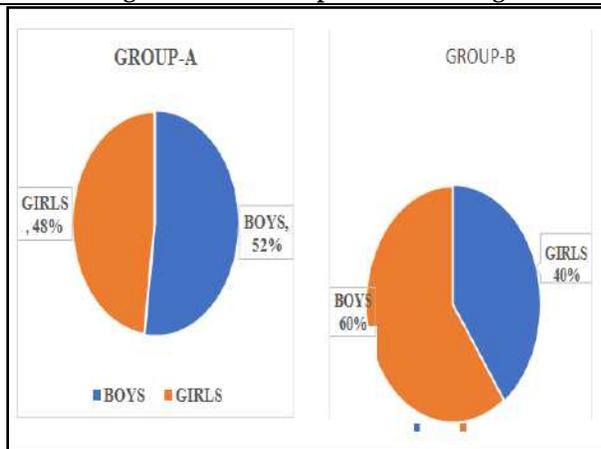
Fig. 5 shows the baseline characteristics of the gender of students with flat foot treated with heel stretcher exerciser and stretching exercises for group A and basic strengthening exercise for group B
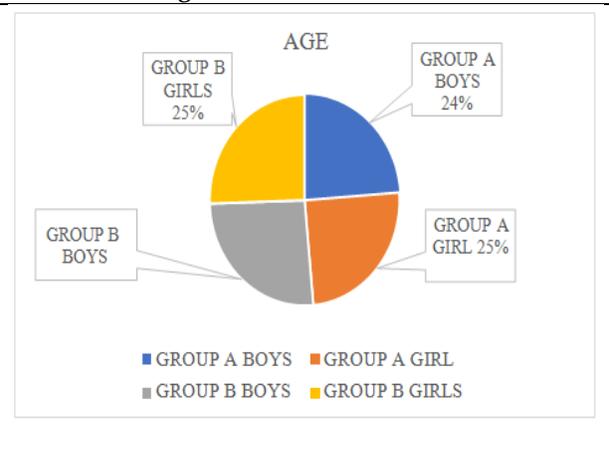
Fig.6 shows the baseline characteristics of the age of students with flat foot treated with heel stretcher exerciser and stretching exercises for group A and basic strengthening exercise for group B
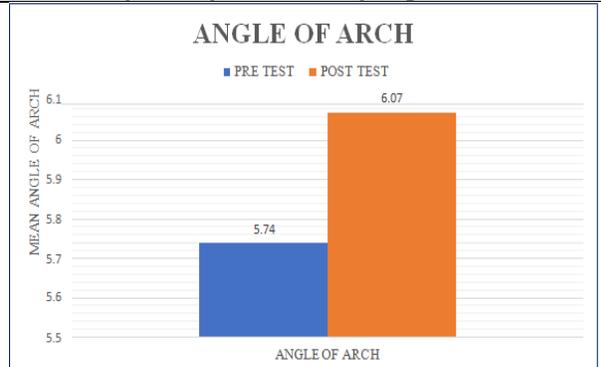
Fig.7 Analysis of Pre Test and Post Test Mean Values of Angle of Arch for Group A
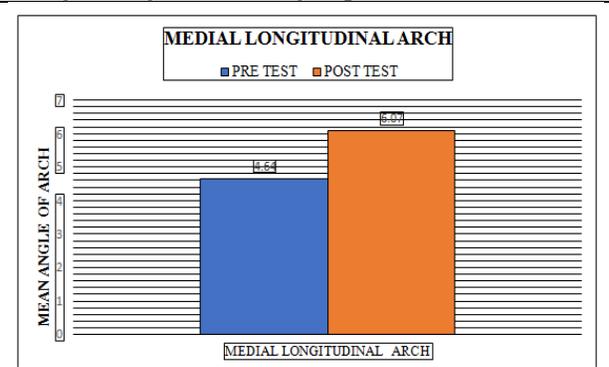
Fig.8. Analysis of Pre Test and Post Test Mean Values of Medial Longitudinal Arch for Group A

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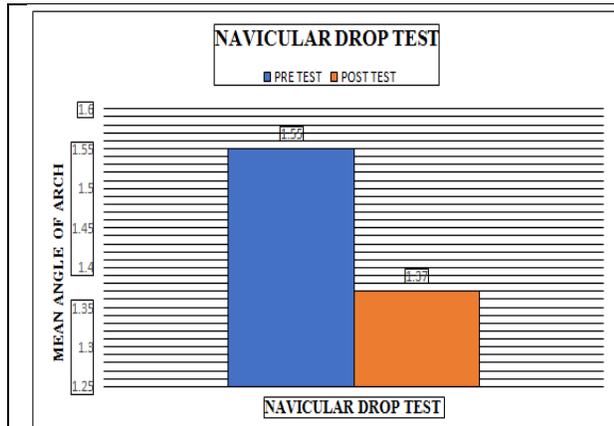
Fig.9 Analysis of Pre Test and Post Test Mean Values of Navicular Drop Test for Group A
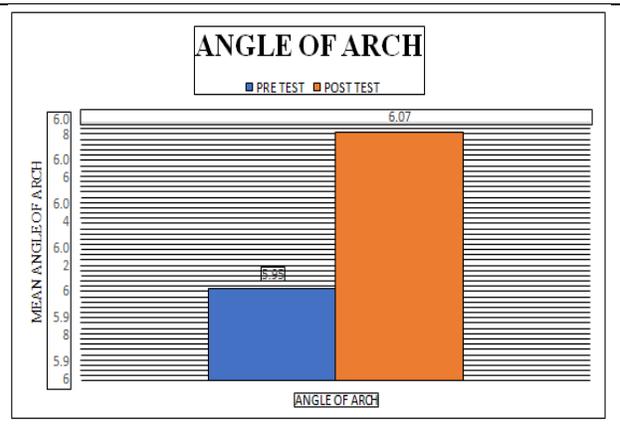
Fig.10 Analysis of Pre Test and Post Test Mean Values of Angle of Arch for Group B
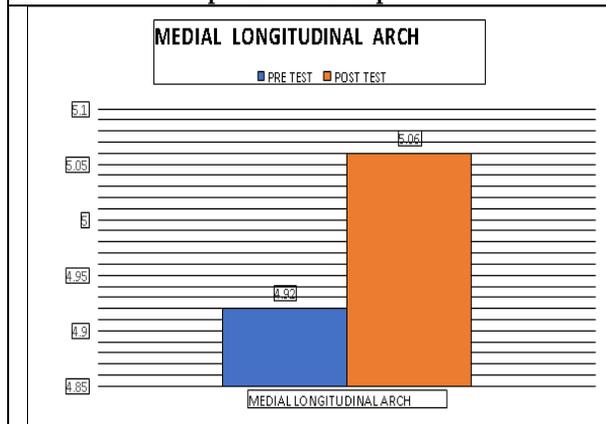
Fig. 11. Analysis of Pre Test and Post Test Mean Values of Medial Longitudinal Arch For Group B
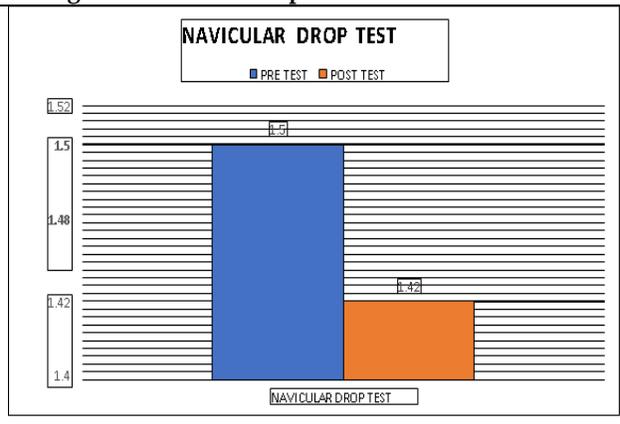
Fig.12 Analysis of Pre Test and Post Test Mean Values of Navicular Drop Test For Group B
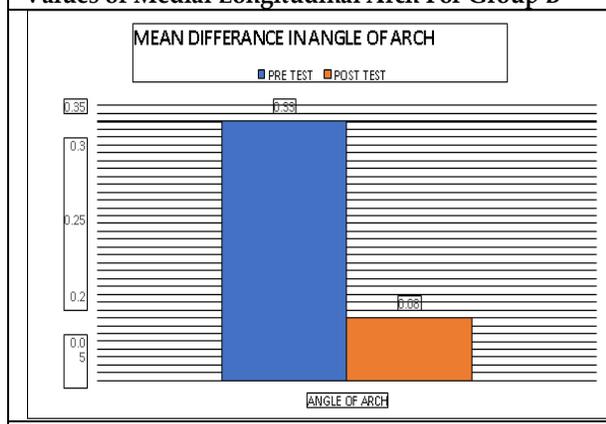
Fig.13.Analysis of Group   and Group B Mean Difference of Angle of Arch
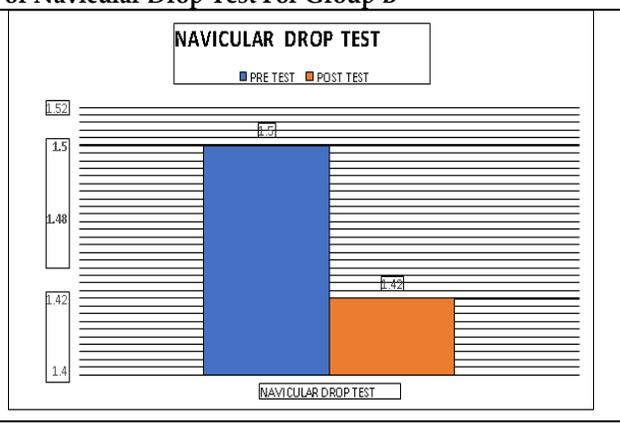
Fig.14.   Analysis of Group A and Group B Mean Difference of Medial Longitudinal Arch

RESEARCH ARTICLE

Analysis of Performance Measure Factors In the Indian Healthcare Industry

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ABSTRACT

The purpose of this paper is to evaluate Performance Measures (PMs) and their attributes in Indian healthcare. Various problems in the health care industry have been addressed through factor and attribute analysis, factor analysis, correlation, and other framework parameters. Apart from customer and employee satisfaction, it was discovered that societal performance, hospital image, and treatment were the most important PMs. Because there is no clear framework for excellence in healthcare, where stakeholders are an integral part of the complete service, developed PMs and their connectivity to attributes may help to resolve Indian Hospital's service level issues.

Keywords: Health care; Hospital; Performance Measure; Patient Expectation; QualityExpectation; Service Level.

INTRODUCTION

Global service level expectations have put enormous strain on service industries. Stakeholder expectations have limited the service provider's ability to address competitive trends and service-related issues. This is also true for the Indian hospitality industry. The hospitality industry includes the healthcare industry, and it has provided an opportunity to improve hospital service standards. Almost all hospitals in the health care industry provide the same type of services, but the quality of services varies greatly [1]. The study focuses on various issues in all of the major

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areas with which hospitals deal. Treatment time, cost feasibility, cleanliness, hygiene, patient care and comfort, privacy concerns, and infrastructure are all factors to consider.

Challenges in Indian Healthcare Industry

Healthcare is a necessity regardless of demographics, culture, income, age, or gender. Healthcare inaccessibility and excellence in Indian healthcare may appear to be contradictory statements. People's expectations are rising, creating an environment conducive to providing better healthcare services. However, a lack of understanding of the factors that contribute to excellence, as well as a scarcity of patients, has created an ambiguous scenario in the healthcare system. Reasons include a growing population, a lack of infrastructure, a scarcity of trained workers, a changing disease profile, inefficient spending, and a lack of access to healthcare services. Poor operational strategies, waste management, and disposal policies exist in Indian healthcare establishments. They disregard the rules in exchange for monetary consideration. Ward attendants and other support staff are untrained. This compels hospital administrators to make appropriate decisions to improve information system integration. This compels hospital administrators to make appropriate decisions to improve information system integration by referring to technological, environmental, and organisational dimensions [2]. To help employees and organisations, it is critical that organisational culture encourages and supports teamwork and cross-functional performance evaluation [3].

REVIEW OF LITERATURE

As service expectations and technological advancement have changed the expectations of patients and their families, the scenario has changed from merely treatment in hospital to quality treatment. Padma *et al.*[4] identified basic factors that lead to patient dissatisfaction if not met, but do not lead to satisfaction if met. One-dimensional factors cause satisfaction when their presence is high and dissatisfaction when their performance is low, which is directly related to patients' needs and desires. Excitement factors result in patient satisfaction, which does not result in dissatisfaction if they are absent. When indifferent factors are present, they neither cause satisfaction nor dissatisfaction. Koumaditis et.al.[5] have held leadership accountable for organisational and infrastructural facilities. According to Rateb *et al.*[6], top management commitment has the highest score among training and education, continuous improvement, and teamwork. Hariharan *et al.* [7] have improved patient care by providing better medical, nursing, and paramedical services through a cross-functional approach. Drotz *et al.* [8]proposed leadership involvement in decision making through decentralisation of authority, power sharing, and active participation. Goh *et al.* [3] defined patient safety as the organization's teamwork culture. Mosadeghrad[9]has stated that incoherent culture and compatibility account for 50% of the variation. Talib *et al.* [10] emphasised the importance of first impressions, which include effective food management, hygienic food and environment, confidence, treatment cost, patient focus, complaint resolution, and so on. According to Garg *et al.* [11], it is critical for healthcare organisations to manage staff retention in order to avoid intellectual loss and additional training costs for new employees. Sabry [12] discovered that training has the highest significant correlation with service quality, not infrastructure, which is assumed to be an existing facility. Dutta *et al.* [13], on the other hand, have focused on physical infrastructure such as beds, equipment, and dealing with emergency services. According to Talib *et al.*[14], India's healthcare sector needs to significantly expand in terms of the availability and quality of its physical infrastructure as well as human resources in order to meet rising demand and compete favourably with international standards.

The Research Process

Patients, Doctors, Nursing Staff, and Support Staff Management were the primary focus of study since the measuring instrument was developed for Indian hospitals. The Service Quality practises used by the hospital, doctors, and support staff, as well as how patients and their families perceived them, were investigated. The difference in service quality perceived by patients and received by them was investigated. Because the goal was to create a measurement instrument that could be used in hospital service operations, hospitals with at least 50 beds were considered. Doctors, nurses, paramedics, support staff, management, and patients were interviewed in person, and stakeholders were informed about the importance of this study.

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Expectations of patients discharged from the hospital, as well as their concerns and experiences, are documented. For strong and weak factor relationships, the model proposed by Shrivastava [15] was used. The goal of this study was to connect the Service Quality Critical Factors. After the constructs were found to be both reliable and valid, this correlation was examined. Sixty healthcare's attribute requirements for effective Service Quality practises and five constructs were generated from forty-three hospitals. The categorization process produced an instrument that was firmly rooted in literature. As a performance factor for service quality, the sixty requirements were referred to as dependent variables. Figure 1 depicts the flow chart for this research model."Service quality improvement approaches" and "productivity improvement approaches" are the dependent variables. Some of the outcomes derived from those dependent variables are cleanliness of the room, treatment and outcomes, preoperative advice by doctors, competent paramedical & support staff, patient privacy, service administration, reduced medicine administration errors, visible safety rules, facility for patient attendant, sense of being in safe hands, and regulations. Table 5 displays all of the attributes along with their PMs.

Factor analysis was used to check the content reliability and validity, as shown in Tables 1 and 2, and the communalities of attributes and their correlation, as shown in Tables 3 and 4. Internal consistency variable data was estimated using reliability coefficient such as Cronbach's alpha. According to Nunnally [16], a Cronbach's alpha value of 0.7 indicates good internal consistency. The overall Cronbach's alpha for independent variables was 0.939, indicating that the developed instrument was trustworthy. The KMO represents factors with eigenvalues of 1 and was found to be 0.636 to 0.777, which is greater than the minimum standard of 0.5, indicating sample adequacy for factor analysis and supporting the suitability of factor analysis to investigate the listed attributes. The Bartlett's test of sphericity was highly significant (p 0.000), rejecting the null hypothesis that the important twenty-seven characteristics are uncorrelated in the population. This indicates that there are enough samples for factor analysis [17].

RESULT AND DISCUSSION

This clarifies the total Variance. Component 1 accounted for 32.311 percent of the total 100 percent of 60 concurrent performance items. Similarly, components 3 and 5 contributed 6.85 and 3.39 percent of the total, respectively. The authors chose five factors that accounted for 78.63 percent of the total hundred percent. This was done based on a review of the literature and the worldwide acceptance of the Scree plot for this type of study. Scree plot suggested that those components that collectively constitute 50% of the total can be taken, while the remaining components have no significant contribution to the study and can be discarded. The authors, on the other hand, chose to represent the components, which included 27 of the 60 items under consideration.

CONCLUSION

Policy and decision makers in any hospital setting should evaluate the status of Service Quality Management. This paper will not only help hospital active stakeholders understand their patients' needs and requirements regarding services and performance quality, but it will also encourage them to implement practises they previously thought were unimportant for running their business. If the hospital considers all of the Service Quality performance attributes for implementation to improve customer satisfaction-service quality in terms of performance will be stable. The initial results of the measures were not encouraging because the gestation period is ordinarily 6-12 months. To corroborate the results for further improvement and to boost the number of customers the hospital must conduct extensive research in service areas.

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Table 1: Overall Reliability of all Independent variables

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.937	0.939	60

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Table 2: Extracted factors and reliability

SN	Name of Output Factors	No. of Items	Items removed	Cronbach α	KMO	Total variance explained by these factors
1	Social	14	10	0/803	0.738	3.160
2	Customer	14	08	0/826	0.696	3.010
3	Hospital Image	11	06	0.801	.0754	2.598
4	Treatment	08	03	0.798	0.733	2.318
5	Employee	13	06	0.861	0.690	2.832

Table 3: Communalities of Factor attributes

	PMs	Attribute:	Initial	Extraction
Factor-1	Societal performance	1.Customer Inclination	1.000	0.858
		2.Linkedtheory&Practice	1.000	0.919
		3.Errorfreeservice,treatment	1.000	0.957
		4.Serviceondemandwithminimaleffort&time	1.000	0.969
		5.IncreasedMarketvalueofHospital	1.000	0.997
		6.Recruitment&Retentionoftalent	1.000	0.854
		7.Minimumthroughputtime	1.000	0.952
		8. Structured authority	1.000	0.956
		9.24Hourpharmacy	1.000	0.864
		10.Returnofunuseddrug/medicine	1.000	0.898
		11.Duringstayathospital–promptnessofstaff	1.000	0.984
		12.Duringstayathospital –cleanliness of room	1.000	0.986
		13.Handrailsinaisles,rampdesignedforwheelchair	1.000	0.904
		14.Uninterrupted medical supplies service level	1.000	0.982
Factor-2	Customer satisfaction	15.Senseofbeinginsafehand	1.000	0.997
		16.Reduceddowntime	1.000	0.854
		17.Reducedupkeepcost	1.000	0.952
		18.IncreasedOperationflexibility	1.000	0.942
		19.Betteralignmentwithtask	1.000	0.917
		20.Problemsolving capability	1.000	0.961
		21.Handlingofunforeseen/unexpected condition	1.000	0.977
		22.Friendlydoctor'sstaff	1.000	0.962
		23.Explanationabouttreatmentandoutcomesbydoctor	1.000	0.979
		24.Doctorsexplainingthingsinawayyoucanunderstand	1.000	0.847
		25.Knowledgeofdoctor	1.000	0.874
		26.Righttimespentbydoctorwithyou	1.000	0.956
		27.Answeringyourquestionbydoctor	1.000	0.864
		28.Doctorexplainingmedicalconditiontoyou	1.000	0.898
Factor -3	Hospital Image	29.Promptsimpleandclearadmissionprocedure	1.000	0.984
		30.Reducedinvoicingerror	1.000	0.854

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31.Reducedpatientcomplaint	1.000	0.952
32.Effectivehouse-keeping&Laundryservice	1.000	0.917
33.CleanLobby&ward	1.000	0.961
34.Clear sign board with instruction & guidelines	1.000	0.977
35.Overallambience,hygiene,facility&safety	1.000	0.977
36. Facility for patient attendant	1.000	0.855
37.Fairmedicaltreatment	1.000	0.854
38.Facilitating the benefit received from supplier/ government	1.000	0.952
39. Ethical principle across the organization / segments of society	1.000	0.956

Table 4: Correlation of attributes

	Factor -1	Factor -2	Factor -3	Factor -4	Factor -5
9.24 Hour pharmacy	0.670**	0.439**	0.419**	0.360**	0.255**
11.During stay at hospital– promptness of staff attending call on demand	0.734**	0.339**	0.397**	0.340**	0.276**
12.During stay at hospital–cleanliness of room	0.801**	0.377**	0.419**	0.346**	0.270**
13.Handrails in aisles, ramp designed for wheel chair	0.726**	0.456**	0.465**	0.376**	0.205**
15. Sense of being in safe hand	0.393**	0.541**	0.433**	0.318**	0.194**
16.Reduceddowntime	0.287**	0.498**	0.324**	0.425**	0.283**
20.Problemsolving capability	0.378**	0.485**	0.261**	0.412**	0.183**
23.Explanation about treatment and out comes by doctor	0.225**	0.630**	0.308**	0.241**	0.241**
26.Right time spent by doctor with you	0.256**	0.567**	0.303**	0.266**	0.147**
28.Doctor explaining medical condition to you	0.244**	0.517**	0.339**	0.108*	0.153**
29.Prompt simple and 4 admission procedure	0.325**	0.426**	0.551**	0.318**	0.197**
32. Effective house-keeping & Laundry service	0.395**	0.267**	0.466**	0.236**	0.196**
33.CleanLobby&ward	0.422**	0.404**	0.576**	0.292**	0.170**
36. Facility for patient attendant	0.281**	0.216**	0.556**	0.207**	0.165**
39. Ethical principle across the organization / segments of society	0.133**	0.183**	0.423**	0.127*	0.184**
40. Medical advice and instruction during discharge by doctor	0.389**	0.439**	0.247**	0.613**	0.209**
41. Preoperative advice by doctors	0.211**	0.183**	0.182**	0.549**	0.164**
43. Ease of getting diagnostic test done	0.429**	0.419**	0.386**	0.583**	0.240**
46. Reduced medicine administration errors	0.266**	0.388**	0.302**	0.550**	0.393**
47. Fruitful treatment	0.222**	0.305**	0.214**	0.554**	0.294**

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48. Trained and qualified staff	0.120*	0.165**	0.137**	0.255**	0.310**
51. Competent paramedical & support staff	0.195**	0.274**	0.173**	0.184**	0.787**
52. Competency and skill of doctors	0.179**	0.132*	0.159**	0.073	0.654**
56. Applying new methods and techniques	0.370**	0.383**	0.354**	0.322**	0.661**
57. Increased efficiency of Hospital	0.136**	0.160**	0.142**	0.096	0.753**
58. Updated knowledge of technology & process	0.247**	0.308**	0.262**	0.318**	0.771**
59. Increased safety standard & procedure	0.335**	0.424**	0.369**	0.390**	0.694**

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

*.Correlation is significant at the 0.05 level (2-tailed).

Table 5: Critical factors and their significance

Sr. no.	Critical factors for Service Quality Improvement	Explanation of Critical Factors
1	Societal performance	Structured authority, Uninterrupted medical supplies, Minimum through put time, Linked theory and Practice, Retention of talent, Return of unused medicine, Promptness of staff, Error free treatment, 24 Hour pharmacy
2	Customer satisfaction	Problem solving capability, Friendly doctor's staff, Right time spent by doctor, Doctor explaining medical condition, Reduced upkeep cost, Doctor answering query – easy to understand, Handling of unexpected condition, Alignment with task, Sense of being in safe, Treatment and outcomes, 50% of the variation takes place just due to cultural in coherence, reporting errors without blame, open discussion about errors, statistical analysis of error data,
3	Hospital Image	Simpleandclearadmissionprocedure,Reducedpatientcomplaint,CleanLobby and ward, Reduced invoicing error, Effective house-keeping & Laundry service, Facility for patient attendant, Fair medical treatment, Over all ambience, hygiene, facility & safety, Ethical principle, Cleard is play with instruction &guidelines
4	Treatment	Preoperative advice by doctors, Reduced medication delays, Post-operative care, Clear information regarding rules and procedure, Fruitful treatment, Reduced medicine administration errors
5	Employee satisfaction	Trained and qualified staff, Use of Quality tools, Teamwork by doctors and nursing staff, Applying new methods and techniques, Increased safety standard&procedure,Concurrentapproachtoproblemresolution,Updatedknowledge of technology

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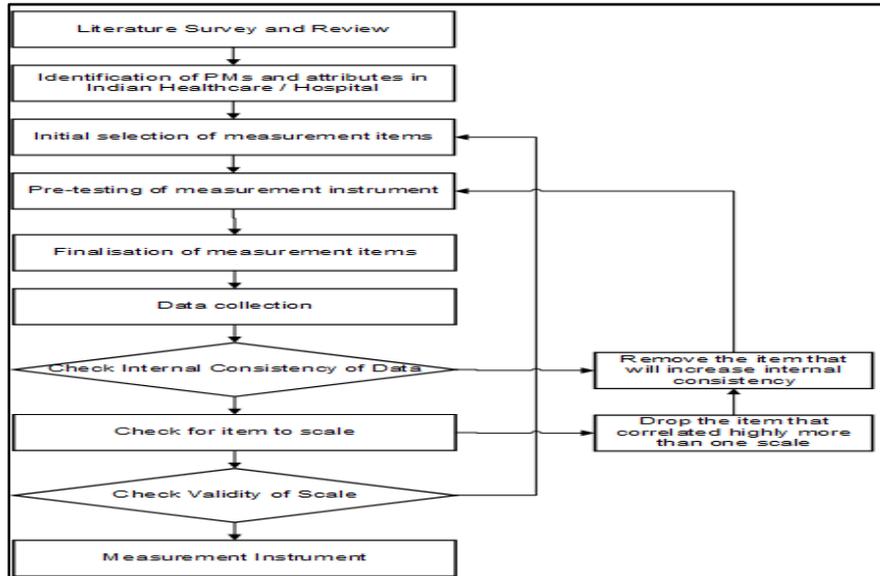
Figure1: Research process: Independent Variable Questionnaires Scanning For Measurement Instrument

RESEARCH ARTICLE

Impact of Digital Addiction on Cardiovascular Fitness in Collegiate Population

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ABSTRACT

The advancement in digital technology has made the work of humans easier resulting in its overuse. Digital overuse in the form of smartphone, digital gaming, and social networking has led to its addiction especially in the youths. This has affected them psychologically and physically making them sedentary. The decreased level of physical activity in the young generation has impaired their overall physical fitness. To study the effect of digital addiction on cardiovascular fitness among college going students.
30 college students were chosen according to the inclusion criteria. Digital addiction scale questionnaire was given to the participants and their cardiovascular fitness [VO_2 max]was assessed by 3-minute step test. Significant decline in the cardiovascular fitness [p = 0.019] was observed among the college going students with digital addiction as a negative relationship [r = -0.43] with pearson's correlation. It is understood that digital addiction among the collegiates negatively affects their level of cardiovascular fitness as these students showed decreased peak oxygen consumption levels.

Keywords: Digital addiction, smartphone, digital gaming, social networking, cardiorespiratory fitness

INTRODUCTION

The technological modification of mechanical and analogue devices to digital devices has led to development of a new era, the Digital Era. Digital devices are utilized in wide range of areas including education, banking, trading, social networking, child games and many more [1]. The usage of digital devices, most commonly, smartphones, television, computers, video games, etc are on a great rise [2]. Addiction can be defined as "An impulse dependent on a habit of a certain activity or substance use though it has destructive effects on the physical, social, emotional, and mental health of the individual" [3]. It is a monotonous behavior leading to harmful results on overall health of an individual. Digital Addiction is an impulse which leads to overuse of the digital devices to an extent that it directs the individual towards physical, psychological, emotional and social problems [1]. It can be present in many forms including smartphone addiction, game addiction, facebook addiction, internet addiction and social networking addiction [3]. In the last edition of DSM [Diagnostic and Statistical Manual of Mental Disorders], internet gaming disorder, a form of internet addiction is considered as a psychological problem. Montag *et al.,* stated that use of technology increases our productivity but its overuse can have deteriorating effects. Digital overuse has led to an atrophy of our social minds [4].

In social settings, particularly for the youths, the pressure to function digitally is high. Digital overuse can be an outcome of this 'Digital Functioning' pressure [5]. Duke and Montag identified 'Checking Habit' as a part of smartphone addiction is the brief repetitive look- over of the phone to watch for new content. It has proved to disturb the 'flow' of any important work which the individual is performing. They also highlighted that individuals check their smartphones every 18 minutes on an average [6]. Excessive use of digital devices has proved to be problematic for children as well as adolescents and adults. Digital addiction increases the risk of obesity, higher cholesterol levels in childhood, sleep disturbances, decreased cardiorespiratory fitness as a result of less physical activity, reduced time with parents and siblings, reduced creative imagination, etc. This is linked to increased cardiovascular risk at later age [2, 7].

Among the young adults, the easy accessibility and convenience experienced because of these digital devices, lead them to its overuse resulting in its addiction. Text messages, internet browsing, video conferencing, online surfing, games, camera, online shopping, media player, GPS, etc has made the younger generation totally dependent on digital media [8]. D. Blackwell *et al.,* stated that problems such as extraversion, neorocitism, attachment style and Fear of Missing Out [FOMO] are the predictors of social media addiction [9]. Excessive gaming on digital devices has proved to decrease the physical activity among the adolescents, leading to increased BMI resulting in obesity [10]. Studies by D. Smahel *et al.,* to understand the impact of digital media on children, help to identify that it leads to many physical and psychological consequences. Online gaming resulted in eye problems, headache, skipping meals, tiredness, etc[11]. Reduced physical activity among the college going students decreases their overall output. Decreased aerobic capacity, increased BMI and reduced endurance resulted in deteriorated health status among them [12].Digital overuse has made the young generation sedentary. Richa Rai *et al.,* stated that these sedentary individuals have significantly reduced level of physical fitness [13].

The haphazard use of digital technology resulting in digital addiction has become a topic of concern among the colligate population. In this competitive era, the young generation is constantly making efforts to excel in every field from education to technology. This is leading them to overuse of digital devices. Many studies have proved that digital addiction affects an individual psychologically. It deteriorates the psychological and physical well-being of the individual. As it is known that cardiovascular fitness affects the productivity and quality of life among the college going students, it becomes necessary to assess their fitness and improve it. There is dearth of studies which correlate digital addiction with physical fitness and hence serve for the need of the study. Thus, this study intended to evaluate the effect of addiction due to digital devices on cardiovascular fitness among college going students.

METHODOLOGY

This correlation study used convenience sampling technique. Data was collected from a total of 30 college going students. Both male and female collegiate between the age group 18 to 25 years of age, using digital devices such as smartphones, laptops in daily life, at least for 3 hours per day for 2 years, were included. Individuals with any cardiorespiratory, musculoskeletal or neurological disorders, who involved in any sport activities were excluded.

Procedure

Following the ethical clearance from institutional ethical committee, the subjects were selected on the basis of the selection criteria and an informed consent was taken from them for participation. Digital Addiction Scale questionnaire was given to the participants and then scoring was done for each of them[14]. 3-minute step test was performed to assess cardiovascular fitness of the participants through VO2 max calculation using heart rate. After this the results were analyzed[15].

RESULTS

The results of the study showed that the pearson's correlation coefficient value is $r = -0.43$. This depicts a negative correlation between digital addiction scale scores and VO2 max values for a college going individual. The level for significance was kept as $p = <0.05$. Considering the p value for this current study which is $p = 0.019$, it can be understood that the negative correlation achieved is statistically significant.

DISCUSSION

The present study was aimed at evaluating the concordance between the digital addiction and cardiovascular fitness among collegiate population. It is proved through our research that there is significant decline in the cardiovascular fitness among the students with digital addiction. Andrew *et al.,* in his study showed that as the digital screen use increases, the sedentary behavior pattern is observed to be accelerated among these individuals. This leads to reduced physical activity and thus it causes depletion in the peak oxygen consumption [VO2 max] in these individuals. Moreover, as the frequency of digital use varies accordingly there is a change in the level of physical fitness [16]. Digital addiction resulting in diminished physical activity further causes an elevated level of fat mass and decreased level of muscle mass in these college going students. This is considered as a rationale to the reduced cardiovascular fitness among these individuals [7]. Maya Samaha *et al.,* in a study proved that smartphone addiction among individuals have led to a surge in the levels of psychological stress and a poor level of satisfaction with life [17].

Kathrin *et al.,* in their study showed that increase in the level of psychological stress, reduced or poor quality of sleep and declined psychological well-being gives rise to elevated fatigue in the body, as it disturbs the responses from hypothalamic-pituitary-adrenal axis [HPA axis] in the body. This physiological rationale serves as an explanation to decreased physical activity and ultimately a reduction in cardiovascular fitness [18]. Internet addiction, gaming addiction, social networking addiction, etc involve a major part of digitally addicted population. These forms of digital addiction are increasing the level of tiredness and eventually impact the demanding physical activity which is lessened. D Smahel *et al.,* in their study have said that this overuse of digital gadgets affects both mental as well as physical health. They further added that these negative impacts on physical and mental health are interconnected between each other affecting the overall cardiovascular fitness of the individuals [11]. Many studies have also been conducted to evaluate the effect of gaming addiction on physical activity among young adults. These studies represented similar results in the form of negative correlation between both [3, 11]. Generation Z or the internet generation showed a higher level of time spent on digital devices rather than physical activity, inducing various musculoskeletal problems and obesity among them. This again causes decreased cardiovascular fitness [1, 10].

Surging up of the digital overuse has led to elevated cholesterol levels and high levels of fasting insulin, ultimately resulting in lower cardiovascular fitness [2].

CONCLUSION

With the results of our present study and keeping in view all the recent evidences, it is understood that digital addiction causes a deteriorated cardiovascular fitness among college going students as a result of decline in peak oxygen consumption levels [VO2max] due to reduced physical activity and sedentary lifestyle.

Limitations
Particular digital device of addiction was not considered.
Whether device was used for leisure activities or academic activities was not considered.

Recommendations
Digital addiction's effects on health among adult and middle-aged population can be done.

Source of Fund
Self

Conflict of Interest
None

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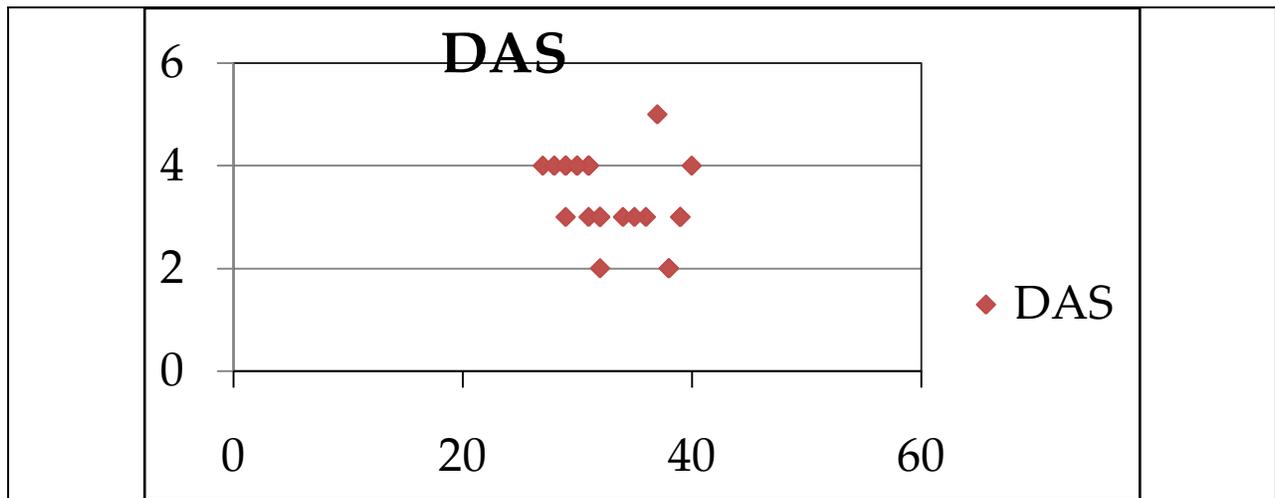
Fig.1 Graph represents the interpretation of relationship between digital addiction and cardiovascular fitness levels of the participants. X-axis denotes VO$_2$ max values of the individuals, while Y- axis denotes the corresponding digital addiction scores.

RESEARCH ARTICLE

Assessment of the Performance of Kisan Credit Card Scheme among the Farmers: An Exploratory Study in the Region of Bangalore Rural District

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ABSTRACT

The kisan Credit Card scheme is a very popular and widely used agricultural promotion scheme of India. Since the scheme introduced in the year 1998 it has served many farmers by proving many benefits for crop productional improvement. An exploratory data was collected from the farmers of Bangalore rural district to know how many are using the scheme and how are benefited from KCC. The data was also collected to assess how banks are taking part in this scheme to help farmers by providing credit facilities to farmers. The information related to farmers membership and its rate of improvement towards the scheme was also studied. The factors which influence the farmers to avail the card and problems in availing the card by the farmers were identified. Some of the measures to overcome these problems were also suggested to improve the accessibility of the scheme in the study region.

Keywords: agricultural, farmers, problems, improvement, scheme, kisan

INTRODUCTION

Agriculture is the main occupation of the country. The majority of population in India are dependent on agriculture for living their life. At the same time there is lot of difficulty faced by farmers due to gradual development of service sector and technical upgradation in all most all the sectors of the economy. Due to these radical developments happening in other sectors of the economy, agriculture is facing problem in its sustainability. In order to overcome these challenges of agricultural sector and to maintain sustainability in agriculture the Government of Karnataka has

introduced various agricultural promotion schemes. One among those popular schemes is Kisan Credit Card. The plan Kisan credit card was begun in August 1998 to giveideal and bother free credit for the creation necessities of the farmers. The primary motivation behindthe plan was to meet the creation as the need might arise of the farmers. It works within giving monetary help to the farmers to meet their credit needs according to creation, utilization as well as other united exercises all through the year as and when required. Credit help is expected by a rancher for a few purposes. This can be with the end goal of developmentof the yields starting from making the land cultivable, trailed by developing the land, planting, supporting the yields, utilizing manures and pesticides and so on till the crop harvests. (Hardarshan Kaur, 2018)

NABARD planned aKisan Charge card scheme for uniform reception by the banks sothat the farmers might utilize the card to buy agriculture inputs, for example, seeds, composts,pesticides and so on and draw cashfor their production needs. The model plan was flowed to

Commercial Banks, Co-operative Banks and Regional RuralBanks in August 1998. It is proper to concentrate on the effect ofthis plan since it has finished over multi decade.(A. M. SAJANE, 2011)Thus,the current

REVIEW OF LITERATURE

The 'Kisan Credit Card' (KCC) scheme was presented in August 1998 by GoI. NABARD formed the plan for uniform reception by banks so ranchers can utilize the card for their cash credit need and buy sources of info like seeds, manures, pesticides and furthermore permit them to pull out some money for meeting their other harvest creation related necessities. It is multi credit item framework by offering ranch business visionaries, single credit extension through a solitary window for numerous reasons. The plan is quicker coursed through every business bank, agreeable banks and Provincial Rustic Banks in the country. It means to give crop advances up to Rs. 3 lakhs to ranchers at a loan cost of 2% each year. The KCC plot is hugely benefited to ranchers in Western Maharashtra. Reimbursement period depends on the reaping and promoting of harvests for which the credit sum was taken out.(Patil, 2021)

The examination was led in Latur and Osmanabad locale of the Marathwada districtduring the year 2020 and 2021 which was chosen purposively based on most extreme number ofKisan Charge card Plan recipient ranchers. Ex-post-facto research configuration was taken on in this study. The information was gathered with the assistance of pretested interview plan from the respondents also, investigated by utilizing Pearson's coefficient of relationship, various relapse examination and Way examination. It was seen from relationship investigation that instruction, yearly pay, occupation, landholding, social cooperation and augmentation contact were emphatically and essentially related with the effect of KCC Plan while wellsprings of data, financial inspiration, risk direction and information were positive and exceptionally critical relationship with the effect of KCC Plan. According to way investigation, it was seen that, wellsprings of data, expansion contact, training, information, land holding, yearly pay, social support, age, occupation and chance direction were significant factors without any which free factors can't impact the effect of KCC Plan on its recipients.(D. D. Nigade, 2022)

Credit accessibility is the pivotal contribution for working on the presentation and efficiency of the horticulture area. The principal objective of the study was to know the Issues and difficulties before the reception of KCC Plan by rancher families and how much this plan prevails with regards to settling the past issues and difficulties. The examination configuration utilized in the current review was Enlightening and Exploratory in nature which means to figure out the wellsprings of money when the reception of KCC Plan selected by rancher families for profiting the credit to satisfy the capital prerequisite of agribusiness and exercises united to farming. The current review uncovers huge positive change in inclination of wellspring of credit after the reception of KCC Plan with medium impact. The recipient ranchers moved from Non-Institutional to Institutional wellsprings of credit after the reception of KCC Plan. The plans like Kisan Charge card changed the situation of provincial credit in India.(Shubham Pratap Singh, 2022)

An examination was completed during the year 2017-2018 for the current concentrate in the main phase of testing two (2) block viz.; Medziphema and Chumukdima were chosen, absolute 85 respondents were consulted, out of

that80 respondents were chosen on both classifications viz.; 40 KCC recipients, 40 non-recipients and 5 quantities of banking personals for their viewpoints and issue looked in giving the KCC credit. The current review features the effect of the speculation scope of the chose factors viz; saving, time, bother, decreased, functional, ampleness inthe future against the sources of info chose to help better benefit through three expected factors as a profit. The premier imperatives looked by the KCC recipients is accounted for the issue of tracking down the underwriter,followed by acquiring reasonable security and association of such a large number of delegates in promoting channels; though,the financiers additionally confronted the recuperation level of credit as greatest test under thelimitations.(Promela Bhattacharjee, 2021)

The Regional Rural Bank assumes a significant part to give monetary help to the ranchersthrough carrying out the KCC conspire. This study has assessed the presentation of Territorial Country Banks'parts of two distinct areas for example Damoh region, Sagar Locale of M.P. in light of the dispensed measure of advance and late sum. under the KCC plot between the year 2018-19 and 2019-20. The information has been gathered from the Provincial Office of RRB for directing this review. At last, analysts inferred that the execution of the Provincial Country Banks of the two locales for example Damoh area, Sagar Locale in the term of the dispensed measure of credit and past due sum are impacted unfavourably in light of the fact that the two sums are developing dynamically.(Udit Malaiya, 2021)

Objectives of the study
1. To review the effect of Demographic factors on choosing Kisan Credit Card.
2. To analyse the difficulties faced by farmers in accessing Kisan Credit Card.

METHODOLOGY
In respect of the study the data was collected from 100 farmers in Bangalore rural district. A structured questionnaire was prepared and data collected by interviewing each farmer individually.

Analysis
Discriminant Analysis
Discriminant analysis is a predictive model that discriminates the subgroups in a group based on linear combinations. Logarithmic determinants decide the differentiation level. In this analysis, two sets data are used and they are, Attributes of KCC and the difficulties of accessing KCC. In both cases, chi square determines the hypothesis selection.
Hypothesis Ho1 : There is no significant effect of demographic variables on choosing KCC.

Effect of age on choosing KCC
Hypothesis Ho1a: There is no significant effect of age on choice of KCC
Independent variables: attributes of KCC

The model shows that there Wilki's lambda is near to 1 and chi square is not statistically significant. This shows that the age is not influencing the analysis of KCC attributes before choosing the scheme. It means, all age group analyse the attributes and take decision. There is no variation in it. Low interest rate, easy accessing of credit, post-harvest expenses of scheme have higher function coefficients and they are more influenced by age. Support from the bank and availability of loan are important.

The model shows that there Wilki's lambda is near to 1 and chi square is not statistically significant. This shows that the age is not influencing the choice of Kisan Credit card scheme. It means, all age group analyse the attributes and take decision. There is no variation in it. short term credit requirements for cultivation of crops, post-harvest expenses, working capital for maintenance of farm assets and activities allied to agriculture, Investment credit requirement for agriculture and allied activities are immediate benefits of Kisan Credit card.

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In both cases, F test was not statistically significant for Box M Test for both funds and their attributes. Similarly, Chi-square in Wilki' test is also not significant.
Hence null hypothesis accepted.

Hence, the hypothesis H01a, null hypothesis selected
Effect of Gender on choosing KCC decisions
Both Box M and Wlki's lambda are statistically insignificant. So there is no effect of number of people engaged in agriculture on analysing the attributes of Kisan Credit Card. Null hypothesis accepted
Hence, the hypothesis H01b , null hypothesis selected that there is no significant effect of gender engaged in agriculture on source of funds

Effect of number of people engaged in agricultureon choosing KCC
Hence, the hypothesis H01c , alternate analysis is selected for the choosing KCC.
Effect of source of income on attribute of choosing KCC:
Both Box M and Wlki's lambda are statistically significant. So, there is an effect of source of income on analysing the attributes of Kisan Credit Card. Null hypothesis accepted.

FINDINGS

The important demographic factor age has no significant effect of choosing Kisan credit card by the farmers. Because the age where the farmers start their farming is from 20 and up to 60 years, they can do farming. But from the data collected and the Box's M analysis it reveals that the age of the farmers has given homogeneous response for choosing Kisan Credit card for their anticultural practices. The test result of Box's M with respect to age and choosing KCC is 0.351.
In the same way Wilks' Lambda shows the statistical result of 0.992 which is not having significant effect of age on choosing KCC.
Hence, from the above analysis the null hypothesis is accepted.

The second most important demographic variable gender also has no significant effect on choosing KCC.
The Box's M result shows that 0.629 is the significant effect of gender with choosing KCC. It is more than 0.05, hence the null hypothesis is accepted. That is theirconsistent effect of gender on choosing KCC. Usually, in India most of the people engaged in farming are male rather than female, due to many families oriented and natural conditions female are not involved much in farming. Even though the choice of KCC is not depended on the gender, because the card is very important for farmers in doing farming and get many benefits of it irrespective of gender.
The statistical test result of Wilks' Lambda .629, there is no significant effect of gender on choosing KCC. Hence the null hypothesis is accepted.

The third demographic variable number of people engaged in farming is having a very significant effect on choosing farming. The statistical result of Box's M analysis shows 0.000. From this result it is clear that the there is a significant effect of number of people engaged in farming with choosing KCC. The wilks' Lambda also has given a result of .041, and has significant effect of number of people and choice of KCC. When there is a smaller number of people involved in farming i.e., less than 4 people their choice of KCC is high and vice versa. The determinants like banks issuing KCC and online procedure of obtaining KCC are having high significant effect (18.5 and 14.9) on choosing KCC by the farmers. The variable repayment after harvest is having moderate effect of 11.551 on choosing KCC. The remaining variables like low interest rate, documents required to obtain KCC, Access of card in ATM's, digital renewal of the card are having less significant effect of 3.584, 1.839, 6.287, 8.99 respectively on choosing KCC by the farmers.

Hence the alternate hypothesis is selected foe choosing KCC.

The alternate hypothesis is source of income with choosing KCC:

The Box's M and Wikis' Lambda testes for this hypothesis is having significant effect on choosing KCC. Box's M result for this test is 0.029 and Wikis' Lambda for the same is 0.013. It is less than 0.05, hence this hypothesis is accepted. The source of income has a major role in choosing KCC, the people getting more income from agriculture prefers to obtain KCC more because they know the importance of KCC and they are getting many benefits from it.

The people getting more income from service sector other than agriculture are preferring less because KCC is not very important for them to get more income since they are already earning more income from service sector. The income earned from other sources are very less explored the use of KCC, because they are not expecting more income from agriculture and they does not required to use KCC. The farmers are highly choosing KCC because they are obtaining good support from agricultural officer at banks, the knowledge of loan availability and proper guidance on availing it. The farmers also feel that the timely availability of loan is moderately important determinant for selecting KCC for their agricultural purposes.

The support from bank and withdrawal facility of KCC has less impact on farmers foe choosing KCC. Difficulties faced by farmers related to their demographic factors: The demographic variable like marital status is not having significant effect on difficulties faced by farmers. But with regard to Lack of the proper management for withdraws on kisan credit card and Lack of proper knowledge about loan is having significant effect. The variable age is having significant effect on Lack of proper knowledge about loan and Illiteracy of farmers. Other difficulties are not having relationship with the age of farmers. The occupation variable is having significant effect on only one difficulty faced by farmers. That is Lack of awareness about the benefits of scheme. Education is having significant effect on Untimely available of loan, Bribe for taking the loan on card and Lack of awareness about the benefits of scheme. Other difficulties are not impacted by the education of farmers.

Experience is having effect on Lack of availability of the agriculture Officer in the Bank. The variables work, self-farming, Income, Awareness, Government support and family size are not having any significant effect on the difficulties faced by the farmers.

CONCLUSION

Farmers are dealing with numerous issues in utilizing KCC, lack of education of farmers, a lot of crowds in the bank for withdrawals and need of the appropriate administration for withdraws on Kisan credit card. The farmers recommended that some arrangement like isolated data accommodate KCC holder for withdraws, appropriate data given by the official in nearby language, KCC give the advance on time, officer ought to utilize the cordial behaviour with KCC holder and officer shouldn't utilize the bribe on making KCC, Bank director ought to give the appropriate data about KCC scheme. Accurate record of all the transactions happening through the KCC has to be recorded properly to track the cards benefits to the farmers and its repayment. This can be done through the proper pass book management by the banks.

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Table.1. Log Determinants

Age	Rank	Log Determinant
20-30 years	7	-5.114
30-40 years	7	-4.441
40-50 years	7	-4.460
50-60 years	7	-5.113
Pooled within-groups	7	-4.552

The ranks and natural logarithms of determinants printed are those of the group covariance matrices.

Table 2. Test Results

Box's M		91.501
F	Approx.	1.052
	df1	84
	df2	168934.889
	Sig.	.351

Tests null hypothesis of equal population covariance matrices.

Table 3. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.945	25.112	21	.242
2 through 3	.992	3.639	12	.989
3	.999	.506	5	.992

Table 4. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.965	15.772	18	.608
2 through 3	.990	4.613	10	.915
3	.998	.827	4	.935

Table 5. Test Results

Box's M		60.517
F	Approx.	.932
	df1	63
	df2	173554.452
	Sig.	.629

Tests null hypothesis of equal population covariance matrices.

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Table 6. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.977	10.290	6	.113

Table 7. Test Results

Box's M		60.517
F	Approx.	.932
	df1	63
	df2	173554.452
	Sig.	.629

Table 8. Test Results

Box's M		63.545
F	Approx.	2.232
	df1	28
	df2	689774.267
	Sig.	.000

Table 9. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.943	12.288	7	.041

Table 10. Classification Function Coefficients

	Number of People	
	Less than 4	More than 4
Low interest rate of 7%	3.584	3.399
Documents required to get KCC	1.839	1.899
Banks issuing KCC	18.181	18.562
Online procedure of obtaining KCC	15.400	14.946
Access of Card in ATMs	6.287	6.567
Digital renewal of the card	8.990	8.909
Repayment after harvest	11.551	11.434
(Constant)	-108.902	-108.593

Fisher's linear discriminant functions

Number of people engaged in agriculture has an effect on attributes of the Kisan Credit Card.

Table 11. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.877	22.290	6	.013

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Table 12. Test Results

Box's M		360.517
F	Approx.	2.332
	df1	63
	df2	773554.452
	Sig.	.029

Tests null hypothesis of equal population covariance matrices.

Table 13. Classification Function Coefficients

	Source of Income		
	Agriculture	Service	Others
Support from bank	1.653	1.732	1.565
Timely availability of loan	4.553	4.551	4..235
Withdraw facility of KCC	2.936	2.753	2.332
Guidance on obtaining card	5.632	5.122	5.171
Support from agricultural officer	5.963	5.663	5.725
Knowledge of loan availability	5.652	5.598	5.345
(Constant)	-30.950	-30.724	-30.265

Fisher's linear discriminant functions

Table 13. Difficulties faced by farmers in accepting KCC:

Variable	Test	Lack of support by the bank	Untimely available of loan	Lack of the proper management for withdraws on kisan credit card	Lack of the proper guidance for Getting kisan credit card	Bribe for taking the loan on card	Lack of availability of the agriculture Officer in the Bank	Lack of proper knowledge about loan	Illiteracy of farmers.	Lack of awareness about the benefits of scheme
Marital Status	H0/H1	H0	H0	H1	H0	H0	H0	H1	H0	H0
	Chi Square value	3.723	4.033	22.448	2.748	4.678	5.919	19.289	7.113	13.574
	Significance	0.881	0.854	0.004	0.949	0.586	0.656	0.013	0.524	0.094
Age	H0/H1	H0	H0	H0	H0	H0	H0	H1	H1	H0
	Chi Square value	7.036	5.348	10.238	9.663	12.614	9.97	22.475	23.786	10.55
	Signific	0.855	0.945	0.595	0.645	0.181	0.619	0.033	0.022	0.56

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	H0/H1	H0	H0	H0	H0	H0	H0	H0	H1
Occupation	Chi Square value	6.107	2.11	8.32	7.69	2.43	4.876	6.5	5.6	19.8
	Significance	0.635	0.9	0.39	0.46	0.86	0.771	0.584	0.684	0.011
Education	H0/H1	H0	H1	H0	H0	H1	H0	H0	H0	H1
	Chi Square value	12.48	56.34	2.57	3.68	1.16	14.9	2.4	2.9	39.2
	Significance	0.71	0	1	0.99	0	0.52	1	1	0.001
Work	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	4.8	4.6	2.3	5.18	2.5	7.49	1.6	0.86	1.6
	Significance	0.3	33	0.68	0.26	0.45	0.112	0.8	0.93	0.8
Self-farming	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	2.2	0.59	2.13	3.6	4.6	1.7	0.59	5	1.7
	Significance	0.68	0.96	0.711	0.45	0.19	0.78	0.96	0.23	0.78
Family Size	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	0.445	1.5	1.56	2.7	4.14	1.13	1.92	3.66	2.17
	Significance	0.979	0.824	0.815	0.59	0.24	0.889	0.75	0.45	0.7
Experience	H0/H1	H0	H0	H0	H0	H0	H1	H0	H0	H0
	Chi Square value	7.43	8.4	3.3	6.1	13.3	57.7	5.2	2	8.1
	Significance	0.82	0.75	0.99	0.91	0.14	0	0.95	0.99	0.77
Income	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	2.7	3.9	3	2.6	9.8	2.3	3.8	6.2	7.1
	Significance	0.97	0.86	0.92	0.8	0.13	0.97	0.86	0.62	0.51
Awareness	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	4.7	2.2	5.7	1.4	1.44	1.8	1.4	4.6	1.9

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	Significance	0.31	0.69	0.22	0.83	0.69	0.7	0.83	0.32	0.74
Government Support	H0/H1	H0	H0	H0	H0	H0	H0	H0	H0	H0
	Chi Square value	4.7	2.2	5.7	1.4	1.44	1.8	0.47	3.44	3.31
	Significance	0.31	0.69	0.22	0.83	0.69	0.76	0.97	0.48	0.5

RESEARCH ARTICLE

Deteriorating Inventory Items with Quadratic Time Dependent Demand with Shortage Cost Under Trade Credits: A Fuzzy Approach

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ABSTRACT

In this study, we established an inventory model for deteriorating items with quadratic time dependent demand with shortage cost under trade credits in crisp and fuzzy provisions. We have to determine the optimum cycle time, optimum relevant profit and optimal order quantity under two various situations i.e. for Case I; the credit period is less than the cycle time for settling the account and for Case II; the credit period is greater than or equal to the cycle time for settling the account. The working out of these formulas for optimal time, optimal profit and economic order quantity (EOQ) are established. For this anticipated model, we provide a numerical example and sensitivity analysis.

Keywords: Inventory, Deteriorating Items, Holding Cost, Deteriorating Cost, Ordering Cost, Shortage Cost, Quadratic time – Dependent Demand, Credit Period, Trade Credits – Defuzzification – Graded Mean Integration method.

INTRODUCTION

Inventory management is a perilous component of the supply chain. It is the tracking of inventory from industrialists to warehouses and from these facilities to a point of sale. The aim of inventory management is to have the correct products in the correct place at the correct time. Inventory management plays a vital role in the supply chain management because a company must balance the customer demand with storage space and cash restrictions.
The main purpose of inventory management is to determine the optimal amount and various types of input

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products, products in process and finished products, smoothing production and sales procedures and optimizing costs by keeping them at an optimal level. Inventory is a very significant quality for any company. This is explained as the collection of goods used in manufactured or completed goods held by a company. A software system for tracking inventory levels of the orders, sales and deliveries of goods at any time. It can also be used in production to generate a bill of materials and other production-related documents. Shortage is also known as stock out costs, this is the payment that arises from an out of stock situation. This can include assessable expenses such as the cost of furthered shipping, buying last minute from another dealer, or loss of the margin on incomplete sales. These also include costs that are hard to quantify such as loss of customer assurance or loss of customers, idle employees and loss in goodwill.

In 2016, Sharmila and Uthayakumar investigated that an inventory model with three rate of production rate under stock and time demand for time varying deterioration rate with shortage. In 2017, Shital patel coined that the production inventory model for deteriorating items with different deterioration rates under stock and price dependent demand and shortage under inflation and permissible delay in payments. In 2012, Sachin Kumar, Pawan Kumar and Manju Saini established that an order level inventory model for deteriorating items with quadratic demand rate and variable holding cost. In 2020, Jayanthi and Yasotha Nanthini, discovered that the production inventory model with allowed shortages with a fuzzy approach.In 2004, Samanta and Ajanta Roy invented that a deterministic inventory model of deteriorating items with two rates of production and shortages.In 2020, Jayanthi and Yasotha Nanthini framed that the fuzzy production inventory model for deterioration items with shortages and lead time using penalty cost. In 1995, Aggarwal and Jagg established the ordering policies of deteriorating items under permissible delay in payments. In 1985, Goyal formulated an EOQ under condition of permissible delay in payments. In 1996, Giri and Chaudhuri demonstrated that an EOQ model for deteriorating item with time varying demand and costs. Here we find an inventory model for deteriorating items with quadratic time dependent demand with shortage cost both in a crisp and fuzzy notion. From this model we determine the optimal cycle time, profit and order quantity are derived.

METHODOLOGY

Trapezoidal Fuzzy Number
A trapezoidal fuzzy number $\tilde{A}$= (a, b, c, d) is represented with membership function $\mu_{\tilde{A}}$ as follows:

$$\mu_A(x) = \begin{cases} 0, & x > d \\ \dfrac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b \leq x \leq c \\ \dfrac{d-x}{d-c}, & c \leq x \leq d \end{cases}$$

Graded Mean Integration Method
If $\tilde{A} = \left(a_1, a_2, a_3, a_4\right)$ is a trapezoidal fuzzy number then the graded mean integration representation of $\tilde{A}$ is,

$$p\left(\tilde{A}\right) = \frac{a_1 + 2a_2 + 2a_3 + a_4}{6}$$

Notations and Assumptions
This mathematical model is derived on the basis of the following notations and assumptions.

Notations

$D = D(t) = l + mt + n\,t^2;\ l > 0,\ m > 0,\ 0 \leq n \leq 1$; the annual demand

O   : the ordering cost per order

P   : the unit purchase cost

S   : the unit selling price

r   : the backlogging cost per unit quantity per unit time

θ : the deterioration rate

Q   : the order quantity

C   : the permissible credit period offered by the supplier to the retailer for

Settling the account

I_c :interest rate at which the interest is charged

I_e:interest rate at which the interest is earned

I(t)   : inventory level at any instant of time

T   :replenishment cycle time

$H_i(T)$:total profit per unit time; i = 1,2

Q_i^*:Optimal order quantity; i = 1,2 for Case I and Case II respectively

T_i^* : Optimal replenishment cycle time; i = 1,2

$H_i(T_i^*)$: Optimal profit per unit time; i = 1,2

$\tilde{O}$: the fuzzy ordering cost per order

$\tilde{p}$: the fuzzy unit purchase cost

$\tilde{S}$: the fuzzy unit selling price

$\tilde{r}$: the fuzzy backlogging cost per unit quantity per unit time

$\tilde{Q}$:   the fuzzy order quantity

$\tilde{Q}_i^*$: Fuzzy optimal order quantity; i = 1,2 for Case I and Case II respectively

$\tilde{T}_i^*$:Fuzzy optimal replenishment cycle time; i = 1,2

$\tilde{H}_i(T_i^*)$: Fuzzy optimal profit per unit time; i = 1,2

Assumptions

- The inventory system under consideration treats with the specific products.
- Innumerable planning horizon.
- The demand of the product is a linear increasing function of time.
- Allowed Shortages.
- Zero Lead time.
- Continuously reviewed inventory.
- The retailer can deposit generated sales revenue in an interest bearing account during the permissible credit period.

  At the end of the period, the retailer settlesthe account for allthe units sold keeping the difference for day to day expenditure and paying the interest charges on the unsold items in the stock.

Model Formulation

Proposed Inventory Model in Crisp Environment

From the notations and assumptions, we obtain the optimal cycle time, optimal relevant profit and optimal order quantity for the below said inventory model for deterioration items with quadratic time dependent demand under trade credits with shortages in crisp provision.

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The inventory level I(t) reduces to meet the demand and deterioration. The differential equation leading the rate of change of inventory at any time t is given by,

$$\frac{dI(t)}{dt} + \theta\, I(t) = -D(t), \quad 0 \leq t \leq T \tag{1}$$

With the initial condition I (0) = Q and boundary condition I(T) = 0 ------------- (2)

The solution of (1) is given by,

$$I(t) = \frac{1}{\theta}\left(l - \frac{m}{\theta} + \frac{2n}{\vartheta^2}\right)\left(e^{\theta(T-t)} - 1\right) + \frac{1}{\theta}\left(m - \frac{2n}{\theta}\right)\left(Te^{\theta(T-t)} - t\right) + \frac{n}{\theta}\left(T^2\, e^{\theta(T-t)} - t^2\right) \tag{3}$$

And the order quantity Q is given by,

$$Q = \frac{1}{\theta}\left(l - \frac{m}{\theta} + \frac{2n}{\vartheta^2}\right)\left(e^{\theta T} - 1\right) + \frac{1}{\theta}\left(m - \frac{2n}{\theta}\right)\left(Te^{\theta T}\right) + \frac{n}{\theta} T^2\, e^{\theta T} \tag{4}$$

The total profit per unit time of inventory system consists of the following:

Ordering Cost

$$OC = \frac{O}{T} \tag{5}$$

Sales Revenue

$$SR = \frac{S}{T}\int_0^T D(t)\, dt$$

$$SR = S\left(l + \frac{mT}{2} + \frac{nT^2}{3}\right) \tag{6}$$

Deterioration Cost

$$DC = \frac{p}{T}\left[Q - \int_0^T D(t)\, dt\right]$$

$$DC = \frac{p}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(e^{\theta T} - 1\right) + \left(m - \frac{2n}{\theta}\right)Te^{\theta T} + nT^2\, e^{\theta T} - lT - \frac{mT^2}{2} - \frac{nT^3}{3}\right] \tag{7}$$

Holding Cost

$$HC = \frac{h}{T}\int_0^T I(t)\, dt$$

$$HC = \frac{h}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - T\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2}\right) + nT^2\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3}\right)\right] \tag{8}$$

Shortage Cost

$$SC = \frac{r}{T}\int_0^T I(t)\, dt$$

$$SC = \frac{r}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - T\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2}\right) + nT^2\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3}\right)\right] \tag{9}$$

There are two cases arising by considering interest charged and interest received based on length of T and C.

Case: 1 C< T

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The interest charged per unit time for above case is,

$$IC = \frac{pI_c}{T} \int_C^T I(t)\, dt$$

$$IC = \frac{pI_c}{\theta T}\left[\begin{array}{l}\left(l - \dfrac{m}{\theta} + \dfrac{2n}{\theta^2}\right)\left(\dfrac{e^{\theta(T-C)}-1}{\theta}\right) + \left(m - \dfrac{2n}{\theta}\right)T\left(\dfrac{e^{\theta(T-C)}-1}{\theta}\right) + nT^2\left(\dfrac{e^{\theta(T-C)}-1}{\theta}\right) \\[2mm] -\left(l - \dfrac{m}{\theta} + \dfrac{2n}{\theta^2}\right)(T-C) - \left(m - \dfrac{2n}{\theta}\right)\left(\dfrac{T^2 - C^2}{2}\right) - n\left(\dfrac{T^3 - C^3}{3}\right)\end{array}\right]$$ --------------

(10)

During [0, C] merchantretails the goods and deposits the revenue into an interest earning account at the rate I_e per unit per year. Therefore, the interest earned IE_1 per unit time is given by,

$$IE_1 = \frac{S I_e}{T} \int_0^C D(t)\, t\, dt$$

$$IE_1 = \frac{S I_e C^2}{T}\left[\frac{l}{2} + \frac{mC}{3} + \frac{nC^2}{4}\right]$$ -------------- (11)

Hence, the total profit $H_1(T)$ of an inventory system per unit time is,

$$H_1(T) = SR + IE_1 - OC - DC - HC - IC - SC$$ -------------- (12)

Substitute the values of SR, IE_1, OC, DC, HC, IC and SC in equation (12) and solving by using truncated Taylor's series for approximating the exponential function, we get,

$$e^{\theta T} = 1 + \theta T + \frac{\theta T^2}{2}\ \text{etc,}$$

$$e^{\theta(T-C)} = 1 + \theta T - \theta C$$

$$\begin{aligned}H_1(T) = {} & lS + \left(\frac{mS}{2} - \frac{lp\theta}{2} - \frac{np}{\theta} - \frac{lh}{2} - \frac{lpI_c}{2} + \frac{2mpI_c}{\theta} - \frac{2npI_c}{\theta^2} - \frac{rl}{2}\right)T + \\ & \left(\frac{nS}{3} - \frac{mp\theta}{2} + \frac{np}{2} - \frac{mh}{2} + \frac{nh}{3\theta} - \frac{mpI_c}{2} + \frac{nI_c p}{3\theta} - \frac{rm}{2} + \frac{rn}{3\theta}\right)T^2 - \frac{n}{2}(h + p\theta + r)T^3 \\ & + \frac{lC^2}{2T}(SI_e - pI_c) + \left(mSI_e - \frac{nI_c p}{\theta}\right)\frac{C^3}{3T} + \frac{nSI_e C^4}{4T} + pC\left(lI_c - \frac{2nI_c}{\theta^2} + 2nI_c\right) \\ & + pI_c C^2\left(\frac{nI_c}{\theta} - \frac{mI_c}{2}\right) + nI_c pCT^2 + pI_c CT\left(m - \frac{n}{\theta}\right) - \frac{nI_c p}{2}C^2 T - \frac{O}{T}\end{aligned}$$ ---------------- (13)

Case II: T ≤ M

Hence the merchantretails $D(t)t$ – units in all by the termination of the cycle time and has $pD(t)\, t$ to pay the dealer in complete by the termination of the credit period C. Hence the interest charges,

IC = 0   ------------------ (14)

The interest earned per unit time is

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$$IE_2 = SI_e \left[(l + mT + nT^2)C - \left(\frac{l}{2} + \frac{2mT}{3} - \frac{3nT^2}{4} \right)T \right]$$

------------------ (15)

Hence the total profit $H_2(T)$ of an inventory system per unit time is,

$$H_2(T) = SR + IE_2 - OC - DC - HC - SC$$

---------------- (16)

Substitute the values of SR, IE_1, OC, DC, HC and SC in equation (16) and solving by using truncated Taylor's series for approximating the exponential function, we get,

$$e^{\theta T} = 1 + \theta T + \frac{\theta T^2}{2} \text{ etc,}$$

$$e^{\theta(T-C)} = 1 + \theta T - \theta C$$

$$H_2(T) = S\left(l + \frac{mT}{2} + \frac{nT^2}{3} \right) + SI_e \left[(l + mT + nT^2)C - \left(\frac{l}{2} + \frac{2mT}{3} - \frac{3nT^2}{4} \right)T \right] - \frac{O}{T}$$

$$- \frac{p}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2} \right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta} \right)Te^{\theta T} + nT^2 e^{\theta T} - lT - \frac{mT^2}{2} - \frac{nT^3}{3} \right]$$

$$- \left(\frac{h}{\theta T} + \frac{r}{\theta T} \right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2} \right)\left(\frac{e^{\theta T} - 1}{\theta} - T \right) + \left(m - \frac{2n}{\theta} \right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2} \right) + nT^2 \left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3} \right) \right]$$

--------------- (17)

Determination of Optimal Solutions

To determine the optimal solution for the problem, we maximize H(T) for case I and case II respectively and then compare them to obtain maximum value. Our aim is to find the maximum average profit per unit time for both the cases w.r.to T. The necessary and sufficient condition to maximize $H_1(T)$ and $H_2(T)$ for given values of T are respectively.

$$\frac{dH_1}{dT} = 0, \qquad \frac{dH_2}{dT} = 0 \qquad and \qquad \frac{d^2 H_1}{dT^2} < 0, \qquad \frac{d^2 H_2}{dT^2} < 0$$

Differentiating equation (13) w.r.to T, we get,

$$\frac{dH_1(T)}{dT} = \left(\frac{mS}{2} - \frac{lp\theta}{2} - \frac{np}{\theta} - \frac{lh}{2} - \frac{lpI_c}{2} + \frac{2mpI_c}{\theta} - \frac{2npI_c}{\theta^2} - \frac{rl}{2} \right) -$$

$$2\left(\frac{nS}{3} - \frac{mp\theta}{2} + \frac{np}{2} - \frac{mh}{2} + \frac{nh}{3\theta} - \frac{mpI_c}{2} + \frac{nI_c p}{3\theta} - \frac{rm}{2} + \frac{rn}{3\theta} \right)T - \frac{3n}{2}(h + p\theta + r)T^2 - \frac{lC^2}{2T^2}(SI_c - pI_c)$$

$$- \left(mSI_e - \frac{npI_c}{\theta} - \frac{rq}{\theta} \right)\frac{C^3}{3T^2} - \frac{nSI_eC^4}{4T^2} + 2nI_c pcT + pI_cC\left(m - \frac{n}{\theta} \right) - \frac{nI_c pC^2}{2} \frac{O}{T^2}$$

--------------- (18)

$$\frac{dH_1(T)}{dT} = 0$$

Again differentiate equation (18) w.r.to T, we get,

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$$\frac{d^2 H_1(T)}{dT^2} = 2\left(\frac{nS}{3} - \frac{mp\theta}{2} + \frac{np}{2} - \frac{mh}{2} + \frac{nh}{3\theta} - \frac{mpI_c}{2} + \frac{nI_c p}{3\theta} - \frac{rm}{2} + \frac{rn}{3\theta}\right)$$

$$-3n(h+p\theta+r) + \frac{lC^2}{T^3}(SI_c - pI_c) + \left(mSI_e - \frac{npI_c}{\theta}\right)\frac{2C^3}{3T^4} + \frac{nSI_e C^4}{2T^3} + 2nI_c pC - \frac{2O}{T^3} < 0$$

--------------- (19)

Differentiate equation (17) w.r.to T, we get,

$$\frac{dH_2(T)}{dT} = S\left(l + \frac{m}{2} + \frac{2nT}{3}\right) + SI_e\left[(l+m+2nT)C - \left(\frac{l}{2} + \frac{4m}{3} - \frac{9nT^2}{4}\right)\right] + \frac{O}{T^2}$$

$$+ \frac{p}{\theta T^2}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)e^{\theta T} + 2nT e^{\theta T} - l - \frac{2mT}{2} - \frac{3nT^2}{3}\right]$$

----(20)

$$+ \left(\frac{h}{\theta T^2} + \frac{r}{\theta T^2}\right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - 1\right) + \left(m - \frac{2n}{\theta}\right)\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{2}\right) + 2nT\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{3}\right)\right]$$

$$\frac{dH_2(T)}{dT} = 0$$

Again differentiate equation (20) w.r.to T, we get,

$$\frac{d^2 H_2(T)}{dT^2} = S\left(\frac{2n}{3}\right) + SI_e\left[(2n)C - \left(\frac{9nT}{2}\right)\right] - \frac{2O}{T^3}$$

$$- \frac{2p}{\theta T^3}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)e^{\theta T} + 2nT e^{\theta T} - l - \frac{2mT}{2} - \frac{3nT^2}{3}\right]$$

$$- \left(\frac{2h}{\theta T^3} + \frac{2r}{\theta T^3}\right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - 1\right) + \left(m - \frac{2n}{\theta}\right)\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{2}\right) + 2nT\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{3}\right)\right] < 0$$

------------- (21)

Proposed Inventory Model in Fuzzy Environment

From the notations and assumptions, we obtain the optimal cycle time, optimal relevant profit and optimal order quantity for the inventory model for deterioration items with quadratic time dependent demand under trade credits with shortages in fuzzy provisions.

The inventory level I(t) depletes to meet the demand and deterioration. The differential equation leading the rate of change of inventory at any time t is given by,

$$\frac{dI(t)}{dt} + \theta I(t) = -D(t), \quad 0 \le t \le T \tag{-------------- 22}$$

With the initial condition I (0) = Q and boundary condition I(T) = 0   -------------- (23)

The solution of (22) is given by,

$$I(t) = \frac{1}{\theta}\left(l - \frac{m}{\theta} + \frac{2n}{\vartheta^2}\right)(e^{\theta(T-t)} - 1) + \frac{1}{\theta}\left(m - \frac{2n}{\theta}\right)(Te^{\theta(T-t)} - t) + \frac{n}{\theta}(T^2 e^{\theta(T-t)} - t^2) \tag{---------- 24}$$

And the order quantity Q is given by,

$$Q = \frac{1}{\theta}\left(l - \frac{m}{\theta} + \frac{2n}{\vartheta^2}\right)(e^{\theta T} - 1) + \frac{1}{\theta}\left(m - \frac{2n}{\theta}\right)(Te^{\theta T}) + \frac{n}{\theta}T^2 e^{\theta T} \tag{------------ 25}$$

The total profit per unit time of inventory system consists of the following:

Fuzzy Ordering Cost

$$O\widetilde{C} = \frac{\widetilde{O}}{T}$$ ------------- (26)

Fuzzy Sales Revenue

$$S\widetilde{R} = \frac{\widetilde{S}}{T}\int_0^T D(t)\,dt$$

$$S\widetilde{R} = \widetilde{S}\left(l + \frac{mT}{2} + \frac{nT^2}{3}\right)$$ --------------- (27)

Fuzzy Deterioration Cost

$$D\widetilde{C} = \frac{\widetilde{p}}{T}\left[Q - \int_0^T D(t)\,dt\right]$$

$$D\widetilde{C} = \frac{\widetilde{p}}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)Te^{\theta T} + nT^2 e^{\theta T} - lT - \frac{mT^2}{2} - \frac{nT^3}{3}\right]$$ --------------- (28)

Fuzzy Holding Cost

$$H\widetilde{C} = \frac{\widetilde{h}}{T}\int_0^T I(t)\,dt$$

$$H\widetilde{C} = \frac{\widetilde{h}}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - T\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2}\right) + nT^2\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3}\right)\right]$$ --------- (29)

Fuzzy Shortage Cost

$$S\widetilde{C} = \frac{\widetilde{r}}{T}\int_0^T I(t)\,dt$$

$$S\widetilde{C} = \frac{\widetilde{r}}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - T\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2}\right) + nT^2\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3}\right)\right]$$ ----------- (30)

There are two cases arising by considering interest charged and interest received based on length of T and C.

Case: 1C< T

The interest charged per unit time for above case is,

$$I\widetilde{C} = \frac{\widetilde{p}I_c}{T}\int_C^T I(t)\,dt$$

$$I\widetilde{C} = \frac{\widetilde{p}I_c}{\theta T}\left[\begin{array}{l}\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta(T-C)} - 1}{\theta}\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta(T-C)} - 1}{\theta}\right) + nT^2\left(\frac{e^{\theta(T-C)} - 1}{\theta}\right) \\ -\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(T - C) - \left(m - \frac{2n}{\theta}\right)\left(\frac{T^2 - C^2}{2}\right) - n\left(\frac{T^3 - C^3}{3}\right)\end{array}\right]$$

------------- (31)

During [0, C] retailer sells the product and deposits the revenue into an interest earning account at the rate I_e per unit per year. Therefore, the interest earned IE_1 per unit time is given by,

$$I\widetilde{E}_1 = \frac{\widetilde{S}\,I_e}{T} \int_0^C D(t)\,t\,dt$$

$$I\widetilde{E}_1 = \frac{\widetilde{S}\,I_e\,C^2}{T}\left[\frac{l}{2} + \frac{mC}{3} + \frac{nC^2}{4}\right]$$

-------------- (32)

Hence, the total profit H₁(T) of an inventory system per unit time is,

$$\widetilde{H}_1(T) = S\widetilde{R} + I\widetilde{E}_1 - O\widetilde{C} - D\widetilde{C} - H\widetilde{C} - I\widetilde{C} - S\widetilde{C}$$

-------------- (33)

Substitute the values of SR, IE₁, OC, DC, HC, IC and SC in equation (33) and solving by using truncated Taylor's series for approximating the exponential function, we get,

$$e^{\theta T} = 1 + \theta T + \frac{\theta T^2}{2} \text{ etc,}$$

$$e^{\theta(T-C)} = 1 + \theta T - \theta C$$

$$\widetilde{H}_1(T) = l\widetilde{S} + \left(\frac{m\widetilde{S}}{2} - \frac{l\widetilde{p}\theta}{2} - \frac{n\widetilde{p}}{\theta} - \frac{l\widetilde{h}}{2} - \frac{l\widetilde{p}I_c}{2} + \frac{2m\widetilde{p}I_c}{\theta} - \frac{2n\widetilde{p}I_c}{\theta^2} - \frac{\widetilde{r}l}{2}\right)T +$$

$$\left(\frac{n\widetilde{S}}{3} - \frac{m\widetilde{p}\theta}{2} + \frac{n\widetilde{p}}{2} - \frac{m\widetilde{h}}{2} + \frac{n\widetilde{h}}{3\theta} - \frac{m\widetilde{p}I_c}{2} + \frac{nI_c\widetilde{p}}{3\theta} - \frac{\widetilde{r}m}{2} + \frac{\widetilde{r}n}{3\theta}\right)T^2 - \frac{n}{2}\left(\widetilde{h} + \widetilde{p}\theta + \widetilde{r}\right)T^3$$

$$+ \frac{lC^2}{2T}\left(\widetilde{S}I_e - \widetilde{p}I_c\right) + \left(m\widetilde{S}I_e - \frac{nI_c\widetilde{p}}{\theta}\right)\frac{C^3}{3T} + \frac{n\widetilde{S}I_eC^4}{4T} + \widetilde{p}C\left(lI_c - \frac{2nI_c}{\theta^2} + 2nI_c\right)$$

$$+ \widetilde{p}I_cC^2\left(\frac{nI_c}{\theta} - \frac{mI_c}{2}\right) + nI_c\widetilde{p}CT^2 + \widetilde{p}I_cCT\left(m - \frac{n}{\theta}\right) - \frac{nI_c\widetilde{p}}{2}C^2T - \frac{\widetilde{O}}{T}$$

---------------- (34)

Case II: T ≤ M

Hence the retailer sells D(t)t – units in all by the end of the cycle time and has pD(t) t to pay the supplier in full by the end of the credit period C. Hence the interest charges,

IC = 0   ----------------- (35)

The interest earned per unit time is

$$I\widetilde{E}_2 = \widetilde{S}I_e\left[(l + mT + nT^2)C - \left(\frac{l}{2} + \frac{2mT}{3} - \frac{3nT^2}{4}\right)T\right]$$

---------------- (36)

Hence the total profit H₂(T) of an inventory system per unit time is,

$$\widetilde{H}_2(T) = S\widetilde{R} + I\widetilde{E}_2 - O\widetilde{C} - D\widetilde{C} - H\widetilde{C} - S\widetilde{C}$$

---------------- (37)

Substitute the values of SR, IE₁, OC, DC, HC and SC in equation (37) and solving by using truncated Taylor's series for approximating the exponential function, we get,

$$e^{\theta T} = 1 + \theta T + \frac{\theta T^2}{2} \text{ etc,}$$

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$$e^{\theta(T-C)} = 1 + \theta T - \theta C$$

$$\widetilde{H}_2(T) = \widetilde{S}\left(l + \frac{mT}{2} + \frac{nT^2}{3}\right) + \widetilde{S}I_e\left[(l + mT + nT^2)C - \left(\frac{l}{2} + \frac{2mT}{3} - \frac{3nT^2}{4}\right)T\right] - \frac{\widetilde{O}}{T}$$

$$- \frac{\widetilde{p}}{\theta T}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)Te^{\theta T} + nT^2 e^{\theta T} - lT - \frac{mT^2}{2} - \frac{nT^3}{3}\right]$$

$$- \left(\frac{\widetilde{h}}{\theta T} + \frac{\widetilde{r}}{\theta T}\right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - T\right) + \left(m - \frac{2n}{\theta}\right)T\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{2}\right) + nT^2\left(\frac{e^{\theta T} - 1}{\theta} - \frac{T}{3}\right)\right]$$

--------------- (38)

Determination of Optimal Solutions

To find the optimal solution for the problem, we maximize H(T) for case I and case II respectively and then compare them to obtain maximum value. Our aim is to find the maximum average profit per unit time for both the cases w.r.to T. The necessary and sufficient condition to maximize $H_1(T)$ and $H_2(T)$ for given values of T are respectively.

$$\frac{dH_1}{dT} = 0, \qquad \frac{dH_2}{dT} = 0 \qquad and \qquad \frac{d^2 H_1}{dT^2} < 0, \qquad \frac{d^2 H_2}{dT^2} < 0$$

Differentiating equation (34) w.r.to T, we get,

$$\frac{d\widetilde{H}_1(T)}{dT} = \left(\frac{m\widetilde{S}}{2} - \frac{l\widetilde{p}\theta}{2} - \frac{n\widetilde{p}}{\theta} - \frac{l\widetilde{h}}{2} - \frac{l\widetilde{p}I_c}{2} + \frac{2m\widetilde{p}I_c}{\theta} - \frac{2n\widetilde{p}I_c}{\theta^2} - \frac{\widetilde{r}l}{2}\right) -$$

$$2\left(\frac{n\widetilde{S}}{3} - \frac{m\widetilde{p}\theta}{2} + \frac{n\widetilde{p}}{2} - \frac{m\widetilde{h}}{2} + \frac{n\widetilde{h}}{3\theta} - \frac{m\widetilde{p}I_c}{2} + \frac{nI_c\widetilde{p}}{3\theta} - \frac{\widetilde{r}m}{2} + \frac{\widetilde{r}n}{3\theta}\right)T - \frac{3n}{2}\left(\widetilde{h} + \widetilde{p}\theta + \widetilde{r}\right)T^2 - \frac{l\widetilde{C}^2}{2T^2}\left(\widetilde{S}I_c - \widetilde{p}I_c\right) \text{---------- (39)}$$

$$- \left(m\widetilde{S}I_e - \frac{n\widetilde{p}I_c}{\theta} - \frac{\widetilde{r}q}{\theta}\right)\frac{\widetilde{C}^3}{3T^2} - \frac{n\widetilde{S}I_e\widetilde{C}^4}{4T^2} + 2nI_c\widetilde{p}\widetilde{c}T + \widetilde{p}I_c\widetilde{C}\left(m - \frac{n}{\theta}\right) - \frac{nI_c\widetilde{p}\widetilde{C}^2}{2}\frac{\widetilde{O}}{T^2}$$

$$\frac{dH_1(T)}{dT} = 0$$

Again differentiate equation (39) w.r.to T, we get,

$$\frac{d^2\widetilde{H}_1(T)}{dT^2} = 2\left(\frac{n\widetilde{S}}{3} - \frac{m\widetilde{p}\theta}{2} + \frac{n\widetilde{p}}{2} - \frac{m\widetilde{h}}{2} + \frac{n\widetilde{h}}{3\theta} - \frac{m\widetilde{p}I_c}{2} + \frac{nI_c\widetilde{p}}{3\theta} - \frac{\widetilde{r}m}{2} + \frac{\widetilde{r}n}{3\theta}\right)$$

$$- 3n\left(\widetilde{h} + \widetilde{p}\theta + \widetilde{r}\right) + \frac{l\widetilde{C}^2}{T^3}\left(\widetilde{S}I_c - \widetilde{p}I_c\right) + \left(m\widetilde{S}I_e - \frac{n\widetilde{p}I_c}{\theta}\right)\frac{2\widetilde{C}^3}{3T^4} + \frac{n\widetilde{S}I_e\widetilde{C}^4}{2T^3} + 2nI_c\widetilde{p}\widetilde{C} - \frac{2\widetilde{O}}{T^3} < 0$$　　-------------- (40)

Differentiate equation (38) w.r.to T, we get,

$$\frac{d\widetilde{H}_2(T)}{dT} = \widetilde{S}\left(l + \frac{m}{2} + \frac{2nT}{3}\right) + \widetilde{S}I_e\left[(l + m + 2nT)C - \left(\frac{l}{2} + \frac{4m}{3} - \frac{9nT^2}{4}\right)\right] + \frac{\widetilde{O}}{T^2}$$

$$+ \frac{\widetilde{p}}{\theta T^2}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)e^{\theta T} + 2nTe^{\theta T} - l - \frac{2mT}{2} - \frac{3nT^2}{3}\right]$$

$$+ \left(\frac{\widetilde{h}}{\theta T^2} + \frac{\widetilde{r}}{\theta T^2}\right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - 1\right) + \left(m - \frac{2n}{\theta}\right)\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{2}\right) + 2nT\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{3}\right)\right]$$

------------- (41)

$$\frac{dH_2(T)}{dT} = 0$$

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Again differentiate equation (41) w.r.to T, we get,

$$\frac{d^2\tilde{H}_2(T)}{dT^2} = \tilde{S}\left(\frac{2n}{3}\right) + \tilde{S}I_e\left[(2n)\tilde{C} - \left(\frac{9nT}{2}\right)\right] - \frac{2\tilde{O}}{T^3}$$

$$- \frac{2\tilde{p}}{\theta T^3}\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)(e^{\theta T} - 1) + \left(m - \frac{2n}{\theta}\right)e^{\theta T} + 2nT\,e^{\theta T} - l - \frac{2mT}{2} - \frac{3nT^2}{3}\right] \qquad \text{-------------- (42)}$$

$$- \left(\frac{2\tilde{h}}{\theta T^3} + \frac{2\tilde{r}}{\theta T^3}\right)\left[\left(l - \frac{m}{\theta} + \frac{2n}{\theta^2}\right)\left(\frac{e^{\theta T} - 1}{\theta} - 1\right) + \left(m - \frac{2n}{\theta}\right)\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{2}\right) + 2nT\left(\frac{e^{\theta T} - 1}{\theta} - \frac{1}{3}\right)\right] < 0$$

Numerical Example

Numerical Example in Crisp Sense:

Example: 1

Case: I

S = 1500, l = 10, m = 0.5, n = 0.2, M = 73/365, Θ = 0.4, h = 5, s = 50, p = 30, O = 250, I_c = 0.5, I_e = 0.4 and r = 0.5 in approximate units. Optimal Cycle Time T = T_1^* = 2.8459 years, Optimal total relevant profit $H_1(T) = H_1^*(T)$ = Rs. 31,243.84 and Optimal order quantity = Q = Q_1^* = 8,369.7860 units.

Example: 2

Case: II

S = 1000, l = 10, m = 0.5, n = 0.2, M = 75/365, Θ = 0.4, h = 5, s = 40, p = 30, O = 150, I_e = 0.4 and r = 0.5 in approximate units. Optimal Cycle Time T = T_2^* = 1.567 years, Optimal total relevant profit $H_2(T) = H_2^*(T)$ = Rs. 11,654.902 and Optimal order quantity = Q = Q_2^* = 4498.643 units.

Numerical Example in Fuzzy Sense

Example:1

Case: I

$\tilde{S}$ = (1300, 1500, 1700, 1900), l = 10, m = 0.5, n = 0.2 , M = 73/365, θ = 0.4, $\tilde{h}$ = (4,5,6,7), s = 50, $\tilde{p}$ = (20,30,40, 50), $\tilde{O}$ = (200, 250, 300,350), I_c = 0.5, I_e = 0.4 and $\tilde{r}$ = (0.4,0.5,0 .6,0.7) in approximat e units. Optimal Cycle Time $T = T_1^*$ = 2.6789 years, Optimal total relevant profit $H_1(T) = H_1*(T)$ = Rs. 30,435.46 and Optimal order quantity $= Q = Q_1* = 8,178.5870$ units

Example: 2

Case: II

$\tilde{S}$ = (800, 1000, 1200, 1400), l = 10, m = 0.5, n = 0.2 , M = 75/365, θ = 0.4, $\tilde{h}$ = (4,5,6,7), s = 40, $\tilde{p}$ = (20,30,40, 50), $\tilde{O}$ = (100, 150, 200,250), I_e = 0.4 and $\tilde{r}$ = (0.4,0.5,0 .6,0.7) in approximat e units. Optimal Cycle Time $T = T_2^*$ = 1.4890 years, Optimal total relevant profit   **5.** $H_2(T) = H_2*(T)$ = Rs.11,425.79 and Optimal order quantity $= Q = Q_2* = 4,328.731$ units

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Sensitivity Analysis
Sensitivity Analysis In Crisp Sense
Sensitivity Analysis For Case I

S.No	S	T_1^*	$H_1^*(T)$ (Rs.)	$Q_1^*(T)$ (units)
1.	1000	2.6450	29,436.91	8,285.1236
2.	1500	2.8459	31,243.84	8,369.7860
3.	2000	3.0847	33,862.98	8,450.4392
4.	2500	3.1329	35,690.23	8,576.9542
5.	3000	3.3768	37,823.45	8,710.2349

Sensitivity Analysis for Case II

S.No	S	T_2^*	$H_2^*(T)$ (Rs.)	$Q_2^*(T)$ (units)
1.	500	1.3242	8,430.57	4209.3263
2.	1000	1.5672	11,654.02	4498.6435
3.	1500	1.7641	13,659.23	4743.3896
4.	2000	1.9983	15,721.86	4961.2988
5.	2500	2.1346	16,946.54	5102.9537

Sensitivity analysis in Fuzzy Sense

Sensitivity Analysis for Case I

S.No	S	T_1^*	$H_1^*(T)$ (Rs.)	$Q_1^*(T)$ (units)
1.	$\widetilde{S} = (1100, 1300, 1500, 1700)$	2.6512	28,213.19	7,985.1246
2.	$\widetilde{S} = (1300, 1500, 1700, 1900)$	2.6789	30,435.46	8,178.5870
3.	$\widetilde{S} = (1500, 1700, 1900, 2100)$	2.8887	31,746.23	8,211.8213
4.	$\widetilde{S} = (1700, 1900, 2100, 2300)$	3.0329	33,890.15	8,454.9711
5.	$\widetilde{S} = (1900, 2100, 2300, 2500)$	3.2865	35,714.29	8,623.8640

Sensitivity Analysis for Case II:

S.No	S	T_2^*	$H_2^*(T)$ (Rs.)	$Q_2^*(T)$ (units)
1.	$\widetilde{S} = (600, 800, 1000, 1200)$	1.2789	8,273.75	4198.142
2.	$\widetilde{S} = (800, 1000, 1200, 1400)$	1.4890	11,425.79	4328.731
3.	$\widetilde{S} = (1000, 1200, 1400, 1600)$	1.6548	13,274.31	4601.376
4.	$\widetilde{S} = (1200, 1400, 1600, 1800)$	1.8999	15,224.12	4888.925
5.	$\widetilde{S} = (1400, 1600, 1800, 2000)$	2.0921	16,123.03	5102.9537

CONCLUSION

In this study, we investigate an inventory model for deteriorating items with quadratic dependent demand rate with shortage cost under trade credits in both crisp and fuzzy principles. Here we unveiling the numerical solution for manipulating the result of optimal cycle time, optimal order quantity and optimal total relevant profit in both crisp and fuzzy forms. From the sensitivity analysis we coined that the results are quite sensitive with respect to the discrepancy of different parameters. Truncated Taylor's series expansion is used for finding the closed form of this optimal solution. For future studies, we apply the fuzzy provisions for all the parameters and relate the result among the crisp and fuzzy forms.

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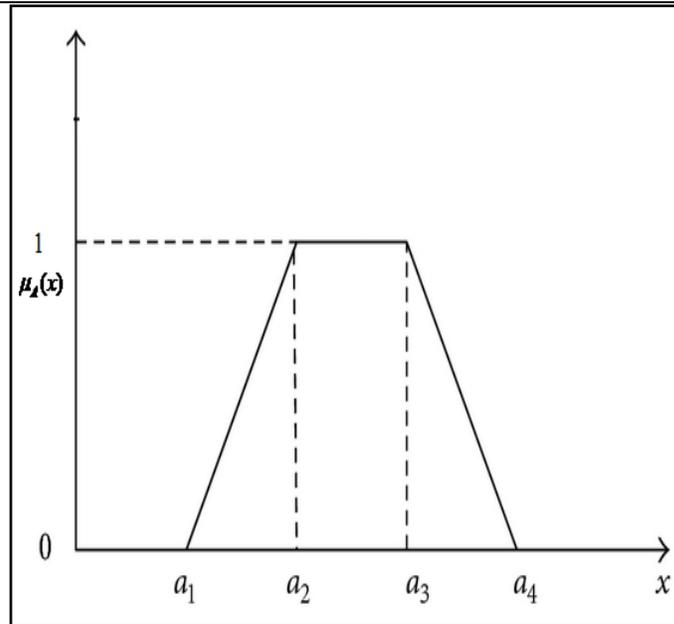
Figure 1. Trapezoidal Fuzzy Numbers

RESEARCH ARTICLE

CI-IDS: Crowd Intellect-based Approach for Intrusion Detection in Wireless Sensor Networks

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ABSTRACT

Cyberattacks and network intrusions pose the greatest threat to Cloud computing service providers. With the increasing sophistication of cyberattacks, traditional detection methods like manual inspection or basic rules-based analysis are no longer sufficient. Constructing an automated Intrusion Detection system at network entry points using a swarm intelligence (SI)-based machine learning model (ML) is crucial for effectively countering cyber threats. Numerous fields of study are now using SI in tandem with ML. Whether or not an IDS needs to be able to pick out useful qualities from noisy data is debatable. We proposed a CI-IDS framework to avoid the crowd-intellect-based approach for Intrusion Detection (IDS) in Wireless Sensor Networks (WSN). The improved ant colony optimization (IACO) is proposed to decrease the amount of noise in IDS models. Compared to the existing LEACH algorithm, the proposed method has been used with Clustering, IACO with Hash Table (HT). It balances the energy consumption while increasing network lifetime by picking an adaptive gateway node. According to the study and NS-2 simulation analysis, CIDS beat the LEACH method regarding energy cost, packet delivery ratio, and throughput.

Keywords: Cyber Attacks, CI-IDS, Hash Table, IACO, WSN

INTRODUCTION

The core of every swarm intelligence system is many basic agents interacting with one another and their surroundings [1]. Many of the models developed in artificial life are built on "swarms" of fundamental agent rules that may generate a higher-level identity, much like the behaviour of a colony of insects [2]. The application developed to simulate the cooperative behaviour of social insects is called swarm intelligence [3]. An autonomous agent is a subsystem that operates relatively autonomously from all other agents in its environment, likely made up of other agents [4]. The self-directed agent doesn't care about following orders or having a grand plan [5]. The Ant system is one such swarm intelligence technique that helps with optimization issues. Some characteristics of artificial ants [6] are not seen in real ants.

The term "Wireless Sensor Network" (WSN) refers to a system in which inexpensive, low-powered computing devices (sensor nodes) are interconnected through radio and are equipped with sensors to measure ambient conditions such as temperature and humidity [7]. They consist of many individuals and tiny sensors with low power, computing, and networking capacities [8-12]. Several applications need the management and use of wireless sensor nodes due to the unattended operation of many sensor nodes. Encryption and other authentication procedures only give a decent level of protection against attacks from remote-class outsiders [13]. This is because once an insider is admitted to a network, they have complete control over any communications passing through that network, including the ability to alter, conceal, or eavesdrop on those communications [14]. To circumvent this, we use intrusion detection systems to monitor for unauthorized access attempts [15].

Because of the unique communication pattern of wireless sensor networks, sinkhole attacks are not impossible [16]. Each sensor node transmits data back to a central hub. If even one hacked sensor node can establish a reliable connection to the central hub, all nodes in the immediate area are vulnerable to attack. As a result of a severe attack known as a sinkhole, the base station cannot collect complete and accurate sensing data, putting higher-layer applications at risk [17]. Unfortunately, sinkhole attacks are difficult to detect because user authentication and signed routing information aren't sufficient to stop compromised nodes from sending signed routing packets with phoney data [18-20]. Without generating false positives, the proposed method for intrusion detection using Improved Ant Colony Optimization can send warnings from sensor nodes based on the node IDS in the rule set. In addition, an IACO-based approach stores log n keys at each notified sensor node to authenticate the suspect list. Light Weight Intrusion Detection Architecture (LIDEA) uses a one-way hash chain function technique to determine which node is under attack, which reduces the amount of data that must be stored at each sensor node given relevant information.
The remaining sections are as follows; in Section 2, existing intrusion detection methods are proposed by various authors. Section 3 discussed the proposed CI-IDS model, Section 4 discussed experimental results, and the conclusion in section 5.

Background Study

A.Mehmood *et al.* [1] KB-IDS was mainly concerned with analyzing events produced by various nodes inside a WSN. Everything that goes on at the control centre was recorded in a database. A single node in every cluster was given the role of leader. As soon as to establish a connection with the base station, the CHs begin sending event data to the knowledge base through inference engines. The work of the KB-IDS falls on a single node in the cluster. Additionally, traffic was watched, and CHs that keep tabs on the different types of events were able to prevent any malicious ones from being made by an attacker node. C. Ioannou *et al.* [3] the Binary Logical Regression (BLR) statistical method to classify local sensor activity as benign or malicious to detect malicious behaviour within a sensor node. The authors demonstrated that the BLR's accuracy ranges between 88 and 99 percent when trained for a specific attack. F. Selahshoor *et al.* [5] the authors proposed the negative selection algorithm (NSA) approach in this study to lower the false alarm rate (FAR) and increase the real positive rate. Based on the sample density, the radius of the self-sample was changed. The proposed method significantly reduces the number of false alerts.

G. G. Gebremariam *et al.* [7], the most energy-efficient and maintainable wireless sensor networks were hierarchical. To create a reliable IDS for WSNs, this study will use a machine learning and decision tree-based categorization approach. Every sensor node reports back to the cluster master on the health of its components. Once the data has been analyzed, the cluster leader will send it forward. The cluster node and the sink node use machine learning using the tree model for attack detection. S. Putty *et al.* [15] This study delves deeply into intrusion detection approaches in WSNs. To begin, a brief explanation of the IDS working method was provided. Furthermore, the characteristics of various attacks were described in this study. Several previously established security breach countermeasures were also discussed. U. Ghugar and J. Pradhan [17] This model incorporates a system for identifying the bad actor in the event of a black hole attack. The findings and discussion demonstrate that as the number of nodes grows, the Detection Accuracy (DA) and the False Alarm Rate (FAR) drop, indicating that our system will serve as a better model for black hole attacks. V. T. Alaparthy and S. D. Morgera [19] An IDS was based on the body's defence mechanisms and looked at all the factors that might affect a WSN's efficiency. While this method was developed with WSNs in mind, it may be adapted to meet the needs of other networks with limited resources.

System Methodology

The proposed method has developed the sensors to identify the location of each sensor on the sink node. The total expected delivery is computed as an average of the packet's surface speed (and the speed of each path's respective sink) at the surfacing time. A node located more than any transmission range away from other nodes will send all packets straight to the sink. The diagram in Figure 1 illustrates the operating principle of the CA-IDS. It takes an SN an additional time to get to the CH, during which it may gather data. Thus, the overall delay should include the extra time delay as well.

1. The distance between intra-cluster nodes and CHs will be sorted in decreasing order by Sensor Node (SN). The greater the propagation delay, the sooner the nodes send data packets.
2. The SN moves along its waypoints to collect data from the sensor nodes.
3. When it comes to WSN latency and energy consumption, the overall quantity of energy and time needed for the SN and sensor nodes to do their jobs is important. With this transmission architecture, sending and receiving data securely to and from the node and any SN within the transmission range is possible without fearing data mistakes.

Network Model

Data is gathered by the sensor nodes and then sent to the CHs. The disadvantages of multi-hop networks (such as unbalanced energy consumption, unreliable communication links, and long end-to-end delays) are reduced by using intra-cluster networks via one hop. Data is transmitted to SN after SN connects to the CH. Once SN has enough data, it will return to the sink node and transfer it to the data centre.

1) The network's sensor nodes are considered to be stable. SN may potentially use location algorithms to learn about places all around the world.
2) Communication distances are expected to be no higher than d0, which modem specification determines.

Each of these issues is crucial. To create an evaluation parameter to measure the trade-off between energy consumption and network throughput, this paper confirmed this previously-disputed hypothesis.

Intra-Cluster Communication

The Cluster Member nodes collect App-specific data from the ocean environment for the Sensing period (Si) duration. While data was being sensed, the Non-CH Nodes were in sleep mode, and the CH Node was awake, listening to the channel. The two phases of inter-cluster communication are data collecting and CH notification at the end of Si. The intra-cluster maximum propagation delay duration is how long all Non-CH nodes are listening on the channel. Once the time elapses, the nodes send their Data Packet. Data packet composition includes the CH ID, sensed data while Si, and residual energy at the sending node. The CH node receives Data Packets and sends Ack Packets to all Cluster Member nodes. Non-CH node: After receiving the Ack Packet, it sleeps. To ensure that every Non-CH node can send data to the CH node before it goes to sleep, the system follows this procedure: Non-CH

nodes wait for their allocated time slots before broadcasting data to the CH node. The CH Notification event (represented by the CH Notification stage) starts when the CH Notification deadline is reached (CHN$_t$). For CH nodes to start listening to the channel, awaken Non-CH nodes. Custer Head CH Notification Packet was sent out. The identifier for the CH is the CH ID, the CH's New CH ID, and the non-CH node ID. The CH node will give its ID to the New CH-ID field if the CH is not updated. This notice packet brings CH nodes to sleep and awakens them at their respective S$_i$ in the following cycle when data for S$_i$ times has been sensed.

Data-Gathering

The data is transmitted based on each node's characteristics. Data received straight from the source is sent directly to the sink. Gateway nodes are set up such that SNs are expected to come, and then the SNs pick up data from the environment and data they get from normal nodes. The data is transmitted during the next type determination phase if the SNs have moved to the surface and there is a gateway node with data, but the data cannot be sent because the SNs are making their way to the surface for a new up-down cycle. To send data to a nearby node, an ordinary node looks in its neighbour list for a closer node. The app initially uses its sensors to get information about all SNs in the same depth and then determines which one is the closest. When the node reaches the end of the neighbour list, it decides which neighbor to choose based on the weight of the selected neighbors in the list. (N$_{eighbor}$).

Intrusion Detection Model Architecture

Each sensor node has an intrusion detection system (IDS) placed on it to detect sinkhole attacks. Numerous modules determine the scope of an IDS's capabilities. A few examples of these parts include a local packet monitoring module, a local detection engine, a cooperative detection engine, and a local response module. The Local Packet monitoring module collects audit data by taking in broadcasts from nearby nodes. The local packet monitoring system at each sensor node stores a ruleset that includes the node identifiers of its neighbouring sensor nodes and the link quality of each node, as determined by monitoring the neighbouring nodes' transmissions to identify a sinkhole attack. The lack of the node of the sensor node housing the IDS renders the ruleset insufficient. The local detection engine checks incoming route update packets by comparing the sensor nodeid to a list of nodeids. Ant Colony Optimization is used to find the sensor nodeid in the route update packet corresponding to the nodeids in the resulet. If the sensor nodeid and connection quality don't match, a sinkhole attack has been identified, and a warning has been delivered. An attacker likely sent the packet if the source IP address does not match the senor node. A connection quality discrepancy suggests that one node is mimicking another. In this case, the nodeid of the receiving endpoint is added to the suspect list of the alerting node. Together, the alert-generating sensor nodes identify the intrusion.

Improved Ant Colony Optimization

The ant colony, standing in for a distributed computing cluster, works through intermediate steps that map to several possible outcomes of a problem. Using the characteristics of trails and attractions, they move according to a stochastic local choice strategy. Each individual, via travels, incrementally builds an answer to the problem. If an ant completes or refines a solution, it will analyze it and likely alter the trail value of its constituent parts. Future ant searches may be aided by this information gathered through pheromones. Two different processes, trail evaporation and (optionally) demon activities, are also part of an ACO algorithm.

All trail values depreciate over time due to trail evaporation, preventing an infinite buildup of trails on a given component. Daemon actions can be used to perform centralized tasks that an individual ant can't, such as executing a local optimization strategy or updating global information needed to assess whether or not to bias the search process from a non-local perspective.

One possible choice for the heuristic information is to calculate the average resource requirement

$$r_i = \Sigma^n_{j=1} \, r_{ij}/t \; ..... \tag{1}$$

Define I = b I / ri for each item. However, this option is flawed because it ignores how limited a single resource is. The heuristic information may be a function of the aj to give even more insight. There is the option of calculating.

$$1r_i' = 1/t. \, \Sigma^n_{j=1} \, a_j/ \, r_{ij}.... \tag{2}$$

Solution building using heuristic information computed as i=bi/ri. Each ant adds an item to the pile only once, but they add it repeatedly using a probabilistic approach influenced by pheromone trails and heuristic information. When no more items can be added without going against the resource constraints, the ant stops building the solution. One interesting aspect of applying ACO to the ants' walk lengths are not predetermined, so different ants may find solutions that vary in duration.

Eq 1

r_i - Receiver initial energy

$\Sigma^n_{j=1}$ -Agent position

r_{ij}/t - Node processing Time

Eq 2

$r_i' = 1/t. \Sigma^n_{j=1} a_j/ r_{ij}$

r_i' - Destination node Distance

$\Sigma^n_{j=1}$ Agent position

a_j/ r_{ij} Data Transmission and Receive based on the node total hop value

It is through updating the velocity and, by extension, the position that a particle xt at time t can be translated to a position xt+1 at Time t+1. Particle xt's velocity vt at time t is calculated using the formula.

$$V_{t+1} = c_1 v_t + c_2.rand1().(x_t – p_{best}) + c_3.rand2().(x_t – g_{best}) \text{ ---} \tag{3}$$

Where rand1() and rand2() are two random numbers between 0 and 1. Since $x_t = (d_1, d_2, ……, d_n)$, the updating formula for the velocity for each coordinate of a particle is given by

$$V_{t+1}(d_i) = c_1 v_t(d_i)+c_2 .rand1().(x_t(d_i)–p_{bestdi})+ c_3.rand2().(x_t(d_i)- g_{bestdi}) \text{ -------} \tag{4}$$

The difference between the particle's present location and its 'pbest' position is given by the component (xt(di)-pbestdi). The cognitive coefficient, denoted by the constant c2, represents the particle's faith in its past experiences. The amount by which a particle's velocity changes as a result of its own past experience may be calculated as rand1()(xt(di)-pbestdi). The difference between the particle's present location and the 'gbest' position is given by the component (xt(di)- gbestdi). The social coefficient c3 measures the particle's level of trust in its immediate surroundings. Consequently, the amount by which a particle's velocity shifts due to its neighbours is represented by the factor c3.rand2().(xt(di)- gbestdi).

The particle movement rule for EPSO is the following: given a particle X_i , a new particle X_i^{new} results from

$$X_i^{new} = X_i + V_i^{new} \text{ ------------------} \tag{5}$$

$$V_i^{new} = W^*_{i0} V_i + W^*_{i1} (b_i- X_i) + W^*_{i2} (b^*_g- X_i) \text{ -------------} \tag{6}$$

The movement rule's inertia, memory, and cooperation are all retained from the Classical EPSO formulation. When applied to objects as parameters, however, the weights eliminate mutation.

$$W^*_{ik}= W^*_{ik} + \tau N(0,1) \text{ --------------} \tag{7}$$

With the properties of a Gaussian random variable (zero mean and one standard deviation).

Random perturbations to the best bg on the planet are used to

$$b^*_g = b_g + \tau' N(0,1) \text{ --------------} \tag{8}$$

The following are the justifications for this shift: A) if the current global best is the global optimum, then this is irrelevant; b) if the optimum has not yet been found, then it may still be in the neighbourhood, and it makes perfect sense not to aim exactly at the current global best - especially when the search is already focused in a certain region, at the latter stages of the process. It is separating learning parameters with commas (either fixed or also treated as strategic parameters and therefore subject to mutation). Since this system is subjected to not one but two "pushes" in the right direction (Darwinian natural selection and the particle movement rule), it stands to reason that it may display more desirable convergence characteristics than ES or PSO alone.

Hash Table Functions

Asymmetric hash key cryptography overcomes the hash key management challenge by using distinct encryption and decryption of multiple hash key pairs. Multiple hash keys, such as the encryption hash key, are insufficient to locate the decryption hash key. As a result, the encryption hash key can be made public as long as the decryption hash key is only known to the person desiring encrypted data (hence the term public/private hash key cryptography). No one may use the public hash key to encrypt a message using the public hash keys of others; the intended receiver can only decode the message. A general rule is enabled by the mathematical link between the public and private hash key pair: any message encrypted with one hash key for one pair slot can only be successfully decoded with the corresponding hash key. Encrypting with the public hash key implies that you can only decode the message slot by slot with the private hash key. When using the private hash key to encrypt, only the public hash key can decrypt.

RESULTS AND DISCUSSION

In the NS2 environment, simulations were run with 0-49 sensor nodes. The comparison charts are created using Timeslot, an existing clustering method, and the CA-IDS, a proposed clustering method. Figure 2 depicts the deployment of wireless sensor nodes and an SN within a 1,500m*2,000m area. Figure 2 represents the comparison chart for throughput with existing LEACH and CA-IDS methods. The X-Axis represents the No of packets, and Y-Axis denotes the throughput values. Figure 3 represents the Energy comparison with LEACH and CA-IDS methods. In X-axis denotes the No of packets, and Y-Axis denotes the Energy level. Figure 4 denotes the comparison for Packet Delivery Time. The X-Axis denotes the Packet Delivery ratio, and Y-Axis denotes the time. Figure 5 represents the packet Received comparison chart. The X-Axis denotes the time in seconds, and Y-Axis denotes the packet Received in bytes.

CONCLUSION

The intrusion detection system (IDS) model is suggested based on Improved Ant Colony Optimization to detect sinkhole attacks and identify attackers in wireless sensor networks. The CI-IDS method is superior to conventional rule-matching methods in detecting sinkhole attacks. To counter the shortcomings of traditional rule-matching architectures like neural networks and support vector machines, a new technique called CI-IDS has been developed for detecting attacks. The IACO algorithm produces fewer searches than binary and sequential search methods. In addition, it has been demonstrated that the swarm intelligence-based vote analysis method requires significantly fewer data storage space than the existing method. To gather the dataset and analyze the ML approach to finding the IDS in WSN.

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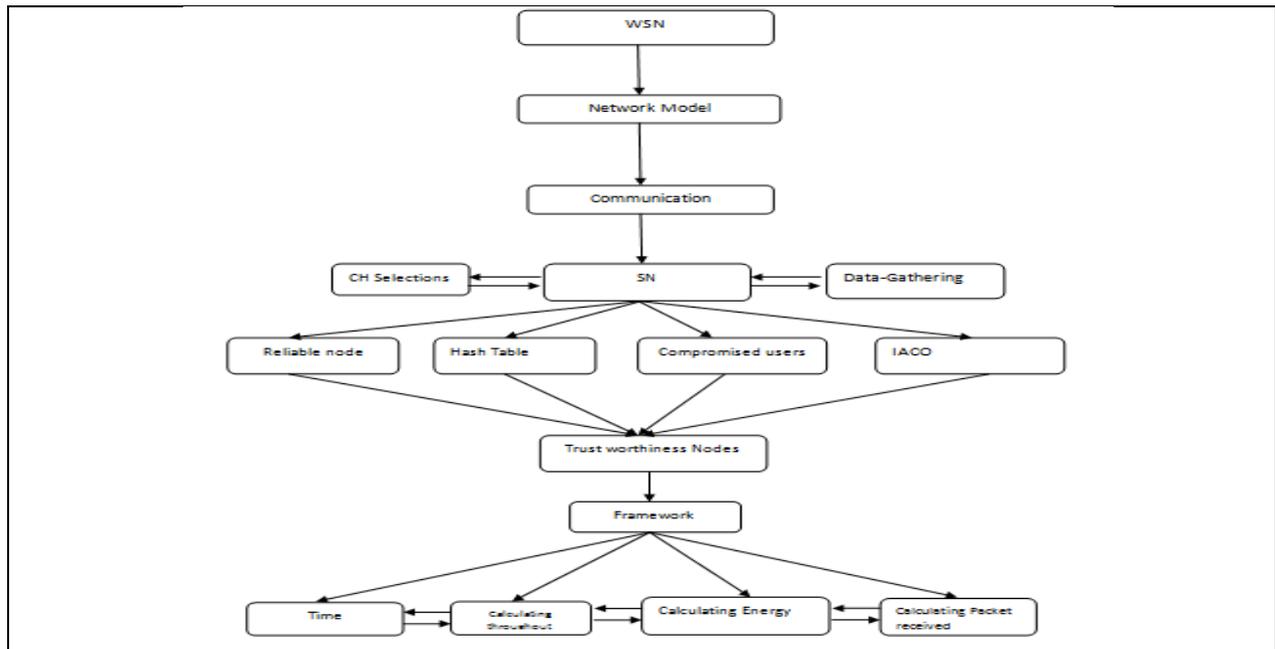
Figure 1: CI-IDS Flow chart
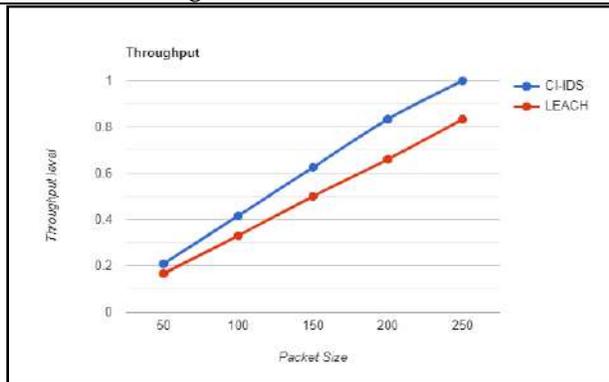
Figure 2: Throughput Comparison chart
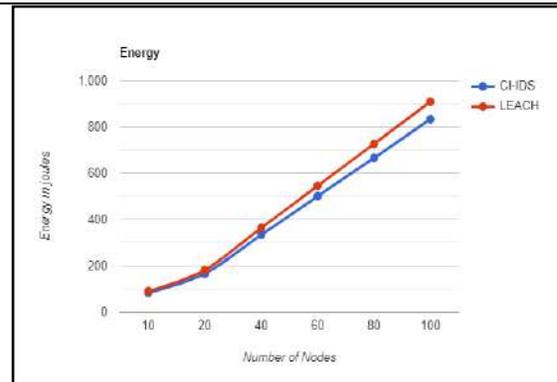
Figure 3: Energy Comparison chart
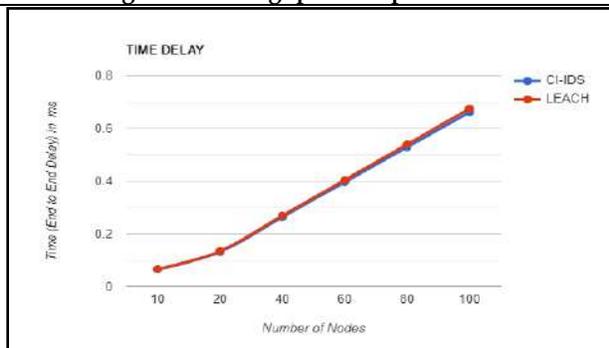
Figure 4: Time comparison chart
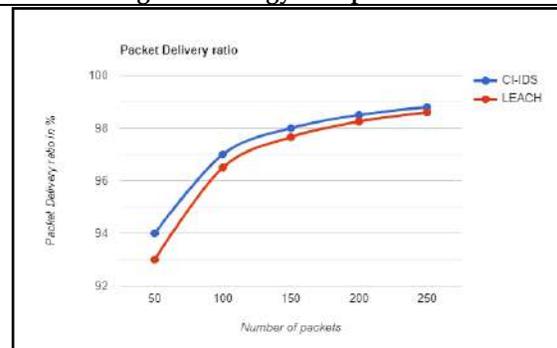
Figure 5: Packet Received Comparison chart

REVIEW ARTICLE

Smart Precision Farming Framework: An IoT and Machine Learning Initiative

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ABSTRACT

Indian Economy has one major contributors in agriculture sector. Research on agriculture is accurate, precise. Internet of Things (IoT) is the Technology, which have been transformed recently. Each and every Industry implements smart agriculture along with precision farming. Different technologies can be utilized for it. Machine Learning is the Technology, which applies Internet of Things(IoT) and Data Analytics. Both of the techniques tend to increase the quality of Crop Field Production to fulfil the Food requirements. Such World Shaking advances are rocking ahead of the conventional agriculture practices. It creates unique and greatest opportunities. The Power of IoT is being demonstrated in precision farming. It requires technologies like Wireless Sensor Networks(WSN), Data Analytics(DA), and Machine Learning(ML) in agriculture sector. Use of Data Analytics, Machine Learning along with IoT help in developing a framework. Kashmir is known for its Apples. It is obvious that it may get diseases in the fruit. So it has tried to predict the disease in apple in Kashmir Valley Orchards. Survey had been made on farmers on the trending technology as well as impact on Precision Agriculture. The Study tries to explore the difficulty in integrating trend of new technology into traditional format of farming. The Methodologies which are adapted for the prediction are being discussed here in this paper.

Keywords: Smart Agriculture, Internet of Things, Machine Learning

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INTRODUCTION

India is a cultivating country. Agriculture is India's biggest Industry. Maximum percentage of the population depend on farming. 60 to 70% of India's Jobs have been provided by this Sector. Agriculture is all about type of crops, plant life, soil fertility, irrigation facility, weather updates, advanced equipments as well as advances in technologies. Plant development has proven to be a novel and best approach, as plant, crops become difficult for commercial and food crops. Today's agriculture sector has faced one major issue i.e lack of knowledge on agriculture and cultivation. The other issue is lack of information on new ongoing developments [1]. During earlier stage, our ancestors had avoided adapting new technological development for particular plants growth. Now a day, this is a normal approach to grow plants in unusual and typical natural adaptabilities. Specific plants cultivation has been made under certain circumstances. Circumstances are higher yield and less compost requirement [2][3]. Information, Technology and Management are three major components of Precision Agriculture. Precision Agriculture is considered to be a management strategy. It uses Information Technologies, which collect important data from various different sources. These factor into the decision making process. Technologies like GPS (Global Positioning Systems), GIS (Geographic Information Systems) help in yielding remote mapping sensors, guidance systems for application with variable rate which enables in depth monitoring of field variations. Precision Agriculture (PA) evolution is popular now a day for the plant growth in greenhouses. One important reason lies with the low cost technology.

This makes farmers able to optimize with the production. Greenhouse is a transparent house like structure. It controls moisture, temperature, light infiltration for optimal plant growth. Precision Agriculture is a method for detecting, monitoring, and responding to environmental changes. This is the approach to detect greenhouse climate. Then data are recognized and uploaded to the cloud, and the person associated to agriculture and farming take action based on these data. It is the most recent technological innovation. IoT expertises and employs web based methods to connect any device to the Internet. The exact agricultural framework is improving as a result of recent advancements in Wireless Sensor Networks (WSNs), which are more advanced than the Internet of Things [4]. Due To Diverse Climatic Conditions, Vegetation Is Abundant And Productive. Despite Abundant Resources, Results Don't Match. Scarcity and Inadequate Use of Technology, Rural Ignorance And Antiquated Ways are the reason. Pests, Insects, And Illnesses Reduce Agricultural Output. Pests Attack Many Crops. Insecticides And Pesticides are not so effective as tit can affect birds, animals. Animal Food Webs and Chains are too affected. Disease reduces Crop Yield [5]. Pests And Diseases Cause Significant Crop Losses in Semiarid India. Weather affects Agriculture Production and Food Production Will be affected by lacking Smart Agriculture Technologies. For Appropriate Resource Management, Indian Farmers require affordable Technology. The approach should help Farmers in preventing Crop Illnesses and increase the food quantity and quality. Smart Farming is essential along with precise Greenhouse Monitoring for Improvised agricultural growth management. Internet Of Things (IoT) Leads to modern age in computer networking, gaining traction [6].

 It has Regression based Supervised Machine Learning Approach to explain precise control in sensing parameters, temperature, soil moisture, humidity, carbon dioxide, and light intensity. A Smart Greenhouse Agricultural System has Plant Development. It has been taken as one novel test, as Plant Fields and Strength became typical Commercial and Food Crops. The lack in agricultural knowledge and Information on new developments is One major issue, faced by new era agriculture [7]. Years ago, ancestors have excluded adapting technical development for special plant growth. Now Farmers are Maintaining Perfect Microclimate Conditions, Optimizing Irrigation And Fertilization Methods, Controlling Infection by avoiding disease outbreaks, reducing theft there by increasing security. By Maintaining Proper Environmental Conditions, Farmers Could be able to Cultivate any Plant an all Seasons. Greenhouse Farming Is Significant, as it holds Moisture, using less water[8]. Temperature and Humidity are controlled to meet Plants requirements. Nurseries can also help in growing crops. Harvests may be Made under Various Environmental Conditions. The cloud computing devices are utilized at the end of the system, that can create a computing system from sensors to tools,which observe data from agriculture field. A novel methodology has been devised for smart farming by including a smart sensing system and smart irrigator system with help of wireless

communication technology [1,4]. This system is not so expensive for installation. Accessibility and control can be easier for the agriculture system in laptop, cell phone or a computer.

LITERATURE REVIEW

Intelligent Agriculture System use a set of sensors and actuators to meet the objectives to get efficient management. Intelligent Precise Control Systems are using Internet of Things for smart agriculture. it has implementation phases in two ways, IoT based monitoring systems and Artificial Intelligence systems based on IoT[7,8].

IoT based Monitoring Systems

A novel system has been developed, which adjust soilless culture conditions for complete distribution of nurseries employing saline water[9]. Internet of Things (IoT) Technology created a framework to monitor and control temperature. An Autonomous Farming System [10] based on Fog Processing Vision and Lora Innovation has been devised. The Investigation was on Structure and design of Web enabled Measuring Cultivating Framework. Ricetalk Recognizes The Rice Effect Using Non Picture IoT Devices. Agritalk is Low Cost IoT System for Precise Soil Development Cultivation [11]. Trials have been made on turmeric development. It demonstrated, Agritalk has improved quality of Turmeric.

An IoT Based Crop-field monitoring an irrigation automation system. It describes how to monitor a crop field[12]. A system is developed by using sensors and according to the decision from a server based on sensed data, the irrigation system is automated. Through wireless transmission the sensed data is forwarded to web server database. If the irrigation is automated then the moisture and temperature fields are decreased below the potential range[13]. The user can monitor and control the system remotely with the help of application which provides a web interface to user. Existing system used to figure the ripeness of soil and presumptions to develop certain kind of products. Excluded are the level of water, dampness and climatic conditions. The profit depends upon the last phase of the harvest in which they depend[13,14]. In proposed system, efficiency of the product has been improved which appraises the nature of the harvest. IoT provide accuracy and conservative cultivation. Wireless sensor networks provide precision Agriculture by separating the solitary plants for checking in the tens or several square feet .WSN also has used different kinds of sensors such as Temperature sensor, Humidity sensor, Soil moisture sensor, Water level sensor and ARM processor[15].

Proposed Framework

Precision agriculture is a farm management concept, revolving around the process of observing, measuring, and responding to various inter and intra field variability inputs for modern agriculture. Construction and natural shrinkage are diminishing arable land[15].

Superior crop disease approaches are needed to meet the growing population's food need. Precision farming and modern agriculture practices focus on reducing production cost and wastage, as it is tailored to the needs of each plot. It centers on data collection and analysis of farm plots, which comprises sensors, drones, and robots for recording the data, and software as a service (SaaS) can be used to adapt to precision farming systems. The study reviews precision agriculture using IoT, Data Analytics and Machine Learning. These Technologies' precision agriculture applications are also addressed. Here it addressed apple crop concerns in kashmir. Apple growers still use standard disease prediction methods without IoT and WSN. Real time measures against diseases like scab, if anticipated accurately and in time, are a major advantage of the proposed technique. Problems experienced in developing and deploying such apps in real time are discussed [16]. A local survey was made to see, what locals think about precision agriculture. The proposed framework faces various hurdles before large scale implementation. Initial implementation cost, deployment, training, weather, and other elements are considered. Once these limits are overcome, profits will become visible and usable. The future work will cover more crop factors.

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Brief Description

IoT sensors and networks-Wireless Sensor Networks can remotely observe ambient and soil parameters to predict crop health. wsn forecasts agricultural field watering schedules by monitoring pressure, humidity, temperature, soil moisture, soil salinity, and soil conductivity[15,16]. A scalable network architecture is made to monitor and control rural agriculture. An IoT based farming control system has neen devised. All system components and upgrades are analysed. It improved energy efficiency, latency, and throughput. The system utilises wild and fog computing to attain this performance. A WSN framework design have been implemented to create a DSS for apple scab detection in Himachal Pradesh utilising mills tables. IoT helps in crop yielding, quality, and costs [17]. Based on wireless sensor networks, a system devised to optimally water lemon, home grown vegetables. The suggested system consists of hardware, web application, and mobile application to control environmental parameters in crop fields. Control box was a wsn and electronic data collection system. Evaluation has been made using data mining association rules. The farmer utilised a mobile app to monitor soil moisture and water automatically or manually. Data Mining suggests 29–30oc and 72–81% humidity for growing homegrown vegetables and lemons [18]. Smart Node is a cost effective precision agriculture technology invented by fonthal et al. for optimal crop development. A Technology and software have been made to monitor agroclimatic parameters. Various sensors capture field data. gsm technology sends the farmer farm conditions. the sensor in the proposed study simply monitors crops. agricultural data collecting using various methods has been made. Their investigation uses wsn, IoT, weather stations, smartphones, drones, and cameras. Smart farmnet, an IoT platform, was also developed[19]. It processed field data on soil, moisture, irrigation, soil fertility, humidity, temperature, etc. the proposed technique correlated data and predicted crop status. paustian and theuvsen explain how precision agriculture uses numerous technology. how german farmers accept precision agriculture using smartphones. precision agriculture benefits farmers, according to regression. the authors suggest IoT agriculture research[20].

Data Analytics and Machine Learning

Before Information Technology, traditional procedures were implemented. They include physical detection of crop diseases and pests, statistical computations to estimate crop yield. Machine Learning lets computers learn from experience. Data Analytics and Machine Learning infer from crop data. it shows hidden patterns, correlations between horticulture parameters like temperature, soil salinity, humidity, etc[21]. Artificial Neural Network (ANN), Support Vector Machine, Regression and logistic regression, Fuzzy Technology for recognition, etc. are used to forecast agricultural diseases and pests using weather data. Machine learning technique are proposed for classifying apple illnesses. apple scab and marsonina coronaria are classified using apple leaf pictures. On the same data, SVM was utilised. The simulation utilised Matlab [17]. K nearest neighbour classified illnesses with 99.4% accuracy. Combining IoT and Machine Learning make easy to predict crop diseases in precision agriculture [22]. Data have been collected from environmental sensors including temperature and humidity. It has been highlighted how large, small, public, and private companies work to enhance profitability. Continuously recorded data can be used to attain goals [24]. Regression Analysis, Neural Networks, and Machine Learning are useful for Decision making. These technologies have several uses. In precision agriculture, farmers use apps to track crop status. Precision agricultural architecture involves three phases [25]. First phase comprises of sensors / IoT nodes to monitor physical or environmental factors, soil conditions, plant conditions, e.g. soil moisture sensor records soil wetness reading or soil nutrient sensor checks soil fertility. in the second phase, we capture exact data and transfer it to the cloud for higher computation and remote monitoring, depending on the necessity. in the third phase of architecture, analytics are used to monitor crop fields. this information is subsequently sent to end users (farmers) to determine if the reading is below or over threshold. accordingly, they send a message to the actuator to switch on (or off) the watering system to pour water on the soil or to spray potassium, nitrogen, and phosphorus to balance soil fertility [26]. when a critical scenario is recognised (sensed/predicted), analytics and actuators trigger a reaction mechanism. Every agricultural technique relies on soil. crop doesn't exist without soil. Soil analysis is the first step to good agriculture [27]. By evaluating soil, we can determine its physical, biological, and chemical state. then farmers can make field decisions. precision farming aims to maximise yield from limited farmland. implementing new technologies is crucial worldwide because we must feed a growing population with limited resources. fall is the time for weather and soil based soil tests. By completing soil testing, we may examine soil nutrients, including fertiliser requirements,

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cropping history, soil type, irrigation level, etc. sensor-based technologies help in soil selection and planning [28]. These technologies help choose the optimal crop for the land. agrocares' lab-in-a-box is a complete soil testing toolbox. Any farmer can test their crops' soil without travelling to a lab. according to this toolset, farmers without lab experience can test 100 samples each day. 36000 samples each year can be examined without a lab. Using vision based technologies and sensors, agriculturists can accurately implant seeds and plants [29].GPS, Sensors, and vision based agribot have been developed for seed sowing. Current technology helps farmers select the optimum land for their crops[29]. The main aim of this study was to predict the apple scab that is the most common disease of apple crop. Here we used the real time data of wireless sensor/ IoT nodes as input for linear regression model. in this an application is developed for farmers which is simple and user friendly to inform them about the status of their apple orchards on real time basis. the framework consists of a number of wsn/IoT nodes scattered in the orchards of the apple with nearby gateway for collection of the data from the mesh of the nodes while performing the research on the said problem various steps have come in the way that forms the basis of our study [30]. The nodes are deployed in the apple orchard for data collection. a network is established between the nodes, data acquisition is done by nearby gateway or a fog node from prefixed number of nodes in the network. the data analysis is done on the real time basis for each location/orchard for quick action if needed. Due to the tremendous advantages of the current technologies like internet of things, wireless sensors, actuators, today's farmers are interested in business models. Using IoT technologies, they will accumulate the data from their farms to support their revenue. the data provided by the farmers are exploited by the most of the existing IoT platform service providers. they provide unrestricted limited services and full services with diverse level of subscriptions. It becomes the part of argument for farmers to supervise their owned data [22,24].

CONCLUSION

Precision farming aims to maximise yield from limited farmland. Implementing new technologies is crucial worldwide because we must feed a growing population with limited resources. The framework consists of a number of WSN/IoT nodes scattered in the orchards of the apple with nearby gateway for collection of the data from the mesh of the nodes While performing the research on the said problem various steps have come in the way. A network is established between the nodes, data acquisition is done by nearby gateway or a fog node from prefixed number of nodes in the network. The data analysis is done on the real time basis for each location/orchard for quick action if needed. Precision Farming can only be possible with technology adaptations. Optimization Model will be improved by adding more no. of components, crops, the years of cultivation etc.

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Figure 1: Smart Farming Framework

Figure 2: Relationship between IoT and Data Analytics

Figure 3: Precision Agriculture Applications

Figure 4: Precision Agriculture Model

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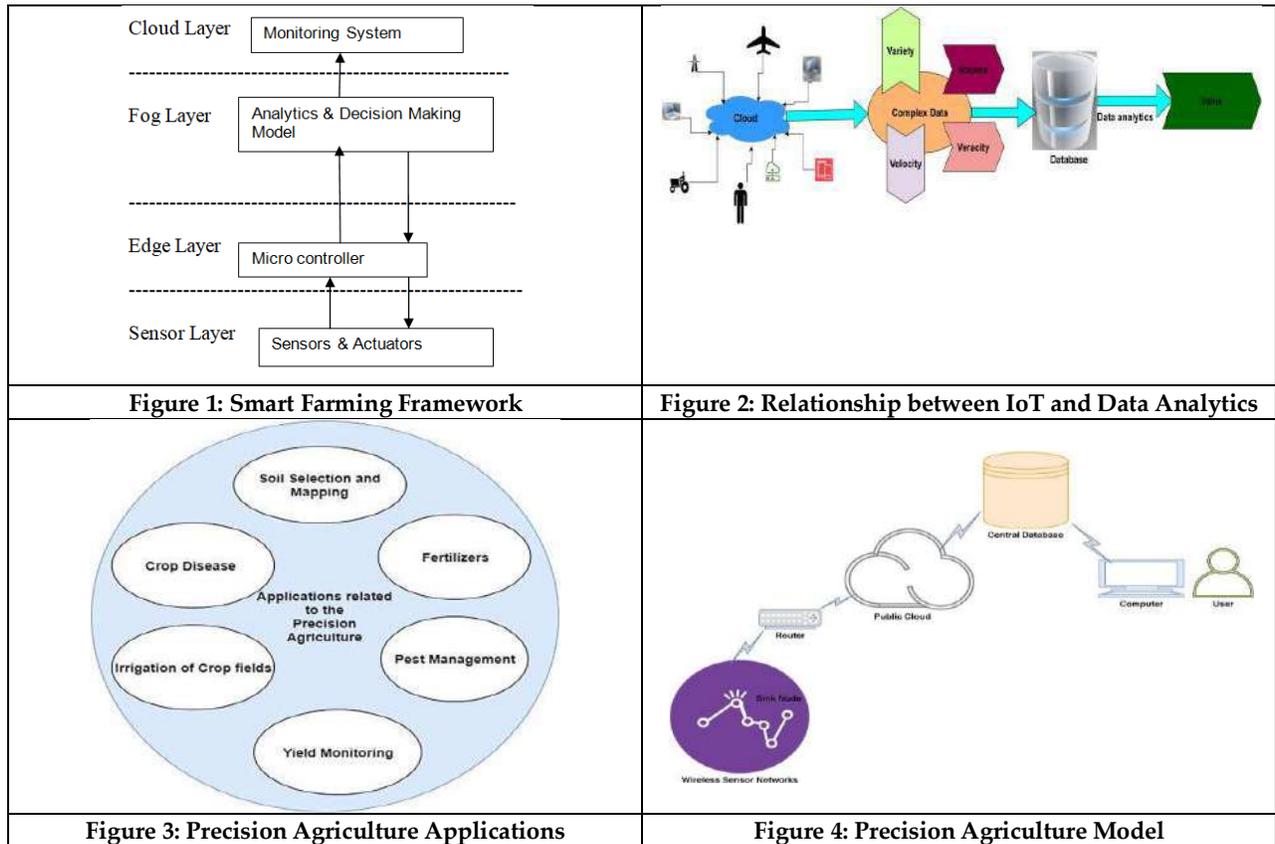
Nature Inspired Adaptive Evolutionary Clustering Algorithms for Biological Sequence Analysis

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ABSTRACT

The present survey is a comprehensive study of nature-inspired adaptive evolutionary clustering algorithms commonly used for biological sequence analysis. The adaptive evolutionary clustering algorithms are auto-evolving clustering techniques that produce optimized results. Clustering is one of the popular tools for sequence analysis problems. It is important to study the parameters used for designing adaptive evolutionary clustering algorithms for solving biological sequence analysis as these problems are categorized as NP-Hard problems in the literature. The present communication is an attempt to study various adaptive evolutionary clustering algorithms, specially designed for solving biological sequence analysis issues, their proposed schema, various components, and their parameters.

Keywords : Nature-inspired, adaptive, evolutionary, clustering, biological sequence analysis.

INTRODUCTION

Clustering is an unsupervised task by which data can be grouped in the number of clusters by minimizing intra-cluster distances and maximizing inter-cluster distances [1]. Clustering is a very popular machine learning tool used by researchers in various research areas such as networking [2-4], the internet of things [5-7], big data [8-10], medical [11-13, 14], biological sequence analysis [15-17], natural language processing[18], software module clustering [19], etc. Adaptive clustering algorithms are used to improve the quality of clusters identified by clustering algorithms. The use of the adaptive clustering approach speeds up and automates the clustering process. The adaptive approach can be used with clustering algorithms if past experiences and external feedback are available and can play a vital role in solving the research issue [20]. If this is not the case, then the use of the adaptive approach in the clustering process will be a burden due to an increase in the complexity of the clustering algorithm. Adaptive systems are

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autonomous systems that are continuously changing to establish their selves in their external environment. An adaptive system has an adaptive plan to control the changes occurring to best fit its environment. The adaptive plan in an adaptive system is implemented in the form of operators [21]. Adaptation improves the quality of clusters however identification of the optimized number of clusters in a dataset is also an important issue. Evolutionary computation techniques are nature-inspired population-based meta-heuristic optimization algorithms that with an adaptation plan give rise to the optimized number of clusters. There are two different adaptive evolutionary clustering approaches observed in the literature, historical information-based adaptation [22,23] and nature-inspired evolutionary computation [24-26]. The first approach relies on the time-variant evolutionary framework where a temporal smoothness penalty is an additional cost function of static clustering [22]. The adaptive extension of this algorithm was proposed by Xugroup [23]. In a parallel study, the second approach towards the evolutionary clustering algorithm was developed which was a nature-inspired evolutionary clustering [24,25]. The adaptive version of the nature-inspired evolutionary algorithm [25-27] has not been much studied to date.

Various computational models for adaptive evolutionary clustering algorithms

Several computational models were proposed in the literature for adaptive evolutionary clustering for sequence analysis (Table 1). The dynamic partitioning clustering approach request for apriori declaration of the number of clusters required and uses a variable-length genome [28]. An epistatic clustering-based adaptive evolutionary computation model was proposed by Pepper (2003). This study suggests that epistatic clustering can increase the rate of adaptation under crossover. It was also revealed that epistatic clustering itself can be evolved through natural selection [29]. Another approach was to use incremental techniques to evolve an adaptive computation model by using merging splitting operations. These two operations were identical to recombination and mutation operators for natural selection [30]. A chromodynamics-based metaheuristics method for maintaining multiple optima between co-evolved sub-population was one of the approaches used to develop adaptive evolutionary clustering algorithms [31]. A graph-based evolutionary clustering supported by multiple clustering criteria was proposed by researchers where there was no need to make assumptions about the size and number of clusters [32]. It is possible to adapt to crossover and mutation operators. This was done in a k-medoid-based adaptive genetic algorithm developed for handling static features and time-series data [33]. The chromosome reorganization technique that prevents the convergence of the evolutionary system to local maxima was implemented by employing the adaptive probabilities of crossover and mutation [34]. A bi-objective clustering approach was where the initial randomly chosen centroid keeps reallocated until convergence of the system occurs [35]. Researchers also used a differential evolutionary approach for adaptive systems [19, 36-38]. An adaptive mutation-based memetic differential evolution algorithm called the multi-objective hyper-heuristic evolutionary algorithm was developed [36].

Components of an Adaptive Evolutionary Clustering Algorithm

Nine fundamental components of an adaptive and evolutionary clustering algorithm were identified from the literature. These components are- optima, individuals, population, chromosome, genes, genotype/phenotype, mating, similarity measure, fitness function, selection operator, genetic operators (also called variation operators - recombination, mutation, increment, heuristic disband operator, merging, crossover, inversion, reallocation, and merging), offspring, and termination condition which are discussed in the manuscript.

Optima

Optima indicate the scope of an algorithm. The conventional clustering algorithms provide locally optimal solutions. Evolutionary and adaptive clustering algorithms can find globally optimal solutions. However, sub-populations that co-evolve can converge to local optima [29]. To overcome the limitation of local maxima and to converge the evolving system to global optima, two separate approaches were considered by the researchers–single optima and multiple optima (Figure 1). To achieve single optima, an optimal value for each trait can be considered. Contrarily, for achieving multiple optima, any deviation from the optimal value may consider decreasing the fitness contribution of an individual in the population.

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Individuals

A population is a set of individuals in an evolutionary system. Two different schemes for the representation of an individual are identified from the literature (Figure 2). The individuals in a population can be haploid [29] or diploid [33].

Population

Generally, a single population is considered in a population in literature [29, 33] yet there is evidence of using multiple populations in the adaptive evolutionary system too [36]. In a multiple-population system, a total population can be subdivided into sub-populations which can be evolved in a self-adaptive way. Each sub-population can be denoted by a separate cluster [36]. The population may be represented as a binary-coded representation [31]. Another approach for the representation of the population in an adaptive evolutionary system is to represent the initial population as a data set/recordset. An individual is represented as one record in the dataset. Genes of the individual are represented by attributes and all attribute values of the individual could be treated as a chromosome of the individual [30,31]. Different options identified in the literature to implement population in an adaptive evolutionary system are shown in table 2.

Chromosomes and genes

An individual in a population is represented as a data item in a dataset and as a record in a population where a population is represented as a recordset. Each instance in a population is called a chromosome [31]. The representation of a chromosome in an evolutionary system is called encoding. A chromosome is generally encoded as a linear sequence with genes placed on it [28]. Some alternative encoding methods used by researchers to represent chromosomes are to encode a single circular chromosome with evenly placed equal-length genes [29], as a string of groups encoded [34]. In this approach, each chromosome is encoded as a string, and the gene on a chromosome is represented by an integer that represents the label of the group in which it is classified. For example, if the data set has six instances {s1, s2, s3, s4, s5, s6} the chromosome (2 2 1 2 1 1) represents that the instances {x3, x5, x6} are classified in one group, while the instances {x1,x2,x4} are classified in the other group [34]. There are some other encoding schemes also. In one of these approaches, a gene is represented as a cluster number with the position of that gene [30,35], and the other one uses variable-length chromosome encoding [35]. Each gene contains information on the centroid of its cluster which distributes on the chromosome according to its distance measure (fitness measure) [30,35]. A gene can also be encoded as an ordered pair as (x,y) where x is the trait value and y is the chromosome number. Genes are arranged on the chromosome as per the x value [28]. The encoding of chromosomes and genes is representing the genotype of an individual. In nature, the genotype of an individual in a population represents one trait. A trait is a distinguishable characteristic of an individual. A phenotype of an individual consists of t traits. The fitness of these traits additively affects the fitness of the individual. And each trait is controlled by g different genes. Each gene affects one trait and the same trait can be affected by many genes. Each gene has a real number value. The trait's value can be is calculated as a product of the associated gene value [29]. The concept map for chromosome representation is shown in Figure 3.

Similarity Measure

Similarity measure indicates the actual composition of the population. There can be many co-evolved sub-populations in a population. It is important to know the level of similarity between the individuals in a population. This can be done using the similarity measure.   Let two individuals (x1 and x2) bein a population. The similarity measure S is a measure that tells how much these individuals are similar or dissimilar. A similarity measure is also known as a distance measure because it tells about the evolutionary distance between two individuals. The distance between individuals in a subpopulation is known as intracluster distance and the distance between clusters representing a sub-population is known as inter-cluster distance. Euclidean distance is a common similarity measure however some other similarity measures were also used in literature eg. Dynamic time warping distance dDTW [33].

Fitness Measures

Natural selection is a process in nature by which nature selects compatible individuals to nature which can adapt to diverse environmental conditions and survive. The Fitness of individuals is the basis of this selection. In nature-inspired adaptive evolutionary systems also, fit individuals are selected to participate in the population in the near future so a fitness measure is needed for this purpose. There are quite different fitness measures used in literature for adaptive evolutionary clustering. The details are given in the following paragraphs-

Compactness and Connectivity- The fitness of the instances in a population is used as a measurement of the compactness of clusters (sub-populations) and cluster connectedness [35].

Compactness is calculated by calculating intra-cluster distance i.e. by calculating the distance between the individuals in the clusters. The similarity measure is used as a measurement of compactness [33]. The deviation is another measure of the compactness of clusters which represents the overall dispersion of the individuals in the cluster. The Deviation is computed as a summation of distances between the data items (individuals) and their corresponding cluster centroid by using the formula, $Dev(C) = \sum_{c_k \in C} \sum_{i \in c_k} \delta(i, \mu_k)$, where C is the set of all clusters, μ_k is the centroid of the cluster c_k, and is the chosen distance function (i.e. Euclidean distance)[35].

Connectivity is the measure of bonding between the individuals (data item) in the population (cluster). This is analogous to the inter-cluster distance in a cluster [35]. It is calculated as the reciprocal of the minimum centroid-to-centroid distances between clusters. $Conn(C) = \frac{1}{\min ||c_i - c_k||^2} \forall_i, k \in C, i \neq k$ where C is the set of all clusters. [35]. The distance between individuals can be calculated by finding differences in the sum of the fitness contributions of each trait in an individual. The fitness effect of a given mutation can be calculated by getting differences in the values of the other genes of the same trait. The distance between the phenotypes of Individuals can be calculated as the mean of the absolute differences from trait optima across all traits. The overall fitness can be calculated as the difference between a deviation of individuals and the largest deviation in the population(dmax)$f_i = d_{max} - d_i$, where di represent an individual's deviation, d_{max} is the largest deviation in population and the lowest fitness is always 0. In evolving systems, it is necessary to keep a check on the population size in the system. To do so,once the population reaches the nominal size, the fitness of the population is rescaled and the fitness of each individual is adjusted by the formula- $f' = f \frac{N}{\sum_i f_i}$ where f is the fitness of the population and f_i is the fitness of an individual. The number of offspring that each individual can produce can be determined by this adjusted fitness [29].

Distance measure

The overall distance between the cluster items is a fitness criterion. The distance measure can be calculated as per the following formula- $eval(pop_i) = \sum_{i=1}^{popNo} 1/e^{distance \, (pop_i, pop_j)}$,where *pop* represents the population of chromosomes and *popNo* is the current population size, and *pop*ime ans the current chromosome [31].

Squared Error

The Square error can be used as a fitness measure. Researchers use the inverse of the sum of squared error as a fitness function [10]. The mean of squared error and its modified versions were used as a fitness function in literature. Heuristic MSE can be expressed as the formula-$MSE_{fitness} = \sqrt{n+1} \sum_{i=1}^{n} \sum_{j=1}^{m_i} d(c_i, x_j^i)$, where n is the number of clusters, c_i is the ith cluster center, mi is the number of data points belonging to the ith cluster, x_j^i is the jth data point belonging to the ith cluster, and d(a; b) is the euclidean distance between points a and b [3].

Weighted Similarity Measure

Gorunescu and Dumitrescu (2003) used the Weighted Similarity Measure as the fitness function which finds the fitness of individuals based on their importance in the population. The formula for weighted similarity measure is as follows- $Compare(a_k, b_k) = \sum_{k=1}^{n}(a_k, b_k)^2 weight_k$, where a and b are the two individuals and n represents the number of attributes (genes), $weight_k$ is a positive number specifying the importance of attribute k [30].

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Min-max cut function (MMC)

The min-max cut function with maximized silhouette index was used as a fitness measure for graph-based evolutionary clustering. Min-max cut function (MMC) maximizesthe similarity within each subgraph and minimizes the similarity among subgraphs. The Min-max cut function can be defined as $MMC = \sum_{m=1}^{k} \frac{cut\ (G_m, \frac{G}{G_m})}{\sum_{v_i, v_j \in G_m}, E(v_i, v_j)}$ where $cut(G_m, \frac{G}{G_m})$ is the sum of edges connecting the vertices in G_m to the rest of the vertices in the graph $\frac{G}{G_m}$ and $E(v_i, v_j)$ is the weight of the edge connecting vertices v_i and v_j . The min-max cut function tends to minimize the number of clusters in the graph[32].

Global Silhouette value

To determine the proper number of clusters adaptively, the silhouette index was used by researchers. For a given cluster, C_i , i = 1, …, k the silhouette index of jth member (v_j, j = 1, …, n$_i$) of cluster $C_i$can be defined as -$S(v_j) = \frac{b_j - a_j}{max\{a_j, b_j\}}$ where n_i is the number of vertices in a cluster C_i , a_j is the average dissimilarity between the vertex v_j and the rest of the vertices in the cluster C_i , b$_j$ is the minimum dissimilarity between vertex v_j and cluster C_n for n = 1, …, k, n ≠ j. In this paper the dissimilarity between two vertices v_i and v_j is computed as 1−E(v_i, v_j). The global silhouette value GS can be calculated as: $S_j = \frac{\sum_{i=1}^{n_j} s(v_i)}{n_j}$, $GS = \frac{\sum_{j=1}^{k} S_j}{k}$ where S_j is the silhouette index of a cluster C_j. The silhouette index takes values between -1 and 1. It is close to 1 when the partition is good and thus the number of partitions (k) is appropriate and close to -1 if not. The concept of MMC and GS were combined using a weighted sum approach by some researchers. The fitness function was defined by researchers as$fitness = w_1 * 1/(1 + MMC) + w_2 * GS$ and this fitness function gives optimized clusters[32]. Various fitness functions used in adaptive evolutionary systems are shown in Figure 4.

Selection Operator

It is important to select potent individuals from the population that can mate and reproduce their offspring. The selection operator plays the role of selector in an evolutionary algorithm. For each iteration of an evolutionary algorithm, two parents are selected by the selection operator for reproduction. The following five types of selection operators are identified in the literature used with adaptive evolutionary systems.

a. Closed Ball selection**-**This selection operator selects parents from a pre-determined circular region called closed ball V(c,r), where c is the current chromosome and r is the radius [31].

b. Roulette wheel selection–This selection operator allows reproducing offspring in the next generation. Each current chromosome in the population contains a roulette wheel sized in proportion to its fitness [33][34].

c. Rand and Rand-to-best selection- Rand selection operator randomly selectsboth of the parents from the population and the Rand-to-best selection operator selects one parent randomly from the population and the parent is the best individual from the population[19].

d. (10+60) Selection- This selection operator uses a (10+60) selection strategy where 10 indicate the number of parent and 60 is the number of offspring produced each generation.

e. Tournament selection **-** A standard tournament selection method is used for selecting parents for reproduction [32,35]. The selection process is based on the fitness of individuals in the population. The standard fitness criteria used for the selection of the parents are overall deviation and connectivity discussed in section VI. The selection of individuals is done by tournaments of size two. Individuals with a better level of dominance are preferred and individuals having the same level of dominance, those having a larger crowding distance are preferred [35]. There is evidence in the literature thateach individual is considered for mating [31].

Genetic Operators

Following genetic operators are used with adaptive and evolutionary clustering in the literature (Figure 6) -

a. Recombination- Recombination operation is performed if a second parent chromosome is found within that range of the first parent [31]. In this process, the standard 2:2 one-point crossover operator is used which

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produces either a merging or a splitting of the two clusters involved. The best two individuals from both parents and offspring are kept in the population and others are killed [30].

b. Mutation- The mutation operator is used for reproduction if the second chromosome is not found within the range of the first parent chromosome then the mutation operator is applied to the first parent chromosome [31].

i. Mutate each gene- A variation of the mutation operator, 'Mutate each gene' perform mutation in each offspring. The value of each gene is altered by adding a random number from a normal distribution with a mean zero and a specified standard deviation with**a** mutation size of 0.1 [29]. A mutation rate of 0.02 per gene can also be used [19].

ii. Using scaling factor-Mutation can be performed by using a scaling factor. For this, each solution vector $X_{i,t}$ is scaled to a predetermined scaling factor F and a new vector $V_{i,t}$ for each generation t. $V_{i,t} = X_{best,t} + F.(X_{r_1^i,t} - X_{r_2^i,t})$ where the indices r_1^i and r_2^i are mutually exclusive integers randomly chosen from the population. F is the scaling factor and $X_{best,t}$ is the vector with the best fitness in the generation t [39].

iii. Copy and Exchange mutations-These are special mutation operators that perform gene-level mutation. In the copy mutation operator, then two genes are selected randomly from the population and the second gene is copied into the first one. However, in the exchange mutation operator, two randomly selected genes exchange their positions [19] in the chromosome.

iv. Self-adaptive mutation-Lee and Antonsson (2000) have used a self-adaptive mutation operator [28].

v. Using splitting or merging operators- Splitting and merging operators randomly select one gene and search for the same valued second gene. If no gene is identified then the cluster gets split and a new cluster with a single gene is formed. If it gets the same valued second gene, the merge operator keeps the current genes and their offspring in an existing cluster. The best individual among the parent and offspring is accepted in the new population, in both cases [35].

vi. Increment-The increment is a genetic variation operator that selects a gene on a chromosome randomly which is not allotted to any cluster previously and places it in an existing cluster or increments it to the next new cluster based on its fitness. This operator is applied to every chromosome in the population [32].

vii. Heuristic Disband Operator-The heuristic disband operator is applied to the child. This operator is used to make the closest cluster. The individuals belonging to the cluster with the minimum intracluster similarity are placed in the closest cluster [32].

viii. Merging-It is a variation of the mutation operator which can be applied if two binary chromosomes are similar. The merging operator flips some of the bits in a chromosome from '0' to '1' or '1' to '0' according to a pre-specified probability of mutation. If the resultant chromosome has valid values, it gets merged into the current cluster. Otherwise, if the resultant chromosome contains an invalid cluster medoid then its fitness is then set to zero to prevent it from surviving in the next generations [33].

c. Crossover- Crossover is a genetic variation method in which a portion of the genetic material of two individuals in a population gets interchanged. The following are a variety of crossover techniques used for evolutionary and adaptive systems by researchers-

i. Two-point cross over-In a two-pointcrossover; the two crossover points are randomly chosen. If both parents share the same genes adjacent to crossover points, the chromosomes are aligned at that point. If this alignment occurs at both points, the crossover is performed else recombination has occurred. In the crossover, offspring with one copy of each gene is survived and enter the next generation. While offspring with a gene deletion or duplication will die without entering the next generation. This prevented the loss of genes during crossover[29]. Two-point crossover is also used as a length-changing operator. If two parents have a different number of genes within the range, both genomes will exhibit length changes after crossover. When only a single gene is swapped between genomes, a simultaneous insertion and deletion operation occurs [28].

ii. One-point crossover-The one-point crossover operation is a simple process and is performed according to a specified probability [33].

iii. Multipoint crossover-Multipoint crossover operator exchanges the genetic material in two chromosomes at more than one point with a crossover rate of 1.0. This crossover induces more vigorous offspring than other types of crossovers [39].

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iv. Uniform crossover, hybrid crossover, and hybrid crossover2- Three different crossover operators altogether are used to generate the offspring. The uniform crossover operator generates offspring by randomly selecting each gene from the two parents. The hybrid crossover1 (hc1) operator hybridizes the single-point uniform crossover by selecting one crossover point in the parent and then the offspring is generated by replicating each gene from the parent to the offspring till the crossover point followed by taking the remaining genes from either of the parents randomly. The hybrid crossover2 (hc2) operator is a two-point uniform crossover operator where two crossover points are selected in parents and the offspring is generated by following the same steps as used with the hc1 operator [19].

v. Heuristic Uniform Operator-This operator is a heuristic uniform cross-over operator. It is a graph-based operator in which one unprocessed node and one parent are selected randomly and grouped into a cluster. This process continues until all vertices are covered. As can be seen, as a result of this process, the number of clusters in the child may be equal to or different from both of the parents. However, it still contains partial clustering information from its parents [32].

vi. Crossover Pool - A pool of genes containing information related to all combinations will be created from which the actual genes of the offspring will be selected at random. Clusters from different individuals may not have common elements, if this is the case, the contribution of that particular cluster combination will be double, and both cluster centroids will be in the pool of genes [35].

d. Inversion-The inversion operator for crossover was introduced by Pepper (2013). Inversion occurred in each offspring with a specified probability. In this, two points between loci are chosen with uniform probability and the genes between them were reversed in order. An inversion rate of 0.001 was chosen for this study [29].

e. Reallocation-The centroid location represented in the genes of the offspring must be reallocated towards the center of mass of the cluster they represent[35].

f. Merging-Each chromosome from the current population will be taken into consideration, observing whether there are other chromosomes similar to it behind a certain threshold called merging radius. If that should be the case, the best one from the group will be kept, and the others will be deleted from the population [31].

Offspring

There are some conventions to generate offspring after reproduction. No new offspring is accepted in the population [6]. Offspring are created by mutating and recombining each parent twice. Hence, a total of six offspring is generated per parent genome per generation [28].

CONCLUSION

The present manuscript is an attempt to give readers a systematical and clear view of the parameters important to implement a novel adaptive evolutionary algorithm for biological sequence analysis problems. The present work introduces the core idea of nature-inspired adaptive evolutionary clustering algorithms and their sources. The manuscript specifies various parameters to implement anature-inspired adaptive evolutionary algorithm to solve various biological sequence analysis issues. A limited study has been performed to date in this area. Therefore, various parameters pertaining to evolutionary and adaptive clustering algorithms were investigated in the survey. All these parameters are indispensable and crucial to be considered before developing a nature-inspired adaptive evolutionary algorithm.

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Table1. Salient features of various adaptive/evolutionary computational models

S.No.	Computational Model	Salient Feature	Reference
1	Dynamic Partitioning	• Dynamic Clustering Algorithm • Use variable-length genome • Apriori declaration of the number of clusters is required	[28]
2	Evolved Epistatic Clustering	• Epistatic clustering increasesthe rate of adaptation • The rate of adaptation is more under crossover • It is possible to evolve epistatic clustering itself using natural selection	[29]
3	Incremental evolutionary clustering	• Merging and Splitting operators used for natural selection	[30]
4	Chromodynamics based metaheuristics	• Maintain multiple-optima	[31]
5	Graph-based clustering	• Use multiple clustering criteria • The number and size of clusters are not required to be provided	[32]

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6	k-medoid based adaptive genetic algorithm	• Adapt crossover and mutation operators • For handling for handing static features and time-series data	[33]
7	Chromosome reorganization	• Prevents convergence to local maxima • Adaptive crossover and mutation	[34]
8	bi-objective clustering	• Centroid keeps reallocated until convergence	[35]
9	differential evolution	• Differential adaptive evolution	[19, 36-38]

Table 2: Implementation of the population in adaptive evolutionary clustering algorithms

Type	• Single Population • Multiple Population • Sub-Population
Adaptation	• Self Adaptive • Iterative
Representation	• Binary coded • Records of a dataset
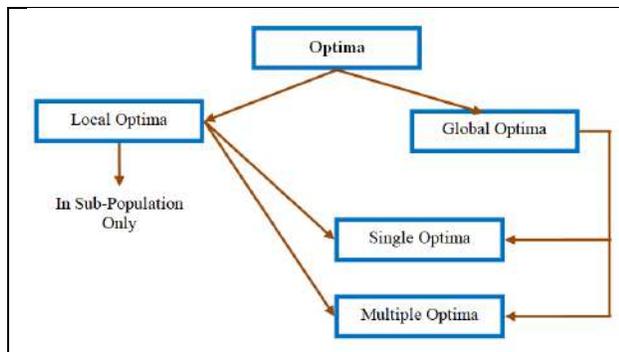
Figure 1: Types of optima used in adaptive evolutionary clustering algorithms
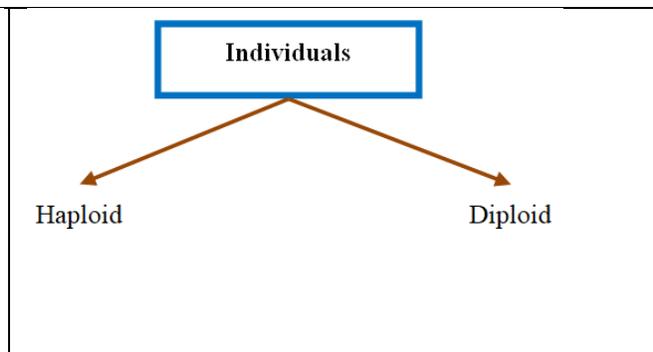
Figure 2: Types of individuals in adaptive evolutionary clustering algorithms
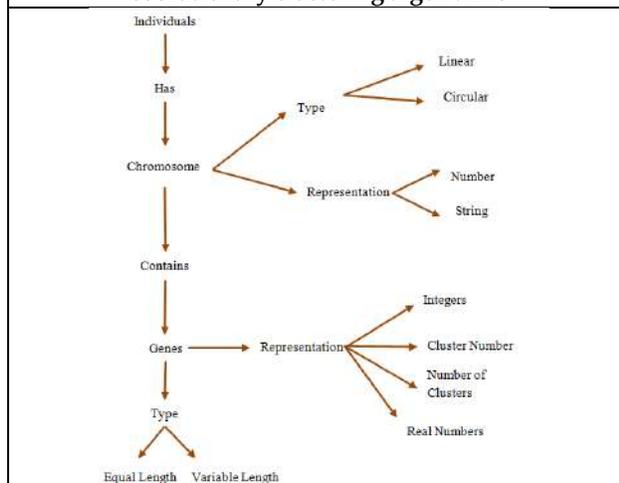
Figure 3: Concept map for chromosome implementation
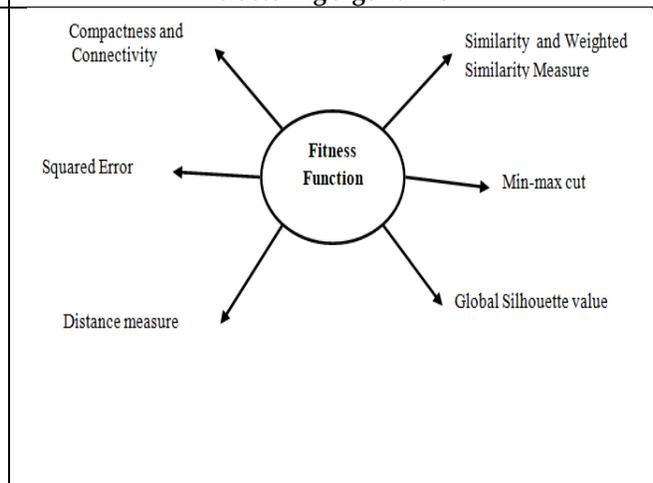
Figure 4: Fitness Functions used in adaptive evolutionary systems

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Figure 5: Selection Operators used in adaptive Evolutionary Systems

Figure 6: Genetic Operators used for adaptive and Evolutionary Systems

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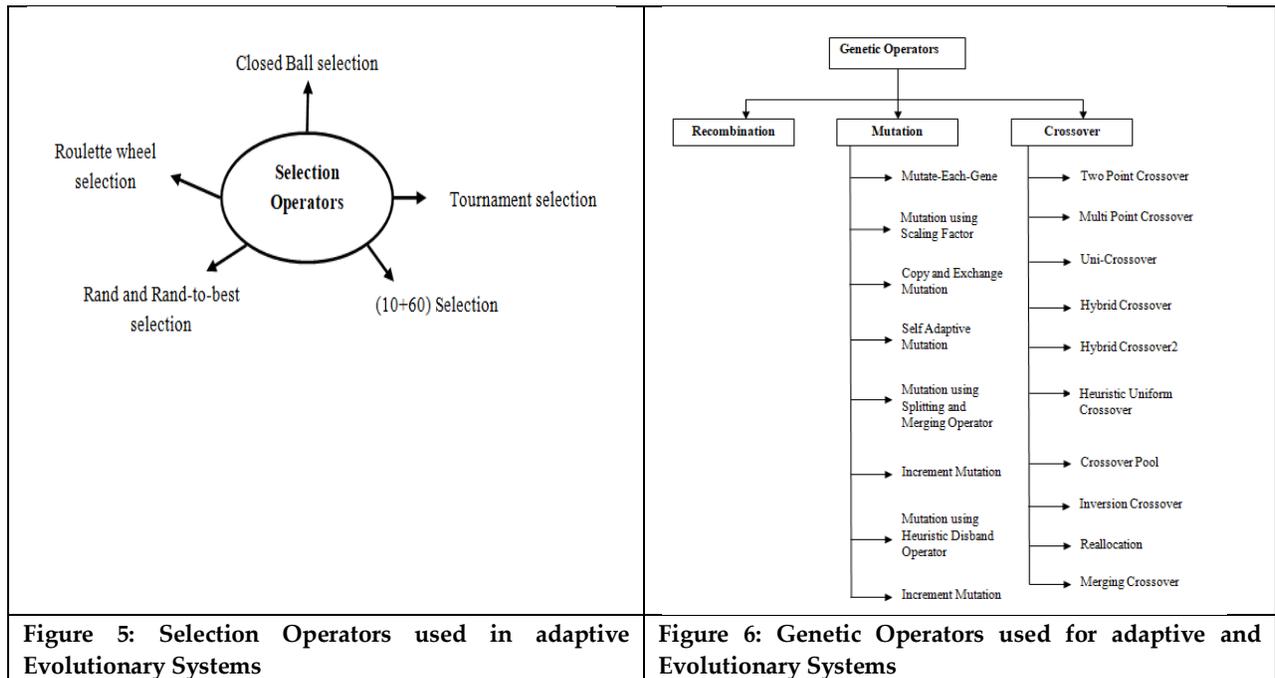
Isolation and Characterization of Alkaloid (Punarnavine) from *Trianthema decandra* Root Extract: A First Report

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ABSTRACT

Numerous medical treatises have recommended using a variety of herbal remedies alone or in combination to cure a variety of diseases. *Trianthema decandra* Linn., also known as gadabani in Hindi and vellai sharuni in Tamil, is a prostrate herb that thrives in tropical and subtropical climates all over the world. It belongs to the family Aizoaceae. In India, it is also extensively available. It has been approved for use in treating human diseases and ailments by several traditional medical systems. Since ancient times, it has been used to treat a wide range of maladies, including burns and wounds, several infectious diseases and bacterial infections, fever, toothaches, and hepatoprotective, analgesic, anti-inflammatory, and diabetic conditions, as well as other skin disorders. It is also renowned for its healing abilities. The alkaloid Punarnavine was first isolated from Trianthema decandra Linn root extract in the current investigation. The examination of Punarnavine found in the root extract of *Trianthema decandra* is covered. Chromatographic methods including TLC, ^{1}H-NMR, ^{13}C-NMR spectrum, GC-MS, as well as

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non-chromatographic methods like UV-Vis spectroscopy and Fourier Transform Infra-Red (FTIR) are used.

Keywords: Punarnavine, Isolation, NMR, GCMS, First report.

INTRODUCTION

Numerous secondary metabolites found in plants, such as tannins, terpenoids, alkaloids, and flavonoids, have been shown to exhibit biological functions such as anti-microbial, antioxidant, anticancer, and others. These compounds can be very important in therapeutic approaches [1]. The therapeutic benefit of plants, which number over 7,000 species, is attributed to chemical compounds that have a specific physiologic effect on humans[2], [3]. Alkaloids are often extracted from plants and biosynthesized from amino acids to produce a variety of chemical structures [4]. Both human treatment and an organism's natural defence depend heavily on alkaloids. About 20% of the known secondary metabolites found in plants are alkaloids [5]. Alkaloids in plants shield them against pests and control their growth [6]. Alkaloids are particularly well known for their therapeutic uses as anaesthetics, cardioprotectants, and anti-inflammatory drugs. In clinical contexts, well-known alkaloids including morphine, strychnine, quinine, ephedrine, and nicotine are employed [7]. The interest in bioactive natural products has recently increased due to both a very pro-active development in the field of conventional medicine (ethnopharmacology) and their potential in drug discovery [8].

Family Aizoaceae, often called Mesembryanthemaceae, is a group of succulent plants native to South Africa. There are 127 genera and about 2500 species in Aizoaceae [9], [10]. Trianthema, Malephora, Lampranthus, Aptenia, Drosanthemum, and Glottiphyllum are the genera that can be found in Asia [11]. Members of the Aizoaceae family have been used to identify more than 188 compounds from various classes. The value of Aizoaceae species as candidates for phytochemical and biological investigations has been made clear by the discovery that they are responsible for a wide spectrum of therapeutic activity, including antioxidant, anti-inflammatory, anti-hepatotoxic, anticancer, and antibacterial capabilities [12]. There are 20 species in the genus Trianthema, although only a few have been studied for their phytochemical content. Three species' phytochemical characteristics are known to be from India. Only a few compounds from the genus Trianthema have had their structures determined, including a trianthenol (15-hydroxymethyl-2, 6, 10, 18, 22, 26, 30-heptamethyl-14-methylene-17- hentriacontene) [13], a flavonoid (5, 2′-dihydroxy-7-methoxy-6, 8-dimethylflavone) [14] Nonacos-1-en-4-one, a ketone from *T. pentandra*, was crystallized by Misra and Tiwari, [15], and neolignan and ecdysteroids were isolated from *T. turgidifolia* [16]. *Trianthema decandra* and its species are utilized for anti-inflammatory, anti-hyperglycemic, hepatoprotective, and antioxidant purposes in traditional medical systems like Ayurveda and Unani. Terpenoid, alkaloid, and flavanoids are just a few of the many phytochemicals that have been identified from this genus, but not from this species [17]. *Trianthema decandra* has been the subject of studies in the past, and the extract showed pharmacological action [18]. We are now reporting a novel alkaloid called punarnavine that was isolated from *T. decandra* root extract for the first time. Punarnavine has the chemical formula $C_{17}H_{22}N_2O$ and a melting point of 236-237 °C [19]. Punarnava has punarnavoside, which has been found to offer a variety of medicinal benefits, including diuretic [20], antifibrinolytic [21], anticonvulsant [22], and antibacterial characteristics [23]. Researchers found that this plant's extract has anti-inflammatory, analgesic, and hepatoprotective properties [24], [25], [26]; immunomodulatory; and anti-proliferative properties [27], [28], [29], [30]. The objective of the current work is to isolate, purify, and characterize the bioactive molecule punarnavine from *Trianthema decandra* root extract. This was done using chromatographic methods such TLC, ^{1}H-NMR, ^{13}C-NMR spectrum, GC-MS, as well as UV-vis and Fourier Transform Infrared spectroscopy (FTIR).

MATERIALS AND METHODS

Preparation of Solvent Extracts by Soxhalation
A 200 g of shade-dried root powder sample was taken in a thimble and extract were collected by using the solvent chloroform [31]. Then, the filtrate was concentrated by a rotary evaporator (Buchi R200 Rota vapor) and the sample were collected, labeled and were kept at 4 °C in a refrigerator for further use.

Isolation of Punarnavine
The Manu and Kuttan method was used to isolate the alkaloid punarnavine from the plant [32]. A Soxhlet device was used to extract 25g of powdered medication with 95% ethanol at 70 °C until the syphoning solution was colourless. The extract was dried in a water bath at 50–60 °C after the solvent was recovered using distillation. The filtrate was dried out to a dry consistency, leaving behind sticky substance. To remove potassium nitrate, this was extracted with hot water and concentrated. It was filtered, the filtrate was made ammonical, and chloroform was used to extract it repeatedly. The extract of chloroform was evaporated, and the resulting residue was then macerated with diethyl ether. After that, it evaporated, producing amorphous punarnavine. Punarnavine was also extracted with diluted HCL from the sticky material that was left over after the water extraction. Punarnavine that had become amorphous was subsequently crystallized from a little amount of ethyl alcohol, and it was once again purified through recrystallization. Punarnavine that has crystallized has a 235 °C melting temperature. The solvent system (30:70) diethylamine: cyclohexane was used for the thin layer chromatography of crystallized punarnavine. With the help of treated $FeCl_3$, the isolated chemical Punarnavine underwent additional qualitative analysis to produce a green colour. With $FeCl_3$, concentrated H_2SO_4, red with HNO_3, no colour with HCl, a black precipitate with KI_3, a blue colour followed by a blue precipitate with phosphomolybdic acid, a greyish white precipitate with phosphotungstic acid, and a brown precipitate with Dragendorff's reagent, the isolated compound produced positive results for the alkaloid Punarnavine.

UV and FT-IR Spectroscopic analysis
Using a Perkin Elmer Spectrophotometer, the collected sample was scanned in the 200-900nm wavelength range, and the distinctive peaks were found. Utilizing a Perkin Elmer Spectrophotometer system, FTIR analysis was carried out in order to identify the distinctive peaks between 400 and 4000^{cm-1} that correspond to each compound's functional groups. Recorded were the FTIR and UV peak values. Each analysis was carried out twice to confirm the spectrum.

NMR Spectroscopy
Thin Layer chromatography was used to further purify the collected fractions after the plant extract had been divided into fractions using Column chromatography. With 5 mg of the purified chemical dissolved in DMSO, the NMR experiment was performed on a BRUKER-AMX400 MHz equipment. Chemical shifts are expressed in ppm and referenced to tetramethylsilane as the internal standard.

Mass Spectrum Analysis
The JEOL GC MATE-11 HR Mass spectrometer was used to analyze the sample using GC-mass spectrometry (GC-MS). The DB 5 MS capillary column (30 m x 0.25 mm i.d., film thickness 0.25 μm) was used for the chromatography. At 70ev, the mass spectrometer was run in electron impact mode. The temperature of the transfer line and ion source was controlled at 250°C. Positive ion mode mass spectra with a mass range of 50 to 600 m/z were captured. A computer or integrator converts the individual signal peaks from the electrical signal that the detector produces from the number of molecules into a graph.

RESULT AND DISCUSSION

Isolation and crystallization of Punarnavine identified by TLC

The   thin   layer chromatography for crystallized punarnavine was performed using solvent system diethylamine: cyclohexane (30:70).   In the present study we observed the Rf value was 0.88, which confirmed the presence of a single constituent, punarnavine (Table 1& Figure 1). The similar R_f value (0.87) was observed by an earlier report by Dhingra and Valecha [33]. In earlier punarnavine compound was isolated from *Boerhaavia diffusa* leaves extract, the R_f value was observed in TLC showed a single band (R_f= 0.87) [32].

UV Spectrum analysis of Punarnavine

In the present study, the **UV** λ_{max} value of Punarnavine was found to be 260.23nm and represent in figure 2. An investigation conducted by Imad Ahmad *et al.* [34] explained that punarnavine showed maximum absorption at 262 nm in UV spectroscopy which is in resemblance to our findings [34]. The results of the UV spectrum study supported the presence of punarnavine.

FTIR Spectrum analysis of punarnavine.

The FT-IR is prove to be a valuable tool for the characterization and identification of compounds or functional groups (chemical bonds) present in an unknown mixture of plant extracts. The FTIR spectrum of the plant extract is given in Figure 3. The FTIR analysis of plant extract gave a broad peak at 3402.22cm^{-1} which indicated the presence of phenyl group. Peaks from 2900.17 cm^{-1}represent alkane C–H stretching and peaks at 1648.94cm^{-1} represent C=C stretch which indicated the presence of alkenes. Peaks at 1295.43cm^{-1} C-N stretch attributed to aromatic amine present whereas 1718.06 shows –C=O stretch which indicates the presence of ketone. Our finding of the alkaloid has major functional groups reported by Erick Korir *et al.* [35] and the results of the study supported that Punarnavine has aromatic and phenyl groups present.

¹H-NMR spectrum of Punarnavine

NMR spectrum showed characteristic resonances for Punarnavine type alkaloids at δH 3.67, δH 3.77, δH 2.90, δH 2.11, δH 2.83 and δH 2.04 as well as for the methylene groups which both overlap as a multiple at δH 2.62, and proton resonances which appear at δH 0.98 (m) and δH 1.45 (m) respectively (Figure 4). The proton resonances at positions 10 and 15 are all shielded since they are adjacent to the nitrogen atoms at position 1 and N-methyl at δ 2.1-3.6 while appearance for aromatic group between δ 10 and 12.5. It was characterized as punarnavine. Alkaloid was reported by Tanahashi *et al.* [36] and Kashiwaba *et al.* [37].

¹³C -NMR spectrum of Punarnavine

Supporting evidence for the structure of the punarnavine was provided by the analysis of ¹³C-NMR data and a complete assignment is given in figure 5. Punarnavine characteristic peaks in ¹³C NMR spectrum for carbonyl (δ 162-177), methoxyl (δ 52-58.2), and oxygenation substituted aromatic carbon (δ 147-162), methylenedioxy (δ 94-104) and N-methyl (δ 24-44). The peaks present in the NMR spectrum showed resemblance with the Alkaloid which was also confirmed by previous literatures [36], [37]. Thus, it can be confirmed that the isolated compound is found to be punarnavine.

Mass spectrum of the isolated compound Punarnavine

The mass spectrum of the isolated compound is illustrated in **figure 6.** A base peak [M]$^+$ for the compound was observed at m/z 309.36 in the mass spectrum indicating the compounds as Punarnavine. The molecular formula was inferred from $C_{18}H_{15}NO_4$. This result agrees with an earlier report by Imad Ahmad et al. [34] who reported that mass spectrum peak 309.32.was found to be Punarnavine isolated from extract.

Isolated Punarnavine

Based on the chemical and spectral data evidence have been characterized as an isolated compound was Punarnavine (2-(2H-1,3-Benzodioxol-5-yl)-7-methoxy-1-methylquinolin-4(1H)-one) (MF: $C_{18}H_{15}NO_4$) (Figure 7)**.** Previously, Punarnavine, a quinolizidine alkaloid isolated from *Boerhaavia diffusa* is known to possess analgesic, antiinflammatory, hepato-protective, immunomodulatory and anti-proliferative properties [30].

CONCLUSION

The secondary metabolites derived from natural sources are the potent maneuver for drug discovery and development. Present study has suggested that *T. decandra* is a potential source of bioactive compounds which is evident by the phytochemical analysis. It is the first ever report on the isolation and characterization of bioactive compound punarnavine from *T. decandra*. Further investigations on the anticancer properties of punarnavine are in progress to validate their anticancer efficacy, by assessing their effect on induction of cell cycle arrest, apoptosis, DNA damage and expression of tumor suppressor genes in human cancer cells.

Conflict of Interest

The authors declare no conflict

ACKNOWLEDGEMENT

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Table 1: Punarnavine identified by TLC

Sample (S)	Sample/Solvent (cm)	R_f value (n = 4)
Isolation sample	4.90/5.50	0.88±0.01
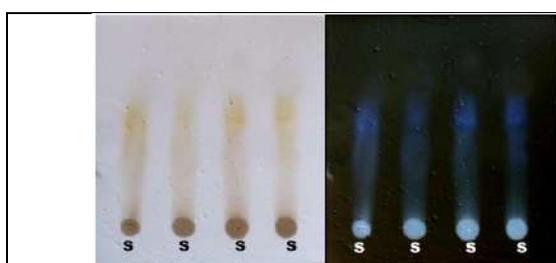
Figure 1: Thin layer chromatography of punarnavine
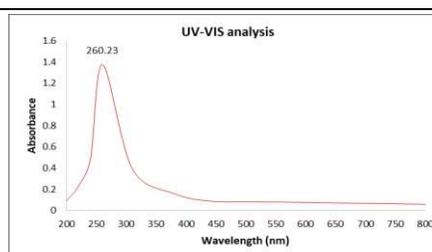
Figure 2: UV Spectrum of punarnavine
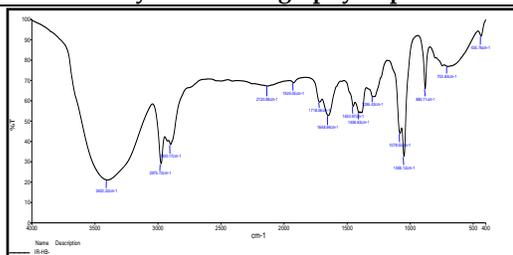
Figure 3: FTIR Spectrum of punarnavine
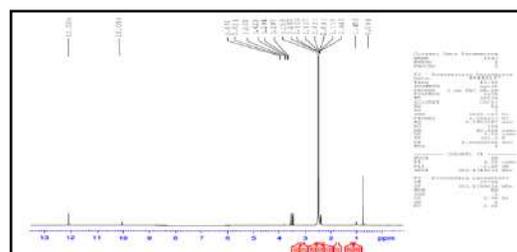
Figure 4: ^{1}H -NMR spectrum of punarnavine
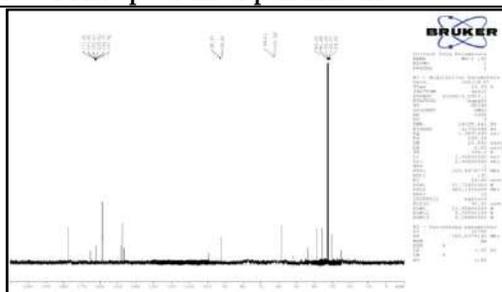
Figure 5: ^{13}C -NMR spectrum of punarnavine
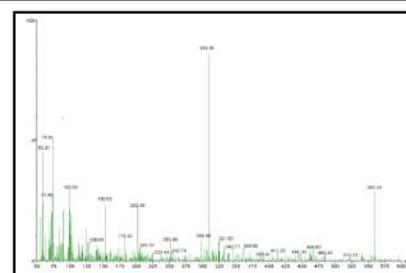
Figure 6: GCMS mass spectrum of punarnavine
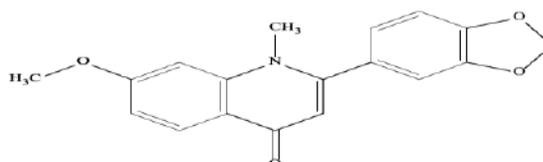
Figure 7: The chemical structure of Punarnavine

RESEARCH ARTICLE

Influence of Dimethyle Sulfate on Direct Multiple Shoot Induction and SDS-PAGE Analysis in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

The present part of the research work was undertaken to analyze the role of BAP in terms of multiple shoot induction with special reference to know the effect of dimethyl sulfate on *in vitro* cultured cotyledonary nodal segments of groundnut. Among the various concentrations, 12.0 mg/l of BAP plus 1.0 mg/l of IAA was found to be the most effective in terms of multiple shoot formation. For mutagenic treatment, the pre-cultured cotyledonary nodal segments were transferred to DMS introduced media and again sub-cultured on fresh shoot induction medium. The growth parameters like percentage of response, number of shoots per culture, shoot length, fresh and dry weight also highly influenced by the various concentrations of DMS. The SDS-PAGE analysis of regenerated shoots showed variations in protein banding pattern in treatment with DMS.

Key words: *Arachis hypogaea* L. Multiple shoot induction, Dimethil sulfate and SDS-PAGE analysis.

INTRODUCTION

Groundnut, also known as peanut (*Arachis hypogaea* L.) is an important leguminous oil crop Sharma and Anjaiah, (2000). It is cultivated in over 100 countries world wide over 24 million hectares of land with a total production of 38 million tons FAOSTAT, (2010). Groundnut seed contains about 43-55% oil and 25-28% protein which are important to human and livestock nutrition Gohari and Niyaki, (2010). Groundnut also contributes to income generation to farmers through trade, provides fodder for livestock and helps improve soil fertility through nitrogen fixation Giller *et al.,* (2002).

Plant tissue culture methods have a wide scope for the creation, conservation, and utilization of genetic variability for the improvement of field, fruit, vegetable, and forest crops and medicinal/aromatic plants. Micropropagation technology ensures true-to-type, rapid, and mass multiplication of plants for quick bulking up of new varieties and rejuvenation of old varieties. *In vitro* culture in combination with mutagenic agent is an effective method for enhancing variability.

Mutations are the tools and being used to study the nature and function of genes which are the building blocks and basis of plant growth and development, thereby producing raw materials for genetic improvement of economic crops Adamu *et al.,*(2007). Mutation methodology has been used to produce many cultivars with improved economic value and study genetics and plant developmental phenomena Van, Den-Bulk *et al.,*(1990); Bertagne – Sagnard *et al.,*(1996).The seed storage protein were analysis helps in identification and characterization of diversity in crop varieties, cultivars and their wild varieties and also provides information on phylogenetic relationship of the accession Nisar et al.,(2007); Tanksley and Jones (1981); Thanh and Kirata (2000).

MATERIALS AND METHODS

The commonly cultivated groundnut cultivar TMV-7 was obtained from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The seed of groundnut cultivar TMV-7 was used as experimental material for *in vitro*/aseptic germination to collect nodal segments.

Aseptic germination
The sterilized seeds were aseptically transferred to pre-sterilized culture tubes containing moistened cotton. Then the culture tubes were maintained in culture room. After 7 days, the cotyledonary nodal segments were excised and inoculated in the multiple shoots induction medium.

Multiple shoot induction medium:
The isolated cotyledonary nodal segments were inoculated on multiple shoot induction medium containing different concentrations of BAP (3 to 15 mg/L) and IAA(1.0mg/L).

Treatment of chemical mutagens
For treatment with DMS, the known quantity of DMS was mixed in MS basal medium and dissolved thoroughly. The pH of the medium was adjusted to 6.0 for DMS prior to mutagenic treatment. The solutions were then brought in to the laminar air follow chamber and sterilized using millipore filter unit with the help of vacum pump. After filter sterilization, the DMS was mixed with sterilized shoot induction medium (2.0 to 10.0mM). The pre-cultured cotyledonary nodal segments grown in shoot induction medium were transferred to DMS introduced media and kept for 48 hrs. After mutagenic treatment, again the cultures were transferred to fresh shoot induction medium.

Calculation
The number of shoots/ culture, shoot length, were calculated and taken as average for each concentration of BAP and DMS treatment on 45th day.

Qualitative of protein analysis was carried out through   Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE) .*Reagents (Laemmli, 1976) methods*

RESULTS

Effects of BAP with IAA on multiple shoot induction from cotyledonary nodal segments.
The cotyledonary nodal segments collected from aseptically   germinated seedlings of groundnut cultivar TMV-7 were inoculated on multiple shoot induction medium containing MS+B5 with BAP 3.0 to 15.0 mg/l with single concentration of IAA(1.0mg/l). The excised cotyledonary nodal explants of groundnut showed a well defined morphogenetic responses in MS medium with B5, vitamins and supplemented with various concentrations of BAP+IAA. Among these, maximum number of shoots have been noticed in 12.0mg/l BAP with 1.0mg/l of IAA. Like that, shoot length ,fresh weight and dry weight also increased with higher concentrations of BAP. The percentage of responses was recorded from 52.0 to 80.0 likewise number of shoots from 3.2 to 5.2. The fresh and dry matter production also noticed from 0.46 to maximum of 0.72 and the dry weight are observed from 0.04 to 0.019. The BAP concentration above 12 mg/l reduced all the characters studied. (Table: 1).

Effect of DMS on multiple shoot induction from cotyledonary nodal explants of groundnut
The cotyledonary nodal segments were excised from aseptically grown seedlings of groundnut and inoculated on shoot induction medium containing 12.0 mg/l BAP along with IAA 1.0mg/l. After 15 days of inoculation, the responsive cultures have been transferred to dimethyl sulfate introduced media (2.0 to 10.0 mM) for 48 hours and again transferred to the same multiple shoot induction medium. After 45 days ,several growth parameters were measured in mutagen derived cultures and control. The dimethyl sulfate introduced media influenced the growth parameters like   percentage of response, mean number of shoots, shoot length, fresh and dry matter production. The above said characteristics were increased up to 6.0 mM concentration of   DMS. Then there was a significant reduction in 8.0 and 10.0 mM DMS. (Table -2) The maximum number of shoots (17.0)were noticed in 6.0 Mm DMS followed by 12.0 and 9.0 in 4.0 and 2.0 Mm DMS. The maximum reduction in shoot number was noticed in 10.0 mM (3.6). But in control, the highest number of shoots were 6.5 .

Like that of number of shoots , the shoot length also increased gradually up to 6.0 Mm DMS in control shoot length was   1.4 cm but it was increased up to 2.9 cm in 6.0 Mm DMS followed by a maximum reduction of 0.89 in 10.0 Mm DMS. In control the mean value of shoot length was 1.4 cm. In addition with number of shoots and shoot length, the fresh and dry weight also measured in control and DMS derived shoots. The maximum fresh weight was 2.93 gm in 6.0 Mm and the minimum of 0.89 gm in 10.0 Mm DMS. At the same time, in control it was 1.4 gm . The same tendency was also found in dry matter production.

DISCUSSION

Like that of our present study, the significant role of BAP for shoot differentiation in legumes have been reported previously by Gulati and Jaiwal (1994). The percentage of shoot bud differentiation and the mean number of shoot per culture increased at higher concentrations of cytokinin in combination with auxin (Palanivel *et al.*,2002). In our study the KIN and BAP concentrations up to 12 mg/l increased the multiple shoot formation. Above 12.0 mg/l inhibited the shoot bud, and multiple shoot development. These could be due to the genotypic variation. Our results are in agreement with the findings of earlier workers (Benerjee, 2007:Radhakrisahnan,1996)

In this present research work, direct organogenesis was achieved in cotyledonary nodal segments. The direct organogenesis was reported by various authors. (Palanivel and Jayabalan,2002) reported direct multiple shoot induction from different mature seed explants mature seed explants of groundnut. But seed explants required higher concentrations of cytokinins than seedling explants like cotyledonary nodal segments used in this study.

(Kanyand Matand *et al.*,2013) also reported more improved peanut(*Arachis hypogaea* L.) protocol for direct shoot organogenesis in mature cotyledonary and root tissues. The groundnut seeds treated with different concentrations of DMS and germinated aseptically for 7 days and then cotyledonary nodal segments were excised and subjected to multiple shoot induction. The lower concentrations of DMS showed possitive response up to 6.0mM. The enhanced effect of mutagenic agents has been reported by several authors.

In general *in vitro* mutagenic studies were very limited in our study lower concentrations of DMS enhanced the various parameters. Like this (Muthusamy *et al.*,2007) reported the effect of mutagens on somatic embryogenesis and plant regeneration in groundnut. They induced embryogenic calli from hypocotyl explants of groundnut and treated with gamma ray, EMS and Sodium azide. The mutated embyogenic calli showed positive response in items of somatic embryo development and plantlet regeneration in lower concentration mutagenic agents. The mutagens have been used to induce mutations in callus culture of groundnut (Venkatachalam and Jayabalan,1997 b).

In our study, the lower concentrations of DMS showed positive response but the higher concentration exhibited negative response the similar study was reported by (Swanson *et al.*1989). They suggested that the mutagenic treatments followed by tissue culture of explants the number of shoots regenerated from each explants at the lower doses, whereas it decreased proportionally with increasing of dosages. Similar observed were reported in *Gerbera* (Laneri *et al.*,1990), *Asparagus* (Delberil and Julien 1994), *groundnut* (Venkatachalam *et al.*,1999),Venkatachalam (2000),

In our study, SDS-PAGE was carried out in control and DMS treated multiple shoots from cotyledonary nodal segments of groundnut But, the mutagenic treatment and electrophoretic analysis in *in vitro* condition is almost absent. Vijayageetha(2011) carried out SDS-PAGE electrophoresis in mustard cultivars. Turi *et al.*, (2010) studied the total seed storage proteins in indigenous *Brassica* species based on SDS-PAGE analysis. Recently Muniappan *et al.*, 2016 analyzed the seed proteins in different groundnut cultivars.

CONCLUSION

The present study is useful to understand the effect of Dimethyl sulfate in combination with *in vitro* culture of groundnut. Moreover, this part of the research finding is a preliminary approach to evolve mutants of groundnut through in vitro mutagenesis.

ACKNOWLEDGMENT

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Table-1. Effect of BAP in combination with IAA on multiple shoot induction from cotyledonary nodal segment of groundnut cultivar TMV-7(Mean±SD)

S.No	Hormones mg/l BAP+IAA	Percentage of response	No.of. Shoot	Shoot length	Fresh weight	Dry weight
1.	3.0+0.5	52.51±2.50	3.25±0.707	2.7 ±0.141	0.51±0.067	0.04±0.020
2.	6.0+0.5	64.03±5.00	4.5 ± 0.433	2.87±0.147	0.57±0.043	0.05±0.010
3.	9.0+0.5	68.57±3.33	6.2 ± 0.57	2.97±0.147	0.62±0.053	0.06±0.007
4.	12.0+0.5	72.89±2.83	9.6 ± 0.95	3.45±0.304	0.72±0.045	0.07±0.024
5.	15.0+0.5	80.31±6.10	5.25 ± 0.5	3.07±0.129	0.46±0.038	0.04±0.019

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Table: 2. Effect of DMS on multiple Shoot induction from cotyledonary nodal segments of groundnut (Mean±SD)

S.No	Treatment DMS	Percentage of Response	No.of Shoots	Shoot Length(cm)	Fresh Weight(gm)	Dry Weight(gm)
1	Control	77.20±1.15	6.56±1.15	2.95±0.91	1.44±0.13	0.28±0.44
2	2.0mM	81.12±2.24	9.33±1.15	3.17±0.26	2.00±0.21	0.32±0.03
3	4.0mM	83.44±1.74	12.33±1.52	3.87±0.77	2.54±0.17	0.38±0.02
4	6.0mM	90.20±2.14	17.33±3.05	4.45±0.51	2.93±0.19	0.43±0.01
5	8.0mM	72.33±2.11	5.0±2.0	2.12±0.27	1.59±0.19	0.24±0.03
6	10.0mM	61.54±1.33	3.66±2.08	1.22±0.45	0.89±0.10	0.11±0.15

Table :3. Rf Value on different protein bands of different concentrations of DMS based on SDS-PAGE.

S.NO	kDa value	Rf value	Control	2.0mM	4.0mM	6.0mM	8.0mM	10.0mM
1	11.2	0.0530	+	-	-	-	-	-
2	12.5	0.1071	+	+	+	+	+	+
3	22.3	0.2142	+	-	-	-	-	-
4	23.5	0.2858	+	+	-	-	+	-
5	26.4	0.3750	+	+	-	-	+	-
6	31.6	0.4464	-	+	+	-	-	-
7	43.1	0.5357	+	+	+	+	+	+
8	45.5	0.6071	+	+	+	+	+	+
9	51.2	0.6964	+	+	+	+	+	+
10	72.8	0.7678	-	+	+	-	-	-
11	75.5	0.8392	+	+	+	+	-	-
12	98.2	0.9285	+	+	-	-	+	-
13	105.4	0.9821	+	-	-	-	-	-
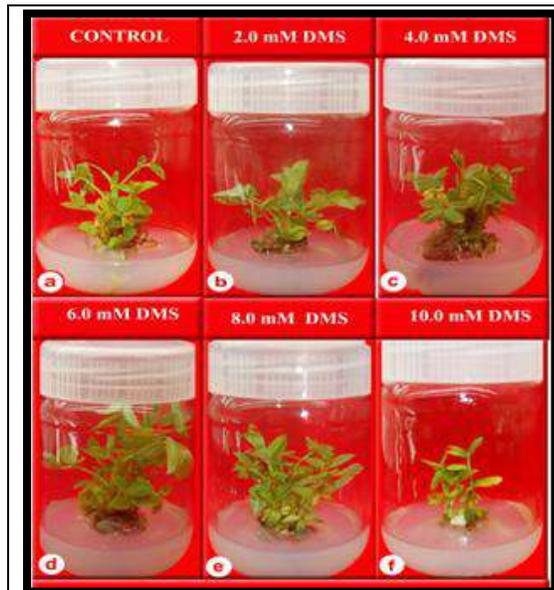
Plate: 1. Effect of DMS on multiple shoot induction from cotyledonary nodal explants in groundnut (*Arachis hypogaea* L.)
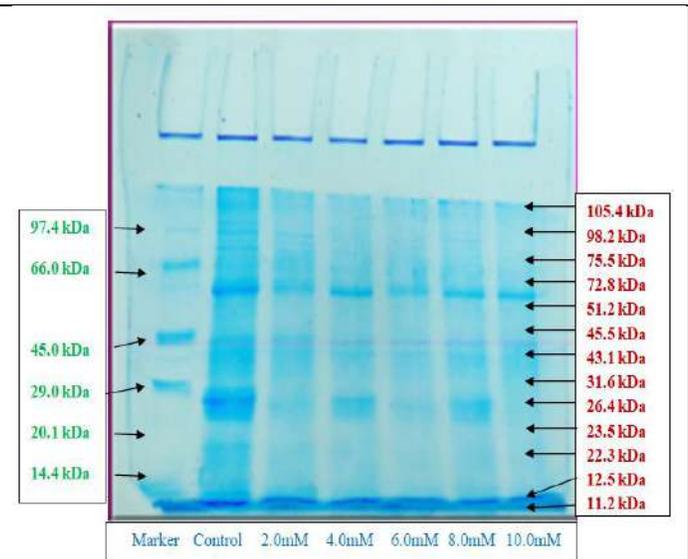
Plate: 2. SDS-PAGE analysis in DMS treated shoots of groundnut (*Arachis hypogaea* L.)

RESEARCH ARTICLE

To Assess the Practice in Plain Radiography in Terms of Radiation Protection

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ABSTRACT

The aim of this study was to assess the practice in plain radiography in terms of radiation protection, to determine the availability of radiation protection devices in X-ray unit for staff, patients and attendants and to monitor the protection measures taken to prevent unnecessary radiation. This study was conducted at a tertiary care hospital from December 2020 to May 2021. 30 patients and 10 patient's attendants were considered as sample of this study. Usage of radiation protection devices such as lead apron, thyroid shield, gonad shield, collimator and many more was assessed by using data capture sheets. It was found that in 20% cases only, lead apron was used on patients as a radiation protection device. Thyroid shield was used only in 6% of examinations. Radiation beam is restricted to the area of interest with the help of collimator in 66.6% of cases during patient's scan. Study shows that in 57% of cases lead aprons was used during lower extremities examination of patients. Patients' attendants included in the study were 70% male 30% female. It was also observed that 72% of male attendants had wear lead apron while supporting their respective patient's. It was observed that all the participants included in the study had good knowledge of radiation protection and their devices still to save time they avoid to opt radiation protection measures in maximum number of examinations. Probably due to the heavy workload in the radiology department or the number of patients the radiographers used to avoid radiation protection devices during each examination which may impact the results of the study. The analytical data analysis also impacts results.

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Keywords: X-ray Unit, Radiation Protection, Ionizing Radiation, Radiation hazards.

INTRODUCTION

Cosmic rays, Radon gas and naturally occurring radio-nuclides are common example of natural sources of radiation [1]. Alpha particles, beta particles, neutrons and protons are the example of particulate radiation, they travel in the form of particle beam. These radiations play major role in nuclear medical imaging. Neutron radiations produced by the process of nuclear reactions consist of mass and no charge is present. High linear energy transfer characteristics are present in neutron radiations and they can be highly penetrating. Radio waves, infrared rays, micro waves, ultraviolet radiations are some examples of electromagnetic waves. These radiations can travel from one place to another without any medium and with the speed of light. Electromagnetic radiation consists of characteristics of both waves and photons [2,3]. In contrast with the ionizing radiations, non-ionizing radiations are radiation which does not contain enough energy to ionize particular atom or molecule. These are the radiations present with lower frequency, higher wavelength and low energy as compared to ionizing radiations. Their energy can only cause excitation. Recently it was found that international agency for Research on cancer stated that there could be some harmful effects of non-ionizing radiations also [2]. In diagnostic radiology mainly X-rays are used to see internal organs of human body, they are electromagnetic waves of high frequency and very short wavelength due to which they acquire high penetrating power. Due to their high penetrating power, they can penetrate through various types of materials and can be used in diagnostic radiology and scanners of airport to see inner objects [3,4]. X-rays are ionizing in nature and cannot be felt through our senses. X-rays can cause harmful effect on body tissue, living cell in short time and can cause radiation sickness. A wide use of X-rays increases the risk of cancer, it signifies that X-rays are both useful as well as harmful in nature. In medical radiology X-rays are major source of radiation exposure. As we know that side-effects of X-rays cannot occur in few days, so the individuals who take long term exposure may suffer from side effects like hair loss, nausea, vomiting, weight loss, eye weakness, infertility, burning of skin, restlessness, mutation, cancer etc.

As the advancement in X-ray technology has increased, safety protocol has also been increased. Nowadays, the practice of radiation protection devices has been increased in radiology department to prevent harmful effects of ionizing radiation. Radiation safety devices help to develop safe relationship between employee, patients and staff. The demand of professional radiologic technologist has increased in healthcare industry because professional technologists are properly trained and have sufficient knowledge of radiation hazards and how they can be prevented. They have knowledge about the proper use of radiation protection devices. Demonstration of radiation hazards is very important for evaluation of necessary radiation protection and to prevent unnecessary exposure. The use of radiation protection devices reduces the risk of these effects. The lead lined garments are generally used in radiology department because lead has high atomic number and lead garments provide good safety from scatter radiation. It is heavy metal so it can absorb the X radiation and blocks further penetration. We can calculate the radiation dose by three different ways. The absorbed dose of radiation which deposit on an object can be measured in milli grays (mGy). The dose of equivalent can be measured in millisieverts (mSv). The effective dose is that dose which depicts total equivalent dose of particular organ of the individuals and can be measured in millisieverts (mSv)[5]. Direct interaction of ionizing radiation results in tearing of the cell membrane or break down of chromosomal structure, later these particles form abnormal structure results in chromosomal aberration by joining together in different form. In indirect interaction, radiation interacts with the molecules of medium and forms free radicals, these radicals then interact with the target molecules by breaking DNA bonds and interfering with cell function. The biological effects caused by ionizing radiation are like radiation sickness, chromosomal breakage, cell death. Degree of damage due to exposure is totally depends on rate with which radiation dose is delivered to the patient. Severe damage occurs when high magnitude radiation is applied in short period of time. For example: chromosomal damage can be noticed above 0.1Gy of dose.

When only a part of the body is exposed, it cannot be life threatening only serious local effects can be observed, danger of harmful effect by radiation exposure totally depends on the time for which person being exposed and rate of the exposure [6]. When the person is exposed to the radiation above threshold dose, he/she will definitely be affected. These effects are generally results of radiation accident and irradiation in radiotherapy as these effects occur only when someone is exposed with the high exposure. Deterministic effects can be completely prevented by reducing the amount of radiation dose. Some common deterministic effects are: epilation, cataract, organ atrophy, fibrosis, blood changes, skin erythema and radiation in sperm count [6]. Ionizing radiations are used in clinical radiography. To minimize the harmful effects from ionizing radiation, radiation protection devices are used for the protection of patients, staff and those who receive radiation during the study. In hospitals, there are many radiation protection devices available to protect patients and staff like Lead apron, thyroid shield, lead glasses, lead gloves, abdominal shield, gonads shield. These devices reduced the exposure dose and protect the patient from getting exposed.

It's the duty of radiologic technologist to read the philosophy, factors and rules that minimize ionizing radiation exposure to the patients. There are some other methods also to reduce radiation exposure dose like use of proper collimation, grids, filter and distance are directly related to amount of radiation exposure a patient receives. We can say that a 90% exposure reduction is possible when radiation protection devices are used in all radiologic examination. Radiation protection device must be provided against primary and scattered radiations [7]. Lead is most commonly used in diagnostic radiology because of its high atomic number which is 82. Shielding thickness is inversely proportional to exposure rate. More is the shielding thickness; less is the exposure rate. For diagnostic purpose, the recommended thickness of the lead shield is 0.5 mm. Personnel and patient shielding can be done by maximizing the distance between the radiographer and patient. Lead aprons, thyroid shield should be used by radiographer during exposure. For patient shielding, minimum exposure factor, proper collimation, use of filter are the measures that can be taken. Proper shielding and immobilization to the patients should be applied during radiography to prevent motion artifact, repeat exposure and to improve the image quality in single exposure. The purpose of radiation protection devices is to protect patients, staff and environment from the harmful effects of radiation. Personal protective devices are made of lead and lead-free material. Lead aprons, thyroid shield, lead glasses, abdominal shield are most commonly used in personal protective devices. In 1950s, radiologists start to shield reproductive organ and pregnant women foetus during exposure with the help of gonad shield. These are specially designed shield which helps in preventing radiation exposure to gonad area of the patient during radiographic procedure. Gonad shields reduce radiation dose to reproductive organ and prevent mutation, malformation, infertility due to unnecessary radiation exposure[8]. Thyroid shield can be used to reduce the effect of thyroid cancer during x ray study by radiation exposure. To protect thyroid gland the thickness of thyroid shield should be 0.5mm. Lead apron can be used as the primary radiation protective device used for radiographers, patients and attendant during X-ray procedure. It helps in reducing the gamma ray and X-ray which comes in direct contact of the body. Thickness of lead apron should be 0.25-1.5 mm thick.

Aprons should always hang on the wall mounted hanger. They are not foldable because lead may be damaged or cracked. When the aprons are not in use it should be handled properly. It can be used during skull x-rays, during x-rays of knee, elbow, ankle, feet, hand, wrist to protect the trunk of the body from unnecessary exposure. Aprons of higher thickness weigh about 50%- 100% more than the weight of 0.25mm thickness lead apron and provides much better protection than it. Sometimes radiologists or radiographers avoid to carry lead apron because of its high weight. Use of lead apron helps in protecting the torso region of the body only as it does not cover thyroid, eyes, face, skull, neck, arms and lower legs[6]. Lead glasses are important devices for the protection of eye from ionizing radiation. It is used by radiologists and any operator during study[10]. Lead glasses help in reducing about 30%- 70% effects of the radiation, it depends on the content of lead used during the production of glass. Lead glasses which are generally used in hospitals provides only 20% attenuation[6]. Reducing the m As is best way of radiation protection. As we know that exposure of radiation can be reduce by using higher kVp and lower mAs. Limitation of this technique is reduced image contrast due to the use of X-ray beam of high effective energy[6].

By using proper collimation, field size can be reduced which results in less scatter radiation and less radiation dose to the adjacent parts of the body. Hence, use of proper collimation and smallest possible field size reduces total dose delivered to the patient and increases image contrast. It also provides shielding from the leakage radiation[6]. Patient dose can be reduced by increasing source to object distance (SOD) because radiation intensity is inversely proportional to square of the distance from source to object. Increase in the value of SID (source to image distance) has clinical advantage also as by using 100cm or more SID maintains the quality of diagnostic information[6]. High frequency generators or constant potential generators can be used to reduce dose. So, use of optimal equipment like anti-scatter grid interspacing, low attenuation materials for cassette fonts are helpful in reducing patient dose[6]. It is necessary to use proper filtration as it helps in reducing the total amount of radiation delivered to the patient. As we know X-rays contains both high energy and low energy X-rays, high energy X-rays contributes in the formation of image while low energy X-rays are not able to penetrate deep so they are absorbed in the layers of skin which results in increment in the radiation dose to skin. Skin injuries by low energy X-rays can be avoided by using proper filters

which absorbs low energy X-rays selectively[6]. In general radiography:
1.5 mm Al filter is used below 70kVp
2.00 mm Al filter is used between 70kVp - 100kVp
2.5 mm Al filter is used above 100kVp [6]

Patient dose can also be decreased by using high speed image receptors. Lower speed image receptor requires high exposure while high speed image receptors require less exposure to produce same optimal density and helps in reducing radiation dose. Use of high-speed film-screens reduces the patient dose but it does not provide appreciable image quality[6].

There are some other principles used in radiation protection. Three basic principle of radiation protection advised by ICRP:
1. Justification
2. Optimization
3. Dose limit

Justification:
It is the valuable decision that may change the radiation exposure situation by providing more benefits and cause less harm. It means that to reduce the risk of biological damage, the procedure should be done with the aim of to do more benefit than harm to the patients. All radiation examination should be done if they help to treat a disease and help to diagnose or operate [11].

Optimization:
It means that the radiation protection should be done so that there will be maximum benefits and minimum harm. The exposure factors should be used based upon the indication of patients, patient weight, anatomical area scanned. To avoid unfair outcomes of optimization process, dose should be restricted [11].

Dose limit:
Total dose to any patient should not exceed the limit suggested by ICRP and reduce the dose at a level that are "As Low As Reasonably Achievable". This principle state that individuals are not exposed to high amount of ionizing radiation[11]. ALARA is used in radiation protection. It stands for "As Low as Reasonably Achievable". It is radiation protection principle and the purpose of this principle is to reduce the radiation dose and limits the use of radioactive material into nature by applying all reasonable methods. The requirement of ALARA is mandatory in all radiation protection programs. The purpose of this principle is to protect individuals from unnecessary radiation.

The three basic principle of cardinal rules are:
Time
Distance
Shielding

Time
Time spent in handling the radiation source is directly proportional to total dose received. Lesser the time spent near radiation source lesser will be the dose, if we increase the time spent in radiation area then the radiation dose will also increase. So, time of exposure should always be minimal.

Distance
Due to divergence of the beam, intensity of the radiation beam is reduced with increase in distance. It follows inverse square law. We can easily estimate the safe distance from the vector of radiation exposure and its initial intensity by using above law. It stated that the capacity of primary beam is inversely proportional to square of distance. If we double the intensity of beam then the distance becomes four times. Increasing the distance from radiation source is another important dose reduction technique. All people present in radiation area should stand as far away as possible from the radiation source. Proper distance should also be maintained between patient and source of the radiation for proper imaging and to avoid unnecessary exposure.

Shielding
Lead shielding use in radiology department to reduce radiation exposure. Commonly used materials for shielding are concrete, lead, lead glass or bricks to reduce or prevent transmission of radiation. Various types of shielding used in radiation protection such as lead aprons, lead gloves, lead glasses, gonad shields, pelvic shields, thyroid shields etc. These shielding are very likely to use when working in radiation zone. Any material which absorbs the radiation exposure is known as shield and these shield helps in reducing the dose of radiation to patient, staff as well as general public.

METHODS AND MATERIALS

A retrospective and cross-sectional type of study was conducted in Radiology department of Tertiary Care Hospital between 1st December 2020 to 30th May 2021. Demographically age, gender, type of study conducted, type of radiation protection measures taken during study and on the basis of clinical condition of patient were considered as study variables. Data was assessed both qualitatively as well as quantitatively. Total 40 people were considered as the sample of the study, which includes 30 patients who came with the requisition of X-ray examination and 10 attendants who were working as a staff member in the same hospital. Subjects were selected for this study with no age bar. Out of 30 patients 18 were males and 12 were female patients. Seven male and three female attendants were also included in the experiment. Study was conducted from 1st December 2020 to 30th May 2021. Primary data was collected by an observational method. During this survey all patients those who came for plain X-ray examination were observed to evaluate the radiation protection measures taken during the examination. Attendants those who came with the patient for X-ray examination were also observed to check weather radiation protection devices were given to them for their protection or not. Categories of patients those who were included in the experiment are: Patients with any age group, pregnant patients, paediatric patients, and patients with psychological illness. Road traffic accident patients, Medico-legal cases, uncooperative patients, patient under ventilation and patient with no requisition form were not included in the experiment. Patients and attendants were observed during examination. Data was collected on the basis of opted radiation protection measures during X-ray examination by using data capture sheet. Then collected data was compared with standard protective measures which should be taken during particular study. Microsoft excel, descriptive statistical tools, percentage, frequency, mean, proportions and contingency tables were used for description of the data. Three X-ray units were used for data collection of the study.

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These machines were installed in the X-ray unit of radiology department for the X-ray examination of patients namely:

● ALLENGER-525 (G-XR-20844): Analog X-ray system of Allengers-525 was used for the study.
● ALLENGER DigiX FDX (G-XR-102767): It was a diagnostic X-ray system for general purpose radiographic imaging. System consisted of ceiling mounted X-ray tube suspension with vertical bucky stand, and fixed patient bucky table.
● ALLENGER- MARS-50 (G-XR-20660)

In addition, with the X-ray units lead apron, lead gloves, lead glasses, gonad shield, thyroid shield, collimation and filters were included in the experiment for assessment. Data was analysed by using descriptive statistical tools, frequency mean and percentage. Data collection capture sheet was prepared with the columns of patient age, sex, name of examination, lead apron, thyroid shield, lead gloves, abdomen shield, collimator and filters column to assess how many times protective measures were taken or not. The researchers had monitored the study while the faculties of the department have supervised it. Data was collected on the basis protective measures taken or not taken during the examination.

RESULT

Cross-sectional study was done with the sample size of 30 patients and 10 attendants. Most of the patients were of age group of 16-30 years. Out of 30 patients, 18 were male and 12 were female patients. More than 80% female patients were in their reproductive age group. Table. 1 show that most of the patients included in the study were came for X-ray examination of vertebral column. Only 14% patients were coming for X-ray examination of skull and pelvis. More than 90% positive result was obtained while monitoring the use of lead apron in case of patients (Fig. 1). Lead apron was provided only to the patients who were going to have X-ray examination of extremities and skull while thyroid shield was given only to the one patient out of 14 patients (Fig. 2). During the examination of patients, gonad shield should be provided to 9 patients. From (Fig. 3), it was found that gonad shield was provided to not even a single patient. Similarly, lead gloves and pelvic shield were also not provided to any patient during the examination (Table 2 and Table 3). It was found that proper collimation technique was implemented in 66.7% X-ray examination (Table 4) and proper filtration technique was followed in 100% of cases with the help of inherent and added filters. In case of attendants, it was observed that they had make a use of only lead aprons and thyroid shields while attending their patients. Other shielding equipment were used by not even a single attendant during patient examination. Table 5 shows that out of total, lead aprons were used by 70% attendants and only 20% attendants have used both lead apron and thyroid shield.

DISCUSSION

Many studies have been performed to assess radiation protection practices in diagnostic X-Rays. Many researchers have performed multiple studies around the world to check the knowledge of radiation technologists, patients and patient's attendants about radiation protection and dose limits those working in the radiation field. This study was also conducted to evaluate practice of radiation protection at a tertiary care hospital. Overall results of this study described that radiographers had good knowledge of radiation protection devices still they used to avoid the use of radiation protection devices in most of the examination to save time. Most of the radiographers had 3 to 5 years of experience. The result of the present study was different from the study carried out in 2011 by Cletus Uche Eze *et al*. Their study was performed only on experienced radiographers who had experience of 5-17 years clinical experience[12]. It was based upon questionnaire. In their study most of the participants were females. The result of the study showed good knowledge of radiographers in the use of radiation protection devices. The study stated that the use of gonad shield was more in their hospitals while in present study gonad shield was not even used in single X-ray examination for patient protection.

Slight difference was observed between the present study and the study done by Zahra Farzanegan *et al.* Farzanegan has carried out that study in which two intern students had observed 100 X-ray examinations which were done in five different hospitals[13]. Collimator was used only in 46% of cases as compare to present study in which collimator was used in 66%of cases.

Practice of radiation protection devices of radiographer was not satisfactory in present study as compare to study carried out between September 2013 to December 2013 by KJ awosan et. Which showed good practice of radiation protection devices such as lead apron, thyroid shield, collimator etc. The study was based upon questionnaire [14] in which radiation technologists, scientists and nurses of radiology department were included. Some kind of similarity was observed between the present study and the study done by Morteza Safi *et al.* from November 2011 to December 2012. This study was based upon questionnaire[15] in which the participants were divided in two groups. Trained participants were included in the first group and untrained participants were included in the second group. The result of the study described that the trained participants had good knowledge of radiation protection devices as compare to the untrained participants. Again, a questionnaire-based survey was performed on Italian radiographers by F. palicchi *et al*[16]. A survey was based upon radiation protection devices and radiation monitoring dose. The result of the study was not satisfactory. Better results were obtained in the present experiment as compare to the study carried out by S Tahira *et al.* to assess the knowledge of patients about the use of radiation and its hazards[17]. In the previous study it was found that 80% of patients did not know about the effect of radiation and also the practice of radiographers in respect to the use of radiation protection devices was also not good. They were also unaware about the effects of ionizing radiation.

Slightly similar results were observed between present study and the study carried out by I. Erkan *et al.* A questionnaire-based study was performed on Istanbul health workers[18]. 10% of radiographers participated in this study and they had the knowledge about radiation safety and other health workers had less knowledge about radiation safety. In present study the proper use of collimator was done and all the workers know about the basic rules of radiation protection while the study carried out by Tarun Jindal *et al.* stated that the most commonly lead apron and thyroid shield were used in urology department. 15 residents out of 50 did not know about the radiation safety devices and other rules of radiation protection[19]. According to the present study, radiographers had good knowledge about radiation protection and their devices. The result was different from Said Asadian *et al.* which states that radiographers had poor knowledge in terms of radiation protection[20]. Based on the findings, it was concluded that good practice was performed in terms of the practice of radiation protection devices on patients and their attendants as compare to some of other previous researches. The purpose of the study was to reduce the radiation exposure by use of proper radiation protection devices.

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Table 1:% of Patients With Respect To The Type of X-Ray Examination

Region of Examination	Percentage
Chest	13%
Upper Extremities	13%
Lower Extremities	13%
Vertebral Column	47%
Skull	7%
Pelvis	7%

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Table 2: Patients to Whom Lead Gloves Were Given

	No. of Patients
Lead Gloves should be given to	05
Lead Gloves were given to	00

Table 3: Patients to Whom Pelvic Shield Were Given

	No. of Patients
Pelvic Shield should be given to	12
Pelvic Shield were given to	00

Table 4:Number of Cases In Which Collimation Was Applied

	No. of Patients
Collimation should be done	30
Collimation was done	20

Table 5:Number of Attendants Who Had Used Lead Apron And Thyroid Shield

	No. of attendants
Total no. of attendants	10
Lead apron was used by	07
Thyroid shield was used by	05
Both lead apron and thyroid shield was used	02
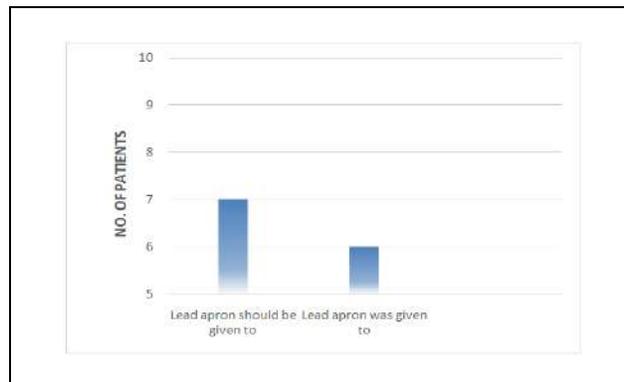
Figure 1. No. of patients to whom lead apron was given during study
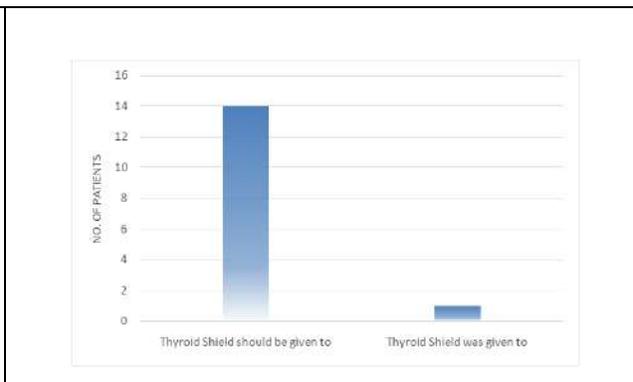
Figure 2. No. of patients to whom thyroid shield was given during study
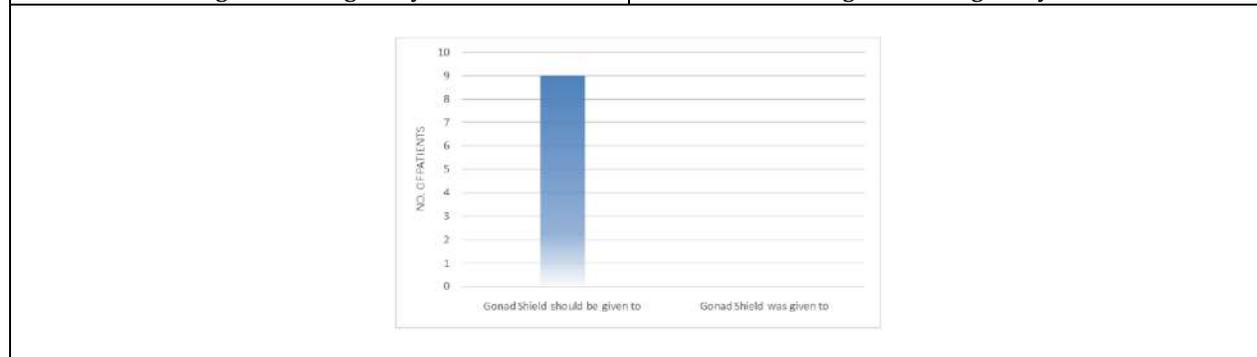
Figure 3. No. of patients to whom gonad shield was given during study

RESEARCH ARTICLE

Gender Equality in Cyber Space in India: Responsibilities and Challenges

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ABSTRACT

Ensuring Gender equality in cyber space is always one of the mammothissues in society. Government and non-Government actors are trying to ensure gender equality by different initiatives, policy making and action-oriented programmes. The challenge before the democratic society is how to establish an equal and enabled cyber space for women and children. Cybercrimes have created various challenges to women's rights in Cyber Space, for instance Right to Privacy. According to *European Institute for Gender Equality*, **one in ten women** has already experienced a form of cyber violence since the age of 15. Further, the percentage of women professionals in cyber space is extremely low compared to men. The challenges experienced by women in cyber space should be addressed properly. It is the responsibility of both government and society to create an ideal cyber space which ensures gender equality. It is worthwhile to note here, cyber ethics is considered a necessary practicenot only to create gender equality in cyber world but also to sensitise the women and children about the menace of cybercrimes. This study presents the need of gender equality in cyber space especially in India. Further, it presents the responsibilities and challenges for stakeholders to ensuring gender equality in cyber space.

Keywords: Cybercrimes, Cyber Ethics, Cyber Hygiene, Cyber Space, Gender Equality.

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INTRODUCTION

Gender Equality is a fundamental human right which is essential for the progress and development of democratic nation. Democratic nations around the world are trying their level best to establish gender equality by ensuring equal rights and opportunities to all genders. However, despite all sincere efforts to ensure gender equality in cyber space, male domination is visible in the society. In India, there are various challenges in ensuring gender equality for women and children in cyber space. It is to be noted here that, the gender inequality in virtual world is equal or larger than the inequality in real world. Gender inequality in the cyberspace of India is happening due to various reasons such as various cybercrimes against women, gender digital divide, under representation of women in cyber profession, lack of proper implementation of cyber laws, lack of cyber hygiene, etc. Government and other stakeholders' have the responsibilities to ensure gender equality in cyberspace. Proper awareness on cybercrimes and prevention measures, updating and effective implementation of cyber laws, inculcating cyber hygiene practices among women and children, etc. can ensure gender equality in cyberspace. When the gender digital divide and cybercrimes against women are eliminated then only women can presumably achieve or reap the benefits of cyberspace [1]. Today, the modern world considers gender equality as a broad term which is not limited to men and women. But this article limits itself to men and women while mentioning gender equality.

Objectives
1. To explore the needs for ensuring gender equality in cyber space
2. To unearth the reasons for gender inequality in cyber space in India.
3. To elicit the responsibilities and challenges in ensuring gender equality in cyber space.

METHODOLOGY

The article follows descriptive and analytical method. The major chunk of data is collected from Cyber Security Experts opinion, NCRB data, newspaper reports, scholarly articles published in journals and edited books, fact finding reports of the NGO's, reports of various investigation agencies etc.

DEFINING GENDER EQUALITY

The definitions of gender equality differ according to the time and space but the basic concept is same everywhere and every time. Gender equality demotes the equal status of all genders in the society. All human beings have equal status in the society without considering the gender. It is considered as a natural and fundamental human right. According to UNICEF gender equality is "the concept that women and men, girls and boys have equal conditions, treatment and opportunities for realizing their full potential, human rights and dignity, and for contributing to (and benefitting from) economic, social, cultural and political development"[2]. Gender equality is considered as an essential condition for sustainable development of society and indicator of welfare and peaceful society. The UNO included Gender Equality as one of the Sustainable Development Goals in 2015, which is to be fulfilled in 2030.Gender equality is considered as an essential fundamental right which will boost women empowerment and leads to economic growth of the society.

According to the United Nations, the gender equality is the equality in rights and opportunity among different genders [3]. Gender equality helps all genders to act freely and develop themselves without the limitations based on genders. Modern society, especially democratically elected governments give importance to maintain gender equality in socio-economic and political sphere. The Indian constitution ensures gender equality through different articles such as articles 14, 15, 16, 17 and 29. They protect the rights of all genders and prohibit any kinds of discriminations based on gender. Even though, the concept of gender equality brings different ideas it basically ensures equality among all genders and prohibits discrimination on the basis of gender. Government and

stakeholders initiated different policies and programmes and implemented new rules and regulations to ensure gender equality, but still gender inequality is existing especially in cyberspace.

NEED FOR GENDER EQUALITY IN CYBERSPACE

Cyberspace or Virtual world plays a vital role in the society as it is the basis of modern communication, education, entertainment, security etc. The role of cyberspace has become equal to the real world and challenges and problems of the real world are seen in virtual world too. As the gender inequality is present in the real world, it also exists in virtual world. It is widely believed that, ensuring gender equality in cyberspace is considered as essential to ensure a peaceful and safe cyberspace for women and children. It gives confidence to the women to be active, free and fearless in cyberspace and to create and develop their own space in virtual world.

Further, the gender equality in cyber space is vital to reduce the cybercrimes against women and to minimize the menace of gender digital divide. These efforts would certainly promote women to be part of cyber profession and they can use their creativity and efficiency in cyberspace. It helps the women to overcome the biases and blocks that prevent them to be active and successful in cyberspace. Further, it provides women a safe cyberspace to enhance their career, to enjoy their life, to have goods and services in online and to present their ideas and voices freely [4].

REASONS OF GENDER INEQUALITIES IN CYBERSPACE

Cyber Crimes against Women in India

The number of cybercrimes against women in India is increasing every day and this is very evident at the time of pandemic covid-19. The reports from National Crime Records Bureau show the increasing rate of cybercrimes against women and children in India. For instance, in 2019 the reported cybercrimes against women were 8379 and in 2020 the number increased to 10405[5&6].According to the Cyber Security experts, "every second one woman in India is being targeted in cyberspace and cyberspace become a new platform to attack women". Majority of the cybercrime victims in India are from women [7] and it is very easy to target women in cyberspace due to the inefficiency of the security system and legal provisions. The frequently happening cybercrimes against women are Cyber bullying, Online Harassment, Cyber Stalking, Morphing, Defamation, Revenge Porn, etc. [8].Most of the cybercrimes against women are happening from the fake profiles in social media. The anonymous nature of the fake profiles gives confidence to the criminals to commit crimes against women in cyberspace. Recently, Arjuna Award winner, Jwala Gutta, Indian Badminton player was victimized by cyberbullies on her racial background and even she was called 'Made in China' by criminals and asked her to prove her nationality [9]. Further, there are cybercrimes against women in which women are targeted by using different mobile applications and websites. In 2022, Delhi and Mumbai police registered cases and arrested people those who created mobile applications, 'Bulli Bai' and 'Sulli Deals' which targeted Muslim women by posting their photos and conducted online auction [10].

Gender Digital Divide

According to the Gender Digital Index, "The gender digital divide is the gap between men's and women's ability to access and use the Internet and digital technologies and contribute to and benefit from their development. It is the set of biases, barriers and constraints that prevent women and girls from fully adopting and using digital technologies in their lives" [11].Gender digital divide is seen in use of mobile phones, computer, internet, etc. all over the world, it is very clear that women are far behind in using technology or they are not able to access the digital technology compare to men [12].Gender digital divide holds back women from achieving the merits of cyber technology. Globally only 48 per cent of the women are able to access internet because of social, cultural and geographical limitations [13].According to *National Family Health Survey-V* in India only 33.3% of women are ever used internet. In rural India, gender divide is very visible as 48.7% of men are using internet but only 24.6% of women are able to use it. Further, no State or Union territory in India is free from the gender digital divide [14]. The gender digital divide prevents women from realizing the opportunities in cyberspace especially in education, information, entertainment, social security, etc.

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Women and Children are not properly sensitized about the nuances of Cyberspace

Even though, cyberspace is common platform but most of the users especially the women and children are not aware about the nuances of cyberspace. The cyber criminals can use the cyberspace to victimize the women and children easily. Without knowing the issues and challenges in the cyberspace, the children and women are surfing in the internet, shared personal details and has become victims [15].Lack of awareness or lack of sensitization about issues and challenges in cyberspace, the women and children are prone to cybercrimes or cyberspace-based rights violations. Because of the lack of awareness, the women and children are mindlessly shared their personal information in the cyberspace especially in social media platforms, for instance *Whats App, Facebook, Link India, Instagram etc.* While installing and using different websites and mobile apps they have agreed all the terms and conditions without reading them. For criminals it is easy to collect the information from these platforms and cheat or threaten women and children from fake profiles. In May 2022, Uttar Pradesh police arrested a Nigerian citizen for cheating around 300 women and looted crores of rupees. The accused cheated the women by duping himself as a Non -Resident Indian in Canada and approached the women through matrimonial websites. After gaining their confidence and emotional attachments he tricked them and asked to transfer money for various purpose [16]. The culprit used the data of women from social media and matrimonial websites which were shared by them without knowing the nuances of cyberspace.

The attachment of women towards free or offers in commercial websites and online loan apps also cheat them by using their ignorance. Several innocent people including women committed suicide after being trapped in online loan app. A woman from Vijayawada have committed suicide in July 2022 after being cheated and threatened by online loan applications. She took loan from online loan apps without knowing the after effects and after issuing the loan the executives from the app threatened her to clear the loan within time or they publish her nude photos. After receiving various threatening calls and messages she committed suicide [17]. The careless and ignorant attitude of women also paved way for cybercrimes against them. Even though they can hide their personal details from the public by using the features of the websites or apps they are not using them or avoiding them. Further, women or children are not really aware about their legal rights in cyberspace and legal provisions to be followed if they were victimized [18].

Under Representation of Women in Cyber Profession

Even though the professions in cyberspace are gender free compared to the professions in physical world, the number of women in cyber professions are very less in number. The stereo type norms and conditions from family and society prevented women from having a profession in cyberspace. The patriarchal norms and values of the society considered women as misfit for the cyber profession [19]. In India the gender gap in cyber security profession in low as only 21per cent of the cyber security experts are from women [20].Software and Hardware developer profession is considered as male dominated profession and the presence of the women is negligible. This is very clear from the Software Developer Survey 2022. According to the survey 91.88% of software developers are men and only 5.17% women are doing the software developing professions. Further, in most of the companies, females are not promoted to the key position [21].

Lack of Cyber Hygiene Practices

Cyber hygiene practices are the security measures which are taken in the cyberspace to be safe and free from cyber threats. Although there are various cyber hygiene practices in cyberspace many users especially women are not taking them properly or avoiding them because of carelessness or ignorance. Hygiene practices are necessary to keep good health. Likewise cyber hygiene practices are necessary to keep cyberspace safe and secure. The following are some of the Cyber Hygiene Practices:

i.   Use of proper firewall
ii. Having strong passwords
iii. Regular updating of Software.
iv. Installing original software and anti-virus software.

v.   Conducting Cyber Patrol or Cyber Audit.
vi. Know the safety measures to protect rights in cyber space.
vii. Being away from fraud calls, emails and messages.

It worthwhile to mention here, common cyber hygiene practices are not being followed by the women and children properly but lack of these practices certainly will give space to cyber criminals to unleash cybercrimes. Personal or professional data can be taken by the criminals very easily and these data lose may lead to various issues such as financial loss, legal actions, etc**.** In Pune, a woman was cheated by criminals after responding towards a fraud call from the customer care of her bank. The criminal pretended as the customer care official from the bank and asker details of her debit card in order to get relief from an annual charges and cancellation of card. Believing the call, she shared the details and lost more than 8 lakhs rupees from her account [22].Even though government and private companies are taking cyber hygiene seriously, personal cyber hygiene is important and it is the responsibility of individuals to practice cyber hygiene [23].

The curriculum is also not designed in a such a way to protect rights of women and Children in Cyberspace
Curriculum has a vital role to play in protecting and promoting the cyber rights of the women and children. Social and moral formation is very much dependent on the curriculum which is followed in the education. Respect and concern to the weaker sessions should be formed in the human beings from the childhood itself. Hence, the curriculum should be framed in accordance with recent developments in cyber space, advancement in Science & Technology, existing laws to protect the cyber rights of the people etc.   The Students, Women, Children and other stakeholders must aware about the rights of human beings especially women and children in cyberspace. Further, they must be aware about the legal provisions and ways to avoid victimization in cyberspace. The digital literacy, cyber law awareness and moral or ethical behavior play an important role in the cybercrime prevention and they must be included in the curriculum [24].

CHALLENGES TO GENDER EQUALITY IN CYBERSPACE
One of the main challenges of Gender Equality in cyberspace is the privacy issue. Even though men and women have equal rights in cyberspace and face same privacy issue in cyberspace, women are more vulnerable to the cyberspace in related to privacy issues. They cannot enjoy the same life as men have in cyberspace because of privacy issues. Even in cyberspace, they are considered as inferior and accountable to men and become safe targets of cybercrimes. Further, the complex gender-based biases and social and moral issues of real world is present in virtual world too [25]. These biases and issues also create challenges to the gender equality in cyberspace. Increased rate of cybercrime against women also poses challenge to the gender equality in cyberspace. The cybercrimes prevent women from being active in cyberspace and from enjoying the benefits. Lack of adequate cyber laws or legal provisions [26] and delay in investigation and prosecution [27] are considered as challenges to gender equality in cyberspace. The criminals are not afraid or not having proper respects to the laws and take them as easy. This results in increment of cybercrimes against women [5&6].

The attitude of IT companies towards women also challenges the gender equality in cyberspace as there are imbalance in pay and power [28]. Even though, the number of girl students in science and technology education in increasing the gender gap in profession is still remaining. According to the report, prepared by the United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) the gender gap in the professions in technology industry is starting from the time recruitment itself. Most of the companies are considering male applicants than female. Even after admission women are facing various challenges such as wage gap, male friendly environment, harassment, etc. The gender gap is clear in promotion and leadership too. These challenges tempt women to be away from these professions [29].

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LEGAL PROVISIONS TO PROTECT WOMEN'S RIGHTS IN CYBERSPACE

Information Technology Act 2000 & Amendment 2008

Information Technology Act (IT Act) 2000 and Amendment 2008 deals with offences in cyberspace and penalties. Sections 43, 64 to 67 B are related to the offences in cyber space and the punishments in India [49]. The offences like tampering with computer source documents, hacking or unauthorized use of computer, identity theft, online cheating, publishing obscene material, cyber terrorism, etc. and their punishment are explained in the Act [30&31].

Indian Penal Code (IPC)

Indian Penal Code is the official criminal code of India. Sections 292 (handling obscene material), 354A (Sexual harassment), 354B (sextortion),354C (taking and publishing pictures of private parts of women), 354D (Stalking), 379 (theft of data, computer, etc.), 411 (it follows the section 379, using or possessing the stolen items mentioned in 379), 417 & 420 (cheating, dishonesty, fake websites, cyber frauds, etc.), 463 (falsification of documents electronically), 465 (forgery), 468 (fraud activities to cheat), 469 (forgery to defame or disrepute a person), 500 (defamation), 504 (threaten or insult), 506 (intimidation) and 509 (crime against modesty of women) are related to cybercrimes [32].The sections 354A, 354B, 354C and 354D were inserted in IPC by the Criminal Law (Amendment) Act, 2013 [33].

Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021

Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021 was enacted in India in order to regulate the social media platforms, OTT platforms and Digital News in India. The content control and removal are possible if they go against the privacy of the individual. Further, the individual can approach the grievance officer of the social media platform when it goes wrongly [34].

The Indecent Representation of Women (Prohibition) Act, 1986

The Indecent Representation of Women (Prohibition) Act, 1986 was implemented in 1987 to prohibit the indecent representation of women or distribution of indecent content in any form of publication or media [35].

Right to Privacy

Right to Privacy is a fundamental right in India which was included in the Article 21 of India's Constitution in 2017. The right to privacy is closely related to the right in cyberspace. The landmark verdict was given in relation to the case *K.S. Puttaswamy V. Union of India* [50]. The case was related to the issue of data security and privacy along with the Aadhaar scheme. According to the verdict the individuals' privacy cannot be disturbed by anyone including the state but it has reasonable restrictions as other fundamental rights. Right to privacy protects individuals from unauthorized access to the personal data in virtual space and physical space [36]. The right to privacy becomes important as the Information Technology especially the social media grows unimaginably and collects, stores and shares the personal details of individuals.

MEASURES TO ENSURE SAFE CYBERSPACE FOR WOMEN AND CHILDREN

In India, Central Government and State Governments are taking various measures to ensure a safe cyberspace for women and children. Besides the legal provisions, there are different initiatives taken by central government to ensure a safe cyberspace for women and children. They are following:

Online Cybercrimes Reporting Portal

Ministry of Home Affairs initiated online cybercrime reporting portal to help the victims/complainants to report cybercrime complaints easily. This portal deals the complaints related to cybercrimes especially the cybercrimes against women and children. The victims can report the crime with or without revealing their identity [37]. Further, it provides a helpline number, 1930 to register complaints without any delay.

Citizen Financial Cyber Frauds Reporting and Management System

Citizen Financial Cyber Frauds Reporting and Management System helps the people to register the financial crimes in cyberspace. If the victims can report the fraud without any delay the officials can retrieve the amount of money by blocking the transaction [38].

CCPWC (Cybercrime Prevention against Women and Children) Scheme

CCPWC Scheme is an initiative by Ministry of Home Affairs to prevent cybercrimes against women and children. The scheme includes different components such as Online Reporting Unit, Forensic Unit, Capacity Building Unit, Research and Development Unit and Awareness creation Unit [39]. As per the constitution of India, public order and police come under state list. Hence, state governments are taking number of initiatives and awareness programmes to ensure a safe cyberspace to women and children. Central government is providing financial and technical assistance to coordinate the initiatives taken by various state governments. Further, central government provides various assistance in capacity building and awareness programmes. National Commission for Women and National Commission for Protection of Child Rights are initiating various awareness programmes and providing guidelines to be safe in cyberspace [40].

SUGGESTIONS

Providing gender equality for women and children in cyberspace is a collective responsibility of government and other stakeholders.   All of these should work together and enrich one another to achieve the goal i.e., gender equality in cyberspace. Among these, the most powerful mechanism is government and hence government should come forward to eliminate the gender inequality in cyberspace by preventing cybercrimes against women, by reducing the gender gap in cyberspace and by ensuring proper representation and working environment in IT profession. Even though government is taking various measures to prevent cybercrimes and preventive mechanisms, they are not enough to combat cybercrimes, especially against women. This is very clear from the report of the NCRB, as every year the number of cybercrimes, especially against women are increasing [41, 5&6]

In order to prevent cybercrimes against women effectively, the government should implement the existing cyber laws effectively and the investigation and prosecution should be completed within time. Any delay in investigation and prosecution will certainly affects the evidence collection and denies justice to the victims. The crimes in cyberspace must be considered as the crimes in real world and they should be dealt seriously and properly. Further, the government should conduct various cybercrimes awareness programmes effectively to the general public, especially to women and children. For example, at present Kerala government is being organizing various programmes to ensure cyber security in Kerala. Further, Kerala police Cyberdome is conducting annual cyber security event named c0c0n in order to promote ethical hacking and understand the new threats in cyberspace[42]. Public awareness on cybercrimes and cyber security is given by Kerala Police through various online platforms such as *Facebook*, websites, etc.[43&44]. Initiatives such as Kid Glove, *Aparajitha* is Online, *Koottu*, cyber safety webinar series, etc. are specially aiming cyber safety for women and children in Kerala [45, 46, 47& 48].

Gender gap in cyberspace can be removed only through implementing robust schemes for women especially for the rural women. The issue of Digital divide in rural areas should be addressed properly by ensuring the internet connectivity and imparting technical education to women and children. The availability of Smartphone and internet can change the digital life of the women and thus the digital gender gap can be reduced. The Government should promote researches on gender digital divide to support policy formulation. Under representation of women in cyber profession can be reduced by encouraging girls to choose cyber related programmes. Government should ensure safe working environment and equal payment for women in IT firms and foster women's entrepreneurship and engagement in innovation**.** Further, the existing curriculum must be updated in order to inculcate basic knowledge on cyberspace and rights for women and children in cyberspace.

Besides government, various stakeholders have responsibilities to ensure safe cyberspace for women and to reduce the gender gap in cyberspace. Private companies especially the telecom companies can initiate various schemes for

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women to encourage their digital life. Access to smartphones and the internet will help women to have knowledge and resources in cyberspace. Further, they can provide various awareness programmes or messages to alert women on cybercrimes. Various organizations, such as women rights organizations and NGOs can influence government in forming women friendly cyber policies and in ensuring gender equality in cyberspace [13].

Various IT companies and firms have responsibility to ensure gender equality among their employees. The gender diversity and equality in the companies will provide different solutions to the problems and resolve unequal treatment and workplace harassment [21]. They should encourage women and girls to come forward in cyberspace by providing equal respect towards them. They should initiate programmes and schemes to ensure technological access and connectivity among women [14] especially the women in rural India.

The responsibility of the individual is the basis in overcoming the gender inequality in cyberspace. Individuals, especially women should be more aware about the risks in cyberspace and they should follow proper cyber hygiene in their cyber life to keep away cybercrimes. Women must have basic knowledge regarding their rights in cyberspace and legal measures to be followed if they are victimized. The society, especially men should be trained to respect women specially in cyberspace. Further, women should avoid the stereo type norms and regulations of the family and society in selecting cyber profession and should react properly against the inequality in their work environment.

CONCLUSION

Gender inequality in cyberspace is a reality to be addressed and it is the collective responsibility of the society. The society can be flourished only when all the members get equal opportunities and enjoy equal rights. This equality should be present in cyberspace too as the modern life is very much related to cyberspace. The gender inequality in cyberspace has become a major impediment to women empowerment in India.   Ensuring gender equality is possible when the government, stake holders and citizens do their responsibility effectively.

Gender equality in cyberspace in India is vulnerable due to various reasons, such as cybercrimes against women, gender digital divide, under representation of women in cyber profession, etc. The lack of gender equality in cyberspace preventing women from enjoying the advancement of information technology in their life. Even though there are different mechanisms available in India, the government and other stakeholders failed to ensure gender equality in cyberspace. As the future is based on cyberspace, it is the time to ensure the gender equality in cyberspace. There is an urgent need to work together to promote gender equality by ensuring equal opportunities and rights to women in cyberspace. The cybercrimes against women and the gender digital divide should be removed by taking pro-active measures. The government should come forward in ensuring digital literacy in society especially among women and in making them aware about the nuances of cyberspace.

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REVIEW ARTICLE

A Comprehensive Review on Kandathiri Chooranam, A Siddha Herbal Drug

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ABSTRACT

Siddha, a branch of traditional system of medicine follows 5 elemental theories. The human body is made up of 96 thathuvams. Every component in this world is made up of five boothams. The character of the components depended upon the bootham present in it. The treatment aspect of the siddha system is based on the Iymboothakolgai. Medicines used in this system are divided into 32 internal and external medicines. Internal medicines are choosing in the order of Herbal, Metals, Minerals and Animal products. There are vast numbers of Herbal preparation in the siddha literature. They are all indicated to treat mild to severe diseases. Herbal preparation possesses potent action against curing chronic condition also. This article is going to review the herbals present in the Kandathiri Chooranam from Agathiyar Vaithiya Rathinasurukkam and its effectiveness in treating sirakambavatham (Cerebral palsy).

Keywords : Kandathiri chooranam, Internal medicine,Cerebral Palsy, Sirakambavatham.

INTRODUCTION

The development of the prevention and treatment of disease was remarkably present since prehistoric and ancient times till date [1]. The search for information increases from the older period till the new age period .Our own ancient medicine have the deep roots .It is difficult to trace the beginning of this ancient system. Siddha system of

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Medicine intertwined its roots with the culture of ancient Tamil civilization [2]. It has disclosed its importance in curing many diseases. Effectiveness of siddha system of medicine has made a remarkable prognosis in the conditions by disturbed CNS function. There are several diseases of nervous system which affect the pediatric population. Cerebral palsy describes a group of permanent disorders of the development of movement and postures ,causing activity limitation that are attributed to non-progressive disturbances that occurred in the developing fetal or infant branch[3].Cerebral palsy can be correlated with sirakambavatham. Sirakambavatham is one among the vatha diseases. Kandathiri chooranam is the drug formulation which has indication to treat vatha diseases.

METHODS AND MATERIALS

Kandathiri chooranam is formulation which is described in Siddha shastric text Agathiyarvaithiyarathinasurukkam. The ingredients are

❖ Inji
❖ Seeragam
❖ Milagu
❖ Thippilimoolam
❖ Thalisapathiri
❖ Kirambu
❖ Kostam
❖ Vaivilangam

Method of preparation

Ginger was cut into small pieces and soaked in lime juice for a day which was then dried in sunlight. Cumin was taken and the same procedures were repeated as for ginger. All the other raw drugs were fried with light flame. All ingredients were mixed and grinded into a fine powder. The obtained powder was sieved by *vasthrakayam* (sieving by cloth) procedure and was purified by *pittaviyal*(steam boiling) method. Then it was dried and powdered. Finally equal ratio of palm jaggery was mixed into it.

Dosage- *Verukadi Piramanam* (1350 mgs)
2 to 3years - 200mgs 4 to 7 years - 450 mgs 8 to 12 years - 650mgs .
Indication :*Vatha* diseases are cured. (*Vatha rogangal theerum*)

1. **INJI –** *Zingiber officinale*

SYNONYMS

English	- Green Ginger	Telugu	- Allamu	
Sanskrit	- Adrakam	Kanada	- Hashi- shunti , Vona - sunthi	
Malayalam	- Chukka, Inji	Hindi	- Adarkh , Sonth	

DESCRIPTION [5]

Habitat - Ginger is mostly native to India. Now it is widely grown as commercial crop in parts of Asia, Africa, and America and in Australia.It was the first oriented species to arrive in Europe, obtained from Greeks and Romans.
Morphological Description-Zingiberis derived from the Greek word zingiberis, which itself comes from the Sanskrit word singabera, meaning spice.
Underground parts - Rhizome which is branched and thickened. It has outer layer usually brown in colour and removed while using ginger and has a pale yellow center.
Shoot -The pseudostem of grow upto 1.2 m tall.
Leaves -Leaf bases forms the pseudostems by enwrapping each other. The leaves measures 7cm long, 1.9 cm wide with leaf blades arranged alternatively.
Flowers- Pale yellow coloured flower with greenish to yellowish leaf like bracts. It shaped like a cone with spikes.

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Cultivation- For cultivation of ginger, climate should be hot, humid, shady conditions. It requires amount of nutrients, hence it grow well with fertile soil and sand with humid condition. Harvesting is simply done by taking the rhizome out of soil and dried in sunlight.

PART USED - Tuber

ORGANOLEPTIC CHARACTERS
Taste   - Pungent   Character - Hot   Division - Pungent

BIOACTIVE COMPOUNDS
Gingerols[6], Shogaols[6], Bisapolene[7], Zingiberene[7], Zingiberol[7], Curcurmene[7], Geraniol[7], Neral[7]

PHARMACOLOGICAL ACTIVITY
Neuro protective [6], Antioxidant [6], Anti-inflammatory [6]

ACTION
Carminative, sialagogue, digestive, stimulant, rubefacient

THERAPEUTIC USES
It is used to treat muscular aches, pains sore throat, cramps, constipation, indigestion, and vomiting, hyper tension. It is used to treat all three deranged humours. It is one of the rejuvenating medicines.

SEERAGAM –*Cuminum cyminum*

SYNONYMS
English   - Cumin seeds   Telugu   - Jilakarra
Sanskrit   - Jirakams   Kanada   - Jirla
Malayalam -Jirakam   Hindi   - Zira

DESCRIPTION [9]
Habit **-**Desert region of Iraq, mainly on the alluvial plain, Mediterranean Europe, Cyprus, Syria, Arabia, Egypt, Armenia, Azerbaijan, Georgia, Iran, Afghanistan, Widely cultivated also on a small scale within this region as well as in North West India, China North America, and South America.
Morphological features -Short erect annual 15–20 cm
Stem - Bushy with ascending branches from near base upwards grows up to 600 m or more.
Leaves -Leavesare mostly doubly trifoliate and have narrow sheath grows up to 4cm or more.
Inflorescences -Umbels 3to 6-rayed. Each ray is about 0.5–1 cm, equaled or exceeded by 3–6 bracts of the involucre.Few Partial umbels around 2–6, flowered.
Flowers - Colour- Magenta, pedicels 2–6 mm, exceeded by the 3 or 4 bracteoles.
Fruits -Fruit 4–6 × 2 mm, schizocarp, red in color styles short, rigid.
Cultivation- It takes 120 days of frost free weather from planting to harvesting. Seeds need to be 36 to 41 degrees for emergence. A group of 4 seeds at a depth of 1/4" to be planted for every 4 to 8 inches.

PART USED: Seeds

ORGANOLEPTIC CHARACTERS
Taste   - Pungent   Character - Cold   Division - Sweet

BIO ACTIVE COMPOUNDS

α ,β –Pinene [10], α, β –Phellandrene [10], α, Υ-Terpinene [10], Cumin aldehyde [10], p-Mentha-1,3-diene-7-al [10], Eucalyptol [11], Menthol [11], Cumenol [11], Carvone [11], Oleic acid [11]

PHARMACOLOGICAL ACTIVITY
Anti-inflammatory [12], Anti-stress activity [12], Memory enhancing activity[12], Epileptiform activity[12], Immuno modulatory [13], Anti-carcinogenic / Anti-mutagenic [13], Anti -oxidant [13]

ACTION
Carminative, Stimulant, Stomachic, Astringent

THERAPEUTIC USES
It is used to treat hoarseness of voice, vitiated vatham, constipation, and diarrhea.
Paste externally applied to allay pain, irritation due to worms in the abdomen.
It is used for indigestion

MILAGU – *Piper nigrum*
SYNONYMS
English   - Black Pepper   Telugu   - Miriyalu
Sanskrit   - Maricha   Kanada   - Menasu
Malayalam - Kurumulaku   Hindi   - Kali-Mirch

DESCRIPTION [15, 17]

HABITAT
Black pepper is suited to grow well in tropical regions like Brazil, Indonesia and India. It is confined to Western-Ghats of South India. It is also cultivated in Malaysia and Sri-Lanka.
Morphological features
Black pepper plant is a woody perennial climbing vine .Climber grows in the shade on supporting trees or trellises. It grows up to maximum height of 4 meters.
Leaves - Almond of heart shaped leaves.5–20 cm long and3–6 cm wide.
Stem - It is 10mlong and 6 cm in diameter. Lateral branches arise from the main central stem. Each stem has 20-30 spikes of fruits.
Inflorescence - The flowers are produced on pendulous spikes. Spikes grow up to 7 to 15 cm. Sessile, bracteate, achlamydeous, and uni/bisexual. Flower is white to yellow-green flowers.50–150 flowers produced from a spike.
Fruits -Small drupe and dark red in colour. The dried unripe fruits of Piper nigrum are known as a peppercorn. Each fruit contain a seed.
Green pepper - Unripen fruits are freezed and dried. Black pepper - Unripen fruits are dried in sunlight.White pepper- Remove the skin of the ripen fruits and the seeds are dried in sun.

PART USED: Seeds

ORGANOLEPTIC CHARACTERS
Taste   - Bitter, Pungent   Character - Hot   Division - Pungent

BIO ACTIVE COMPOUNDS
Sabinene[16], Limonene [16], Camphene [16], Myrcene[16], Cis-Ocimene[16], α-Selinenes[16], β-Bisabolene[16], Benzaldehyde [16], Eugenol [16], Methyleugenol [16], Myristicin [16]

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PHARMACOLOGICAL ACTIVITY
Neuro protective property [17], Anti-inflammatory [17], Anti-oxidant [17], Antidepressant activity [18],Anti-tumor [18]

ACTION
Carminative, Antiperiodic, Anti vata, Resolvent

THERAPEUTIC USES
They are useful in arthritis, asthma, fever, cough, dermatopathy, dyspepsia.

THIPPILI MOOLAM –*Piper longum*
SYNONYMS

English	- Long Pepper Root	Telugu	- Pippili -Mulam
Sanskrit	- Pipalee - Moola	Kanada	- Hippfli-Beru
Malayalam	- KattuThippili	Hindi	- Felfelai - Maya

DESCRIPTION [20, 21]
Habitat - Long pepper is Indo Malay native plant. It is mostly grown around tropical rainforests of India, Nepal, Indonesia, Malaysia, Sri Lanka, Timor and Philippines.

Morphological features
It is a perennial climber, aromatic with woody roots creeping and rooting below.
Stem -The stem is pubescent and flexuous.
Leaves- Leaves are wide ovate, cordate with 5-9 cm long, 5 cm wide.
Inflorescence -Cylindrical pendunculate spike
Flowers- The plant develops its unisexual flowers in erect solitary spikes. The male spikes are larger and slender than female spikes.
Fruit -The fruits are small berries, shiny and ovoid in shape with blackish green to yellowish orange in colour. It is one seeded with three layered pericarp.
Cultivation - It requires a hot moist climate for cultivation. It can be propagated through suckers, seeds or by layering of mature branches [22].

PART USED: Root

ORGANOLEPTIC CHARACTERS
Taste   - Pungent   Character - Hot   Division   -Pungent

BIO ACTIVE COMPOUNDS
Piperine[23], Sesamin[23] , Pipalestrol[23], Pippalartin[23], Dihydro stigmasterol[23], Piperlonguminine [24]

PHARMACOLOGICAL ACTIVITY
Anti-apoptosis [23], Antioxidant [23], Anti-tumor activity [23], Neuro protective [24]

ACTION
Stomachic

THERAPEUTIC USES
It is used for vitiated condition of vatham, gout, lumbago. It is beneficial in prolonged fever, cough and diarrheal diseases. When powder is inhaled through nostrils, migraine, giddiness is resolved.

KOSTAM- *Costus specious*
SYNONYMS
English - Costus root   Telugu - Kostam
Sanskrit - Kostam   Kanada - Koshtam
Malayalam - Kottam   Hindi - Kust

DESCRIPTION [26]
HABITAT
Costus specious is cultivated for its importance in medicinal and ornamental value. It grows well in moist and wet areas mostly in Indo-Malay region.
Morphological features
Costus specious is erect, perennial succulent plant with thin rhizomes. It grows upto 2-2.7 m.
Leaves -Lanceolate, subsessile, elliptic or obovate leaves spirally arranged on the stalk.
Inflorescence -Cup shaped labellum
Flowers- White in colour, 5-6 cm long. It is called as "Crepe ginger" because flowers look like crape paper.
Fruit - Capsule, red in color. Seeds are 5 in number with a white fleshy aril and black in colour.
Cultivation - It grow in moist or clay loam soil under deciduous forest of South India. It is cultivated in rainy seasons. It is propagated by vegetative methods or by seeds and by other methods.

PART USED:Root

ORGANOLEPTIC CHARACTERS
Taste - Bitter   Character - Hot   Division - Pungent

BIOACTIVE COMPOUNDS
β - carotene[27] , Diosgenin[27] , β – sitosterol [27], β-D-glucoside [27], Prosagenin [27],
Dioscin[27], Gracilin[27], Dihydrophytylplastoquinone [27], α-tocopherolquinone [27]

PHARMOCOLOGICAL ACTIVITY
Anti-oxidant [26], Anti-hyperglycemic [26], Anti-inflammatory [26], Anti-stress 26], Anti-cholinesterase [28], Anti-depressant [28]

ACTION
Stomachic, Expectorant, Tonic, Stimulant, Diaphoretic.

THERAPEUTIC USES: Used to treat arthritis.

VAIVILANGAM – *Embeliaribes*

SYNONYMS
English   - Emebelia   Telugu   - Vayu - vilangamu
Sanskrit   - Vidanga   Kanada   - Vayi - vulanga
Malayalam   -Vizhalari   Hindi   - Bal -badang
DESCRIPTION [30, 31]
Habitat- It is found throughout mountainous region of India mainly in Maharashtra, Kerala in Western Ghats and Tamil nadu in Eastern Ghats upto altitude of 1500m.
Morphological features
This bulky shrub is almost a climber with long slender.
Leaves - Leaves are obtusely acuminate alternate, coriaceous, simple, smooth, elliptic-lanceolate,
broad, obtusely acuminate, entire and shiny above.

Stem -Stem are whitish grey with the girth in between 45-72cm and roots are brownish grey.

Flowers - Flowers are small pentamerous and white or greenish in colour.

Fruits -Berry are2, 4-4 mm, globose in shape. Dull red to black warty in colour which is one seeded mostly. Seed is depressed at base.

Cultivation -It is propagated by seeds or by stem cuttings.

PART USED: Fruit, Seed

ORGANOLEPTIC CHARACTERS

Taste - Pungent   Character -Hot   Division - Pungent

BIOAVTIVE COMPOUNDS

Embeliaribyl ester[31], Sitosterol[31], Vanillicacid[31], Vilangin[32], Embelicacid[32], Christembine[32], Embelin[32], Vilangin[32], Quercetol[32]

PHARMOCOLOGICAL ACTIVITIES

Anxiolytic activity [31], Neuro -protective property [32], Anti-convulsant activities [33], Adapto genic activities [33], Anti-oxidant property [33], Cardio protective effect[33]

ACTION: Anthelmintic, Carminative, Stomachic, Stimulant

THERAPEUTIC USES

In combination with iron is an effective remedy for Anemia and Jaundice.

Beneficial in fever, skin disease, worm infestation.

It is used to reduce weight gain and also cures the diseases of head.

KIRAMBU – *Syzygium aromaticum*

SYNONYMS

English	- Cloves	Telugu	- Lavangalu
Sanskrit	- Lavangam	Kanada	- Lavanga
Malayalam	- Karampu	Hindi	- Long

DESCRIPTION [35, 36]

Habitat

Syzygium aromaticum is native to the Maluku island and North Moluccas ,the "Spice Islands" of Indonesia. Now, it is widely cultivated in India,Malaysia,Indonesia and Srilanka.

Morphological description

The tree is median sized which grows upto 8 -12m with aromatic in leaves, bark and flower bud.

Leaves -Leaves are simple, square or elliptical shaped and opposite. It contains aromatic oil and grows upto 13 cm.

Flowers -Flowers has 4 petal, four sepal and long calyx which develop from small clusters.

Flower buds - After 4 years of planting, it produces flower buds. Length varies about 13 to 19 mm. They are pale in colour at young and changed to green and later look bright red. It is harvested when the four petals remains unopened which resembles ball and surrounded by four sepals.

Fruits- Reddish purple in colour and contain one or two seeds.

Cultivation -Mostly cultivated in coastal areas. They are propagated by seeds.

PART USED: Flower

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ORGANOLEPTIC CHARACTERS
Taste   - Pungent   Character - Hot   Division - Pungent

BIOACTIVE COMPOUNDS
Eugenol[37], B-caryophyllene[37], Ethyl hexanoate[37], Gallotannicacid[38], Methyl salicylate[38], Rhamnetin[38], Chavicol[38]

PHARMOCOLOGICAL ACTIVITY
Antinociceptive[37], Analgesic[38], Antioxidant[38], Anti-depressant[38], Bone preserving[38]

ACTION
Anti-spasmodic, Carminative, Stomachic

THERAPEUTIC USES
Beneficial in colic, flatulence and in strengthening of gums.Externally applied in lumbago, neuralgia, rheumatic pain, sciatica.It is used to treat morning sickness.It is used for eye disorders.

THALISAPATHIRI –*Cinnamomum tamala*

SYNONYMS
English   - Cassia cinnamon   Telugu   - Adavi - lavangapatri
Sanskrit   - Tamalapatram   Kanada   - Kadulavangapatte
Malayalam - Paccila   Hindi   - Tejpatt

DESCRIPTION [40, 41]
Habitat - It is widely cultivated in Northern India and Pakistan. It grows in mountain slopes with broad leaved forest with altitude of 300 -2400 meters. Grows well in Himalayas and in Khasi hills.
Morphological description
The trees are medium sized, grows 2-10m height. The leaves and bark contain oils which are widely used for medicinal properties
Leaves -Sup opposite or opposite or sometimes spirally arranged, ovate, smooth upper surface, nerves are prominent in base. Young leaves are pinkish tinged and shiny.
Inflorescence-Panicle axillary grows upto 10 cm long.
Flowers- Flowers are yellow in colour. Tepals are longer than stamens.
Fruits- Colour of fruit is dark purple with a single seed. Basal part of fruit is hardened.
Cultivation- It requires sandy soil with moisture retaining ability. Aroma of leaves is decreased when plant is exposed to continuous rainfall. The leaves are dried in sunlight for 3 to 5 days.

PART USED: Leaves

ORGANOLEPTIC CHARACTERS
Taste   - Pungent Character - Hot   Division - Pungent

BIOACTIVE COMPOUNDS
Furanosesquiterpenoids[40], Furanogermenone[40], βcaryophyllene[40], Sabinene[40], Germacrene[40], α-Pinene[41], Thymol[42], 3-Methoxyacetophenone[42], α-Elemene[42], α-Cubebene[42], Vanillaldehyde[42]

PHARMOCOLOGICAL ACTIVITY
Anti-ulcer activity [40], Anti-diabetic activity [40], Antioxidant [42], Anti-microbial [42]

ACTION
Stimulant, Carminative, Stomachic, Diaphoretic

THERAPEUTIC USES
They are useful in cardiac disorders, inflammations, ophthalmic diseases, vitiated conditions of vatha, diarrhoea.
It is also beneficial in ulcers, vomiting and respiratory infections.

CONCLUSION

Siddha a traditional system of medicine have evolved since many years. Since early years, herbals have remnant remarks in curing diseases. They are the first choice of treatment. There are some herbs which are used in Allopathic medications for chronic conditions. The molecules present in herbs are cannot be reproduced. The chemical compounds present in these herbals are very much useful in curing vadha diseases. So the medicine Kandathiri Chooranam will make improvement in Vatha diseases. The ingredients which are present in the Kandathiri Chooranam possess anti Vatha properties. The compounds present in the Kandathiri Choornam are easily available and safe for children. So this medicine can be used for Vatha diseases in Pediatric age group.

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S.No	Ingredients	Botanical name	Part used	Quantity	Purification method
...					

Table 1.Quantity and Purification Method of Ingredients

S.No	Ingredients	Botanical name	Part used	Quantity	Purification method
01	Inji	*Zingiber officinale*	Rhizome	10 palam (350 gm)	Peel the external layer
02	Seeragam	*Cuminum cyminum*	Seeds	10 palam (350 gm)	Remove the dirt/unwanted things in it
03	Milagu	*Piper nigrum*	Fruit	1palam (35 gm)	Soak it in buttermilk for three hours
04	Thippili moolam	*Piper longum*	Root	1palam (35 gm)	Nodes were removed
05	Thalisa pathiri	*Cinnamomum tamala*	Leaves	1palam (35 gm)	Remove the dirt/ unwanted things in it
06	Kirambu	*Syzygium aromaticum*	Flower	1palam (35 gm)	Remove the dirt/unwanted things in it
07	Kostam	*Costus specious*	Root	1palam (35 gm)	Remove the dirt/unwanted things in it
08	Vaivilangam	*Embeliaribes*	Seeds	1palam (35 gm)	Remove the dirt/unwanted things in it

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Table 2.Taxonomical Classification of *Zingiber officinale* **[4]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Petrosaviidae
ORDER	Zingiberales
FAMILY	Zingiberaceae
GENUS	*Zingiber*
SPECIES	*officinale*

Table 3.Taxonomical Classification of *Cuminum cyminum* [8]

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
ORDER	Apiales
FAMILY	Apiaceae
GENUS	*Cuminum*
SPECIES	*cyminum*

**Table 4.Taxonomical Classification of ** *Piper longum* [19]

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Magoliidae
ORDER	Piperales
FAMILY	Piperaceae
GENUS	*Piper*
SPECIES	*nigrum*

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Table 5.Taxonomical Classification of *Piper longum* **[19]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Magoliidae
ORDER	Piperales
FAMILY	Piperaceae
GENUS	*Piper*
SPECIES	*longum*

Table 6.Taxonomical Classification of *Costus specious***[25]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Zingiberidae
ORDER	Zingiberales
FAMILY	Costaceae
GENUS	*Costus*
SPECIES	*specious*

Table 7.Taxonomical Classification of *Embelia Ribes* **[29]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Dilleniidae
ORDER	Ericales
FAMILY	Primulaceae
GENUS	*Embelia*
SPECIES	*ribes*

Table 8.Taxonomical Classification of *Syzygium aromaticum* **[34]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Magnoliidae
ORDER	Myrtales
FAMILY	Myrtaceae
GENUS	*Syzygium*
SPECIES	*aromaticum*

Table 9.Taxonomical Classification of *Cinnamomum tamala* **[39]**

KINGDOM	Plantae
SUBKINGDOM	Viridiplantae
PHYLUM	Streptophyta
SUBPHYLUM	Streptophytina
SUPERDIVISION	Embryophyta
DIVISION	Tracheophyta
SUBDIVISION	Spermatophyta
CLASS	Magnoliopsida
SUBCLASS	Magnoliidae
ORDER	Laureles
FAMILY	Lauraceae
GENUS	*Cinnamomum*
SPECIES	*tamala*

RESEARCH ARTICLE

Analysis and Prediction of Vegetation Dynamics of Delhi using MODIS Satellite Data

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ABSTRACT

For a variety of reasons, understanding and analysing changes in vegetation cover is essential, particularly when it comes to implementing the necessary conservation measures. Based on NDVI (Normalized Difference Vegetation Index) values, this study evaluates the vegetation changes in Delhi from year 2000 to 2022. The NDVI measurements were taken using MODIS Terra satellite imagery. Using the same NDVI dataset this study discovered that between year 2001 and 2021, Delhi's vegetation had grown by about 18.63% greener.The time series was generated using a dataset containing 509 NDVI values. With the help of an LSTM (Long Short-Term Memory) network and this MODIS NDVI time series data, an attempt has been made to predict the changes in vegetation. On the same set of data, the prediction was run on two different LSTM models' side by side, and a comparative study has been conducted. The findings demonstrate that both LSTM models can predict future NDVI values with a discernible degree of accuracy, but Model-1 predicts with a higher degree of accuracy and fewer errors.Model-1 accurately forecasts future NDVI values with an R^2 greater than 0.77 and an RMSE less than 0.034. Model 2 follows closely behind, with an RMSE of about 0.036 and an R^2 of about 0.74. Therefore, this study concludes that it is possible to accurately predict vegetation changes using LSTM networks well in advance and to implement the necessary proactive measures to preserve and improve the vegetation in any area.

Keywords: vegetation change analysis, NDVI, vegetation index, LSTM, time series, prediction.

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INTRODUCTION

It is crucial to analyse the vegetation dynamics of a place to know the sustainability. Vegetation structure varies quickly for a variety of causes which are influenced by both natural and man-made forces, which could lead to degradation and destruction. Lifecycle patterns, seasons, and climatic circumstances have an effect on vegetation phenology, which modifies their spectral reflectance patterns [16]. This work will present an enhanced change detection method for the analysis of satellite images based on Normalized Difference Vegetation Index (NDVI). NDVI employs the Multi-Spectral Remote Sensing data technique to find Vegetation Index, land cover classification, vegetation, water bodies, open area, scrub area, hilly areas, agricultural area, thick forest, thin forest with few band combinations of the remote sensed data. Land Resources are easily interpreted by computing their Normalized Difference Vegetation Index for Land Cover classification [1]. Remote Sensing data from MODIS/Terra satellite image along with NDVI and DEM data layers have been used to perform multi-source classification [2]. The Vegetation analysis can be helpful in predicting the unfortunate natural disasters to provide humanitarian aid, damage assessment and furthermore to device new protection strategies. The concept of neural network has gained much significance in the analysis of vegetation dynamics using remote sensing satellite data. Artificial neural networks (ANNs) and RNNs (Recurrent neural networks) can be used to forecast the NDVI values but as we know that ANNs don't have memory cells to store past data in the time series, so the results are not that efficient. RNNs have memory and they can also be used to predict the time series but it is less suitable because of its vanishing gradient problem [17].Additionally, they involve a lot more computational overhead than a Long Short-Term Memory (LSTM) network because they need a large number of preceding values to predict the values that will come after. The LSTM is an RNN variant that has internal memory to keep the data that has been received up to time t for a very long time in the model. Because of this characteristic, LSTMs are far superior to other time series prediction methods [18].

LITERATURE REVIEW

A literature review locates and summarises research on a certain topic. In the context of blended procedures, the written material examination is regarded as a trustworthy method for determining the true type of concentration, whether quantitative or subjective. In order to gather pertinent data that helped in addressing the research questions, a thorough literature review is conducted using sources such as IEEE and other journals on vegetation dynamics analysis. References to studies relating to NDVI have also been made in order to aid in the execution of this proposed work. Normalized Difference Vegetation Index (NDVI) is an improved method for the analysis of satellite image for detection vegetation dynamics for any region [3].NASA states that NDVI is a good indicator of drought. When water limits vegetation growth, it has a lower relative NDVI and density of vegetation [4].One of the most well-known indices for studies relating to vegetation is the Normalised Difference Vegetation Index (NDVI) [5]. A numerical measure of how green vegetation is derived from the visible and near infrared (NIR) bands is called the NDVI [6][7]. A higher NDVI value denotes greener and denser vegetation, and the NDVI values are typically normalised between +1 and -1[8]. The non-vegetated classes such as water, cities, arid lands, snow, etc. are indicated by the negative NDVI value. With plant growth, the generalised annual NDVI profile for vegetation rises until it reaches a peak or plateau [9]. The profile eventually disappears as a result of plant death or leaf senescence. As a result, the NDVI series offers a way to describe plant phenology[10] [11]. As seen in the vegetation of tropical rainforest due to subtle climatic variations, the phenological changes in concurrence with time, however, appear to be very minimal or obscure [12].

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STUDY AREA AND METHODOLOGY

Delhi has been chosen for the study as geographic location. According to Indian geography, the state is situated in the middle of the Indian subcontinent, between the Himalayan and Aravalli mountain ranges. Delhi is located at a latitude of 23.38 degrees north and a longitude of 77.13 degrees east. The Delhi Ridge, the Yamuna Flood Plain, and the Plains are the three geographic divisions of Delhi. It's interesting to note that the vegetation in each of these areas is distinctive. Due to river flooding and the abundance of alluvial soil, the Yamuna river plains are extremely fertile. The Aravalli range, which passes through the state, includes the Delhi ridge, which is its most notable feature.The city's ridge area provides the ideal conditions for the growth of acacias and other cacti. However, the ridge is overrun with herbaceous plants during the monsoon. As far as the plain region of Delhi is concerned, it is characterised by Shisham trees.

Vegetation of Delhi mainly comprise of medium size trees and herbs. However, Delhi is known for its varied flowering plants. Weeds and grass grow on the banks of the Yamuna River. Delhi Weather varies with the different climatic conditions that are faced by this city. Delhi is a city characterized by weather extremes. The geographical location of this city influences the weather conditions of Delhi. Also, the state experiences tropical steppe type of climate and hence its seasons are marked with extreme temperatures. The area of interest (AOI) has been marked on the Google earth map using Global Administrative Unit Layers (GAUL) shape filefig.2. The Global Administrative Unit Layers (GAUL) contributes to the standardization of the spatial dataset that represents administrative units by gathering and disseminating the best information on administrative units for every nation in the world. The GAUL always maintains global layers with a unified coding system at country, first (e.g. departments), and second administrative levels (e.g. districts). When data is available, it offers layers that are broken down into third, fourth, and lower levels on a nation basis. The following methodology shown in fig.3 has been adopted for the vegetation change detection:

Data Collection and NDVI Extraction

The dataset used for the study has been derived from MODIS terra satellite using Google Earth Engine. The dataset is present by the name "MOD13A1.006 Terra Vegetation Indices 16-Day Global 500m [deprecated]". The MOD13A1 V6 product offers a Vegetation Index (VI) value per pixel. There are two main layers of vegetation. The first is the Normalized Difference Vegetation Index (NDVI), also known as the continuity index to the current NDVI derived from the NOAA-AVHRR, i.e. National Oceanic and Atmospheric Administration-Advanced Very High-Resolution Radiometer. This study involves only the NDVI band of the MODIS dataset. NDVI is highly useful in detecting the surface features of the visible area.The data extraction and visualization of this study is done in Google Earth Engine Code Editorandthe programming language that is used here to process the Spatial Dataset files is JavaScript. After the time series extraction from the satellite, the LSTM models are deployed using python language on Google Colab software.

LSTM Model
The .csv file of the above time series is then used by the proposed LSTM models to forecast the future values. The LSTM models used here are model-1 and model-2 indicated in the figures below fig.7 and fig.8 respectively.

Data Pre-Processing
Data pre-processing and data visualization are done before final presentation of changes and results. Data normalization has been done by multiplying the extracted NDVI values by 0.0001. This is done to bring the range of NDVI values between 0 and 1. Having values in the range of 0 and 1 makes the analysis easier and visualization better. Following code reflects the normalization of the data values.

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RESULTS AND DISCUSSIONS

The time series derived from Google earth engine from the MODIS dataset has been used as the primary dataset for the time series analysis. The MODIS dataset consists of 509 NDVI values of different months of the years ranging from 2000 to 2022**[13]**. The MOD13A1 Version 6 product provides Vegetation Index (VI) values at a per pixel basis at 500 meter (m) spatial resolution. The VI values taken here are NDVI at an interval of 16 days. This NDVI time series plot has been stated in the chart below fig.4: Study of this time series chart with trend line depicts that gradually over years the average NDVI values have increased. It can be easily seen that in the years around 2000 the average NDVI index value was close to 0.3. Now this average index value is approaching close to 0.4. This is a good sign for the national capital as it the heart of our nation and healthy vegetation becomes the necessity of it. These significant changes can be better seen through the NDVI map. Following are the NDVI maps for different years over the time period 2000 to 2022.

Map indicates that central region had very less green vegetation. This is true because of the heavy urbanization and construction in the central part of Delhi. Similarly, the eastern and southern region had lesser vegetation. Later for the year 2021 we can see in the following map that there has been significant growth in the greener part. Except for the eastern Delhi and central part of Delhi almost every other area has seen decent amount of increase in the vegetation. Southern Delhi has witnessed a larger amount of change since 2001. Compared to 2001 NDVI image, 2021 NDVI vegetation map is completely opposite. Now it's almost all green. Only little parts of south Delhi are untouched with vegetation and that is understandable as it is due to houses and public places.

Training of dataset on the proposed LSTM model

The dataset of 509 NDVI values have been used for predicting the model's accuracy. The dataset has been divided into 8:2 ratios for training and testing purpose. 407 entries i.e. 80% of the total data was used for training and 102 i.e. 20% was used for testing the model. We have tried both the models with different number of epochs and same has been defined in the below table. Table-2 shows the error metrics and r² values corresponding different epochs for model-1 whereas table-3 shows for model-2. Model-1 shows best results for 70 epochs with RMSE 0.034 and R² of 0.7796 while model-2 gives better results for 65 epochs with RMSE of 0.0365 and R² of 0.7463. The above metrics show that model-1 has better accuracy than model-2 as it has greater R²and lesser RMSE value. Even MAE is lesser for model-1 than model-2.

For validation we have taken a small part of testing dataset. Following graphs fig.9 and fig.10 plot indicates how validation loss decreased significantly with each epoch. For model-1 we trained data for 70 epochs to train our model while for model-2 the 65 epochs have been taken. Batch size taken was of 10 and validation split was just 0.07. As the validation loss almost remained constant after 70 epochs so we stopped training our model 75 epochs. Blue lines indicate the training loss with respect to number of epochs. We can see that training loss curve falls sharply for the initial epochs. After that it decreases slowly and then attains a constant value after certain epochs. The orange line indicates validation loss on test data. It also shows similar pattern and becomes constant after particular number of epochs.

Both training as well as validation loss stabilizes after a point, this means that the proposed model is neither under fit nor over fit. It is good fit for the dataset taken. Model-1 attains a stable value of validation as well as training loss sooner thanmodel-2. Even the loss for the starting epochs is greater in model-2 graph plot. This means that model-1 learns the data variations quickly than model-2. But both the models produce good fit lines for loss. So, we can say that LSTM model is good for predicting this type of NDVI time series. The accuracy of the models is very close that means there is no much difference if we are using a LSTM model. The above fig.11 shows the plot of observed NDVI values over the years plus the forecasted values by the model. The green part is the training data that has been ploted

by the model and the blue lines are the test data values. Train and test data are the true values. The red line is the prediction made by the model after learning from the train data.

True Vs Prediction

In the fig.12 and fig.13 below we have taken forecasted vs true time series by model-1 and model-2 respectively. The true line here means the real observed values we have fed to the model for the testing. While the red line is the forecasted time series by the models. We can see that the prediction line is very close to the true line. The peak and lowest points of both the lines are almost at the same place. This adds more confidence to the accuracy of the model. If we closely observe the above figures, we can see that model-2 misses some of the peak values or the lowest points. The prediction looks accurate for rest of the time except the peaks and lowest points. For model-1 these misses are little lesser than model-2. The r^2 calculated between the true values and predicted values for model-1 is 0.779662 while for model-2 it is 0.74631. The r^2 value close to one indicates very good model. This means that the predicted values do not vary much from the original value. MAE close to zero and R-Square approaching 1 are indicative of high accuracy between observed and predicted values. The value of R^2 also indicates that model-1 has better accuracy than model-2. These results evidently show that the model-1 LSTM network is more effective in predicting the future NDVI values by learning all the seasonal and annual changes in vegetation, changes due to deforestation or natural calamities, etc. with an appreciable accuracy. Thus, it is recommended to use LSTM network for reliable outcomes.

CONCLUSION

Using a temporal MODIS Terra dataset, the current study examined how urbanisation, long-term changes in vegetation cover, and their spatial relationships with NDVI changed over the state of Delhi between 2000 and 2022. The outcomes indicate that the LSTM models developed for the change prediction are capable enough to learn and forecast with acceptable accurate results. There is not much of difference in both model's accuracy so we can say that for vegetation change prediction using NDVI time series LSTM model is good choice. The quantitative values found during the assessment demonstrate how specific land use practices have an impact on the loss of vegetation cover, its density, and the development of densely populated areas as well as other open and arid land. The current study endorsed the conclusion that when urbanisation is being done, the vegetation cover and natural environment must be considered. To prevent the further deterioration of urban health and greenery, it is also suggested that the area needs further evaluation by taking high resolution data sets into account to estimate the hot spot points in the city. This study sees a positive change over the years for Delhi's vegetation health. Only concern is the eastern Delhi region where there is almost no change. This can be improved with government initiatives and local public help.

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Table-1: Bands of MOD13A1.006 dataset

Name	Min	Max	Scale	Description
NDVI	-2000	10000	0.0001	Normalized Difference Vegetation Index
EVI	-2000	10000	0.0001	Enhanced Vegetation Index

Table -2 Metrics Table Corresponding Different Epochs For Model-1

No. of Epochs	MAE	RMSE	R^2
75	0.026501	0.034276	0.776634
80	0.026369	0.034332	0.775910
85	0.026710	0.034644	0.771837
70	**0.026239**	**0.034043**	**0.779662**
65	0.026478	0.034239	0.777118
60	0.026672	0.034465	0.774166

Table -3 Metrics Table Corresponding Different Epochs For Model-2

No. of Epochs	MAE	RMSE	R^2
75	0.03034	0.03900	0.710799
70	0.029278	0.03787	0.72732
65	**0.02855**	**0.036528**	**0.74631**

60	0.032216	0.040803	0.683477
80	0.02879	0.037706	0.72969
85	0.030602	0.0393264	0.70597

Table-4: Calculated Results

S.No.	Parameters	Results
1.	Total % change from 2001 to 2021	18.6298%
2.	mean-1	0.326539
3.	mean-2	0.350537
4.	variance-1	0.006320
5.	variance-2	0.005907

Table-5:Error metrics for models

Parameters	Model-1	Model-2
MAE	0.026239	0.02855
RMSE	0.034043	0.03653
R^2	0.779662	0.74631

Fig 1: District map of Delhi[14]	Fig 2: Shape file of Delhi
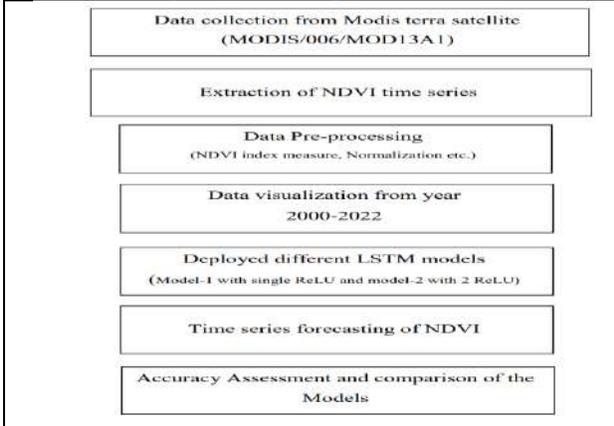
Fig.3: Flowchart of Methodology	Fig.4: NDVI time series for the time period 2000 to 2022
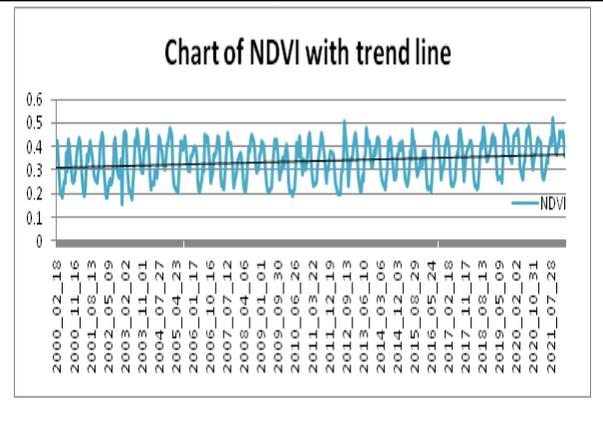
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| (2001) | (2021) |
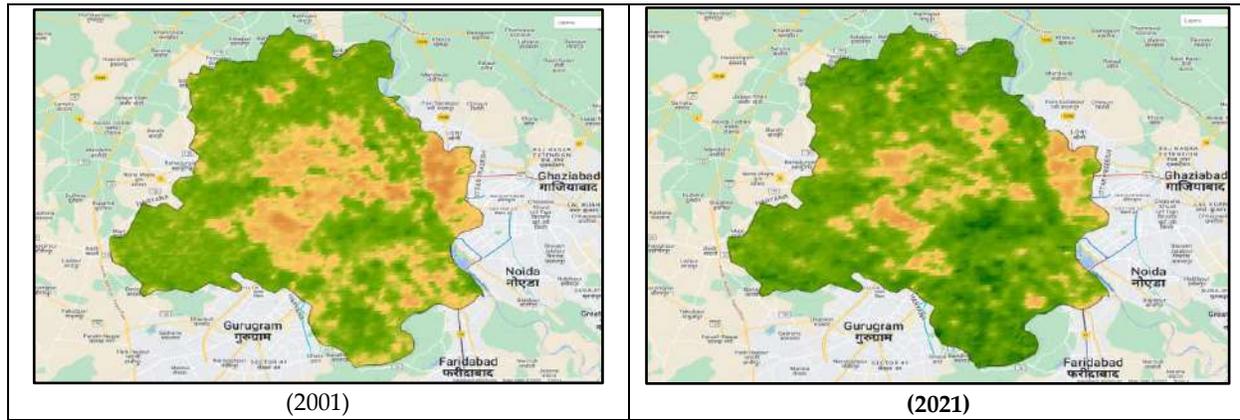
Fig.5: NDVI vegetation map of Delhi for year 2001 and 2021
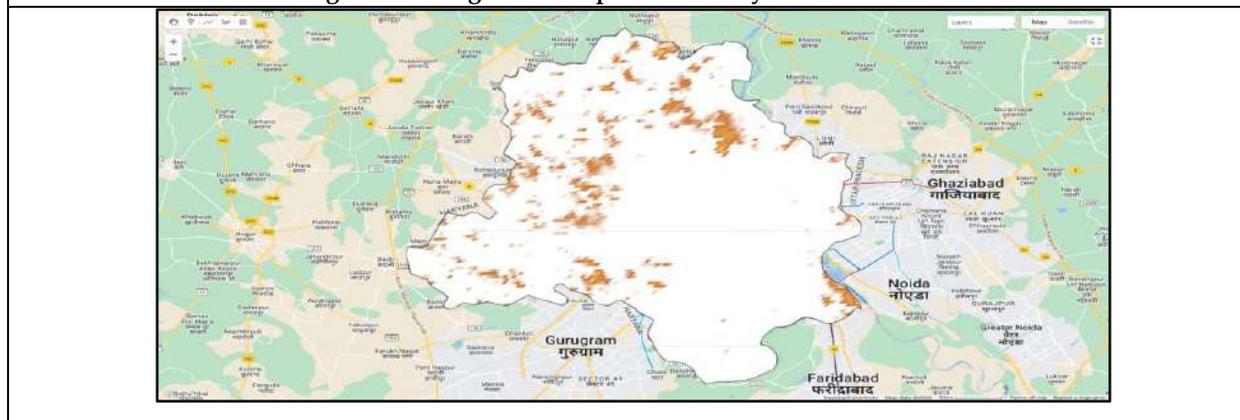
Fig.6: vegetation difference between year 2001 and 2021

```
[11] model = keras.Sequential()
     model.add(keras.layers.LSTM(128,return_sequences=True,input_shape=(X_train.shape[1], X_train.shape[2])))
     model.add(keras.layers.LSTM(128,activation='relu',return_sequences=True))
     model.add(keras.layers.LSTM(128))
     model.add(keras.layers.Dense(1))
     model.compile(loss='mean_squared_error', optimizer=keras.optimizers.Adam(0.001))
```

Fig.7: LSTM Model-1

```
[ ] model = keras.Sequential()
    model.add(keras.layers.LSTM(128,return_sequences=True,input_shape=(X_train.shape[1], X_train.shape[2])))
    model.add(keras.layers.LSTM(128,activation='relu',return_sequences=True))
    model.add(LSTM(units =128, activation='relu', return_sequences=False))
    model.add(Dropout(0.2))
    model.add(keras.layers.Dense(1))
    model.compile(loss='mean_squared_error', optimizer=keras.optimizers.Adam(0.001))
```

Fig.8: LSTM Model-2

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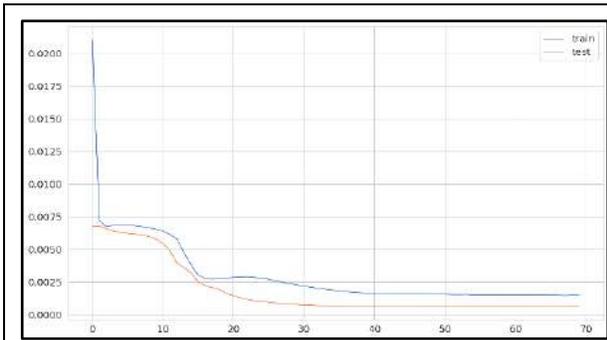
| **Fig.9: Validation and training loss graph for model-1** | **Fig.10: Validation and training loss graph for model-2** |

| **Fig. 11 Forecasted Time Series Plot for model-1** | **Fig.12: True values Vs Predicted values graph for model-1** |
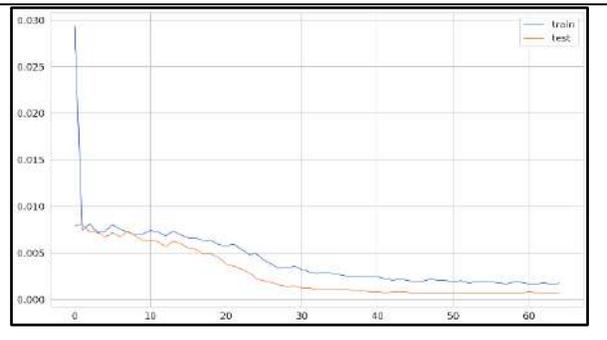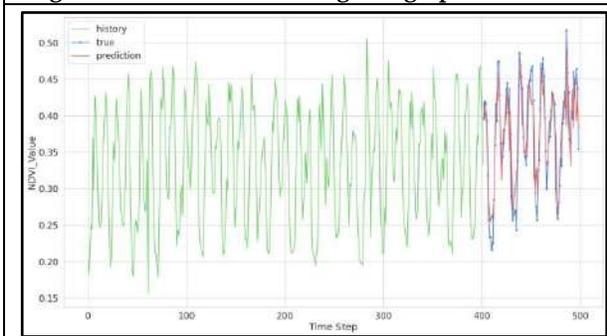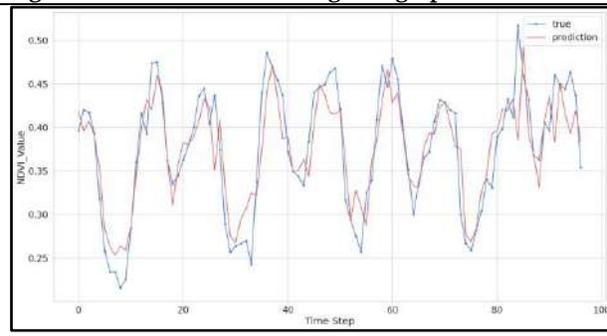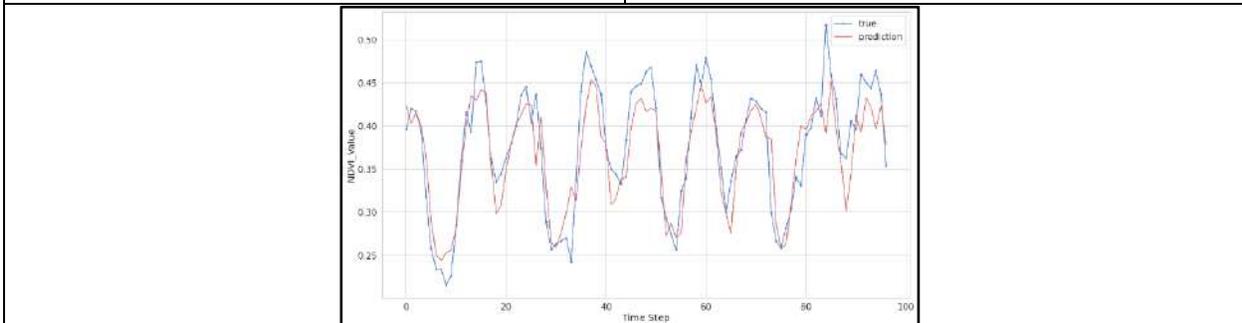
Fig.13: True values Vs Predicted values graph for model-2

RESEARCH ARTICLE

A Comprehensive Analysis and Implementation of a Versatile Algorithm to Improve the Quality of Service in IoT Wireless Sensor Networks

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ABSTRACT

The Internet of Things is a network of physical objects or things that are equipped with sensors, software, and other technologies to communicate and exchange data with other devices and systems over the Internet (IoT). These devices range from basic household goods to cutting-edge industrial equipment. Huge networks are connected by billions of internet-capable devices, and processing vast amounts of data is necessary. Everyday items are connected to the Internet in the IoT evolution period. To interpret valuable data from the raw data collected by these sensors, big data analytics and cloud storage are required [9]. The fundamental issue makes quality of service (QoS) provisioning much more critical and difficult in the Internet of Things (IoT) due to the diversity of end-user expectations linked to the volume of generated data, its variety, and the speed of its transmission. Quality-of-Service (QoS) refers to traffic control techniques that aim to deliver predictable or guaranteed performance to applications, sessions, or traffic aggregates or to differentiate performance based on application or network operator requirements. Packet delay and losses of various kinds are the fundamental QoS phenomena [20]. The requirement for defined latency and loss rate in video and audio conferencing is the QoS's starting point. Video and audio streaming may not be as sensitive to delay because it requires a set packet loss rate. Apps that are time-critical (real-time control) and for which bounded latency is regarded as a significant consideration

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should receive better services than applications that are less valuable [19]. The study offers a thorough and current analysis of QoS support in IoT networks and communication protocols. The layer-dependent QoS measures, network resource optimization techniques, and IoT architectures with a focus on quality of service are all examined. The current state-of-the-art research' shortcomings in terms of effective QoS metric supply are examined. The paper finishes with proposals for future research on end-to-end provisioning of QoS in the IoT utilising an adaptive framework and flexible algorithm with real-time analysis improvement results using the best IoT tools.

Keywords: Algorithms, Analysis, Models, Technology, and Tools; Internet of Things.

INTRODUCTION

A sensor network is often composed of a vast number of tiny devices, all of which have the basic purpose of identifying and relaying specific climate characteristics [1]. When their number reaches in the thousands, these components or hubs can be used effectively to achieve a single common aim. Multiple sensors, actuators, and distinct control elements might be included in a control framework. Therefore, in any case, when the correspondence between each set of devices is described by a low piece rate and requires only mild or minimal transmission delays, the overall piece rate that the organization must maintain can reach extremely high qualities, and time delays may become inappropriate if not properly managed. They have a lot of limitations, especially in terms of integrating systems and administrations, transferring data quickly, and including large areas. However, communication organizations have so far been improved to support certain services (such as the transmission of audio, video, or information records), necessitating some modification to provide various services. The need to support various Quality of Service requirements is often the most recent development with regard to combining administrations in the same network (QoS). Additionally, modifying low piece rate administrations in such organizations is linked to the management of time lost during parcel collection and planning; these viewpoints collectively have an impact on QoS. The engineering of a measured framework was taken into account and suggested [2]. A Terminal Connector, which is its key component, enables the multiplexing of separate streams created by low piece rate administrations into a single overall stream. Making a booking calculation is essential to factually multiplexing several data streams while taking defer prerequisites and other significant QoS limits into account. The following is how the paper is organized. The coordination of low piece rate traffic in correspondent networks is examined in Segment II. While Section IV outlines a few calculations used to carry out traffic gathering, Segment III presents a few fundamentals of traffic planning. Area V depicts the outcomes of the simulation, while Section VI introduces a few goals.

Comprehensive Analysis of QoS Algorithms
FIFO Queuing
In first-in, first-out (FIFO) queuing, packets wait in a buffer (queue) until the node (the router or switch) is ready to handle them. If the average rate of packet arrival exceeds the average rate of packet processing, the queue will fill up and new packets will be erased [11].

Priority Queuing
Priority queuing assigns a priority class to packets first. Every priority level has its own queue. The highest priority packets in the queue are the first ones to be processed. The packets with the lowest priority are the last to be processed. It should be noted that the system keeps serving a queue until it is empty. Because higher priority traffic, like multimedia, can reach its destination faster than FIFO traffic, a priority queue can provide a superior quality of service (QoS) than a FIFO queue. But there might be a drawback. If there is a steady flow in a high-priority queue, the packets in the lower-priority queues won't ever have a chance to be processed [12].

Weighted Fair Queuing

A better scheduling method is weighted fair queuing. In this manner, the packets are still permitted to various queues and assigned to various classes. However, the queues are weighted based on priority; a greater priority translates to a higher weight. The system processes packets in each queue in a round-robin fashion, with the amount of packets processed from each queue being decided by the appropriate weight [13].

Identification of QoS Problems

The primary goal of this research is to offer solutions for the following problems. The issues are explained below.

Delay

The time taken to transmit a packet from the host to the transmission medium is called Transmission delay.

Jitter

Jitter measures the variability in ping by varying the time delay between when a signal is broadcast and when it is received via a network connection. This is frequently brought on by clogged networks, underperforming hardware, and a lack of packet prioritizing implementation.

Throughput

The amount of data successfully transferred through a network in a given period is known as throughput.

Packet Loss

When one or more data packets travelling through a computer network are lost, they are unable to reach their intended location. Data transmission problems, which often occur across wireless networks, or network congestion are the two main causes of packet loss [11].

Selections of Network Modeler

The available tools, including NOTIFY, COOJA, NETSIM, NS-3, TOSSIM, BEWYWISE, ANSYS, MATLAB, RIVERBED, J-SIM, and OMNET++, are analyzed in this section based on key factors including license, platform support, programming language, scalability, protocol optimization, mobile network support, dynamic network topology, standards, MAC and routing support, and network support. This study discovered that several WSN test systems, like OMNET++ and NS-3, needed to be adjusted in order to achieve precise results. When considering adaptability, NS-3 is weaker than all other test systems that have been investigated. The results of this investigation also revealed that the percentage of the investigated devices that are included in literary works already in circulation is generated for explicitly demonstrating situations, and great precision is only achieved when displaying those scenarios. MATLAB and RIVERBED modeler were regarded as premier ongoing simulation tools that combined the application layer for code execution with the working frameworks [14].

MATLAB

A fascinating IoT module that lets you build and test smart devices simultaneously with gathering and analyzing IoT data on the cloud is highlighted by MATLAB. It begins by gathering data from smart devices, compiles it in the cloud, and then gradually examines it. Following the separation of examples and calculations, experts can use this information to create model calculations and run them on the cloud. The user can create and model IoT frameworks using MATLAB. More specifically, you can make computations in Simulink and transfer them to your implanted device subsequently. Additionally, you can model your smart devices using Arduino and Raspberry Pi. [15].

Riverbed Modeler

Riverbed Modeler (previously known as OPNET Modeler) is an organization test system instrument. Wangetal, C. [65] produced a QoS model known as the need-based clog control convention using the OPNET Modeler (PCCP). The bundle between appearance time and parcel administration time was managed in Riverbed Modeler to deliver a certain amount of clog. Utilizing Riverbed Modeler charting tools, the initial presentation boundary, line length, and hub/framework throughput were determined. The Riverbed Modeler's ability to execute line the board + [23] is another advantage. To envision, develop, and test new plans, models, and calculations for working on the exhibition

of the boardline, Riverbed Modeler is used. The executive's agenda and budget can be dynamically established and supplied inside the instrument [3].

Simulation Tools for Integrating Wireless Sensor Networks of Quality of Service in the Internet of Things

This chapter starts off with an overview of the simulation tools that are currently on the market and a review of related research in WSN QoS investigations. To highlight the intricacy of the inquiry, a summary of related work addressing interactions between network modelling tools and computation tools will be given next. Selected tools and methodologies for designing and assessing the integrated QoS model are offered, drawing on the study. In order to reflect the study activities, key elements of the chosen tools are highlighted. A summary of the testbed architecture used for QoS model validation is offered in the parts that follow a presentation of several state-of-the-art WSN tests. From the aforementioned research findings, we deduce that PQ and WFQ perform well when applied to VoIP traffic, while FIFO performs poorly when used to Jitter, start-to-finish package delays, and the average number of dropped groups as a measure of the association execution. WFQ is often the best option for video traffic, with PQ receiving a respectable show. Jitter respects the consistent accomplished incapacitated Nature of IP-based audio and video calls, which FIFO consistently delivers a high concession worth. In this way, the PQ and WFQ mixtures provide improved QoS in IoT networks for Audio, Voice, and Video applications [16] over FIFO.

Comparison Between Previous Algorithm and Versatile Algorithm using Samples

Let's consider the following example

Table 3 displays the order of execution for processes P1 through P5, along with their arrival and execution times. The solution was given based on priority scheduling (preemptive)to decrease the QoS problems with a Gantt chart: Table4 depicts the execution flow of all the processes using existing algorithms. Hence waiting time for each process. *Waiting Time (Pi)= Total waiting Time(Pi)-No of milliseconds process executes previously-Arrival Time(Pi)*

Step2:

The flexible QoS method relies on the priority queue and waiting time to operate. Each step is based on priority and waiting time at the same time. These actions demonstrate how this VQOS algorithm functions. Table 5 explains how the proposed algorithm executes the process simultaneously. Waiting Time (Pi)=Sum of the execution time of all the remaining processes(Pi)- Arrival time of the particular processes (Pi)

Total Execution Time=0+2+22+43+45/5**=24.5ms**

According to the experiment results above, the five processes p1, p2, p3, p4, and p5 with varying arrival time, burst, and time priority result in a higher enhancement of the QoS method. Results of the experiment were compared to those of the priority queue (PQ) and flexible Quality of Service (QoS). On the basis of the necessity and significance of a given process, the priority queue will probably produce superior outcomes. From the aforementioned experimental findings, I calculate the waiting and execution times for each procedure. All five processes in the priority queue are finished in 29 milliseconds. When compared to alternative scheduling method, QoS concurrently considers and executes priority and waiting time, shortening the wait time for three processes. The five procedures in the QoS are completed in 24.5 ms. The calculation step's delay and jitter are decreased by QoS, and the process speed results in an improvement in bandwidth and throughput. Lastly, I showed that VQoS calculations can manage administration-related problems including postponement, jitter, transmission capacity, and throughput from the aforementioned test study [22 and 17].

Implementation of Versatile Algorithm with Real-Time Application

This chapter's primary goal is to present the versatile algorithm's modeling and simulation findings. The findings of the modeling and simulation operations are then given, followed by the model implementation and testing of the separate components. Using Riverbed Modeler and MATLAB, the network models and key elements of the service differentiation method were created and examined. The Riverbed Modeler is a competent discrete event based

network simulator but lacks a robust mathematical simulation framework, as discussed in Chapter 3. MATLAB, on the other hand, offers a better mathematical environment. In order to predict the performance of the QoS framework, the features of the service differentiation model were obtained through MATLAB. In order to comprehend and research the service differentiation algorithm's properties, MATLAB was initially used in the implementation. For users to validate and troubleshoot the algorithm under study, MATLAB provides visual output. The reaction of the service differentiation to continuously streaming data with various QoS specifications (such as real-time or delay-tolerant) was then examined [4, 2 and 7]. The proposed algorithm shows the improved results below compared with other existing methods.

CONCLUSION AND FUTURE WORK

Real-time and non-real-time traffic are the only two primary classifications of traffic that have received the majority of support in earlier research. As a result, they simply take into account the QoS related to the timeliness requirements. This study is based on the idea that a WSN must meet the reliability and timeliness QoS requirements. Delay-tolerant data also has reliability needs that must be carefully maintained, contrary to popular notion that real-time data is significantly more important than delay-tolerant data. It is also required to manage the traffic dynamics among heterogeneous data traffic in order to maintain the QoS for all types of traffic [21, 16, and 5]. In this thesis, we first proposed a flexible architecture with three layers physical, organizational, and informational or data that solves issues with IoT applications. The major goal is to achieve high throughput and large bundle transport extent while making sure that diminishing dependable traffic from heterogeneous devices with less time requirements emerges close to the end user with little deferral and improved quality criteria. Second, a flexible QoS method was put forth to handle the quality-of-service problems brought on by heterogeneous information in a particular application. This algorithm would use the Priority Queue (PQ) and Weighing Time Based (WTB) techniques. More QoS components, including security and privacy issues, will be added in future work employing IoT devices.

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Table 1: Comparative Analysis of QoS Algorithms

Algorithm	Space	Time	Delay	Jitter	Bandwidth	Packet Loss	Throughput	Power	Service
SPF-TE	$O(V^2)$	$|V^2|$	1000 ms	>20ms	Kbps	Low	High	Less	Traffic Scheduling
WSPF	$O(V^2)$	$|V^2|$	500 ms	>30 ms	Kbps	Low	Mid	Less	Traffic Scheduling
TOP	$O(V^2)$	$|V^2|$	500ms	>30 ms	Kbps	High	High	Less	Traffic Scheduling
DORA	$O(N)$	N	<250 ms	<30 ms	Mbps	Low	Low	More	Dynamic Routing
ADORA	$O(N)$-1	N-1	<250 ms	<30 ms	Mbps	Low	Low	More	Dynamic Routing
FIFO	$O(n)$	$O(1)$	<1s	<1s>10s	Mbps	Low	High	Less	High Throughput
PRIORITY	$O(n)$	$O(N \log N)$	>1s	>1s	Mbps	Medium	Low	Less	Scheduling

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WFQ	N/P	N/T	<50ms	<10ms	Gbps	Low	High	Less	Classify Scheduling Traffic Shaping Bandwidth Weight
LEAKY BUCKET	n	N	>1s	>10s	Mbps	Low	Low	High	Packet
TOKEN BUCKET	n	N	>1s	>10s	Mbps	Low	Low	High	Token

Table 2: Graphical Representations of Riverbed Modeler Results

Algorithm/ Models	Packet Delay In Secs (150)	Jitter In Secs (150)	Packet Received	Packet Loss	Speed (%)
SPF	190	125	367	33	19
DORA	182	110	360	40	28
FIFO	165	105	352	48	34
PQ	90	5	400	0	76.25
WFQ	95	0	400	5	76.25
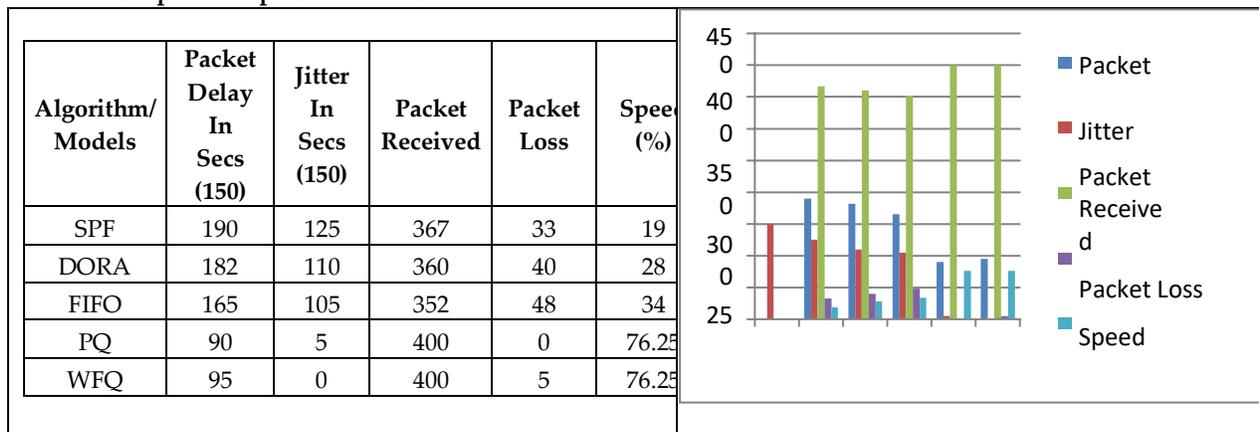
Table3: Process Table

Process ID	Arrival Time	Burst Time	Priority
P1	0	11	2
P2	5	28	0
P3	12	2	3
P4	2	10	1
P5	9	16	4

Table4: Existing Algorithm Execution Table

#		Process	Arrival Time (ms)	Waiting Time (ms)	Execution Time (ms)	Process Stage
1		P1	0	2	2	Pre-empted
2		P4	2	3	3	Pre-empted
3		P2	5	3	28	Completed
4		P4	33	28	7	Completed
5		P1	40	38	9	Completed
6		P3	49	37	2	Completed
7		P5	51	42	16	Completed

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Table5: Proposed Algorithm Execution Table

#	Simultaneous Action	Start Time	Wait time (ms)	Execution Time(ms)
1(P1,P5)	Arrival Time	0	0	11
	Wait Time	9	2	16
2(P2,P3)	Priority	5	22	28
	Wait Time	12	43	2
3(P4)	Priority	2	55	10

Table 6: Proposed Algorithm Results

Process	Delay (Sec)	Speed	Loosed Packets	Bandwidth	Execution Time
P1	0	HIGH		10000	
P2	0	HIGH		10000	
P3	0	HIGH	0	10000	5.336

Table 7: Improvised Results of Proposed Algorithm with Existing Algorithms

Algorithm	Delay (3 Seconds)	Speed (100%)	Loosed Packets(30,000) Packets	Throughput (30,000)Packets	Execution Time
FIFO	0.8	37.5%	16000	14000	5.908
PQ	0.4	75%	4000	26000	5.589
WFQ	0.1	90%	3000	27000	5.756
Proposed Algorithm	0	100%	0	30000	5.336
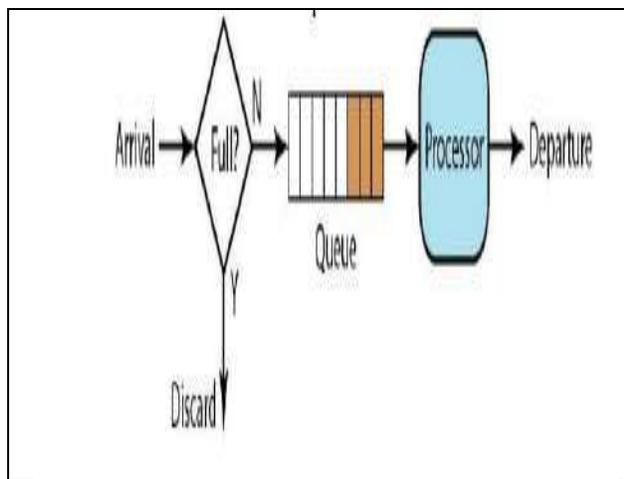
Figure 1: FIFO Queuing	Figure 2: PQ Queuing
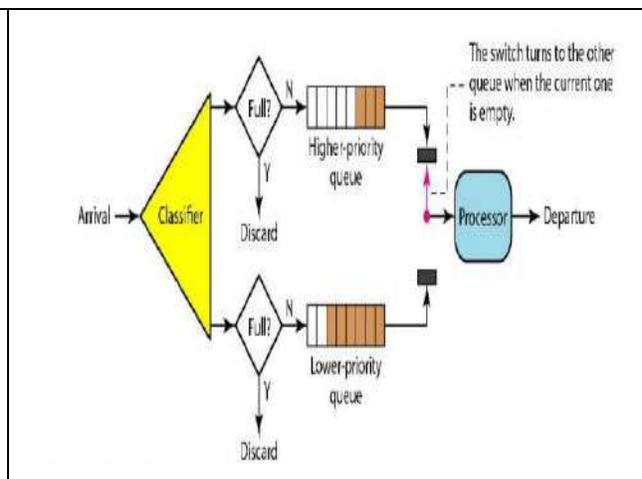
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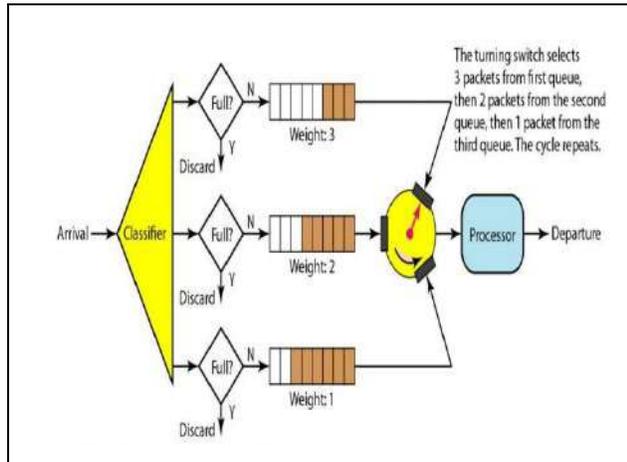
Figure 3: WFQ Queuing	**Figure 4: Simulation Results of FIFO, PQ, WFQ (Delay, Jitter, Throughput and Speed)**
Average Waiting Time	**Bandwidth**
Delay	**Execution Time**
Figure 5: MATLAB Results of Proposed Algorithm	
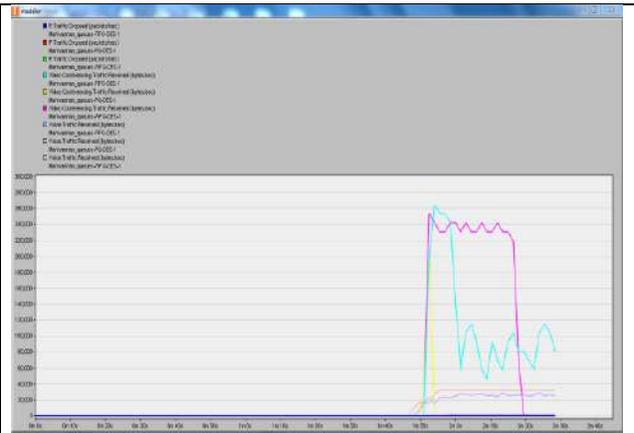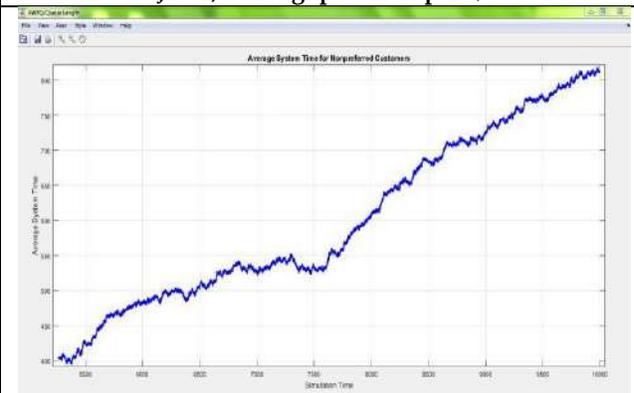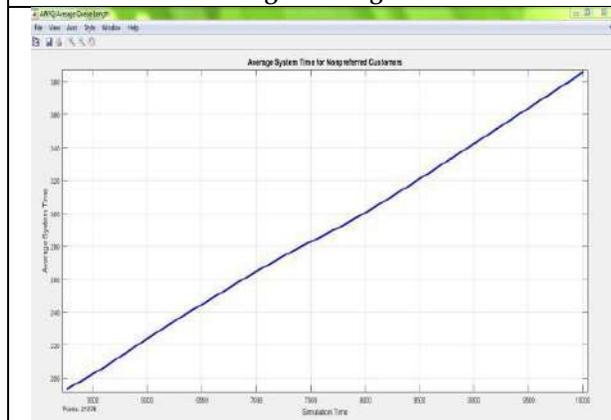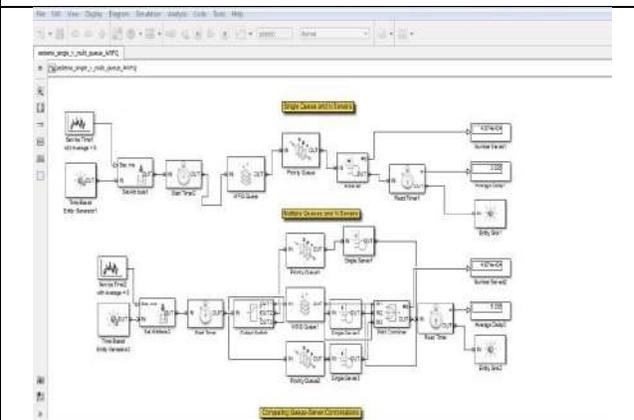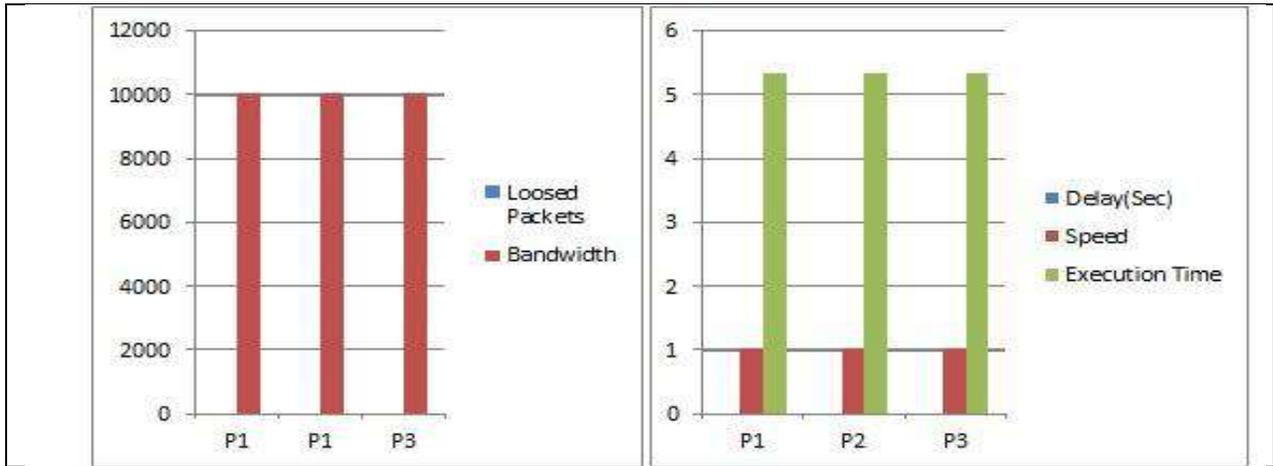
Figure 6: Graphical Representation of MATLAB Results for Proposed Algorithm

RESEARCH ARTICLE

The Application of Artificial Intelligence (AI) in Marketing: Opportunities and Challenges

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ABSTRACT

In the current contemporary context, Artificial Intelligence plays a predominant role in strengthening and transforming industries across the globe. The global AI market is estimated to grow with an expected market value of $190.61 billion by 2025. The application of AI in marketing is in its infancy in India. But marketing companies have to leverage AI to remain competitive. This research paper aims to identify the areas where AI is applied in marketing and study the opportunities and challenges while implementing it. However, the application of AI in marketing is promising, and companies that use AI in marketing may benefit by getting the expected outcome.

Keywords: Artificial Intelligence, Marketing, Competitive, Opportunities, and Challenges.

INTRODUCTION

Artificial Intelligence Marketing
AI marketing enables successful judgments based on a collection of data, analysis of data, and additional examinations of demographic or patterns of the economy that may impact marketing efforts. Artificial intelligence is regularly used in marketing efforts when speed is crucial. Keeping user profiles and data as a basis, AI systems learn how to interact with consumers successfully and then send them personalized messages at the right time without the involvement of marketing staff, guaranteeing maximum productivity. Many marketing companies have started using artificial intelligence (AI) to bolster their teams to undertake more tactical tasks that don't need much human interaction. The following are some examples of AI marketing applications:

- Data analysis
- Natural language processing
- Marketing plans and procurement
- Automated decision-making
- Project initiation

Components of AI in Marketing

Artificial intelligence is undoubtedly crucial in assisting marketing companies in interacting with consumers. The components below are included in today's finest AI marketing systems, which help bridge the gap between vast volumes of buyer data accessible and actionable following actions that can be applied to future campaigns.

Machine Learning

Machine learning uses computer algorithms to analyze data and learn about their errors. Machine learning devices evaluate new systems using relevant past data, enabling them to make decisions based on what has worked and has not worked.

Big Data and Analytics

A rush of big data has flowed in with the growth of digital media, enabling marketing companies to understand their efforts better and rightly distribute value across channels. Many businesses are finding it difficult to determine which statistical models are worthwhile to collect, and an oversupply of data has emerged.

AI Platform Solutions

AI-powered solutions effectively provide marketers with a single platform for managing large amounts of data. AI-powered media may give you access to actionable marketing information for your target customers, enabling choices based on a data-driven approach about how to engage with them most effectively. For example, Bayesian Learn and Forgetfulness methodologies may help marketers better evaluate how responsive a buyer is to too specific marketing activity.

Factors Influencing the Use of AI in Marketing

The following are the factors that every marketer should consider before deploying AI technology for marketing campaigns:

Establish Goals

Clear goals, including marketing statistics, must be defined from the start, like in any marketing effort. You must begin by identifying areas inside campaigns or operations, such as segmentation, where AI could assist. After that, for evaluative goals such as "enhancing customer experience," set specific KPIs to help disclose the most successful AI-enhanced campaign.

Data Privacy Standards

Be sure your Internet application will not breach the border of minimum information use and name of customization when you start your AI program. Ensure that privacy rules are defined and programmed to maintain regulatory and consumer trust.

Data Quantity and Sources

Marketers must have vast volumes of information at home to get launched with AI marketing. The same will teach the AI tool about client preferences, forward it, and other variables that will affect the performance of AI-powered advertising. This information can be gleaned through the company's CRM, marketing

initiatives, and website. Marketers can also use two- and three data to supplement this information. It contains location, weather, and other external factors influencing a purchase choice.

Acquire Data Science Talent

Most marketing organizations lack individuals with the requisite knowledge of data science and AI skills; working with large volumes of data and delivering insights can be challenging. To get programmed off the ground, companies should join hands with third-party organizations that can assist in data collection and analysis and continue maintenance.

Selecting an *A*I Platform

Choosing the correct system or firm to begin an AI promotional campaign is a crucial first step. Marketing companies should be cautious about identifying gaps their ecosystem aims to fill and selecting technical solutions based on their competencies. It may vary depending on the aim marketers are trying to accomplish; for example, AI tools designed to improve consumer happiness will have different functions than products designed to operate quickly and efficiently. Remember the amount of openness you'll need to comprehend that an Analytics platform came to a given result when picking a solution. Depending on the technology used, marketing companies may obtain a research result that concludes on what a specific phrase means but which statistics impacted the decision. Still, algorithms operating at a more intensive level using algorithms are not always able to offer a definitive explanation.

Benefits of Leveraging Artificial Intelligence in Marketing

Marketing companies can leverage the benefit of deploying AI into their activity in the following ways:

Increased Campaign ROI
Suppose marketers use AI in the right areas. In that case, they may use it to change their marketing campaign entirely, selecting the most useful information from current collections and responding to them in real-time. AI skills can support decisions on the fly on how to spend media dollars wisely across platforms or investigate the most successful ad locations to guarantee that they engage the customers regularly, maximizing campaign value.

Betterment of Customer Relationships & Real-Time Personalization
Customized communication can be sent to the target customers at the right time with the help of AI. At-risk clients may be identified with the use of AI, and marketers can advise them to engage with the company again.

Enhancement of Marketing Measurement

Most companies struggle with the quantity of data facilitated by new initiatives, making it increasingly tough to link campaign success to marketing tactics. The dashboards powered by AI provide a complete picture of what's working, allowing you to replicate it across channels and properly allocate resources.

Faster Decision Making

AI can perform tactical machine learning faster than humans and use ML algorithms to make decisions more quickly, based on commercial and customer contexts. It enables free time for team members to focus on strategic projects, which can subsequently be used to inform AI-powered marketing. Marketing companies can use basic analytics to determine better the selection of media, rather than waiting until the conclusion of a strategy to make decisions, thanks to AI.

Few Examples of Artificial Intelligence in Marketing

Artificial intelligence (AI) is employed in marketing activities across various sectors, including the banking system, government, comedy, healthcare, industry, and more. Each use case yields distinct outcomes, such as improved campaign success, better customer experience, or increased marketing operations efficiency.

Machine learning may be used to help organizations construct a complete marketing strategy. Consider the following:

Selection of Right Message

Consumers react differently to different communications across media - some are influenced by emotional appeals, some by comedy, and others by logic. Artificial intelligence (AI) can monitor which communications customers have reacted to and build a complete picture of them. Marketing firms may then give users information tailored to their interests and preferences. Netflix, the pioneer in the OTT platform, uses machine learning to determine which category a consumer-like. The content that the viewer views is then tailored to their tastes. "Let us look at customizing the picture we use to represent the film Would Will Hunting," they note on the Vimeo Tech Website, revealing how they utilize algorithms to determine which artwork will encourage a viewer to watch a given title. We may tailor this selection depending on the genres and topics a member loves. If we present the artwork using Matt Adams and Minnie Driver, someone who has watched a lot of Bollywood comedies would be attracted to Good Will Hunting, but someone who's had a lot of humor will be drawn to the cinema if we show the picture with Robin Williams, some healthy comedian."

Granular Personalization

Consumers nowadays anticipate a high level of granular customization. The interests of the users, buying pattern, location, previously engaged brands, and a variety of other data elements should all be considered when crafting the messages for marketing. Marketing teams can use AI to learn about consumption habits on a granular, personalized level and specific demographic data. It helps marketing companies build customized experiences depending on their customers' preferences. Spotify, for example, utilizes AI to produce personalized music based on what a person has previously listened to, current hits within that category, and what music is trending. These databases are used to construct personalized playlists for users, and genre plays based on artists mentioned in conversations, publications, and other sources. It has aided Spotify's rise to prominence as a leading streaming service that places a premium on customer experience through personalization. Atomic content is another AI-enabled personalization concept. Here, Algorithm learns customers' needs and selects relevant images, videos, and articles from a content library to build a personalized email or deal for a client.

Chat bots and Conversational Experiences

Because of AI's advances in natural language processing, machines are already used to complement the employees taking care of customer service. Customers with straightforward inquiries may employ chatbots to react promptly and adequately. They would gladly provide customized results based on past searches and historical data. It allows customer support agents to focus on more complex issues that require more human sensitivity.

Predictive Marketing Analytics

With massive data inflow, advertising agencies struggle to extract insights. Predictive analytics, which forecasts future behavior using a mix of machine learning, technology, models, and datasets, helps marketing companies to take advantage of every data point. It may assist digital marketers in figuring out what items people are looking for and when they're looking for them, enabling them to better place adverts. Predictive analytics, for example, is used by Amazon to propose goods to users based on prior purchases and behavior, resulting in higher converts and customer satisfaction. Marketing teams may also use AI to track attribution better, enabling them to see which activities benefited greatly from ROI.

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Marketing Operations

The main objective of using AI in communications is to boost the effectiveness across different activities. AI can assist in automating tactical procedures such as sorting marketing data, addressing consumers' inquiries, and security authorizations. It gives free time for marketing companies to involve themselves in investment and analytical tasks.

Dynamic Pricing

Marketing companies can become more competitive by delivering dynamic pricing with the help of AI. AI technologies can recommend appropriate product prices in real-time by analyzing the vast volumes of past and competitor data. In the retail industry, this strategy has shown to be incredibly effective. It allows companies to adjust pricing in response to demand for specific items, resulting in increased sales and a competitive edge.

Challenges for AI Marketing

Modern advertising depends on a thorough understanding of client needs and desires and the ability to respond quickly and accurately to that information. Because of its capacity to make actual, data-driven judgments, AI has climbed to the forefront of most marketing stakeholders' minds. However, marketers must be cautious when incorporating AI into marketing plans and procedures. The research and implementation of AI tools are still in their infancy. Consequently, when incorporating AI into marketing, there are some concerns.

Training Time and Data Quality

Artificial intelligence (AI) technologies don't always know what actions to take to achieve marketing goals. It will require time for training the corporate research objectives, customer expectations, and past trends, grasp the whole situation and develop competency. Not only will this take time, but it will also demand data quality guarantees. If Devices are not trained on high-quality, dependable, timely, and accurate data, they are likely to make errors that do not represent user preferences, decreasing the instrument's value.

Privacy

Consumers and government authorities are putting pressure on firms to limit how they utilize personal data. Marketing teams must ensure that consumer data is handled correctly and in compliance with legislation such as Data or risk significant fines and reputational harm. It is an issue relating to AI. Unless its technologies are designed to adhere to specific legal criteria, they may go beyond what is considered acceptable in terms of consumer data personalization.

Getting Buy-In

Digital marketers may find it challenging to persuade corporate stakeholders of the worth of AI investments. While KPIs such as ROI and performance are easy to track, proving how AI has influenced user engagement or brand awareness is more challenging. With both in mind, sales management should make sure they have the tools they need to attribute these qualitative benefits to AI investments.

Deployment of Best Practices

AI is a new technology in marketing; solid best practices are required to help advertising companies through their earliest deployments that have yet to materialize.

Adapting to a Changing Marketing Landscape

Marketing efforts will be affected frequently as AI becomes more prevalent. Marketers must figure out which jobs will be lost and which will be gained. According to one poll, marketing technology will replace about six out of 10 marketing executive and analyst jobs.

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Future Trends of AI Marketing

Artificial intelligence (AI) would still be a relatively new concept in marketing, but it is predicted to grow in popularity. In the future years, there are just a few AI developments that marketers should be aware of:

AI is Growing

- According to Gartner, AI in marketing will replace about 33% of experienced market researchers by 2022.
- Tech behemoths see AI's potential and usefulness. In 2016, they spent an average of $20 billion to $30 billion. 90% of the overall funding was allocated to deployment and research.
- Furthermore, according to Gartner, by 2020, well over 40% of big data jobs will be automated.

Teams have to Scale through AI

Digital marketers will have more pressure to show their executive stakeholders the value and ROI of marketing. Teams will use AI technologies to achieve these goals, better distribute funding to successful campaigns, and give marketing data illustrating campaign worth.

Marketing Companies have to Leverage the use of AI to remain Competitive

According to Gartner, people in charge of marketing insights will not only be competitive
in this evolving marketing landscape. Only 13% of those questioned by Gartner do not see a purpose for AI for the next three years, while the percentage of those polled use AI solutions with their marketing technique and aim to use it aggressively whenever possible.

CONCLUSION

In today's fast-paced market, a new breed of consumer has emerged: the fast-paced, knowledge-based consumer. They anticipate getting value from a commodity before purchasing it. They must believe that the brand is concerned about them rather than their requirements. Before making a purchase, customers want the product to know exactly what they want. They urgently require advice, tips, answers, and support. That isn't going to change; in fact, it is just going to get worse. Deep Learning is the only tool for firms to keep going with their customers' ever-increasing demands and expectations. To suggest believing AI is the marketing of products is an understatement. The sky is the limit regarding how far human experiences will be brought closer to technologies because of their rapid advancement.

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RESEARCH ARTICLE

Preparation of M-type Hexagonal BaFe₁₂O₁₉ using Disaccharides as Fuel by Sol-Gel Method

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ABSTRACT

Barium hexaferrite nanoparticles were synthesized via sol-gel method based on the reaction between $Ba(No_3)_2$ and $Fe(No_3)_3.9H_2O$ in distilled water, in the presence of disaccharides (maltose, Lactose and Cellobiose) as a fuel. The final solution is magnetically stirred for 4h at room temperature & then surplus water is removed in a vacuum rotary evaporator at 60-80°C until the gel is obtained. The burnt powder was situated into muffle furnace at 700°C, 800°C and 900°C. The present work aimed at the study on the effect of disaccharides on the synthesis. The product were characterized by X-Ray diffraction, Fourier transform Infrared Spectroscopy, Vibrating sample magnetometer and Scanning Electron microscope. The absorption bands exist in around 594 and 443 cm⁻¹ can be assigned to Fe-O and Ba-O bonds from $BaFe_{12}O_{19}$ respectively. The XRD pattern reveal that the formation of hexagonal structure of $BaFe_{12}O_{19}$. The crystalline size was calculated using Debye Scherer's formula which indicates the nanocrystalline

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nature of the prepared sample. The resulted product has the property of the hard magnetic material. The morphology of the sample checked by scanning electron microscope. Constituent elements and chemical composition were analyzed using EDAX spectrum.

Keywords: $BaFe_{12}O_{19}$, Disaccharides, XRD, FTIR, VSM and SEM.

INTRODUCTION

In general, microwave absorbing materials consist of dielectric or magnetic filler and polymer. In the past, lossy dielectric materials have been used for absorbing EM wave due to the low density and perfect temperature stability [1, 2, 3]. Common dielectric materials used for absorption are carbon, graphite and metal flakes, *etc.*. [4, 5]. However, they are usually too bulky for convenient operation. For example, in order to obtain a same absorbing performance as magnetic materials, the effective thickness of dielectric materials would be over 12 cm, while the thickness for magnetic materials is only about 0.2 cm [6, 7]. Therefore, in recent years, magnetic absorbing materials have attracted considerable attention.

Ferrites and metallic alloys are two most important magnetic fillers for use as EM absorbing materials. Metal materials usually have large saturation magnetization and high complex permeability. Therefore, it is possible to make thin absorbers using metallic magnetic materials [8, 9]. Among the metallic magnetic powders, Fe-Si-Al alloy, carbonyl iron, Fe, Co or Ni and their permalloys have been widely studied as absorbing materials [10, 11, 12, 13]. However, there are still some serious drawbacks when metallic magnetic materials are used for EM absorption. The electric conductivity of these materials is generally high, and resonance frequency is very low [14]. Due to the eddy current loss, the permeability decreases rapidly at high frequency [15]. In addition, the permittivity is very large, thus it is difficult to satisfy impedance match between the material and free space. Therefore general metallic magnetic materials are also not suitable candidates for microwave absorption. In considerations of practical applications, there are also some other requirements for EM absorbing materials, such as low density, small thickness, high mechanical strength and good chemically stability.

Hexaferrite have significantly large crystalline anisotropy due to their low crystal symmetry, as compared with the cubic symmetry of spinal or garnet ferrites. Therefore, the resonance frequency can reach as high as 100 GHz [16]. Furthermore, the location of resonance can be modified over a wide frequency range by the substitution of ions in hexaferrite [17] As we know, microwave frequency bands cover a frequency range from 3 MHz to 300 GHz, but the greatest number of operational radar waves fall within 1-18 GHz. Hence, the magnetic resonance frequency for studied ferrites should be controlled as several GHz. On the other hand, for an ideal EM absorbing material, the reflectivity should remain as small as possible over as wide a frequency range as possible. Therefore, this study will focus on controlling the resonance frequency and enhancing the absorbing performance in Barium hexaferrite. There is lot of methods to synthesis the barium hexaferrite particles [18-24]. This paper gives the properties of $BaFe_{12}O_{19}$ particles thus synthesized for various fuels (i.e. Maltose, Lactose, Cellobiose), by sol gel method.

MATERIALS

All the reagents are the analytical grade and used as received, without further purification. Barium Nitrate [Ba$(NO_3)_3$.6H_2O, Ferric nitrate [Fe $(NO)_3)_3$.9H_2O], Maltose, Lactose, Cellobiose, Ethylene glycol [$C_6H_6O_2$], Oxalic acid.

METHODS

Barium ferrite nanoparticles are prepared by the sol-gel combustion method. 1:1 ratio of metal nitrates and fuels are dissolved in distilled water. Here disaccharides are (like Maltose, Lactose and Cellobiose) act as fuel. Then a small amount of Oxalic acid is added to the solution. The final solution is magnetically stirred for 4h at room temperature & then surplus water is removed in a vacuum rotary evaporator at 60-80°C until the gel is obtained. For about 10h, the obtained gel is dried in a hot air oven at 120°C. The prepared sample of $BaFe_{12}O_{19}$ by using maltose, lactose and Cellobiose are labeled as sample 1, 2 and 3 respectively. After that, it is situated in a muffle Furnace at various temperatures (700°C, 800°C and 900°C) which is noted as sample 1(a,b,c), 2(a,b,c), 3(a,b,c) respectively.

RESULT AND DISSCUSSION

XRD Investigations
The XRD pattern of the burnt gel of prepared $BaFe_{12}O_{19}$ by using maltose, Lactose & Cellobiose as a fuel shown in fig.2, 3 and 4 at various temperatures. As can be seen, Barium hexaferrite phase has been started to form at 700°C and by increasing the calcining temperature to 900°C a complete single phase barium hexaferrite has been started. But here noticed that forming of barium hexaferrite in 800°C itself. This temperature is lower than the calcining temperatures used in other methods. From Fig.2, it is clearly observed that, as increasing the crystalline temperature the width of the diffraction peak become narrower. XRD pattern shows the peaks at angles 2Θ of 34, 32, 30 and 37 corresponding to (114), (107), (110) and (203) orientation. The Characteristics peaks corresponding to (h k l) planes are indexed using JCPDS 84-0757.The structure of $BaFe_{12}O_{19}$ are M type hexagonal crystals.

IR Spectrum
The FT-IR spectrum of 500-4000cm^{-1} nanoparticles of $BaFe_{12}O_{19}$ by using various fuels at various temperatures as shown in fig. 3. The absorption peak occurs at 1442 cm^{-1} ,2324cm^{-1} attributed to stretching vibration of C-H of carboxylic acid, O=C=O respectively. The absorption peak occurs around 4000 to 3700 cm^{-1} represents the stretching vibration of O-H. The absorption bands at 550-590 cm^{-1} and 420-480 cm^{-1} are assigned the Fe-O and Ba-O bond from $BaFe_{12}O_{19}$ respectively [25, 26]. Compare to the lactose and Cellobiose, the maltose molecules decompose to water and carbon dioxide when heated above 700°C. This result is in agreement with XRD results with suggests that single $BaFe_{12}O_{19}$ powders can be obtained when calcined at the above 700°C. The increase calcinations temperature improved the $BaFe_{12}O_{19}$ phase formation [27].

Magnetic Property
Fig.4. shows a magnetic hysteresis loop of the samples annealed at 800°C for 2h. The specific magnetic saturation and coercivity of the sample no.1 obtained from VSM measurement. The specific magnetic saturation of the synthesized Barium hexaferrite 54 emu/g.[28]The coercivity (H_c) of the sample is about 4908Oe. Fig 5 & 6 shows the magnetization loop of sample 2 and 3 respectively. The comparison between the M_s, M_r and H_c values are represented in Table.2.
Structural Analysis The Figure.7 displays the SEM images of the synthesized samples. The crystallites are found to be distributed evenly across the sample. The dense structure of all the grains in uniform in size. A hexagonal shape was shown by the synthesized ferrites because the samples are subjected to annealing temperature during synthesis because the ideal hexagonal structure has been distributed. The EDAX spectrum shows the presence of elements in the desired ratios and no impurity peaks has been detected, confirming the purity of the synthesized samples.

CONCLUSION

In this work, nanoparticles of Barium hexaferrite are prepared via sol-gel method by using metal nitrates. This method offers utilization naturals and nontoxic instead of chemical materials. The XRD, FTIR, SEM and VSM

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characterized by the prepared samples. XRD studies proved that the samples are hexagonal structures of single phase M-type. IR spectrum showed that the presence of $BaFe_{12}O_{19}$ A uniform distribution with dense crystallite formation was displayed in surface morphology study. The uniform nanoparticles are produced when maltose is used as a fuel. Barium hexaferrite is the main constituent responsible for magnetism. The coercivity of the Sample1, 2 and 3 shows that the hard magnetic property of the prepared samples.

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Table.2. Comparison between Samples 1,2and 3 calcinated for 2h at 800℃

Sample no.	M_s (emu/g)	M_r (emu/g)	H_c (Oe)
1	54	29	4908
2	42	24	5037
3	47	26	4617
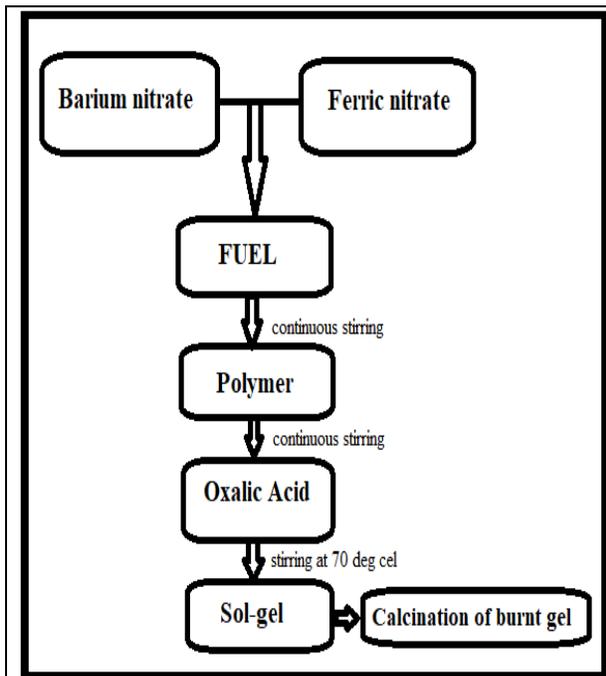
Fig.1. Flowchart of Sample preparation
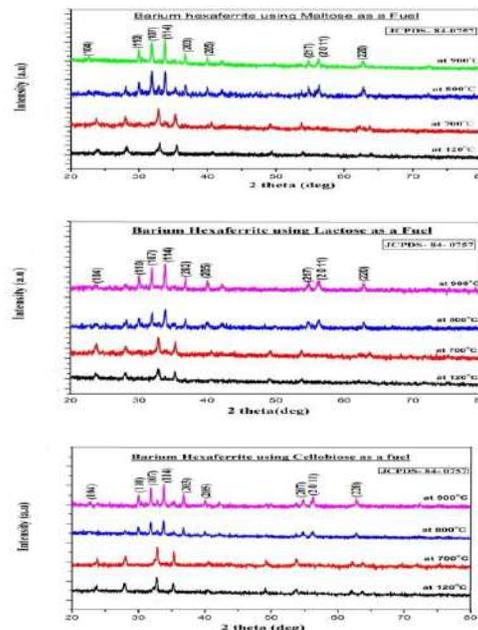
Fig.2. XRD pattern of Sample 1, 2 and 3 calcinated for 2h at 700, 800 and 900℃
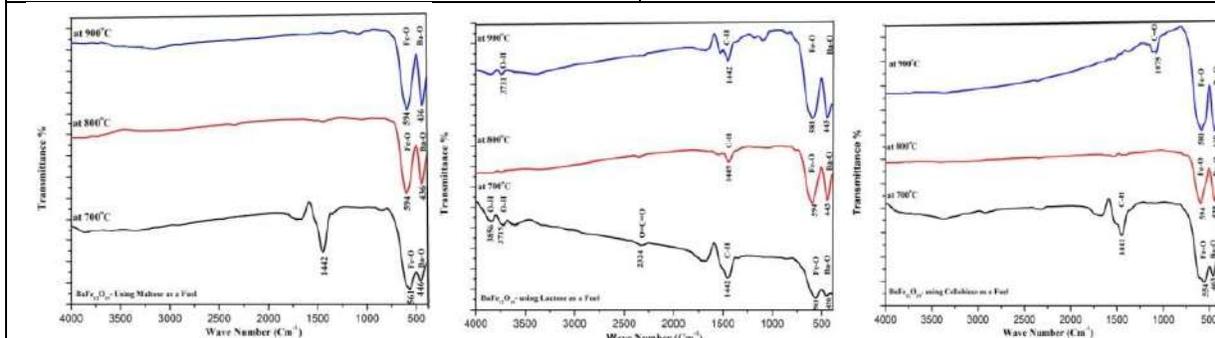
Fig.3. IR Spectrum of Sample 1, 2 and 3 calcinated for 2h at 700, 800 and 900℃
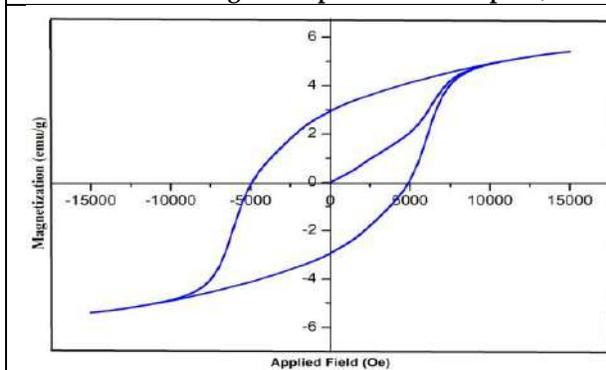
Fig.4.Magnetization curve of Sample 1 calcinated for 2h at 800℃
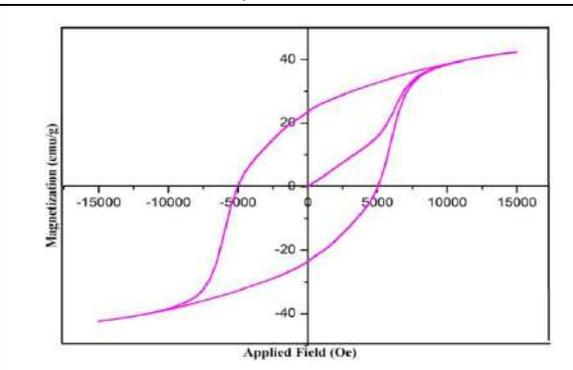
Fig.5.Magnetization curve of Sample 2 calcinated for 2h at 800℃

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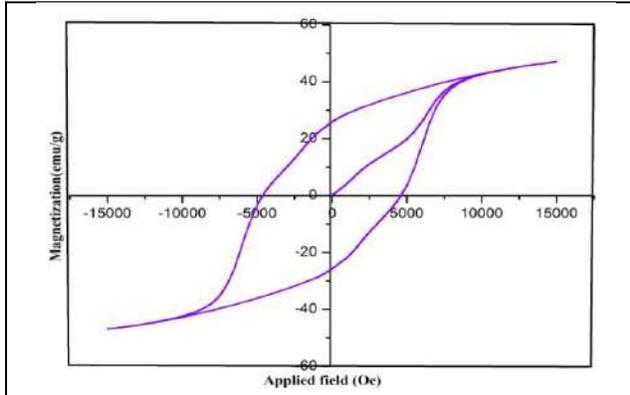
Fig.6.Magnetization curve of Sample 3 calcinated for 2h at 800℃
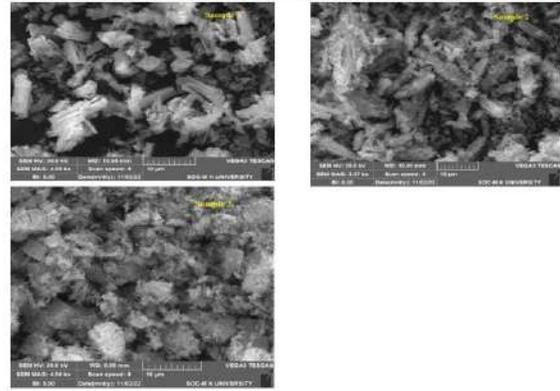
Fig.7. SEM images of Sample 1, 2 and 3
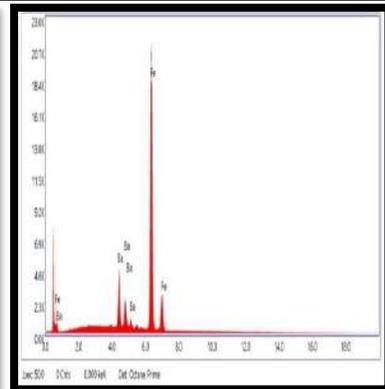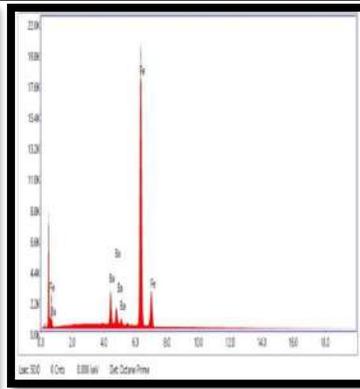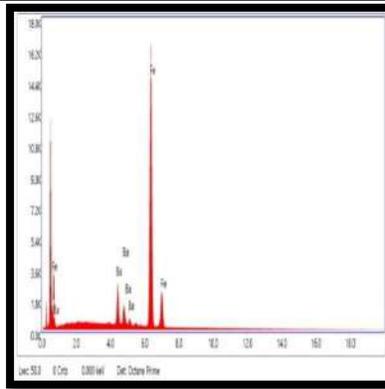
Fig.8. SEM images of Sample 1, 2 and 3

REVIEW ARTICLE

Is Post-Pandemic Opportunity Knocking for Entrepreneurs: A Review

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ABSTRACT

Covid-19 has an unexpected impact on the corporate sector but has also presented young entrepreneurs with a tremendous learning opportunity. Restaurants, brick-and-mortar shops, and event services have all been able to become more imaginative with business solutions and stay competitive as a result of social distance and remote work. It gives business owners a variety of alternatives for satisfying their customers' ever-changing needs. A pandemic will not deter many entrepreneurs because they are innovative, ingenious, and unafraid to take risks. In the digital market, there are many untapped specific niches or empty areas where entrepreneurs may benefit from unmet demand and give their entire foot forward in a challenging business atmosphere. According to the study's goal, entrepreneurs have a new post-pandemic opportunity. According to the study's findings, current brands and new start-up enterprises have immense potential to profit from an opening or a problem. This disease continues to impact practically every aspect of our lives.

Keywords: Creative, Entrepreneurs, Innovative, Post-pandemic, and Risk-Taking.

INTRODUCTION

Businesses including enterprise technology, home entertainment, medical equipment manufacturers and distributors, e-commerce retailers, courier pick-up and delivery, cyber security, and sanitary product manufacturers have seen considerable growth in recent years. Businesses in nearly every sector can take advantage of overseas opportunities. This epidemic has also shifted trade to the internet. The increasing use of digital technology in many

multinational projects has resulted in lower costs, better coordination, more production, and broader access. Entrepreneurs may now take advantage of new technology and market demands by communicating across borders more efficiently than ever before.

Post Pandemic Opportunity for Entrepreneurs

Cleaning Services
Because of the ongoing growth of COVID-19 instances throughout the globe, there is a countrywide surge in demand for cleaning services. Many cleaning service firms have seen an increased demand for extra services, such as regularly cleaning and frequently disinfecting workplace areas to avoid spreading corona virus.

Medical Light
After reopening a firm, the entrepreneur's primary goal is to undertake frequent staff screening as they enter the workplace. According to the National Labor Relations Board (EEOC), employers must use the green light to check the temperature of workers arriving for work, according to the National Labor Relations Board (EEOC), to prevent the corona virus's spread. As a result, firms that produce medical light are in high demand.

Stylish Protection
People wearing face masks have become one of the most familiar sights on the sidewalks of cities throughout the globe in recent years. The fear of the corona virus has persuaded an increasing number of individuals worldwide to wear masks whenever they leave their homes. People don't simply want a show but one with various styles and colors. Big firms have already begun producing fashionable face masks that don't demand.

Delivery Services
The companies that provide delivery services have been vying for market share for several years. However, the leaders will now seize the initiative and try with potential subscribers, hoping that once the pandemic ends, some of the customers will continue to use the services for just a more extended period. Many start-ups may concentrate on a specialized supply of previously unavailable benefits.

Remote Applications
Because of the lockdown, university professors have experienced a new typical way of using remote apps. Education is something change, and businesses have learned to employ remote working software and tools to provide value while lowering overhead expenses. The creation of remote working apps and solutions will become more common.

Remote Fitness
Fitness studios throughout the nation are closing their doors and adapting to a new reality as the corona virus spreads. Soul Cycle announced they would provide virtual sessions on-demand later this year. During this time, the notion of a virtual instructor is gaining traction.

Cyber Security
Working remotely has the downside of suddenly exposing conventional apps to cyber hacker assaults. Investors are willing to support start-ups developing better versions of applications or browser-based security solutions in today's market.

E-Commerce
Due to the COVID-19 pandemic, physical retail outlets have been compelled to close to prevent the corona virus from spreading further. It will hasten the expansion of E-Commerce enterprises to even greater heights. Due to the lockdown, an online pet retailer called Chewy has recently experienced an increase in consumer orders.

Entertainment

During this crisis, gaming solutions have seen a rapid increase in popularity. The number of people watching Hot star and Netflix has skyrocketed. Investors are eager to provide a hand to the next generation of entrepreneurs who can give one-on-one entertainment to the public.

Challenges for Entrepreneurs

The COVID-19 pandemic poses substantial hurdles for new businesses since they are more exposed than established businesses to the shock of the crisis. Other SMEs are more likely to engage in high-risk activities, have trouble obtaining conventional capital, and have the most productive relationships with suppliers and consumers. They rely heavily on a limited founding team, which raises the danger of labor supply shock during the epidemic. During this period of economic uncertainty, government containment measures, and a sharp drop in demand for products and services, the recent start-ups have become much more financially vulnerable. They need assistance to meet their short-term liquidity requirements, which are vital to their survival.

Top Indian Start-Ups Are Thriving Despite Covid-19 Pandemic

BYJU's

In the middle of the epidemic, BYJU, one of India's premier edutech or e-learning start-ups, has surpassed all its rivals with a value of $10.5 billion. With the introduction of countrywide lockdown and social distancing rules, virtual learning platforms have acquired a lot of traction to offer ongoing education for children, which is now considered a major priority.

PharmEasy

E-Pharmacy has played an essential role in the critical business during this epidemic. Because of the house quarantine, people have difficulty getting their prescriptions and over-the-counter (OTC) drugs. Online pharmacies like PharmEasy use a single platform to provide contactless home delivery of medicines and other healthcare supplies. Online pharmacy development is a gift in disguise for older people living alone at home, as it allows them to remain on top of their health by ensuring they do not miss any prescribed dosages. Ordering drugs via the internet is easy and trustworthy, and entirely safe.

Rooter

During this epidemic, when practically all athletic activities have been abandoned worldwide, one of India's most powerful sporting community platforms has generated $ 1.7 million. Rooter provides its supporters with user-generated live audio / visual material from various sports anda personalized sports feed based on the user's preferences.

Khabri

Khabri has just emerged as India's fastest-growing digital music platform. It provides its users with audio material in regional languages, which anybody may make, listen to, or discover on this app. Khabri launched the COVID-19 hotline as a vast outreach campaign for India's visually impaired population. Aside from this outreach campaign, they're raising sanitation awareness among the general population.

Big basket

During COVID-19, Big basket has seen a significant rise in the number of orders it receives until enough consumers choose to acquire basics and foods online. Big basket provides numerous delivery slots with some waiting periods due to increased client demand. During these challenging times, company survival becomes a question mark, and all entrepreneurs do everything they can to make it work.

CONCLUSION

The past two years have been full of twists and turns, mainly due to the global COVID-19 outbreak. Many Indian entrepreneurs have tried their ideas in existing business prospects, with some failing and others profiting from the current openings. India is the preferred destination for start-ups because it offers low-cost trained labor, domestic and foreign investors' funding, and plenty of room for expansion. As per Financial Express, start-up financing in India reached a new record in the timeframe Jan-Mar 2021, with just an injected price of $ 4.4 billion, which is 26% higher than the amount invested in the previous year during the same time. It demonstrates that, even amid the COVID-19 epidemic in India, start-ups had found a means to remain ahead.

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A New Generalization of Quasi Shanker Distribution with Properties and Applications in Engineering Sciences

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ABSTRACT

In this paper, we have introduced a new model of quasi shanker distribution known as area biased quasi Shanker distribution. Its various structural properties including its moments, survival analysis, order statistics, entropies, bonferroni and Lorenz curves have been described and discussed. Its parameters have also been estimated by applying the technique of maximum likelihood estimator and also its Fisher's information matrix have been observed. Finally, a newly proposed area biased quasi Shanker distribution has been analysed and investigated with real life data set to examine its supremacy and flexibility.

Keywords: Weighted distribution, Quasi Shanker distribution, Survival analysis, Order statistics, Entropies, Maximum likelihood estimation.

INTRODUCTION

The concept of weighted probability models attracted a lot of researchers to contemplate on and to carry out research on this topic. The concept of weighted models can be traced from the work of Fisher (1934) in connection with his studies on how methods of ascertainment can influence the form of distribution of recorded observations. Later Rao (1965) developed this concept in a unified manner while modelling the statistical data when the standard

distributions were not appropriate to record these observations with equal probabilities. As a result, weighted models were formulated in such a situation to record the observations according to some weighted function. Weighted distributions occur in a natural way in specifying probabilities of events as observed and recorded by making adjustments to the probabilities of actual occurrence of events taking into account the method of ascertainment. Failure to make such adjustments can lead to wrong conclusions. Weighted probability models play a very important role in some situations arising in various practical fields like medical sciences, engineering etc. The weighted distributions are applied in various research areas related to reliability, biomedicine, ecology and branching processes. The weighted distribution reduces to length biased distribution when the weight function considers only the length of units of interest. The concept of length biased sampling was first introduced by Cox (1969) and Zelen (1974). The statistical interpretation of length biased distribution was originally introduced by Cox (1962) in the context of renewal theory. There are various good sources which provide detailed description of weighted distributions. Van Deusen (1986) arrived at size biased distribution theory independently and applied it in fitting assumed distributions to data arising from horizontal point sampling. In fisheries, Taillie, Patil and Hennemuth (1995) modelled populations of fish stocks using weights. Ghitany, Alqallaf, Al-Mutairi and Husain (2011) introduced a two-parameter weighted Lindley distribution with applications to analyse survival data. Ajami and Jahanshahi (2017) introduced weighted Rayleigh distribution as a new generalization of Rayleigh distribution and discussed its parameter estimation in broad. In ecology, Dennis and Patil (1984) used stochastic differential equations to arrive at weighted properties of size-biased gamma distribution. Fazal (2018) discussed on the area-biased poisson exponential distribution with applications. Rao and Pandey (2020) obtained the parameter estimation of area biased Rayleigh distribution. Bashir and Rasul (2016) studied the size biased Janardan distribution with properties. Perveen et al. (2016) presented the area biased weighted Weibull distribution. Bashir and Rasul (2016) discussed the poisson area biased Lindley distribution with its applications in biological data to prove that it gives a better fit than Poisson distribution. Osowole *et al.* (2020) presented Area biased quasi-Transmuted uniform distribution. Sharma *et al.* (2018) studied the length and area-biased Maxwell distributions. Ade et al. (2020) presented area biased generalized uniform distribution with some statistical properties. Recently, Elfattah et al. (2021) discussed on the length biased Burr-XII distribution with properties and applications.

Quasi Shanker distribution is a recently introduced for two parametric distribution by generating the one parameter Shanker (2017) distribution.Its various mathematical and statistical properties including its moments, coefficient of variation, skewness, kurtosis, index of dispersion, hazard rate function, mean residual life function, stress strength reliability, stochastic ordering, mean deviation, bonferroni and lorenzcurves have been discussed. Further, method of maximum likelihood estimation has been discussed and illustrated with engineering application

RESULT AND DISCUSSION

Area Biased Quasi Shanker (ABQS)Distribution

The probability density function of quasi Shanker distribution is given by

$$f(x;\theta,\alpha) = \frac{\theta^3}{\theta^3 + \theta + 2\alpha}\left(\theta + x + \alpha x^2\right)e^{-\theta x}; \ x > 0, \theta > 0, \theta^3 + \theta + 2\alpha > 0 \qquad (1)$$

and the cumulative distribution function of quasi Shanker distribution is given by

$$F(x;\theta,\alpha) = 1 - \left(1 + \frac{\alpha\theta^2 x^2 + \theta x(\theta + 2\alpha)}{\theta^3 + \theta + 2\alpha}\right)e^{-\theta x}; x > 0, \theta > 0 \qquad (2)$$

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Suppose X is a non-negative random variable with probability density function $f(x)$. Let $w(x)$ be the non-negative weightfunction, then the probability density function of weighted random variable X_w is given by

$$f_w(x) = \frac{w(x)f(x)}{E(w(x))}, \quad x > 0.$$

Where $w(x)$ be the non - negative weight function and $E(w(x)) = \int w(x)f(x)dx < \infty.$

Weighted models are of various choices particularly when $w(x) = x^c$, the resulting distribution is called weighted distribution. In this paper, we have to obtain the area biased version of quasi Shanker distribution, so we will take consequently at $w(x) = x^2$ in order to obtain the area biased quasi Shanker distribution. Then, the probability density function of area biased quasi Shanker distribution is given by

$$f_a(x) = \frac{x^2 f(x)}{E(x^2)} \tag{3}$$

Where $E(x^2) = \int_0^\infty x^2 f(x)dx$

$$E(x^2) = \frac{2\theta^3 + 6\theta + 24\alpha}{\theta^2(\theta^3 + \theta + 2\alpha)} \tag{4}$$

By substituting equations (1) and (4) in equation (3), we will get the probability density function of area biased quasi Shanker distribution as

$$f_a(x) = \frac{\theta^5}{(2\theta^3 + 6\theta + 24\alpha)} x^2(\theta + x + \alpha x^2)e^{-\theta x} \tag{5}$$

and the cumulative distribution function of area biased quasi Shanker distribution can be obtained as

$$F_a(x) = \int_0^x f_a(x)dx$$

$$F_a(x) = \int_0^x \frac{\theta^5}{(2\theta^3 + 6\theta + 24\alpha)} x^2(\theta + x + \alpha x^2)e^{-\theta x}dx$$

$$F_a(x) = \frac{1}{(2\theta^3 + 6\theta + 24\alpha)} \int_0^x x^2\theta^5(\theta + x + \alpha x^2)e^{-\theta x}dx \tag{6}$$

After the simplification of equation (6), we will obtain the cumulative distribution function of area biased quasi Shanker distribution as

$$F_a(x) = \frac{1}{(2\theta^3 + 6\theta + 24\alpha)}\left(\theta^3\gamma(3, \theta x) + \theta\gamma(4, \theta x) + \alpha\gamma(5, \theta x)\right) \tag{7}$$

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Survival analysis

In thissection, we have obtained the survival function, hazard rate function, reverse hazard rate function andMills ratio of the proposed area biased quasi Shanker distribution.

Survival function

The survival function is also known as reliability function or compliment of the cumulative distribution function. The survival function is also defined as the probability that a system survives beyond a specified time. The survival function or reliability function of area biased quasi Shanker distribution can be computed as

$$S(x) = 1 - F_a(x)$$

$$S(x) = 1 - \frac{1}{(2\theta^3 + 6\theta + 24\alpha)}\left(\theta^3\gamma(3, \theta x) + \theta\gamma(4, \theta x) + \alpha\gamma(5, \theta x)\right)$$

Hazard function

The hazard function is also known as hazard rate or instantaneous failure rate or force of mortality and is given by

$$h(x) = \frac{f_a(x)}{1 - F_a(x)}$$

$$h(x) = \frac{x^2\theta^5(\theta + x + \alpha x^2)e^{-\theta x}}{(2\theta^3 + 6\theta + 24\alpha) - (\theta^3\gamma(3, \theta x) + \theta\gamma(4, \theta x) + \alpha\gamma(5, \theta x))}$$

Reverse hazard function

The reverse hazard rate function is given by

$$h_r(x) = \frac{f_a(x)}{F_a(x)}$$

$$h_r(x) = \frac{x^2\theta^5(\theta + x + \alpha x^2)e^{-\theta x}}{(\theta^3\gamma(3, \theta x) + \theta\gamma(4, \theta x) + \alpha\gamma(5, \theta x))}$$

Mills Ratio

$$M.R = \frac{1}{h_r(x)} = \frac{(\theta^3\gamma(3, \theta x) + \theta\gamma(4, \theta x) + \alpha\gamma(5, \theta x))}{x^2\theta^5(\theta + x + \alpha x^2)e^{-\theta x}}$$

Statistical properties

In this section, we will discuss the different statistical properties of area biased quasi Shanker distribution especially its moments, harmonic mean, moment generating function and characteristic function.

Moments

Let X denotes the random variable following area biased quasi Shanker distribution with parameters θ and α, then the rth order moment $E(X^r)$ of area biased quasi Shanker distribution can be obtained as

$$E(X^r) = \mu_r' = \int_0^\infty x^r f_a(x)dx$$

$$= \int_0^\infty x^r \frac{\theta^5}{(2\theta^3 + 6\theta + 24\alpha)} x^2(\theta + x + \alpha x^2)e^{-\theta x}dx$$

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$$= \frac{\theta^5}{(2\theta^3 + 6\theta + 24\alpha)} \left(\theta \int_0^\infty x^{(r+3)-1} e^{-\theta x} dx + \int_0^\infty x^{(r+4)-1} e^{-\theta x} dx + \alpha \int_0^\infty x^{(r+5)-1} e^{-\theta x} dx \right) \qquad (8)$$

After simplification of equation (8), we obtain

$$E(X^r) = \mu_r' = \frac{\theta \Gamma(r+3) + \theta^{r+3} \Gamma(r+4) + \alpha \theta^{r+2} \Gamma(r+5)}{\theta^{2r+2}(2\theta^3 + 6\theta + 24\alpha)} \qquad (9)$$

By putting *r* = 1,2, 3 and 4 in equation (9), we will obtain first four moments of area biased quasi Shanker distribution.

$$E(X) = \mu_1' = \frac{6\theta + 24\theta^4 + 120\alpha\theta^3}{\theta^4(2\theta^3 + 6\theta + 24\alpha)}$$

$$E(X^2) = \mu_2' = \frac{24\theta + 120\theta^5 + 720\alpha\theta^4}{\theta^6(2\theta^3 + 6\theta + 24\alpha)}$$

$$E(X^3) = \mu_3' = \frac{120\theta + 720\theta^6 + 5040\alpha\theta^5}{\theta^8(2\theta^3 + 6\theta + 24\alpha)}$$

$$E(X^4) = \mu_4' = \frac{720\theta + 5040\theta^7 + 40320\alpha\theta^6}{\theta^{10}(2\theta^3 + 6\theta + 24\alpha)}$$

$$\text{Variance} = \frac{24\theta + 120\theta^5 + 720\alpha\theta^4}{\theta^6(2\theta^3 + 6\theta + 24\alpha)} - \left(\frac{6\theta + 24\theta^4 + 120\alpha\theta^3}{\theta^4(2\theta^3 + 6\theta + 24\alpha)} \right)^2$$

$$S.D(\sigma) = \sqrt{\left(\frac{24\theta + 120\theta^5 + 720\alpha\theta^4}{\theta^6(2\theta^3 + 6\theta + 24\alpha)} - \frac{(6\theta + 24\theta^4 + 120\alpha\theta^3)^2}{(\theta^4(2\theta^3 + 6\theta + 24\alpha))^2} \right)}$$

Harmonic mean
The harmonic mean for the proposed area biased quasi Shankerdistribution can be obtained as

$$H.M = E\left(\frac{1}{x} \right) = \int_0^\infty \frac{1}{x} f_a(x) dx$$

$$= \int_0^\infty \frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha} x(\theta + x + \alpha x^2) e^{-\theta x} dx$$

$$= \frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha} \left(\theta \int_0^\infty x^{(3)-2} e^{-\theta x} dx + \int_0^\infty x^{(3)-1} e^{-\theta x} dx + \alpha \int_0^\infty x^{(4)-1} e^{-\theta x} dx \right)$$

After simplification of above equation, we get

$$H.M = \frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha} \left(\theta \gamma(3, \theta x) + \gamma(3, \theta x) + \alpha \gamma(4, \theta x) \right)$$

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Moment generating function and characteristic function

Let X be a random variable following area biased quasi Shanker distribution with parameters θ and α, then the moment generating function of X can be obtained as

$$M_X(t) = E(e^{tx}) = \int_0^\infty e^{tx} f_a(x)dx$$

Using Taylor's series, we get

$$= \int_0^\infty \left(1 + tx + \frac{(tx)^2}{2!} + \ldots\right) f_a(x)dx$$

$$= \int_0^\infty \sum_{j=0}^\infty \frac{t^j}{j!} x^j f_a(x)dx$$

$$= \sum_{j=0}^\infty \frac{t^j}{j!} \mu_j'$$

$$= \sum_{j=0}^\infty \frac{t^j}{j!} \left(\frac{\theta\Gamma(j+3) + \theta^{j+3}\Gamma(j+4) + \alpha\theta^{j+2}\Gamma(j+5)}{\theta^{2j+2}(2\theta^3 + 6\theta + 24\alpha)} \right)$$

$$\Rightarrow M_X(t) = \frac{1}{\theta^2(2\theta^3 + 6\theta + 24\alpha)} \sum_{j=0}^\infty \frac{t^j}{j!\theta^{2j}} \left(\theta\Gamma(j+3) + \theta^{j+3}\Gamma(j+4) + \alpha\theta^{j+2}\Gamma(j+5)\right)$$

Similarly, the characteristic function of area biased quasi Shanker distribution can be obtained as

$$\varphi_x(t) = M_X(it)$$

$$M_X(it) = \frac{1}{\theta^2(2\theta^3 + 6\theta + 24\alpha)} \sum_{j=0}^\infty \frac{(it)^j}{j!\theta^{2j}} \left(\theta\Gamma(j+3) + \theta^{j+3}\Gamma(j+4) + \alpha\theta^{j+2}\Gamma(j+5)\right)$$

Order Statistics

Order statistics have been largely applied in the field of reliability and life testing. Let $X_{(1)}, X_{(2)}, \ldots, X_{(n)}$ denotes the order statistics of a random sample $X_1, X_2, \ldots, X_n$ drawn from a continuous population with probability density function $f_x(x)$ and cumulative distribution function $F_x(x)$, then the probability density function of rth order statistics $X_{(r)}$ is given by

$$f_{x(r)}(x) = \frac{n!}{(r-1)!(n-r)!} f_X(x)\left(F_X(x)\right)^{r-1}\left(1 - F_X(x)\right)^{n-r} \tag{10}$$

By using the equations(5) and (7) in equation (10), we will obtain the probability density function of rth order statistics of area biased quasi Shanker distribution which is given by

$$f_{x(r)}(x) = \frac{n!}{(r-1)!(n-r)!}\left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}x^2(\theta + x + \alpha x^2)e^{-\theta x}\right)$$

$$\times\left(\frac{1}{2\theta^3 + 6\theta + 24\alpha}\theta^3\gamma(3,\theta x) + \theta\gamma(4,\theta x) + \alpha\gamma(5,\theta x)\right)^{r-1}$$

$$\times\left(1 - \frac{1}{2\theta^3 + 6\theta + 24\alpha}\theta^3\gamma(3,\theta x) + \theta\gamma(4,\theta x) + \alpha\gamma(5,\theta x)\right)^{n-r}$$

Therefore, the probability density function of higher order statistic$X_{(n)}$ of area biased quasi Shanker distribution can be obtained as

$$f_{x(n)}(x) = \frac{n\theta^5}{2\theta^3 + 6\theta + 24\alpha}x^2(\theta + x + \alpha x^2)e^{-\theta x}$$

$$\times\left(\frac{1}{2\theta^3 + 6\theta + 24\alpha}\theta^3\gamma(3,\theta x) + \theta\gamma(4,\theta x) + \alpha\gamma(5,\theta x)\right)^{n-1}$$

and the probability density function of first order statistic$X_{(1)}$ of area biased quasi Shanker distribution can be obtained as

$$f_{x(1)}(x) = \frac{n\theta^5}{2\theta^3 + 6\theta + 24\alpha}x^2(\theta + x + \alpha x^2)e^{-\theta x}$$

$$\times\left(1 - \frac{1}{2\theta^3 + 6\theta + 24\alpha}\theta^3\gamma(3,\theta x) + \theta\gamma(4,\theta x) + \alpha\gamma(5,\theta x)\right)^{n-1}$$

Likelihood Ratio Test

Let the random sample $X_1, X_2,\ldots, X_n$of size n drawn from the area biased quasi Shanker distribution. We set up the hypothesis for testing

$$H_o : f(x) = f(x;\theta,\alpha) \qquad \text{against} \qquad H_1 : f(x) = f_a(x;\theta,\alpha)$$

In order to investigate whether the random sample of size $n$comes from the quasi Shanker distribution or area biased quasiShanker distribution, the following test statistic is used

$$\Delta = \frac{L_1}{L_o} = \prod_{i=1}^{n}\frac{f_a(x;\theta,\alpha)}{f(x;\theta,\alpha)}$$

$$\Delta = \frac{L_1}{L_o} = \left(\frac{\theta^5(\theta^3 + \theta + 2\alpha)}{\theta^3(2\theta^3 + 6\theta + 24\alpha)}\right)^n\prod_{i=1}^{n}x_i^2$$

We should reject the null hypothesis, if

$$\Delta = \left(\frac{\theta^5(\theta^3 + \theta + 2\alpha)}{\theta^3(2\theta^3 + 6\theta + 24\alpha)} \right)^n \prod_{i=1}^{n} x_i^2 > k$$

Equivalently, we also reject the null hypothesis, where

$$\Delta^* = \prod_{i=1}^{n} x_i^2 > k \left(\frac{\theta^3(2\theta^3 + 6\theta + 24\alpha)}{\theta^5(\theta^3 + \theta + 2\alpha)} \right)^n$$

$$\Delta^* = \prod_{i=1}^{n} x_i^2 > k^*, \text{Where } k^* = k \left(\frac{\theta^3(2\theta^3 + 6\theta + 24\alpha)}{\theta^5(\theta^3 + \theta + 2\alpha)} \right)^n$$

When the sample is large of size *n*, *2log Δ* is distributed as chi-square distribution with one degree of freedom and also chi-square distribution is used for obtaining *p*value. Thus, we reject the null hypothesis, when the probability value is given by

$$p\left(\Delta^* > \beta^* \right), \text{Where } \beta^* = \prod_{i=1}^{n} x_i^2 \text{ is less than a specified level of significan ce and } \prod_{i=1}^{n} x_i^2 \text{ is the}$$

observed value of the statistic Δ^*.

Bonferroni and Lorenz Curves

The bonferroni and Lorenz curves haveassumed relief not onlyin economics to study the distribution of income and wealth or income and poverty, but also being used in other fields like reliability, medicine, insurance and demography. The bonferroni and Lorenz curves are given by

$$B(p) = \frac{1}{p\mu_1'} \int_0^q x f_a(x) dx$$

$$L(p) = pB(p) = \frac{1}{\mu_1'} \int_0^q x f_a(x) dx$$

Where $\mu_1' = \dfrac{6\theta + 24\theta^4 + 120\alpha\theta^3}{\theta^4(2\theta^3 + 6\theta + 24\alpha)}$ and $q = F^{-1}(p)$

$$B(p) = \frac{\theta^4(2\theta^3 + 6\theta + 24\alpha)}{p(6\theta + 24\theta^4 + 120\alpha\theta^3)} \int_0^q \frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha} x^3(\theta + x + \alpha x^2) e^{-\theta x} dx$$

$$B(p) = \frac{\theta^9}{p(6\theta + 24\theta^4 + 120\alpha\theta^3)} \left(\theta \int_0^q x^{(4)-1} e^{-\theta x} dx + \int_0^q x^{(5)-1} e^{-\theta x} dx + \alpha \int_0^q x^{(6)-1} e^{-\theta x} dx \right)$$

After simplification, we obtain

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$$B(p) = \frac{\theta^9}{p(6\theta + 24\theta^4 + 120\alpha\theta^3)}\left(\theta\,\gamma(4,\,\theta q) + \gamma(5,\,\theta q) + \alpha\,\gamma(6,\,\theta q)\right)$$

$$L(p) = \frac{\theta^9}{(6\theta + 24\theta^4 + 120\alpha\theta^3)}\left(\theta\,\gamma(4,\,\theta q) + \gamma(5,\,\theta q) + \alpha\,\gamma(6,\,\theta q)\right)$$

Entropies

The concept of entropies is important in various areas such as probability and statistics, physics, communication theory and economics. Entropies quantify the diversity, uncertainty, or randomness of a system. Entropy of a random variable X is a measure of variation of uncertainty.

Renyi Entropy

The Renyi entropy is important in ecology and statistics as index of diversity. The Renyi entropy is also important in quantum information, where it can be used as a measure of entanglement. For a given probability distribution, Renyi entropy is given by

$$e(\beta) = \frac{1}{1-\beta}\log\left(\int f_a^{\beta}(x)dx\right)$$

Where, $\beta > 0$ and $\beta \neq 1$

$$e(\beta) = \frac{1}{1-\beta}\log\int_0^\infty\left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}x^2(\theta + x + \alpha x^2)e^{-\theta x}\right)^{\beta}dx$$

$$e(\beta) = \frac{1}{1-\beta}\log\left(\left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}\right)^{\beta}(\theta + x + \alpha x^2)^{\beta}\int_0^\infty x^{(2\beta+1)-1}e^{-\theta\beta x}dx\right)$$

After simplification, we obtain

$$e(\beta) = \frac{1}{1-\beta}\log\left(\left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}\right)^{\beta}(\theta + x + \alpha x^2)^{\beta}\frac{\Gamma(2\beta+1)}{(\theta\beta)^{2\beta+1}}\right)$$

Tsallis Entropy

A generalization of Boltzmann-Gibbs (B.G) statistical properties initiated by Tsallis has focused a great deal to attention. This generalization of B-G statistics was proposed firstly by introducing the mathematical expression of Tsallis entropy (Tsallis, 1988) for a continuous random variable is defined as follows

$$S_\lambda = \frac{1}{\lambda-1}\left(1 - \int_0^\infty f_a^{\lambda}(x)dx\right)$$

$$S_\lambda = \frac{1}{\lambda-1}\left(1 - \int_0^\infty\left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}x^2(\theta + x + \alpha x^2)e^{-\theta x}\right)^{\lambda}dx\right)$$

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$$S_\lambda = \frac{1}{\lambda - 1}\left(1 - \left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}\right)^\lambda (\theta + x + \alpha x^2)^\lambda \int_0^\infty x^{(2\lambda+1)-1} e^{-\lambda\theta x} dx\right)$$

After simplification, we obtain

$$S_\lambda = \frac{1}{\lambda - 1}\left(1 - \left(\frac{\theta^5}{2\theta^3 + 6\theta + 24\alpha}\right)^\lambda (\theta + x + \alpha x^2)^\lambda \frac{\Gamma(2\lambda + 1)}{(\lambda\theta)^{2\lambda+1}}\right)$$

Maximum Likelihood Estimation and Fisher's Information Matrix

In this section, the maximum likelihood estimation has been widely used for estimating the parameters of area biased quasi Shanker distribution. Let X_1, X_2,…, X_n be a random sample of size n from the area biased quasi Shanker distribution, then the likelihood function can be written as

$$L(x) = \prod_{i=1}^{n} f_a(x)$$

$$L(x) = \prod_{i=1}^{n}\left(\frac{\theta^5}{(2\theta^3 + 6\theta + 24\alpha)} x_i^2 (\theta + x_i + \alpha x_i^2)e^{-\theta x_i}\right)$$

$$L(x) = \frac{\theta^{5n}}{(2\theta^3 + 6\theta + 24\alpha)^n}\prod_{i=1}^{n}\left(x_i^2 (\theta + x_i + \alpha x_i^2)e^{-\theta x_i}\right)$$

The log likelihood function is given by

$$\log L(x) = 5n\log\theta - n\log(2\theta^3 + 6\theta + 24\alpha) + 2\sum_{i=1}^{n}\log x_i$$

$$+ \sum_{i=1}^{n}\log(\theta + x_i + \alpha x_i^2) - \theta\sum_{i=1}^{n}x_i \tag{11}$$

Now differentiating the log likelihood equation (11) with respect to parameters θ and α. We must satisfy the normal equations as

$$\frac{\partial\log L}{\partial\theta} = \frac{5n}{\theta} - n\left(\frac{(6\theta^2 + 6)}{(2\theta^3 + 6\theta + 24\alpha)}\right) + \sum_{i=1}^{n}\left(\frac{1}{(\theta + x_i + \alpha x_i^2)}\right) - \sum_{i=1}^{n}x_i = 0$$

$$\frac{\partial\log L}{\partial\alpha} = -n\left(\frac{24}{(2\theta^3 + 6\theta + 24\alpha)}\right) + \sum_{i=1}^{n}\left(\frac{x_i^2}{(\theta + x_i + \alpha x_i^2)}\right) = 0$$

It is important to mention here that the analytical solution of the above non linear system of equationsare unknown. Algebraically, it is very difficult to solve the complicated form of likelihood system of nonlinear equations. Therefore we use R and wolfram mathematics for estimating the required parameters of the proposed distribution.

We use theasymptotic normality results in order to obtain the confidence interval. We have that if $\hat{\lambda} = (\hat{\theta}, \hat{\alpha})$ denotes the MLE of $\lambda = (\theta, \alpha)$. We can state the results as follows:

$$\sqrt{n}(\hat{\lambda} - \lambda) \rightarrow N_2(0,\, I^{-1}(\lambda))$$

Where $I^{-1}(\lambda)$ is the Fisher's information matrix.i.e .

$$I(\lambda) = -\frac{1}{n}\begin{pmatrix} E\left(\dfrac{\partial^2 \log L}{\partial \theta^2}\right) & E\left(\dfrac{\partial^2 \log L}{\partial \theta\, \partial \alpha}\right) \\[3mm] E\left(\dfrac{\partial^2 \log L}{\partial \alpha\, \partial \theta}\right) & E\left(\dfrac{\partial^2 \log L}{\partial \alpha^2}\right) \end{pmatrix}$$

Here we can show that

$$E\left(\frac{\partial^2 \log L}{\partial \theta^2}\right) = -\frac{5n}{\theta^2} - n\left(\frac{12\theta(2\theta^3 + 6\theta + 24\alpha) - (6\theta^2 + 6)(6\theta^2 + 6)}{(2\theta^3 + 6\theta + 24\alpha)^2}\right) - \sum_{i=1}^{n}\left(\frac{1}{(\theta + x_i + \alpha x_i^2)^2}\right)$$

$$E\left(\frac{\partial^2 \log L}{\partial \alpha^2}\right) = n\left(\frac{24(24)}{(2\theta^3 + 6\theta + 24\alpha)^2}\right) - \sum_{i=1}^{n}\left(\frac{E(x_i^4)}{(\theta + x_i + \alpha x_i^2)^2}\right)$$

$$E\left(\frac{\partial^2 \log L}{\partial \theta\, \partial \alpha}\right) = -n\left(\frac{24(6\theta^2 + 6)}{(2\theta^3 + 6\theta + 24\alpha)^2}\right) - \sum_{i=1}^{n}\left(\frac{E(x_i^2)}{(\theta + x_i + \alpha x_i^2)^2}\right)$$

Since λ being unknown, we estimate $I^{-1}(\lambda)$ by $I^{-1}(\hat{\lambda})$ and this can be used to obtain asymptotic confidence intervals for θ and α.

Application

In this section, we have fitted a realdata set in area biased quasi Shanker distribution to show thatthe area biased quasi Shanker distribution fits better over quasi Shanker and Shanker distributions.The following real data set is given below as. The following data set is reported by Bader and Priest (1982) represents the tensile strength measured in GPa, of 69 carbon fibres tested under tension at gauge lengths of 20mm.The data set is given below in table 1 as

In order to estimate the model comparison criterion values, the unknown parameters are also estimated through the technique of R software. In order to compare the area biased quasi Shanker distribution with quasi Shanker and Shanker distributions. We are using the criterion values *AIC* (Akaike Information Criterion),*BIC* (Bayesian Information Criterion), *AICC* (Akaike Information Criterion Corrected) and*-2logL*. The better distribution is which corresponds to lesser values of *AIC, BIC, AICC* and *-2logL*. For calculating criterion values *AIC,BIC*, *AICC* and *-2logL* can be evaluated by using the formulas as follows:

$$AIC = 2k - 2\log L, \qquad BIC = k\log n - 2\log L \qquad \text{and} \qquad AICC = AIC + \frac{2k(k+1)}{n - k - 1}$$

Where *k* is the number of parameters in the statistical model, *n* is the sample size and –2log*L*is the maximized value of log-likelihood function under the considered model.

From table 2 given above, it can be easily seen from the results that the area biased quasi Shanker distribution have the lesser *AIC, BIC, AICC* and *-2logL*values as compared to the quasi Shanker and Shanker distributions, which clearly indicates that the area biased quasi Shanker distribution fits better than the quasi Shanker and Shankerdistributions. Hence, it can be concluded that the area biased quasi Shanker distribution leads to a better fit than the quasi Shanker and Shanker distributions.

CONCLUSION

In the present paper, we have studied a new extension of quasi Shanker distribution called as area biased quasi Shanker distribution. The subject distribution is generated by using the area biased technique and taking the two parameter quasi Shanker distribution as the base distribution. Its various structural properties including moments, harmonic mean, survival function, hazard rate function, reverse hazard rate function, order statistics, entropies, bonferroni and Lorenz curves have been discussed. For estimating its parameters, the technique of maximum likelihood estimation have been used and its Fisher's information matrix have been discussed. Finally a real life data set has been fitted in new distribution to demonstrate its supremacy and usefulness and it is found from the results that the area biased quasi Shanker distribution provides better fit than the quasi Shanker and Shanker distributions.

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Table 1:Data regarding tensile strength of carbon fibres measured in GPa

1.312	1.479	2.055	2.359	2.570	2.818	1.314	2.027	2.301	2.566
2.809	3.433	2.021	2.301	2.554	2.800	3.233	1.865	2.274	2.535
2.773	3.128	1.861	2.179	2.514	2.770	3.096	1.803	2.140	2.426
2.726	3.090	1.700	2.098	2.382	2.629	3.084	1.552	2.063	2.382
2.586	2.821	3.585	1.944	2.224	2.434	2.633	2.848	3.585	1.958
2.240	2.435	2.642	2.880	1.966	2.253	2.478	2.648	2.954	1.997
2.270	2.490	2.684	3.012	2.006	2.272	2.511	2.697	3.067	

Table 2: Comparison and Performance of fitted distributions

Distributions	MLE	S.E	-2logL	AIC	BIC	AICC
Area Biased Quasi Shanker	$\hat{\alpha} = 8371.879969$ $\hat{\theta} = 2.039601$	$\hat{\alpha} = 16777.249207$ $\hat{\theta} = 0.109803$	153.6892	157.6892	162.1574	157.8710
Quasi Shanker	$\hat{\alpha} = 1.829619$ $\hat{\theta} = 1.223755$	$\hat{\alpha} = 1.677722$ $\hat{\theta} = 8.505259$	184.5146	188.5146	192.9829	188.6964
Shanker	$\hat{\theta} = 0.65803010$	$\hat{\theta} = 0.05237384$	233.0054	235.0054	237.2395	235.0651

Table 3: List of Abbreviations

$E(X)$	Expectation of X
$V(X) = \sigma^2(X)$	Variance of X
$f(x)$	Density function
$F(X)$	Distribution function
$S(x)$	Survival function
$h(x)$	Hazard Function

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H.M.	Harmonic Mean
$M_X(t)$	Moment Generating Function
B(p)	Bonferroni Curve
L(p)	Lorenz Curve
$e(\beta)$	Renyl Entropy
S_λ	Tsallis Entropy
L(X)	Maximum Likelihood Estimation
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
AICC	Akaike Information Criterion Corrected

RESEARCH ARTICLE

An Exploratory Study on Open Banking has the Potential to Disrupt the Current Banking Practices

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ABSTRACT

Through open banking, financial institutions can share consumer information with third-party app builders and companies to facilitate the development of innovative financial services. Financial industry data silos are crumbling as a result of APIs that allow for broader data sharing. Open banking was pioneered in Europe in 2018, and since then it has been embraced by more than fifty countries. Account aggregators are governed by laws in India that require them to verify the privacy and security of their clients' data before releasing it. Any and all data retrievable, transferable, or otherwise made public is subject to the discretion of the customer. When dealing with money, data security is critical; just because clients provide their consent does not mean that the information may be viewed by unauthorised parties. Even while open banking is a relatively new innovation, it has the potential to revolutionise the financial sector and make banking more convenient for consumers. If user data is safeguarded and malicious third-party applications are blocked, it has the potential to inspire the creation of new digital businesses and put pressure on existing ones to improve.

Keywords: Open Banking, Customer, Security, Financial

INTRODUCTION

With open banking, financial institutions are able to make their customers' data available to outside developers and businesses for use in creating new products and services. Data silos in the financial sector are dismantled, and APIs make data accessible to more people (APIs). More than fifty nations have adopted open banking since it was first introduced in Europe in 2018. Open banking is gaining popularity as the global economy develops because it

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facilitates safe and quick financial transactions anywhere in the globe and provides customers with additional options for handling their money.

Is India ready for open banking?

When it comes to open banking, account aggregators are one of the first implementations in India. They are allowed by the RBI to disclose client financial data to other businesses offering FS. When it comes to financial services (FS), account aggregators operate as go-betweens by way of application programming interfaces (APIs). In spite of this, the open banking ecosystem is growing and no longer only reliant on account aggregators. Consequently, governments and regulators are making significant changes to the financial services industry in order to provide citizens with more alternatives. As people spend more time on digital devices, they expect more from their digital interactions, including banking. Open banking has several advantages, and adopting it would be a good idea. The following are some of the fundamental aspects of open banking that make it possible to expand access to financial services:

Scalability

With open banking, app makers have access to a wealth of reliable data with which to create groundbreaking new products, while financial services providers may expand their operations to meet the increased demand for their goods. Account aggregator regulation in India is now a hybrid of prescriptive and facilitative approaches. The rate of adoption will be dependent on the scalability of the participating businesses and the quality of their technical requirements. With account aggregators still in their infancy, however, there is no telling if adoption will be spurred on by market forces alone or if a government push would be required down the future.

Resilience

Massive data, instantaneous concurrent access, and action guided by analytics. by a wide network of partners are the cornerstones of open banking. Therefore, in order to implement open banking, a robust and nimble IT infrastructure is required to support API interfaces with a wide range of organisations. In order to do this, we would have to go from a monolithic to a micro-service design. Integration with legacy systems is a potential stumbling block, as a result, FS providers will need to prioritise cyber security and data monitoring even as they assess the risk related to data interchange and security.

Monitoring

There are rules in India that govern how account information can be shared between companies that aggregate many accounts. The customer may decide for themselves what data is retrievable, shareable, and transferable. The Reserve Bank of India (RBI) has outlined the additional facets of this open banking plan in India, including the preservation of financial data integrity, security, and confidentiality; strong IT governance and controls; and a comprehensive consumer protection and grievance redressal mechanism. Reserve Bank Information Technology Private Limited (ReBIT) has also created a series of important technology standards to facilitate the seamless transfer of data and the consent-based exchange of financial data among all participants in the ecosystem. Not only that, but it's crucial to prioritise data security if working with cash. Consumers' consent to data sharing does not guarantee that any third party will not be harmed as a result of exposure to such data. For this reason, open banking systems include disaster risk management, information system audits, and adequate measures against unauthorised data access, alteration, destruction, and disclosure.

Access to the Banking System

When it comes to banking, open banking is a game-changer. It will bring new channels, boost innovation, and increase competition in the financial product market, all of which will alter the way customers interact with their financial institutions.

Changes in Business Processes Driven by Digital Technology

Leverage the benefits of the digital age to boost productivity, attract more customers, and develop new products.

Services with No Friction

Consumers' financial data may be accessed through an app's integration with FinTech or third-party APIs. Therefore, FS providers may streamline the onboarding process with open banking API thanks to improved risk detection and rapid verification. Open banking's strength is in its foolproof and fuss-free interfaces. All of the ecosystem's partners and customers may communicate with greater ease via APIs, regardless of the channel they use to do so. Open banking is more useful for financial institutions and their clients when data is accurate and transferred quickly. Open banking is an emerging industry disruptor, yet it has the ability to usher in more progressive banking procedures for both banks and their customers. It might create new tech companies and put pressure on the established ones to improve, but only if user data is well protected, harmful third-party apps are kept out, and regulatory safeguards are taken to prevent service consolidation. When it comes to compliance, risk management, pricing, and user experience, this ecosystem has the potential to encourage conventional firms to modernise and innovate for continued success.

LITERATURE REVIEW

The banking industry is eager to use new technologies like mobile banking and near field communication. On the other hand, new media make it easier for consumers to buy things and help financial institutions that aren't banks to do well. In light of these changes, the main goal of our study is to find out how new media has changed the way banks do business from the point of view of bankers. The study found, among other things, that there is a clear demand for channel-independent business processes, that mobile banking has a big effect on how banks work, and that the traditional interaction scenario will still be the most common over the next 5–10 years, but it will lose a lot of ground to impersonal and indirect scenarios. Also, even people who work in traditional banking think that mobile payments will become more important. As a contribution to methodology, we lay the groundwork for reporting research results using Delphi diagrams. (K., J., & J., 2015)

We simulate the impact on a tiny, open, oil-exporting economy of major balance-of-payment shocks, such as those that rocked the Russian economy in 2014 and 2015, and test out a range of potential responses. To achieve this, we incorporate elements that are unique to the Russian economy into Romer's (2013) IS-MP general equilibrium model (tradables and oil vs. non-tradables). Applying this model, we investigate the optimal interaction of a freely floating exchange rate, FX liquidity provision by a central bank, and short-term tightening of monetary policy. Having a freely changing exchange rate helps to cushion the effects of economic shocks and stimulates sagging domestic demand and output. When inflation expectations are not well-grounded, a contractionary monetary policy might help stabilise them. Providing banks with access to foreign currency (FX) liquidity helps reduce risks to the financial system. (A. & K., 2016)

The goal of this study is to provide a framework for understanding how financial institutions are increasingly incorporating new service innovations. Concept, Methodology, and Strategy - The information was gathered by an extensive survey of Luxembourg-based financial institutions. The innovation procedures of banks were detailed by their executives and innovation managers between 2010 and 2012. The research uncovered four commonalities among NSD procedures. The problem-driven pattern is a bank's reaction to a problem, and it begins with defining the problem. The proactive pattern begins with the production of ideas to investigate several possibilities. The market-focused style is heavily weighted toward a cash-flow justification and operates out of a business analysis as its groundwork. The first step of the strategy-driven pattern is to create a notion for a service within the context of the business's overall aims. There is a middle ground between openness and isolation when it comes to banks' attitudes on working with outside parties on innovation. The collaborative innovation stage is most accessible during the creation of a service concept, and it is least accessible during the stage of a service's launch to a market. Implications/Limitations for Future Research: This study has limitations due to its small sample size and generalizability to the national level. The application of results to new contexts and the investigation of the consequences of NSD patterns are two promising areas for future study. Application: In order to achieve their innovation objectives, banks take a variety of methods to the innovation process. Practitioners can utilise this

information to rethink their approach to innovation. The revealed mapping of NSD processes adds context to the study of new developments in banking. Managers of innovative projects, researchers, and students will all benefit from these discoveries. (A. & A.-L., 2016)

China's monetary policy stands apart from the norm because it uses so many different mechanisms. This study assesses the performance of many methods by using a model of the banking system and elasticities calculated using data from China. We find that in China, monetary policy instruments other than changes in direct interest rates, such as shifts in the reserve requirement ratio and the loan-to-deposit ratio, are more successful. Possible explanations for the Chinese central bank's reluctance to use interest rate modifications as a policy tool include the fact that it is difficult to predict how demand for deposits will respond to such changes. Furthermore, we show that the ambiguous deposit demand response means that interest rate liberalisation is likely to strengthen monetary instruments, while exchange rate liberalisation is likely to undermine them. (L., G., & D., 2016)

This research aims to examine the role of social media in the financial services industry. Our research delves at the motivations behind banks' social media initiatives and the challenges they confront. We explain how social banking may be used for either promotional objectives (showcase) or to foster open, continuous, and transparent contact with customers and potential customers in order to build lasting connections. We investigate why people use social banking and, by extension, what benefits banks anticipate reaping in terms of exposure, loyalty, brand recognition, customer involvement, and goodwill. Finally, we lay forth a potential future for the social media process in financial institutions, with an emphasis on the role of promotional resources. We also compare the banking industry to others and investigate the connection between social media strategy, client behaviours, and reputation. (A., P., G., & P., 2017)

Should there be international coordination of policies to ease financial tensions? This article looks into the ways in which monopolistic banks' staggered loan arrangements might affect monetary policy. Using the LQ framework, we demonstrate that policy cooperation results in long-run advantages beyond those from reducing wasteful swings across the economic cycle, as is typically the case in models with price rigidities. Cooperation and noncooperation lead to distinct Ramsey optimum stable states. Benefits of this kind result from collaboration whether or not capital accounts are liberalised. (I. & Y., 2017)

Constant advances in technology and significant changes in the law are driving rapid change in the payment services industry. The amended Payment Services Directive (PSD2) is one such piece of legislation, with the goal of boosting market integration and efficiency and bolstering consumer protection by further defining an unified payment structure and applicable law industry in the European Economic Area. To foresee and convert the obstacles of PSD2 into opportunities, it may be crucial to strengthen collaborative infrastructures. This article describes the creation of an open banking platform called CBI Globe — Global Open Banking Ecosystem, with the goal of facilitating API-based communication between financial institutions and outside parties. Adhering parties will be able to take advantage of the economic opportunities made possible by PSD2 by using this platform to streamline and improve the management of current accounts by providing reporting, payment, and collection services. (L.F., 2018)

Technology, new regulatory measures, and altering customer expectations are all driving fast transformation in the payments business. As a result, non-banking businesses now perceive a great chance to develop traction and upset the incumbents, notably financial institutions, in a more liberal climate. Fintech startups, internet giants, and mobile network operators are indeed posing new, innovative products and services in an effort to disintermediate banks from their central position in the payment system. Mobile wallets are one of the technologies with the most growth potential in the consumer-to-business segment of the payments sector. When it comes to retail banking, the payments business is a huge and lucrative market. New income sources from card payment transactions aren't the only thing digital payments have made possible. As non-bank rivals increase in the retail banking sector, this paper analyses four business cases to assist traditional banks compete. Mobile wallet solutions might be a useful tool for banks that focus on their customers. The framework of this paper analyses the most recent changes in the financial

services industry, such as the emergence of new players (Fintech), the evolution of payments in the market, the implementation of the concept of ecosystem into the new payment landscape, and the emergence of the banks' roles in the new mobile payment environment. (A.E., 2018)

Financial resources are created in the form of deposits rather than real resources being intermediated by banks through lending. That's why modelling bank loans as a monetary event that boosts domestic demand and inflation pressures is essential. There have been just a few of attempts to incorporate banks as money-issuing organisations into the DSGE model. Here, we offer a straightforward DSGE model that accounts for banks as true monetary organisations and that accounts for banks' unique capacity to issue new money. In our model, we have a tiny open economy with nominal pricing, consumers, businesses, and a financial system that includes banks. We may examine the actual and nominal consequences of bank credit (and money) creation following an exogenously induced shock to bankers' desire to lend since the dynamics of deposits closely resemble that of credit. (J. & T., 2019) The banking industry is correct to be concerned that it is being pushed around by outside forces. The agenda is increasingly being driven by regulatory bodies, consumer needs, and emerging technologies. In this paper, we look at the causes of this trend and discuss the steps that financial institutions may and should do to 'take back control. Note that this document uses simple language and does not take into account the sensibilities of its readers. (M. S. , 2019)

In this study, we investigate how the development of open banking will modify the design of conventional financial systems. Both supply- and demand-side solutions are considered, and platform models for open banking are presented. For the end user, we discuss the pros and pitfalls of open financial systems and the resulting network effects. It is hypothesised that the growth of open banking and the regulatory reach of such platforms are highly associated using the platform's feedback model of behaviour. The one-of-a-kind trans-transactional properties of open banking solutions are identified in order to guide the development of architectures that enable open banking. With these traits in mind, it's clear that cloud technologies play a crucial role in the development of open banking systems. Then, several open banking systems are outlined with regards to the core architectural features and partnerships that make them unique. Account servicing and payment service providers, as well as third-party providers, stand to gain from the widespread use of such open banking systems, and these benefits are underlined below. (G.S.D., 2020)

However, the repercussions of modern banks' trend of decreasing their physical footprints in favour of steering consumers toward digital channels have not been thoroughly investigated. This study looks into how customers' omni channel banking habits are affected by the expansion and contraction of banks' physical branch networks. Using anonymized transaction data from a large commercial bank in the United States, this research examines the asymmetric consequences of branch openings and branch closures on consumers' omni channel banking behaviour over the course of 33 months. Specifically, we find that the opening of new branches contributes to an increase in customers' branch transactions; nevertheless, the opening of the first branch location causes a migration of sophisticated transactions to the branches, which may lead to a net loss in online banking in the near run. Clients' use of digital banking and other non-traditional channels increases over time as a result of the "learning spill over effect," which occurs when more consumers actively use a certain channel. The learning spill over effect will increase from basic internet searches to more complex online purchases as more stores open. When a branch closes, clients often switch to using online banking instead of visiting the location. But if the last store serving a certain customer's location closes, the downward tendency may halt. In the context of branch growth and contraction, we separate the elements that drive consumers' omnichannel banking behaviour and analyse the managerial implications for reorganising branch networks and banking channel management. (M., D., V., & B., 2020)

The trend of changing financial institutions is expected to grow in prominence as open banking becomes the norm. The current research endeavours to provide an answer to the following question: Is the decision to transfer banks or not a product of deliberate and free choice? Primary research shows that members of the switching group are much more self-aware than those in the control group. They are more likely to shop about for the best deal by comparing the services offered by other financial institutions, reading personal finance blogs, displaying initiative when making

financial choices, and using a wider variety of service providers. A look at the perceptual maps reveals that there are distinct switching costs for each of the group's members. (T., 2021)

This investigation examines how the COVID-19 pandemic has altered the partnership between financial technology companies and traditional banking institutions. We use monthly stock data from all banks with a listing on the Indonesian Stock Exchange starting in February 2018 and ending in March 2021. We use four surrogates for information on financial technology that combined account for P2P lending and borrowing. There are five distinct model requirements that we use to ensure that the data we present is accurate. We use the fixed effect and two-stage system estimators, as well as the generalised approach of moments estimator, to estimate models. According to our estimates, major banks have a lower risk of being disrupted by fintech. Another time period that exemplifies this link is the COVID-19 pandemic. We believe these findings have significant implications for the future of Indonesia's financial system and the open banking policy of the country's monetary authorities. (M.S., N., & T., 2021)

There has been a dramatic shift in the corporate landscape due to the advent of digitization and the development of IT. To adapt to these shifts and the Open Innovation (OI) framework, traditional financial institutions are increasingly interested in acquiring fintech companies through mergers and acquisitions. Given the lack of clarity around the effects of these M&A deals, this study explores how they could affect the future earnings of an acquiring bank. Thus, Using an event study methodology, this research examines how the stock market reacts when news of M&A transactions is released to the public. In addition to contributing to our understanding of how fintech M&As might affect a bank's future profits and, more generally, illuminating the boundary conditions that make OI practises beneficial for organisations, the study's findings are relevant for managers because they provide preliminary advice on which acquisitions are more beneficial for banks. . (F., F., R., & E., 2022)

The goal of this study is to assist IMFIs like Indonesia's Baitul Maalwat Tamwil (BMT) by creating micro-fintech models that would improve the institution's ability to combine Islamic social and commercial microfinance. This research uses the analytic network approach and Delphi methods to elicit the opinions of academician-regulators, BMT practitioners, and Fintech practitioners. Findings: According to IMFI/first BMT, digital banking, payment, P2P finance, P2P social, and e-commerce are all essential micro-fintech tools. The BMT may develop these alone, in conjunction with an APEX or Association, or in alliance with an existing fintech business that specialises in micro-fintech through digitising the offline world. Thus, the collection and distribution of zakat and waqf would be performed offline, while commercial financing for micro and small company clients would be conducted online. According to the second group of numbers, the limited open ecosystem and the hybrid ecosystem are the best micro-fintech conditions for IMFIs/BMT to flourish in. The private, controlled setting that BMT has selected may also become a reality in the near future if all indicators point to future success. Here are some of the research's implications and applications: For the most part, this study is qualitative in nature. Because of the constraints of the existing methods, it is possible that including new perspectives might improve the models. It's also probable that the results will only apply to BMTs in Indonesia, as both the case and the respondents are locals there. In short, a BMT or BMT group can employ micro-fintech in an open, unprotected ecosystem right now, and in the future, they can use it in a closed, protected habitat. BMT might reach more individuals in need with the use of the micro-fintech approach, which could be used to increase the collection of zakat, infaq, and waqf. Due to the paucity of literature on the subject of fintech's rise in Islamic microfinance, no work has been done to develop a micro-fintech model appropriate for IMFIs, particularly BMTs. There is a big hole in the research on this topic. (A. & A., 2022)

Objectives
- To know about open banking.
- To know the advantages of open banking
- To know the adoptability of open banking
- To know the Changes in Business Processes Driven by Digital Technology

RESEARCH METHODOLOGY

The researcher has adopted the exploratory research design and review of literature collected from the various secondary sources like internet, journals, magazines and previous study reports. It helps us to understand key areas in open banking system, the studies help us to know the market and marketing opportunities.

FINDING AND CONCLUSION

Open banking enables financial institutions to make their clients' data accessible to third-party developers and enterprises for use in the creation of new goods and services. In the financial industry, data silos are eliminated, and APIs increase data accessibility. Since its introduction in Europe in 2018, more than fifty countries have implemented open banking. Account aggregators are subject to rules in India based on whether or not they have the consent of their consumers to share their information. The customer has full control over the information that is retrievable, disseminable, and transferable. When dealing with money, data security is a necessary; even if clients provide their consent, it is not secure for anybody else to view their information. Open banking is an emerging industry disruptor with the potential to bring in more progressive banking practises for both banks and their clients. It might spawn new tech businesses and put pressure on existing ones to improve, but only if user data is adequately safeguarded and malicious third-party apps are blocked. App creators may use open banking data to create innovative new solutions, while financial services providers can grow to meet demand. Indian account aggregator regulation is currently prescriptive and facilitative. Scalability and technological needs will determine acceptance. However, account aggregators are very young, so it is unknown if market forces or government intervention will promote adoption.

Open banking relies on big data, fast concurrent access, and analytics-led execution by a large network of partners. Thus, open banking requires a flexible IT architecture to facilitate API interactions with many organisations. This requires switching from monolithic to micro-service design. FS providers must prioritise cyber security and data monitoring while assessing data interchange and security risk due to legacy system integration. In India, account aggregators are required to get permission from users before they may share their information. Customers have complete control over what data is backed up, shared, and sent. Financial data integrity, security, and confidentiality; robust IT governance and controls; strong consumer protection and grievance redressal are all part of RBI's vision for India's open banking strategy. To improve the ecosystem's capacity for sharing and receiving financial data, the Reserve Bank Information Technology Private Limited (ReBIT) has also developed technical specifications. Data security is essential for money, too. In spite of permission from buyers, data is still not safe to transmit. Therefore, appropriate data protection against unauthorised access, alteration, destruction, and disclosure is an integral part of open financial systems.

An app can obtain financial data through FinTech or third-party APIs. Since open banking API improves risk identification and verification, FS providers may speed onboarding. Open banking's interfaces are simple and reliable. APIs simplify communication between ecosystem partners and customers regardless of channel. Data accuracy and speed improve open banking for financial organisations and their clients. Open banking, a new industry disruptor, can improve banking for banks and clients. If user data is secured, bad third-party apps are kept out, and regulatory protections are taken to avoid service consolidation, it might generate new digital businesses and push existing ones to develop. Thiss ecosystem may inspire traditional enterprises to modernise and innovate in compliance, risk management, pricing, and user experience to succeed.

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RESEARCH ARTICLE

Commutative Monoid and Monoid Homomorphism using Luka - Implication Operator over Fermatean Fuzzy Matrices

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ABSTRACT

We concentrate some logarithmic properties of the implication operator from Lukasiewicz's over Fermatean Fuzzy Matrices. We broaden these activities of IFMs to Fermatean fuzzy matrices and demonstrated their mathematical properties like distributivity, associativity, commutativity, and complementary of these activities. We set up the arrangement of all FFMs forms a commutative monoid under these activities. Likewise, we depict a monoid homomorphism over FFM.

Keywords: Intuitionistic Fuzzy Set, Intuitionistic Fuzzy Matrix (IFM), Pythagorean Fuzzy Matrix, Fermatean Fuzzy Set, Fermatean Fuzzy Matrix (FFM),Implication operator (Lukasiewicz's).

INTRODUCTION

Fuzzy sets introduced by Zadeh [12] shows meaningful applications in many fields of study. The idea of fuzzy set is welcome because it handles uncertainty and vagueness. So, a new concept namely Intuitionistic Fuzzy Set (IFS) was

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introduced by Atanassov [1] and represented as A = {x, μA(x), νA(x) /x ∈ E}, where E denotes a universal set in which μA: E → [0, 1] and νA : E → [0, 1] denote membership and non-membership functions of A respectively and its sum is less than or equal to one. Kim and Roush [4] introduced the concept of FM. FM plays a vital role, in various areas in Science and Engineering and solve the problems involving various types of uncertainties by Thomason [10]. The notion Intuitionistic Fuzzy Matrix (IFM) was introduced by Atanassov. Several authors have worked on IFMs and obtained various interesting results, which are very useful in handling uncertainty problems in our daily life. Pythagorean Fuzzy Set (PFS) was introduced byYager [11]. In Peng XD, Yang Y. [6], they are discussed some results for PFSs and its algebraic properties. In Peng X, Selvachandran G[7] studied the PF and future directions Senapati and Yager (2019)[8] outlined basic operation over FFSs and introduced new score functions and accuracy function of FFSs .The generalization of FFSs is the sum of the cubes of the values of the degree of membership and non-membership is not exceeding one. I.Silambarasan [9] *introduce* the concept of *Fermatean fuzzy matrices*, which are direct extensions of an intuitionistic *fuzzy matrices*.K.Atanassov introduced Lukasiewicz's intuitionistic fuzzy disjunction and conjunction [2].

We contemplated the mathematical properties of two tasks$\rightarrow_L$ and $\leftarrow_L$ from Lukasiewicz's implication [5] over FFMs.
This study as follows. In Section 2 , we will briefly review FFMs and their operations.
In Section 3 , some properties of the operations $\rightarrow_L$ and $\leftarrow_L$ from Lukasiewicz's type over FFMs are studied . The set of all FFMs forms a commutative monoid under these operations. Also, we describe a monoid homomorphism over Fermatean fuzzy matrices.

Preliminaries

Definition 2.1: Let Y= {y₁,y₂,…..yₙ}be a universe of discourse .An intuitionistic fuzzyset Pin Y is of the form P = {$(y, \mu_P(y), \nu_P(y)/y\epsilon Y)$}   where$\mu_P(y), \nu_P(y): Y \to [0,1]$ such   that $o \leq \mu_P(y) + \nu_P(y) \leq 1$where $\mu_P(y), \nu_P(y)$ are*knownasthedegreeofmemebershipandthedegreeof*non membership of the element.

Definition 2.2:[3]AnIntuitionistic Fuzzy Matrix (IFM) is a matrix of pairs P =$(\langle p_{ij}, p'_{ij}\rangle)$ of nonnegative real numbers $p_{ij}, p'_{ij}\epsilon[0,1]$ satisfying $p_{ij} + p'_{ij} \leq 1$ for all i , j.

Definiion 2.3: A Pythagorean Fuzzy Matrix (PFM) is a matrix of pairs P =$(\langle p_{ij}, p'_{ij}\rangle)$ of nonnegative real numbers $p_{ij}, p'_{ij}\epsilon[0,1]$ satisfying $p_{ij}^2 + p'^2_{ij} \leq 1$ for all i, j.

Definition 2.4: Let Y be a universe of discourse .A Fermatean fuzzyset (FFS) P in Y is of the form P = {$(y, \mu_P(y), \nu_P(y)/y\epsilon Y)$ } where $\mu_P(y), \nu_P(y) : Y \to [0,1]$ such that $o \leq (\mu_P(y))^3 + (\nu_P(y))^3 \leq 1$ where $\mu_P(y), \nu_P(y)$ are known as the degree of membership and the degree of non-membership of the element.

Definition 2.5:A Fermatean Fuzzy Matrix(FFM) is a matrix of pairs P =$(\langle p_{ij}, p'_{ij}\rangle)$ of nonnegative real numbers $p_{ij}, p'_{ij}\epsilon[0,1]$ satisfying $p_{ij}^3 + p'^3_{ij} \leq 1$ for all i , j.

Definition 2.6: For any two FFMs P, Q $\epsilon \mathcal{F}_{mn}$.

(i) $PVQ = (\max(p_{ij}, q_{ij}), \min(p'_{ij}, q'_{ij}))$

$(ii) P \wedge Q = (\min(p_{ij}, q_{ij}), \max(p'_{ij}, q'_{ij}))$

$(iii) P^c = (p'_{ij}, p_{ij})$

$(iv)\ P \geq Q if and only if p_{ij} \geq q_{ij} and p'_{ij} \leq q'_{ij}.$

(v) An Universal FFM is denoted as U whose all entries are $(\langle 1,0\rangle)$

A zero FFMis denoted as 0 whose all entries are $(\langle 0,1\rangle)$

Definition 2.7: Using the intuitionistic fuzzy form of Lukasiewicz implication, we introduce a disjunction.

$$P \rightarrow_L Q = (\sqrt[3]{min(1, p_{ij}^3 + q_{ij}^3)}, \sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)})$$

$$P \leftarrow_L Q = (\sqrt[3]{max(0, p_{ij}^3 + q_{ij}^3 - 1)}, \sqrt[3]{min(1, p_{ij}'^3 + q_{ij}'^3)})$$

Definition 2.8: A homomorphism between two monoids (M₁,**x**) and (M₂, .) is a function φ: M₁→ M₂ such that (i) φ(a **x** b)= φ(a). φ(b) (ii) φ(e_{m_1}) = e_{m_2} where e_{m_1} and e_{m_2} are the identities of M₁and M₂ respectively.

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Few Results of FFMs

We introduce Lukasiewicz implication of conjunction and disjunction over Fermatean Fuzzy Matrices.

Let P=$(\langle p_{ij}, p'_{ij}\rangle)$ be a FFM of order m xn.

Definition 3.1:

P is said to be reflexive if and only if $(\langle p_{ii}, p'_{ii}\rangle)=(\langle 1,0\rangle)$ and P is said to be irreflexive if and only if $(\langle p_{ii}, p'_{ii}\rangle)=(\langle 0,1\rangle)$

Definition 3.2: P is said to be symmetric if and only if $P^T = P$

Definition 3.3: P is said to be nearly irreflexive if $(\langle p_{ii}, p'_{ii}\rangle) \leq (\langle p_{ij}, p'_{ij}\rangle)$ for all i.j.

Property 3.1: Let P, Q $\epsilon \mathcal{F}_{mn}$

(a) If P and Q are reflexive then $P \to_L Q, P \leftarrow_L Q$ are reflexive.

(b) If P and Q are irreflexive then $P \to_L Q, P \leftarrow_L Q$ are irreflexive.

(c) If P and Q are symmetric then $P \to_L Q, P \leftarrow_L Q$ are symmetric.

(d) If P and Q are nearly irreflexive then $P \to_L Q, P \leftarrow_L Q$ are nearly irreflexive.

Proof: To Prove (a).

P and Q are reflexive $\langle p_{ii}, p'_{ii}\rangle = \langle 1,0\rangle, \langle q_{ii}, q'_{ii}\rangle = \langle 1,0\rangle$

$$P \to_L Q = (\sqrt[3]{min(1, p_{ii}^3 + q_{ii}^3)}, \sqrt[3]{max(0, p_{ii}'^3 + q_{ii}'^3 - 1)})$$

$$P \to_L Q = (\sqrt[3]{min(1, 1+1)}, \sqrt[3]{max(0, 0+0-1)})$$

$$P \to_L Q = \langle 1,0\rangle$$

$$P \leftarrow_L Q = (\sqrt[3]{max(0, p_{ii}^3 + q_{ii}^3 - 1)}, \sqrt[3]{min(1, p_{ii}'^3 + q_{ii}'^3)})$$

$$P \leftarrow_L Q = (\sqrt[3]{max(0, 1+1-1)}, \sqrt[3]{min(1, 0+0)})$$

$P \leftarrow_L Q = \langle 1,0\rangle$ which proves that $P \to_L Q$ and $P \leftarrow_L Q$ are reflexive.

In a similar manner we can prove (b).

To Prove(c).

P and Q are symmetric $\langle p_{ij}, p'_{ij}\rangle = \langle p_{ji}, p'_{ji}\rangle$ and $\langle q_{ij}, q'_{ij}\rangle = \langle q_{ji}, q'_{ji}\rangle$

$$P \to_L Q = \langle r_{ij}, r'_{ij}\rangle$$

$$P \leftarrow_L Q = \langle s_{ij}, s'_{ij}\rangle$$

$$(\langle r_{ij}, r'_{ij}\rangle) = (\sqrt[3]{min(1, p_{ij}^3 + q_{ij}^3)}, \sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)})$$

$$= (\sqrt[3]{min(1, p_{ji}^3 + q_{ji}^3)}, \sqrt[3]{max(0, p_{ji}'^3 + q_{ji}'^3 - 1)})$$

$$= (\langle r_{ji}, r'_{ji}\rangle) \text{ which proves } P \to_L Q \text{ is symmetric.}$$

In a similar manner we can prove $P \leftarrow_L Q$ is symmetric.

To Prove (d).

P and Q are nearly irreflexive if $(\langle p_{ii}, p'_{ii}\rangle) \leq (\langle p_{ij}, p'_{ij}\rangle)$

$(\langle q_{ii}, q'_{ii}\rangle) \leq (\langle q_{ij}, q'_{ij}\rangle)$ for all i.j.

$$P \to_L Q = \langle r_{ij}, r'_{ij}\rangle$$

$$(\langle r_{ij}, r'_{ij}\rangle) = (\sqrt[3]{min(1, p_{ij}^3 + q_{ij}^3)}, \sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)})$$

$$(\langle r_{ii}, r'_{ii}\rangle) = (\sqrt[3]{min(1, p_{ii}^3 + q_{ii}^3)}, \sqrt[3]{max(0, p_{ii}'^3 + q_{ii}'^3 - 1)})$$

$$p_{ii} \leq p_{ij} \Rightarrow p'_{ii} \geq p'_{ij} \Rightarrow p_{ii}'^3 \geq p_{ij}'^3$$

$q_{ii} \leq q_{ij} \Rightarrow q_{ii}^3 \leq q_{ij}^3$ and $q'_{ii} \geq q'_{ij} \Rightarrow q_{ii}'^3 \geq q_{ij}'^3$

$p_{ii}^3 + q_{ii}^3 \leq p_{ij}^3 + q_{ij}^3$ and $p_{ii}'^3 + q_{ii}'^3 \geq p_{ij}'^3 + q_{ij}'^3$

$$\sqrt[3]{min(1, p_{ii}^3 + q_{ii}^3)} \leq \sqrt[3]{min(1, p_{ij}^3 + q_{ij}^3)} \qquad ---------(1)$$

$$\sqrt[3]{max(0, p_{ii}'^3 + q_{ii}'^3 - 1)} \geq \sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)} \qquad ----------(2)$$

Using (1) and (2) we get $\langle r_{ii}, r'_{ii}\rangle \leq \langle r_{ij}, r'_{ij}\rangle$ which proves $P \to_L Q$ is nearly irreflexive.

In a similar manner we can prove $P \leftarrow_L Q$ is nearly irreflexive.

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Property 3.2: Let P $\epsilon \mathcal{F}_{mn}$ be any FFM.

(a) $\ln \to_L (P \to_L P^T)$ is reflexive.

(b) $\ln \to_L (P \to_L P^T)$ is symmetric.

(c) $\ln \to_L (P \to_L P^T) = \ln V (P \to_L P^T)$

Proof: Let $P = (p_{ij}, p'_{ij})$, $P^T = (p_{ji}, p'_{ji})$

$$P \to_L P^T = (\sqrt[3]{min(1, p_{ij}^3 + p_{ji}^3)}, \sqrt[3]{max(0, p_{ij}'^3 + p_{ji}'^3 - 1)})$$

Let $A = P \to_L P^T = \langle a_{ij}, a'_{ij} \rangle$, B $= \langle b_{ij}, b'_{ij} \rangle = \ln \to_L (P \to_L P^T)$

$$= \ln \to_L A = \{(\sqrt[3]{min(1, 1 + a_{ij}^3)}, \sqrt[3]{max(0, 0 + a_{ij}'^3 - 1)}) \, if \, i = j$$

$$(\sqrt[3]{min(1, 0 + a_{ij}^3)}, \sqrt[3]{max(0, 1 + a_{ij}'^3 - 1)} \, if \, i \neq j$$

Case(i) : If i =j , $\langle b_{ij}, b'_{ij} \rangle = \langle 1, 0 \rangle$ which proves B is reflexive.

Case (ii): If i ≠ j, then $\langle b_{ij}, b'_{ij} \rangle = (\sqrt[3]{min(1, 0 + a_{ij}^3)}, \sqrt[3]{max(0, 1 + a_{ij}'^3 - 1)}) = \langle a_{ij}, a'_{ij} \rangle$ --------(3)

$$\langle a_{ij}, a'_{ij} \rangle = (\sqrt[3]{min(1, a_{ij}^3 + a_{ji}^3)}, \sqrt[3]{max(0, a_{ij}'^3 + a_{ji}'^3 - 1)})$$

$$= (\sqrt[3]{min(1, a_{ji}^3 + a_{ij}^3)}, \sqrt[3]{max(0, a_{ji}'^3 + a_{ij}'^3 - 1)}) = \langle a_{ji}, a'_{ji} \rangle$$ --------------------(4)

Using (4) in (3) we have $\langle b_{ij}, b'_{ij} \rangle = \langle b_{ji}, b'_{ji} \rangle$ which proves B is symmetric.

$\ln \to_L (P \to_L P^T)$ is symmetric.

To Prove (c) : If i = j, $(\langle b_{ii}, b'_{ii} \rangle) = \langle 1, 0 \rangle \langle b_{ij}, b'_{ij} \rangle = \langle a_{ij}, a'_{ij} \rangle$

Consider $\ln V (P \to_L P^T) = \langle 1, 0 \rangle \vee \langle a_{ij}, a'_{ij} \rangle = \langle 1, 0 \rangle$ if i =j

$= \langle 0, 1 \rangle \vee \langle a_{ij}, a'_{ij} \rangle = \langle a_{ij}, a'_{ij} \rangle$ if i ≠ j

Hence we have proved that $\ln \to_L (P \to_L P^T) = \ln V (P \to_L P^T)$

Property 3.3: Let P,Q,R $\epsilon \mathcal{F}_{mn}$ are any three FFMs .We have $PV(Q \to_L R) = (PVQ) \to_L (PVR)$

Proof:

Let A $= \langle a_{ij}, a'_{ij} \rangle$, B= $\langle b_{ij}, b'_{ij} \rangle$, C $= \langle c_{ij}, c'_{ij} \rangle$, D $= \langle d_{ij}, d'_{ij} \rangle$ and E $= \langle e_{ij}, e'_{ij} \rangle$ are the FFMs of $(Q \to_L R), (PVQ), (PVR), PV(Q \to_L R) and (PVQ) \to_L (PVR)$ respectively.

$$\langle a_{ij}, a'_{ij} \rangle = (\sqrt[3]{min(1, q_{ij}^3 + r_{ij}^3)}, \sqrt[3]{max(0, q_{ij}'^3 + r_{ij}'^3 - 1)})$$

$$\langle b_{ij}, b'_{ij} \rangle = (max \,(p_{ij}, q_{ij}), min \,(p'_{ij}, q'_{ij})) \, ; \langle c_{ij}, c'_{ij} \rangle = (max \,(p_{ij}, r_{ij}), min(p'_{ij}, r'_{ij}))$$

$$\langle d_{ij}, d'_{ij} \rangle = (max \,(p_{ij}, a_{ij}), min \,(p'_{ij}, a'_{ij})) \, ; \langle e_{ij}, e'_{ij} \rangle = (\sqrt[3]{min(1, b_{ij}^3 + c_{ij}^3)}, \sqrt[3]{max(0, b_{ij}'^3 + c_{ij}'^3 - 1)})$$

To Prove $\langle d_{ij}, d'_{ij} \rangle = \langle e_{ij}, e'_{ij} \rangle$

To Prove $\langle d_{ij}, d'_{ij} \rangle \leq \langle e_{ij}, e'_{ij} \rangle$. i.e., To prove $d_{ij} \leq e_{ij}$ and $d'_{ij} \geq e'_{ij}$

Case I: Suppose $\langle p_{ij}, p'_{ij} \rangle > \langle q_{ij}, q'_{ij} \rangle$, $\langle p_{ij}, p'_{ij} \rangle > \langle r_{ij}, r'_{ij} \rangle$

$\langle b_{ij}, b'_{ij} \rangle = \langle c_{ij}, c'_{ij} \rangle = \langle p_{ij}, p'_{ij} \rangle$

$$\langle e_{ij}, e'_{ij} \rangle = (\sqrt[3]{min(1, 2p_{ij}^3)}, \sqrt[3]{max(0, 2p_{ij}'^3 - 1)})$$

Subcase 1: Suppose $\langle d_{ij}, d'_{ij} \rangle = \langle p_{ij}, p'_{ij} \rangle \leq \langle e_{ij}, e'_{ij} \rangle$

Subcase 2: $\langle d_{ij}, d'_{ij} \rangle = \langle a_{ij}, a'_{ij} \rangle$

$2p_{ij}^3 > q_{ij}^3 + r_{ij}^3 \Rightarrow min(1, 2p_{ij}^3) > min(1, q_{ij}^3 + r_{ij}^3)$

$e_{ij} \geq a_{ij} = d_{ij}$

Similarly $max(0, 2p_{ij}'^3 - 1) \leq max(0, (q_{ij}'^3 + r_{ij}'^3 - 1)) \Rightarrow e'_{ij} \leq a'_{ij} = d'_{ij}$

$(\langle e_{ij}, e'_{ij} \rangle) \geq (\langle d_{ij}, d'_{ij} \rangle)$ i.e., $\langle d_{ij}, d'_{ij} \rangle \leq \langle e_{ij}, e'_{ij} \rangle$

Subcase 3: Suppose $\langle d_{ij}, d'_{ij} \rangle = \langle p_{ij}, p'_{ij} \rangle$

We can prove this case using subcase1 & subcase2.

Case II : Suppose $(\langle p_{ij}, p'_{ij} \rangle) < (\langle q_{ij}, q'_{ij} \rangle), (\langle p_{ij}, p'_{ij} \rangle) < (\langle r_{ij}, r'_{ij} \rangle)$

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$\langle b_{ij}, b_{ij}' \rangle = \langle q_{ij}, q_{ij}' \rangle$, $\langle c_{ij}, c_{ij}' \rangle = \langle r_{ij}, r_{ij}' \rangle$

$\langle e_{ij}, e_{ij}' \rangle = \left(\sqrt[3]{min(1, q_{ij}^3 + r_{ij}^3)}, \sqrt[3]{max(0, q_{ij}'^3 + r_{ij}'^3 - 1)} \right)$

$\qquad = \langle a_{ij}, a_{ij}' \rangle$

Subcase 1: Suppose $(\langle d_{ij}, d_{ij}' \rangle) = \langle p_{ij}, p_{ij}' \rangle$

$d_{ij} = \sqrt[3]{p_{ij}^3} < \sqrt[3]{min(1, q_{ij}^3 + r_{ij}^3)} = e_{ij}$

$$d_{ij} \le e_{ij}$$

Similarly, $d_{ij}' \ge e_{ij}' (\langle d_{ij}, d_{ij}' \rangle) \le (\langle e_{ij}, e_{ij}' \rangle)$

Subcase 2:

$\qquad$ Suppose $(\langle d_{ij}, d_{ij}' \rangle) = (\langle a_{ij}, a_{ij}' \rangle) = (\langle e_{ij}, e_{ij}' \rangle)$

Suppose $(\langle d_{ij}, d_{ij}' \rangle) = (\langle a_{ij}, a_{ij}' \rangle)$

$(\langle d_{ij}, d_{ij}' \rangle) = (\langle e_{ij}, e_{ij}' \rangle)$ by subcase 1.

Case III:

Suppose $(p_{ij}, p_{ij}') < (q_{ij}, q_{ij}')$ and $(p_{ij}, p_{ij}') > (r_{ij}, r_{ij}')$

$(\langle e_{ij}, e_{ij}' \rangle) = \left(\langle \sqrt[3]{min(1, q_{ij}^3 + p_{ij}^3)}, \sqrt[3]{max(0, q_{ij}'^3 + p_{ij}'^3 - 1)} \rangle \right)$

Subcase 1:

$\qquad$ Suppose $(\langle d_{ij}, d_{ij}' \rangle) = (\langle p_{ij}, p_{ij}' \rangle)$

$Min(1, q_{ij}^3 + p_{ij}^3) > p_{ij}^3$

$\sqrt[3]{min(1, q_{ij}^3 + p_{ij}^3)} > p_{ij}$

$e_{ij} > d_{ij}$ and $q_{ij}'^3 - 1 \le 0; q_{ij}'^3 + p_{ij}'^3 - 1 \le p_{ij}'^3$

$max(0, (q_{ij}'^3 + p_{ij}'^3 - 1)) \le p_{ij}'^3$

$\sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)} \le p_{ij}' \Rightarrow e_{ij}' \le d_{ij}'$

$(\langle e_{ij}, e_{ij}' \rangle) \ge (\langle d_{ij}, d_{ij}' \rangle)$ ie) $(\langle d_{ij}, d_{ij}' \rangle) \le (\langle e_{ij}, e_{ij}' \rangle)$

Subcase2: Suppose $(\langle d_{ij}, d_{ij}' \rangle) = (\langle p_{ij}, p_{ij}' \rangle)$

$p_{ij}^3 > c_{ij}^3 \Rightarrow min(1, p_{ij}^3 + q_{ij}^3) > min(1, q_{ij}^3 + r_{ij}^3)$

$e_{ij} > p_{ij} = d_{ij}$

Similarly we can prove $e_{ij}' < d_{ij}'$

$(\langle d_{ij}, d_{ij}' \rangle) \le (\langle e_{ij}, e_{ij}' \rangle)$

Case IV:

$\qquad$ Suppose $(\langle p_{ij}, p_{ij}' \rangle) > (\langle q_{ij}, q_{ij}' \rangle)$ and $(\langle p_{ij}, p_{ij}' \rangle) < (\langle c_{ij}, c_{ij}' \rangle)$

$(\langle e_{ij}, e_{ij}' \rangle) = \left(\sqrt[3]{min(1, p_{ij}^3 + r_{ij}^3)}, \sqrt[3]{max(0, p_{ij}'^3 + q_{ij}'^3 - 1)} \right)$

The proof case (IV) is similar to case (III).

Hence, from all the above cases we have $PV(Q \rightarrow_L R) = (PVQ) \rightarrow_L (PVR)$

Property 3.4

$\quad$ Let P,Q,Rare any three FFMs of same size, P,Q,R $\in \mathcal{F}_{mn}$

a) $(P \rightarrow_L Q) \rightarrow_L R = P \rightarrow_L (Q \rightarrow_L R)$

b) $(P \leftarrow_L Q) \leftarrow_L R = P \leftarrow_L (Q \leftarrow_L R)$

Proof:Proceeding as above the result can be proved.

Property 3.5:Let P,Q $\in \mathcal{F}_{mn}$ are any two FFMs then we have

(a) $(P \rightarrow_L Q)^c \le P^c \rightarrow_L Q^c$

(b) $(P \leftarrow_L Q)^c \ge P^c \leftarrow_L Q^c$

Property 3.6: Let $\mathcal{F}_{mn}$denote the set of all FFMs then we have

(a) $(\mathcal{F}_{mn}, \rightarrow_L, 0)$ *isacommutativemonoid.*

(b) $(\mathcal{F}_{mn}, \leftarrow_L, U)$ *isacommutativemonoid.*

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Proof: Follows using the definition 2.7 and Property 3.5.

Corollary: Let $(\mathcal{F}_{mn}, \to_L, 0)$ and $(\mathcal{F}_{mn}, \leftarrow_L, U)$ are two monoids and a function

$$\varphi : \mathcal{F}_{mn} \to \mathcal{F}_{mn} \text{ such that } \varphi(P) = P^c$$

then there exists a monoid homomorphism $\to_L$ and $\leftarrow_L$ operations.

Proof: Let $P, Q \in \mathcal{F}_{mn}$

$$\varphi(P \to_L Q) = \varphi\left(\langle \sqrt[3]{\min(1, p_{ij}^3 + q_{ij}^3)}, \sqrt[3]{\max(0, (p_{ij}^{'3} + q_{ij}^{'3} - 1))} \rangle\right)$$

$$= \left(\langle \sqrt[3]{\min(1, p_{ij}^3 + q_{ij}^3)}, \sqrt[3]{\max(0, (p_{ij}^{'3} + q_{ij}^{'3} - 1))} \rangle\right)^c$$

$$= \left(\langle \sqrt[3]{\max(0, p_{ij}^3 + q_{ij}^3 - 1)}, \sqrt[3]{\min(1, (p_{ij}^{'3} + q_{ij}^{'3}))} \rangle\right)$$

$$= (\langle p_{ij}', p_{ij} \rangle) \leftarrow_L (\langle q_{ij}', q_{ij} \rangle)$$

$$= P^c \leftarrow_L Q^c = \varphi(P) \leftarrow_L \varphi(Q)$$

$$\varphi(0) = 0^c = U \; ; \; \varphi(U) = U^c = 0$$

Therefore φ is a homomorphism.

CONCLUSION

In this work, we studied some results of two operations and from Luckasiewicz's type over Fermatean fuzzy matrices. In addition we discussed some properties like distributivity, associativity, commutativity, and complementary of these operations. Also we described a monoid homomorphism over Fermatean fuzzy matrices.

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RESEARCH ARTICLE

Ensemble Classifier Based Identification of Parkinson's Disease using Machine Learning Algorithms

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ABSTRACT

Parkinson's disease (PD) is one of the serious disorders of nervous system in the world population. It is estimated that around 10 million people affected by PD worldwide and 1 million in India. In the recent years, many research has been emerged based on machine learning algorithms for the classification of PD. As the name implies, these algorithms can be used to extract meaningful features from the PD dataset. Most of the algorithms based on Decision tree, Logistic regression, Support Vector Machine (SVM), and Random Forest. The work aims to propose an ensemble-based classification approach using various machine learning methods to find the best prediction model for the efficient prediction of PD. The study also provides the comparative analysis of various machine learning algorithms such as Random Forest, Convolutional Neural Network (CNN), linear regression, bagging, boosting, stacking, and J48. The performances of the various machine learning algorithms are evaluated using error rates. Based on the error rates, all the methods are compared using ROC, accuracy, sensitivity, specificity, and precision. From the result, we have observed that Random Forest achieves the highest accuracy rate of 98%, ROC of 93.6%, and precision of 88.7% when compared to other machine learning algorithms. Hence, the prediction efficiency has been improved which would be helpful for the PD patients.

Keywords: Stacked Ensemble; NLP; Random Forest; NBTree; Average absolute error (AAE); Average related Error;

INTRODUCTION

Parkinson disease is the neurological disorder which is considered as the most serious disorder and presently no treatment available. Dopamine is a chemical produced by nerve cells that is used for communication between brain and nervous system to coordinate the human body. People who are affected with Parkinson disease are due to low level of dopamine in the brain they have usually lost 60 % of dopamine neurons. There are several factors that causes PD to an individual. Environmental factors, age factors, speech articulation factors, brain damages, and genetic factors are the some of the important factors. Unhealthy life style, poor air quality, water quality, and stress are some of the common environmental factors that are influencing PD. Age factor mainly contributes for the development of PD because 11,747,102 out of 1, 065, 070, 6072 people affected by PD in India [1]. People with age more than 65 are affected by this incurable disease. Motor and non-motor symptoms are the two kinds of symptoms for PD. Motor symptoms indicates the movement related disorder such as difficulty in walking and standing, stiffness, changes in posture, reduced facial expression, or any balance problems. Non motor symptoms directly affect the life of an individual which includes sleep disorders, fatigue, cognitive dysfunction as well as loss of smell. Forecasting and diagnosing PD is important to treat this incurable disease that affects millions of people worldwide. In India, 1 million people are affected by this disease every year [2]. Over the past few years, many studies have been evolved with investigation of speech, gait, and EEG signal for the early detection of PD. However, speech analysis is the important consideration for the detection of PD since 90 % of the people are affected by speech and voice disorders. There is no specific test for identifying PD, doctors should carefully analyze the medical history of patents. However, this kind of clinical analysis is inaccurate and only 53 % are accurate according to the study of National Institute of Neurological. Therefore, diagnosing of PD in an early stage is important to reduce the later effects. The objective of the work is to build an effective prediction model that improve the accuracy of PD using different machine learning algorithms such as Random Forest, Convolutional Neural Network (CNN), linear regression, bagging, boosting, stacking, and J48 based on ensemble techniques. The organization of the paper is as follows. In section 2, we discuss about the currently available schemes for the detection of PD. Section 3 describes the methods, tools, and dataset used in the work. Section 4 discusses the ensemble learning methods that we have proposed in the work. In section 5, the experimental analysis and the obtained results are discussed. Section 6 concludes the work.

Related Work

This section discusses about the currently available PD detection schemes that uses machine learning strategies with its merits and demerits for the early prediction of PD. In[4], authors have proposed a data driven model using deep learning techniques to determine if there was any severity in the disease. Authors have used clinical information from early onset. They have applied neural network and random forest methods to test the accuracy of the results. Though the accuracy is improved than the earlier techniques, it increases the computational complexity that affects the performance of overall work. In [5], authors have presented an assessment model to find the efficient features on Parkinson dataset based on dysphonia. This model uses non standard methods that can effectively separate healthy subjects from PD. However, this method is not suitable for voice signals in acoustic environments. In [6], the authors use support vector machine for the diagnosis of PD. They have selected 110 features out of 720 features and 22 features were selected for speech data. The work performs well in the early diagnosis of PD. However, the time complexity of the proposed model might be increased when the number of features increases. In another study[7], authors have implemented a machine learning model using decision tree algorithm. The work records the voice of PD affected subjects first. Then they use Praat to generate voice report. This method achieves 94% of accuracy using decision tree method. However, this method is not well applicable in more complex dataset. Authors in [8] describes the significance of motor and non-motor systems which was ignored by several medical practitioners over motor systems. This work considers four machine learning algorithms such as Random Forest, Naïve Bayesian, Logistic regression and boosting. This method is helpful for diagnosing PD based on Rapid eye movement (REM), sleeping behaviour of subjects, distortion and loss of smell. In [9], authors have proposed a predicting model to detect a cognitive outcome in Parkinson's disease. Authors have considered motor and non-motor symptoms of PD. The work investigated 981 features and most optimal features were selected using feature selection algorithms. Finally, ensemble-based voting is

constructed to derive high score features. Authors have claimed that the work can effectively identify subtypes in PD. However, the image processing technique employed in the work affects the overall performance of the algorithm. In [10], authors considered longitudinal datasets from PPMI (Progressive Marker Initiative) and select both HC (Healthy Control) and PD subjects. They used both supervised and unsupervised model. The work uses 10 predictor techniques and investigate the error rate with the help of LASSOLAR (Least Absolute Shrinkage and Selection Operator - Least Angle Regression) considering 93 features. Then they applied Genetic Algorithm (GA) as part of feature subset algorithm and consider only 18 features. Finally, authors conclude that predictor algorithm with feature subset selection approach can have efficient prediction of cognitive outcome in Parkinson affected subjects. From the above studies, we observed that most of the work focused only on specific features and there are some restrictions for outcome prediction, only limited sets of subjects were considered which is inefficient for the early prediction of PD. Moreover, most of the work focused on conventional schemes such as RF, LR, and SVM. Only few works performed boosting, bagging, and stacked generalization.

Methods and Materials

The study employs dataset from Parkinson's Progression Markers Initiative (PPMI)with 885 PD subjects, and 981 features. We developed a prediction model based on different machine learning algorithms to perform efficient feature selection. The performance of the work is evaluated by assessing the accuracy, ROC, precision, sensitivity, and specificity. The work investigates the significance of all the machine learning methods based on the error rates. These details are analyzed to classify the healthy subjects and PD affected subjects.

Dataset Details

The dataset is acquired from www.ppmi-info.org/dat df. This work uses 981 features including features for investigating motor and non-motor analysis. To identify the early diagnosis of PD, the work proposed a 2-layer ensemble-based learning with multi modal features. The benefits of all the classifiers considered in the work such as Random Forest (RF), linear regression, bagging, boosting, stacking, and J48 are analyzed in the first layer. The work investigates the results of the proposed work based on precision sensitivity, specificity. These details are analyzed to classify the healthy subjects and PD affected subjects. In second layer, we applied logistic regression technique for classification to classify PD.

The Proposed Ensemble Based Learning Model

Ensemble algorithms are popular for better prediction model that combines several prediction models to increase the prediction accuracy[11-14]. There are numerous ensemble methods available for developing prediction model. Each model can be different in the way they do behave based on population, technique of modeling, and hypothesis. The important question is how to combine models to classify a better prediction model. It is similar to voting rule, majority of result will decide which algorithm to select. Figure 1 shows the basic ensemble prediction. There are many ensemble-based algorithms available in for machine learning approach. However, the three popular methods are stacking, bagging, and boosting.

Bagging

Bagging is used to acquire a new dataset from the original training dataset. For huge volume of data, bagging will divide the dataset into many subsets, then random data will be utilized to frame any rules for the outcome of the model with the help of training algorithm. Finally, the better prediction model will be determined based on voting. Therefore, bagging is importantly used to reduce variance when larger dataset is used. This algorithm is mainly used for nonlinear type of data and it is not suitable for linear type of data[15]. This is similar to RF except that the RF will choose random set from the total dataset while bagging will consider all the features in the total subset.

Boosting

Boosting is a technique to reduce bias and variance. Bias occurs in the machine learning methods when the algorithm fails to observe the result correctly. Variance will be exhibited if the model is sensitive to even little fluctuations. This method is used to boost the learning algorithm to make it stronger by reducing the variance and bias. Boosting is

considered as a stabilized algorithm than the other ensemble methods because boosting will verify the previous iterations before proceed to next. However, there is no corrective loop in other methods for the errors occurred in the previous iterations. The output of all the machine learning algorithms can be combined to compute the final outcome of the classifier. Assume that if a boosting is

$$F_{T(a)=} \sum_{i-1}^{T} f1(a) \qquad\qquad (3)$$

$$E_{T=} \sum_i E\ [F1\ (a_i)\ \alpha h(a_i)\ ] \qquad\qquad (4)$$

Where Er is the training error for week learners, F1(a_i) is the booster classifier, hypothesis for week learner output is denoted as h(a)

Stacking
We propose a stacking approach to perform efficient prediction of PD. A multi classifier model is used by combining several models with the help of meta-learning is stacking approach [16-17]. Stacking is short for stacked generalization. Here different learning models are combined to by considering heterogeneous week learners. But bagging and boosting considers only homogeneous learning. In this model, whole training set is considered to train each model in the classification. Finally, meta classifier is used to produce the output. This meta classifier can be either trained well on a predicted label or the probability of the Ensemble classification. The overview diagram of stacked approach consists of two or more models such as base models and meta models. Based on the predictions given by base models, meta model is trained. Algorithm for stacking is shown in algorithm 1.

Algorithm 1: Stacked generalization
//Input: Training data: TR$_{d\ =\ x=1\ ton}$\{m^i, n^i\}
// Output: Ensemble Classifier E
Set Ensemble learning classifiers
for I = to N do
Learn Ei based on TR$_d$
End for
New dataset is created for prediction
for i = to m do
Et = \{m^i, n^i\}
End for
Learn a meta classifier
Learn N based Eh
Return N
Along with this proposed Ensemble framework, the Learning algorithm NBTree, J48, Logistic Regression, and Random Forest are used to evaluate the performance of the proposed workfor classifying the PD using the ensemble classifier approach.

Learning Algorithms
NBTree
NBTree is considered as a hybrid classifier which include a decision tree and it is based on Naïve Bayesian theorem. The trained and learned knowledge is represented in the form of Tree. The construction of the tree is done recursively. This tree will have 0 or more decision nodes and leaf nodes. Each decision node will be tested based on some attributes. Records can be classified on nodes at leaf level. As a first part of the work, utility C1 is estimated at the root node. Secondly, we consider utility D1 is estimated for child nodes. The values of root node and child nodes are considered as weights. If C1 is greater than D1 then the root nodes will transfer to leaf node. If C1 is less than D1 then the root node will transfer to decision node. The accurate prediction can be expected even for large amount of dataset using NB classifier.

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J48
This algorithm is utilized to create a decision tree that represent a supervised method for classification problem. J48 is considered as the most widele used model for Classification and Prediction problems. The decision tree is constructed with mutiple nodes and internodes. Decision tree classifiers are particularly used to make some decisions in critical situations. Tress are designed in such a way that the nodes are splitting based on previously input of previous outcome. The value 0 and 1 represents The representation of the Decision Tree is rather similar to flow charts denoting the instances. Classification is done based on the selected feature values. Nodes in the trees denote the input instance, wherein the outputs are termed as branches and the leaf nodes are the class labels. The J48 classifier is an application of the C4.5 decision tree algorithm. From the given attribute values, the decision tree is developed and classifies the new instance. When a new training set is given, it immediately responds and takes the responsibility to accurately classify the various instances by eliminating the irrelevant and ambiguous data.

Logistic Regression
LR is used in classifying the given problem into multiple or binary classes as Yes/No, True/false, and predicts the output in a discrete/ categorical nature. Probability of data points are computed by LR for a specific class. LR can be can be computed as follows:

$$l = log n \frac{p}{p-1} \; \beta 0 + \beta 1 x 1 + \beta 2 x 2 + \cdots \ldots \beta n x n \tag{1}$$

Where p is the probability of existing data points for a class, other parameters are n and β.
Probability for Y=1 is computed as

$$p = \frac{1}{1+n^{\beta 0 + \beta 1 x 1 + \beta 2 x 2 + \cdots \ldots \beta n x n}} \tag{2}$$

Training data T and N instances are denoted as T= {t$_1$, · · ·, tN}, T is defined as:

$$LR(B|T) = \sum_{a=1}^{N} \log P\beta(t) \tag{3}$$

The instances are assigned to labels that are I = {a1, a2, ….an}and the utilities C1 and D1 are given as

$$\begin{cases} I(Ci, Di) = \sum_{d\epsilon\Omega D} P(Ci, Di) log \frac{P(Ci,Di)}{P(Ci)(Di)} \\ ICi; Cj|D) = \sum_{d\epsilon\Omega D} P(Ci, Cj, Di) log \frac{P(Ci,Cj,Di)}{P(Ci)(cj)(Di)} \end{cases} \tag{4}$$

Random Forest
Random Forest is the enhanced version of decision tree. Multiple decision trees are grouped to randomly identify the subset features of the original dataset. The following are steps of RF algorithm
1. Choose k-features among the available n-features say k=√n.2.
2. Pick the optimal node or data point among k features.
3. Divide the node into child nodes based on best- subset features.
4. Repeat step 1 to 3 the cost of node is low.
5. Decision tree construction can be done using steps 1 to 3. Forest can be built by using steps 1 to 4.
6. Target class prediction can be performed for decision tree during the process of testing.

Multiple decision trees are possible in bootstrap technique. Where bootstrap technique reduces the sensitivity of training data. The features are randomly selected that supports to minimize the correlation between the trees. The predictions are performed based on the results of the multiple decision tree. Finally, they are collected to build a prediction model.

EXPERIMENTS AND RESULTS

The experiment was conducted with the help of Python environment. Numby, Pandas, NLTK, Keras are the python library files to conduct this experiment. The performance evaluation for the proposed work is measured in terms of accuracy, precision, specificity and sensitivity. The requirements of the hardware are 8 GB RAM, 1 TB HDD, 4GB GDD with Intel i7 core processor.

- Precision
- ROC
- Specificity
- Sensitivity
- Classification Accuracy

Precision, ROC, Sensitivity and Specificity Precision is the ratio between the number of accurately predicted PD and the total number of predicted data that are annotated as PD. ROC is the ratio between the number of accurately predicted PD subjects and healthy subjects. Specificity is defining as how exactly PD subjects is identified and classified as true positive. Specificity is defining as how exactly healthy subjects are identified.

Classification Accuracy It is the ratio between the number of accurately predicted the person with disease and the person does not affect with disease.

$$Accuracy = \frac{TRUE\ POSITVE\ +\ TRUE\ NEGATIVE}{100}$$

$$Precision = \frac{TRUE\ POSITVE}{TRUE\ POSITIVE + FALSE\ POSITIVE}$$

$$ROC = \frac{TRUE\ POSITVE\ RATE}{FALSE\ POSITIVE\ RATE}$$

$$Sensitivity = \frac{TRUE\ POSITVE}{TRUE\ POSITIVE + FALSE\ NEGATIVE}$$

$$Specificity = \frac{TRUE\ NEGAITVE}{FALSE\ POSITIVE + TRUE\ NEGATIVE}$$

Several machine learning algorithms are tested for their error rates as a first step. The error rates consider here are AAE and ARE. Then, all the machine learning methods are compared with their error rates against ROC, precision, sensitivity and specificity. Among all the algorithm we observed that RF performs well with the accuracy of 89.2%, Precision 87.3% and ROC 97.2%.In the second step, we considered feature selection algorithm to select only the most relevant features and 91 features are considered from the dataset. From the observation, we understand that the RF algorithm performs well with the accuracy of 97.2%, ROC 93.6%, and precision of 93.2%. When we compare the obtained results with other machine learning models, the proposed work seems to be more efficient than the other models. Table 1 shows the analysis of error rates Error rates are calculated using AAE and ARE. Table 2 shows the comparative analysis of the various machine learning algorithms. The variance of predicted value and original value is AAE and is calculated as follows.

$$AAE = \left(\frac{1}{n}\right) \sum_{i=1}^{n} |(Xi - X)| \tag{5}$$

Where Xi represent the predicted value and X represent the original value and n is the number of parameters used in the calculation.
ARE is used to measure the whole size of the object with absolute error.

$$ARE = \left(\frac{1}{n}\right) \sum_{i=1}^{n} |(Xi - X)| / (Xi + 1) \tag{6}$$

Figure 4 shows the error rate analysis. Staking and RF exhibits lower error rates. From the observation, stacked generalization model seems to be the better classification model with low error rates. The evaluation of the proposed work indicates the better performance of the model with other models.

The work also performs the comparative analysis of the machine learning methods with the performance measures such as precision, ROC, Sensitivity, Specificity, and accuracy. Figure 5 shows the overall analysis of the work. Figure 6, 7, & 8 shows the performance analysis of the work in terms of accuracy, ROC, specificity, and sensitivity. From the

outcome, we observed that stacked model performance better than the other models with the accuracy of 97%, precision 85%, and ROC 96%. The reason for performance improvement is due to the efficient feature selection based on machine learning models along with the help of ensemble learning algorithms. The obtained result is compared with the single classifier to exhibit the performance and the error rate. Here, the Accuracy is validated between the Ensemble classification method and a single classifier method. As per the expectation, our proposed Ensemble method outperforms more accurately than the currently available prediction model. It has been proved that the combination of works done by the expertise sounds better compared with a single men army[18]. It performs less when used as a single classifier, rather combining with the other classifier random forest, J48, Logistic Regression as an ensemble shows better performance.

CONCLUSION

The proposed work applies a Stacked Ensemble along with various prediction model to build a better classification model for Parkinson disease. The work uses stacking, bagging, boosting, random forest, logistic regression, NB tree, J48 to perform machine learning for the prediction of PD. The performance measurements that we considered in the work are accuracy, precision, ROC, specificity, and sensitivity. We also calculated the error rate using ARE and AAE to obtain the expected outcome. The accuracy prediction is 97%for stacked generalization model is obtained which is better than the current state-of-the art model. We demonstrated excellent prediction model which can able to find better features of PD and the performance has been assessed with dataset from PPMI. Thus, it improves the classification accuracy through an efficient prediction model. In future, we plan to evaluate the imaging dataset to identify radiomic features of the PD.

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Table 1. Error rate analysis

S.No	Techniques	AAE	ARE
1	Boosting	0.045607	0.043342
2	Bagging	0.055312	0.052132
3	Stacked Generalization	**0.035607**	**0.033342**
4	Random Forest	0.038301	0.033287
5	Logistic Regression	0.047607	0.043402
6	J48	0.055622	0.053347
7	NB tree	0.052271	0.052376

Table 2. Comparative analysis of all the machine learning with performance metrics in percentage

Classifier	Precision	ROC	Sensitivity	Specificity	ACC
Nb-tree	87	92	0.52	0.89	88
J48	85	93	0.50	0.91	86
Logistic regression	83	89	0.54	0.73	84
Random forest	84	94	0.95	0.96	96
Stacked model	85	96	0.97	0.97	97
Bagging	74	85	0.74	0.92	94
Boosting	72	95	0.86	0.94	93

Figure 1. Ensemble based prediction
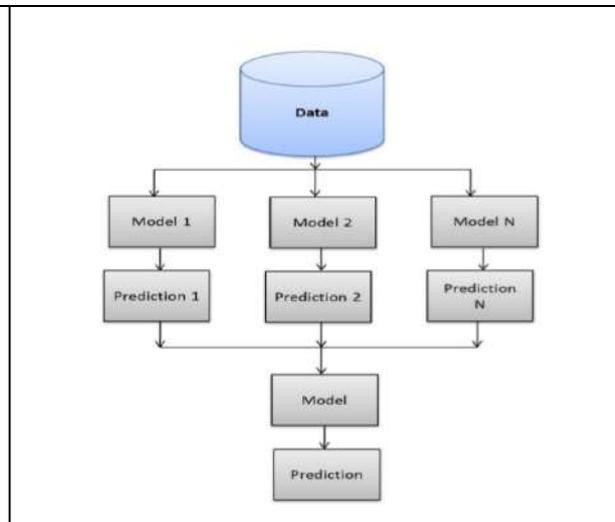
Figure2. Stacked Generalization
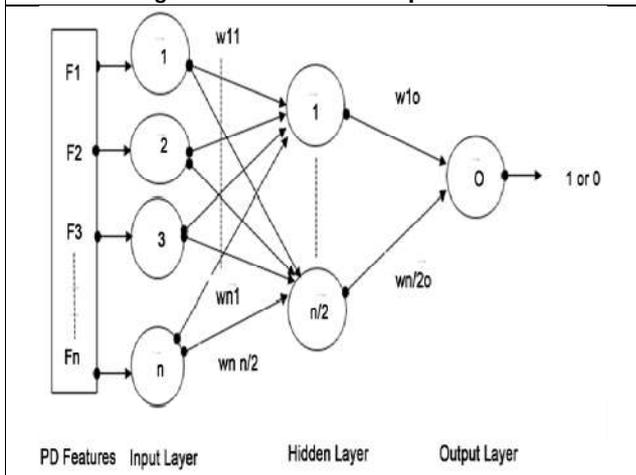
Figure 3. J48 classifier

Figure 4. Error Rate Analysis

	Boosting	Bagging	Stacked Generalization	Random Forest	Logistic Regression	J48	NB tree
ARE	0.045607	0.055312	0.035607	0.038301	0.047607	0.055622	0.052271
AAE	0.043342	0.052132	0.033342	0.033287	0.043402	0.053347	0.052376
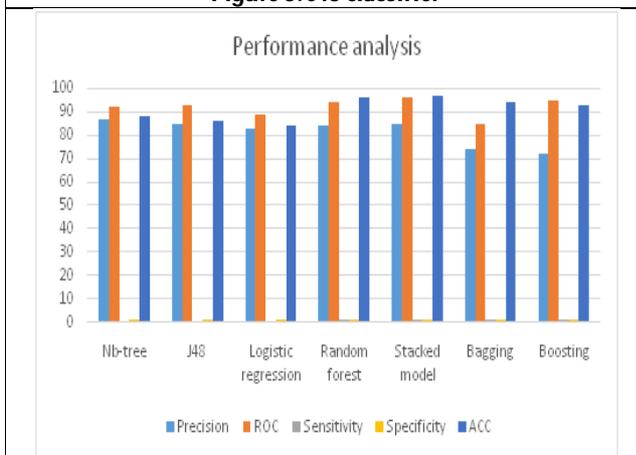
Figure 5. Over all Comparative analysis
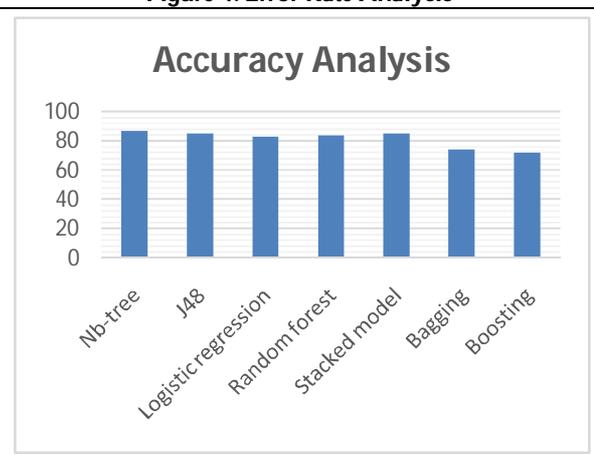
Figure 6. Accuracy Analysis

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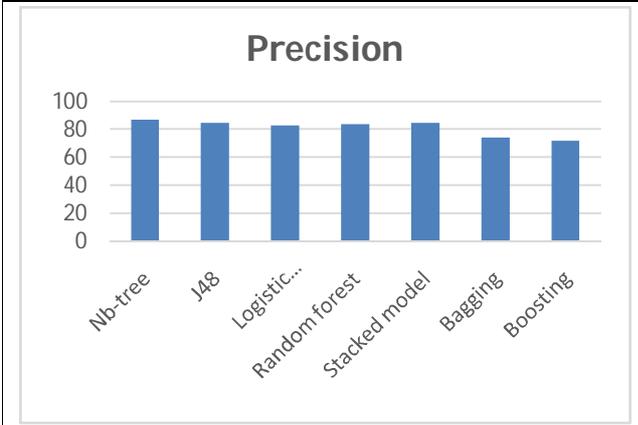
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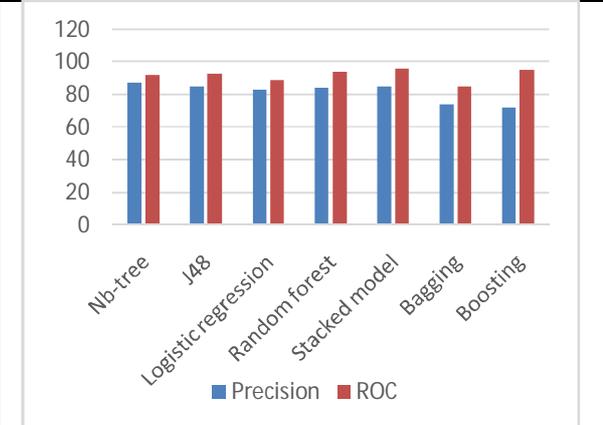
REVIEW ARTICLE

A Review on Antimicrobial, Antioxidant, Antiviral, Anticancer and Mosquitocidal Activity of Fungi Synthesized Nanoparticles

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ABSTRACT

Interest in the scientific field is developing for the green production of nanoparticles. This is a result of the product's simple availability, relatively inexpensive price, eco-friendliness, and biological safety. An advanced field of nanobiotechnology that encompasses living things of both unicellular and multicellular provenance, such as algae, bacteria, fungi, and plants, is created when nanotechnology and biology are integrated. Nanoparticles are produced by bioactive molecules both extracellularly and intracellularly. The best contender for synthesising different nanoparticles is fungi. Fungi produce a range of secondary metabolites for the production of nanoparticles. The purpose of this research was to assess recent advancements in gold, silver, copper, selenium, tellurium, platinum, cadmium, magnesium oxide, titanium dioxide, and cerium oxide mycosynthesis nanoparticles and their use in a variety of industries, including agriculture and biomedicine. Biological synthesis, however, provides alternate developmental possibilities and potential uses for the future, taking into account the existing environmental concerns and pollutants linked to chemical synthesis.

Keywords: Fungi, Nanoparticles, Antimicrobial, Antioxidant, Mosquitocidal, Antiviral, Anticancer activity

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INTRODUCTION

By explanatory factors, nanotechnology is an area of knowledge that enables novel solutions in a variety of fields, particularly medicine, agriculture, and food supply. For decades, scientists have built and examined noble metal nanoparticles (Loza *et al.,* 2020; Pereira *et al.,* 2020). The prefix "nano" is used to represent one billionth of a portion and derives from the Greek word "Nanos," which means minuscule. According to the American Society for Testing and Materials International (2006), nanoparticles are described as nanomaterials with more than two dimensions and sizes of about one hundred nanometers (Malik *et al.,* 2017).Nevertheless, whether through physical or chemical synthesis, typical nanoparticle manufacturing has a negative impact on the environment and human health. A growing discipline called "green synthesis" is devoted to the advancement of eco-friendly, safe, and efficient methods for producing nanoparticles (Wang *et al.,* 2019). Therefore, biological synthesis of nanomaterials is the best option because it is economical, advantageous, and friendly to the environment. It also requires no input from hazardous chemicals or energy sources and can be used in biomedical applications, particularly in the clinical fields. For this synthesis, many plants and microorganisms have been used. Bacteria, fungi, yeast and algae are commonly involved in the synthesis of silver, gold, copper, palladium, zinc oxide and iron nanostructures (Saravanan *et al.,* 2021). Physical, chemical, and biological processes are used to create nanoparticles. These processes may be roughly categorized into top-down and bottom-up techniques (Sajid & Płotka-Wasylka, 2020).

Fungi are among the biological resources that exhibit higher threshold and metal bioaccumulation capacities, which are beneficial traits for the synthesis of nanoparticles(Ottoni *et al.,* 2017). Because they generate and release enormous numbers of metabolites, many of which may reduce metal salts and generate nanoparticles, considering they are simple to handle, filamentous fungi are microorganisms that are frequently employed as mediators in the biological synthesis techniques of silver nanoparticle. Due to fungi's very effective ability to secrete extracellular enzymes, it is simple to produce nanoparticles on a massive scale (Ottoni *et al.,* 2017; Santos *et al.,* 2021). A filamentous explorative mycelium made of fungal hyphae grows, branches and fuses to have a high surface area to mass ratio and nutrient transfer capabilities. The hydrated mucilaginous sheath that frequently envelops hyphae acts as a matrix for geochemical processes. The enormous number of metal-binding functional groups in the cell wall and related extracellular polymeric substances (EPS) that serve as nucleation sites make the branching network an effective template for the creation of nanoparticles or nano minerals. Furthermore, due to a variety of active and accidental mechanisms to counteract metal toxicity, many fungi are great candidates for metal immobilization, mineral dissolution, and formation. Many of these fungi can also thrive in the presence of high metal concentrations (Li *et al.,* 2021).Because they represent a unique, abundant, and consistent source of secondary metabolites and nanoparticles with antibacterial, antioxidant, anti-cancerous, anti-diabetic, and antiviral effects, endophytic fungi have been the subject of most research (Akther *et al.,* 2020).

Synthesis of Nanoparticles
The primary risk for environmental contamination derives from the fact that the chemical and physical processes utilized to create nanoparticles produce a huge quantity of harmful byproducts (Singh *et al.,* 2018). There are two different approaches to the creation and evaluation of nanoparticles top-down and bottom-up techniques. Particle size reduction using the top-down approach starts with huge drug particles. It is referred to as the Physical method (Mahesh *et al.,* 2014; Prabhu & Poulose, 2012). In the bottom-up technique, the crude is dissolved in organic solvents using the bottom-up method, and it is then precipitated by adding an anti-solvent while a stabilizer is present (Figure1). It consists of all three methods of nanoparticle synthesis (Verma *et al.,* 2009).

Green Synthesis of Nanoparticles
The methods used in the biosynthesis of nanomaterials may be used in a variety of ways to produce nano-and micro-length materials, which advances research in a comparatively new and extensively unexplored field (Malik *et al.,* 2017). Microorganisms could be used to create nanoparticles, but their active form is slower and they are only capable of a small range of sizes and shapes in comparison to processes based on plant-based materials. The capacity

of some microorganisms to reduce inorganic metals as electron acceptors and oxidise organic compounds as electron givers. Fungi are currently gaining favor on a global scale as green nano-factories for the production of nanoparticles (Kharissova*et al.,* 2013). Biosynthesis of nanoparticles uses two methods they are Intracellular synthesis and extracellular synthesis (Figure2). It is known that both single-cell and multicellular organisms may create inorganic materials either inside or outside of their cells(Jaidev & Narasimha, 2010). By adding a reducing agent during the plant extraction, nanoparticles were synthesized(Pantidos, 2014). The bio-reduction of metal salts to elemental metal during the biosynthesis of metal nanoparticles can be stabilised by organic compounds found in microorganisms like fungus and bacteria. Targeted therapeutic delivery, cancer treatment, gene therapy, DNA analysis, antibacterial agents, biosensors, boosting reaction rates, separation science, and magnetic resonance imaging are just a few of the possible uses for these biosynthesized nanoparticles that are described (Kulkarni & Muddapur, 2014).

Plants Nanoparticles

The process of using plant extracts to create nanoparticles is easier than using entire plant extracts or plant tissue. A growing amount of research is being done on plant extract-mediated synthesis. Plant extracts may function in the creation of nanoparticles as both reductants and stabilising agents (Mittal *et al.,* 2013).*Diospyros kaki* leaf extract was used to extracellularly manufacture platinum nanoparticles. Platinum nanoparticles were also generated using the Fumariae plant (Jan *et al.,* 2021).*Terminalia catappa* leaf, *Dracocephalum kotschyi* leaf, *Olea europaea* leaf, *Mangifera indica* leaf, and various plant components were utilized to make gold nanoparticles. The plant *Ipomoea carnea was also used.*The size of gold nanoparticles synthesised from alfalfa seed ranges from 2 to 20 nm (Santoshkuma *etal.,* 2017). Sliver nanoparticle production appears to have a tremendous potential in the plant family *Euphorbiaceae.Asteraceae, Rutaceae, Poaceae, Myrtaceae, Solanaceae*, and other families also appear to be strong candidates for catalyzing the synthesis of silver nanoparticles. As per reports, the Apocynaceae plant family produces silver nanoparticles that are effective against Plasmodium and mosquitoes that spread several human and animal illnesses (Borase *et al.,* 2014). Copper salts including copper acetate, copper sulphate, and copper nitrate have all been used in the phytosynthesis of copper nanoparticles. *Calotropis procera* latex and *Aloe vera* flower broth were used to create copper nanoparticles of 15 and 40 nm starting with copper acetate as the substrate. Copper nanoparticles between 5 and 93 nm were created by phytosynthesis utilising leaf extract from *Syzygium aromaticum, Tabernaemontana divaricate, Vitis vinifera*, and brown algae. Citrus medica fruit juice and *Bifurcaria bifurcata* extract have been generated *(Kasana et al.,* 2017).Zinc oxide nanoparticle was biosynthesized by plants such *Aloe vera, Sargassum muticum, Eichhornia crassipes*, and fruit of the *Borassus flabellifer*. Synthesis of zinc oxide nanoparticle from *Passiflora caerulea* leaf and evaluation of their antibacterial efficacy against pathogens causing Urinary tract infections (Santhoshkumar, Kumar, *et al.,* 2017). Zinc oxide nanoparticles are generated using *Camellia japonica* leaf extract to fight bacteria that produce extended spectrum beta lactamases (Maruthupandy *et al.,* 2018).

Bacteria Nanoparticles

Prokaryotes have received considerable attention in the literature because they can produce metallic nanoparticles. Bacteria are a suitable candidate for study due to their abundance in the ecosystem and capacity to adapt to harsh environments (Pantidos, 2014).Experimentally, *Desulfovibrio desulfuricans* and *Actinobacter calcoaceticus* were used to produce platinum nanoparticles. Prokaryotic microbes *Rhodopseudomonas capsulata*, which is known to be among the ecologically and environmentally significant bacteria typically found in the natural environment, was researched for its ability to reduce Au3+ ions in a single step at ambient temperature. Under the lower initial pH, gold nanoplates in particular were created (He *et al.,* 2007). *Pseudomonas pentosaceus, Enterococcus faecium, Lactococcus garvieae, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa*and silver-resistant bacteria that produce anisotropic silver nanoparticles were contrasted with the capacity of nine distinct Lactobacillus species to collect and subsequently decrease silver ions (Sintubin et al., 2009).Copper is a less expensive material than other noble metals like Pt, Au, and Ag but it is equally susceptible to oxidation, especially at the nanoscale. Copper nanoparticles have a variety of qualities, including ones that are optical, catalytic, anti-bacterial, anti-fungal, and cancer-preventing. Seaweed-derived marine endophytic actinomycetes were employed to help in the manufacture of copper nanoparticles (Rasool & Hemalatha, 2017). *Aeromonas hydrophila, Lactobacillus sporogens, Pseudomonaas aeruginosa,*

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Rhodococcus pyridinivorans, Bacillus licheniformis, and *Serratia ureilytica* were synthesised from various sizes and shapes of zinc nanoparticles(Agarwal *et al.,* 2017).

Algae Nanoparticle

A broad range of photoautotrophic, eukaryotic, aquatic, unicellular, and multicellular organisms are considered algae. Because they grow quickly, are approachable, and their biomass growth is often 10 times more rapid than that of higher plants, algae are frequently utilised for the production of different metallic and metal oxide nanoparticles(Chaudhary *et al.,* 2020).Algae are the best choice for green synthesis because of their capacity to hyper-accumulate metals and convert them into NPs. Algae exhibit prokaryotic and eukaryotic behaviours that probably produce silver and gold nanoparticles. In rare cases, zinc oxide nanoparticles are used. The Sargassaceae family of algae produces zinc oxide nanoparticles. (AlNadhari*et al.,* 2021; Puja & Kumar, 2019). *Sargassum wightii, Turbinaria conoides, Laminaria japonica*, and *Stoechospernum marginatum* were able to synthesise gold nanoparticles (Khan *et al.,* 2019). As a result, silver nanoparticles will soon take centre stage in the nanoindustry. Different microalgae and macroalgae from the Cyanophyceae, Chlorophyceae, Rhodophyceae, and Phaeophyceae families have been used to create Ag-NPs (Khanna *et al.,* 2019).*Shewanellasp* ability to reduced $PtCl_6$ into platinum nanoparticle (Jan *et al.,* 2021).

Nanoparticles Mycosynthesis

Numerous families of fungus have been studied in the field of research and it has been demonstrated that they provide excellent candidates for the synthesis of various nanoparticles (Mohammed Fayaz *et al.,* 2009). In comparison to bacteria, fungi generate more enzymes, which are more easily converted into nanoparticles. In the creation of nanoparticles, the fungal cell wall is crucial(Lahiri *et al.,* 2021). When intracellular synthesis takes place inside the fungal cell while enzymes are present, extracellular creation of nanoparticles requires capturing metal ions on the surface of cells and decreasing them. Extracellular proteins that are secreted by fungi have been employed to remove metal ions as nanoparticles(Siddiqi & Husen, 2016). Fungi may generate many sorts of metal nanoparticles, such as Au, Ag, Ti, Zn, Ce, Fe, Mg,ZnO and Pt. Fungi are the most preferred microorganisms in the manufacture of nanomaterials because they grow in mycelial form and excrete significant quantities of extracellular enzymes and proteins (Chhipa, 2019).

Nanoparticles Synthesising Technique

Intracellular and extracellular techniques used by microorganisms (Yadav *et al.,* 2015). Nanoparticles synthesised intracellular by metal ions adhere to the cell surface due to the electrostatic force produced by the opposing charge. The cell wall plays an important role in intracellular nanoparticle synthesis. Using metabolites as catalysts, metal ions are reduced to produce nanoparticles. The synthesised nanoparticles accumulated in periplasmic space and passed through the cell wall during extraction (Bahrulolum *et al.,* 2021). Cell lysis can be used to extract released intracellular nanoparticles. Co-factors, reductive enzymes, and transmembrane proteins all contribute to a part in the creation of nanoparticles. In this method, the cell has to be active. It is not required for the cell to be alive during extracellular synthesis. It is a superior solution for metal reduction. The union of metal ions with functional chemical groups on the cell wall and with released metabolites can accomplish extracellular biosynthesis. Extracellular mechanisms are enhanced and reduced to solid-liquid separation processes like centrifugation and filtration in order to obtain nanoparticles (Pinto *et al.,* 2020). When chemical derivatives and ions in the cell undergo oxidation or reduction processes, nanoparticles are synthesized. Metallic nanoparticles were created by enzymes such as nicotinamide adenine dinucleotide (NADH)-dependent reductase (Das *et al.,* 2014). The rate of conversion of the metallic salts to metallic nanoparticles is faster because the amount of enzyme generated by fungus is larger than that of bacteria. The method of metal ion absorption and reduction for the creation of nanoparticles was significantly aided by the fungal cell wall(Lahiri*et al.,* 2021) (Table1).

Mycosynthesissilver Nanoparticles

For the reduction of silver nanoparticles, fungi like *Alternaria alternata* produce the enzyme NADH-dependent nitrate reductase. It synthesised spherical Ag-NPs with an average size of 32.5 nm and a size range of 20 to 60 nm using scanning electron microscope characterization(Gajbhiye *et al.,* 2009). The dark brown color changes of *Penicillium*

brevicompactum indicated the synthesis of silver nanoparticles within 72 hours. By the characterization of transmission electron micrographs, 58.3517.88 nm particle size was shown (Shaligram *et al.,* 2009). *Aspergillus tamarii* , *Aspergillus niger* and *Penicllium ochrochloron* produced different sizes of spherical nanoparticles, 3.53.3nm, 8.76nm, and 7.74.3nm (Devi & Joshi, 2015). According to nanoparticles produced by *Humicola sp* extracellularly, the morphology is mostly spherical and ranges in size from 5 to 25 nm (Syed *et al.,* 2013). In a UV-visible spectrophotometric study of the generated silver nanoparticles of *Penicillum verrucosum,* the particles displayed a plasmonic peak at 420 nm. It showed 2–20 nm of size with an irregular shape(Yassin *et al.,* 2021). Silver nanoparticles were synthesised extracellularly by *Trichoderma viridare, Trichoderma harzianum, and Trichoderma longibranchiatum. Trichoderma viridare and Trichoderma harzianum*showed color changes from yellow to intense brown, but there were no color changes in *Trichoderma longibranchiatum*(Elamawi *et al.,* 2018). The particle sizes of nanoparticles were modified by the incubation temperature, pH, and other factors. In spite of the fact that *Fusarium oxysporum* synthesised 70% of the particles in the 15–40 nm range, optimization results indicate that over 90% of the particles were in the 5–13 nm range(Husseiny *et al.,* 2015). Silver nanoparticles with a diameter of 11 nm and a spherical form were created by *Neurospora crassa*(Castro-Longoria *et al.,* 2011).

Mycosynthesizedgold Nanoparticles
Fusarium oxysporum produced gold nanoparticles that were between 20 and 50 nm in size and had a variety of forms, including spherical, hexagonal, and octagonal(Pourali *et al.,*2017). The unique light to deep purple color helps to analyse the development of gold nanoparticles by *Rhizopus oryzae.* It synthesised a spherical shape with 167 and 194nm sizes(Kitching *et al.,* 2016). For the production of gold nanoparticles, higher temperatures and a pH range of 3 to 10 are ideal. *Aspergillus terreus* synthesised an anisotropic morphology with a size of about 10–50 nm (Balakumaran *et al.,* 2016). Gold nanoparticle production would be catalysed by NADH-dependent reductase. *Botrytis cinerea* created nanoparticles in a variety of forms and sizes (between 1 and 100 nm)(Castro *et al.,* 2014). Gold nanoparticles were synthesised extracellularly and intracellularly, and they took on a spherical form and ranged in size from 30 to 50 nm (Du *et al.,* 2011). *Neurospora crassa* synthesised silver and gold nanoparticles with a diameter of 11 nm and spherical in shape(Castro-Longoria *et al.,* 2011).

Fungi Synthesized Other Nanoparticles
Aspergillus welwitschiae showed 60.80 diameter in nanometers of tellurium nanoparticles in oval or spherical shapes(Abo Elsoud *et al.,* 2018). Green selenium nanoparticles that were generated by *Penicillium expansum* were spherical in form and ranged in size from 4 to 12.7 nm*(Hashem et al.,* 2021). Cu2+ ions were reduced into copper nanoparticle which resulted in the formation of nanoparticles by *Aspergillus niger.* By describing transmission electron microscopy, spherical forms with a size of 5–100 nm were seen(Noor *et al.,* 2020). *Trichoderma koningiopsis* synthesised nanoparticles extracellularly with a diameter of 87.5 nm (Salvadori *et al.,* 2014). The presence of platinum nanoparticles in the solution is shown by the dark brown color of the solution. *Fusarium oxysporum* produced spherical nanoparticles with diameters ranging from 5 to 30 nm (Syed &Ahmad, 2012).Cadmium sulphide nanoparticles generated by *Fusarium sp* were visible using scanning electron microscopy and had an average particle size of 80–120 nm and a spherical shape(Reyes *et al.,* 2009). *Penicillium chrysogenium* produced magnesium oxide nanoparticles with a diameter of 10.28 nm (El-Sayyad *et al.,* 2018). The cubic structure and spherical form of the *Aspergillus niger* synthesised cerium oxide nanoparticles, with particle sizes ranging from 5 to 20 nm, were evident(Gopinath *et al.,* 2015).

Application Of Fungal Nanoparticles In The Biomedical Field
Antimicrobial Activity
Pathogenic bacteria and fungi have developed an alarming rate of resistance to commercially accessible antimicrobial drugs recently, which has turned into a severe issue. Since antiquity, silver has been the most frequently used in the treatment of infections among inorganic antibacterial agents. Fluconazole and silver nanoparticles made by *Alternaria* together had the strongest antifungal effect on *Candida albicans*(Gajbhiye *et al.,* 2009). Silver nanoparticles of *Penicillium oxalicum* were measured at 17.50.5 mm against *Staphylococcus aureus* and *Shigella dysenteriae* (Feroze *et al.,* 2020).*Cladosporium cladosporoides is enormously efficient* against both fungi and bacteria(Manjunath Hulikere & Joshi,

2019). *Aspergillus flavus silver nanoparticles* showed antibacterial activity against *Bacillus subtilis* and the ability of fungi nanoparticles to prevent the growth of fungus like *Trichoderma spp* and *Aspergillus niger*(Fatima *et al.,* 2016). Lower concentration of selenium nanoparticles produced by *Penicillum expansum* showed major antibacterial activity against *Staphylococcus aureus and Bacillus subtilis* with inhibition diameters of 12.20.371mm and 8.50.26mm. It also produced the greatest inhibition against fungal pathogens such as *Aspergillus fumigatus* and *Aspergillus niger*(Hashem *et al.,* 2021).*Aspergillus tamarii's* silver nanoparticles were found to be more effective against *Candida albicans*(Nanda *et al.,* 2018). The destruction of bacterial outer membranes by reactive oxygen species (ROS), especially hydroxyl radicals (OH), which results in phospholipid peroxidation and ultimately cell death, has largely been linked to the bactericidal activity of titanium dioxide nanoparticles. *Escherichia coli* were shown to require a minimum inhibitory concentration of 40 g ml for the produced TiO2 nanoparticles.

Antioxidant Property
Silver nanoparticles demonstrated strong antioxidant capability, and as their concentration increased, so did their capacity to scavenge free radicals. The antioxidant activity of *Cladosporium cladosporoides* was induced by its phenolic component(Manjunath Hulikere & Joshi, 2019). When compared to ascorbic acid, selenium nanoparticles of *Penicillum expansum* have more antioxidant activity; at lower concentrations, selenium nanoparticles exhibit antioxidant activity exceeding 50%(Hashem *et al.,* 2021). With rising sample concentrations, the radical scavenging activity increased. The highest percentage was determined to be 85.52% at a concentration of 100 g/ml of zinc oxide nanoparticles(Ganesan *et al.,* 2020). By demonstrating their strong radical scavenging ability against DPPH, silver nanoparticles made with the marine-produced fungus *Aspergillus brunneoviolaceus* have stronger antioxidative potentials(Mistry *et al.,* 2021).

Mosquitocidal Activity
Seetharaman *et al.* (2018) claimed that the silver nanoparticles penetrate the exoskeleton and bind to proteins' sulphur or DNA's phosphorous, blocking translation and transcription as well as the respiratory chain reaction and shattered permeability of the membrane, which restricts cellular function and leads to death. IInd and IVth instar larvae of *Culex quinquefasciatus* had LC50 and LC90 values of 1.01 ppm and 4.49 ppm at 24 hours. Under laboratory circumstances, the *Aspergillus niger* silver nanoparticles exhibited high toxicity against *Aedes aegypti* I, II, III, and IV instar larvae and pupae, with LC50 and LC90 values of 12.4-22.9 ppm and 22.4-41.4 ppm, respectively(Awad *et al.,* 2022). Their respective LC50 values were 0.033, 0.045, 0.074, 0.085, and 0.116%. After a 24-hour dosing interval, the Aspergillus niger fungal filtrate revealed extremely low death rates for I-IV instars of 46, 40, 32, and 28 and 20% for pupa, respectively. Their LC50 values were determined as 0.297, 0.353, 0.426, 0.453, and 0.467%(Gopinath *et al.,* 2015). After one hour of exposure, the Culex quinquefasciatus larvae showed 100% mortality to the *Aspergillus niger* synthesised AgNPs, whereas the *Anopheles stephensi* and *Aedes aegypti* larvae were shown to be less vulnerable(Soni & Prakash, 2013).

Antiviral And Anti-Cancer Activity
The findings revealed a constant decline in replication efficiency for HSV-1 and HPIV-3, as well as a negligible impact on HSV-2 replication. With silver nanoparticle produced by *Fusarium oxysporum* when confronted with HSV1, and with silver nanoparticles produced by *Curvularia indicum* when challenged with HPIV-3, the dose-dependent reduction in virus infectivity can reach 80% inhibition(Galdiero *et al.,* 2013). To test the anti-cancer activity, copper oxide nanoparticles from the endophytic fungus *Aspergillus terreus* were used. At a dosage of 22 g/mL, 50% of cell inhibition in the HT-29 cell lines was discovered. CuNPs/CuONPs play a crucial role in oncology by gradually reducing the growth of tumour cells. The tiniest amount of CuONPs may reduce the initiation of cell growth (Mani *et al.,* 2021). The fungal biomass of Aspergillus niger effectively reduced cell viability in a dose- and time-dependent manner. Zinc Oxide nanoparticles are an effective anticancer contender because they can target and eradicate malignant cells with specificity. The lung (A549) cancer cell line was exposed to mycosilver nanoparticles produced using *Botryosphaeria rhodina* at various doses. AgNPs demonstrated the greatest cytotoxicity toward A549, with an IC50 of 40 g/mL(Akther *et al.,* 2019). The inhibitory concentration (IC50) value of *Cladosporium.sp* synthesised gold

nanoparticles was found to be 38.23 g/ml. It was hypothesised that the gold nanoparticles' smaller size and irregular shape may be the cause of their increased cytotoxicity (Munawer *et al.,* 2020).

CONCLUSION

One of the newest fields, nanotechnology, has many practical uses for issues related to the environment and the economy. In my opinion, the greatest method of producing nanoparticles is through a green synthesis that uses no hazardous ingredients. Because they are readily accessible and manageable, plants, bacteria, algae, fungi, and yeast have been employed to create nanoparticles. Top-down and bottom-up are the common techniques employed to synthesise nanoparticles. Therefore, using biocontrol agents is crucial. There is evidence that microbes can stabilise nanoparticles of a variety of sizes and decrease metal ions. Fungi are employed to create novel therapeutic items for human usage because they have a greater accumulation of metabolites than any other species of organism. Numerous families of fungi have the ability to synthesise nanoparticles both intracellularly and extracellularly. The most commonly synthesised nanoparticles are silver and gold. Tellurium, selenium, copper oxide, platinum, cadmium sulphide, magnesium oxide, titanium oxide, and cerium oxide are some of the other nanoparticles that fungus can produce. In the biomedical field, the regulation of nanoparticle size and morphology can be used therapeutically.

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Table.1:Various Nanoparticles of Fung

Organism name	Nanoparticles type	Shapes	Sizes	Reference
Alternaria alternate	Silver nanoparticle	Spherical	32.5 nm	(Gajbhiye *et al.*, 2009)
Aspergillus flavus	Silver nanoparticle	Spherical	50nm	(Fatima *et al.*, 2016)
Aspergillus niger	Silver nanoparticle	Spherical	3.5±3.3nm	(Devi & Joshi, 2015)
Aspergillus tamari	Silver nanoparticles	Spherical	8.7±6nm	(Devi & Joshi, 2015)
Fusarium oxysporum	Silver nanoparticles	Spherical	5-13nm	(Husseiny *et al.*, 2015)
Penicillium brevicompactum	Silver nanoparticle	-	58.35± 17.88 nm54323	(Shaligram *et al.*, 2009)
Penicllium ochrochloron	Silver nanoparticles	Spherical	7.7±4.3nm	(Devi & Joshi, 2015)
Humicola sp.	Silver nanoparticles	Ring pattern with center cubic(Spherical)	5–25 nm	(Syed *et al.*, 2013)
Trichoderma longibranchiatum	Silver nanoparticles	Spherical	10nm	(Elamawi *et al.*, 2018)
Trichoderma harzianum	Silver nanoparticles	Spherical	30-50nm	(Elamawi *et al.*, 2018)
Trichoderma viridare	Silver nanoparticles	Spherical	5-40nm	(Elamawi *et al.*, 2018)
Fusarium oxysporum	Gold nanoparticles	Spherical, Hexagonal, Octagonal	20-50nm	(Pourali *et al.*, 2017)
Rhizopus oryzae	Gold nanoparticles	Spherical	16±7 and 19±4nm	(Kitching *et al.*, 2016)
Aspergillus terreus	Gold nanoparticles	Anisotrophic morphology	10-50nm	(Balakumaran *et al.*, 2016)
Botrytis cinerea	Gold nanoparticles	Triangle, Hexagonal, Decahedral, Pyramidal	1-100nm	(Castro *et al.*, 2014)
Penicillium sp	Gold nanoparticles	Spherical	30-50nm	(Du *et al.*, 2011).
Neurospora crassa	Silver and gold nanoparticles	Quasi spherical	11nm&32nm	(Castro-Longoria *et al.*, 2011)
Aspergillus welwitschiae	Tellurium nanoparticles	Oval or spherical	60.80 diameter in nm	(Abo Elsoud *et al.*, 2018)
Penicillium expansum	Selenium nanoparticles	Spherical	4-2.7nm	(Hashem *et al.*, 2021)
Aspergillus niger	Copper nanoparticles	Spherical	5-100nm	(Noor *et al.*, 2020)
Trichoderma	Copper	Spherical	87.5nm	(Salvadori *et al.*,

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koningiopsis	nanoparticles			2014).
Fusarium oxysporum	Platinum nanoparticles	Spherical	5-30nm	(Syed & Ahmad, 2012)
Fusarium sp	Cadmium sulphide	Spherical	80–120 nm	(Reyes *et al.*, 2009)
Penicillium chrysogenium	Magnesium oxide	-	10.28nm	(El-Sayyad *et al.*, 2018)
Aspergillus flavus	Titanium dioxide	Spherical	62–74 nm	(Rajakumar *et al.*, 2012)
Aspergillus niger	Cerium oxide	Cubic structure and spherical shape	5-20nm	(Gopinath *et al.*, 2015)

Figure: 1 Synthesis of Nanoparticles

Figure: 2 Biosynthesis of Nanoparticles

RESEARCH ARTICLE
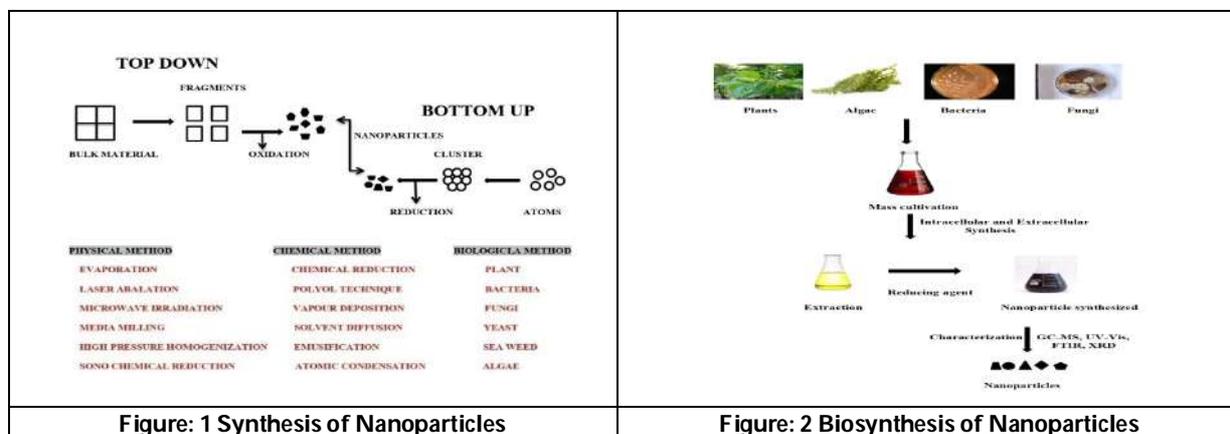
Cost Analysis of Oral Hypoglycemic Drugs among Type – 2 Diabetes Mellitus Patients

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ABSTRACT

Cost analysis is an act of breaking down a cost summary into its constitutes, studying and reporting each factor. Nowadays cost analysis of treatment is contributing to the increase in health expenditure therefore there is a growing need to evaluate the cost of medicine in the treatment of type – 2 diabetes mellitus. We systematically reviewed the cost analysis study associated with the treatment of type – 2 diabetes mellitus where the searching of studies describes the direct cost and medicine cost of treating type –2 diabetes mellitus. We conducted a literature search on Pubmed, EMBASE, Cochrane Database of systematic review(CDSR), and springers link were reviewed for the original article. Based upon the studies conducted in the last five years. The 8 original articles were shortlisted for evaluation of the mean annual direct cost per person. In these reviewed articles the average costs were ranging between US$220 and US$7,600 where the studies show a greater impact on the cost of medicine and hospitalization per person. Costs associated with using oral hypoglycemic medications have grown. However, it is still unclear how the rising use of oral hypoglycemic medications affects total spending. Therefore, prescription by brand name is a matter of concern.

Keywords: Cost analysis, Oral hypoglycemic drugs, Type – 2 Diabetes Mellitus Patients, Systematic review.

INTRODUCTION

Type – 2 diabetes mellitus is a chronic metabolic disorder that is expanding into a global health problem. It is a common metabolic condition where the body fails to produce enough insulin or when insulin does not work properly. Type – 2 diabetes mellitus accounts for around 90% which is commonly seen in people older than 45 years. Still, it is increasingly seen in children, adolescents, and younger adults due to other factors such as obesity, physical inactivity, and an energy-dense diet. Type – 2 diabetes mellitus is providing to be a global public health burden as it is expected to rise by 200 million by 2040. As epidemiology increases the cost of the medicine will also be increased. According to International Diabetes Federation (IDF), the global expenditure in 2006 was $ 232 (18395 Indian rupees), and in 2017 was $ 727 (57644 Indian rupees) and is expected to increase to $ 776 (61529 Indian rupees) by 2045[1]. Hence, including all developed and developing countries data are reviewed to find out the total cost of medicine, and direct cost per person. Therefore, this article reviews the expenditure on medicine taken by Type – 2 diabetes mellitus patients spent among developed and developing countries people, this creates an awareness of expenditure on generic prescribing and reimbursement of medicine.

METHODS

Research design
This systematic review was conducted according to the preferred reporting items for the systematic review (PRISMA) statement.

Search strategy
The literature search is conducted in English databases such as Pubmed, EMBASE, Cochrane Database of systematic reviews (CDSR), and springer link. The original articles were collected for reviewing in this database considering the cost analysis of the type – 2 diabetes mellitus treatment. The electronic search strategy included keywords such as diabetes (i.e type – 2 diabetes, type – II diabetes mellitus, T2DM, hypoglycemia), cost (i.e cost, costs, expenditure), economics (i.ecost analysis, pharmacoeconomics, health care cost, direct cost) and medications (i.e drug, drugs, medicine, medicines, medication, medications, glucose-lowering medications, oral hypoglycemic drugs, anti-diabetic drugs). These searches were considered only if the study was published between the last five years (2017-2021) and limited to evaluating only the cost of medicine.

Literature selection criteria
The assessment was conducted individually by two authors according to the guidelines compliance. Any divergence that was resolved through discussion and confirmation by another author is done.

Quality Assessment
We evaluated the studies caliber using the Jadad score (Jadad *et al.,* 1996). Three appraisal elements were used to determine the quality of the included studies such as selection bias, blinding and attrition bias. After that, studies were graded from 0 to 5 on a scale. Studies with a score of more than 3 were of a high caliber.

RESULTS

Figure.1 Summarized the search strategy and the results were presented in table - 3 which represents the characteristics of the studies. Table – 4 represents the mean annual direct cost per person and mean annual medicine cost per person in the included studies.

DISCUSSION

Diabetes is considered a global burden. The high prevalence of type 2 diabetes worldwide continues to rise, and there are no signs of it stabilizing[9]. This review focuses on the mean cost of oral hypoglycemic drugs Table 4, shows that the mean direct costs per person in Northern Italy and Germany are quite similar. Whereas northern Italy records the highest expenditure on medicine per person(Figure.2). Among the studiesfindings of mean annual direct cost per person, India reported the lowest expenditure. In 2020, according to the International Diabetes Federation(IDF), 463 million people have diabetes in the world, and 88 million people, 77 million belong to India. A recent study showed that, In India, the total annual expenditure by patients on diabetes care was, on average, Rs.10,000 in urban areas and Rs. 6260 in rural areas[10].While Indonesia records the second-lowest spending in the included studies. Among these India and Boston is almost the same cost of expenditure. In 2015, a study conducted by Shuyu Ng *et al*[11]in Singapore reported the lowest expenditure whereas, in 2016,Elgart *et al.* study reported the highest expenditure on medicine. Among these reviews, northern Italy records the highest expenditure on medicines cost per person. The studies related to diabetes indicate that the direct cost implication of diabetes is multifold worldwide. These individual studies vary the direct cost due to the patient's disease progress, age, and complications. The cost of diabetes therapy increases linearly along the duration of diabetes[8]. Zhou *et al.* obtained data from the Medical Expenditure Panel Survey, a nationally representative survey for the civilian noninstitutionalized population in the U.S. National spending on glucose-lowering drugs were estimated by extrapolating to the entire U.S. population[14]. The authors estimated that total national spending on glucose-lowering medications increased by 240% (from $16.9 to $57.6 billion per year expressed in 2017 dollars) in 2015–2017 compared with 2005–2007. Over the same time period, the authors estimated a 38% increase in the number of people using glucose-lowering drugs (from 15.3 to 21.1 million) and a 147% increase in the average annual cost per user (from $1,106 to $2,727)[9]. In the majority of studies, the most prescribed drugs were metformin and sulfonylurea such that the study conducted by Sharma et al. demonstrated the changing trend from 55% of patients beingtreated with metformin as the first agent in 2003 to 83.6% in 2013 in the United Kingdom. In a similar study from the United States, data collected over 2009–2013 revealed that only 57.8% of people were started on metformin as an initial drug for new-onset diabetes[9]. Whereas Rajiv single et.al 2018 study, also reported that metformin, at 90.62%, is the drug of choice during the early years of diabetes[1]. Among these reviews, none of the drugs were reported to be prescribed generic names. All drugs were prescribed with a brand name, hence the cost analysis of the findings of the hypoglycemic drugs among various countries is unrecognized.

CONCLUSION

Based on the literature reviews, we suggest that the prescription of generic drugs should be implemented by the physicians then only there will be reimbursement in cost for each medicine.

Limitations of Study

- This review only the reports on the direct cost of antidiabeticdrugs attributable to type – 2 diabetes Mellitus between the 2017 – 2021 year.
- Prescription patterns among the generic name were only analysed and the brand name was not analysed where the cost of medicine is majorly affected by the prescription of the brand name.
- This review included the use of different methodologies and differences in healthcare systems across the countries.

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Table.1: Criteria for inclusion of systematic review

Oral antidiabetic drugs in the treatment of type – 2 diabetes mellitus
1. Biguanides (Metformin)
2. Sulphonylureas (Glimepiride, glipizide, glibenclamide, gliclazide)
3. Dipeptidyl peptidase – 4 Inhibitors (sitagliptin, saxagliptin, vildagliptin, teneligliptin, linagliptin, and alogliptin)
4. Glinides (repaglinides)
5. Glitazone (pioglitazone)
6. SGLT – 2 Inhibitor (dapagliflozin, empagliflozin, canagliflozin)
7. GLP – 2 analogues(Exenatide)

Table.2: Criteria for exclusion of systematic review

1. Studies on cost analysis of Type1Diabetes Mellitus
2. Studies on comorbidities eg; CKD, Heart condition, Obesity, and lifestyle interventions.
3. Studies do not quote cost
4. Studies on medication adherence
5. Studies on other diabetic complications i.e diabetic foot, diabetic nephropathy, diabetic neuropathy)
6. Cost-benefits and cost – minimization study

Table.3:Characteristics of the studies

Country	Study design	Setting for study design requirement	Methods	Study duration (year)	Sample size	Inclusion Criteria	Mean age (years%)	Funding body
India Rajiv singla et.al (2018)	Retrospective Cross-sectional study	Primary health care	Electronic medical record data	2018	489	Diagnosed T2DM	45	Privately financed
Italy Alowayesh MS et.al (2018)	Cross-sectional study	Primary health care	Medical records data	2018	1182	Diagnosed T2DM	39.2	Publicly financed
Boston PeggahKhorrami et.al (2021)	Cross-sectional study	Tertiary health care	Medical records data	2020-2021	22788	Diagnosed T2DM	52.12	Privately financed
India DnyaneshLimaye et.al(2017)	Prospective randomized cross-sectional study	Tertiary health care	Validated Questionnaire	2016	152	Diagnosed T2DM	54	Privately financed
India Mina Jafarnia et. al(2020)	Prospective study	Tertiary health care	Medical records data	2020	275	Diagnosed T2DM	Male-38.9 Female-61.09	Privately financed
Indonesia	Retrospec	Tertiary health	Medical	2014-2017	134	Diagnosed	Male-43.28	N/A

Akhmadpriyadi et. al(2021)	tive observational study	care	records data			T2DM	Female-56.72	
Northern Italy (Demurtas et al., 2017)	Retrospective study	Tertiary sector	Medical records	2012	24.087	Diabetes is classified as "insulin-treated diabetes", and "non-insulin treated diabetes" above 45 years	69.2	Publicly financed
Germany Jacob, von Vultee, &Kostev, (2017)	Retrospective study	General practices and diabetic centers	Medical records	2015	36382	Diagnosed T2DM	N/A	Publicly and privately financed

Table.4:Cost of mean annual direct cost per person and mean annual medicine cost per person in the included studies

Country	Price year	Currency/exchange rate	Income classification	Mean annual direct cost/person	Mean annual medicine cost / person in Indian rupee [*]	Medication cost is estimated on the basis of the following characteristics	Direct cost estimated on the basis of the following characteristics
Northern ItalyDemurtas *et al.,* (2017)	2012	€	High Upper-Income groups	3,310	263699.42	Medication Included sulfonylureas, thiazolidinedione	Hospitalization, outpatient care cost, medication cost.
GermanyJacob, von Vultee, &Kostev, (2017)	2015	€	High Upper-Income groups	2,389	190448.48	Nine classes of anti – hyperglycemic therapy	N/A
India Rajiv singla *et.al* (2018)	2018	₹	Middle to upper-Income groups	Categorized according to the duration of diabetes mellitus; < 5yr-₹16.42; 5-10 yr-₹38.034; 10-15 yr-₹62.34; 15-20 yr-₹77.183; >20 yr-₹106.34	3260	Medication included Metformin, sulfonylurea, DPP-4 inhibitors, SGLT2, Pioglitazone, Meglitinides, AGI, GLP1RA	Hospitalization

Indonesia Akhmadpriyadi *et. al*(2021)	2021	Indonesian rupiah (IDR)	Middle to upper-Income groups	2014 – IDR 7388940 2017 – IDR 8629930	2014 - 39247.28 2017 - 45838.95	N/A	N/A
India Mina Jafarnia *et. al*(2020)	2020	₹	N/A	N/A	N/A	Metformin, Glimipiride, Teneligliptin	N/A
India DnyaneshLimaye *et.al*(2017)	2016	₹	Upper-Income group	2520	2520	Metformin, Glimepiride, Pioglitazone,Gliclazide/Repeglinide, Vildagliptin	Inpatient and outpatient from the general ward
Boston PeggahKhorrami *et.al* (2021)	2020	$	Upper-Income group	$148	11790.79	Metformin, Sulfonylureas,SGLT-2 inhibitors, GLP-1 agonists,DPP-4 inhibitors	Hospitalization
Italy Alowayesh MS *et.al* (2018)	2018	€	Upper-Income group	€ 1278	101880.77	Metformin, sulfonylurea, DPP-4 inhibitors, GLP – 2 analogues,Glinides	Hospitalized Inpatient

*Conversion of cost is done by an online currency calculator (X-Rates)
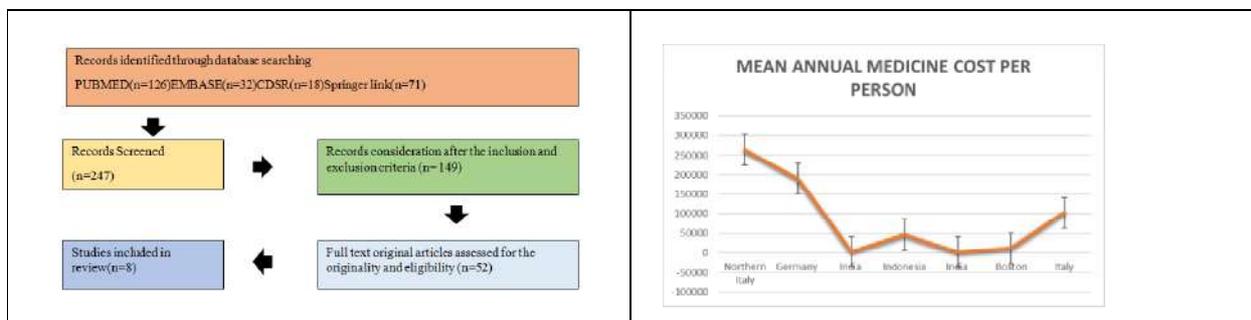
Figure 1: Data extraction	**Figure 2 Mean annual medicine cost per person among included studies**
Figure 3 Prescription pattern by drug class in included studies	
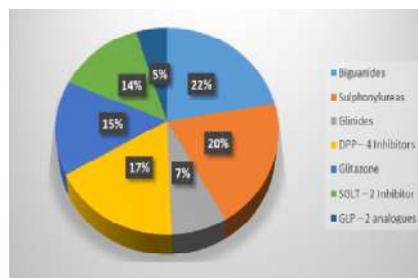
RESEARCH ARTICLE

Diversity of Aquatic Insects in Relation to Physico Chemical Water Quality in Kallada River, Kollam, India

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ABSTRACT

Insects comprise the most diverse group of organisms that exist on Earth. Aquatic insects are colossally diverse group consisting of thirteen orders having aquatic or semi aquatic stages. The diversity and distribution of aquatic insects and physicochemical water quality variables were studied along three segments of the River Kallada from February 2018 to January 2019. A total of 5,978 individuals belonging to 71 families and 9 orders were identified from River Kallada. Among the aquatic insects collected, order Coleoptera was the most diverse, followed by Odonata, Hemiptera, Diptera, Trichoptera, Ephemeroptera, Lepidoptera, Plecoptera and Megaloptera. However, the most dominant order with the highest numerical abundance was Hemiptera (30.22%). Highest Shannon-Wiener diversity index values were recorded from site S1 (3.523) of upstream segment during premonsoon season and lowest value of 2.76 was noted for site S8 of midstream segment during postmonsoon season. Berger- Parker dominance index was higher in site S8 (0.14) of midstream segment and the lowest value 0.06 was noted for upstream segment during premonsoon season. The physico chemical variations of stream were found to be influencing the distribution of aquatic insects. The high diversity of insects in streams is a sign of large number of microhabitat diversity and good water quality conditions. Deterioration of microhabitat and perturbation in an aquatic ecosystem considerably affects diversity and abundance of entamofauna.

Keywords: Aquatic insects, Ecological indices, Water quality, Richness Index, Diversity Index

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INTRODUCTION

Aquatic insects are very diverse groups, including thirteen orders of insects with aquatic or semi aquatic stages. Of these, approximately 76,000 species are accustomed to all sorts of freshwater environments [1]. Moreover, they are most suitable indicators for detecting water purity and they have different levels of tolerance on environmental disturbance. Therefore, studies on the diversity and distribution of these macroinvertebrates play a major role in predicting the health status of a stream. Changes in physicochemical properties may affect water quality and subsequently alter the distribution pattern of aquatic organisms, including insects [2]. Hydro-morphological and physicochemical alteration in a stream drastically reduces the diversity of sensitive insects like mayflies and only few species can cope up with these alteration [3]. Some natural processes such as weathering, evapotranspiration, wind deposition, leaching of soil, hydroelectric flow and biological processes in the aquatic environment also alter the properties of water [4]. Anthropogenic sources such as untreated industrial waste, improperly treated household waste, and agricultural waste are major contributors to surface water pollution and water quality degradation. Abridged level of dissolved oxygen and high biological oxygen demand, accumulation of organic pollutants in rivers invigorates microbial growth, leading to oxygen diminution and uproar of the entire river ecosystem [5]. According to Popoola and Otalekor, dipterans are common in nutrient enriched water and they can tolerate less oxygenated water [6]. Most physicochemical characteristics directly or indirectly affect the diversity of macroinvertebrates, either adversely or positively. Habitat degradation along with loss of water quality can lead to diversity drop among aquatic invertebrates because of unavailability of natural resources [7]. The main objective of the present study was to assess seasonal changes of various physico chemical properties of water and its impact on aquatic insects diversity.

MATERIALS AND METHODS

Study area and sampling locations
The study was carried out in Kallada River, Kollam, India, from February 2018 to January 2019 at monthly intervals. The River originates from the Kulathupuzha ranges of Western Ghats, flows towards the west as Kulathupuzha River, near Parappar in Thenmala, joins with Chendurni and Kazhuthurutty rivers and ultimately drains in to the Ashtamudi Lake (Figure 1). To determine the physico chemical water quality and distribution of aquatic insect taxa, six sampling sites were selected from three segments of river namely upstream, midstream and downstream. Stations S1, S3, S5, S7, S9, S11, S13, S15 and S17 represent reference sites and S2, S4, S6, S8, S10, S12, S14, S16 and S18 were test sites (Table 1).

Sample Collection and Analysis
Aquatic insect sampling
Insects were sampled by adopting Large-river Bioassessment Protocol [8]. Aquatic insects were collected from 500 m reach having equally divided 100 m transect for each site. A total of six transects were set. First transect location was selected at the downstream end of the reach with the remaining five transects at 100 m, 200 m, 300 m, 400 m and 500 m, each transects having 10 m sample zone. Sampling gears used were Peterson Grab (25.75 x 13″), Kicknet (600 μm) and D-frame dip net (500 μm). Using D-frame net, a total of 6 sweeps, each of 0.5m in length, were collected within the sample zone on either side of transects. Kick screen net was used at sites where depth of stream was below 1.0 meter and 5 kicks were sampled at various velocities in the water. Grab sampler was used for bottom sampling. Three replicates were taken from each sampling zone. Samples from each transects were preserved in 90% ethyl alcohol for laboratory processing. In the laboratory, all the individuals from each transect sample were sorted, counted, and then preserved in 70% ethyl alcohol for further taxonomic identification.

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Sampling of Water

Water samples were collected in polyethylene sampling bottles previously washed with clean distilled water followed by rinsing with water from sampling sites. Temperature and pH were analyzed at the site itself by using thermometer and digital pH meter respectively. For measuring dissolved oxygen, the samples were fixed at the site itself and parameters such as Total Hardness, Dissolved Oxygen, Biological Oxygen Demand, Sulphate, Nitrate and Phosphate were analyzed in the laboratory by using standard methods [9].

Data Analysis

Abundance and taxonomic richness of aquatic insects were estimated for each sample. Ecological indices, including the Shannon-Wiener diversity Index (H'), Berger- Parker Dominance Index (D), Margalef Richness Index were determined for each sampling site. Statistical analysis conducted for physico chemical parameters were Analysis of Variance (between season) and t test (between sites) at 5% level of significance using the software SPSS (SPSS Statistics 21.0). Canonical correspondence analysis (CCA) was performed for finding correlation between insect families and environmental variables using PAST 4.03.

RESULTS AND DISCUSSION

A total of 5,978 individuals belonging to 71 families and 9 orders were identified from River Kallada. Highest diversity was found among insects under order Coleoptera followed by Odonata, Hemiptera, Diptera, Trichoptera, Ephemeroptera, Lepidoptera, Plecoptera and Megaloptera. However, the most dominant order with the maximum numerical abundance was Hemiptera (Figure 2).

Ecological Indices

Table 2, 3 and 4 shows the diversity indices of aquatic insects during premonsoon, monsoon and postmonsoon seasons respectively. Highest Shannon-Wiener diversity index value of 3.52 was recorded from site S1 of upstream segment during premonsoon season and a lowest value of 2.76 was noted for site S8 of midstream segment and site S18 of downstream segment during monsoon and postmonsoon season respectively. The study of Hasmi *et al.* showed that a positive correlation exists between dissolved oxygen and Shannon-Wiener diversity Index [10]. In the current study, high dissolved oxygen was observed in upstream segment than lower reaches. Current result also shows that Berger- Parker Dominance Index value ranges between 0.06 (reference site) to 0.14 (test site). A polluted aquatic environment can infact sustain certain tolerant organisms to persist and propagate, thus affecting diversity [11]. Hence, higher dominance index is an indication of low water quality in the present study. Richness index measures the number of different taxa in a given area. Here, highest Margalef Richness Index value of 7.03 was observed in Site S1 of upstream segment during postmonsoon season. Margalef Richness Index values were found to be higher in reference sites than test sites. The results of ecological indices revealed that, the diversity and richness of insects at reference sites were high and the dominance index was high at the test sites.

Physicochemical water quality

Physicochemical variables of each sampling station along the stream are shown in table 5. In the present study, the annual mean value of temperature ranged from 26.4 ± 0.33 to 27.2 ± 0.58 in upstream, 27.6 ± 0.36 to 28.6 ± 1.09 in midstream and 27.6 ± 0.4 to 28.6 ± 1.11 in downstream segment. Seasonal mean value of temperature showed significant variation in all the sites during study ($p<0.05$). pH was minimum in site S8 of midstream segment with a value of 6.02 ± 0.27 and maximum at site S18 of downstream segment with a value of 6.89 ± 0.35. In terms of dissolved oxygen, significant seasonal variations were found in sites S3 of upstream segment, S13 of midstream segment and S16 and S17 of downstream segment ($p<0.05$). Annual mean value of dissolved oxygen ranged from 5.96 ± 0.2 at site S18 of downstream segment to 7.33 ± 0.37 at site S1of upstream segment. Biological oxygen demand ranged between 0.74 ± 0.15 and 2.91 ± 0.31.The total dissolved solids varied significantly during seasons in all stations, and showed significant variation between sites too. In the midstream and downstream segments, total dissolved solids became high in monsoon and post-monsoon seasons. Nitrate and sulphate values were observed

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within the acceptable limit of drinking water quality standards; however nitrate content was high during postmonsoon season. In midstream and downstream segments, phosphate exceeded the standard permissible limit of WHO [12].

According to the analysis of results, most of the physicochemical parameters varied significantly during seasons. In the present study, the temperature showed relatively high values in the midstream and downstream segments, this may be due to the absence of canopy cover and the presence of various pollutants [13]. In the current study, pH values of different stations observed within the permissible limit of Indian water quality standards [14]. The optimum pH for aquatic life is in the range of 6.5 – 8 [15]. Aquatic organisms are hassled as the level of dissolved oxygen drops below 5.0 mg /L [16]. In the present study, dissolved oxygen was comparatively low in midstream and downstream segments. It is obvious from the overall result of physico-chemical analysis that the middle and lower reaches of the stream need more attention to maintain the quality.

Aquatic insect taxa and its correlations with physicochemical parameters

Figure 3 shows the Canonical Correspondence Analysis for correlating distribution of insects with physico chemical variables. Taken together, the first two axes explain 61.26 percentage of variance (Table 6). Axis-1 reveals that the parameters such as Hardness (r = -0.929), Total Dissolved Solids (r = -0.884) and Phosphate (r = -0.773) pose a negative influence on the insect abundance. Axis-2 shows that pH has highest positive effect (r = 0.676) whereas biological oxygen demand (r = -0.561) and temperature (r = -0.527) have highest negative effect on the abundance of aquatic insect. In this study, CCA analysis discloses that, abundance, diversity and distribution of insects are mainly related to dissolve oxygen positively. Ephemeroptera, Plecoptera, and Trichoptera are sensitive groups that require noble water quality conditions [17]. Along with these sensitive taxa, families such as Psephenidae (Coleoptera) and Aphelocheridae (Hemiptera) also showed great affinity towards dissolved oxygen. Elmidae and Gyrinidae also prefers good water quality conditions [18-19]. Intolerant groups of aquatic insects were completely absent in the lower stretches of river with exceptions from among order Ephemeroptera such as Baetidae and Caenidae [20]. Abundance, diversity and distribution of insects were also positively influenced by pH. Decreased temperature, nutrients such as Nitrate, Phosphate and Sulphate and biological oxygen demand positively influenced the diversity of insects. However, families such as Chironomidae, Ceratopogonidae, Tipulidae and Culicidae of Diptera and Coleopterans like Scirtidae, Ptilodactylidae, Chrysomelidae and Carabidae showed tolerance towards low water quality [21-22]. According to Adu et al. [23], Coenagrionidae and Libellulidae in the order Odonata showed adoration towards warmness of water. Mesoveliidae and Leptopodidae showed affinity towards hardness and total dissolved solids. In concordance with the study of Payakka and Prommi, Mesoveliidae showed positive correlation with alkalinity [24]. Previous findings have shown that distribution of aquatic insects like Baetidae, Heptageniidae, Gerridae and Nepidae are interconnected to phosphate concentration and water temperature [25]. Aquatic insects possess different tolerance levels to various contaminants and hence their presence or absence in each site gives an insight to contamination of that aquatic ecosystem.

CONCLUSION

Among the aquatic insects collected, order Coleoptera was the most diverse order whereas, the most dominant order with maximum numerical abundance was Hemiptera. Ecological indices such as Shannon -Weiner Index and Margalef Richness Index showed highest values in reference sites and the Berger- Parker dominance index was high at test sites. In CCA ordination biplot, environmental variables have pronounced influence on numeral abundance and diversity of insect community in all the sites. The distribution pattern of aquatic insects in Kallada River shows that moderate perturbation exists in midstream and downstream segments which needs to be addressed.

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Table 1. Description of the sampling sites of Kallada River

Upstream Sites	S1	S2	S3	S4	S5	S6
Latitude	8.5736	8.958282	8.5745	8.5809	8.982719	8.5922
Longitude	77.0518	77.06347	77.0217	77.0102	76.9904	76.584
Midstream Sites	S7	S8	S9	S10	S11	S12
Latitude	8.998628	9.0054	9.036960	9.04431	9.0455	9.0518
Longitude	76.95996	76.5621	76.91734	76.8966	76.4518	76.452
Downstream Sites	S13	S14	S15	S16	S17	S18
Latitude	9.081353	9.058490,	9.056896	9.026013	9.0134	9.002742
Longitude	76.72517	76.71102	76.68894	76.66482	76.3848	76.62472

Table 2. Ecological Indices of Aquatic Insects During Premonsoon Season in Kallada River

Sites	Number of Family	Number of Individuals	Shannon-Weiner Diversity Index	Berger-Parker Dominance Index	Margalef Richness Index
S1	38	196	3.52	0.06	7.01
S2	18	114	2.84	0.08	3.58
S3	26	114	3.07	0.09	5.28
S4	20	117	2.86	0.09	3.98
S5	25	103	3.08	0.11	5.18
S6	19	105	2.86	0.1	3.87
S7	25	103	3.13	0.09	5.18

S8	18	108	2.76	0.12	3.63
S9	21	102	2.99	0.08	4.32
S10	19	106	2.87	0.12	3.86
S11	23	105	3.04	0.095	4.73
S12	21	108	2.93	0.1	4.27
S13	34	112	3.44	0.06	6.99
S14	28	109	3.24	0.07	5.75
S15	30	126	3.29	0.09	5.99
S16	21	105	2.93	0.1	4.3
S17	25	117	3.09	0.08	5.04
S18	18	105	2.84	0.11	3.9

Table 3. Ecological Indices of Aquatic Insects During Monsoon Season in Kallada River

Sites	Number of Family	Number of Individuals	Shannon-Weiner Diversity Index	Berger-Parker Dominance Index	Margalef Richness Index
S1	25	116	3.05	0.09	5.1
S2	17	108	2.77	0.102	3.41
S3	24	107	2.98	0.09	4.92
S4	19	102	2.79	0.1	3.89
S5	26	104	3.18	0.07	5.38
S6	20	107	2.93	0.8	4.06
S7	23	105	3.02	0.08	4.72
S8	17	102	2.78	0.09	3.45
S9	24	102	3.07	0.09	4.97
S10	23	102	3.04	0.09	4.75
S11	23	102	2.98	0.1	4.75
S12	20	105	2.91	0.1	4.08
S13	34	110	3.39	0.09	7.02
S14	25	108	3.08	0.01	5.12
S15	28	120	3.14	0.1	5.64
S16	19	102	2.8	0.11	3.89
S17	22	103	2.94	0.107	4.53
S18	17	102	2.76	0.108	3.45

Table 4. Ecological Indices of Aquatic Insects during Postmonsoon Season in Kallada River

Sites	Number of Family	Number of Individuals	Shannon-Weiner Diversity Index	Berger-Parker Dominance Index	Margalef Richness Index
S1	37	167	3.5	0.08	7.03
S2	18	110	2.83	0.082	3.61
S3	21	108	2.89	0.1	4.27
S4	20	118	2.82	0.12	3.46
S5	23	101	2.94	0.12	4.76

S6	19	104	2.81	0.13	3.87
S7	24	108	3.09	0.09	4.91
S8	19	111	2.82	0.14	3.82
S9	22	103	3.02	0.09	4.53
S10	22	104	3.03	0.09	4.52
S11	23	105	3.04	0.1	4.72
S12	20	112	2.88	0.11	4.02
S13	35	142	3.46	0.06	6.86
S14	27	127	3.19	0.09	5.36
S15	29	122	3.28	0.07	5.82
S16	21	103	2.97	0.09	4.31
S17	22	106	3.01	0.1	4.5
S18	18	114	2.8	0.11	3.58

Table 5 Annual Average of Physicochemical Water Quality of Kallada River (Mean ± SD)

Sites	Temperature (^{0}C)	TDS (mg/l)	pH	DO (mg/l)	BOD (mg/l)	Hardness (mg/l)	NO$_3$- (mg/l)	PO$_4$$^{3-}$ (mg/l)	SO$_4$$^{2-}$ (mg/l)
S1	26.4±	15.61±	6.81±	7.33±	0.74±	10.08±	0.05±	0.1±	0.2±
	0.33	1.83	0.1	0.37	0.15	8.75	0.03	0.03	0.17
S2	26.7±	21.7±	6.35±	6.47±	1.54±	14.63±	0.37±	0.34±	0.81±
	0.34	2.58	0.19	0.19	0.28	10.84	0.15	0.08	0.31
S3	26.5±	13.87±	6.76±	7.01±	0.96±	13.35±	0.16±	0.31±	0.3±
	0.37	2.9	0.18	0.41	0.11	11.82	0.04	0.14	0.15
S4	26.7±	24.9±	6.47±	6.73±	1.31±	13.76±	0.22±	0.26±	0.23±
	0.25	7.44	0.18	0.34	0.16	12.11	0.05	0.15	0.09
S5	26.8±	19.64±	6.64±	6.61±	1.08±	14.99±	0.32±	0.32±	0.38±
	0.4	3.33	0.21	0.27	0.18	11.41	0.17	0.19	0.32
S6	27.2±	28.56±	6.61±	6.33±	1.85±	21.33±	0.73±	0.44±	0.8±
	0.58	3.46	0.29	0.4	0.22	13.22	0.27	0.22	0.27
S7	28.1±	18.5±	6.62±	6.54±	1.85±	16.87±	0.15±	0.23±	0.56±
	1.05	2.51	0.13	0.52	0.29	13.6	0.06	0.13	0.31
S8	28.6±	24.07±	6.02±	6.03±	2.48±	23.05±	0.33±	0.52±	1.33±
	1.09	3.49	0.27	0.25	0.33	15	0.12	0.1	0.95
S9	27.9±	18.17±	6.51±	7.09±	1.7±	16.64±	0.22±	0.48±	0.34±
	0.41	2.16	0.31	0.17	0.13	11.99	0.09	0.17	0.15
S10	27.6±	27.49±	6.41±	6.31±	1.77±	19.79±	0.27±	0.69±	0.26±
	0.36	8.4	0.24	0.22	0.18	13.11	0.11	0.21	0.15
S11	27.8±	23.5±	6.64±	6.75±	2.08±	18.6±	0.31±	0.56±	0.52±
	0.57	2.62	0.13	0.37	0.84	12.72	0.07	0.11	0.43
S12	27.6±	30±	6.48±	5.98±	2.91±	26.21±	0.38±	0.74±	1.35±

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	0.44	3	0.18	0.27	0.31	16.78	0.24	0.19	0.82
S13	28±	27.75±	6.61±	6.61±	2.05±	21.77±	0.34±	0.25±	0.46±
	1.08	3.7	0.16	0.23	0.22	16.01	0.15	0.08	0.1
S14	28.6±	29.25±	6.49±	6.33±	2.86±	27.85±	0.39±	0.49±	0.75±
	1.11	2.73	0.27	0.18	0.47	20.3	0.19	0.16	0.16
S15	27.9±	30.47±	6.61±	6.82±	2.62±	30.85±	0.25±	0.42±	0.49±
	0.54	4.84	0.25	0.42	0.33	21.83	0.16	0.17	0.16
S16	27.6±	52.14±	6.59±	6.2±	2.8±	39.54±	0.49±	0.54±	0.65±
	0.4	7.12	0.14	0.52	0.55	28.78	0.23	0.22	0.24
S17	27.7±	91.51±	6.68±	6.31±	2.13±	50.81±	0.45±	0.5±	0.38±
	0.67	26.52	0.19	0.26	0.4	38.83	0.18	0.12	0.23
S18	27.6±	1217.76±	6.89±	5.96±	2.34±	93.26±	0.6±	0.91±	0.53±
	0.44	634.9	0.35	0.2	0.26	73.25	0.25	0.34	0.13

Table 6. Summary Statistics of CCA between Aquatic Insect Abundance and Environmental Variables for First Two Axes in Kallada River

Environmental Parameters	Axis 1	Axis 2
Temperature	-0.338	-0.527
pH	-0.143	0.676
Total Dissolved Solids	-0.884	0.492
Dissolved oxygen	0.681	0.382
Biological oxygen demand	-0.529	-0.561
Hardness	-0.929	0.250
Nitrate	-0.651	-0.260
Phosphate	-0.773	-0.125
Sulphate	-0.221	-0.452
Eigenvalue	0.263	1.181
% of variance explained	36.35	24.91
Total % explained	61.26	

Source: E sri, M axar, GeoEye, Earthstar Geographics, CNE S/Airbus D s, SDA, USGS, AeroGRID, IGN and the GIS User Community

Figure 1. Location Map of Study Area with Sampling Sites at Different Segments
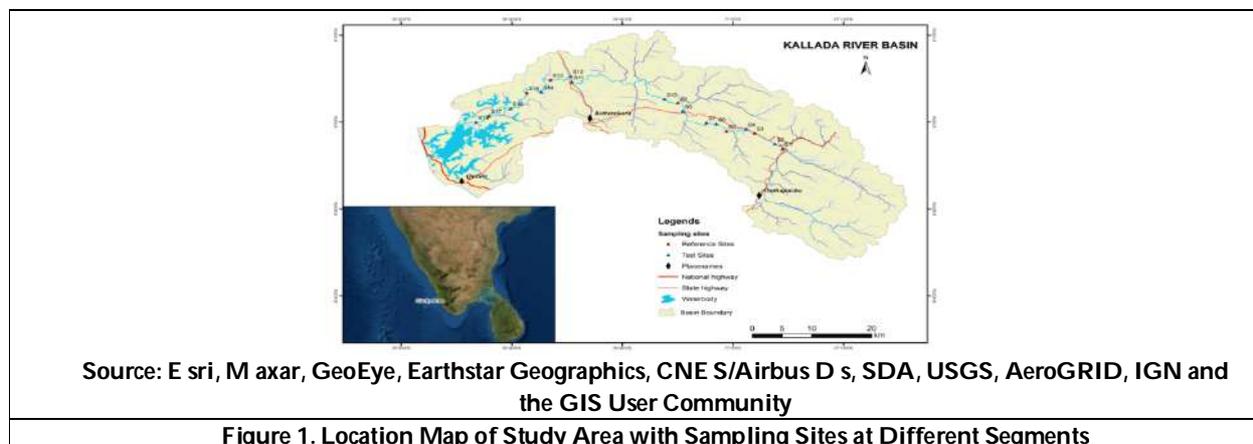
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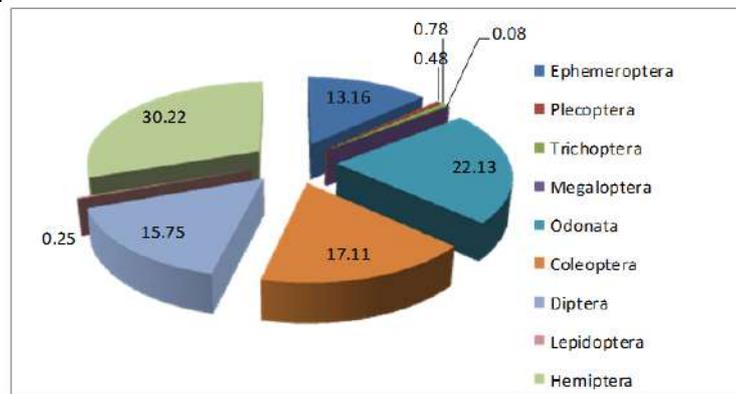
Figure 2. Composition of Aquatic Insect Orders Collected from Kallada River
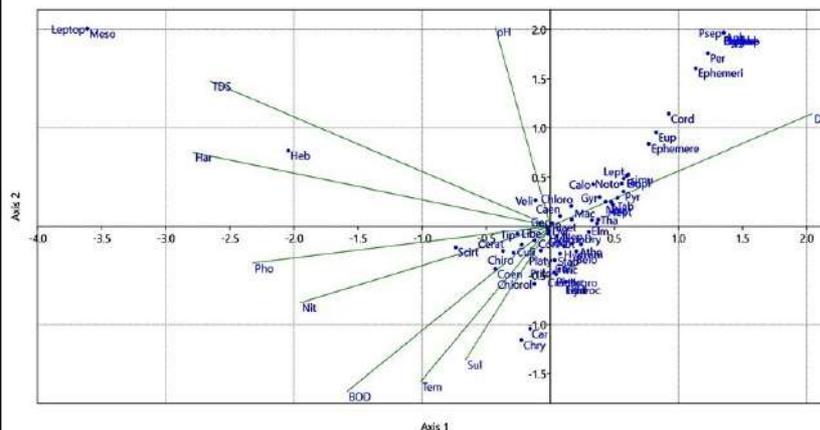
Figure 3 CCA Ordination Biplot Diagram for the Data set Between Aquatic Insect Taxa and Environmental Variables in Kallada River.

Note: Abbreviations of taxa (Baet (Baetidae), Caen (Caenidae), Ephemere (Ephemerellidae), Ephemeri (Ephemeridae), Hept, (Heptageniidae), Iso (Isonychidae), Lept (Leptophlebiidae), Tric (Tricorythidae), Per (Perlidae), Cala (Calamoceratidae), Hydrob (Hydrobiosidae), Hydrop (Hydropsychidae), Lepido (Lepidostomatidae), Lepto (Leptoceridae), Philo (Philopotamidae), Poly (Polycentropodidae), Sten (Stenosychidae), Cory (Corydalidae), Chlorol (Chlorolestidae), Chloro (Chlorocyphidae), Prot (Protoneuridae), Platy (Platystictidae), Gom (Gomphidae), Libe (Libellulidae), Eup (Euphaeidae), Cord (Corduliidae), Platyc Platycnemididae), Coen Coenagrionidae), Calo (Calopterygidae), Mac (Macromidae), Car Carabidae), Chry (Chrysomelidae), Cur (Curculionidae), Dry (Dryopidae), Dyt (Dytiscidae), Elm (Elmidae), Gyr (Gyrinidae), Hydrae (Hydraenidae), Hydroc (Hydrochidae), Hydroph (Hydrophilidae), Hygro (Hygrobiidae), Lam (Lampyridae), Not (Noteridae), Psep (Psephenidae), Ptilo (Ptilodactylidae), Scirt (Scirtidae), Stap (Staphylinidae), Tene (Tenebrionidae), Athe (Athericidae), Cerat (Ceratopogonidae), Chiro (Chironomidae), Culi (Culicidae), Empi (Empididae), Simu (Simulidae), Tab (Tabanidae), Tha (Thaumalidae), Tip (Tipulidae), Cra (Crambidae), Pyr (Pyralidae), Aph (Aphelocheiridae), Belo (Belostomatidae), Cori (Corixidae), Ger (Gerridae), Heb (Hebridae), Hydrom (Hydrometridae), Leptop (Leptopodidae), Meso (Mesoveliidae), Nau (Naucoridae), Nep (Nepidae) and Noto (Notonectidae)

RESEARCH ARTICLE

Electrochemical Analysis of Green Synthesized Nanoparticles

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ABSTRACT

In this study, pure cobalt oxide and copper doped cobalt oxide nanoparticles were bio-synthesized using eclipta alba leaves extract. Electrochemical properties of the prepared nanoparticles were examined using Cyclic Voltametry (CV) and Electrochemical Impedance Spectroscopy (EIS) analysis.

Keywords: Cyclic Voltammetry, Electrochemical Impedance Spectroscopy, Eclipta Alba, Supercapacitors, Cobalt oxide nanoparticles.

INTRODUCTION

Nanomaterials, which show tremendous potential in drug delivery, wastewater treatment, high-energy storage devices, sensors, biological labeling, treatment of cancers, etc., because of their excellent properties, have attracted considerable research interest in recent years. Electrochemical characterization is the most powerful technique used to evaluate the performance of these materials in energy storage applications and as sensors and to understand the relevant reaction mechanisms involved in charge transfer, mass transfer, electrolyte transport, electron transport, etc. Electrochemistry is a broad and interdisciplinary area of research and development activity, concerned with the interrelation of electrical and chemical effects. A considerable aspect of this field is the study of chemical changes caused by the passage of an electric current and the production of electrical energy by chemical reactions, which

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encompass an array of different phenomena (e.g., electrophoresis and corrosion), devices (electrochromic displays, electro analytical sensors, batteries, and fuel cells), and technologies (the electroplating of metals and the large-scale production of aluminum and chlorine) [1].

The demand of renewable energy sources has been increased during recent years due to increasing population, and thus, researchers have great responsibility to find out some sophisticated energy storing devices to overcome the shortage of renewable energy sources [2]. Among this, energy storing device such as the super capacitor is more famous due to its outstanding characteristics including fast charging–discharging rate, efficient power density, outstanding cyclic performance, and excellent charge retention. Supercapacitors are power storage devices that are used in a diverse range of consumer and industrial applications. Supercapacitors can store large amount of charge in their porous electrodes that after discharge is converted both into energy and power. The electrochemical performance of the supercapacitor's electrode is majorly important for highly efficient device. Therefore, for this purpose, Supercapacitors are reviewed for number of electrode materials, including carbon, transition metal oxides and conducting polymers. However, among all three electrode materials, transition metal oxides are most promising materials for supercapacitor. Recently, cobalt oxides are the most studied materials due to their low cost and excellent performance in supercapacitor. To this regard, actual challenging issues concern the devising and optimization of synthetic strategies towards high purity nanomaterials with specific features, opening new frontiers not only for understanding their fundamental properties, but also for developing new generation nano devices with improved performances [3].

Fabrication of An Electrode

An electrochemical cell is used to generate voltage and current from chemical reactions or induce chemical reactions by the input of electrochemical signals. The most commonly used electrochemistry system is the three-electrode system, which consists of a WE (an electrode at which the reaction of interest occurs), an RE, and auxiliary electrode (AE) to examine the electrochemical properties of the pure and copper doped cobalt oxide nanoparticles. For the electrochemical performance, the synthesized nanoparticles were utilized to modify the Glassy Carbon Electrode (GCE) using an oxide slurry coating technique. A bare Glassy Carbon Electrode (GCE) was cleaned and rinsed with double distilled water. The electrode material of Co_3O_4 NPs (1 mg ml^{-1}) was dispersed in an aqueous solution of ethanol to form slurry. The resultant slurry was sonicated for 10 min. Then 20ml of slurry was placed onto the GCE electrode surface using a micropipette. After the solvent was evaporated, the electrode surface was covered with 5ml of Nafion solution and the electrodes were dried at 70°C for 1 h under vacuum to evaporate the solvent [4]. The Co_3O_4 modified working GCE, a saturated calomel electrode (SCE) as the reference electrode, and a Platinum foil acts as the counter electrode and 0.1 M KCl was used as an electrolyte. A schematic illustration of the three-electrode system is shown in Fig. 1.

Working Procedure of Electrochemical Cell

The working electrode makes contact with the analyte as its surface is the place where the reaction occurs. After the working electrode is applied with a certain potential, the transfer of electrons between electrode and analyte starts to take place. The current observed at the electrode will pass through the auxiliary electrode for balance. Inert conducting materials such as platinum and graphite with comparably large surface areas are usually used to make an auxiliary electrode. The reference electrode has a known reduction potential, yet no current passes through it. It only acts as a reference when measuring the working electrode potential. The three common reference electrodes commonly adopted in the three electrode system are the standard hydrogen electrode (SHE), the calomel electrode, and silver/silver chloride electrode [5]. To avoid contamination of the sample solution, the reference electrode can be insulated from the sample reaction via an intermediate bridge. The term "reference electrode," by convention, is the anode and denotes an electrode with potential that is independent of concentration of analyte (or other) ions in solution, and independent of temperature. The ideal auxiliary electrode should be easy to make and to use. It is placed as close as possible to the working electrode to minimize any drop caused by cell resistance (iR). The ideal

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reference electrode provides a stable, known potential so that any change in electrochemical cell is attributed to the analyte's effect on the potential of the indicator electrode [6].

RESULTS AND DISCUSSIONS

Electrochemistry, as a branch of chemistry, studies the charge transfer process at electrode/electrolyte interfaces and has wide applications in battery, catalysis, chemical analysis, sensing, imaging, and corrosion protection. Depending on the charge storage mechanism, electrochemical supercapacitors are classified into two types: (1) Electric Double Layer Capacitors (EDLCs), in which the charges are electrostatically stored through an adsorption/desorption process. (Carbon-based materials are widely used as electrodes due to a very high surface area [7].), (2) pseudocapacitors, in which the charges are stored through Faradic reactions (Oxide-based materials and conducting polymers are used as electrodes [8, 9].). In the case of asymmetric or hybrid supercapacitors (a combination of EDLCs and pseudocapacitors), there has been an increasing trend in using nanomaterials based on various transition metal oxides. This is due to their high pseudocapacitance, which has a higher capacitance performance than normal electric double layer capacitors, lower cost and environmental friendliness [10, 11]. Electrochemical analysis of pure and copper doped cobalt oxide nanoparticles were described in this section.

Cyclic Voltametry

The electrochemical properties of Co_3O_4 and $CuCo_2O_4$ was analyzed using cyclic voltammetry (CV) in a three-electrode system with modified pure Cobalt oxide/copper doped cobalt oxide-glassy carbon electrode was employed as the working electrode, a calamol electrode acted as the reference electrode, a platinum wire as the counter electrode and the supporting electrolyte was 0.1 M KCl. Cyclic voltammetry (CV) was employed over a potential range from +2 to -2 volt at various scan rates 10, 20, 30, 50, 60, 80, 100, 120 and 150 mV/sec. The cyclic voltammograms of the electrochemical experiment is shown in Fig. 2 and Fig. 3 and the plot between scan rate and the specific capacitance was depicted in Fig. 4 and Fig. 5. The specific capacitance of both the nanoparticles can be calculated by Eq. 1 and tabulated in table 1.

$$C_S = \frac{A}{mk\Delta V} \qquad\qquad (1)$$

The observed curves are rectangular in shape with redox and oxidation peaks indicating the pesudocapacitive behavior of the prepared electrode and the capacitance value increases with decrease in scan rate. At higher scan rates, the K+ ions from the electrolyte doesn't have enough time to enter into the inner portion of the Co_3O_4 / $CuCo_2O_4$ electrode material and it is difficult to reach all the available sites which results in surface adsorption. The incomplete redox reaction due to their limited rate of movement in the electrolyte gives lower capacitance. At slower scan rate, the ions have sufficient time for diffusion and occupy not only on the surface, but also all the available site of Co_3O_4 for redox reaction which gives higher specific capacitance [12]

Electrochemical Impedance Spectroscopy

EIS is an excellent technique for investigating electrical properties of a nanomaterial. Nyquist diagrams, over the frequency range of 1Hz to 1MHz for Co_3O_4/ $CuCo_2O_4$ nanoparticle electrode is given in Fig. 6 and Fig. 7. The impedance curves of the prepared electrode show a distorted semi-circular shape in the high-frequency region owing to the porosity of nanoparticles and a vertically linear spike in the low-frequency region. The high-frequency intercept of the semi-circle with the real axis yields the uncompensated resistance (R_s), while the diameter provides the charge-transfer resistance (R_{ct}) of the nanomaterial/electrolyte interface. EIS revealed that in the potential range between +1.0 and −1.0 V, at high frequencies, charge transfer dominates with a semicircle and at low frequencies diffusion of the anion dominates [13]. Size of a semicircle in the high frequency region represents the dominant resistive nature of the supercapacitor system consisting of electrode/electrolyte/current collector. The values of Rs, R_{ct} and C $_{dl}$ determined from the EIS analysis was listed in table 2. Fig. 8 shows a standard Randles equivalent circuit [14]. The Nyquist plot of a pure Co_3O_4 electrode exhibited an almost straight 45° line, arising from the Warburg

impedance and indicating diffusion limited electrochemical process and a well defined semicircle on a high frequency region, arising from the response of R_{ct} and C_{dl}. The R_{ct} of 47384 Ω confirmed that the significant diffusion and the redox reaction was undergoes on the electrode surface. Subsequent modification of the copper doped cobalt oxide nanoparticles resulted in a Warburg impedance at low frequency and a small semicircle at higher frequency. The deposition of layers onto the $CuCo_2O_4$ NPs resulted in significant R_{ct} of 11400 Ω [15].

CONCLUSION

The Co_3O_4 and $CuCo_2O_4$ nanoparticles prepared using bio-synthesis process using eclipta alba leaves extract. The cyclic voltammetry measurements suggested that these electrodes reveal a well specific capacitance of 477 F/g and 822 F/g respectively. The overall experimental result shows that $CuCo_2O_4$ nanoparticles will hopefully be a potential electrode material for high-performance supercapacitors than the Co_3O_4 nanoparticles. From the electrochemical impedance analysis a significant diffusion and the redox reaction were undergoes on the $CuCo_2O_4$ electrode when compared with Co_3O_4 electrode and has an electric double layer capacitance of 7 μF and 19 μF respectively. Thus, from the electrochemical analysis copper doped cobalt oxide nanoparticle can be used as a potential electrode material for electronic applications.

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Table. 1, Scan rate and their specific capacitance for Co_3O_4 and $CuCo_2O_4$ nanoparticles

	Co_3O_4			$CuCo_2O_4$	
S. No	K (mV/s)	C_s (F/g)	S. No	K (mV/s)	C_s (F/g)
1	10	477	1	10	822
2	20	213	2	20	540
3	30	114	3	30	492
4	50	94	4	50	347
5	60	83	5	60	101
6	80	62	6	80	95
7	100	76	7	100	93
8	120	38	8	120	83
9	150	34	9	150	70

Table. 2, Evaluation of parameters for Randles model on Co_3O_4 and $CuCo_2O_4$ electrodes

S. No	Electrode Surface	R_s (Ω)	R_{ct} (Ω)	C_{dl} (pF)
1	Co_3O_4	-310	47384	7
2	$CuCo_2O_4$	417	11400	19
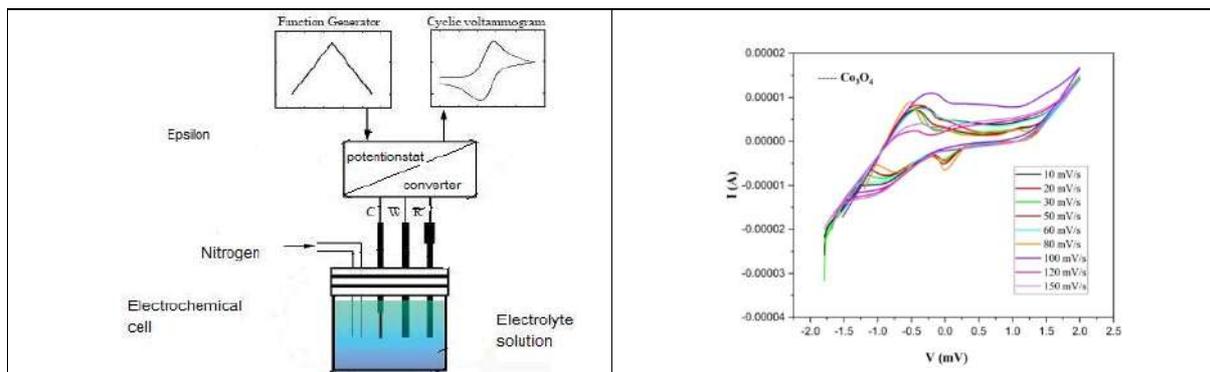
Fig.1 Image of three-electrode system
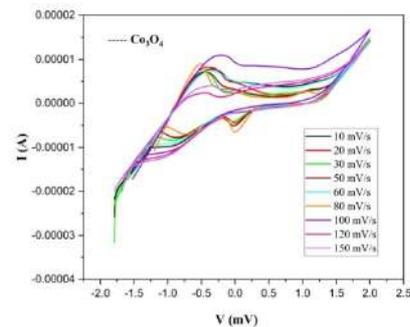
Fig.2 CV for Co_3O_4 nanoparticles
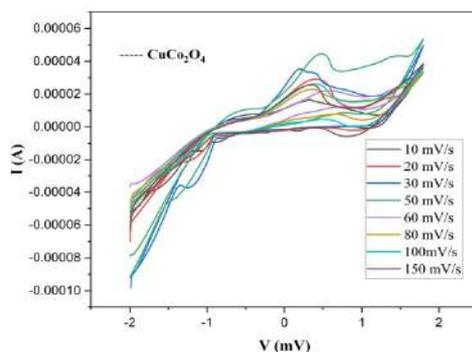
Fig.3 CV for $CuCo_2O_4$ nanoparticles
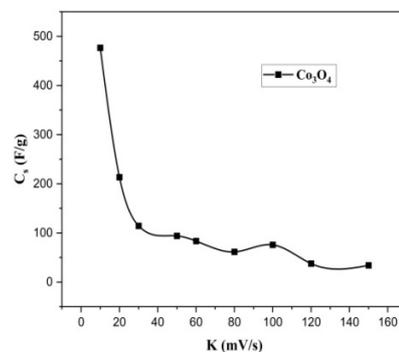
Fig.4 C_s versus K for Co_3O_4 nanoparticles

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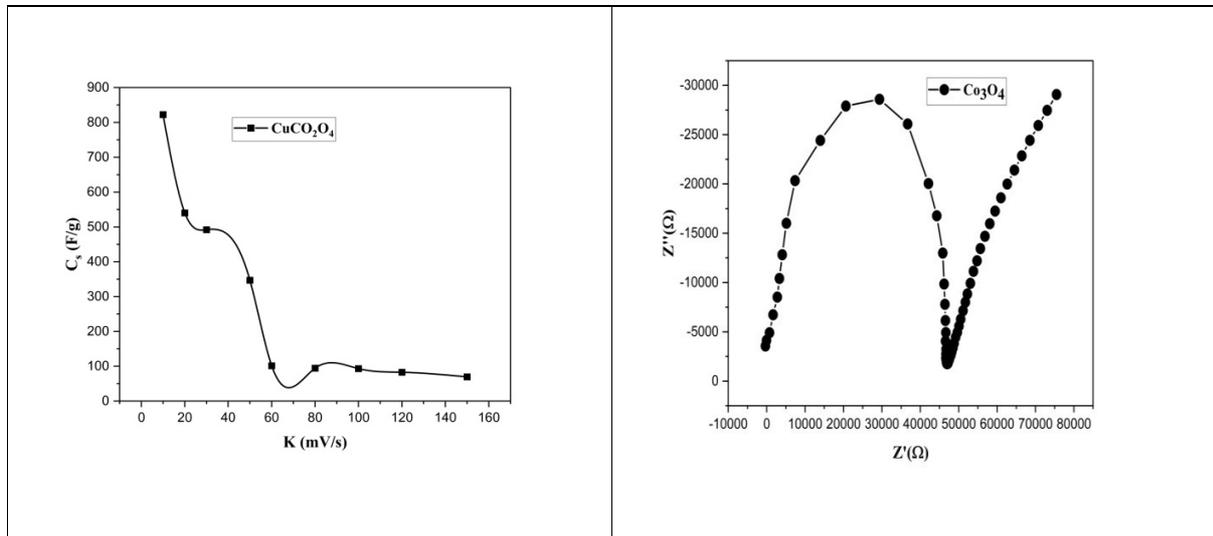
Fig.5 C$_s$ versus K for CuCo$_2$O$_4$ nanoparticles	**Fig.6, Nyquist plot for Co$_3$O$_4$ nanoparticles**
Fig.7, Nyquist plot for CuCo$_2$O$_4$ nanoparticles	**Fig. 8, Randles equivalent circuit**
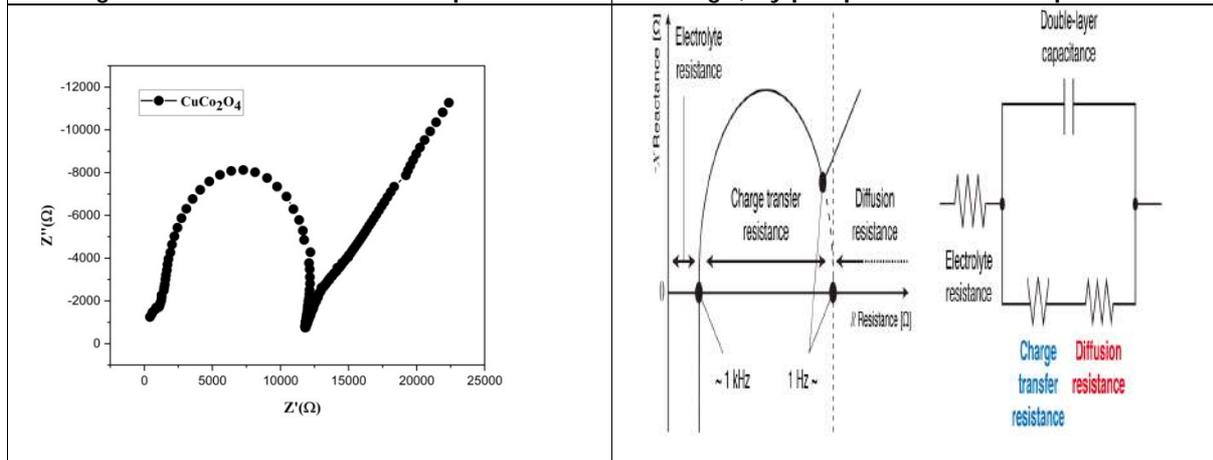
RESEARCH ARTICLE

Secure and Efficient Data Transmission (SET) using Identity-Based Digital Signature (IBS) and Identity-based Online / Offline Digital Signature (IBOOS)

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ABSTRACT

For Cloud Networks (CNs), secure data transmission is a significant concern. Clustering is a realistic and effective approach to improve the performance of CNs' systems. Cluster-based Cloud Networks(CCNs)are introduced here clusters are established dynamically and frequently in order to investigate a safe data transmission method. LEACH-like protocols are difficult to implement since they dynamically, arbitrarily, and on a regular basis reorganise the network's clusters and data links, ensuring stable, long-term node-to-node trust relationships, and common key distributions are sufficient (most existing solutions are provided for distributed CNs, but not for CCNs). To address this issue, two Secure and Efficient Data Transmission (SET) protocols for CCNs were created. SET-IBS and SET-IBOOS are two SET protocols for CCNs suggested in this paper Identity-Based Digital Signature (IBS) and Identity-Based Online/Offline Digital Signature (IBOOS) schemes were used, respectively. Security in SET-IBS is based on the pairing domain difficulty of the Diffie-Hellman issue. SET-IBOOS decreases the computational burden for protocol security, which is critical for CNs, while relying on the discrete logarithm problem's hardness for security. The security requirements of the SET-IBS and SET-IBOOS protocols give better security analysis against potential threats. To demonstrate the efficacy of the recommended protocols,

computations and simulations are provided. In terms of security overhead and energy usage, the suggested protocols outperform existing secure protocols for CCNs, according to the findings.

Keywords: Secure and Efficient Data Transmission (SET), Identity-Based Digital Signature (IBS) scheme and Identity-Based Online/Offline Digital Signature (IBOOS), Cloud Networks (CNs), Cluster-based Cloud Networks (CCNs), and Identity-Based Online/Offline Digital Signature (IBOOS).

INTRODUCTION

A Cloud Network (CN) is a network system that uses wireless sensor nodes to monitor physical or environmental factors such as sound, temperature, and mobility. Individual nodes are capable of sensing their surroundings, processing data locally, and transmitting data to one or more collection sites in a CN. One of the most crucial concerns for CNs is data transfer efficiency. Meanwhile, many CNs are deployed for specific applications, such as military domains and sensing jobs in untrustworthy environments, in harsh, neglected, and often aggressive physical conditions. As a result, secure and efficient data transfer is very important and expected in many actual CNs [1].Researchers have looked into cluster-based data transmission in CNs to achieve network scalability and management, which maximises node lifetime and reduces bandwidth consumption by leveraging local collaboration among sensor nodes. In a cluster-based CN (CCN), each cluster has a cluster head sensor node (CH). The data acquired by the leaf nodes (non-CH sensor nodes) in a cluster is aggregated by a CH and sent to the base station (BS). The Low-Energy Adaptive Clustering Hierarchy (LEACH) methodology is well-known for reducing and balancing total energy consumption in CCNs. LEACH rotates CHs through all sensor nodes in the network in rounds to prevent rapid energy consumption of the set of CHs. LEACH improves a variety of metrics. Following the concept of LEACH, a variety other protocols, such as APTEEN and PEACH, have been proposed that utilise similar concepts to LEACH. For the sake of this research, we refer to cluster-based protocols as LEACH-like protocols [2].

CCNs have been extensively studied in the literature over the last decade. The implementation of the cluster-based architecture in the real world, however, is somewhat difficult. Because LEACH-like protocols dynamically, randomly, and frequently reorganise the network's clusters and data links, adding security to them is difficult. As a result, for LEACH-like protocols, ensuring stable long-term node-to-node trust connections and shared key distributions is insufficient (most existing solutions are provided for distributed CNs, but not for CCNs). SecLEACH, GS-LEACH, and RLEACH [3] are several secure data transfer methods based on LEACH-like protocols. The majority of them, on the other hand, use symmetric key management for security, which suffers from the so-called orphan node problem, which happens when a node in its preloaded key ring does not share a pairwise key with others. The key ring of a node is insufficient to share pairwise symmetric keys with all nodes in a network to reduce the storage cost of symmetric keys. In this circumstance, it is unable to join any cluster and must consequently elect itself as a CH. Furthermore, when the number of alive nodes is having paired keys drops after a lengthy period of network operation, the orphan node problem reduces the likelihood of a node associating with a CH.

Because the number of CHs they elect affects the overall energy spent by the network orphan node problem, increasing the number of CHs increases transmission overhead and system energy consumption. Even if a sensor node has a pairwise key with a far CH but not with a nearby CH, transmitting data to the distant CH consumes a lot of energy. Recently, the possibility of asymmetric key management has been demonstrated in CNs, which compensates for the security deficit caused by using symmetric key management. In asymmetric key management systems, where the binding between the public key and the signer's identification is obtained, digital signature is one of the most important security services provided by cryptography. Based on the difficulties of factoring numbers from identity-based cryptography (IBC), the identity-based digital signature (IBS) system derives an entity's public key from its identification information, such as its name or ID number [4].

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IBS has recently been created as a key management system in CNs for security. Carman was the first to combine the benefits of IBS with crucial predistribution set into CNs, and a few publications have appeared in recent years as a result. To lower the calculation and storage costs of signature processing, the IBOOS technique has been proposed. A method for creating online/offline signature schemes in general. For key management in CNs, the IBOOS scheme could be useful. In particular, the offline phase can be run on a sensor node or at the BS before communication, while the online phase is run during communication. After that, some IBOOS schemes are created for CNs. However, the offline signature in these systems is precomputed by a third party and is not reusable, therefore they are ineffective. As a result, they are unsuitable for CCNs.By combining the IBS and IBOOS, the proposed work created two Secure and Efficient Data Transmission (SET) protocols for CCNs, dubbed SET-IBS and SET-IBOOS. The Diffie-Hellman problem's difficulty in the pairing domain is used to secure SET-IBS. SET-IBOOS minimises the computing complexity of protocol security, which is critical for CNs, while relying on the discrete logarithm problem's hardness for its security. The security requirements and security analysis of the SET-IBS and SET-IBOOS protocols are analyzed clearly.This is how the rest of the paper is organized. In Section 2, we briefly summaries similar studies of secure cloud data. Give a summary of the suggested approach for safe data transfer in cloud networks in Section 3. Section 4, secure data transmission results and discussion Section 5 has the conclusion.

LITERATURE REVIEW

Wei et al. [5] introduced the Secure Cloud (SecCloud) protocol for data security in the cloud, with the goal of discouraging privacy cheating and ensuring secure computation auditing. It's the first protocol to consider linking secure storage and secure computation auditing in the cloud, as well as preventing privacy cheating through designated verifier signatures, batch verification, and probabilistic sampling approaches. Different users' requests can be handled concurrently through batch verification to improve efficiency. The goal of the study is to find the best sampling size for the least amount of money. Another significant contribution is the creation of a viable secure-aware cloud computing experimental environment, such as the Secure Hadoop Distributed File System (SecHDFS) as a test bed for SecCloud implementation. It is demonstrated that the suggested protocol is effective and efficient for creating secure cloud computing by detailed security analysis and performance simulation in developed SecHDFS. More testing findings have shown that the proposed SecCloud is effective and efficient. In future work, pay special attention to the above computation's privacy considerations.

Shin and Kim [6] suggested a for cloud storage services differentially private client-side deduplication algorithm. First, analyse the prior methods' security flaws, which are based on a randomised methodology. Second, provide a storage gateway-based solution that provides network efficiency and flexibility while ensuring robust security. Third, examine its effectiveness through trials and analyse its security using the definition of differential privacy. A storage gateway enables effective data deduplication while also lowering the danger of data leakage. According to the notion of differential privacy, its security can be strongly assured. Experiments should also be used to assess the suggested protocol's effectiveness and efficiency.

Miao et al [7] offer a threshold blind signature-based deduplication strategy for Storage Cloud Service Providers (S-CSPs) and Key Cloud Service Providers (K-CSPs), which effectively resists collusion attacks between cloud servers and numerous key servers. Furthermore, incomplete key servers are unable to learn the distributed secret key shared by all key servers. The suggested method is secure in terms of the proposed security model, and it can withstand brute force attacks even if a small number of key servers are compromised, according to the security analysis. Demonstrate that the construction can provide the requisite security features as well.

Liu et al [8] developed Time-based Proxy Re-Encryption (TimePRE) For safe data exchange in the cloud,. It allows a user's access right to expire after a certain amount of time has passed. In this instance, the data owner may be offline while revocations are being processed. The main idea is to use a mix of Attribute Based Encryption (ABE) and PRE to add the concept of time. Each data item is connected with an attribute-based access structure and an access time, and each user is recognised by a set of characteristics and a set of eligible time periods that represent the user's access right's validity duration. The data owner and the CSP must then disclose a root secret key ahead of time; so that the

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CSP can automatically update the data's access time with the moment it gets a data access request. As a result, only users whose attributes satisfy the access structure and whose access privileges are effective in the access period can recover relevant data using the re-encrypted ciphertext. The fundamental flaw in the suggested approach is that it needs all attributes connected with a person to have the same effective time periods. Despite the potential for improvement, consumers will be given more UAKs. Future work will allow varying effective time periods for different attributes linked with a user, without increasing the amount of UAKs connected with each user, to alleviate this problem.

Lu and Li [9] presented a Certificate-Based Proxy Re-Encryption (CB-PRE) for safe data exchange in public clouds. In the random oracle model, the proposed technique is shown secure under the computational DiffieHellman assumption. The proposed approach considerably reduces the calculation cost by removing the time-consuming bilinear pairing processes. It has a clear benefit in computation efficiency over prior CB-PRE systems with bilinear pairings, making it more suitable for computation-limited or power-constrained devices. This excellent quality makes it particularly well suited for use in computation-constrained or power-constrained devices.

Xu et al [10] developed CertificateLess Proxy Re-Encryption (CLPRE)for safe data sharing with public clouds. CLPRE, a data owner, encrypts shared data in the cloud with an encryption key, which is then encrypted and changed by the cloud before being delivered to legitimate receivers according to access control. The cloud-based transformation is unique in that it uses re-encryption keys produced from the data owner's private key and the public keys of receipts, eliminating the key escrow problem and the necessity for a certificate in identity-based cryptography. CLPRE uses maximum cloud resources to lower the processing and connectivity costs for the data owner while preserving data and key privacy from semi-trusted cloud. In order to run a proxy in a public cloud environment, multi-proxy CLPRE and randomisedCLPRE are proposed, both of which improve security. In order to run proxy in a public cloud environment, multi-proxy CLPRE and randomisedCLPRE are proposed, which improve the security and robustness of CLPRE. Also, test and assess all CLPRE schemes for security and performance.

PROPOSED METHODOLOGY

IBS has recently been created as a key management system in CNs for security. Carman was the first to combine the benefits of IBS and key pre distribution set into CNs, and some publications published in IBOOS scheme to reduce signature processing computation and storage costs. The IBOOS scheme could be useful for key management in CNs because it introduces a general approach for establishing online/offline signature schemes. The offline phase can be performed on a sensor node or at the BS prior to communication, whereas the online phase should be performed during communication.The proposed work uses the IBS and IBOOS schemes to provide two secure and efficient data transmission protocols for CCNs, dubbed SET-IBS and SET-IBOOS, respectively. Both SET-IBS and SET-IBOOS are based on the idea of authenticating encrypted sensed data by using digital signatures on message packets for efficient transmission and key management for security. The BS distributes and preloads secret keys and pairing parameters in all sensor nodes in the proposed protocols, overcoming the key escrow problem outlined in ID-based cryptosystems.

In SET-IBS, secure communication is built on ID-based cryptography, in which the user's public keys serve as their ID information. As a result, users can receive the necessary private keys without the need for additional data transmission, which improves communication efficiency and saves energy.SET-IBOOS is a proposal to reduce the computational overhead for security utilizing the IBOOS scheme, which depends on the discrete logarithmic problem's hardness for security. Both SET-IBS and SET-IBOOS use symmetric key management to tackle the orphan node problem in secure data transfer.The feasibility of proposed protocols is measured with respect to the security requirements and analysis against three attack models. Moreover, compare the proposed protocols with the existing secure protocols for efficiency by calculations and simulations, respectively, with respect to both computation and communication. Figure 1 shows the data flow diagram of proposed IBOOS scheme.

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Steps of the Proposed System
- Server Client Module
- Network Security
- Attack Models
- Protocol characteristics
- Secure Data Transmission

Server Client Module
Client-server computing, often known as networking, is a distributed application architecture in which duties or workloads are divided between service providers (servers) and service requesters (clients). Clients and servers frequently use separate hardware to communicate over a computer network. A server machine is a powerful host that runs one or more server programmes that share resources with clients. Clients also share any of their resources; as a result, clients establish communication sessions with servers, which wait for (listen to) incoming requests.

Network Security
As the identification of attackers is not generally accessed for lawful purposes, network-accessible resources may be put in a network as surveillance and early-warning systems. During and after an assault, the attackers' strategies for attempting to compromise these decoy resources are investigated to keep a watch on novel exploitation approaches. This type of research could be used to improve the security of the actual network that the data is protecting [11,12].

Data forwarding can also be used to divert an attacker's focus away from genuine servers. A user encourages attackers to divert their attention away from the real server's data by encouraging them to spend time and energy on the decoy server. A user, like a server, is a network that has been set up with purposeful flaws. Its objective is also to attract attacks in order to study the attacker's methods and use the information to improve network security [13].

Attack Models
Assign attack models to one of three categories based on their attacking methods, and then investigate how these attacks might affect the proposed protocols

Passive attack on wireless channel
The passive attack on wireless channel is discussed as follows,
- **Passive assault on wireless channel:** Passive attackers can eavesdrop on any point of the network, or even the entire network's communication. As a result, based on the monitored oreaves lost messages, they can do traffic analysis or statistical analysis.
- **Active wireless channel attack:** Active attackers have more power than passive adversaries who can tamper with wireless channels. As a result, the attackers have the ability to fabricate, reply, and change messages. Various sorts of active assaults, such as false and replayed routing information attacks, sinkhole and wormhole attacks, can be launched by attackers, particularly in CNs
- **Node compromising attack:** As far as we can tell, node compromising attackers are the strongest opponents of the proposed protocols. Physically compromising sensor nodes allows attackers to gain access to the private information contained in the compromised nodes, such as security keys. The attackers can also alter the internal state and behaviour of the compromised sensor node, causing it to behave in ways that differ from the standard protocol requirements.

Protocol Characteristics
This section covers protocol features and hierarchical clustering solutions. To begin, consider the following characteristics of the proposed SET-IBS and SET-IBOOS protocols:
- **Key management:** The symmetric and asymmetric key cryptographies employed in the protocol to achieve safe data transmission.

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- **Neighborhood authentication:** By authenticating with each other, it is possible to gain safe access and data transfer to nearby sensor nodes. "Limited" refers to the likelihood of neighbourhood authentication, in which only nodes that share a pairwise key can authenticate one another.
- **Storage cost:** Represents the requirement of the security keys stored in sensor node's memory.
- **Network scalability:** Determines whether or not a security protocol can scale without jeopardising security. When compared to SET-IBS and SET-IBOOS, "comparatively low" means that in secure data transmission with symmetric key management, the higher the network scale, the more orphan nodes exist in the network, and vice versa.
- **Communication overhead:** The security overhead in the data packets during communication.
- **Computational overhead:** The cost of energy and the efficiency of computation in the development and verification of security certificates or signatures. t and computation efficiency on the generation and verification of the certificates or signatures for security.
- **Attack resilience:** the different forms of attacks that a security protocol can defend against.

Secure Data Transmission

In large-scale CCNs, multihop data transmission is usedfor transmission between the CHs to the BS, where the direct communication is not possible due to the distanceor obstacles between them [13,14]. The version of the proposed SET-IBS and SET-IBOOS protocols for CCNs can be extended using multihop routing algorithms, to form secure data transmission protocols for hierarchical clusters. The solutions to this extension could be achieved by applying the following two routing models:

- The multihop planar model. A CH node transmits data to the BS by forwarding its data to its neighbor nodes, in turn the data are sent to the BS. An energy-efficient routing algorithm for hierarchically clustered CNs in suitable for the proposed secure data transmission protocols.
- The cluster-based hierarchical method. The network is broken into clustered layers and the data packages travel from a lower cluster head to a higher one, in turn to the BS.
- Both the proposed SET-IBS and SET-IBOOS protocols provide secure data transmission for CCNs with concrete ID-based settings, which use ID information and digital signature for authentication. Thus, both SET-IBS and SET-IBOOS fully solve the stray-node problem from using the symmetric key management for CCNs.
- The proposed secure data transmission protocols are with concrete ID-based settings, which use ID information and digital signature for verification.

RESULTS AND DISCUSSION

With symmetric radio channels, all sensor nodes and the BS are time synchronised, nodes are spread randomly, and their energy is restricted. Sensor nodes in CCNs use energy for data sensing, processing, and transmission. Data transmission is significantly more expensive than data processing. As a result, the approach in which an intermediary node (CH) combines data and provides it to the BS is preferable to the technique in which each sensor node sends data directly to the BS. Depending on the Time-Division Multiple Access (TDMA) control used for data transmission, a sensor node goes into sleep mode to save energy when it doesn't sense or data transmission.The following procedures make up an IBS scheme for CCNs: setup at the BS, key extraction and signature signing at the data sending nodes, and verification at the data receiving nodes:

- **Setup**. The BS (as a trust authority) generates amaster key msk and public parameters param for the private key generator (PKG), and gives them to allsensor nodes.
- **Extraction.** A sensor node uses msk to produce a private key sekID associated with an ID string.
- **Signing signatures.** The sending node constructs a signature SIG from a message M, a time stamp t, and a signing key.
- **Verification.** The receiving node outputs "accept" if SIG is genuine, and "reject" otherwise, given the ID, M, and SIG.

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The figure 2 and figure 3 shows the input design and output design in CCNs for secure data storage in Cloud computing.

SYSTEM TESTING

Testing is a process of checking whether the developed system is working according to the original objectives and requirements. It is a set of activities that can be planned in advance and conducted systematically. A small system error can conceivably explode into a much larger Problem. Effective testing early in the purpose translates directly into long term cost savings from a reduced number of errors. Another reason for system testing is its utility, as a user-oriented vehicle before implementation. The best programs are worthless if it produces the correct outputs.

UNIT TESTING

A program represents the logical elements of a system. For a program to run satisfactorily, it must compile and test data correctly and tie in properly with other programs. Achieving an error free program is the responsibility of the programmer. Program testing checks for two types of errors: syntax and logical. Syntax error is a program statement that violates one or more rules of the language in which it is written. An improperly defined field dimension or omitted keywords are common syntax errors. These errors are shown through error message generated by the computer. For Logic errors the programmer must examine the output carefully.

FUNCTIONAL TESTING

Functional testing of an application is used to prove the application delivers correct results, using enough inputs to give an adequate level of confidence that will work correctly for all sets of inputs. The functional testing will need to prove that the application works for each client type and that personalization function work correctly. When a program is tested, the actual output is compared with the expected output. When there is a discrepancy the sequence of instructions must be traced to determine the problem. The process is facilitated by breaking the program into self-contained portions, each of which can be checked at certain key points. The idea is to compare program values against desk-calculated values to isolate the problems.

CONCLUSION AND FUTURE WORK

First, we looked at the concerns with data transfer and security in CCNs. The shortcomings of symmetric key management for safe data transmission have been examined, and two secure and efficient data transmission protocols for CCNs, SET-IBS and SET-IBOOS, have been described. In the assessment part, we discussed the viability of the proposed SET-IBS and SET-IBOOS in terms of security needs and routing attack analysis. SET-IBS and SET-IBOOS are efficient in communication and application of the ID-based cryptosystem, which meets security criteria in CCNs and solves the orphan node problem in secure transmission protocols using symmetric key management. Finally, the comparison of computation and simulation results reveals that the proposed SET-IBS and SET-IBOOS protocols outperform existing secure CCN protocols.In terms of both computation and communication costs, it was also mentioned that for safe data transfer in CCNs, employing SET-IBOOS with reduced auxiliary secure data transmission in CCNs.In future work,will improve the data deduplication ratio in particular node through means of the help of cache containerof CCNs.

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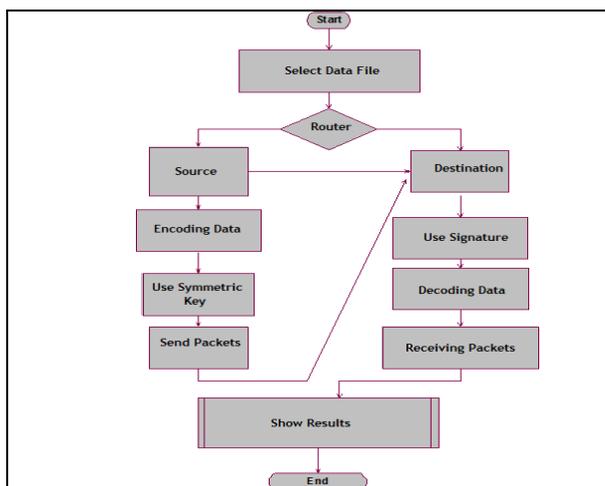
Figure 1. Dataflow Diagram of IBOOS Scheme
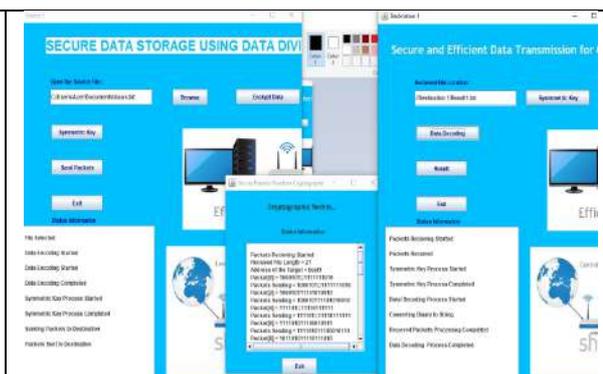
Figure 2. Input Design of Secure Data Storage in Cluster Based Cloud Network (CCNs)

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Figure 3. Output Design of Secure Data Storage in Cluster Based Cloud Network (CCNs)

Figure 4. System Testing Design of Secure Data Storage in CCNs

Figure 5. Unit Testing Design of Secure Data Storage in CCNs

Figure 6. Functional Testing Design of secure Data Storage in CCNs

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RESEARCH ARTICLE

Some Characterizations on Moore – Penrose Inverse of Symmetric Neutrosophic Fuzzy Matrices

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ABSTRACT

This paper analyses a various g – inverse of neutrosophic fuzzy Matrices, L-R cancelable NFMs and drive the equivalent conditions for the existence of the generalized inverse. We describe the relation between the minus–ordering and the different g – an inverse of neutrosophic fuzzy matrices and we above explain that the characterizations symmetric NFM, it is exposed symmetric NFMs possess symmetric Moore – Penrose inverse.

Keywords: Neutrosophic Fuzzy Matrices (NFM), generalized inverse (g – inverse),minus ordering, Symmetric Fuzzy Matrices.

INTRODUCTION

The concept of fuzzy sets was introduced by Zadeh L.A [9] in 1965. "The fuzzy matrices were introduced by Thomason M.G [8] and he determined the convergence of power of fuzzy matrix. Atanassov K.T [1] introduced the approach of intuitionistic fuzzy sets as an expansion to the theory of ordering fuzzy sets by choice to any element in the nature not only a membership degree but also non – membership. Meenakshi AR and Inbam C [4] studied the minus ordering for fuzzy matrices and demonstrated that the minus ordering is a partial ordering in the set of each regular fuzzy matrices. Bhowmik M and Pal M [2] introduced some results on intuitionistic fuzzy matricesand Cen [3] introduced T –ordering in fuzzy matrices and relationship between the T – ordering and Sriram S and Murugadsa

P [6] explicate the minus ordering for Moore Penrose inverse of Intuitionistic fuzzy matrices and Florention Smarandache [7] introduced the concept of neutrosophic set which handles the problems as $T_{Q(s)}$ – truth membership , $I_{Q(s)}$ – Indeterminate membership and $F_{Q(s)}$ – falsity membership are independent.

Definition 1.1 [9] Consider a matrix Q = $(q_{ij})_{s \times t}$, where $q_{ij} \in [0,1], 1 \le i \le s$ and $1 \le j \le t$. Then Q is called fuzzy matrix.

Definition 1.2 [7]A neutrosophic matrix Q of order s × t is defined as Q = $\{x, T_{q(x)}, I_{q(x)}, F_{q(x)}\}$, where T,I,F are called truth – membership, indeterminacy – membership and falsity – membership values of the i, j^{th} element in Q satisfying the condition $0 \le T_{q(x)}, I_{q(x)}, F_{q(x)} \le 3$ for all (i,j).

Example 1.3 Assume that the reality of conversation Q = { q_1 , q_2, q_3 } where q_1, q_2 and q_3 define the rate , trustworthiness and price tag of the tag objects . It may be beyond our assumption that the values of { q_1 , q_2, q_3 } are in [0, 1] and they are obtained from some analysis of some authorities . The authorities may establish their opinion in three components viz. The degree of quality, the degree of indeterminacy and degree of poorness to define the attribute of the objects. Suppose A is a neutrosophic set (NS) of Q such that ,
A = {(q_1, 0.21,0.5,0.8),(q_2, 0.71,0.82,0.4),(q_3, 0.4,0.1,0.35)} where for q_1 the degree of quality is 0.21 , q_2 the degree of indeterminacy is 0.5 and$q_1$the degree of falsity is 0.8 etc.

Definition 1.4[6]Let U be the universalset and E be a set of parameter.Consider a non – empty set A ,A $\subset E$and let N(U) denote the set of all fuzzy neutrosophic set of U. The collection (R,A) is termed to be the fuzzy neutrosophic matrix over U, where R is mapping form R : A → N(U). Here after consider A as fuzzy neutrosophic matrix over U instead of (R, A).

Definition 1.5[6] Let U = { $d_1, d_2, d_3, \dots \dots d_m$ } be the universal set and E be the parameter set given asE = { $e_1, e_2, e_3, \dots \dots e_m$ }.Let A $\subset$ E a pair (P,A) be a Fuzzy neutrosophic matrix over U.Then the subset of U × E is defined by S_A = {$(v, e): e \in A, v \in F_A(e)$} which is called a relation form of {F_A, E }. The membership function , indeterminacy membership function and non – membership function are written by $T_{Q(A)}: U \times E \to [0,1]I_{Q(A)}: U \times E \to [0,1]$ and $F_{Q(A)}: U \times E \to [0,1]$where$T_{Q(A)}(u, e) \in [0,1], I_{Q(A)}(u, e) \in [0,1]$ and $F_{Q(A)}(u, e) \in [0,1]$ are the membership value , Indeterminacy value and non-membership value respectively of u ∈ U for any e ∈ E.

Definition 1.6 [6]Let P and q be two components of a NM such that P = $(P_{ij}^T, P_{ij}^I, P_{ij}^F)$, Q=$(q_{ij}^T, q_{ij}^I q_{ij}^F)$.The component wise addition and multiplication is defined as

$P + Q = (\max\{p_{ij}^T, q_{ij}^T\}, \max\{p_{ij}^I, q_{ij}^I\}, \min\{p_{ij}^F, q_{ij}^F\})$

$P . Q = (\min\{p_{ij}^T, q_{ij}^T\}, \min\{p_{ij}^I, q_{ij}^I\}, \max\{p_{ij}^F, q_{ij}^F\})$

Definition 1.7[6] Let P∈ $F_{m \times p}$ and Q ∈ $N_{m \times n}$ the composition P and Q defined as ,

$$P \circ Q = \sum_{s=1}^{n} (p_{is}^T \bigwedge q_{is}^T), \sum_{s=1}^{n} (p_{is}^I \bigwedge q_{is}^I), \prod_{s=1}^{n} (p_{is}^F \bigvee q_{is}^F)$$

The product $P \circ Q$ is defined if and if the number of columns of P is same as the number of rows of Q . P and Q are said to be conformable for multiplication. We can write PQ instead of $P \circ Q$. $Where \sum (p_{is}^T \wedge q_{is}^T)$ means max – min operations and $\prod (p_{is}^F \vee q_{is}^F)$ means min – max operations.

Definition 1.8[7] In a neutrosophic fuzzy matrix if all entries are Zero then it is called Null Neutrosophic fuzzy matrix. That is all elements are in the form $(0, 0, 1)$.

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Definition 1.9[7] A square neutrosophic fuzzy matrix is said to be unit Neutrosophic fuzzy matrix if q_{ii} = $(1,1,0)$ and $q_{ij} = (0,0,1)$, $i \neq j$ for $i = j$. It is denoted by 1.

Definition 1.10[6] The matrix P ∈ $F_{s \times t}$ is said to be regular if there exists Q ∈ $N_{t \times s}$ such that PQP = P. Then P has a g – inverse is denoted as P^-.

Definition 1.11[6] For the neutrosophic fuzzy matrices P and Q of order $s \times t$, minus ordering is defined as $P \leq^- Q$ if only if $PP^- = PQ^-$ and $PP^- = QP^-$ for some $P^- \in A\{1\}$.

Definition 1.12[6] Let $P, Q \in N_{s \times t}$ Neutrosophic Fuzzy Matrices the T – ordering of P and Q is defined as $P \leq^T Q \iff P^T P = P^T Q$ and $PP^T = QP^T$.

Remarks 1 Let P,Q ∈ $F_{s \times t}$ the following conditions are equivalent",
i) $P \leq^- Q$
ii) $P = PP^- Q = QPQ^-$

2.Some Properties of minus ordering

In this section, wediscuss the different g – inverses of NFMs, the left and right cancelable NFMs."Also, we define the presence of g – inverse and relation between the minus – ordering and the Moore – Penrose (MP) inverse.

Definition 2.1 Let P and Q be two components of a NM such that $P = (P_{ij}^T, P_{ij}^I, P_{ij}^F)$,$Q = (q_{ij}^T, q_{ij}^I q_{ij}^F)$.Then component wise addition and multiplication is defined as

$$P \circ Q = \left(\prod_{s=1}^{n} (p_{is}^T \bigvee q_{is}^T) \ \prod_{s=1}^{n} (p_{is}^I \bigvee q_{is}^I) \ \sum_{s=1}^{n} (p_{is}^F \bigwedge q_{is}^F) \right)$$

Definition 2.2[2] Semi – inverse :A NFM 'P' of order $s \times t$ and Q of order $t \times s$ is said to be, $\{1,2\}$ inverse or semi inverse of P, if PQP = P and QPQ = Q.
Least Square g – inverse: A NFM 'P' of order $s \times t$ and Q of order $t \times s$ is said to be, $\{1,3\}$ inverse or a least square g – inverse of P, if PQP =P and $(PQ)^T = PQ$.
Minimum norm - inverse: A NFM 'P' of order $s \times t$ and Q of order $t \times s$ is said to be, $\{1,4\}$ – inverse or minimum norm g - inverse of P, if PQP =P and $(QP)^T = QP$.
Moore – Penrose inverse :A NFM 'P' of order $s \times t$ and Q of order $t \times s$ is said to be, Moore - Penrose inverse of P, if PQP =P, QPQ = Q and $(PQ)^T = PQ$ and $(QP)^T = QP$.The Moore – Penrose inverse of P denoted by $P^†$.

Definition 2.3[2] If $P(\delta)$denotes is the set of all δ – inverses of P, where δ is a subset ofA$\{1,2,3,4\}$.

Definition 2.4[2] For an $P \in N_{s \times t}$, P is called left (right) cancelable if $P^T P Y_1 = P^T P Y_2 (Y_1 PP^T = Y_2 PP^T) \Rightarrow PY_1 = PY_2 (Y_1 P = Y_2 P)$for any $Y_1, Y_2 \in N_{s \times t}$.
P is called cancel able if it is both left and right cancelable.

Theorem 2.5 For any Neutrosophic Fuzzy Matrix (NFM) Q of order $s \times t$ the following statements are equivalent
i) $Q\{1,3\} \neq \emptyset$.
ii) The Neutrosophic Fuzzy relation equation $YQ^T Q = Q$ has solutions.
iii) Q is left cancelable and $Q^T Q\{1\} \neq \emptyset$.

Proof

$(i)\ implies\ (ii)$

For R $\in Q\{1,3\}$, then

$Q = QRQ = (QR)^T Q = R^T Q^T Q$

Thus , R^T, is a solution of $Q = YQ^T Q$

$(\ ii\ )\ implies$ (iii)

Let R be a solution of $YQ^T Q = Q$

Then, $RQ^T Q = Q$

For $Y_1, Y_2 \in F_{s \times t}$

If $Q^T QY_1 = Q^T QY_2$, then

$QY_1 = RQ^T QY_1 = RQ^T QY_2 = QY_2$

Here, Q is left cancelable and

$Q^T Q = (RQ^T Q)^T RQ^T Q = Q^T QR^T RQ^T Q$

$\Rightarrow R^T R \in Q^T Q\{\ 1\}$

$Q^T Q\{\ 1\} \neq \emptyset$

(iii) $\Rightarrow$ (ii) Let $Y_1 \in Q^T Q\{\ 1\}$

$\Rightarrow Q^T QY_1 Q^T Q = Q^T Q$

$\Rightarrow QY_1 Q^T Q = Q$ by definition 2.3

QY_1 is a solution of

$YQ^T Q = Q$

(ii) $implies$ (i)

Let R^T be a solution of $RQ^T Q = Q$

$\Rightarrow R^T Q^T Q = Q$

$Q = R^T Q^T Q = (QR)^T Q = QRQ$

Since, $(QR)^T = (R^T Q^T QR)^T = R^T Q^T QR = QR$

Thus , $(QR)^T = QR\ and\ Q = QRQ$

$\Rightarrow R \in Q\{\ 1,3\ \}and\ Q\ \{\ 1,3\ \} \neq \emptyset.$

Example 2.6

Let $Q = \begin{bmatrix} (1,0,0) & (0,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix}$ then , T $= \begin{bmatrix} (1,0,0) & (1,0,0) \\ (1,0,0) & (0,0,0) \end{bmatrix}$

$QT = \begin{bmatrix} (1,0,0) & (1,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix}$,$QTQ = \begin{bmatrix} (1,0,0) & (0,0,0) \\ (0,0,0) & (0,0,0) \end{bmatrix}$

Satisfies QTQ = Q , $(QT)^T = QT\ and\ TQ^T Q = Q.$

Therefore, $Q\ \{\ 1,3\ \} \neq \emptyset \Rightarrow$ there exist a solution $TQ^T Q = Q.$

Theorem 2.7 For any $Q \in F_{s \times t}$ the following statements are equivalent,

(i) $Q\{1,4\} \neq \emptyset$

(ii) The Neutrosophic fuzzy relation equation $QQ^T Z = Q$ has solutions.

(iii) Q is right cancelable and $Q^T Q\{1\} \neq \emptyset$.

Proof

This solution is similar to the solution of theorem 2.5.," because $Q\{1,3\} \neq \emptyset$ if and only if $Q^T\{1,4\} \neq \emptyset$.

Example 2.8 If $Q = \begin{bmatrix} (1,0,0) & (0,1,1) \\ (0,1,1) & (1,0,0) \end{bmatrix}$

Then Q = Y itself is a g – inverse satisfying $QTQ = Q$, $(YQ)^T = YQ$.

Theorem 2.9 Let $Q, R \in F_{s \times t}$, $Q \leq^- R$. If $R^\dagger$ exist, Q is cancelable and $Q \in R\{2\}$ then $Q^\dagger$ exists and $Q^\dagger = (R^\dagger)^T Q (R^\dagger)^T$.

Proof

Given, $Q \leq^- R \Rightarrow Q^- Q = Q^- R$ and $QQ^- = RQ^-$.

Also, $Q = QQ^- R = RQ^- Q$.

Now, $QR^\dagger Q = (QQ^- R)R^\dagger(RQ^- Q)$

$= QQ^-(RR^\dagger R)Q^- Q = QQ^- RQ^- Q = (QQ^- R)Q^- Q = Q^- Q = Q$

This shows that $R^\dagger \in Q_{s \times t}$

Let, $y_1, y_2 \in F_{s \times t}$

For, $Q^- Q y_1 = Q^- Q y_2$

$Q y_1 = QQ^- R y_1 = QQ^- Q y_1 = QQ^- Q y_2 = Q y_2$

Therefore, $Q^- Q y_1 = Q^- Q y_2 \Rightarrow Q y_1 = Q y_2$

Take, $y_1 = QQ^-, y_2 = R^\dagger R$

We have $QQ^- = Q^- R$

$Q^- QQ^- Q = Q^- RR^\dagger R$

$= Q^- QR^\dagger R$

$\Rightarrow QQ^- Q = QR^\dagger R$

$\Rightarrow Q = QR^\dagger R$

Similarly, $Q = R^\dagger RQ$

Consider, $QR^\dagger = RR^\dagger QR^\dagger = R(R^\dagger QR^\dagger) = RR^\dagger$

$= (RR^\dagger)^T$

$= (RR^\dagger QR^\dagger)^T$

$= ((RR^\dagger Q)R^\dagger)^T = (QR^\dagger)^T$

Similarly we can prove $R^\dagger Q = (R^\dagger Q)^T$

Therefore, $R^\dagger \in Q\{1,2,3\}$

Hence by theorem 2.5, 2.6 we conclude that $Q^\dagger$ exist and $Q^\dagger = (R^\dagger)^T Q (R^\dagger)^T$

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Theorem 2.10 Let $Q, R \in F_{s \times t}$ and $Q^{\dagger}$ exist, then the following are equivalent.
(i) $Q \leq^{-} R$
(ii) $Q^{\dagger}Q = Q^{\dagger}R \ and \ QQ^{\dagger} = RQ^{\dagger}$
(iii)$QQ^{\dagger}R = Q = RQ^{\dagger}Q$

Proof
This proof is clear cut from property by 1 replacing $Q^{-} \ by \ Q^{\dagger}$.

Corollary 2.11 If $Q \leq^{-} R$ and $Q^{\dagger}$ exists , then $R \in Q^{\dagger}\{1\}$

Proof
$Q^{\dagger}$ exist $\Rightarrow Q^{\dagger} = Q^{\dagger}Q = Q^{\dagger}RQ^{\dagger} \Rightarrow R \in Q^{\dagger}\{1\}$

Theorem 2.12 Let $Q, R \in F_{s \times t}$. If $Q^{\dagger}$ and $R^{\dagger}$ both exist and $Q \in R\{2\}$ then the following conditions are equivalent.
(i) $Q \leq^{-} R$
(ii) $Q^{\dagger}Q = R^{\dagger}Q \ and \ QQ^{\dagger} = QR^{\dagger}$
(iii)$R^{\dagger}QQ^{\dagger} = Q^{\dagger} = Q^{\dagger}QR^{\dagger}$
(iv)$Q^{T}QR^{\dagger} = Q^{T} = Q^{T}RQ^{\dagger}$

Proof
This solution is similar to the solution of theorem 2.10.

Theorem 2.13 If $Q \in F_{s \times t}$ and $Q^{\dagger}$ exist, then we have,
(i) $(QQ^{T})^{\dagger}$, $(Q^{T}Q)^{\dagger}$ are also exist and $(QQ^{T})^{\dagger}=(Q^{\dagger})^{T}Q^{\dagger}$,$(Q^{T}Q)^{\dagger}=Q^{\dagger}(Q^{\dagger})^{T}$.
(ii) $(QQ^{\dagger})^{\dagger}$,$(Q^{\dagger}Q)^{\dagger}$ are also exist and $(QQ^{\dagger})^{\dagger}=QQ^{\dagger}$,$(Q^{\dagger}Q)^{\dagger}=Q^{\dagger}Q$.

Proof
$QQ^{T} = QQ^{\dagger}QQ^{T}=(Q^{\dagger})^{T}Q^{T}QQ^{T}$

$= (Q^{\dagger})^{T}(QQ^{\dagger}Q)^{T}QQ^{T} = (Q^{\dagger})^{T}Q^{\dagger}QQ^{T} \ QQ^{T}$

$\Rightarrow (Q^{\dagger})^{T}Q^{\dagger}$ is solution of $QQ^{T} = YQQ^{T}QQ^{T}$

Therefore, $(Q^{\dagger})^{T}Q^{\dagger} \in QQ^{T}\{1,3\}$

Since , QQ^{T} is symmetric

$(Q^{\dagger})^{T}Q^{\dagger} \in QQ^{T}\{1,4\}$

By theorem 2.5 and 2.6

$(QQ^{T})^{\dagger}$ exist and

$(QQ^{T})^{\dagger} = ((Q^{\dagger})^{T}Q^{\dagger})^{T}QQ^{T}((Q^{\dagger})^{T}Q^{\dagger})^{T}$

$= (Q^{\dagger})^{T}Q^{\dagger}QQ^{T}(Q^{\dagger})^{T}Q^{\dagger}$

$= (Q^{\dagger})^{T}Q^{\dagger}Q(Q^{\dagger}Q)^{T}Q^{\dagger}$

$= (Q^{\dagger})^{T}Q^{\dagger}QQ^{\dagger}QQ^{\dagger}$

$= (Q^{\dagger})^{T}Q^{\dagger}QQ^{\dagger} \ =(Q^{\dagger})^{T}Q^{\dagger}$

Similarly , $(Q^{T}Q)^{\dagger}$ exist and $(Q^{T}Q)^{\dagger} = Q^{\dagger}(Q^{\dagger})^{T}$

(i) $QQ^{\dagger} = QQ^{\dagger}QQ^{\dagger}QQ^{\dagger}$

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$QQ^\dagger$ is solution of $QQ^\dagger = Y\ QQ^\dagger QQ^\dagger$ and $(QQ^\dagger QQ^\dagger)^T = QQ^\dagger QQ^\dagger$

Therefore $QQ^\dagger \in QQ^\dagger\{1,3\} \cap QQ^\dagger\{1,4\}$

Hence, $(QQ^T)^\dagger$ exist

And $\left(QQ^\dagger\right)^\dagger = \left(QQ^\dagger\right)^T QQ^\dagger \left(QQ^\dagger\right)^T = QQ^\dagger$

Similarly $\left(QQ^\dagger\right)^\dagger = QQ^\dagger$.

3. Characterization of Symmetric NFMs:

Theorem 3.1 For any NFM $Q \in F_n$, the following statements are equivalent :
(i) Q is symmetric and $\rho(Q)$ = r.
(ii) $C(Q) = C(Q^T)$.
(iii) $Q^T = QG = LQ$ for some NFMs G and L.

Proof

(i) *implies* (ii) Q is symmetric that is $Q^T = Q$. *So that*, $R(Q) = R(Q^T)$.
Again, for any symmetric NFM,
$C(Q) = R(Q^T)$ and $C(Q^T) = R(Q)$.
This implies that, $C(Q) = C(Q^T)$.
(ii) *implies* (iii) As $R(Q^T) = R(Q)$, then each row of Q^T is a linear combination of the rows of Q. Hence $Q^T{}_{i*}\sum_j x_{ij}Q_{j*}$
and from which it follows that $Q^T = LQ$ for some $L \in F_n$.
Similarly, using $R(Q^T) = R(Q)$ and $(LQ)^T = Q^T L^T$, we can show that $Q^T = QL$ *for any* $L \in F_n$.
(i) *implies* (iv) $(PQP^T)^T = (P^T)^T Q^T P^T = PQ^T P^T = PQP^T$.
So, PQP^T is symmetric for some NFPM P.
For the rank of Q is r, so there exists r independent rows of Q. Again PQP^T is the matrix whose rows and columns are re – arrangements of the matrix Q . So rank of PQP^T will remains the same, $\rho(PQP^T) = r$.

Example 3.2

A NFM, $Q = \begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.2) \\ (0.6,0.3,0.2) & (0.8,0.2,0.1) \end{bmatrix}$. Here $Q^T = Q$, that is , Q is symmetric.

Now, $((0.7,0.2,0.1)(0.6,0.3,0.2)) \neq c((0.6,0.3,0.2)(0.8,0.2,0.1))$ for any $c \in F$. So the rank of Q, $\rho(Q)$ = 2. Also $C(Q) = R(Q^T)$ as $Q = Q^T$.
For,
$G = \begin{bmatrix} (0.9,0.1,0.1) & (0.5,0.4,0.2) \\ (0.6,0.4,0.2) & (0.8,0.1,0.1) \end{bmatrix}$

$= \begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.2) \\ (0.6,0.3,0.2) & (0.8,0.2,0.1) \end{bmatrix}\begin{bmatrix} (0.9,0.1,0.1) & (0.5,0.4,0.2) \\ (0.6,0.4,0.2) & (0.8,0.1,0.1) \end{bmatrix}$

$QG = \begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.2) \\ (0.6,0.3,0.2) & (0.8,0.2,0.1) \end{bmatrix} = Q$

And for

$= \begin{bmatrix} (0.8,0.2,0.1) & (0.6,0.4,0.3) \\ (0.5,0.5,0.2) & (0.8,0.1,0.2) \end{bmatrix}$

$LQ = \begin{bmatrix} (0.8,0.2,0.1) & (0.6,0.4,0.3) \\ (0.5,0.5,0.2) & (0.8,0.1,0.2) \end{bmatrix}\begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.2) \\ (0.6,0.3,0.2) & (0.8,0.2,0.2) \end{bmatrix}$

$LQ = \begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.2) \\ (0.6,0.3,0.2) & (0.8,0.2,0.2) \end{bmatrix} = L$

For $= \begin{bmatrix} (0,1,0) & (1,0,0) \\ (1,0,0) & (0,1,0) \end{bmatrix}$

$PQ = \begin{bmatrix} (0.7,0.2,0.1) & (0.6,0.3,0.1) \\ (0.7,0.3,0.1) & (0.8,0.2,0.1) \end{bmatrix}$

$PQP^T = \begin{bmatrix} (0.8, 0.2, 0.2) & (0.6, 0.3, 0.2) \\ (0.6, 0.3, 0.2) & (0.7, 0.2, 0.1) \end{bmatrix}$,

It is also symmetric, therefore , $PQP^T = PQP$ and $\rho(PQP) = 2$.

Theorem 3.3 For any $Q \in NF_n$ be a NFM and $Y \in Q\{1,2\}$ such that QY,YQ are symmetric.Then Q is symmetric if and only if Y is symmetric.

Proof

Since $Y \in Q\{1,2\}$, we have QYQ = Q, YQY = Y . Also QY and YQ are symmetric , so $R(QY) = R((QY)^T)$ and $R(YQ) = R((QY)^T)$.

Now, $R(Q) = R(YQ)$ ($Y \in Q\{1\}$)

$R(Q) = R((YQ)^T)$ (YQ is symmetric)

$= R(Y^T Q^T)$

$= R(Y^T)$

$R(Q^T) = R(Y^T Q^T)$ ($Y^T \in Q\{1\}$)

$= R((YQ)^T)$

$= R(YQ)$ (QY is symmetric)

$= R(Y)$

and Q is symmetric implies, $R(Q) = R(Q^T)$, i.e., $R(Y^T) = R(Y)$.Hence, Y is symmetric.

Conversely, Y is symmetric implies, $R(Y) = R(Y^T)$, i.e., $R(Q) = R(Q^T)$. Thus, Q is symmetric.

Remark 1 For the above theorem, the condition QY and YQ both symmetric is necessary. Otherwise, for the symmetric NFM Q,Y ∈ Q{1,2} may not be symmetric, which is shown in the following example.

Example 3.4

For any NFM $Q = \begin{bmatrix} (0.6, 0.3, 0.2) & (0.6, 0.3, 0.4) \\ (0.6, 0.3, 0.4) & (0.7, 0.2, 0.1) \end{bmatrix}$, which is symmetric.

For $Y = \begin{bmatrix} (0.6, 0.3, 0.1) & (0.6, 0.3, 0.2) \\ (0.7, 0.3, 0.2) & (0.7, 0.2, 0.1) \end{bmatrix} \in$ Q{1,2}

$QY = \begin{bmatrix} (0.6, 0.3, 0.2) & (0.6, 0.3, 0.2) \\ (0.7, 0.3, 0.2) & (0.7, 0.2, 0.1) \end{bmatrix}$, which is not symmetric but

$YQ = \begin{bmatrix} (0.6, 0.3, 0.2) & (0.6, 0.3, 0.2) \\ (0.6, 0.3, 0.2) & (0.6, 0.2, 0.1) \end{bmatrix}$, which is symmetric.

Also Y is not symmetric

CONCLUSION

Here some theorems explained the properties of the existences of symmetric Neutrosophic Fuzzy Matrices also some of the explained characterization of symmetric Neutrosophic Fuzzy Matrices using the g – inverse concept. Further work is planned to find the necessary and sufficient conditions for the existences of Idempotent Neutrosophic Fuzzy Matrices.

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RESEARCH ARTICLE

Microwave Assisted Synthesis of Some Schiff base Derivatives and their Biological Activities

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ABSTRACT

In the current study, we described the synthesis of Schiff's base derivatives using P-anisidine and aromatic aldehyde using both conventional and microwave irradiation. Microwave irradiation produces excellent yield in a short amount of time, coupled with other benefits like time-consuming, gentle reaction conditions, and safer environmental circumstances. IR, ^{1}HNMR, and mass spectra are utilized to Confirmed the structures of Schiff's bases. The compounds 3(a-e) are also screened for their antioxidant, anti-inflammatory, and anti-diabetic properties. Regarding standards, all the compounds demonstrated good biological activity.

Keywords: Antioxidant activity, Anti-inflammatory activity, Anti-Diabetic Activity, Schiff's base, Microwave irradiation.

INTRODUCTION

An aldehyde or ketone counterpart for nitrogen with the C=N-R group in place of the C=O It is frequently produced by mixing an aldehyde or ketone with a primary amine. Schiff bases, which are mostly formed from different heterocyclic rings, have been shown to have a variety of biological and pharmacological effects [1]. The creation of

novel Schiff bases for chemotherapy is currently catching the interest of medicinal chemists. They have a history of engaging in a number of powerful behaviors. Among the pharmacologically favourable properties are the hypnotic, herbicidal, antibacterial, anticonvulsant, anti-inflammatory, anti-cancer, anti-hypertensive, anti-fungal, antipyretic, antimicrobial, and anti-HIV effects [2]. In reality, transition metal metal complexes of Schiff bases have been produced and employed as chelating agents in radiopharmaceuticals for cancer treatment and agrochemicals [3]. The imine group -N=CH- that distinguishes Schiff bases makes it easier to understand how transamination and racemization reactions in biological systems work [4]. Additionally, they are used to control diabetes and AIDS. They serve as biological models that make it easier to comprehend how biomolecules are made and how biological systems work in living organisms. They participate, work to treat cancer treatment resistance, and frequently undergo antimalarial testing. Another use for it is the immobilization of enzymes [5]. Prabhat Kumar Baroliya [6] reported the Schiff bases using salicylaldehyde (0.01 mol) and sulphanilic acid (0.01 mol) by the conventional method, room temperature method, grindstone method, and microwave method.In comparison to conventional organic synthesis, microwave (MW) aided organic compound synthesis has grown significantly in relevance due to its higher yields, quicker workup, and lower solvent use [7] When compared to the traditional technique of heating, microwave heating was already proven to significantly shorten reaction times, increase product yields, and improve product purity [8–11]. As it expedites the action of a wide range of synthetic changes, solvent-free processes without the use of supporting reagents, and hence environmentally benign processes, microwave heating of organic reactions has quickly grown in favor. Chemical processes that once required hours or even days to complete are now finished in a matter of minutes. Numerous advantages of using microwave energy for synthesis include faster reaction rates, higher yields, easier processing and handling, and cleaner chemistries [12–15]. Free radicals are very unstable molecules that are produced naturally during exercise and throughout the body's energy conversion process from food. Free radicals can also enter your body from a number of environmental factors, including sunshine, air pollution, and cigarette smoke. Free radicals may result in "oxidative stress," which can result in cell damage. Numerous diseases, including cancer, cardiovascular disease, diabetes, Alzheimer's, Parkinson's, and eye conditions like cataracts and age-related macular degeneration are known to be impacted by oxidative stress.Research in the lab has shown that antioxidant molecules can lessen oxidative stress (for example, in cells or animal studies). It is questionable, nevertheless, if ingesting a lot of antioxidants in the form of supplements improves health. Additionally, there is some worry that taking too many antioxidant supplements can be dangerous.

Hyperglycemia caused by a partial or total lack of insulin characterizes diabetes mellitus (DM), a metabolic illness with a high prevalence [16]. Blocking carbohydrate hydrolyzing enzymes in the digestive system, such as alpha amylase (-amylase) and alpha glucosidase (-glucosidase), is one of the most efficient approaches to reduce postprandial hyperglycemia. Pancreatic amylase is a digestive enzyme that catalyses the breakdown of starch into smaller oligosaccharides, which are then transformed into smaller glucose units for absorption by glucosidases. Increased postprandial hyperglycemia is brought on by the fast conversion of dietary starch to glucose by the hydrolyzing cascade. Controlling these digestive enzymes may be a crucial strategy for the treatment of DM (type 2) [17–19].

MATERIALS AND METHODS

Sigma-Aldrich was the source for the chemicals and reagents that were used to make the Schiff base complexes. For the antioxidant experiments, the conventional DPPH technique was applied. Anti-inflammatory action was achieved utilizing the albumin denaturation method, while anti-diabetic activity was achieved using the enzyme alpha-amylase. A Perkin-Elmer Spectrometer was used to record Infrared Spectra (IR) in KBr. The ^1H and ^{13}C NMR values of produced compounds are characterized using a Bruker Advance 400 MHz spectrometer.

Synthesis of Schiff base compounds by conventional method

P-Anisidine, a variety of aromatic aldehydes, and ethanol (20 mL) are combined to form Schiff bases, which are then refluxed for three to six hours while being heated vigorously and stirred. TLC kept track of the reaction's

development. When the reaction was finished, the result was an amorphous yellow substance that was filtered, dried, and then crystallized again from ethanol.

Synthesis of Schiff base compounds by microwave irradiation method
The compound P-anisidine was combined with various aromatic aldehydes in a 100 ml conical flask with a stopper, along with 20 ml of ethanol/DMF. The flask was exposed to microwave radiation (200w) for roughly 2–15 minutes, with a brief break to allow for cooling and prevent solvent evaporation. Conical flask was cooled when the reaction was finished, and the contents were then poured onto crushed ice. The ethanol-derived Schiff bases were filtered, dried, and crystallized.

Spectral information of created molecules
Compound [3a],
Yellow solids; m.p. 110-113 ^{0}C;   FT-IR ν C=N and aromatic ν C-H stretching 1685 and 1892 cm-1, aromatic ν C=C 3066 cm-1. ^{1}H NMR(400 MHz, CDCl3) δ 6.96 (d, J = 8.8 Hz, 1H) and 7.42 (d, J = 8.0 Hz, 1H) for (H-13) and (H-12), δ 7.07 (dd, J = 8.4 Hz, 2H), 7.25 (dd, J = 8.8 Hz, 2H) for (H-2,4), (H-1,5) δ 7.53 ppm (s, H -16) δ 8. N=CH, (s, H-10) ⊚ 3.77 and 3.83 (s, -OCH3). ^{13}C NMR(100 MHz, CDCl3) δ 158.48 ,111.86 -158.08 ,158.08, 152.02, 149.51 ,55.76 and 56.12 . MS (m/z); (M+) for $C_{16}H_{17}NO_3$, 271.

Compound [3b]
Yellow solids; m.p. 125-128^{0}C;   FT-IR ν C=N and aromatic ν C-H 1685 and 1892 cm-1, aromatic ν C=C 3066 cm-1. ^{1}H NMR(400 MHz, CDCl3) δ 6.93 (dd, J = 8.8 Hz, 2H), 7.23 (dd, 2H) for (H-2,4), (H-1,5) , δ 7.14 (H -12,16), δ 8.37 N=CH, (H-10) ⊚ 3.83 (s, H-8), δ 3.91 (s, H-17,21), and δ 3.94 (s, H-19) (-OCH3). ^{13}C NMR(100 MHz, CDCl3) δ 158.24, 105.58 -157.95 ,15.95, 153.52 and 144, 55.50, 56.25 and 60.96. MS (m/z); (M+) for $C_{17}H_{19}NO_4$, 301.

Compound [3c]
Yellow solids; m.p. 163-165 ^{0}C;   FT-IR ν (-OH) 3427 cm-1, ν C=N and aromatic ν C-H 1610 and 2036, aromatic ν C=C 3095 cm-1. ^{1}H NMR(400 MHz, CDCl3) δ 6.96 (d, J = 8.8 Hz, 1H) and 7.41 (d, 1H) for (H-13) and (H-12), δ 7.03 (dd, J = 8.4 Hz, 2H) and 7.26 (dd, 2H) for (H-2,4) and (H-1,5) δ 7.30 (s, H -16) δ 8.45 N=CH, (s, H-10), ⊚ 3.77 and δ 3.84 (s, -OCH3), δ 9.35 (s, -OH). ^{13}C NMR(100 MHz, CDCl3) δ 158.46, δ 112.08 -157.99, 157.99, 151.03 and 147.17, 55.73 and 56.07. MS (m/z); (M+) for $C_{15}H_{15}NO_3$, 257.

Compound [3d]
Yellow solids; m.p. 191-192 0C; FT-IR ν (-OH) 3745 cm-1, ν C=N and aromatic ν C-H 1625 and 2052 cm-1, aromatic ν C=C 3067 cm-1. ^{1}H NMR(400 MHz, CDCl3) δ 6.52 (d, J = 8.8 Hz, 1H) and 6.64 (d, J = 8.4 Hz, 1H) for (H-14) and (H-12), δ 6.94 (dd, 2H) and 7.32 – 7.27 (m, 3H) for (H-2,4) and (H-1,5,13), δ 8.53 (s, H -16), δ 9.73 N=CH, (s, H-10), ⊚ 3.77 (s, -OCH3), δ 9.91 (s, -OH). ^{13}C NMR(100 MHz, CDCl3) , δ 158.83, 114.51 -158.43, 158.43 and 158.10, 55.78. MS (m/z); (M+) for $C_{14}H_{13}NO_2$ 227.

Compound [3e]
Yellow solids; m.p. 213-215 0C;   FT-IR ν C=N and aromatic ν C-H 1620 and 1901 cm-1 ,ν C=C 3010 cm-1, ν Cl 838 cm-1. ^{1}H NMR(400 MHz, CDCl3) δ 6.99 (dd, J = 8.4 Hz, 2H), 7.32 (dd, J = 8.4 Hz, 2H), 7.58 (dd, J = 8.4 Hz, 2H), δ 7.93 (dd, J = 8.4 Hz, 2H) for (H-2,4), (H-1,5), (H-13,15) and (H-12,16), δ 8.66 N=CH, (s, H-10), ⊚ 3.78 (s, -OCH3). ^{13}C NMR(100 MHz, CDCl3) , δ 158.62, 114.91-157.48, 157.48, 55.79. MS (m/z); (M+) for $C_{14}H_{12}ClNO$, 244.

ANTIOXIDANT ACTIVITY OF COMPOUNDS
DPPH- Scavenging activity
The radical scavenging method was carried out by using previous reported methods [20].

Reagents
Methanol in2,2-Diphenyl-1-picryl hydrazyl (DPPH at 90.25 mM in a dark environment

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Procedure

Cyperusrotundus's ethanolic Rhizome (250-1500 gram) is treated with an equivalent capacity of methanolic DPPH solution (90.25 mM) .using methanolic DPPH, and diluted to 1.0 mL.The identical amount of methanol was administered to the control group. After 20 minutes, the absorbance at 517 nm was assessed using a UV-Visible Spectrophotometer using ascorbic acid as a reference standard. The equation below was used to determine the proportion by which DPPH reduced the risk of free radical damage.

Scavenger %   = 100 x [('A' Control OD –' A' sample) / Control OD]
Where "A sample" stands for the test compound's absorbance and "A control" for the control reaction's absorbance.

Anti-inflammatory Properties of Substance
Albumen Denaturation Inhibition

The recommended technique of SakatetaI.,2010 was used through small alterations. The mixture included 1% bovine albumin fraction solution and Samples; A slight quantity of 37°C HCl was added this mixture to modify the pH.The sample extracts have been at first cultured at 37°celcius for twenty min before being heating to 51°Celcius for twenty min. After the samples were cooled, turbidity was assessed, using a spectrophotometer at 660 nm. Standard drug considered was Diclofenac sodium. The experiment performed in triplicate. The following was determined regarding the prevention of protein denaturation:

% of Inhibition   = 100X [OD Control–OD Sample) /OD Control]

Anti-diabetics activity of compounds
α-Amylaseenzyme Inhibition

By spinning 0.1 grammes of potato starch in 100 millilitres of buffered 16 millimole sodium acetate, a starch liquid solution of 0.1% w/v was produced. By combining 27.5 milligram of amylase with 100 milliliters of purified water, the enzyme solution was made.Creating the colorimetric reagent, combine 3,5-Dinitrosalicylic acid (DNS) and ninety six milli mole sodium potassium tartaratesolution.Subsequently, the solution of starch is included with the plant extract tubes & control, and then allowed to respond with the amylase soln at 25°c in alkaline conditions. About3 mins, the mixture was allowed to continue and ProductionofMaltose was estimated by lowering 3,5-Dinitrosalicylic acid to 3-amino-5-nitro salicylic acid. The response can be noticed at 540nm (Singh, Malik 1980).
% of Inhibition =100X   [(Control OD - Test OD) /Control OD]

RESULTS AND DISCUSSION

P-anisidine (1), Benzaldehyde (2), and Methanol (20 ml) were combined. The reaction took 1.30 hours to complete and had a 45% yield of the intended product (3). (Table 2, entry 1). 53% of the desired product yield was generated after three hours of refluxing the same reaction (Table 2, entry 2).The product yield increased to 58% after 1.30 hours of switching to ethanol at reflux. (Entry 3 in Table 2,). The same reaction was replicated 68% of the time under reflux for 4 hours, with the same outcome (3). (4th entry in Table 2).

The reaction employed a mixture of the solvents methanol and DMF to reflux for varying amounts of time, yielding the product (3) in 65 and 69% of the cases, respectively (Table 2, entry 5&6). The procedure produces a 74% yield when various solvent mixtures of methanol and CHCl3 are used under reflux at 80°C for 30 minutes (Table 2, entry 7). We used unconventional methods, such as microwave irradiation, in an effort to boost the yield.

The reaction was conducted at various times and with various mixture solvents, including Methanol+DMF, Ethanol+DMF, and Ethanol+CHCl3 (Table 2, entries 8–13), however the reaction's high yield of 95% was attained using the mixture solvent ethanol+DMF (Table 2, entry 12) Accordingly, we came to the conclusion that the microwave irradiation method is the most effective way to create Schiff base derivatives with high yields (Fig 3).

Antioxidant activity of Schiff base compounds

There are multiple ways to evaluate a compound's antioxidant activity. The DPPH scavenging assay is a sensitive, quick, and simple method for screening Schiff base for antioxidants. The DPPH radical gains one electron whenever an antioxidant is present, and indeed the absorbance lowers.The DPPH scavenging capacity of the P-anisidine benzylidene derivatives in the current investigation increased with increasing concentration. The information in Table makes it clear that the material has DPPH test performance.The percentage of cytotoxicity Compound [3a], for different concentration such as 0.2, 0.4, 0.6, 0.8, 1.0 mg/ml at 38%, 53.5% , 64% , 82.3%, 90% respectively. The percentage of cytotoxicity for Compound [3b] at 0.2, 0.4, 0.6, 0.8, 1.0 mg/ml at 35%, 51.5%, 60%, 70%, 80% is respectively. The inhibition percent is determined to be 12.3%, 20.6%, 30.6%, 41.5%, and 60.5% for the cytotoxic impact of Compound [3c] at various concentrations (mg/ml) of 0.2, 0.4, 0.6, 0.8, and 1.0.The inhibition percent is determined to be 40%, 53%, 65%, 81%, and 94% for the cytotoxic impact of Compound [3d] at various concentrations (mg/ml) of 0.2, 0.4, 0.6, 0.8, and 1.0.The percentage of cytotoxicity Compound [3e], for different concentration such as 0.2, 0.4, 0.6, 0.8, 1.0 mg/ml at 14%, 23%, 36%, 40.9%, 56% respectively.Ascorbic acid, a common drug, is contrasted with these inhibitory values at concentrations of0.2, 0.4, 0.6, 0.8, 1.0 mg/ml as 40%, 50%, 60%, 75%, 85%respectively.The DPPH test utilised P-anisidene benzylidene derivatives at concentrations of 0.2 mg/ml, 0.4 mg/ml, 0.6 mg/ml, 0.8 mg/ml, and 1.0 mg/ml.The potential derivative of Compound[3a] to thwart DPPH foragingwas investigated as role of the mechanism of antioxidant capacity analyzation. According to Invitro antioxidant study, the inhibition percentage of (3, 4-Dimethoxy –Benzylidene)-(4-Methoxy-Phenyl)-amine [3a] and 3-[(4-Methoxy-Phenyl imino)-Methyl]-Phenol [3d]values. The percentage of inhibition rises when the concentration is increased concurrently, and when compared to the ascorbic acid as standard medication, the observed value is closer to 3a and 3d.

Anti- inflammatory activity
Albumin denaturation method inhibition

There are drawbacks to using animals in experimental pharmacological research, including ethical issues and the absence of a justification when better options are available..The anti-inflammatory activity of P-anisidine benzylidene derivatives was therefore assessed in vitro in the current investigation using the protein denaturation bioassay.Inflammation is well-known to be caused by albumen denaturation. When denatured, the majority of organic proteins lose their organic properties. Protein denaturation is the cause of autoantigen production in positive arthritic disorders. The denaturation route includes modifications to electrostatic hydrogen, hydrophobic, and disulfide bonding. The most important contributor to inflammation, according to recent study, is protein denaturation.The inquiry into the mechanism of the anti-inflammatory activity has previously examined the potential of the Schiff base to prevent protein denaturation. Selected Schiff bases have been effective in avoiding albumin denaturation brought on by heat.In the past, aspirin was a widely used anti-inflammatory drug, as seen in Figure [Table 4 and Figure 5]. Samples containing P-anisidine benzylidene derivatives were tested using the albumin denaturation method at concentrations of 100 µg/ml, 200 µg/ml, 300 µg/ml, 400 µg/ml, and 500 µg/ml.The capacity for Schiff base to inhibit albumin denaturation was investigated as portion of the review process of anti-inflammatory properties. The Invitro research of anti-Inflammatory potential shows that Compound [3b] has a greater inhibition percentage. When concentration is increasing at the same time, the significant proportion of protein denaturation increases, and the observed value is closer to 3b and 3e on comparison with standard drug aspirin.

Anti diabetic activity
inhibition of alpha-amylase enzyme

A category of metabolic illnesses known as diabetes mellitus are distinguished by consistently high blood sugar levels. By halting the breakdown of carbohydrates into monosaccharides, a primary cause of rising blood glucose levels, inhibition of the carbohydrate-digesting enzymes (-glucosidase and -amylase) can lower hyperglycemia. Therefore, developing drugs that inhibit carbohydrate hydrolyzing enzymes can be a useful strategy for controlling diabetes.According to Figure 6 and Table 5, the concentration of (3, 4-Dimethoxy -Benzylidene)-(4-Methoxy-Phenyl)-amine [3a] strongly inhibited the enzymes -amylase and -glucosidase in a dose-dependent manner. The anti-diabetic

potential of the biomolecules therefore likely exceeded that of the synthesized drugs.These inhibition levels were 50% at 20 g/ml, 60% at 40 g/ml, 70% at 60 g/ml, 80% at 80 g/ml, and 100% at 100 g/ml when compared to known drugs. target. as 90%. The alpha-amylase enzyme was run once with unique concentrations of derivatives of P-anisidine benzylidene: 20,40,60,80,100 μg/ml of the alpha-amylase enzyme. rice field. Protein denaturation no longer showed a large difference between 20 and 40 μg/ml Schiff's base, but was prevalent for nanoparticles at 0.15, 0.20and 0.25 μg/ml , were all contrasting values. It is converted to the widely used drug acarbose (Figure.6).The potential of Schiff bases to inhibit the α-amylase enzyme was once investigated as a step in studying the mechanism of antidiabetic activity. In vitro anti-diabetic recovery studies suggest that the percentage of inhibition of the alpha-amylase enzyme by recreational compounds [3a] and compounds [3d] have higher values. , the rate of protein denaturation is expanded to the precisely found charge and compared to known acarbose drugs close to 3aand 3d.

CONCLUSION

We synthesized Schiff's base compounds 3(a-e) via microwave assisted method. This protocol offers several advantages such as less reaction time, high yields. All compounds showed good biological activities compared with respective standards.

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CONFLICT OF INTEREST

The authors declare the no conflict of interest regarding the research article

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Table 1: Name of synthesized compounds

S.No	Name of the synthesized Compound	Compound ID
1	(3, 4-Dimethoxy –Benzylidene)-(4-Methoxy-Phenyl)-amine	3a
2	(4-Methoxy-phenyl)-(3,4,5-Trimethoxy-Benzylidene)-amine	3b
3	2-Methoxy-5-[(4-Methoxy-Phenyl imino)-Methyl]-amine	3c
4	3-[(4-Methoxy-Phenyl imino)-Methyl]-Phenol	3d
5	(4-Chloro-Benzylidene)-(4-Methoxy-Phenyl)-amine	3e

Table 2: optimization of compound 3a

Entry	Solvent	Temp.(°C)	Time(min)	Yield(%)
1	Methanol	Reflux	90	45
2	Methanol	Reflux	180	53
3	Ethanol	Reflux	90	58
4	Ethanol	Reflux	240	68
5	Methanol+DMF	Reflux	60	65
6	Methanol+DMF	Reflux	90	69
7	Methanol+CHCl$_3$	80	30	74
8	Methanol+DMF	MW	10	68
9	Methanol+DMF	MW	8	74
10	Ethanol+DMF	MW	9	80
11	Ethanol+DMF	MW	7	85
12	Ethanol+DMF	MW	5	95
13	Ethanol+CHCl$_3$	MW	7	75

Table 3. Anti-Oxidant Studies DPPH scavenging assay activity

S.No	Test	% of inhibition	Concentration of the sample (mg/ml)				
			0.2	0.4	0.6	0.8	1.0
1	DPPH	3a	38	53.5	64	82.3	90
2		3b	35	51.5	60	70	80
3		3c	12.3	20.6	30.6	41.5	60.5
4		3d	40	53	65	81	94
5		3e	14	23	36	40.9	56
6		Ascorbic Acid (Standard)	40	54	68.4	82.3	97

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Table 4. Anti- inflammatory activity inhibition of albumin denaturation

S.NO	Test	% of Protein Denaturation	Concentration of the sample (µg/ml)				
			100	200	300	400	500
1	Albumin denaturation	3a	30	45	50	60	80
2		3b	39	53	64	75	89
3		3c	12	25	35	45	55
4		3d	30	40	50	60	85
5		3e	29	38	48	59	70
6		Aspirin (standard)	40	55	66	76	90

Table 5. Anti diabetic activity inhibition of alpha-amylase enzyme

S.NO	Test	% of inhibition	Concentration of the sample (µg/ml)				
			20	40	60	80	100
1	Alpha amylase inhibitory activity	3a	49	60	67	80	89
2		3b	24	30	40	50	55
3		3c	40	55	65	73	89
4		3d	48	59	70	79	90
5		3e	30	40	50	65	75
6		Acarbose (Standard)	50	60	70	80	90
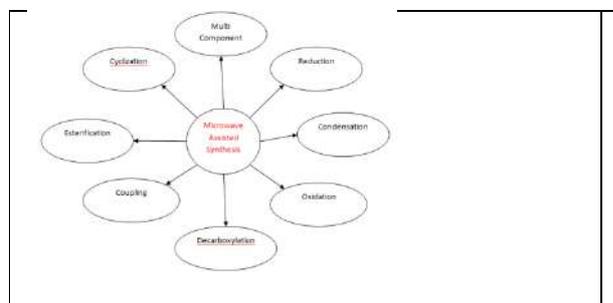
Fig. 1. Applications of microwave assisted method
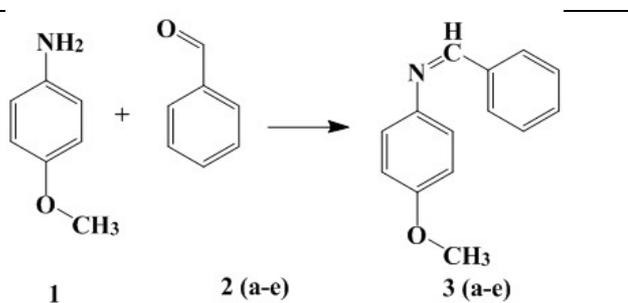
Fig. 2. Synthesis of Schiff's base
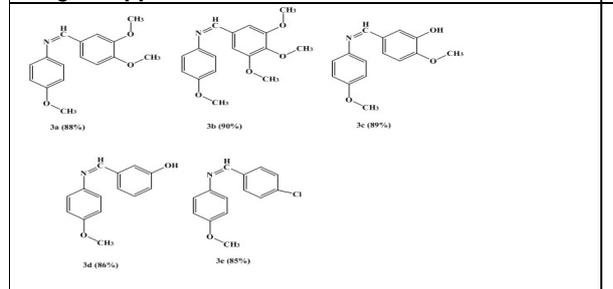
Fig. 3. Diversity of Schiff base compounds
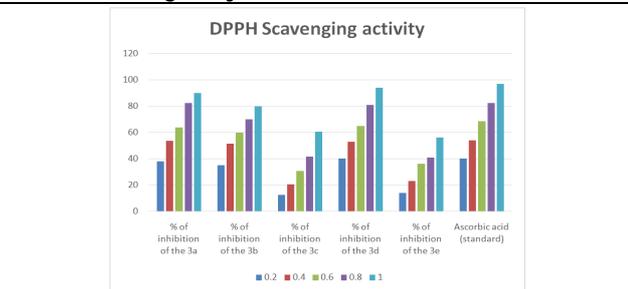
Fig. 4. Graph of DPPH radical scavenging activity of compounds (3a-e)

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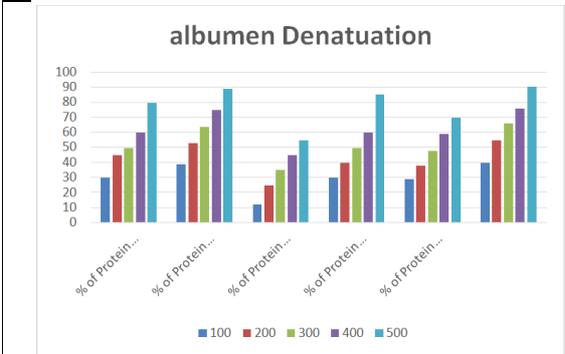
| Fig. 5. Graph of Anti- inflammatory activity inhibition of albumin denaturation | Fig. 6. Graph of Anti diabetic activity inhibition of alpha-amylase |
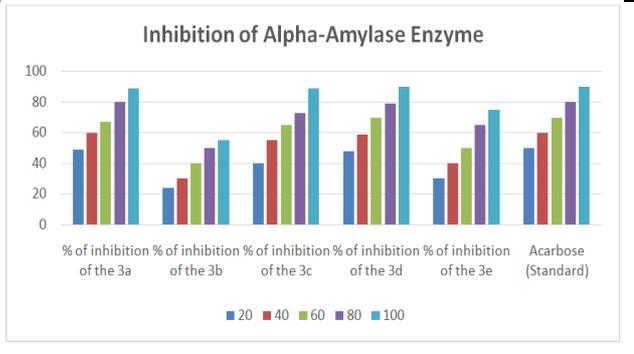
REVIEW ARTICLE

Ocular Drug Delivery through Eudragit Based Nano Formulations: A Review

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ABSTRACT

The therapeutic effectiveness of ocular drug delivery is restricted by the physiological and anatomical barriers of the eye. Thus remains as a significant challenge for the pharmaceutical scientists. Several pharmaceutical strategies like nano formulations have been demonstrated their ability to overcome these barriers. The polymeric nanoparticles act as a potential nano carrier for delivering ocular therapeutics due to their capacity to prolong residence time and drug release pattern along with their ocular tolerability. This review describes about ocular barriers, various nano formulations and mainly focuses on recent research studies based on Eudragit nanoparticles as a potential carrier for ocular drug delivery.

Keywords: Eudragit, nanoparticles, controlled release, cornea, permeability, ocular

INTRODUCTION

The eye is a diverse organ. Its distinctive anatomical and physiological characteristics acts as a major challenge for ocular drug delivery [1] .The two main anatomical segments of the eye include anterior and posterior segments. The anterior segment composed of tissues like cornea , conjunctiva , aqueous humour , iris , ciliary body ,and lens .The sclera , choroid , retinal pigment epithelium , optic nerve and vitreous humour make up the posterior section [1,2] . Minor ocular diseases to vision threatening diseases may affect both posterior and anterior segments of the eye. The common diseases include glaucoma, allergic conjunctivitis, cataract, age related macular degeneration, diabetic retinopathy and infective keratitis [1, 3]. The topically applied ophthalmic drugs provide limited absorption due to the protective mechanism of eye, which is mainly against foreign materials including drugs. The protective

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mechanisms like tear turnover, nasolachrymal drainage, reflex blinking, dynamic barriers obstructs the ocular drug permeation which results in the reduced therapeutic concentration of drug in the posterior segment [4].

The conventional topical formulations like eye drops were widely preferred as a non –invasive route of drug administration to the eye. Even though it is the most convenient route of ocular drug application which limits the availability of drug due to reduced residence time, which is only for approximate five minutes. Thus frequent administration of eye drops is required to obtain therapeutic drug concentration. Repeated administration of the drugs to the anterior segment of the eye may results in severe side effects. Intra vitreal injections and periocular injections are used to deliver drugs to the posterior segment. But these methods may require regular eye puncture which may results in endophthalmitis , hemorrhage, retinal detachment which leads to poor patient compliance and also skilled administration is required [1, 4]. Several methods were developed to enhance the ocular residence time and bioavailability, such as application of viscosity and penetration enhancers. However such liquid formulations will be removed by the usual protective mechanism. Here the drug delivery requires careful selection of enhancers because of the highly sensitive tissues like cornea & conjunctiva [5].

Nanoparticles are the particles ranging size from 1-1000 nm, in which the drug may either encapsulated, entrapped or dispersed in a matrix. Nanoparticles can act as a flexible drug delivery system which can overcome the barriers of the eyes [5].The polymeric nanoparticles can be considered as colloidal systems for ocular drug delivery. Colloidal carriers for the topical delivery is assigned to facilitate engulfment of the drug loaded particles by the corneal epithelial cells, which can then acts as a reservoir to sustain the drug delivery. The colloidal nanoparticles have a particle size less than 1000 nm [3]. Although a size range from 40 nm to 0.5 µm is usually considered optimum for ophthalmic preparations [5]. The Eudragit polymers are widely used in developing polymeric nanoparticles. Eudragit based nanoparticles have been evaluated for their significance in ocular drug delivery. Eudragit is a cationic mucoadhesive polymer which will induce a molecular electrostatic interaction with negatively charged mucin of the ocular mucosal membrane. The Eudragit polymers act as a key tool for developing sustained release formulations. It exhibits suitable characteristics for ophthalmic preparation due to absence of toxicity, positive charge and controlled release profile [6]. This review mainly focuses on the ocular barriers, role of nano formulations and significance of eudragit based nanoparticles in ocular drug delivery.

Barriers to Ocular Drug Delivery

The barriers present in the eye have significant importance in providing a protection against foreign materials like chemical substances, other pollutants and drugs. These barriers provide required nutrition to the tissues present in the eye and are necessary in maintaining the normal physiological functions of the eye. The presence of these barriers limits the diffusion and penetration of ocular dosage forms.[7, 8, 9] The ocular barriers can be classified based on their function and anatomical location. The barriers can be classified as 1) Anterior segment barriers, 2) Posterior segment barriers (Figure.1)

Anterior Segment Barriers

Cornea is a transparent impermeable tissue having a thickness of 0.5 mm. It acts as a mechanical barrier which restricts the entry of foreign materials and also the drugs that are applied topically. The cornea prevents the diffusion of drug into the deeper ocular tissues. It limits the absorption of both hydrophilic & lipophilic drugs [9].The presence of six to eight layers of cells in the corneal epithelium forms a tight junction which limits the absorption of hydrophilic drugs through transcellular pathway. The lipophilic drugs can easily transport across the cornea by transcellular mechanism, due to the lipophilic nature of the cornea. [7, 8].Human Conjunctiva is a thin glassy mucus membrane composed of epithelium and sub epithelial stroma [10].The conjunctiva presents around 17-fold greater surface area than cornea for drug absorption [9] .However the conjunctiva is a permeability barrier for the drugs which are applied topically. The barrier properties are due to its transepithelial electrical resistance. The presence of conjunctival blood capillaries and lymphatics causes the loss of drug through systemic circulation. Secretory glands like goblet cells in the conjunctiva produces mucous, a component of tear fluid which hinders the drug absorption.

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The inferior conjunctival sac contains around 3 µl of tear fluid and the conjunctival cul-de-sac comprise 7-9 µl of tear fluid [11].Tear fluid reduces the concentration of drug and at the conjunctival site. The conjunctival tissue restricts entry of drug molecules having molecular weight higher than 20 kDa[12]. The drugs while crossing conjunctiva is taken away into lymph and systemic circulation when applied topically. Thus the permeability of the drugs to the deeper tissues is limited.

Blood Aqueous Barrier maintains the chemical composition of eye. The endothelium of the iris-ciliary blood vessels and non pigmented ciliary epithelium are two distinct cellular layers that form the BAB in the anterior part of the eye. The BAB is poorly permeable and manages the transport of solute within the anterior and posterior segment of the eye [13].The passage of drugs are limited due to the drainage of aqueous humour with a flow rate of 2.0 to 3.0 ml/minute [14].Drugs reaching the aqueous humour are absorbed by the pigments of iris and cleared through iris blood circulation [8]. The Aqueous humour is an optically clear, slightly alkaline, colorless fluid secreted by the ciliary body, occupies in the anterior & posterior chambers of the eye, which is protected by the blood aqueous barrier. The flow of aqueous humour towards the cornea limits the entry of topically applied drugs because the direction of drug application is just opposite to direction aqueous humour flow. Aqueous humour eliminates large hydrophilic drugs and thus reduces their concentration in the inner ocular tissues [8, 13].The tear drainage into nasolacrymal ducts– Precorneal barrier is the major reason for loss of about 80-90% of the administered drug. Around 7-9 µl of tear fluid is present in the cul-de-sac. The bottles with topical ophthalmic formulation are expected to deliver around 40-50 µl (1 drop) of eye drop. The reflex tears produced by the stimulation of corneal nerves results in the increased volume of tear fluid in the cul-de-sac causes lachrymal drainage as well as excess reflex blinking. The excess of the applied formulation is eliminated due to rapid eyelid movements within 90 seconds [7,8,11].

Posterior Segment Barrier

Human sclera is the outermost layer of the eye. Sclera provides protection to the posterior segment tissues by preventing the entry of external substances. Permeability of drug across the sclera mainly depends on molecular weight and radius and surface charge of the drug molecule. Sclera is considerably permeable to solutes compared to cornea and conjunctiva. Hydrophilic compounds permeate through transscleral diffusion via aqueous medium of prosteoglycans. The increase in the lipophilicity and molecular size reduces the scleral permeability of a drug molecule [8,9]. The Bruch's membrane is present between the retinal pigment epithelium (RPE) and choroidal capillaries of the eye. It is a unique structure with collagen and elastin rich matrix, which forms a semi permeable molecular sieve. The primary function of Bruch's membrane is the exchange of biomolecules, nutrients, and oxygen between the retina and choroidal circulation. Secondly, they provide cell support for cell adhesion and migration. The Bruch's membrane restricts the choroidal and retinal cellular migration by acting as a division barrier. Most of the drugs are lost through choroid, prior reaching the Bruch's membrane [8, 15].

Blood Retinal Barrier (BRB) is a physiologic barrier which is extremely tight and restrictive. The major function of BRB is regulation of ions, water flux, and protein towards and from the retina. The inner BRB and Outer BRB make up the BRB and maintain microenvironment of retina. The inner BRB is made up of tight junctions (Zona occludientes) between retinal endothelial cells (REC).The outer BRB is composed of tight junctions between retinal pigment epithelial (RPE) cells. The paracellular movement of molecules to blood and retina is prevented by both inner BRB and outer BRB. The BRB is similar to Blood Brain Barrier since BRB also posses lack of fenestrations in RPE and REC, thus passive drug diffusion is prevented. Only lipophilic and small molecules like Oxygen diffuse to inner retinal tissues through RPE. Increase in molecular radius and protein binding also influence the drug diffusion by limiting the permeability [8, 16]. Choroid is a highly vascularized barrier present between sclera and RPE and it is also provided with lymph vessels. The oxygen and nutrients for the retina is supplied by this layer. Choroid acts as a dynamic barrier because of the high choriocapillaries layer-blood flow, thus restricts hydrophilic compounds. The drug diffusivity to the posterior section also depends on the molecular size of the drug [8, 17].

Application of Nanocarriers in Ocular Drug Delivery

Nanoparticles are drug carrier systems with a small size of 1-1000 nm made up of different biodegradable substances like natural or synthetic polymers, metals and lipids [18]. The nanoparticles are fabricated using various chemical processes [19] in which drugs are either entrapped/dissolved in the matrix or the drugs are attached to the surface. Based on the mechanisms of drug housing, the nanoparticles can be subdivided into nanocapsules and nanospheres [20].

The benefits of nanoformulations in ocular drug delivery include:

- Reduced sensation and ocular irritation [21]
- Enhanced mucoadhesion towards the ocular tissue or mucosa, which prevents the immediate wash out of drug caused by the eye's defense mechanism [21]
- Controlled drug delivery to the target site [21]
- Enhanced permeability [21, 22]
- Reduce the need of frequent dosing and dosage [21, 23]
- Minimal toxicity [21-23]
- Prevent degradation of unstable drugs [22] by providing protection against enzymes like peptidase and nucleases [23].

These benefits offer increased bioavailability of the administered drug and its enhanced therapeutic efficacy in the treatment of ocular diseases, thus indicating the significance of nanoformulations over conventional ocular drug delivery methods [19]. The main objective of using nanotechnology in ocular drug delivery is to overcome the ocular barriers. The surface charge of nanoparticles is important in understanding their influence in overcoming barriers. Nanoparticles made from cationic polymers shows improved duration of retention on the negatively charged ocular tissues such as cornea and conjunctiva. Thus increases the possibility of drug diffusion into the deeper ocular tissues [19].Another important factor to be considered in ocular drug delivery is the size of the nanoparticles. In order to diffuse the ocular barriers the size of the nanoparticles should be least minimum [19]. Nanoparticles with a size less than 200 nm can be used for anterior drug delivery [23].This size allows easier uptake of nanoparticles through cornea and conjunctiva. Nanoparticles with size less than 250 nm are usually taken up by endocytosis mediated by retinal cells [24].The pore size of the sclera ranges from 30-300 nm. This allows the passage of nanoparticles less than this size range through scleral membrane and large molecules are difficult to enter the sclera [19,25].

Eudragit Based Nanoformulations In Ocular Drug Delivery

Eudragit polymers are polyacrylate polymers made by polymerization of acrylic, methacrylic acid or their esters [26, 27]. They posses different degree of solubility and thus they are appropriate for sustained release of drug from the dosage forms. The eudragit polymers can be used for various purposes which include sustained release in predetermined manner, Gastro intestinal tract targeting by enteric formulations and taste masking [27]. The challenges in the conventional ocular drug delivery include tear drainage, reduced residence time and corneal epithelial impermeability. The eudragit polymers posses a suitable characteristics like cationic charge, controlled release profile and reduced toxicity. The cationic charge improves the ocular residence time by interacting with the ocular epithelial surface. The controlled release profile suggests reduced frequency of drug administration and better treatment efficacy [26]. The following section discuss about research studies based on eudragit nanocarriers to demonstrate their benefits in ocular drug delivery.

Long back, R. Pignatello *et al.* assessed the ocular tolerability of Eudragit RS 100 and Eudragit RL100 nanosuspension for controlled ocular delivery. Blank Eudragit RS and RL nanosuspensions and drug loaded nanosuspensions were prepared using quasi-emulsion solvent diffusion method. The damaging effects or ocular irritancy of the prepared nanoformulations was tested using modified Draize test. The *in vivo* studies showed that no ocular discomfort/inflammation was produced in the rabbit eyes. Four months after the preparation of formulation, the ocular tolerability was again tested. Conjuctival swelling, iris hyperemia and corneal opacity were found to be zero all the time. The drug loaded nanoformulation also resulted in improved bioavailability compared to eye drops. Since the nanoformulations posses a positive charge and very small size, it provided mucoadhesion to the corneal surface. This study concluded that the Eudragit RS 100 & RL 100 nanosuspension can be considered as a safe and

suitable carrier for ocular delivery [28]. The Eudragit RS 100 and RL 100 polymer excipients were widely accepted by USFDA as a tool for controlled drug delivery. They are also effective in providing small size, positive charge and mucoadhesive character to the formulation. In 2019, Elmotasem H *et al.* carried out optimization strategy in order to formulate an *in situ* gel formulation loaded with niosomal vesicles and Eudragit nanoparticles. The ocular drug delivery systems were developed as a carrier of Fluconazole for their antifungal activity. The main objective of the study was to prolong and improve bioavailability of the drug. The in vitro drug release study revealed a pattern of prolonged release from both nanoformulations. The smaller particle size is observed with Eudragit nanoparticles compared to the niosomal formulations. The developed formulations represented an improved permeation through corneal surface, which was assessed using isolated rabbit cornea. Besides the polymer, the cyclodextrin complex also acts as a permeation enhancer. The ocular toleration and antifungal activity of the prepared formulations were suitable for ocular drug delivery and this study pointed out the formulation as a better ocular drug delivery system for treating fungal infections [29].

Another study was carried out by Taghe. S *et al.* (2020), as they have developed polymeric inserts based on Eudragit RL 100 nanoparticles as a carrier for ocular delivery of Azithromycin(AZM). The nanoparticles were prepared using solvent diffusion technique. The Eudragit RL 100 nanoparticles loaded with AZM was incorporated into Hydroxy propyl methyl cellulose (HPMC) and Hydroxy ethyl cellulose (HEC) solution to obtain ocular inserts. A biphasic release pattern with initial burst release and later a sustained release pattern observed with Eudragit RL 100 nanoparticles of AZM. The release was observed for about 80.75 to 99.48% during six days. The *ex vivo* permeation studies performed in isolated goat cornea, suggested an improved corneal permeability. This may be due to the smaller size of the nanoparticles formulation (35.58-97.27 nm) and its hydrophobic character. The AZM-eudragit nanoparticles showed an increase in apparent permeability coefficient than AZM solution. The *in vivo* studies represented enhanced pharmacokinetics characteristics with AZM-eudragit nanoparticles. The study recommend the ocular inserts with AZM-eudragit can be considered as satisfactory delivery system with prolonged drug release, improved mucoadhesive properties and biodegradable characteristics. This system can reduce the frequency of drug administration and leading to increased patient compliance [30].

S. Datta *et al.* (2021) developed Nanoparticles loaded *in situ* gel for ophthalmic delivery of Ciprofloxacin. The nanoparticles were prepared using Eudragit RL 100 polymers by nano precipitation technique & *in situ* gel was formulated using chitosan polymer. The Study revealed that the nanoparticles loaded *in situ* gel provided improved permeability & drug release characteristics. The Quaternary ammonium groups in the Eudragit RL 100 may offer the improved permeability. The combined effect of Chitosan and Eudragit offered increased residence time in the cornea & they have concluded that the formulation can prolong drug release & thus reduce dosing frequency. Therefore it is an effective drug delivery system over conventional ocular drug delivery systems [31].

In 2022, Khin S.Y *et al.* developed Fenofibrate loaded Eudragit RL 100 nanoparticles suspension. The purpose was to increase the solubility of Fenofibrate through cyclodextrin complex and develop eye drop formulation containing Fenofibrate-eudragit nanoparticles. The particle size ranged between 50-100 nm and zeta potential values were ranged between +22.23 mV to +41.92 mV. The positive charge of nanoparticles formulation is suitable for ophthalmic drug delivery *i.e.* corneal adhesion by interaction of anionic surface of cornea and positively charged nano formulation thus prolongs corneal residence time. The *in vitro* mucoadhesive studies revealed that increase in the concentration of Eudragit RL 100 also increased percentage mucoadhesion. This may be due to interaction between ammonium groups of Eudragit and negative charge of mucin chains. The formulation demonstrated a sustained drug release pattern and improved permeation through mucin coated octanol membrane. This study concluded this formulation as a safe, non irritant drug delivery system for the treatment of diabetic retinopathy [32]. All these studies suggested Eudragit polymers exhibits a greater potential for ocular drug delivery since the nano formulations can overcome the barriers associated with ocular drug delivery.

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CONCLUSION

In the light of communicated reports, nanocarriers act as a potential technique to overcome barriers of ocular drug delivery. Especially Eudragit based nano formulations secured a valuable position in treating ocular diseases due to their unique properties like cationic charge for effective interaction with ocular mucosa, controlled release profile and ocular tolerability. The Eudragit polymers can be considered as a tool for novel ocular drug delivery due to their significant contributions and which can be even more appreciable in the future.

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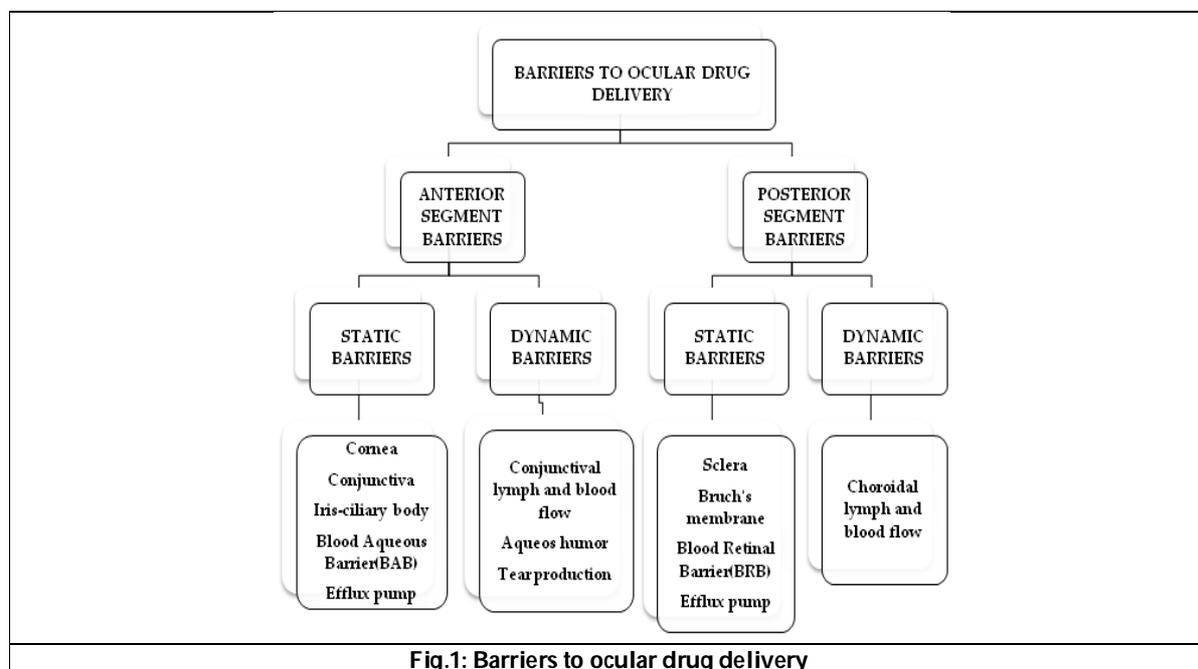
Fig.1: Barriers to ocular drug delivery

RESEARCH ARTICLE

NLP Approach for Recognizing Alzheimer's Dementia from Spontaneous Speech

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ABSTRACT

Alzheimer's disease is a progressive disorder that deteriorates memory and mental functioning. Identification of Alzheimer precisely becomes important in-order to monitor patients from their early stages of the disorder. The analysis becomes harder as the number of clinically generated records is low and hence the detection models are more likely to suffer from over-fitting. Analysis of patterns in spontaneous speech recordings and text transcripts using language models is observed to yield good results on detecting Alzheimer. In this paper different approaches are studied, and viable methods are presented for classification and MMSE score regression tasks, using ADReSS 2020 dataset. Previously existing acoustic feature extraction techniques are compared with recently developed pretrained language models. Pretrained ELMo model showed accuracy score of 83% and MMSE score of 4.53 for classification and regression tasks respectively, with 32.8% accuracy and 29% RMSE score improvement compared to baseline results.

Keywords: Speech processing · Natural language processing · Machine learning · MMSE · Dementia

INTRODUCTION

Alzheimer's dementia (AD) is a long-term disorder causing memory loss and cognitive function. Due to its severity worldwide, it is required to devise a more efficient and cost-effective way to detect Alzheimer's dementia. The

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MMSE score (mini mental state exam) is a 10-minute pencil and paper test, scaling the level of disorder out of a 0-30 scale. A MMSE score of 20 to 24 indicates mild dementia, 13 to 20 indicates moderate dementia, and less than 12 indicates severe dementia. An efficient way to predict MMSE score and to identify the disorder automatically could potentially reduce the requirement of clinical staff to audit and score MMSE tests. The development in the speech and natural language processing techniques has instilled the exploration of spontaneous speech-based systems for the detection of Alzheimer's patients. The progression in machine learning and deep learning from speech and text perspective has produced exceptional results. Patterns extracted from acoustic and linguistic features from speech utterances have been popular approaches for Alzheimer's classification in the past but with use of Vectorization techniques - TF, TF-IDF vectorization [1] and pretrained models - GLoVe, Word2Vec, ELMo, BERT have opened possibilities for improvement. Even though there is rapid development in the field of deep learning, it becomes a necessity to have large datasets, which is hard. It thereby becomes difficult to train deep models, urging the use of transfer learning techniques. Here we have designed and used pretrained models to produce viable results with even a small dataset. In this paper, acoustic, linguistic and vectorization models and pretrained embedding models are analysed for effective feature extraction. We then compare the performance of various ML models learned on these features. We thereby propose the best and effective method to predict the MMSE score as well as detect Alzheimer's dementia using vectorization and embedding techniques. The remainder of the paper is organized as follows. Section 2 discusses about dataset, as well as various features used for the classification and regression task. Section 3 outlines the experimental setup for the ADReSS task. The results and analysis of the proposed systems are given in Section 4. Section 5 concludes the paper.

Proposed System
Database
The common and general way to collect spontaneous speech sessions is through picture description test [9][22]. The patient has to describe what they could infer from the image displayed. The dataset consists of 156 recordings with 78 audio samples and corresponding transcripts of non-AD patients and 78 audio samples of AD patients. More details about the ADReSS challenge task is given in [10]. Age and gender distribution of the dataset is shown in Table 1 and Table 2. The features provided for each patient consists of full audio recordings of the conversations during the test and their corresponding text transcripts, age, gender of the individual.

The dataset used in the proposed work is provided by DementiaBank [3] for ADReSS (Alzheimer's Dementia Recognition through Spontaneous Speech) Challenge. The dataset consists of text transcripts containing both sides of an interview between an interviewer and a patient. The recognition models are trained on 108 recordings and the remaining 48 recordings are used as test data (approx. 30% of the total number of recordings). Each record has audio chunks generated from Voice Activity Detector (VAD) and normalized. The chunked recordings make up 1,955 speech segments from 78 non-AD subjects and 2122 speech segments from 78 AD subjects.

Features Extraction
In this section 3 different approach - Acoustic & cosine similarity features, TF/TF-IDF vectorization and pretrained text embedding features are studied. These 3 feature extraction strategies were studied individually and analysed.

Acoustic and Cosine similarity features
Since Alzheimer's dementia being a disorder of forgetfulness, it becomes valuable to segregate the audio clips into speech chunks and empty gaps [9][5][20]. Acoustic features are extracted from the audio clips. Also, the statistical measures such as mean, median, standard deviation of the lengths of voiced chunks are analysed and mean was observed to give important information. The VAD generated data is used to get the following features:

-Number
Number of speech utterances - Total number of normalized speech instances identified by the voice activity detector in a session recording.
Speech Rate – The number of speech utterances identified by the voice activity detector per second in the sessions

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recording.

Length of each utterance - Statistical measures such as mean, median and standard deviation of the speech utterance lengths generated by the voice activity detector.

Length of empty gaps - mean of lengths of empty gaps.

Ratio of speech length to empty length - Ratio between the length of speech segment to length of empty segment. Each speech session is annotated with transcripts using ASR systems [23][19][22]. The text transcripts with Parts of Speech [19] are considered, as they contain tags such as adjectives, verbs, etc., which could add to qualitative description of the shown image. In addition, a particular detail of the image could have been repeated by the patient during the image description test, which clearly indicates the forgetfulness of the patient. These repetitions are captured by generating a bag of words from the most significant words in the sentences and comparing each pair of sentences using cosine similarity [17][21][4]. Cosine similarity between two sentence vectors , $\mathbf{s}\vec{d}, \vec{q}$ is calculated as

$$-\vec{d} = \omega_{d0}, \omega_{d1,...,} \omega_{dk} \quad (1)$$
$$-\vec{q} = \omega_{q0}, \omega_{q1,...,} \omega_{qk} \quad (2)$$

Where w_{di} and w_{qi}, indicate the frequency of each term in a sentence.

$Cosine\text{-}similarity\ (-\vec{d}, -\vec{q}) = -\vec{d}. -\vec{q}\ |\ \vec{d}. -\vec{q}\ |\ (3)$

Features extracted for linguistic and sentence similarities:

POS count - POS tag count.

Cosine similarity - Each sentence is converted into bag of words and pairwise cosine similarity of sentences within each transcript is generated. Mean of the similarity values are then calculated.

Vectorization Techniques

Occurrence based vectorization techniques [8] are applied on the text transcripts to convert text documents into numerical vectors. The occurrence-based vectorization techniques considered are:

TF Vectorization

TF-IDF Vectorization

The count vectorization constructs a table of word counts for words in the transcripts, POS tags, etc., The repetition of words is observed to be a potential feature as memory loss patients tend to repeat the sentences or words that they said previously. Term Frequency-Inverse Document frequency (TF-IDF) vectorization is also considered to give good results [21]. It contains two parts – term frequency part and the inverse document frequency part. The term frequency counts and normalizes the word count with respect to total words in the document. The term frequency of common words like 'the', 'a', 'in', 'of' would suppress the term frequency of important terms, so, to reduce this effect, an inverse document frequency term is introduced. For each word t in a document d from the document set D TD-IDF is calculated as:

$$tfidf(t,d,D) = tf(t,d).idf(tD) \qquad (4)$$

Were

$$tf(t,d) = log(1 + freq(t,d)) \qquad (5)$$
$$idf(t,D) = log(N\ count(d_{\in}D : td)) \qquad (6)$$

N is the total number of documents.

Text Embedding

Even though the strategies explained in 2.2.1 and 2.2.2 produce improvements in performance, it is limited by the number of labeled records available for training. So, language models pretrained on large corpus of unlabeled text

could be considered to extract semantic feature vectors. The following pretrained embedding models are studied individually:

Word 2 Vec - CBOW based model [11], pretrained on 100B Google News.
GloVe - Log-bilinear model with a weighted least-squares objective [15], trained on 6B Wikipedia 2014 and Gigaword5 corpus is used. As [12] has proven that GloVe model gives relatively good results, this model was considered for the study.
Fast text - Skipgram model with each word represented as a bag of char n-gram [7][4], trained on 16B Wikipedia 2017 corpus.
ELMo - Deep bidirectional language model [16], learned on 1.9B Wikipedia + 3.9B WMT corpus.
BERT - Transformer based model [6] – BERT-Large Cased weighted is used. As BERT is the state-of-the-art model for text classification tasks such as sentiment analysis, this model is considered.

A sentence of L words generates a embedding of dimension D*L, where D is the embedding dimension on which the language model is trained on. The vector average of these word embedding (dimension 1*D) is considered as feature vector for each sentence. The transcripts are preprocessed to extract only the conversational sentences and then embedding is applied.

Experimental setup

10-fold cross validation is performed on the train dataset. The features explained in Section 2.2.1 is hand engineered, the vectorization features explained in Section 2.2.2 is extracted using scikit- learn feature extraction module, with n-gram value as 1. The Word2Vec, GloVe, Fasttext, ELMo models are implemented using magnitude library [13] and BERT model is implemented using sentence- transformer library [18]. Various machine learning models such as Bernoulli Naive Bayes (NB), Random Forest (RF), Multilayer perceptron (MLP) with single hidden layer of 512 nodes and Support Vector Machine (SVM) with polynomial kernels were trained with features as explained in Section 2. The models are compared using accuracy and F1 scores for classification and Root Mean Square Error (RMSE) for regression, with scikit-learn metrics module [14].

Alzheimer's dementia Classification The inputs for this task are the features extracted from the above-mentioned techniques. The outputs are 0 for non-AD patients and 1 for AD patients. MMSE score prediction the inputs for this task are the same as those used for the classification task but here the output is the MMSE score of the patient, which a real valued number is ranging from 0 to 30.

RESULTS AND DISCUSSION

The following subsections briefly discuss the results of the various systems developed for classification and regression tasks.

AD classification task

The acoustic features from speech and cosine similarity between sentences are extracted and different machine learning models are compared. Even though these hand engineered features don't produce great performance, it clearly surpasses the baseline systems. TF-IDF vectors extracted from text transcripts, generate sparse vectors of high dimensions. These vectors are classified using different machine learning models. The cross- validation results of the classification task using different classifiers are given in Table 3. From Table 3 it can be observed that high dimension sparse matrix TF-IDF features along with NB classifier is a viable model as explained in [2], producing cross validation accuracy of 95%and cross validated RMSE score of 3.264. By using the pretrained sentence embedding models such as GloVe, word2vec, ELMo, FastText and BERT, the sentences of the patients' transcripts are encoded. Multilayer Perceptron model is observed to show better results for classification and so was considered to compare the embedding models. Out of all the trained embedding techniques ELMo and Fasttext techniques shined well with

cross validation accuracy above 85%, as shown in Table 3. As these embedding models are pretrained on a large corpus in an unsupervised fashion, they showed better results compared to hand engineered acoustic and cosine similarity model. From Table 4, the improvement in results is clearly visible comparing the text embedding techniques with acoustic and primitive linguistic features extracted. The advancement of the unsupervised pre-trained language models for feature transfer has increased the accuracy by around 4-5% as compared to acoustic and cosine similarity features.

From Table 3, it has been noted that the TF- IDF, ELMo and Fasttext models produce accuracy results above 85% with just the text transcripts of the sessions.

MMSE prediction task
Using the same pipeline explained in Section 4.1, MMSE prediction task is carried out. The results of the MMSE prediction task are shown in Table 5. It is observed that the random forest model with TF- IDF, ELMo and Fasttext embedding show viable solutions for the task. From Table 6, it can be observed that pretrained embedding models and TF- IDF models are showing better performance compared to hand engineered acoustic and cosine similarity features.

Testing
The test data is distributed equally among the various age groups to maintain generality [10]. We have submitted scores of five systems for the ADReSS challenge task. It could be observed that the ELMo embedding gives up to 83% accuracy for task1 and 4.53 RMSE for task2 in the test-set. The TF-IDF gives good improvement compared to baseline results with RMSE score of 4.32. The results on the test set for classification task and prediction task are shown in Table 7 and 8 respectively.

CONCLUSIONS

Text patterns extracted from spontaneous speech are extremely helpful in the identification of AD efficiently even when using a small dataset. This paper compares various speech and NLP based approaches for both classification and MMSE prediction tasks. It is observed that the TFIDF and ELMo language model show significant improvement from the baseline model. ELMo embedding features produce 83% accuracy for AD classification tasks on the test-set, showing 33% improvement over the challenge baseline system. ELMo model showed RMSE score of 4.53 for MMSE prediction task, with 29% improvement over the challenge baseline system. Altogether, this paper showed that text-based features give best results for both cross validation and test set respectively by fine tuning language models trained on large corpus.

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Table 1 ADReSS challenge training set details

Age Interval	AD male	female	non-AD male	female
[50,55)	1	0	1	0
[55,60)	5	4	5	4
[60,65)	3	6	3	6
[65,70)	6	10	6	10
[70,75)	6	8	6	8
[75,80)	3	2	3	2
Total	24	30	24	30

Table 2 ADReSS challenge test set details

Age Interval	AD male	female	non-AD male	female
[50,55)	1	0	1	0
[55,60)	2	2	2	2
[60,65)	1	3	1	3
[65,70)	3	4	3	4
[70,75)	3	3	3	3
[75,80)	1	1	1	1
Total	11	13	11	13

Table 3 cross validation scores of various systems with different classifiers for the ad classification task

Feature	Model	Accuracy	F1Score
Acoustic	MLP	**0.82**	**0.81**
+	LR	0.80	0.80
Cosine	NB	0.54	0.53
Sin	SVM	0.63	0.63
	RF	0.76	0.76
TF	MLP	0.84	0.84
	LR	0.82	0.81
	NB	**0.95**	**0.95**
	SVM	0.71	0.68
	RF	**0.95**	**0.95**
TF	MLP	0.85	0.85
IDF	LR	0.79	0.79
	NB	**0.95**	**0.95**
	SVM	0.83	0.83
	RF	0.93	0.92
GloVe	MLP	0.84	0.84
Word2Vec	MLP	0.83	0.83
Fast text	MLP	**0.86**	**0.86**
ELMo	MLP	0.85	0.85
BERT	MLP	0.83	0.83

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Table 4 summary of best classification models from the various feature-classifier combinations

Feature	Accuracy	F1Score
Acoustic + cosine similarity	0.82	0.81
TF-IDF vectorization	0.95	0.95
Fast text-Embedding	0.86	0.86

Table 5 cross validation scores of various models with different classifiers, for MMSE regression task

Feature	Model	RMSE
Acoustic	MLP	8.253
Cosin	LR	6.018
Sin	SVM	7.624
	RF	**5.515**
TF	MLP	7.869
	LR	5.369
	SVM	6.767
	RF	**3.585**
TF	MLP	5.934
IDF	LR	5.291
	SVM	6.767
	RF	**3.264**
GloVe	RF	4.881
Word2Vec	RF	5.169
Fasttext	RF	4.698
ELMo	RF	4.738
BERT	RF	**5.137**

Table 1 summary of best MMSE regression models from the different feature-model combinations

Feature	RMSE score
Acoustic + cosine similarity	5.51
TF-IDF vectorization	3.264
Fast text-Embedding	4.698

Table 7 performance of the baseline and the test-set scores for Alzheimer classification task

Feature	Model	Accuracy	F1score
Baseline(com ParE)[10]	-	0.625	-
Acoustic + cosine similarity	MLP	0.6875	0.6863
TF-IDF	NB	0.7917	0.7883
TF-IDF	RF	**0.8125**	**0.8124**
Fasttext	MLP	0.7917	0.7902
ELMo	MLP	**0.8333**	**0.8322**

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Table 8 performance of the baseline and the test-set scores for MMSE prediction task

Feature	Model	RMSE score
Baseline(com Par E)[10]	-	6.14
Acoustic + cosine similarity	RF	4.6021
TF-IDF	RF	6.9532
TF-IDF	LR	**4.3268**
Fast text	MLP	4.7171
ELMo	MLP	**4.5350**

RESEARCH ARTICLE

Phytochemical Analysis and Antifungal Activity of Medicinal Plants against *Candida albicans*: an *In vitro* Study

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ABSTRACT

Plants as source of medicinal compounds have continued to play a predominant role in the maintenance of human health since ancient time. The present study was designated to evaluate the antifungal activities of methanolic, acetone, chloroform and aqueous extract from leaves of *Psidium guajava, Couroupita guianensis* and *Cymbopogon citratus.* The antifungal activities of the extracts against *Candida albicans* were screened by agar well diffusion method, Compared to all organic solvents methanolic extract of all the leaves extract showing good result against *Candida albicans*, where as acetone and chloroform extract shows moderate activity and aqueous extract showing low antifungal activity. The phytochemical examination of both qualitative and quantitative testof these leaf extracts has high alkaloid, flavonoid, phenol and steroids, but relatively low in tannin, terpenoid, glycosides, saponins, carbohydrates, amino acids and proteins.

Keywords: Antifungal activity, *Candida albicans, Couroupita guianensis, Cymbopogon citratus,* Methanolic extract, Phytochemical analysis, *Psidium guajava.*

INTRODUCTION

Candida albicans is a common microbe in the oral cavity, it has the potential to develop into a pathogen that cause on oral infection if there are underlying risk factors. The risk factor are low immunity, metabolic illness, immunosuppressive treatment and acquired immunodeficiency syndrome(AIDS/HIV). Upto 50% of instances of oral candidiasis are brought on by *candida albicans*. Clinical manifestations of the infection include pseudomembranous candidiasis, erythematous candidiasis, leukoplakia candidiasis and denture stomatitis. Angular cheilitis, median rhomboid glossitis and HIV related oral candidiasis are associated to it. Additionally *candida albicans* leads to the development of microbial activity, which results in the fermentation of glucose and maltose and the production of acid and gases [1].The use of synthetic materials for treatment has advanced significantly, nystatin, amphotericin B, ketoconazole and fluconazole are example of synthetic antifungal medication. Due to the prolonged usage of synthetic (conventional) medications, microbes are now resistant to many antibiotics, in order avoid the adverse effect, different therapeutic approaches such as herbal medicines are required [2].

Psidium guajava most commonly referred to as the guava, belong to family myrtaceae [3]. Due to its pharmacological properties, *Psidium guajava* is used as both a food and a traditional medicine in almost everywhere in the globe. This plant play a significant role in the medicinal systemal most everywhere in the world. It is commonly known that guava is frequently used in many regions of the world to treat a variety of illnesses including carries, gastroenteritis, hypertension, diarrhea, reducing fever, dysentery, pain relief and diabetes [4]. *Couroupita guianesis* belonging to family lecythidaceae, *C guianesis* is used to treat hypertension, tumors, pain and inflammatory processes and also used to boost the immune system to fight number of disease [5]. And *Cymbopogon citratus* commonly known as lemongrass belongs to the poaceae family, it has been traditionally used to treat fever, cough, elephantiasis flu, leprosy, malaria, and also used for HIV complications, especially secondary bacterial infections and other digestive problems [6]. In this present study we tried to find out the antifungal effect of *Psidium guajava*, *Couroupita guianesis* and *Cymbopogon citratus* leaves extracts against *Candida albicans* and also phytochemical analysis of the medicinal plants.

MATERIALS AND METHODS

Preparation and identification of leaf powder
Fresh leaves from different plants were collected from Bhadravathi taluk of Shivamogga district, these leaves were washed twice with distilled water and cut into small pieces with a knife or scissors and allowed to air dry. The dried leaves were then grinded into a fine powder using a sterile electric grinding jar. The powder was collected and kept dry and out of the sun in an air tight container [7]. The collected plant leaves were identified by the Department of Botany, Sahyadri Science College, Kuvempu Univercity, Shivamogga.

Preparation of solvent extracts of leaf powder
10gm of grinded plant material was dissolved for 48hours in 100ml organic solvent (methanol, acetone, chloroform and aqueous. Hi media Pvt. Ltd. Bombay). At the end, the extract was filtered through whatman filter paper No 1. The filtrate was collected and evaporated under low pressure and final extract was stored at 4ºC for further study [8][9].

Qualitative analysis of the phytochemical constituents of medicinal plants
Alkaloids test: The extract was collected in test tube and add 0.2ml of diluted HCl. Then 1ml of Meyer's reagent was added. A yellowish coloration suggests the existence of alkaloids [10].

Flavonoid test: Two ml of 2% NaOH mixture was mixed with leaves extract, formation of concentrated yellow color andyellow color disappears when we add 2 drop of diluted acid to test sample, this result indicates the flavonoid presence[11].

Steroids test: Plant extract were taken in test tube and dissolved with chloroform (10ml) and then addequal amount of concentrated sulfuric acid to the test tube. The upper layer of the solution was converted into red and sulfuric acid layer showed yellowish with green fluorescence. It indicates the presence of steroids in the leaves extracts [12].

Terpenoid test: Chloroform (2ml) was mixed with 5ml of plant extract and 3ml of conc H_2SO_4 was carefully applied to create a layer, for positive result for terpenoid, a coloration of reddish brown was developed [13].

Tannin test: About 5ml of the leaf extract was taken in a test tube and add 2ml of 5% of the $FeCl_3$ solution. A greenish black precipitate suggests that presence of tannin [10].

Glycosides test: A small amount of extract was taken in a test tube and add 1ml of water and few drops of aqueous NaOH, a yellowish color indicate the presence of glycosides [14].

Phenol test: About 0.2g of plant extract was weighted and treated with 5% ferric chloride and observed for the formation of deep blue color, which indicates the presence of phenol [14].

Carbohydrate test: Benedict's reagent of 0.5ml was treated with 0.5ml of plant extract, then incubated in water bath for 2-4 minutes. The distinctive red color shows the presence of reducing sugar [13].

Amino acid test: Plant extract of 0.2g was weighted and treated with ninhydrin solution and noted for a distinctive purple color, suggesting the presence of amino acid[14].

Protein test: Few drop of the biuret reagent were added to the leaves extract, boil for one minutes and observed for violet precipitate formation indicating the protein presence.

Quantitative analysis of the phytochemical constituents of medicinal plants
Determination of alkaloid: A total of 200ml of 20% acetic acid was added to5g of leaf powder taken in a separate 250ml beaker and stand for 4 hours. The mixture containing solution was filtered and the volume was compressed to one fourth of solution using water bath. To this sample concentrated ammonium hydroxide was added drop by drop until the precipitate was fully formed. The whole solution was allowed to settle and the precipitate was collected via filtration and weighed [15].

The percentage of the total amount of alkaloid was determined as
% alkaloid= Wg of residue / Wg of sample × 100

Determination of flavonoid: 2.5 g of the sample were taken in a 250ml beaker to this add 50ml of the 80% aqueous methyl alcohol. The beaker was covered and left for 4 hours at room temperature. The residue was again extracted with same volume of ethanol after the supernatant was discarded. The material was filtered using whatman filter paper number 1. After that, the sample filtrate was put into a crucible and dried over a water bath. The crucible's contents were cooled in a desiccator before being weighed to maintain a constant weight [16].

The flavonoid content was calculated as:
% flavonoid = Wg of residue/ Wg of sample × 100

Determination of total phenol: Leaf extract were dissolved in 80% Methanol at a concentration of 100µg/ml. folin-ciocalteu reagent was then mixed with 100µl of the solution (1N). This mixture was agitated after 3 minutes, 2ml of 2% Na_2CO_3 was added, mixed and incubated for 30 minutes in the dark. Using a UV Spectrophotometer, absorbance was taken at 750nm. The results were given in mg of gallic acid equivalent/gram of extract (mg GAE/g). Gallic acid was used as the standard to create a calibration curve [17].

Determination of antimicrobial activity of medicinal plants

Psidium guajava, Couroupita guianensis and *Cymbopogon citratus* leaf extracts (methanol, acetone, chloroform and aqueous) were subjected for antimicrobial activity against *Candida albicans* stain (NCIM 3628).

Preparation of *Candida albicans* Suspension

Standard stain was inoculated on SDA media with the help of inoculation loop. Then colonies were transferred on to SD broth tubes, the tubes were incubated at 37ºC for 24-48 hours. The broth turbidity was compared with Mac Farland 0.5 standard and final turbidity of the suspension was equivalent to 1.5×10^8 cfu/ml of fungal count [1].

Antifungal activity by agar well diffusion method

Sterile SDA medium was prepared poured into plates. Using sterile cotton swabs, the standardized *Candida* suspension was swabbed to the solidified culture medium and left10 minutes. A control Petri plate without inoculation was used. Test plates and control wells were made, to the wells leaf extract of different concentrations of 25, 50 and 75%were added respectively.10% DMSO was used as the negative control and nystatin was used as the positive control. Plates were incubated at 37ºC for 24-48 hours, the zone of inhibition was assessed using the Himedia zone scale. The entire process was carried out in triplicate, following the methodology of[7][3][18].

Statistical analysis

A quantitative study of phytochemical components and antimicrobial activity was conducted in triplicate.Mean and standard deviation (mean ± SD) were calculated using Microsoft excel 2016 software.

RESULT AND DISCUSSSION

Qualitative analysis of the phytochemical constituents of medicinal plants

In the present study phytochemical screening was carried out with methanol, chloroform, acetone and aqueous extractsleaves of (*Psidium guajava, Couroupita guianensis and Cymbopogon citratus*).These leaves were abundant in flavonoid, alkaloids, phenol, terpenoids, tannins and steroids. Traditionally, the medicinal plants grown in rural area, were used for the recovery of inflammation, wound healing, carminative, expectorant antiseptic and also even for certain infection of candidiasis [19][20]. Table 1 shows the result of phytochemical screening of the methanol, acetone, chloroform and aqueous extract of medicinal plants. The alkaloid, flavonoid, steroids, terpenoid, tannin and phenol were present in different solvent extracts of *Psidium guajava*, our results correlate with the previous work [21]. *Couroupita guianensis* shows alkaloid, flavonoid, tannin, steroid and phenol were there in different solvent extracts, the previous study concordant by[5]. The alkaloid, flavonoid, steroids, tannin and phenol are there in different solvent extraction of *Cymbopogon citratus,* our results correlate with the previous work [22].

Quantitative analysis of the phytochemical constituents of medicinal plants

Methanol extract obtained in this study showed higher solubility for more number of phytochemicals, due to the reason, the quantitative determination of phytochemicals was carried out for only methanol extract solvent. In our study quantitative analysis of alkaloid was 3.36±0.01, flavonoid was 1.60±0.05 and phenol (µg/mg) was 242±0.03 in *Psidium guajava* leaf extract, in previous study alkaloid and flavonoid was 0.54mg/g and 6.42 ±0.01mg/g respectively has been reported in *Psidium guajava* [23].

In current study shows that alkaloid was 31.66±0.57, flavonoid was14.44±1.15 and phenol(µg/mg) was 92.24±0.4 in *Couroupita guianensis* leaf extract, in previous study alkaloidwas 2.4 ±0.12, flavonoid was 30.4±1.52 and phenol (µg/mg) was 1.1±0.06 reported in [24].In present study shows that alkaloid was 31.33±1.17, flavonoid was 15.66±0.5 and phenol(µg/ml) was 20.81±0.06 in *Cymbopogon citratus* leaf extract, in previous study phenol and flavonoid was 1584.56±16.32mg/g and 5.8mg/g respectively has been reported in [25][26].The quantitative analysis of methanol extract of leaves was depicted in (table 2).

Antimicrobial screening by agar well diffusion method

The zone of inhibition for the *Candida albicans* stain was assessed after 24 to 48 hours of incubation. The results of the inhibition zone measurements arein millimeter (mm)in table 3. The methanol, acetone, chloroform and aqueous in different concentration can be used for extraction purpose. However, methanol extract of three plants were also equal competent for inhibitory activity against *Candida albicans*. Acetone extract shows mild antifungal activity. Whereas, the chloroform and aqueous extract shows low activity. In these three plant extract *Psidium guajava* showed more inhibitory activity against test culture compare to *Couroupita guianensis* and *Cymbopogon citrates* leaf extract (figure 4-6). Our result correlate with the previous work done by (2)(27)(6). Inhibition zones are formed due to the presence of active substances contained in *Psidium guajava, Couroupita guianensis* and *Cymbopogon citrates* leaf extracts contain alkaloids, flavonoids, tannin and steroids. Alkaloids have antimicrobial activity due to pH more than 7 the alkaline properties that can inhibit the RNA and DNA polymerization and fungal cell protein synthesis. Therefore the growth of *Candida albicans* can be suppressed. Flavonoids are biological response because of their intrinsic ability to alter the reaction of the allergies and they have anti-inflammatory, antimicrobial anticancer activity. Tannin is a polyphenol group compound that works with the target of fungal cell wall polypeptide which causes damage to the fungal cell wall and causes increase to fungal cell permeability, thus fungal growth is inhibited, steroids are inhibit fungal growth through the cytoplasm of the fungal cell or interfere with the growth and development of fungal spores, steroids have lipophilic properties that can inhibit spore generation [1].

CONCLUSION

Our findings suggest that these leaves may be a beneficial dietary source of bioactivechemical, and aid that their consumption may aid in the prevention of a number of ailments. Therefore, these plants extracts may be the good source for many novel medications. Many of these substances are known to have strong antifungal and antioxidant properties. Our preliminary result supports the use of leaves in pharmaceuticals as a naturalantifungal agents. This present study will be useful in tracing of different agentsand can be used to treat fungal diseases which are prevalent in particular areas.

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Table 1: Qualitative analysis of phytochemical constituents of medicinal plants.

SI. No	Medicinal plants	Solvent used	A	F	S	Te	Ta	G	P	C	Aa-	Pr
01	*Psidium guajava*	Methanol	+	+	+	+	+	-	+	-	-	-
		Acetone	+	+	+	+	+	-	+	-	-	-
		Chloroform	+	+	+	-	-	+	+	-	-	-
		Aqueous	+	+	-	+	+	+	+	-	-	+
02	*Couroupitaguianensis*	Methanol	+	+	+	+	-	+	+	+	-	-
		Acetone	+	+	-	+	-	+	+	-	-	-
		Chloroform	+	+	+	-	+	-	+	-	-	-
		Aqueous	+	+	-	+	-	-	+	-	-	-
03	*Cymbopogoncitratus*	Methanol	+	+	-	+	+	-	+	+	-	-
		Acetone	+	+	-	-	-	+	+	-	-	-
		Chloroform	+	+	+	-	-	+	+	-	-	-
		Aqueous	+	-	-	-	+	+	+	-	-	-

A: Alkaloid; **F: Flavonoid**; **S: Steroids**; **Te: Terpenoid**; **Ta: Tannin**; **G: Glycosides**; **P: Phenol**; **C: Carbohydrates**; **Aa⁻: Amino acid; Pr; Protein.**

Table 2: Quantitative analysis of phytochemical constituents of methanol extract of medicinal plants:

SI. No	Medicinal plants	Phytochemical constituents	Amount of compounds (%)
01	*Psidium guajava*	Alkaloid	3.36 ± 0.01
		Flavonoid	1.60 ± 0.05
		Phenol (μg/mg)	242 ± 0.03
02	*Couroupita guianensis*	Alkaloid	31.66 ± 0.57
		Flavonoid	14.66 ± 1.15
		Phenol (μg/mg)	92.24 ± 0.4
03	*Cymbopogon citratus*	Alkaloid	31.33 ± 1.1
		Flavonoid	15.66 ± 0.5
		Phenol (μg/mg)	20.81 ± 0.06

Table 3: Antimicrobial activity of medicinal plants against *Candida albicans* by agar well diffusion method

Medicinal plants	Plant extract	Zone of inhibition in mm				
		25%	50%	75%	Standard (Nystatin)	Control (DMSO)
Psidium guajava	Methanol	17.33 ± 0.57	19.66 ± 0.57	24.33 ± 0.58	13.6 ± 0.57	0
	Acetone	16.66 ± 0.58	18.33 ± 0.57	19.66 ± 0.57	14.33 ± 0.58	0
	Chloroform	16 ± 1.0	17.33 ± 0.58	18.33 ± 0.57	13 ± 0.0	0
	Aqueous	15.66 ± 0.57	16.66 ± 0.5	17.66 ± 0.57	13.66 ± 0.5	0
Couroupita guianensis	Methanol	11.66 ± 0.57	13.66 ± 0.5	16.33 ± 0.57	14 ± 1.0	0
	Acetone	13.33 ± 0.57	13.33 ± 0.5	15.66 ± 0.57	14.33 ± 1.1	0
	Chloroform	11 ± 1.0	13 ± 1.0	15.33 ± 1.15	13.66 ± 1.5	0
	Aqueous	11.66 ± 0.6	13.33 ± 0.5	15.33 ± 1.1	14.33 ± 1.1	0
Cymbopogoncitratus	Methanol	12.33 ± 1.5	14 ± 1.0	16 ± 0.0	14.33 ± 0.57	0
	Acetone	11.66 ± 0.57	14 ± 1.0	15.66 ± 0.57	14.66 ± 0.5	0
	Chloroform	12.33 ± 0.57	13.66 ± 0.5	14.33 ± 1.15	15.33 ± 0.57	0
	Aqueous	0	10.66 ± 0.57	12 ± 1.0	13 ± 1.0	0

Each value is the mean of three replicate determination ± standard deviation (SD).
DMSO = Dimethyl Sulfoxide.
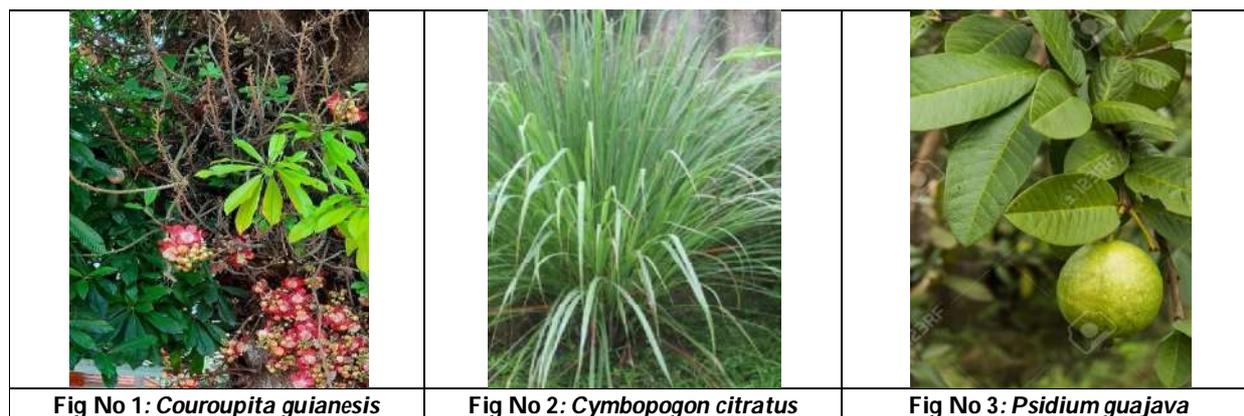
Fig No 1: *Couroupita guianesis*	**Fig No 2:** *Cymbopogon citratus*	**Fig No 3:** *Psidium guajava*

Collection of different plant leaves for the study
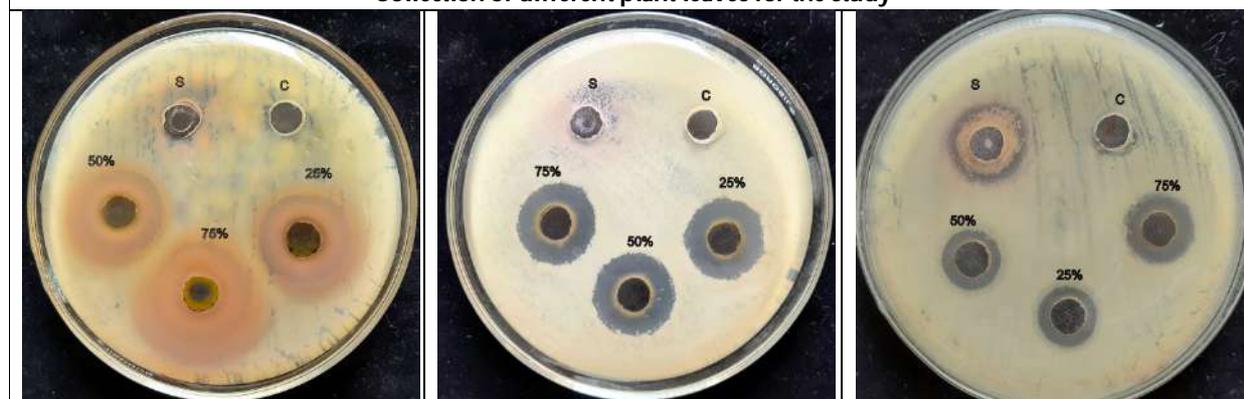
Fig No 4: *Psidium guajava*	**Fig No 5:** *Couroupita guinensis*	**Fig No 6:** *Cymbopogon citratus*

Antimicrobial activity of medicinal plants against *Candida albicans* by agar well diffusion method. Where C= Control and S = Standard.

RESEARCH ARTICLE

A Comparison Study between C and F Fly Ash Aggregates

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ABSTRACT

In the past, many researchers have researched the utilization of fly ash in concrete as the replacement of cement. It is focused on partial replacement of cement with appropriate amounts of fly ash, but utilization of fly ash aggregates in concrete as the replacement of natural aggregates helped in large volume in construction. In the present scenario, the researcher mostly interested to do the research in fly ash in wide range because the utilization of large amount of fly ash reduces the environmental pollution and abate of natural resources. Natural aggregates used in concrete as an inert filler give strength and provide bulk volume to the concrete. Natural crushed aggregates that used in concrete are mainly produced from exhausting the natural resources so that it requires substitute building materials. So it leds wide research on using the waste product as the preparation of aggregate. So fly ash use to prepare the aggregate which mix with cement in the ratio of 1:5 having the water cement ratio 0.3 to 0.5 in a standard atmospheric condition. In this paper it is mainly concentrated on fly ash aggregate that is light in weight and followed by 28 days of curing. The shape of these aggregates are round and approximately 10-20mm size. The tests have been conducted for the characteristic of the fly ash aggregates and the result suggested that these fly ash aggregates can be used as the replacement of natural coarse aggregate in concrete. The by-products like fly ash, bottomash, silica fumes, blast furnace slag that used to prepare the artificial lightweight aggregates. Fly ash are the byproducts of nearby power plants like NTPC, Talcher & IMFA power plant, Choudwar easily available with minimum cost. In the recent time, due to the cost effectiveness, the construction material are widely used in concrete for mass application.

Keywords: replacement, fly ash, Choudwar, concrete

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INTRODUCTION

Fly ash is a harmful byproduct released from thermal power plants and that causes environmental pollution. In India due to rapid increase in the population, use of electricity also increases in a heavy demand in the domestic as well as commercial purposes. So thermal power plants produce electricity and as a result the byproduct like fly ash is also produced in large quantities. Fly ash is the harmful byproducts that cause environmental pollution. In India the use of coals used in power plant mainly contains high quantity of fly ash which aggravates the dumping issue. We can use fly ash aggregate as the coarse aggregate replacement material because dumping is a serious challenge to the environment. Now a days due to the scarcity of the basic materials used for construction, the world is facing many problems. The extended utility of natural resources for concrete manufacturing some location in India, generate many alarming situation to the environment. So the research work particular these areas have been doing to find new alternatives materials. Hence in the present scenario, the researcher concentrated on artificial fly ash aggregates by replacing natural coarse aggregates.

The whole world is facing many problems due to the less availability of raw materials for construction. On the other hand the natural resources get diminished by continuous use for the production of concrete. Soits a very big challenge for the researchers to identify the new alternatives of the natural resources for the construction industry. In this condition, artificial fly ash aggregates is very much focused as compare to coarse aggregates. In concrete the waste material like fly ash mixed with cement as binder can be used In concrete the cement and fly ash mix together as a binder. This industrial waste product fly ash is the essential requirement for the green building, as this is environmental friendly building material, because it reduces the pollution.

Fly ash is of two types
1. C-Type
2. F-Type

Test On Fly Ash
1. FINENESS TEST
2. SPECIFIC GRAVITY TEST

Moisture Content Test
.Fineness Test:
Take 100gms of fly ash sample and do the wet sieving by using 45 micron for 15 to 20 minutes.Take the wet fly ash including the sieve for drying in the oven for 15-20 minutes at a temperature of 100-110 degree C.Collect the dry sample and take the weight.
Calculation = (Total wt.- Passing of wt 45 micron)/100

Specific gravity Test
There are two methods used for this test
a. By using Pycnometer
b. By using density bottle
Specific gravity(G) = $W_2-W_1/(W_2-W_1)-(W_3-W_4)$

Moisture Content Test
Take both C & F-fly ash in a container .Weight the samples and then put the samples of both the fly ash into the oven to dry.Then take the measurement of both the samples and calculate the percentage of moisture content.
Weight the C-fly ash samples i.e. W_1= 71 gm
Weight the C-fly ash samples after oven dry i.e. W_2= 71 gm
So, the moisture content for the given sample of C-fly ash =W_2 -W_1=0

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% of moisture content ={(W2-W1)/W1}X100
$\qquad\qquad$ =0%
Weight the F-fly ash samples i.e. W1= 79 gm
Weight the F-fly ash samples after oven dry i.e. W2= 78 gm
So, the moisture content for the given sample of F-fly ash =W2 -W1=1gm
% of moisture content ={(W2-W1)/W1}X100s
$\qquad\qquad$ =1.26%

RESULTS AND DISCUSSION

From the experimental data it was found that
1. The fineness value for C-fly ash was 35% and for F-fly ash was 26%
2. The specific gravity of C -fly ash in pycnometer was 1.94
    The specific gravity of C -fly ash in density bottle was 1.66
    The specific gravity of F -fly ash in pycnometer was 2.6
    The specific gravity of C -fly ash in density bottle was 3.2
3. The moisture content of C-fly ash was 0
The moisture content of F-fly ash was 1.26 %

CONCLUSIONS

This project gives us a conclusion of the study about fly ash and its types. The experiment work has been done on the physical properties of different types of fly ash. Also, we have a comparative study between C-fly ash, F-fly ash with cement. After the experiment, It concluded that we can preferably use the type-C fly ash as the partial replacement of cement to prepare the fly ash aggregate as it will be very light in weight and cost-effective in our future work.

ACKNOWLEDGMENTS

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Table 1. types of Fly ash

SI No	C-Type Fly ash	F-Type Fly ash
1		
2	It is light in colour.	It is dark in colour.
3	C-Type contains a high quantity of calcium oxide(CaO) i.e. more than 20%.	F-Type contains less quantity of calcium oxide(CaO)i.e. less than 10%.

Table 2. Fineness

[1]	Fineness Test (C-type Fly Ash)	[2]	Fineness Test (F-type Fly Ash)
[3]	As per is IS code 3812 part 2 particles retained on 45 micron IS sieve (wet sieving) in less than 50 percent.	[4]	As per is IS code 3812 part 2 particles retained on 45 micron IS sieve (wet sieving) in less than 34 percent.
	[5]		[6]

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[7]	[8]
[9] % of fineness of type C-Fly ash is 35	[10] % of fineness of type F-Fly ash is 26

Table 3. Specific gravity

[11] **By Pycnometer(for class-C fly ash)**	[12] **By Pycnometer(for class-F fly ash)**
[13] Weight of empty bottle (W_1)= 679gm	[18] Weight of empty bottle (W_1)= 677gm
[14] Weight of container + wt dry fly ash(W_2)=.846gm	[19] Weight of container + wt dry fly ash(W_2)=.985gm
[15] Weight of container wt dry fly ash +water (W_3)=1.767 kg	[20] Weight of container wt dry fly ash +water(W_3)=1.879 kg
[16] Weight of container + water(W_4)=.1.686 kg	[21] Weight of container + water(W_4)=.1.686 kg
[17] Specific gravity (G) = W_2-W_1/(W_2-W_1)-(W_3-W_4)	[22] Specific gravity (G) = W_2-W_1/(W_2-W_1)-(W_3-W_4)
[23] **Specific gravity of C-class fly ash is 1.94**	[24] **Specific gravity of F-class fly ash is 2.63**

Table 4. Density Bottle

[25] **By Density Bottle(for class-C fly ash)**	[26] **By Density Bottle(for class-F fly ash)**
[27] Weight of empty bottle (W_1)= 44gm	[32] Weight of empty bottle (W_1)= 39gm
[28] Weight of container + wt dry fly ash(W_2)=.69gm	[33] Weight of container + wt dry fly ash(W_2)=.71gm
[29] Weight of container wt dry fly ash +water (W_3)=103gm	[34] Weight of container wt dry fly ash +water (W_3)= 102 gm
[30] Weight of container + water(W_4)=.93g	[35] Weight of container + water(W_4)=.80g
[31] Specific gravity (G) = W_2-W_1/(W_2-W_1)-(W_3-W_4)	[36] Specific gravity (G) = W_2-W_1/(W_2-W_1)-(W_3-W_4)
[37] Specific gravity of C-class Fly ash is 1.66	[38] Specific gravity of C-class Fly ash is 3.2

Table 5.Comparative study of specific gravity

[39] SL NO	[40] TYPES	[41] THEORETICAL	[42] EXPERIMENTAL [43] (BY PYCNOMETER)	[44] EXPERIMENTAL [45] (BY DENSITY BOTTLE)
[46] 1	[47] **CLASS-C**	[48] 2.46	[49] 1.94	[50] 1.66
[51] 2	[52] **CLASS-F**	[53] 2.49	[54] 2.63	[55] 3.2
[56] 3	[57] **PPC**	[58] 3.15	[59]	[60] 3.14

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[61]

[63] **Figure 1. showing (a) Fly ash (b) Fly ash aggregate**

[64]

[62]

[65] **Figure 2.Class-F & Class-C Fly Ash (Drying)**

[66]

[67]

Empty Pycnometer

Pycnometer with fly ash and water

[69] **Figure 3. Specific gravity**

Density bottle method

[68]

[70] **Figure 4. Density bottle method**

[71]

[73] **Figure 5. Class-F & Class-C Fly Ash (With Moisture)**

[72]

[74] **Figure 6. Class-F & Class-C Fly Ash (Without)**

RESEARCH ARTICLE

E-Commerce Security Issues and Solutions

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ABSTRACT

E-Commerce security is a significant branch of the information security framework. It mainly applies to the parts that affect e-commerce, including network and data security and a wide range of information security frameworks. E-commerce security issues are mainly affected by the end-users in their daily payments and business interactions. Social-related media plays a vital role in cyber security and contributes to many threats that are undertaken in cyberspace. Online shop owners put themselves and their customers at risk for payment theft and fraud. Smaller-scale online stores face many security issues or threats from cyber hackers because of insufficient internet security. This study analyzed the security issues in the e-commerce industry, mainly in Bangalore city, and found some solutions to the security issues arising in the e-commerce industry. The qualitative research technique also helps in decision-making because it helps determine how and why the research will occur. The source of data collection is purely based on secondary data. The researcher addressed some solutions to security problems, such as data integration and confidentiality in the e-commerce market. The person doing online shopping is an essential part of the population affected by e-commerce security.

Keywords: Data Security, E-Commerce, Internet Services, Network Security, Security Issues.

INTRODUCTION TO E-COMMERCE

E-Commerce security is a significant branch of the information security framework. It mainly applies to the parts that affect e-commerce, including network and data security and a wide range of information security frameworks. E-commerce security issues are mainly affected by the end-users in their daily payments and business interactions. Electronic technologies' primary problem is privacy and security issues like lack of trust and data leakage. The major

throwback of e-commerce is the security issues that restrict customers and firms from engaging with e-commerce. Confidence-building is an essential element in doing business, whether it is an online business or a physical business. Trust can be influenced using variable factors like reputation and brand name.

E-Commerce Industry In India

In India, around 354 million of the entire population are internet users, as per the survey conducted in June 2015. It is the largest country with the most significant internet users. China takes the first position. Although India stands in the second position in using the internet, the growth of e-commerce in India needs to be improved compared to other countries like the USA, France, UK. Some of the largest e-commerce companies in India are Amazon, Flipkart, Paytm, and Snapdeal.

The significant advantages of e-commerce in Indian society:

- Improves the standard of living.
- Increases the subscriptions to broad internet brands and users in 3G and 4G internet services.
- Availability of more products in online shops compared to physical retailers.
- Increase in people's growth using smartphones, and India will soon be in the second position for having many smartphone users.
- Increase the number of startups like Swiggy, Zomato, and Book my show.
- Online classified site usage has been increased, like quicker.com and ebay.com.
- There are also online sites for buying and selling derivative products.

The retail market in India, as of 2011, has been estimated at around $470 billion. One of the sectors newly introduced in the e-commerce industry is online medicines. Some companies that are emerging in the field of online medicines, like Oedipus, buy on the kart. Some companies are there those who sell medicines based on a prescription from the doctor, and some other companies in the field of online medicines sell alternative or substitute medicines. In India, there is no strict law for online pharmacies.

Role of Social Media in Cyberspace Security

Social-related media plays a vital role in cybersecurity and contributes to many threats that are undertaken in cyberspace. The growth of social media is tremendous today. As social networking sites' user base increases, the possibility of cyber-attacks increases, like hacking, data misuse, theft, and fraud. Companies cannot stop them from using social media even though cyber-attacks or crimes are increasing. The most important step forward is to solve these security issues or fix all these problems to avoid real damage. Social media should be used only with certain technological and policy rights.

Importance of the Topic

Cyber security is one of the most critical e-commerce features without proper protocols and existing implementation. Online shop owners put themselves and their customers at risk for payment theft and fraud. Smaller-scale online stores face many security issues or threats from cyber hackers because of insufficient internet security. It has been reported or noticed that one in five small online stores falls victim to cyber fraud every year, and more than 60% of these stores are forced to close within a few months.

Nowadays, most e-commerce software platforms provide several built-in security features. The three critical ways online stores owners could use to improve their website security are: -

- Update e-commerce software regularly.
- Implement an address-verifying system.
- Implementation of the card verification value

Statement of the Problem

This study analyzed the security issues in the e-commerce industry, mainly in Bangalore city, and found some solutions to the security issues arising in the e-commerce industry.

Need and Relevance of the Study

The primary purpose of the study on e-commerce security is to provide the following: -

- Data confidentiality: which can be provided by making use of encryption and decryption
- Access control: It governs what resources a user may access the system using a valid user ID and passwords.
- Data integration: It ensures information has not been interfered with.
- Authentication and identification: - It ensures that someone is who they claim to be is implemented with a digital signature.
- Making use of ciphertext: Cipher texts are unreadable to humans, and it uses encryption.

Objectives of the Study

- To study the overview of e-commerce security and to discuss the different security issues in the e-commerce industry.
- To find the solution for the security issues related to the e-commerce industry.

RESEARCH METHODOLOGY

Methodology refers to a systematic, theoretical approach that has been applied to a field of research work. It consists of a theoretical analysis of the body of methods used for the study and the principles associated with a branch of knowledge. It carries paradigms, theoretical models, phases, and qualitative and quantitative research techniques. Using a methodology does not give or provide solutions to a problem, so it is not the same as a method. The methodology offers the theoretical model or best practices that can be selected to analyze a particular case.

Qualitative Research Design

Qualitative analysis is one of the scientific approaches for gathering non-numerical data. Qualitative analysis involves the names, concepts, symbols, study features, and an in-depth overview of our study's work. They may not rely on quantitative research measures. This research technology's key objectives are finding answers to questions such as how and why a specific phenomenon can occur. Many researchers widely used this study method, concentrating principally on natural science and social factors. It is often used in marketing, companies, and evidence of profitless services. The well-known qualitative research approach is case studies where a specific scenario is evaluated in-depth, and the problem is better understood. The aim of the qualitative project differs by project based on the project's context. The qualitative investigation approach is often used to assess how and when a phenomenon is investigated. Politicians, academics, and social workers are the most people who use this technology.

Source of Data Collection

The source of data collection is purely based on secondary data. Secondary data are those data that are collected from sources that already exist. Secondary data can be either published data or unpublished data. The published data will be available in trade journals, online, and in a real-time database. This research collects secondary data through books, annual reports, magazines, newspapers, articles, and various websites.

SWOC Analysis of E-Commerce

In SWOC analysis, we try to determine the strengths, weaknesses, opportunities, and challenges of e-commerce concerning the Indian business environment.

Strength

- *No time constraints*: In e-commerce, 24*7 online transactions can be done anywhere, anytime, as there is no time constraint.
- *Cost-effectiveness*: Decreases the need for brick infrastructures and plays a vital role in eliminating a long chain of intermediaries; this help reduce costs.
- *Fast exchange of information*: The information is exchanged fastest.

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- *Timesaving*: Transactions done through the internet is very fast and save time by reducing physical movement.
- *Global market*: It enables all companies to expand globally and widen their business.
- *Fast buying procedure*: Buying any product is just one click away from the seller; no physical movement is required.

Weaknesses
- *Security*: Customers always find themselves insecure in the payment procedures.
- *Fraudulent websites*: Many fake websites are available online, promising better services and deals.
- *Limitation of products*: Only a limited number of products are available.
- *No bargaining facility*: Bargaining cannot be possible for online shopping.
- *Long delivery time*: A product brought from the net takes a long time. It will be based on the convenience of the seller.
- *No face-to-face interaction*: There is no face-to-face interaction between the seller and the buyer, so the extent of convincing the customer does not exist.
- *Impossible to physically examine the product: Online products cannot be touched, worn, or worn* on the products.
- **Opportunities for increasing** *users*: The number of internet users is increasing daily, and people feel more comfortable shopping online.
- *High availability*: Online products are available 24*7; customers can shop at their convenience and time, even during late-night hours.
- *Advertising*: Advertising is cost-effective in an online system.
- *Regular expansion*: E-commerce can be operated anywhere, anytime, without interruption. So, it always has a scope for expansion.

Challenges
- *Finding the right product for selling*: Anyone can launch an online store within a few days and start selling all kinds of products; choosing the right product according to the customer's needs and wants is a challenge.
- *Attracting new customers*: Sellers must find out where their audience is and find ways to attract them efficiently without killing their marketing budget.
- *Retaining current customers*: Attracting a new customer is more expensive than holding the current ones. The seller must implement new techniques to help them get the most out of their customer base in increasing customer lifetime.
- *Choosing the correct partners and technologies*: Sellers should build the right technology for better growth and achievement, and online sellers must carefully choose whom to work with.

Conceptual Model of the Study
Due to global fluctuations, such as demonetization in India, the e-commerce industry has expanded tremendously in recent years. The conditions conducive to the e-commerce industries and their development have changed. There are significant e-markets in countries like China and the US. This year, the e-commerce sector in the Asia-Pacific region was projected to be higher than in the US. Scientific and technological factors also stimulated the growth of the e-commerce industry. Electronic devices have also increased the number of people shopping on their mobiles, and high sales of e-commerce have also been powered. Several variables are distinct from economic and political in the world e-commerce industry. This is a PESTEL ANALYSIS from the e-commerce industry that analyzes how these different forces can affect e-commerce and its effects.

Political Factors
There are political challenges or problems before these attacks from online shop owners that may differ from the physical ones. E-businesses influence several risk factors. Because of the bureaucratic burden, Amazon is a leading e-business and e-bay developer in Asia. Red tape has become a significant problem in India when starting a new company. E-policy commerce's problems have continued to grow. The massive growth of electronic business in the

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European Union. One of the main political factors too. The EU's goal is to the giants of US technology. Such issues can threaten e-commerce growth; political instability can lead to corporations' failures online and offline.

Economic Factors
Economic factors affect the business, either an online company or physically. Almost all economic factors contribute directly to company income and benefits. During the recession period, investment decreased, and people chose methods to minimize expenses, in which economic activity and the rate of jobs decreased and business profits decreased. Because of this, e-commerce was also affected. These economic fluctuations impact global and local businesses in countries like India, Russia, and Brazil. The country's growth and high sales for e-commerce would boost economic activity quicker. Development will be slower if we lower economic activity. Economic factors may thus have a direct and profound effect on the e-commerce industry.

Social Factors
In the e-business market, the social-cultural aspect has a considerable influence. Trends are evolving and impacting organizations daily. On the computer device side, a significant change takes place. Mobile technology is now very well-known in society. The way e-commerce firms market themselves is a cultural factor influencing e-commerce. E-commerce is regarded as an aspect of westernization in most of India's societies because of the growth of e-commerce in these areas.

Technological Factors
In the e-commerce industry, the technical aspect is essential, as technology is the industry. E-commerce is technology-based. E-commerce companies are at the forefront of their competitors' technological development. For its faster growth, the entire e-commerce industry aims for maximum technological aspects—technology benefits from success to the benefit of an e-commerce business. As a result of its technological growth, Amazon is a leading e-commerce company. Technology is, therefore, one of the most critical factors in the e-commerce industry.

Environmental Factors
One critical factor that influences the e-commerce industry is its environmental factors. There are few direct impacts on the climate of this sector. It may be almost nil or considerably lower but remains primarily sustainable. It could be very productive to invest in sustainability. E-retailers can invest in sustainability, including several sustainable packaging products for waste and renewable energy reductions.

Legal Factors
Each major E-shop has its workers to deal with any legal questions. Failure to comply can result in financial damages, loss of image, and reputation for people or groups. E-retailers must address concerns because different fields vary from labor legislation to sustainability legislation. In various countries, these laws are different for businesses. E-retailers also need to be highly attentive to legal considerations.

E-Commerce Research Framework for Security Issues
Other than complexities and availability of solving code applications, additional requirements are being referred to. A research framework for e-commerce security has been derived based on this:

Complexity in E-Commerce
There are so many attacks happening to e-commerce that there are several security issues, so the first thing we should ensure is to develop a framework that investigates or analyses the attacks happening to e-commerce and on the solving codes algorithms, applications, and protocols. If there is an availability of several protocols and parties in e-commerce, there is a possibility of attacking the computer systems. For secure e-commerce, provable secured stages for solving codes must be developed, and clarify that this development stage is purely secured. The study has also been done on the newly introduced security technologies and new technologies like domain name server computing and quantum computing.

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Anonymity in E-Commerce
In some of the applications that involve e-commerce, it is necessary to implement techniques that can provide services like:
- Receiver's anonymity service
- Server's anonymity service
- Anonymity in transaction service
- To provide these anonymity services

There are several techniques under examination. The relationship between other and anonymity services in e-commerce must be analyzed. Hence, the under and examination techniques will be explored to the applications in the real world.

Experiences, Learning's, and Outcome
As per the study, various factors like political, social, economic, technological, legal, and environmental affect the growth and security of the e-commerce industry. Based on the study on e-commerce security issues in Bangalore city, we found significant security issues in the payment step on online shopping websites. There are also some other issues like unauthorized access, Denial of Services. Nowadays, there is so much software that ensures security in e-commerce for both buyer and seller sides. Some prominent security issues in e-commerce are: -

Client-Side Security Issues
It is one of the major concerns from the point of view of a user. It requires some traditional security methods or technologies like proper user authentication and authorization, access controls and antivirus protection software, communication service, and additional server authentication. It may also require anonymous browsing on the websites. Most banks use single cipher security settings that are vulnerable to cyber-attacks and viruses. The weakest part of online business is client-side safety and protection. Using some encryption applications, e-commerce can achieve access controls, transaction authorizations, accountability, and data integrity.

Server-Side Security Issues
It is one of the major concerns for those who provide services. As the client-side security, server-side security also requires proper authentication and authorization of clients, anonymous publishing on the websites, and non-repudiation. It also requires reliability, accountability, and accessibility.

Transaction Security Issues
The transaction security issues are essential for both client and the server point of view. It requires several security services like the authentication of data, accessing control, the confidentiality of data, and data integration. They require some specific applications that guarantee anonymity for a safer transaction method.
These are some major security issues we face in the e-commerce industry in Bangalore city.

In Some Ways, the Hacker or Assaulter Attacks the Computer Security in E-Commerce
There are so many ways hackers or assaulters attack the computer system, which is one of the significant issues in e-commerce security.

Tricking the customers
Tricking the customer is also known as the social engineering method in which the hacker or the assaulter gathers all the data to use against the customers by keeping a grip of surveillance on the shopper's behavior.

Enquiring the consumer's computers: -
The hardware and the code vendors ensure that their merchandise is simple to put in from their quest and give the products by disabling the safety features. Confused users do not plan to alter any safety options and create a fair path for hackers.

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Guess the passwords

It is one of the common attacks in which hackers guess the user's secret words. It can be classified into two manual attacks and automatic attacks. One of the significant manual attacks is toilsome. Automatic attacks are the best compared to manual attack because it has more possibility of success.

Mistreating the denial of services

By making the servers perform more jobs or unwanted tasks, the servers' capability to perform other important jobs will be reduced.

Security Technologies Existing In E-Commerce Industries

The primary security technologies existing in the e-commerce industry today are:-
- Access controls
- Communication securities

Access Controls

Address access control is one of the significant and apparent concerns in network security. The access controls can be classified into three types.
- Physical access controls: - Physical access controls can be attained with the help of humans like receptionists and guards.
- Technical access controls: - A card access system can achieve technological access controls.
- Mechanical access controls: - The mechanical access controls can be achieved using locks and keys.

There are several technologies to have access control to both intranet and internet. Access controls included authorizations, authentications, and audits. Access controls include digital signatures, biometric scans, and automated device surveillance. An item that can occur independently of other entities inside the system that can perform such acts is called a subject and is part of the access control models. An object known as an object exists separately from another resource that needs to be managed. The topic and object are also program entries rather than end-users. The access control system offers different authentication, verification, and permission services.

Communication Security System

The communication security system is mainly based on the telecommunication field. Some primary communication security services are:
    i. Transmission securities
    ii. Emission securities
    iii. Physical securities
    iv. Crypto securities

Solutions to the Security Issues in The E-Commerce Industry

These are some practical solutions to the security issues affecting the e-commerce industry's functions, which can control security issues.

Firewalls for client

If we connect our system to a network, there is more possibility of having our system at risk. So, by outing a personal firewall, we can protect our system from those security issues.

Firewalls for servers

The server firewalls will ensure the requests enter the system through specific ports.

Educating the customers

The customers should be educated enough to know how to select a strong password and how to keep the data secured.

Mistreating the cookies

System designers' primary problem is maintaining a secured customer session, so the best mechanism is cookies. Cookies can store the customer's data, which are preferable, like languages and currencies.

Secure socket layer protocol

It is a protocol for encrypting the information between the customer's computer and the site servers. Once this protocol is implemented, the server will become a trustworthy entity.

Cyber Ethics That Has To Be Followed

The internet is used for communication purposes, so use this service to communicate with your friends, colleagues, and family and share ideas, thoughts, and information with people worldwide.

- Do not get addicted to the usage of the internet and do bully things on the net.
- The internet provides preliminary information about any topic, so use this information correctly and legally.
- Please do not use others' accounts without their knowledge.
- Do not share your bio data with anyone; hence there are chances of getting misused.
- Do not create fake accounts using other identities that can create many personal troubles.
- Be careful while downloading anything from the net; download only permissible files.

Some significant cyber ethics must be followed when using the internet.

CONCLUSION

This paper deals with security problems and e-commerce solutions. The e-commerce sector is mainly used to purchase and sell products through Internet services. E-commerce has become a modern business approach and is critical to online marketing and goods purchase and sale. There are growing numbers of people using this technology each day. Its safety problems, such as unauthorized entry, theft, and fraud, are the main problem surrounding electronic commerce. One of the enormous topics is security problems on a machine because it is crucial. After all, the world has been linked positively to the internet and used these Internet services to make important transactions. The crimes carried out on computer networks are growing, and security concerns are becoming a big problem. Security controls or specific security applications must be implemented to secure all e-commerce properties from modification, unauthorized access, or destruction. In this paper, the researcher talked about security threats and some solutions to these problems, which can be applied to a safe online shop or business. When the analysis is analyzed, the reactive and constructive teams involved in managing security and risks must be open to attention This research discussed security and privacy issues affecting Bangalore's e-commerce industry as a developing Indian city in information science. The e-commerce industry is a concern to many people. Here, we speak about security and e-commerce industry assaults. The researcher addressed some solutions to security problems, such as data integration and confidentiality in the e-commerce market. The person doing online shopping is an essential part of the population affected by e-commerce security.

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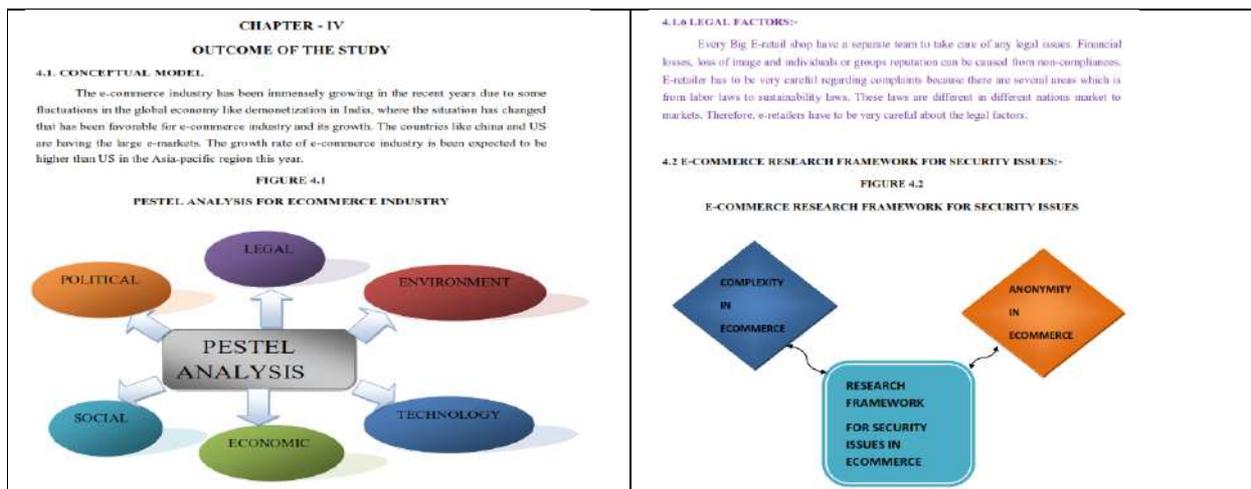
Figure 1: PESTEL Analysis for E-commerce Industry	**Figure 2: E-Commerce Research Framework for Security Issues**
Figure 3: Experiences, Learnings, and Outcome	**Figure 4: Existing Technologies in E-commerce Security**
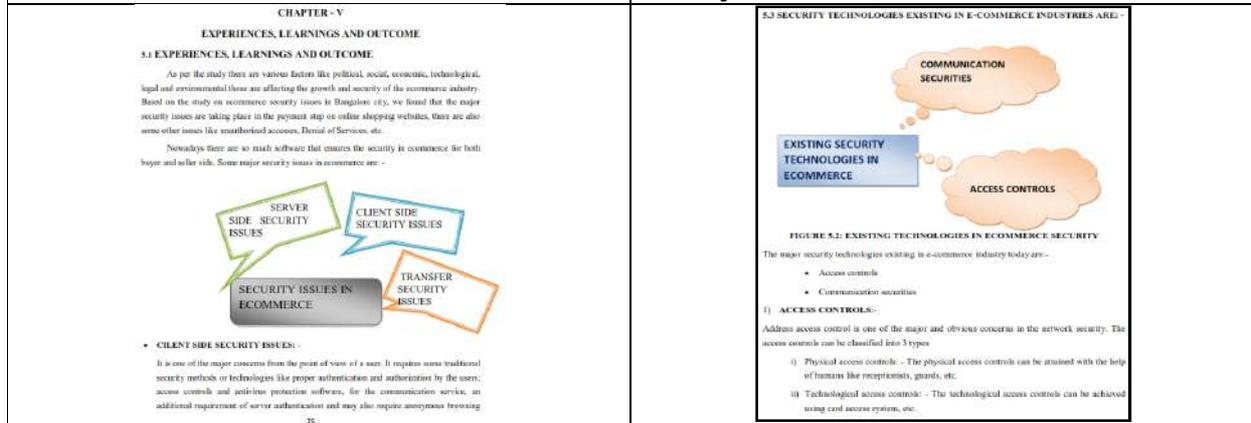
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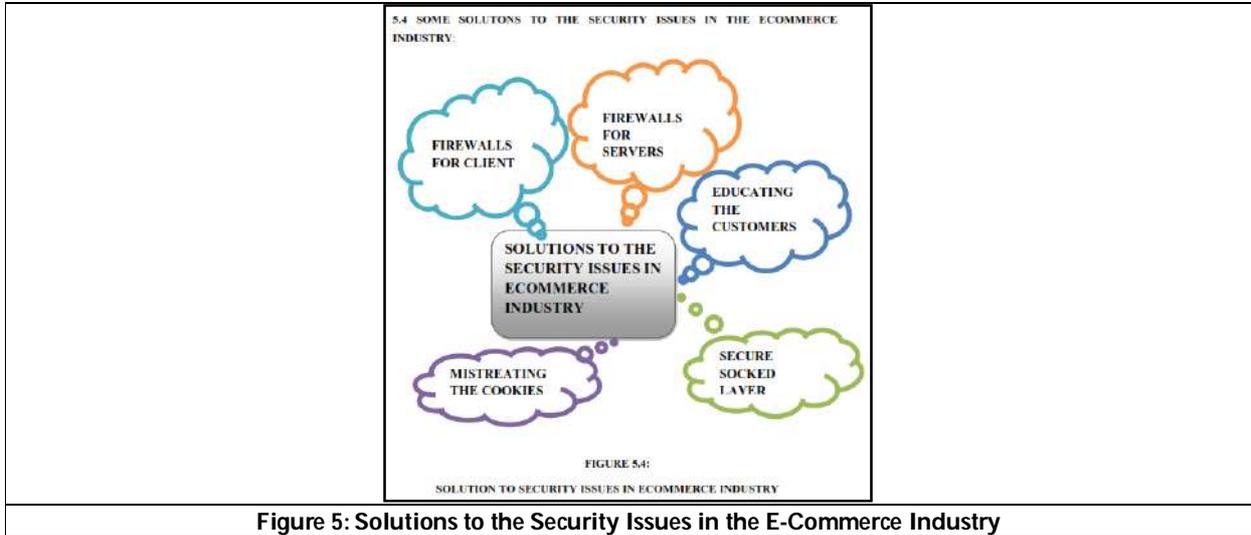
Figure 5: Solutions to the Security Issues in the E-Commerce Industry

RESEARCH ARTICLE

Indoor Navigation System using Drive INN-Study

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ABSTRACT

The evolution of various navigation techniques helps human being in various aspects. Navigation is an application used with the help of androids smartphones for indoor navigation in easy way. Navigation is used to find a way to a certain address or a point. Today, GPS has become the most known navigation system using Satellites. This application uses any of the communication based technology for navigating indoor. It is developed for people to accomplish smooth navigation via smart android phones. During this navigation if a user encounters a deviation it detected instantaneous and directs back to the right path by analysing the current path with the generated path. This application is used as a path finder for humans in localizing various areas by determining the exact path. This system will be useful for navigating in indoor environment.

Keywords: Path, Navigation, Indoor Navigation

INTRODUCTION

Nowadays navigation systems is widely used for outdoor whereas indoor navigation in the early development stage. In mapping software there are two, one is Google map and other is Apple Map. These both maps use navigation device technology. Outdoor navigation is considered a large scale with object ranging from small to larger area. Indoor navigation is considered smaller objects with in a smaller area. The Global Positioning System (GPS) is the most common navigation system used to navigate outdoor which points to the location geographically. GPS has got limitations, as it does not provide fair accuracy in indoor navigation. Google Indoor contains the different types of

obstacles which increase the difficulties for implementing navigation system. The current available systems make use of GPS, Bluetooth, Wi-Fi, Visible Light Communication (VLC), RFID and Sensor Chip technologies.

The indoor navigation consists:
1. Indoor Positioning Module
   Indoor Positioning system identifies the current position and location of the user.
2. Navigation module
   Routing methodsD*, A*, Dijkstra Algorithm, Floyd Algorithm
3. Human Machine Interaction module.
   User communicate with the navigation system through Feedback, Acoustic, Hapatic feedback, Vibration FB via HMI (Human Machine Invention)

Different indoor navigation maps will present different mapping system information. Some indoor navigation apps are interactive, send notifications, provide effective path finding in real-time. Indoor navigation maps are used to help and communicate with user through path finding app. The path finding algorithms are used to generate directions for the shortest path for users. In order to map a building, positioning, share notification, send and receive data, there are a number of various ways in indoor navigation map needs to happen.

The adaptation of navigational systems to the indoor environment is still quite problematic on several levels. Technologically, positioning technology currently remains one of the major issues holding back navigation applications for indoor environments. Several solutions have been proposed over time, beginning with the extension of outdoor GPS to indoor space Furthermore, a large array of new sensors for indoor positioning has been developed and is continuously being improved There are many requirements for those localization technologies: reliability, speed, safety, availability, cost with the main question in this context being what level of accuracy and coverage is required to support navigation and evacuation indoors. Due to this replication the research objective is focused on indoor mapping.

IDENTIFICATION OF RESEARCH GAP
In the earlier days peoples used to ask the local people to find the correct path to the destination. As the technology have raised and having more routes to cover the same destination, determining the correct position has become the major problem. In order to determine the navigation, the system has been implemented from the beginning of the path to the exact location or correct position of the path that the user has to reach. Nowadays many peoples are aware of Global Positioning System known as GPS, which has become a part of everyone's life for determining the position of the places. This GPS is used to navigate outdoor location information. As people used to travel around, they face problem with navigation with exact path to indoor navigation face. However this GPS technology does not work in finding or navigating inside a block or building.

This made the need for tracking and providing exact location to the user. Indoor mapping is a process of representing an indoor floor, positioning etc. This navigation can be done with the help of smartphones. The purpose of this application is to ease people from finding directions by locating in new area. This leads in implementing the indoor navigation in your own space. In this proposed work, we analyse the articles and classify them according to the system's architecture, infrastructure, technologies, techniques, methods, and evaluation. On the analysis of the reviewed papers and with some restrictions and/or limitations, this would be considered as a research gap in current technology and provide the solution regarding the above.The algorithm used for detecting the objects and movement in direction of the users in the environment would work satisfactorily. However, it could be tested with different algorithms in order to improve the system accuracy.

OBJECTIVES OF THE PROPOSED STUDY
Our objective is navigation within buildings of Indoor navigation. Through the GPS reception is generally unavailable inside buildings; the automatic positioning is usually satisfied using other positioning technologies. In

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order to develop the so called indoor GPS navigation system Wi-Fi and other technologies are used as given in the introduction section. In addition to indoor GPS can identify the actual floor level. Indoor navigation apps, using an indoor routing function, guide users precisely through a building and automatically determine their position

The navigation process uses three basic key elements to analyze the current situation and deliver suitable navigation information to the user. These key element information are: (1) the user's current position in the environment, (2) the direction in which the user is moving, and (3) the presence of objects in the surrounding area that may be potential obstacles.

Based on these general requirements we could design a proposed indoor navigation system. Our proposed study is based on the following key elements:

- Identifying and classifying the technologies, techniques, and methods applied
- Study and analyse the existing models and improve the model.
- Use of algorithm for navigation scenario in indoor space.

MAJOR RESEARCH HYPOTHESES

After conducted the research based on hypothesis statement and its validation to support the research idea and answer the research questions in statistical manner with data driven decision and evidences. A hypothesis will formulate our findings and answering our research question. For some research projects, we might have to write several hypotheses that address different aspects of our research question. Here, we came up with the hypothesis validating which method of indoor navigation is found best by the users through the experiments we conducted.

PROPOSED METHODOLOGY FOR THE RESEARCH WORK

When we are inside an unknown building and struggling to reach the destination the proposed methodology aims to find the target destination within the building. Especially at a pressurized moment and when we do not know about the building structure the scope of the project resolves the problem. For instance at a medical emergency or when you are late to attend an interview, people are in need of guidance. As navigation are of two types indoor and outdoor. Most of the people are familiar with outdoor navigation. This outdoor navigation depends on satellites communication and focuses on the building and not on the origin of the destination.

RELEVANCE OF THE PROPOSED STUDY FOR POLICY MAKING

Nowadays every one relies on smart mobile devices, and people uses Global Positioning System (GPS), which is used to determine the location of the outdoor navigation. However, this GPS mainly reliable in using satellites signals. This GPS application is not suitable for indoor determination. This mobile app helps to navigate to a particular point in a location, while other existing mobile application helps to navigate only the location. This mobile app contains an additional feature of voice recognition instead of text based search.

RELEVANCE OF THE PROPOSED STUDY FOR SOCIETY

Indoor navigation is very helpful to areas such as Hospitals, Malls, Universities and colleges. When Indoor mapping comes to the release depending on the area we have look into common constraints such as prior permission from the private concern managers, if it of building then updation has to be done. Visitors, patients, and employees in a hospital. Visitors and patients trying to find their destinations is problematic. Patient's waste their time to seek the right directions for the particular department by roaming around the building. The employees of the hospital also waste their time and energy by guiding the patients/attendees to the right place. Turn-by-turn navigation can relieve the stress of navigating the typically labyrinth of hospital hallways, especially in an already stressful or time sensitive situation.Further some patient's are not aware of finding the location by a text based search instead voice recognition technology is used for better user experience.

CONCULSION

Indoor navigation is a highly challenging in today in visiting a particular place for the first time. Several methods have been developed with these challenges. Although some useful scenarios were developed in detecting indoor navigation. The indoor navigation provides a flexible guidance of people in confusing, unknown buildings inside the hospital premises, Malls, and Universities. The user of an indoor navigation system gets his own location displayed on a map on his own smart device. After selecting a destination, a route to the selected destination is displayed on the mobile app. The user's position in and around the building is permanently updated, so that the device always shows the current position on the route.

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RESEARCH ARTICLE

A Study on Stress Management of Omni Bus Drivers in Chennai City

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ABSTRACT

Stress is a demand for the adaptive capacities of the mind and body. Stress is an adaptive response mediated by individual characteristics and psychological processes. Stress is people's reaction to excessive pressure or demands placed on them. This study mainly focuses on the driver's stress during their journey. Usually, drivers in urban areas are meant to reach a farther destination, including night travel. There are more chances of drivers being sleepless and stressed in that situation, which will result in accidents. We all know that accidents are increasing daily, especially on highways. When the bus goes on the highway route, their eyes tend to receive more reflected rights which will stress their eyes out. This study was conducted to know the work stress among the workers of Omni bus drivers in Chennai City and study the problem and welfare measures provided by them. Today Omni Bus Drivers face so many problems. It will, directly and indirectly, affect the normal working conditions of employees. So this study is an attempt to analyze and evaluate the problems they face and make a good suggestion for such problems. A qualitative research design is concerned with establishing answers to the whys and how of the phenomenon in question.

Keywords: Accidents, Night Travel, Omni Bus Driver, Stress, Traffic

INTRODUCTION

Stress is a demand for the adaptive capacities of the mind and body. Stress is an adaptive response mediated by individual characteristics and psychological processes. Stress is people's reaction to excessive pressure or demands placed on them. It arises when they worry that they cannot cope with the duty organized to them. Human Resource Management is a management function that helps the manager recruit, select training, and develops members for an organization. It is concerned with People's dimensions in organizations.

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Stress is one of the significant psychological disorders found by the inadequate work process. It was initially defined as a nonspecific reaction of a body to any demand which might cause physiological changes in situations that contain strong positive or negative emotions. Organizations are not more bricks, mortal Machinery, and inventories. They are people. It is the people who staff and manage the organization. HRM involves the application of management functions and principles applied to requisitioning, developing, maintaining, and remunerating employees in an organization. Stress is the change that our body or mind experiences as we adjust to the continually changing environment. It has physical and emotional effects on us and Creates positive and negative feelings. As a positive influence, stress can help compel us to action, resulting in a new awareness and an exciting new perspective. As a negative Influence, it can result in feelings of distrust, anger, and depression which can lead to frustration at work and several health diseases, etc. Stress is neither a new phenomenon in work situations nor avoidable in the strictest sense.

Stress is defined as any adjusted demand to one's physiological and psychological reaction to challenges imposed on them that requires coping behavior. Stress is a Perceived phenomenon associated with tension and anxiety. One is considered as being under stress when a situation is perceived as presenting an extra demand on the individual Capabilities and resources Stress is different according to the nature and effect of stress. There are five significant stress levels: eustress, distress, acute stress, chronic stress, and burnout. Eustress is one of the helpful levels of stress. It is the stress level you experience right before you exert physical force. Distress is one of the negative level stresses. This is one of the levels of stress that the mind and body undergo. Acute stress is the type of stress that comes immediately with a change of routine. Chronic stress is the stress level experienced by someone constantly facing moves or job changes. The causes of stress are different working conditions. Different sources of stress are workload, underpaid jobs, technological changes, underutilization of skills, interpersonal with employees, users, and employers, etc.

We all know that driving is a stressful job mainly affected by environmental, social, and inter-personnel interaction factors. Bus drivers are exposed to adverse traffic conditions due to climate changes and poor road conditions in addition to all these factors. They are also exposed to irregular Working hours with low wages, noise, and vibration, job security, business demands, equipment damage, number of stops, schedule related pressure, among others. Driver's social role is also related to the responsibility for passenger and pedestrian lifts and other vehicles. This commitment makes them insecure in professional activity, which results in beneficial actions such as providing more attention and protection to a passerby and in actions that lead to fear and conflicts and may, therefore, trigger illness processes. For all these reasons, employees should not consider bus drivers from the perspective of fulfilling requirements or interest in the economy. It must be noted that the stresses these professionals are exposed to may contribute not only to inadequate traffic attitudes but also to a manifestation of occupational diseases such as stress, phatic, depression, anxiety, and vascular diseases. It is a dynamic process; stress can be worsened if strategies are not implemented to tackle the problem.

Importance of the Topic

This study mainly focuses on the driver's stress during their journey. Usually, drivers in urban areas are meant to reach a farther destination, including night travel. There are more chances of drivers being sleepless and stressed in that situation, which will result in accidents. We all know that accidents are increasing daily, especially on highways. When the bus goes on the highway route, their eyes tend to receive more reflected rights which will stress their eyes out. Such incidents are the main reasons for accidents. And also, sitting in the same position for long hours is not a small thing; they need much patience. Due to their increased travel time, they chose to go at high speed. This study mainly focuses on giving certain precautions to reduce drivers' stress. When such stressed movements happen at your workplace, it leads to the un attentive, incomplete work. Whatsoever it is, in whatever work that you take, it's the same. Everyone should have control in their psychological aspect where if they are doing something, nothing should disturb them at their workplace.

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Statement of the Problem

This study was conducted to know the work stress among the workers of Omni bus drivers in Chennai City and study the problem and welfare measures provided by them. Today Omni Bus Drivers face so many problems. It will, directly and indirectly, affect the normal working conditions of employees. So this study is an attempt to analyze and evaluate such problems faced by them and make a good suggestion for such problem

Need and Relevance of the Study

We all have heard of accidents every day. By reading it, we conclude that the driver drove rashly. We have considered why he drove rashly or the main reason for the accident. If we get into reality, it is all because of something that the drivers go through. We usually can't drive for more than 350km at a time. We get irritated and want to take some rest in between. In the case of drivers, they will have non-stop duty to be done. They might swap to different buses, but driving is their ultimate work. That is such a challenging situation that anyone could think of. So it is essential to know the helpful precautions to make the drivers feel better.

Objectives of the Study

- To understand the stress faced by Omni bus drivers.
- To give certain precautions for overcoming the stress of Omni bus drivers

RESEARCH METHODOLOGY

The research methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as a paradigm, theoretical model, phases, and quantitative and qualitative techniques. A methodology does not set out to provide solutions–it is there for, not the same as a method.

A qualitative research design is concerned with establishing answers to the whys and how of the phenomenon in question. Due to this, qualitative research is often defined as subjective, and findings are gathered in a written format as opposed to numerical. Secondary research or desk research is a research method that involves using already existing data. Secondary research includes research material published in research reports and similar documents. These documents can be made available by public libraries, websites, data from an already filled-in survey, etc. The secondary data can be obtained through research journals, newspapers, diaries, interviews, transcripts, etc., while the quantitative data can be obtained through survey financial statements and statics. Each secondary data research process involves four main steps.

- Identifying the subject domain and where to acquire the information
- Gathering existing data
- Comparing data from different sources, if necessary and if feasible
- Analyze the data

SWOC Analysis
Strength
Excellent Driving Skills

The main strength of a bus driver is his driving skills. Controlling a heavy type of vehicle is not an easy task. To control the vehicle, he needs such characteristics as identifying road signs and exits, navigating to the destination which is capable enough to remember the routes to several places, passing and being overtaken, maintaining proper speed, being courteous to others, and being courteous to others keeping a safe following distance. He should be aware of the speed limit of a vehicle till what speed the vehicle could handle. When a person is in a hurry to reacha destination and travels fast, they will face a problem. And also, because of him, his passengers will be affected by it. And also, if any vehicle is coming in the opposite direction, they will suffer for it. So to leave their lives at risk, driving safely and at a limited speed is better. And also their another tension is that if they go slow and reach their

destination late, then YES, the passengers will again get aggressive with him. So in the description, it should be clearly said that the arrival time is this. The company shouldn't lie or cheat their customers for a safer ride.

Knowledge of Traffic Regulations
Knowledge about traffic rules and regulations has a significant role in the case of bus drivers. Traffic laws are to prevent vehicle drivers from causing accidents or hitting pedestrians. They are also to help control the flow of traffic so that it is more efficient, having a good knowledge about traffic rules and regulations can reduce the chances of accidents. When driving continuously for hundreds of kilometers, it is their basic necessity to follow the traffic rules.

Clear Communication Skills
When in the case of drivers, should they be good enough in their communication and language? They should not seem to be harsh. They should be able to suppress their irritation and reply appropriately to the passengers. Clear communication is very much needed for a driver because when he is aggressive, he might also take abusive words, which will again impact how they behave. Their words should be taken carefully. However, the situation is. They should be polite and respectful to the driver. But in today's condition, I don't think we could find any driver answering someone calmly and peacefully. I have experienced this when traveling. They should need proper communication skills to be a successful driver. Everyone should have respect for their job.

A Driver is Responsible
A good driver is responsible for a vehicle and the passengers' lives. He should drop the passengers at the destination point at the correct time. A driver is the caretaker of the bus and the passengers. It is a diver's whole responsibility for a safe journey. Any problems in his personal life shouldn't disturb them in their work environment. They should have peace of mind to avoid any accidents. A driver is wholes Olly responsible for anything that happens to the vehicle and its passengers. The driver should be in his senses and control of his own body. In a few cases, accidents have occurred because the bus driver has slept. In these cases, they should have control over their body. In an emergency, they should stop the vehicle somewhere, get some refreshments, and then continue their journey. Certain precautions should be taken to avoid such accidents to decrease the rate. So, it is necessary to follow them.

Weakness
When They Are In Stress, They Cannot Concentrate More On Driving.
Driving is a very critical job. If they are disturbed by something that has happened, the concentration might shift and lead to disasters like accidents. A driver should concentrate more on the road, for which he should have a calm mindset. When they can't concentrate more on driving for their reasons, that will not affect them alone. He should be answerable to many. Keeping that in mind, he should have some attentiveness in their workspace. It will show them their attention, sincerity, and respect for their work. They should be on time when the vehicle departs because they will inform us that the bus will arrive and land at another time. They should be punctual when they start their work. It is always irritating for the passengers to wait for the bus. And also, few people will get late to catch their bus because they are overconfident that the bus will be late. And they realize that there is no point in being there on time.

Irritation towards More Traffic
We know the population in metropolitan cities like Bangalore. When drivers of Chennai City gets an opportunity to drive in cities, they will have more problem facing traffic during their journey. At times, the traffic also takes hours and hours to clear. Controlling the mindset of drivers in massive traffic is another weakness because there are chances of losing patience in the traffic, which may increase their stress levels. So being patient and calm in colossal traffic is not easy for drivers. When we see in metropolitan cities like Bangalore, there is a situation where the vehicle has not moved for hours and hours. It is due to the population that is increasing rapidly in Bangalore. And also at few cases, the delay in moving traffic is because there is an accident, and the traffic will not move till the victims move in the ambulance. And the worst part is that there will be no space for the ambulance to reach its destination. All of these are very much common in cities. Now certain fines have been implemented for not following the rules and regulations of the traffic. But it feels that the amount the government charges is much higher.

In foreign countries, the fine is charged based on their salary. That necessarily had to be implemented in our country too.

Family Conflict

A driver is also a family member, with more chances of feeling stressed because of family problems. If the driver has any problems in the family, it will reflect on his driving. Also, it has the chance of losing control over driving. When their family relations and situations are not good, they show irritation in their driving. It is the leading cause of rash driving that could take passengers' lives. They should be given specific training to make them understand that any mistake they make will affect the whole group of people on the bus.

Health Problems

Due to the long journey to reach their destination, they usually lack sleep. Which will affect the health condition of bus drivers too? They can't be usual if they come to work in such conditions. They might have specific emergencies during their travel. Again, the whole passengers have to be affected. Due to their profession, their eyes get stressed when they work at night. As far as I believe, people in the driving field exist there because there is no better opportunity to grab. Because it truly is a risky job, and whosoever is continuing might not be satisfied with their work. But only to run a family. Individuals in the driving field in the private sector are not confirmed how long they will be there in their position. They can dismiss someone with no notice period too. These are the disadvantages of being a driver for private travel.

Opportunities

Health Insurance

In the transportation sector, they give individual health insurance in an emergency. They do consider the health and family of the driver. Being in a risk environment, they have the right to get health insurance. As I mentioned earlier, driving for a more extended period exceeding 200 km is not so easy. We as a person also will not be able to drive continuously, even if we do it occasionally. Since it is their profession, they must withstand the stress and concentrate more on their work than their factors.

Interaction with New People

In this work environment, they meet many new people, which is good for them. Anytime in the future, if you have any emergency, there will be people who will save you from a difficult situation. When they do such jobs, they meet and interact with many people. The circle that they have made during their work condition will help them during their difficult stages. This kind of network includes people who give motivation and are capable enough to help you financially. It will be a positive factor for the driver if he properly relates with the respective people. They are worth being played much more than what they are getting now. But in the private sector, they usually pay less in all the industries than in the government sector. They should also realize that the money they pay should be enough to run a family.

Increase in Their Driving Skill

He will be more expert in their driving when they keep driving trips. And also, they have good opportunities to be paid more. Since they travel more, YES, their driving skills and handling some emergencies would gradually increase. It is a talent, and when their talent gets stronger every day, So it will help them when they move on to another company with a good opportunity and recognition. It is common in all sectors. Once they get their experience, people shift according to their future requirements.

Challenges

Not Being Paid For What They Deserve

We know that driving continuously is very stress full. Taking so much of it, they don't get paid for what they deserve. They have a family to run; keeping that in mind, the owners must pay them properly. Because if a driver is

not satisfied, they shift their jobs. The main thing the company must consider is to satisfy the employee and the customer. In multinational companies, it is said that it is a waste to think of customer satisfaction unless you satisfy your employees. Here too, in the driving field, this should be applicable. And also, if there is specific training given to the drivers based on how to behave with the customers, it will be profitable and recognizable to the company. Because most of the individuals traveling will complain that the driver is disrespectful to the customers. Providing training is a better option to avoid such clashes between them. If such a process is implemented in their sector, customer satisfaction will increase, and complaints will decrease. Which again will make the company stand as one.

Rural Bus Drivers Are Not Allowed To Drive in An Urban Area
There is no proper growth for drivers. They should be sent to other areas like the city and not be restricted to particular areas. Rural drivers are being restricted to their particular area. They should allow them to move out to drive in urban areas to increase their skills. Even they need the skills how-to drive-in cities. They must keep the driver's growth in mind and act accordingly.

Bus Strikes
When unsatisfied with what they get from their owners, they this strike. In strike, they tell their owners what they are demanding and why they are unsatisfied with the amount paid. Bus strikes are majorly done when the employees are unsatisfied with what they are getting. When such actions occur, the company will give them a bonus. In the driving field, the drivers are usually unsatisfied with work, so at least they have to be paid well.

Outcomes of Study
Types of Stress
Stress is your body's response to certain situations. It is subjective, so something stressful for you may not be stressful for someone else. There are many kinds of stress, and not all are wrong. Stress can help you act quickly in an emergency or help you meet a deadline. Stress can affect your physical and mental health and your behavior. Eustress is some stress which leads to psychological, physical, or biochemical stress in a human being. The death of a spouse, filing for divorce, or the death of a family member are examples of eustress. Stress is not only bad for their health but also for the passengers who are presentlyon the bus. In these stress cases, they should either be given specific stress-releasing classes, or that may lead to several distress activities. Stress must be removed, which might lead to a problematic situation in cases not done. Sometimes they get a night job for a single and a straight couple of days. Imagine under what conditions they would be. It is tough to concentrate and drive at that time. But still, most of them do their best. If they fail in it, it is not only the driver who will be affected but also the passengers. In any case, the travel agencies' first motive is to give their customers complete security. If not appropriately treated, stress will turn vigorous, and they cannot handle it properly. It should be stopped at a particular point in time. If you are not capable enough to control it, you will have to face severe obstacles in the future. Which instead is better to be treated so there will be no disaster? Stress happens to everyone. It happens to school kids, graduates, post-graduates, employees, and the aged. It now becomes so common that they think it is normal. They should take precautions before it takes it to another level.

Distress
The word distress leads to severe anxiety or strain; there are many causes we can see in the case of distress, like conflicts, abuse, financial difficulties, depression, etc. Great mental or physical suffering, such as extreme anxiety, sadness, pain, or a state of danger or urgent need. It is seen in's public life of everyone, even in the case of homemakers. It is because none knows how to control stress. It is now a general problem that is seen as a common disorder. They are not thinking of the impacts or results of stress. Some people can handle stress easily

Acute Stress
Acute stress disorder is a mental health condition that can occur immediately after a traumatic event. It can cause various psychological symptoms and, without recognition or treatment, can lead to post-traumatic stress disorder. It is because of not knowing how to handle the stress. Few people, though stressed, don't show it to their face, or no

disadvantages for stress will be shown. But again, if you don't express your feelings, mental health conditions can be attacked. Before letting a person do the driver's job, he should take specific medical tests to confirm that he has no disorders. Because during their journey time, if passengers ask for information, the driver must respond in a well-mannered manner. As per my experience communicating with drivers, I have never received any positive replies. They behave rudely and disrespectfully when they are asked for any information. I think patience is the essential qualification required for anyone working in the service sector, especially in the transportation sector.

Chronic Stress
Chronic stress is the response to emotional pressure suffered for a prolonged period in which an individual perceives they have little or no control. It involves an endocrine system response in which corticosteroids are released. For example, if a person has faced family disturbances, he cannot concentrate more on his work. So though he is doing the work, his complete attention is not on it. Everyone should separate their professional and personal lives to avoid affecting their workspace. Chronic stress is found in drivers and employees working in multinational companies, children going to school, and all.

Burnout
Burnout is a syndrome caused by chronic workplace stress that has not been successfully managed. Job burnout is a type of work-related stress-a state of physical or emotional exhaustion that also involves a sense of reduced accomplishment and loss of personal identity. Burnout is when the person can't handle the stress and show anger toward something else. When I tell showing anger, different individuals have a different ways of showing it. Suppose a person would feel free when he throws something out with anger; another person might feel better when he shouts at another person. So there are various ways of releasing their stress. Which will make the opposite person feel bad or get hurt?

Causes of Stress
Workload
When they have to move to a farther destination, even though they have frequent breaks, they have to be seated in the same place for hours. By which their stress is increasing every day. They have continuous trips to be taken which will lead to sleepless nights. And also, they don't have food in the proper time, leading to health problems. When a person gets the target to achieve more than what he could do. Because of pressure, he will try finishing that work at any cost. In these situations, the individual who is allotting the work should understand their employees and act according to it. This game of workload has been played by the corporate institutions very severely. They should consider the capacity of any human being when they could finish this work. The employees also should be given some time to spend with their family. It is not only the job that they have in their life. The managers should understand this and should control the workload that they are giving to their employees. By this the employees also get satisfied and also the work. When a limited work is given to an individual, I think he or she could give their best.

Physical Problem
Not everyone is fit for the driving job. If a person is not physically capable enough to handle the stress created, it leads to dangerous impacts, including accidents. He should be capable enough to handle the safety and security of passengers and drivers. When an aged person is given work like this, he surely would not be able to achieve or complete this because he is defined for the looks and condition of an individual is considered severe. Few people now, if we see, are back of these diets. They want to be physically fit enough for their looks and keep their future in mind. Everyone is now thinking ahead of their future, which is good to see. But now it has become a trend to be fit and to follow the trend. When a person is fat, they have been teased and harassed that they don't look good. Looks really don't matter; if you are slim, it doesn't mean your health is perfect. For a driver having a physical problem again leads to stress. Some medical facilities should be given to the individuals working as drivers. Their health should be taken seriously even by the organizations. It is suitable for keeping an employee loyal to their job. They feel satisfied that they can give their 100% and is again profitable to the company.

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Lack of Job Security

In private job sector we don't have security as we have in government sector. We all know that even if we retire being a government employee, they will be given some amount of pension. Whereas in driving sectors, they don't have security and will be at risk. Because of lack in job security, people does not feel secured and will not be loyal to their job. Since it is a private job, obviously there will be no job security or any pension kind of things given to the individuals. For example, if there is an individual working in Omni and if they get an opportunity to work under government. Do you think, he will not leave that job and shift. It is a great opportunity for them of course. There should be certain employee loyalty actions taken and also certain benefits given to them for their work at least on the occasions. It is better if they take certain practices for employee enrichment and loyalty.

Natural Factors

Natural factors include the journey environment. For example, if a person is driving in rain it does cause some kind of irritation and stress because it will block some kind of way of the driver. And also in most of the accident issues, the reason might be the opposite person travelling. Even if you're opposite individual does not come in the correct direction, which will affect you too. The accidents or anything bad happening to the bus is not mainly because of their driving, but also the driving of the opposite individuals. If the individual who is opposite to you is not following the traffic rule, it ultimately will affect you too. Since it is a bus, it's not you alone who will bear the loss but also the passengers traveling in the bus. Out of no mistake from their side, they should not be affected by this. Which is why I feel that the driver should be patient, bearable, understanding and patience? Because when an individual go to ask a question to the driver, and if he doesn't reply properly, then there are more chances of conflict happening. In order to avoid them, he should control and doesn't burst on the passengers which will result in having a negative impression on them. It is very usual that conflicts taking place between the employees, but when the conflict arise with the customer, that can be taken to another extent. They should be answerable to number of people at the case. There will be more chances of shifting in the company that they work. In order to keep their employees staying back with them, they should be given some vacations in between whenever needed. So all of these should be reduced and taken certain actions to reduce it. It is never always the same that we expect a situation to be. According to circumstances everything change and we have to act accordingly to it.

Family Conflict

When the driver is not in a good mood because of his family issues that will be clearly shown in his work environment. He should make sure that the personnel and professional life are not connected. So, he doesn't have any obstacles during his work. When a person has a problem with his family, or any disturbances at his house, it is a general reaction that it will be shown during the workspace. But then, you should have the managing skills to make that not affect you. Problems are common to everyone, but when we get a problem, we always think that it will be only us who are going through this situation. No, it is not you alone. There are crores of people who might be facing the same issue. We always look at our problem through a binocular, it is because of the psychology that we have. Maybe the tension you are taking is unnecessary, but then you consider it huge and keep thinking about it. It is really a bad habit where it will show up on your workspace and leads to give a negative impact on you. People when they get a problem doesn't think about the solution instead think about the reasons of causing for it. Such mindsets should be changed and have to start thinking from the original point of view. When a conflict happens, it is mature to think the problem from others perspective too. It is needed because only then you will understand the reason for the fight and could think on the ideas of how to solve it. It would help if you initially had patience only by which you could make things properly without any effects on you.

Signs of Stress

Rash Driving

When a person is not in the mood of driving or is diverted of thinking something else, it results in rash driving. Rash driving most of the time will result in accidents. They do have some kind of precautions that have to be taken when they are entering in to their professional job. Again the reason for rash driving is to again being inattentive towards

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their work. The reason for not being attentive is not always the same. It differs from situation to a situation. In most of the times, they don't do it purposely. It is mainly because, their concentration is shifting to something else and they lack of concentration on driving. Rash driving will obviously and ultimately lead to accidents. Accidents again is of more loss to the individuals and the vehicles. For a mistake that the driver has done, why should the passenger's get affected and face the problem. Rash driving now if recorded in any cameras that have been fixed mostly on the highways, the driver will be taken off his license for few years, there will be a certain amount of penalty that the driver had to pay. And if it is in the serious situation, the person who gave the license to him also will be affected.

Depression

When they have continuous trips to be taken, they get stressed which ultimately leads to depression. Depression is the situation where a person is deeply thinking of something and couldn't come out of it. This will lead to high disasters. At this position, they don't want to talk to anyone and just keep continuing what they are thinking about. Due to their emotions, a person gets more depressed. When a person is at depression stage, he doesn't want to talk to anyone and doesn't want anyone to disturb him. If by chance, someone does that they burst out with anger. The other person will feel that he is behaving rash with him. By which, again, the person's image will be damaged. They should have a control on their anger and should have a sense of what they are doing. Once starts rectifying will lead to the control of the anger. This is very much needed for a bus driver.

Mood Swing

At times when they are travelling to longer destination, if they couldn't handle the stress, there will be a change of mood swings. Mood swing is the situation where a person gets aggressive all of a sudden, sometimes without any reason. Such kind of situations may lead to accidents again. When an individual mood keeps fluctuating, it is a danger that the work that he is doing will directly imply. This is not and never in the control of the individual. The reason for this is their health conditions in most of the cases. In the rest of the situations, they behave weird may be because of some over thinking. When you are at your profession, over thinking of something personnel should be prohibited. This results in behaving an aggressive and rude to the passengers but this is not the reason for the accidents. But still, a person should be aware on what he is doing, the way he is behaving, the words that he is using to talk. Considering all of these, a person's behaviour is evaluated in work.

Concentration Problem

When the driver is thinking something about their problem, they could not concentrate more on driving. When they don't concentrate on what they are doing, it will result in inaccurate loss. Most of the situations, it is accidents. When they are thinking of something outside their work, then YES the concentration will directly shift. At any work place, not only in driving, but they should also keep their personnel away from their professional life. Because when both of them combine, there will be a clash happening. That is not required at the workplace. The passengers of the bus might file a complaint on you. The way you behave should be respectful at least for the passengers. Even in case of the organization if we see, if the higher authority doesn't get his respect, he will shout at you. Maybe in severe cases, they will be fired directly.

Irritation Problem

Even for a small problem, they get irritated more. They don't have control over their emotions and will burst out. That will lead to unpredictable disasters. We usually get irritated when someone does not understand what we are trying to say. This problem is there in all the sectors and in the industries. At those certain cases they should again hide their feelings and act normal. But once you make use of this, then at the end you will be suffering about this. Because these are the main reasons for psychological issues after middle age, it is proven that if an older man dies without any health problems, he dies because of the psychological issue. It is correct. It would help if you freed yourself from all those factors and things that will disturb you.

Jaya

Outcomes of Stress

Physical

Stress can affect human being's health, even though you might not realise it. The physical stress may result of too much to do, not enough sleep, a poor diet or the effects of an illness. When they are not physically good enough or attacked with some virus on normal days, they shouldn't be forced to come for the work. Because when they are unable to do the perfect, they shouldn't be forced to do. They should be given a certain freedom to take holidays on when required. A person cannot work beyond their physical ability. They should be given a certain period of rest for the person to be active in the upcoming journey. When these precautions are taken, the driver feels much better, and the accident rate will decrease simultaneously, again a good factor for the company. They should be given sure leaves when they physically are not stable enough to continue working. When forced to come in these situations, they cannot perform better in their workplace.

Psychological

According to psychology, stress can be defined as strain and pressure; it is some psychological pain. It can increase the risk of strokes, heart attacks, ulcers, and mental illnesses like depression. Stress can alter memory functions, reward, immune function, metabolism, and susceptibility to diseases. I feel that in the driving sector, some medical tests should be undertaken to know how stable a person is. So that we at least know if they are fit for the job. Also, specific inquiries should be taken based on his behavior with others. Because if the result is aggressive, then there is no point in taking him to the job. These would help know a person better than how he has performed in the interview.

Behavioural

Another crucial primary outcome of stress is behavioral changes. Stress can change human beings' behavior. A person's character is decided by the way they behave. They're thinking and analyzing should be proper. The way they talk to the passengers defines so much about their character. They have to be polite and respectful to the passengers traveling only by which they will get satisfied. Few of the passengers don't get satisfied when they reach early. Instead, they get satisfied based on the driver's behavior. That is asignificant factor for the customer to feel good about the service.

Organisational

In the company that they are working as a driver, there are specific policies that they have to follow. In those companies, the individuals working there must always be treated respectfully. They don't tolerate any disrespect. Because of everyone's patience, some part exists, and they can't h after that old. So at least keeping their job in mind, even if they are not calm, they should act as if they are. The people working in the company working primarily in the office have to coordinate mostly and not the fieldwork. They don't have to bare as much stress as barely-driving individuals.

EXPERIENCE, LEARNING, AND CONCLUSION

Experience

In my whole tenure of completing the study, I have realized how hard it is to be a driver. They deserve respect and payment. But I feel they are being mistreated in their financial aspects. They should be paid more since they are risking their health and time. When they go to a farther destination, they might have to stay back at that place. They will be paid for that in a few companies, whereas in other companies, they don't. There should be specific training, a kind of program given to the drivers on how to behave and respect the passengers. Once in a while, the company should conduct some entertainment programs for their employees to have some breaks and act as a stress buster. As a culture that is happening in the MNCs. They should adopt and take these changes in their sector too.

Jaya

Learning

In the process of completing this study, I gained some theoretical knowledge as well as some practical knowledge. To lead a successful life, they should know theoretical and practical aspects. They should be knowledgeable and thinkable to have a good life with decreased downs. Learning as in theory is that I learned what the different kinds of stress are, the reasons behind it, and what precautions take ken to decrease the stress. Stress is just a typical disorder; it can't be treated medically but only psychologically. All the theories that are in stress are mostly related to our emotional factors. Every individual should be capable enough to balance their emotions because emotions will stop you at some point in your life from achieving what you love. Emotions should always boost you up and act as a strength. When it gets your weakness at some point, you have to realize that you are lagging in it, realize and move on. That is what life is.

CONCLUSION

This study made me realize certain factors for what people feel stress, what will be the reasons behind it, how to overcome the stress, and so on. We all are usually habituated to this word, stress. We could hear it from the school kid to the older adults. I don't understand if they know what stress means or not. But when we get into the fact, the work given to a school kid is something more than what they could do. The same in everyone. We are given work to complete something beyond our capacity. Such things should be stopped in the initial stage for better results. As per my consideration, I feel that the professional and personal life should never come across. Once you get to your workplace, you should leave the family tensions that bother you. Because if you are thinking about something and doing something, you will lag in your work concentration. That will again result in leaving us in difficult situations. To avoid such kind of difficulties and move in your life smoothly, you should follow the precautions given above.

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RESEARCH ARTICLE

Problems and Challenges of Farmers in Contract Farming in India

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ABSTRACT

Contract farming is agricultural production that occurs under the terms of a contract between the agricultural producers and a sponsor that specifies the conditions for producing and selling a farm product or goods. In most cases, the farmer contracts to supply agreed-upon amounts of a certain agricultural commodity. These should fulfill the consumer's quality criteria and be delivered when the purchaser specifies. In exchange, the buyer agrees to acquire the product and, in certain situations, to help with production by providing agricultural inputs, land preparation, and technical guidance, among other things. Different business models such as informal, intermediary, multipartite, centralized, and nuclear estate were followed in contract farming, which depends on the nature and scope of their business. Having many advantages, contract farming is still not practiced in many states due to various problems and challenges in it. This paper is exploratory research that focuses on understanding the potential issues farmers face in contract farming and identifying their problems and challenges in contract farming in India.

Keywords: Contract farming, potential issues, problems, challenges, Indian agriculture, etc.,

INTRODUCTION

The term "contract farming" has two-part, one is an agreement enforceable by law concerning farming and the other is that a farmer enters into a contract with the buyer for the supply of agricultural products according to the terms

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and conditions agreed between them (Archana Singh and another 2021). At the outset, it is an agreement between farmers and the buyer/s related to farming in which the terms and conditions are agreed by the parties. The Agricultural Produce Marketing Regulation (APMR) regulates agricultural marketing and it varies from state to state. To regulate contract farming, the Central Government insisted states and the Union Territories amend the Agri marketing laws to establish a holistic system.

REVIEWS OF LITERATURE

1. Archana Singh and another (2021), in their study concluded that a contract farming system should be viewed as a collaboration between farmers and agribusiness. It takes a long-term commitment from both partners to be effective.

2. BrajaBandhu Swain (2016) observed that the APMC Act be amended and reinforced to promote contract farming. Although the APMC Act is in effect across many Indian states, it is not being fully enforced, and small farmers are not benefiting. When a farmer has multiple choices for acquiring inputs and loans, the contract firm's relative influence is considerably reduced. Subsidies to small farmers directly may also be beneficial.

3. The importance of contract farming in crop diversification and job creation was examined by PavneetKaul et al. (2021). Connecting small farmers with technologically advanced agri-business companies through contract farming is seen as one of the many ways to accomplish crop diversification and increase farmers' revenue, while also bringing adverse effects for other local stakeholders such as farm workers, according to a study undertaken in Punjab. Contract farming provides women with employment options, but there is a gender disparity in wage payment. This study necessitates policy and organizational attention, as well as regulatory control, to accomplish a more equitable and efficient impact of contract farming.

4. Haque, (2000) discussed that contract farming is an agricultural/horticultural production and supply system based on advance contracts between producers/suppliers and purchasers

5. Christensen and Scott (1992) in their study discussed the significance of contract farming as it's a case of bringing the market to the farmers, which agribusiness companies handle.

6. Jagdish Kumar and Prakash Kumar K (2008) conducted a study on contract farming and its problems, prospects, and its effect on income and employment and in which they concluded that farmers violating terms and conditions, a lack of adequate administration by the organization, frequent price swings in foreign markets, and a scarcity of transport vehicles during peak seasons are among the key obstacles highlighted by contracting agencies in developing contract farming.

Objectives of the study
1. To study contract farming and its importance in agriculture and the current business scenario.
2. To understand the potential issues that farmers face in contract farming
3. To identify the problems and challenges of the farmers in contract farming in India
4. To provide suggestions

Nature of the study
The present study is exploratory research which looks at research issues that haven't been thoroughly investigated before. Since there are not many studies on contract farming, this study has been undergone by the researchers to understand and identify the problems and challenges of farmers in contract farming. Secondary data has been collected from various international and national journals, other records, and various sources and the study has been carried out to gain a better knowledge of the current situation in the context to contract farming, but it will not yield definitive results.3

Importance of Contract Farming in agriculture

Contract farming in agriculture is important in the following ways:

1. **Risk Reduction**: Buyers can share the risk of crop failure due to bad weather, disease, and other factors by working with contracted farmers. The farmer has the risk of losing production, while the corporation bears the costs of processing facility throughput that is reduced or non-existent.

2. **Obtaining credit is easier:** The farmers usually face many difficulties in obtaining the financial support required for crop production. Contract farming bridges the gap in getting the financial assistance needed. The farmers are provided with monetary support from the buyers. Also in some situations, the farmers are provided with other agricultural inputs.

3. **Under the ambit of law:** The Indian Contract Act of 1872 governs contract farming in India. The Act contains numerous general requirements that apply to contract farming, including contract formulation, party obligations, and contract breach repercussions. Furthermore, the model APMC Act of 2003 contains special contract farming regulations, such as mandatory registration of contract farming sponsors and dispute resolution.

4. **Implementation of suitable technologies:** The companies offer the latest technologies to leverage the best in farming. They can now use technology to make informed selections regarding the crop type to be grown and the method of cultivation. The water scarcity during the irrigation process can be addressed with the help of many automated technical solutions comprising various sensors and devices. Also, Solar power can be utilized which in turn saves more power. This enables the farmers to use the resources efficiently. Also, Contract farming enables the transfer of technology from the buyers to the farmers.

5. **Steady Pay:** Contract farming's fixed income module ensures that farmers obtain consistent pay even in difficult times. This makes the farmers financially secure even in dire circumstances.

6. **Easy market access**: Farmers get market guarantees via contract farming, and buyers get supply assurance. The relationship between the farmer and the provider allows them to access new markets with a stable supply and demand ratio.

7. **Achieving quality requirements:** Contract farming helps the suppliers and end-users to be confident that they will receive high-quality items at competitive prices if the quality is used as a criterion.

Contract farming in the current business scenario:

In today's world of open-market transactions, contract farming is a significantly more controlled mode of commerce governed by a legal agreement that is designed to protect both parties, the producer and the consumer. The idea of contract farming is novel but it might backfire on farmers in a country where the Government favors corporates. Contract farming is increasing its impact in agribusiness nowadays irrespective of whether the goods are acquired by multinationals, smaller enterprises, government agencies, farmer cooperatives, or individual entrepreneurs (Archana Singh and another 2021). Contract farming provides mutual benefits to the companies and farmers. Because of the increasing population's awareness of food safety and quality, as well as the quality needs of the export market in developed nations, the future of contract farming in India seems bright.

Contract farming is a possible alternative agricultural strategy in India that can give farmers guaranteed and reliable input services. It also provides contracting companies with needed agricultural goods. Many Indian and global firms have already started such projects in India, with varying degrees of success. The successful cases should serve as a model for expanding contract farming to enhance the quality of farm produce while also raising the revenues of rural agriculture-based communities.

Issues in contract farming:

Below are some of the potential issues that farmers face in contract farming.

1. **Lack of awareness about contract farming:** The farmers especially the small-hold farmers lack clarity. Many are not aware of the contract farming laws enacted by the government of India and other statutory bodies in India.

2. **Fear to engage with big traders'/business people (unequal playfield):** Biased buying, late payments, inept extension services, bad agronomic counsel, unreliable crop transportation, a mid-season price adjustment, or management's rudeness to farmers are all examples of conditions that can lead to farmer dissatisfaction. Such

problems, if not quickly resolved, can engender hostility toward sponsors, possibly leading to farmers withdrawing from initiatives.

3. **Difficulty in meeting quality requirements:** Farmers are often obliged to use contract inputs for reasons other than those for which they were purchased (Harish and another 2016). They might use the inputs on other crops or even sell them. Therefore, contracted crop yields decreased, and quality decreased. Staff monitoring, farmer training, and the provision of realistic input quantities can all help to fix the problem.

4. **Financial constraints:** The farmers entering the contract farming are sometimes over-dependent on advances being provided by the buyers. This also makes them borrow loans from financial institutions when they are unable to match the obtained and production cost. This would cause arise in the debt possessed by the farmers as the time period and interest to be paid increases.

5. **Lack of Credit and delayed payment:** Sometimes the farmers engaged in contract farming may not be able to obtain enough funds from the provider. The payment process when delayed by the company to the farmer shall result in a loss financially. It also delays the next cultivation cycle that must be followed.

6. **Resource scarcity:** For irrigation purposes when the availability of water is not sufficient in any form, it affects the agricultural process on a larger scale. In India, a land of diversity with different geographical conditions, suitable plans, and technologies to be used should be adapted to solve the crisis. Rajasthan has devised a new Solar Energy policy to meet its power demand and supply. Accordingly, Farmers can use their un-cultivable agricultural land to set up power.

7. **Need for technological updation:** Suitable technological changes should be adopted according to the crops cultivated. There should be a mutual consensus between both parties. The company should provide technological learning facilities to the farmers. So that the farmers learn about the advancements to be made in their respective fields.

Problems and challenges of the farmers in contract farming in India

Contract farming, on the other hand, should not be viewed as a panacea for eradicating rural poverty; it only makes sense for particular commodities in specific markets. Furthermore, if contract farming is not properly managed, it can result in a slew of issues, including power abuse, market failure, side-selling, negative environmental and gender consequences, declining incomes, and the transformation of smallholder farmers into wage-earning agricultural laborers on their land. Though contract farming has many advantages in agriculture and it has been rapidly followed in many states and could be one of the ways of developing rural economies, it has a dark side where the buyers are exploiting the farmers and it leads to more catastrophic consequences for the farmers if they fail to follow the terms of the agreement.

Contract farmers face major constraints such as delayed payment for crop production, water insufficiency for irrigation, intermittent electricity supply, and face challenges in satisfying quality standards. But non-contract farmers face major constraints such as scarcity of water for irrigation, erratic power supply, lack of credit for crop production, and lower prices for crop production. Farmers' violations of terms and conditions, the company's lack of competent management, frequent price swings in foreign markets, and a scarcity of transport vehicles during peak seasons are all key roadblocks to contract farming development, according to contracting agencies (Jagdish Kumar and Prakash Kumar K 2008).

The following are some of the problems and challenges of farmers in contract farming:
- Enforcement of laws for relief
- Payment for agricultural output is delayed
- Other financial constraints in crop production
- water deficit for irrigation
- irregular electricity supply
- difficulty in fulfilling the quality standards
- fear to engage with big traders'/business people (unequal playfield)
- lack of awareness about contract farming

- Financial constraints
- Single Buyer – Multiple Sellers (Monopsony).
- Adverse gender effects - Women have less access to contract farming than men.

CONCLUSION

In this VUCA world, developments in all aspects of every sector are inevitable. In agriculture, many innovations are being carried out and many technologies are being introduced in most of the processes. Better institutional mechanisms can be offered as a way to make contract farming more equitable and sustainable. Because contract farming agreements do not mention soil or groundwater sustainability, the government could support measures such as drip irrigation and organic farming through incentives (Braja Bandhu Swain 2016).One of the most important steps taken by the Government is to provide a legal platform to help both the farmers and the buyers in dealing with agricultural products and services and with this view, several laws have been enacted by the Central and the State governments and each state has its laws to regulate this contract farming. The 2020 Act on Contract Farming will now take precedence over the 2018 statute. Some states had passed contract farming legislation using the 2018 law as a model. Such legislation will now be declared null and void. Due to various problems and challenges for farmers, contract farming has not been carried out effectively in most states. This study has identified some of the problems and challenges in contract farming and this would pave the way to examine the problems and challenges in the future.

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RESEARCH ARTICLE

The Influencing Factors on Trust in the Adoption of M- Wallets - A Study at Bengaluru Rural District, Karnataka

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ABSTRACT

A mobile wallet is a type of electronic wallet for fund transfer that contains information such as credit card details, loyalty card numbers, and debit card numbers. It can be accessed through an app for smart phones or tablets. It enables users to send and receive money and make purchases using their mobile devices. This type of e-commerce model is ideal for people who use mobile devices for accessibility and comfort. Trust is the fiduciary relationship between a trustor (user) and trustee (service provider), the consumers will adopt and continue use the mobile wallet when they trust which serves as the foundation for the study. They learn characteristics through informal learnings but users are worried about trust. The purpose of the study is to analyse how the trust factors influencing in adopting and using m-wallets by Bangegaluru rural district users. Through a structured questionnaire, the researchers were able to collect 61 responses, which revealed that although m- wallets have various positive features, rural users are still reluctant to use them due to their lack of trust. The findings will be used to help improve the trust levels of financial institutions, internet service providers and regulators.

Keywords: m-wallet, influence, factors, trust, rural users.
JEL Classification: O33, Technological Change- Choices and Consequences-Diffusion Processe

INTRODUCTION

A mobile wallet is a type of electronic wallet for fund transfer that contains information such as credit card details, loyalty card numbers, and debit card numbers. It can be accessed through an app for smart phones or tablets. It enables users to send and receive money and make purchases using their mobile devices. This type of e-commerce

model is ideal for people who use mobile devices for accessibility and comfort. When compared to paying with cash or carrying around traditional credit cards, customers prefer mobile wallets to make in-store payments. Stores that are registered with mobile service providers accept payments made with mobile wallets. Since the data in a mobile wallet is encrypted, thieves find it challenging to use it for nefarious purposes. Mobile wallets are tough to steal because they come with encrypted keys that might not provide any relevant information, in contrast to real credit and debit cards that can be stolen or copied. The mobile application employs Near-Field Communication (NFC) technology to connect with other devices when a customer makes an in-store purchase. The user simply shows the appropriate payment format using an NFC enabled device, such as a card, QR code, or token. The user can then start the transaction by either waving or tapping the device over the terminal of the merchant. Trust is the fiduciary relationship between a trustor(users) and trustee(service provider), the consumers will adopt and continue to use the mobile wallet when they trust which serves as the foundation for the study. They learn characteristics through informal learning but users are worried about trust.

Significance of the study

Due to budget friendly internet and low-priced smart phones majority of the consumers are using m-wallets for their daily financial transactions. Despite the inherent benefits of mobile wallet, the number of real users of this service has persisted low (Aggarwal, 2016) in rural India due to many factors. One of the biggest factors that will prevent the adoption of mobile wallets is the lack of trust. According to the Yourgov report 2021., 38% of the mobile users have low confidence in the security of their mobile wallets. Also, majority of the individuals are not ready to adopt mobile wallets due to the unknown risks associated with contactless payments. double payments, block of money and e-wallet vulnerability(IndustryARC-reports-2022), Hence it is relevant to analyse the factors influencing on trusting m-wallets for day to day financial transactions

REVIEW OF LITERATURE

Rana (2017) The study explored that the factors that influence a person's wallet usage are related to their brand loyalty and the variety of services that are offered by different wallets. It also found that the satisfaction level of the wallet is influenced by the premium offers that are made by different wallets. Sujith, *et.al* (2019) The study found that most of the respondents are knowledgeable about m-wallet services, and they are satisfied with their experience. However, they cited various issues such as network problems and security threats as the most common problems faced by users. Furthermore, promotion programs such as reward points and discount coupons can help boost its popularity. Kumar, *et.al* (2018) The study revealed that the perceived ease of use and usefulness of M- wallets significantly affect the intention of users to continue using them. The security of these devices also affects the satisfaction of users. In addition, the quality of information and the switching costs are some of the factors that can influence the future research of these products. Patel (2018) this descriptive study found that wallet usage preferences are influenced by brand loyalty among age groups and usage preferences are influenced by innovative services being offered by various wallets among occupational groups, finally wallet satisfaction level is influenced by premium offers by various wallets among age groups

Chawla And Joshi (2019) The goal of this study was to analyze the factors that influence the behavioral and attitude toward mobile wallet adoption. It also looked into the effects of age and gender on the adoption of mobile wallet. The research revealed that certain factors such as ease of use, security, and trust, as well as lifestyle compatibility, have a significant influence on the intention and attitude of users. The results indicate that the age and gender of the respondents moderate the influence of their selected antecedents on their attitude and intentions. Young users and males also had more significant effects. Nandhini and Girija (2019) The study revealed that the opinions of customers and gender differ when it comes to the use of e-wallets. The study also found that the majority of them prefer the e-wallet for its fast service. However, it is important to note that the main factors that prevent the customers from using the e-wallets are network connectivity and security threats. The study concluded that the customers are satisfied with the overall features of the e-wallets.

Roy And Tandon (2022) The main findings of this study suggest that the attitudes and intentions of Indian consumers are influenced by various factors such as their perceived usefulness, ease of use, and safety concerns. These factors are vital to the development and implementation of m-payment technology in the country. The study also supports the existing literature on the acceptance and use of this technology. Gupta *et.al* (2023)The goal of this study is to find out how the use of technologies can influence the behavioral intentions of tourists when it comes to using mobile wallets and making digital payments. The study was conducted on 250 tourists who visited the Garhwal region of Uttarakhand. Data was collected using a simple random sampling method. The variables that were used included the Perceived Value, Perceived Happiness, Social Influence, and Mediating variables. Outcomes were then analyzed using the Service Trust, Service Satisfaction, and Behavioral intentions of the tourists. The study utilized a partial-least-square model analysis technique known as PLS-SEM to test the proposed model. The results of the study revealed that the relationship between the multiple predictor variables and the mediating variables was significant. The findings showed that the use of technologies could influence the behavior of tourists when it comes to making digital payments.

Statement of the Problem
A mobile wallet is a type of application that can be used on a smart phone. Numbers of these are available in the app market and can be used for various transactions. Since the internet is a part of every person's life, m-Wallets are useful in making various payments. However, despite the digital awareness campaign launched by the government, the number of people who use m-wallets is still low compared to those in urban areas. According to the RBI's annual report, the number of people who use m-wallets is increasing due to the government's digital awareness campaign. The objective of this study is to find out the factors that influence the adoption and use of mobile wallets in rural areas of Bangalore.

Objective
The objective of the study is to find out the influencing factors on trust in the adoption and use of mobile wallets.

Research Methodology
For this descriptive study, the datawas collected from 61 respondents of Bangaluru rural district using structured questionnaire of 5 point Likert scale the questions were formed based on EXTENDED UTAUT2 (doi:10.1177/1847979019889484), The respondents are from different backgrounds. The data was analysed using percentage analysis and chi-square test.

Hypothesis
H0 –Demographic and other factors have no positive association with trust
H1 - Demographic and other factors have positive association with trust

Data Analysis and Interpretation
From the table analysed that, 38% of the respondents belongs to the age category of 31 to 45 years which is highest, 30% of the respondents belongs to the age category of 46 to 60 and above 61 years is 04% which is lowest. 71% of the respondents are male. 51% of the respondents are earning the monthly income between 20001 to 35000 which is maximum and only 3% of the respondents are earning more than 50000. Maximum respondents i,e,56% have done their graduation and maximum respondents belongs to rural or Hobli headquarters. From the table it is analysed, maximum that is 77% of the respondents opinion is m-wallets are useful for daily transactions and only 16%of the respondents are telling not useful for day today transaction and another 5% are neutral. From the table it is understood, maximum that is 82% of the respondents says m-wallets are   helping to complete the transactions quickly and easily and only 16% of the respondents opinion is m-wallets are not helping to complete the transactions quickly and easily   It is clear from the table, maximum respondents i,e, 71% of them says m-wallets are convenient to do the transactions and 29% of them say no, this is a considerable number.

From the table it is understood, maximum that is 67% of the respondents says their personality is permitting them to adopt m-wallets with required skill set and 31% of the respondents says they do not have required personality support to adopt m-wallets. From the table it is analysed, maximum that is 95% of the respondents says m-wallets are   widely accepted to complete the transactions quickly and easily everywhere but only 5% people telling m-wallets are not accepted everywhere. From the table it is understood, maximum that is 96% of the respondents says m-wallets are legal and backed by law, only 4% of the people telling m-wallets are not legal. It is analysed from the table, maximum that is 67% of the respondents says m-wallet transactions related issues are resolved with good backend services immediately, 23% of the respondents opinion is issues are not resolved immediately and 10% of the respondents are neutral. It is analysed from the table, 82% of the respondents says in m-wallets personal and banking data are safe, 15% of the respondents opinion is not safe and 3% of the respondents are neutral. It is understood from the table, maximum respondents i,e, 75% of the respondents are trusting the m-wallets for their day-to-day transactions where as 3 % respondents are neutral and 22% of the respondents are not trusting are trusting the m-wallets for their day-to-day transactions.

Hypothesis Testing

The statistical framework in this analysis is focussing on the Chi-square test with the respondent's trust on m-wallets adoption and usage. In this study the trust factor is decided based on m-wallets usefulness, easiness of use, convenience, motivation to use, social influence to use and security, finally all these factors are contributing to form trust (Eneizan, B., Mohammed, A. G., Alnoor, A., Alabboodi, A. S., & Enaizan, O. (2019)). The outcome of the data analysis resulted with 0.61, hence null hypothesis is rejected and concluded m-wallets usefulness,easiness of use, convenience, motivation to use, social influence and security factors are enhancing the trust in adoption and use of m-wallets in their day to day life.

Major Findings of the Study

1. Maximum respondents are male, their age is 31-45 years. Majority of the respondents are earning up to 20000 per month, they are graduated and most of the respondents are from rural/ Hobli level.
2. Majority respondents opinion is m-wallets are useful and easy to use for day-to-day transactions which are very convenient and contributing to form trust.
3. Respondents are using m-wallets due to social influence, which are widely accepted.
4. It is found from the study, security issues are the major concerns in forming trust and use of m-wallets
5. Trust on m-wallets is dependent factor on other demographic and other independent factors.
6. Continued use of m- wallet is purely depended on trust factor

IMPLICATIONS AND CONCLUSIONS

The study was aimed at finding the factors which are constituting trust on m-wallets based on UTAUT2 constructs and found trust factor is based on m-wallets usefulness, easiness of use, convenience, motivation to use, social influence to use and security. In the process of usage and trusting around 40% of the users are still not trusting m-wallets for their regular use because respondents opinion is that their personal and banking data is not secured, which is not convenient to all and they are with lack of digital literacy. The implementation of m-wallets in rural areas has become a major challenge for policymakers and regulators. They need to understand the various ground-level factors that affect their adoption rate. Besides improving the security features, it is also important that the providers of these services make it easier for the users to use them. The standardization of the procedures and charges associated with the use of wallets is very important to ensure that they are secure and reliable. Many of the respondents are experiencing issues such as network failure and fraud.

Limitations and Prospects for Future Research

This study was restricted to 61 respondents of Bangalore rural district due to various constraints. Behavioural research cannot give long lasting results due to timely changes. The same research can be extended to more number of respondents or can be carried as comparative study.

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Table:1- Demographic profile of the respondents

Factors	Respondents category	No. of Respondents	Percentage
Age	18-30	17	28
	31-45	23	38
	46-60	18	30
	61 and above	03	04
Gender	Male	43	71
	Female	18	29
	Others	00	00
Monthly Income	Up to 20000	16	26
	20001 to 35000	31	51
	35001 to 50000	12	20
	50001 and more	02	03
Educational qualifications	SSLC	07	12
	PUC	13	21
	Graduation	34	56
	Post-graduation	07	11
Locality	Rural/ Hobli HQ	27	44
	TMC	21	34
	CMC	13	22

Source- Primary data

Table:2- Do you think M-wallets are useful for daily payments/ transactions

Factor Usefulness	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	3	7	3	32	16
Percentage	5	11	5	52	27

Source- Primary data

Table:3- Do you think M-wallet transactions helps to complete the transactions quickly and easily

Factor Easy to use	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	4	6	1	17	33
Percentage	6	10	2	28	54

Source- Primary data

Table:4- Do you think M-wallet transactions are convenient for 24 X 7 transactions

Factor Convenience	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	7	11	0	23	20
Percentage	11	18	0	38	33

Source- Primary data

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Table:5- Do you think your personality permits to use m-wallets

Factor Hedonic motivation	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	12	7	1	13	28
Percentage	20	11	2	21	46

Source- Primary data

Table:6- Do you think M-wallet transactions widely accepted

Factor Social influence	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	2	1	0	27	31
Percentage	3	2	0	44	51

Source- Primary data

Table:7- Do you think M-wallet transactions are legal

Factor Security	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	1	1	0	21	37
Percentage	2	2	0	35	61

Source- Primary data

Table:8- Do you think M-wallet transactions related issues are resolved by service providers immediately

Factor Security	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	11	3	6	28	13
Percentage	18	5	10	46	21

Source- Primary data

Table:9- Do you think in M-wallets your banking and personal data is safe.

Factor Security	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	4	5	2	31	19
Percentage	7	8	3	51	31

Source- Primary data

Table:10- Do you thinkabove factors are influencing you to trust m-wallets for your day to day transactions

Factor Trust	Strongly Disagree.	Disagree.	Neutral.	Agree.	Strongly agree.
Number of of Respondents	6	7	2	27	19
Percentage	10	12	3	44	31

Source- Primary data

REVIEW ARTICLE

A Systemic Review on Herbal Plant Supplements used as Antioxidants

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ABSTRACT

Natural antioxidants eliminate abundance free extreme intermediates by lessening hydrogen donors or extinguishing singlet oxygen and deferring oxidative responses in effectively developing malignant growth cells. A few cancer prevention agent chemicals and particles are over communicated in oxidative pressure conditions that can harm cell proteins and DNA.A assortment of plant materials are known to be regular wellsprings of cell reinforcements. Cancer prevention agents and compounds influence signal transduction and energy digestion pathways for the support of cell redox status. A decrease in cancer prevention agent limit emerging from hereditary transformations might build the mitochondrial motion of free extremists bringing about failing of cell flagging pathways. DPPH technique was observed to be utilized generally for the in vitro cell reinforcement action assessment reason while LPO was found as for the most part utilized in vivo cancer prevention agent examine.

Keywords: Antioxidative, Prevention, Thioredoxin, Quercetin, Glutathione.

INTRODUCTION

Antioxidants

Cancer prevention agents are intensifies that hinder oxidation, a compound response that can deliver free revolutionaries and chain responses that might harm the cells of organic entities. Cell reinforcements, as an example, thiols or ascorbic corrosive (vitamin C) may act to hinder these responses. To adjust oxidative pressure, plants and creatures sustain with complex frameworks of covering Anti-oxidant, Eg: glutathione. The main dietary cancer prevention agents are nutrients A, C, and E. The term cell strengthening is additionally utilized for mechanical synthetics added during assembling to forestall oxidation in engineered elastic, plastics, and energizes, or as additives in food and beauty care products. Dietary enhancements promoted as Natural Antioxidant have not been displayed to further develop wellbeing or forestall infection in people. Enhancements of beta-carotene, nutrient A, and nutrient E have no beneficial outcome on death rate or malignancy hazard. Furthermore, supplementation with selenium or nutrient E doesn't diminish the danger of cardiovascular sickness [1].

Relation to Diet

Albeit certain degrees of cell reinforcement nutrients in the eating regimen are needed for acceptable wellbeing, there is as yet impressive discussion on whether cancer prevention agent rich food varieties or enhancements have hostile to infection movement. Besides, in case they are really advantageous, it is obscure which Natural Antioxidant are well being advancing in the eating routine and in what sums past run of the mill dietary admission. A few creators question the theory that cell reinforcement nutrients could plantall persistent infections, and some proclaim that the speculation is doubtful and confused. Polyphenols, which have cell reinforcement properties in vitro, have obscure cancer prevention agent movement in vivo because of broad digestion following absorption and minimal clinical proof of viability [2].

Natural Antioxidants

Natural Antioxidant is regularly gotten from plant sources, and the adequacy is controlled by plant species, assortment, extraction and additionally preparing techniques, and the developing climate. The method of activity for these substances will shift contingent on the source material, the presence of synergists and bad guys, and obviously the food grid. It is important to concentrate on the therapeutic plants with old stories position in a number out their potential as a wellspring of new medications. Today natural medication of strengthened approaches to support the use of home grown medication and to discover implies one of the most fundamental fields of people medication and the usage of home grown meds have been developing fame for different recuperative conditions [3].

Pro-Oxidant Activities

Natural Antioxidant that is lessening specialists can likewise go about as supportive of oxidants. For instance, nutrient C has cell reinforcement movement when it lessens oxidizing substances, for example, hydrogen peroxide; notwithstanding, it will likewise decrease metal particles that create free extremists through the Fenton response.

2 Ferric ion + Ascorbate → 2 ferrous ion + Dehydroascorbate

2 Ferrous ion + 2 H_2O_2 → 2 Ferric ion + 2OH• + 2OH−

The general significance of the cell reinforcement and supportive of oxidant exercises of cancer prevention agents is a space of flow research, yet nutrient C, which applies its belongings as a nutrient by oxidizing polypeptides, seems to have a for the most part cell reinforcement activity in the human body. Nonetheless, less information is accessible for other dietary cancer prevention agents, like nutrient E, or the polyphenols. Moreover, the pathogenesis of infections including hyperuricemia likely includes uric corrosives immediate and backhanded supportive of oxidant properties [4].

Cancer Prevention Agent in Food Technology

Cancer prevention agents are utilized as food added substances to help protector against food decay. Openness to oxygen and daylight are the two principle factors in the oxidation of food, so food is saved by keeping in shadows and fixing it in compartments or in any event, covering it in wax, similarly as with cucumbers. Nonetheless, as oxygen is likewise significant for plant breath, putting away plant materials in anaerobic conditions produces unsavory flavors and unappealing shadings. Subsequently, bundling of new foods grown from the ground contains a ~8% oxygen air. Cancer prevention agents are a particularly significant class of additives as, in contrast to bacterial or contagious deterioration, oxidation responses actually happen generally quickly in frozen or refrigerated food. The most widely recognized particles assaulted by oxidation are unsaturated fats; oxidation makes them turn smelly. Since oxidized lipids are regularly stained and typically have terrible preferences like metallic or sulphurous flavours, keep away from oxidation in fat-rich food varieties [5].

Modern Uses

Natural Antioxidant are often added to modern items. A typical use is as stabilizers in fills and oils to forestall oxidation, and in fuels to forestall the polymerization that prompts the arrangement of motor fouling deposits.Cell reinforcement polymer stabilizers are generally used to forestall the debasement of polymers like rubbers, plastics and cements that causes a deficiency of solidarity and adaptability in these materials. Polymers containing twofold bonds in their fundamental chains, like normal elastic and polybutadiene, are particularly helpless to oxidation and ozonolysis. They can be ensured by antiozonants. Strong polymer items begin to break on uncovered surfaces as the material corrupts and the chains break. Oxidation of polyethylene will in general happen at points of failure in the chain, for example, branch focuses in low-thickness polyethylene [6].

The Safety and Toxicity of Natural Antioxidants

Food added substances are exposed to similar severe security principles whether or not they are normally or artificially inferred. The security of food added substances, in which normal Natural Antioxidant are incorporated, is controlled by considering potential total impacts that are assessed by the result of poisonousness contemplates and from information about the synthetic mixtures. There are some reports within the writing with bearing the importance of wellbeing appraisals and toxicological tests completed on explicit regular concentrates. As specific illustrations, intense and subchronic toxicological tests were performed for bamboo leaf removes, which were by and large viewed as protected by the creators for use as food added substances. What's more, the hydroethanolic concentrate of Dolichandra unguis-cati leaves didn't present significant harmful impacts when managed orally to male and female rodents under intense and subacute tests. The subchronic harmfulness and genotoxicity of the flavonoids rich concentrate from Maydis disgrace were analyzed. The outcomes absolve its protected use as a utilitarian food, food added substance and normal cure. Toxicological investigations of fundamental oils with the cancer prevention agent action of autochthonous-enhancing spices from Portugal uncovered low poisonousness in Swiss mice (DL > 1000 mg/kg) [7].

Wellsprings of Cell Reinforcements

Plant food varieties are rich wellsprings of cancer prevention agents. they're generally bountiful in products of the soil, even as different food sources including nuts, entire grains and a number of meats, fish.
Great wellsprings of explicit Natural Antioxidant include:

- Allium sulphur composites – leeks, onions and garlic
- Anthocyanins – eggplant, grapes and berries
- VIT A – pumpkin, mango fruit, apricots, carrots, spinach and parsley
- Catechins – wine and tea
- Copper – fish, lean meat, milk and nuts
- Cryptoxanthins – red chili pepper, pumpkin and mangoes

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- Flavonoids – tea, green tea, citrus natural products, red wine, onion and apples
- Indoles – Brassicaceae vegetables like broccoli, cabbage and cauliflower
- Isoflavonoids – soya-beans, bean curd, lentils, peas and milk
- Lignans – Sesamum indicum seeds, wheat, entire grains and vegetables
- Lutein – green, verdant vegetables like spinach, and corn
- Lycopene – tomatoes, Citrus maxima and watermelon
- Manganese – fish, lean meat, milk and nuts
- Polyphenols – thyme and oregano
- Selenium – fish, offal, lean meat and whole grains
- VIT A – liver, yams, carrots, milk, and egg yolks
- VIT C – oranges, cassis, kiwifruit, mangoes, broccoli, spinach, capsicum and strawberries
- VIT E – vegetable oils, (for example, wheatgerm oil), avocados, nuts, seeds and full grains
- Zinc – fish, lean meat, milk and nuts
- Zoochemicals – meat , offal and fish. Likewise got from the plants that creatures eat [8].

Plants as A Possible Wellspring Of Cancer Prevention Agents

In perspective on expanding hazard components of human to different dangerous illnesses, there has been a worldwide pattern towards the use of standard substance present in restorative plants and dietary plants as remedial Natural Antioxidant. Cell reinforcement action, cancer prevention agent viability or proficiency of flavors and spices are often controlled by utilizing some logical strategies. the foremost much of the time utilized insightful tests are 2,2-diphenyl-1-picrylhydrazyl (DPPH), ferric lessening cell reinforcement power, oxygen extremist absorbance limit (ORAC), absolute phenolics content, 2,2=-azino-bis (3-ethylbenzothiazoline-6-sulphonic corrosive (ABTS), cupric decreasing cancer prevention agent limit, all out revolutionary catching malignancy prevention agent boundary, Trolox comparable cancer prevention agent limit and anything else [9].

Cancer Prevention Agent in Chemotherapy

Against disease drugs are generally cytotoxic and are related with a large scope of incidental effects due to the adjustment of the cell oxidative status. Chemotherapeutic medications frequently harm DNA by creation of free extremists that intervene cell cycle prompting cell demise by apoptosis or rot. The greater a part of these chemotherapeutic specialists follow abreast of quick partitioning cells viz. bone marrow, epithelial cells then on and an assortment of tissues and organs viz. cardiomyocytes, hepatocytes, lungs, and kidneys. They could harm various organs and cause fundamental issues while meddling with quickly partitioning cells. a possible arrangement would be the use of Natural Antioxidant alongside the malignancy chemotherapy that expansion cell oxidative pressure. Along these lines, the 2 Natural Antioxidant and prooxidants enjoy clear benefits and downsides in disease treatment.

Hostile to malignancy cancer prevention agent treatments are often isolated into two classifications as another kinds of clinical supplementations

1. Prophylactic portion, which may be a lower portion delivering insurance to ordinary cells and growth cells and
2. Therapeutic portion, which may be a higher portion repressing the event of disease cells without meddling with ordinary cell development [10].

Capacity of Cancer Prevention Agents

The Food and drugs Organization (FDA) characterizes Natural Antioxidant even as dietary enhancements to be taken notwithstanding typical food utilization with an end goal to forestall these sicknesses. Natural Antioxidant are known to assume a critical part within the defensive impact applied by fertilizer varieties. Standard utilization of vegetables and natural products has been perceived as decreasing the danger of persistent infections. Studies exhibit that a cancer prevention agent rich eating routine has a particularly sure wellbeing sway over the long-term. As lately , Natural Antioxidant have drawn in extensive consideration consistent with extremists and oxidative

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pressure, disease prophylaxis and treatment. All Natural Antioxidant are working in show collectively, the (cancer prevention agent framework), responsible for anticipation of the harming impacts of free revolutionaries and poisonous results of their digestion. Be that because it may, the cell reinforcement (group) acts to manage levels of free extreme development as an organized framework where insufficiencies during a single part sway the proficiency of others. The four potential component by which Natural Antioxidant capacity to diminish the pace of oxidation of fats and oils. These are hydrogen gift by cancer prevention agents, electron gift by cell reinforcements, expansion of lipid to the Natural Antioxidant and arrangement of a posh among lipid and cell reinforcements. Among food parts battling against ongoing illnesses, extraordinary consideration has been paid to phyto-synthetics, plant-inferred atoms enriched with consistent cancer prevention agent influence. the combination and synergistic exercises of the bioactive particles present in fertilizer are responsible for their upgraded cancer prevention agent properties [11].

Current Spotlight on Antioxident

To audit the importance of cell reinforcement supplements within the support of wellbeing and therefore the avoidance and treatment of sickness, with a stress on information concerning nutrient C, nutrient E, selenium, and carotenoids. An auxiliary target was to speak about the new Dietary Reference Admissions delivered by the inspiration of Medication (IOM) for these supplements. IOM investigates the use of cancer prevention agent nutrients were evaluated for supplement suggestions. Moreover, a MEDLINE search was performed to acknowledge ongoing exploration and survey articles on the purpose , which were broke right down to distinguish key examination discoveries nearby. The audit talks about the biologic cycles of oxidation responses and Natural Antioxidant in biologic frameworks, gives an overview of information on chose cell reinforcement supplements, and investigates their job within the anticipation and therapy of malignant growth, cardiovascular infection, visual issues, and respiratory problems. There have all the earmarks of being huge medical advantages from dietary cancer prevention agents, as can be found in products of the soil. Some imminent evaluation of the impact of supplemental cancer prevention agents additionally proposes advantage, particularly for nutrient E; notwithstanding, there are clashing outcomes around here. Generally, apparently cell reinforcement supplements, particularly those from food sources, play significant parts in forestalling pathogenic cycles identified with malignancy, cardiovascular sickness, macular degeneration, waterfalls, and asthma, and may improve safe capacity. Lately, these kinds of approaches are being done in a few investigations and in works along different nutrition classes and at various levels of the natural way of life and furthermore in more uncommon food sources [12].

Need of Study

Oxidation response relying on location of events presents explicit repercussion. In the event that the site of event is food framework, food crumbles. At the point when oxidation happens in organic cell framework, it makes harm or demise the cell. The oxidative decay of fats and oils, when present as a part in food sources, is answerable for foul scent and flavor with a subsequent diminishing in nourishing quality, tangible allure and wellbeing. This is brought about by the development of essential hydro peroxides and auxiliary conceivably poisonous mixtures through auto-oxidation of unsaturated fats comprising of a free extreme chain instrument. The immediate oxidation of unsaturated lipids with the twofold security in a singlet express (no unpaired electrons, matched electrons are in the equivalent orbital and have inverse twist) by oxygen in its ground trio state (two free electrons in isolated orbital's with same twist bearing) is turn prohibited. To conquer this twist boundary, initiators or impetuses are needed to begin the lipid oxidation measure by eliminating an electron from either the lipid or oxygen or by changing the electron twist of the oxygen. As just follow measures of impetuses are required, numerous circumstances that give off an impression of being unconstrained or uncatalyzed are really determined by impurities or conditions that have gone Undetected or unconsidered. For sure, in many food sources, organic frameworks, and research center tests, any reasonable person would agree that various impetuses and initiators are consistently employable [13].

System
The fundamental review was done in a basic appraisal and assessment of all exploration concentrates on that address a specific issue for a time of 4 months from April 2021 to July 2021. The articles were chosen dependent on the incorporation and rejection standards [14].

Incorporation Models
Dietary mediation either diet alone or in mix with way of life or potentially intellectual systems [15].

Rule For Including the Utilization of Cancer Prevention Agents
Cancer prevention agents are utilized for treating/restoring reason or supporting/further developing body capacities. Cancer prevention agent action ought not be closed dependent on a solitary cell reinforcement test model. Also, by and by a few in vitro test strategies are completed for assessing cell reinforcement exercises with the examples of premium. Cell reinforcement for human utilize as it were.

Prohibition Rules

Tenet for barring the utilization of cancer prevention agents. Cancer prevention agents kill the impacts of ongoing aggravation, which is a component of a wide assortment of obstinate medical conditions in creatures. For all in vivo strategies the examples that are to be tried are normally controlled to the testing creatures (mice, rodents, and so forth) at a positive measurement routine as portrayed by the individual strategy. After a predefined timeframe, the creatures are normally forfeited and blood or tissues are utilized for the measure. Cancer prevention agent for creature utilize as it were.

Enzymatic Antioxidants
Grasses Grasses are chemicals that catalyze the change of superoxide revolutionaries (O) to atomic oxygen (O) and hydrogen peroxide (HO). They fill in as a powerful cancer prevention agent protection against oxidative pressure. Grasses are found in practically all vigorous cells and extracellular liquids. Three significant deposits (His48, His63, and Arg143) and two metal particles (Cu and Zn) are found in the dynamic site of SOD, especially SOD1. The nitrogen iotas of buildup His63 tie to Cu and Zn particles. This limiting is broken and yet again shaped during catalysis. Legitimate situating and direction of superoxide is needed for electron move with Cu particle, and is accomplished by Arg143.

Felines Felines are a class of dismutase compounds that work with disintegration of H O to water and oxygen in the living cell. These compounds are available in each organ of most known creatures, with especially undeniable levels detailed in the liver. Felines forestall the oxidative extremist harming impact of 17β oestradiol and diethylstilbestrol, and are profoundly effective Natural Antioxidant.

GSH system The GSH framework is an enzymatic cancer prevention agent framework that assumes a significant part in the guideline of numerous significant flagging pathways. It is a gathering of cancer prevention agents (GSH, GSH reductase, GSH peroxidases, and GSH S-transferases) principally answerable for eliminating ROS, responsive nitrogen species (RNS).

URIC acid Adenine and guanine, nucleic corrosive constituents, are corrupted to frame uric corrosive, regularly found in the muscle, kidney, and liver. Uric corrosive is a significant low-atomic mass cancer prevention agent present in natural liquids in human, birds, reptiles, and a few primates. As a possible cancer prevention agent, it searches hydroxyl and peroxyl extremists in vitro and in vivo. Cell reinforcement impacts of uric corrosive have been shown in infections of the sensory system (like Parkinson's sickness, various sclerosis, and intense stroke) and in malignancy [16].

Superoxide Dismutase, Catalase, and Peroxiredoxins

Superoxide dismutases (SODs) are a class of firmly related compounds that catalyze the breakdown of the superoxide anion into oxygen and hydrogen peroxide. Turf compounds are available in practically all oxygen consuming cells and in extracellular liquids. Superoxide dismutase compounds contain metal particle cofactors that, contingent upon the isozyme, can be copper, zinc, manganese or iron. In people, the copper/zinc SOD is available in the cytosol, while manganese SOD is available in the mitochondrion. There likewise exists a third type of SOD in extracellular liquids, which contains copper and zinc in its dynamic destinations. The mitochondrial isozyme is by all accounts the most organically significant of these three, since mice coming up short on this chemical bite the dust before long birth.

Conversely, the mice lacking copper/zinc SOD (Sod1) are suitable yet have various pathologies and a diminished life expectancy (see article on superoxide), while mice without the extracellular SOD have negligible deformities (delicate to hyperoxia). In plants, SOD isozymes are available in the cytosol and mitochondria, with an iron SOD found in chloroplasts that is missing from vertebrates and yeast. Catalases are catalysts that catalyze the change of hydrogen peroxide to water and oxygen, utilizing either an iron or manganese cofactor. This protein is confined to peroxisomes in most eukaryotic cells. Catalase is a surprising chemical since, despite the fact that hydrogen peroxide is its main substrate, it follows a ping-pong component. Here, its cofactor is oxidized by one atom of hydrogen peroxide and afterward recovered by moving the bound oxygen to a second particle of substrate. Regardless of its clear significance in hydrogen peroxide evacuation, people with hereditary insufficiency of catalase "acatalasemia" or mice hereditarily designed to need catalase totally, experience not many sick impacts [17].

Thioredoxin and Glutathione Systems

The thioredoxin framework contains the 12-kDa protein thioredoxin and its partner thioredoxin reductase. Proteins identified with thioredoxin are available in completely sequenced creatures [35]. Plants, for example, Arabidopsis thaliana, have an especially incredible variety of isoforms. The dynamic site of thioredoxin comprises of two adjoining cysteines. In its dynamic state, thioredoxin goes about as a productive lessening specialist, searching receptive oxygen species and keeping up with different proteins in their diminished state. Subsequent to being oxidized, the dynamic thioredoxin is recovered by the activity of thioredoxin reductase, utilizing NADPH as an electron contributor.

The glutathione framework incorporates glutathione, glutathione reductase, glutathione peroxidases, and glutathione S-transferases. This framework is found in creatures, plants and microorganisms. Glutathione peroxidase is a chemical containing four selenium-cofactors that catalyzes the breakdown of hydrogen peroxide and natural hydroperoxides. There are no less than four distinct glutathione peroxidase isozymes in creatures. Glutathione peroxidase 1 is the most bountiful and is an exceptionally productive forager of hydrogen peroxide, while glutathione peroxidase 4 is generally dynamic with lipid hydroperoxides. Shockingly, glutathione peroxidase 1 is unimportant, as mice without this chemical have typical life expectancies; however they are excessively touchy to incited oxidative pressure. Likewise, the glutathione S-transferases show high action with lipid peroxides. These compounds are at especially significant levels in the liver and furthermore serve in detoxification digestion [18].

Non-Enzymatic Antioxidants

VIT C - Vit C (ascorbic corrosive) is significant non-enzymatic cell reinforcements. Human and other primate is unfit to incorporated nutrient C, along these lines must be acquired from diet. Leafy foods are an unmistakable dietary wellspring of nutrient C for human and creatures [40]. As a water-dissolvable cancer prevention agent, it might possibly shield significant bio-atoms from harm by rummaging oxygen free revolutionaries in cells, as has been displayed in vitro and in vivo. Nutrient C applies a supportive of oxidant impact, connecting with progress metal particles. Ferric iron (Fe) is changed over into ferrous iron (Fe) within the sight of nutrient C, and Fe responds with HO which structures hydroxyl extremists.

Vit E - Vit E is a gathering of mixtures (tocopherols and tocotrienols). Nonetheless, the impacts of tocopherols have been concentrated most broadly on account of the great bioavailability, prepared ingestion, and digestion of these mixtures. Tocopherols respond with lipid revolutionaries delivered in a lipid peroxidation chain response, shielding the cell layer from oxidation.

Vit A - In female pale skinned person rodents co-controlled BPA and nutrient E for quite some time, nutrient E worked on hepatic and kidney brokenness by limiting oxidative pressure inspired by BPA. In another review, while 3-week openness of male rodents to BPA expanded the body weight though nutrient E treatment decreased the body weight than that of BPA-treated and control gatherings [19].

Melatonin - Melatonin is an endogenous chemical gotten from tryptophan, which was first uncovered in the vertebrate pineal organ. It directs numerous significant natural capacities, like rest, circadian mood, generation, resistance, and oncostatic measures. It is additionally associated with the support of cancer prevention agent balance, appropriate working of the insusceptible framework, and assurance of the cardiovascular framework. It applies a cancer prevention agent impact on organs and against apoptotic impact on cells.

Quercetin (Flavonoid) - Quercetin has a place with an enormous gathering of polyphenolic compounds with a benzo-γ-pyrone structure. It is orchestrated by plants because of microbial disease, as a hydroxylated phenolic substance. As a polyphenolic flavonoid, quercetin is universal in plants and plant food sources. It is quite possibly the most plentiful dietary flavonoid found in natural products (primarily citrus natural products), green verdant vegetables, just as many seeds, buckwheat, nuts, blossoms, bark, broccoli, olive oil, apple, onion, green tea, red grape, red wine, dim cherry, and berries, like blueberry and cranberry. It is notable for its calming, antihypertensive, vasodilator, against weight, hostile to hypercholesterolaemic, and against atherosclerotic exercises. Quercetin is an intense cancer prevention agent in view of its capacity to search free revolutionaries and tie to different change metal particles, subsequently repressing inordinate lipid peroxidation in the cell. It diminishes oxidative harm to macromolecules, for example, lipids and DNA.

Lycopene (Carotenoid) - Brooding of hepatocytes with BPA brings about a period subordinate cell passing, alongside the deficiency of intracellular ATP and absolute adenine nucleotide pools. The antioxidative properties of quercetin may forestall ROS-related mitochondrial brokenness upon its co-organization with BPA, additionally altogether expanding the ATPase SDH exercises in tissue [20].

Assessment of Antioxidants
***In Vitro* Methods**
Cell reinforcement movement ought not be finished up dependent on a solitary cancer prevention agent test model. What's more, by and by a few in vitro test strategies are completed for assessing cell reinforcement exercises with the examples of premium. Another viewpoint is that cell reinforcement test models shift in various regards. Accordingly, it is hard to contrast completely one technique with other one. In this article all in vitro techniques are portrayed and note that one might enhance legitimately the particular strategy to serve his/her trial evenhanded as nobody technique is outright in nature instead of a model.

1. **DPPH Scavenging Activity** The atom 1, 1-diphenyl-2-picrylhydrazyl (a,a-diphenyl-b-picrylhydrazyl; DPPH) is described as a steady free revolutionary by ethicalness of the delocalisation of the extra electron over the particle all in all, so the atom doesn't dimerize, as would be the situation with most other free revolutionaries. The delocalization of electron likewise leads to the profound violet tone, described by an assimilation band in ethanol arrangement focused at around 517 nm. At the point when an answer of DPPH is blended in with that of a substrate (AH) that can give a hydrogen particle, then, at that point this leads to the decreased structure with the deficiency of this violet tone.

2. **Hydrogen peroxide searching (H_2O_2) test:** People are presented to H_2O_2 by implication through the climate almost about 0.28 mg/kg/day with consumption generally from leaf crops. Hydrogen peroxide might go into the human body through inward breath of fume or fog and through eye or skin contact. H_2O_2 is quickly disintegrated into oxygen and water and this might deliver hydroxyl revolutionaries (OH-) that can start lipid peroxidation and cause DNA harm in the body.

3. **Nitric Oxide Scavenging Activity:** NO* is produced in natural tissues by explicit nitric oxide synthases, which utilizes arginine to citrulline with the arrangement of NO* by means of a five electron oxidative response. The compound sodium nitroprusside is known to decay in fluid arrangement at physiological pH (7.2) creating NO*. Under high-impact conditions, NO* responds with oxygen to deliver stable items (nitrate and nitrite), the amounts of which not really settled utilizing Griess reagent.

4. **Peroxynitrite Radical Scavenging Activity:** Peroxynitrite (ONOO*) is a cytotoxicant with solid oxidizing properties toward different cell constituents, remembering Review for in vivo and in vitro strategies assessment of cancer prevention agent movement 145 sulfhydryls, lipids, amino acids and nucleotides and can cause cell demise, lipid peroxidation, carcinogenesis and maturing. It is produced in vivo by endothelial cells, Kupffer cells, neutrophilsand macrophages. Peroxynitrite extremist is a moderately stablespecies contrasted and other free revolutionaries yet once protonated gives exceptionally receptive peroxynitrous corrosive (ONOOH), decaying with an extremely short half-life (1.9 s) at 37 0C to frame different cytotoxicants and that can actuate the oxidation of thiol (- SH) bunches on proteins, nitration of tyrosine, lipid peroxidation and furthermore nitrosation responses, influencing cell digestion and sign transduction. It can at last add to cell and tissue injury with DNA strand breakage and apoptotic cell demise, for example in thymocytes, cortical cells and HL-60 leukemia cells. It's unreasonable arrangement may likewise be associated with a few human illnesses like Alzheimer's infection, rheumatoid joint pain, malignant growth and atherosclerosis [21].

5. **Trolox Equivalent Antioxidant Capacity (TEAC) technique/ABTS Radical Cation Decolorization Assay:** This technique, utilizes a diode-exhibit spectrophotometer to mea-sure the deficiency of shading when a cell reinforcement is added to the blue–green chromophore ABTSÆ + (2,2-azino-bis(3-ethylbenz-thiazoline-6-sulfonic corrosive)). The cell reinforcement lessens ABTSÆ + to ABTS and decolorize it. ABTSÆ + is a steady extremist not found in the human body.

6. **Total Radical-Trapping Antioxidant Parameter (TRAP) Method:** This strategy depends on the insurance given by Natural Antioxidant on the fluorescence rot of R-phycoerythrin (R-PE) during a controlled peroxidation response. The fluorescence of R-Phycoerythrin is extinguished by ABAP (2,20-azo–bis(2-ami-dino-propane)hydrochloride) as an extreme generator. This extinguishing response is estimated within the sight of cell reinforcements. The antioxidative potential is assessed by estimating the rot in decoloration.

7. **Ferric Reducing-Antioxidant Power (FRAP) Assay:** This strategy estimates the capacity of Natural Antioxidant to diminish ferric iron. It depends on the decrease of the complex of Fe 2+ and a couple of, 3, 5-triphenyl-1, 3, 4-triaza-2-azoniacyclopenta-1,4-diene chloride (TPTZ) to the Fe 3+ structure at low pH. This decrease is observed by estimating the adjustment of ingestion at 593 nm, utilizing a diode-cluster spectrophotometer. Cell reinforcement test can be directed by the strategy created by Benzie and Strain (1999). 3ML of organized FRAP reagent is fuse in with 100 IL of weak example; the absorbance at 593 nm is reported after a 30 min brooding at 37oC.

8. **Superoxide Radical Scavenging Activity (SOD):** Despite the fact that superoxide anion is a frail oxidant, it at last delivers amazing and hazardous hydroxyl revolutionaries just as singlet oxygen, the two of which add to oxidative pressure.

9. **Hydroxyl Radical Scavenging Activity:** Hydroxyl revolutionary is one of the strong responsive oxygen species in the organic framework that responds with polyunsaturated unsaturated fat moieties of cell film phospholipids and makes harm cell.

10. **Hydroxyl Radical Averting Capacity (HORAC) Method:** The HORAC test estimates the metal-chelating movement of cancer prevention agents in the states of Fenton-like responses utilizing a Co (II) complex and henceforth the securing capacity against development of hydroxyl revolutionary.

11. **Oxygen Radical Absorbance Capacity (ORAC) Method:** ORAC is an intriguing and progressive new test tube examination that can be used to test "Antioxidant Power" of food sources and other compound substances. This test should be possible utilizing either b-phycoerythrin (b-PE) or fluorescein as target particle.

12. **Reducing Power Method (RP):** This technique depends on the rule of expansion in the absorbance of the response combinations. Expansion in the absorbance shows an increment in the cell reinforcement movement. In this technique, cell reinforcement compound structures a hued complex with potassium ferricyanide, trichloro acidic corrosive and ferric chloride, which is estimated at 700 nm. Expansion in absorbance of the response blend demonstrates the diminishing force of the examples.

13. **Phosphomolybdenum Method:** Complete cancer prevention agent limit test is a spectroscopic strategy for the quantitative assurance of cell reinforcement limit, through the arrangement of phosphomolybdenum complex. The test depends on the reduced of Mo (VI) to Mo (V) by the instance analytic and ensuing progress of a green phosphate Mo (V) complex at acidic pH.

14. **Thiobarbituric Acid (TBA) Method:** TBA technique: The last example convergence of 0.02% w/v was utilized in this strategy. Two mL of 20% tri-chloro acidic corrosive and 2 mL of 0.67% of thiobarbituric corrosive were added to 1 mL of test arrangement.

15. **DMPD (N,N-Dimethyl-P-Phenylene Diamine Dihydrochloride) Method:** DMPD extremist cation decolorization strategy has been created for the estimation of the cell reinforcement movement in food and organic examples. This examine depends on the decrease of cushioned arrangement of shaded DMPD in acetic acid derivation support and ferric chloride. The methodology includes estimation of lessening in absorbance of DMPD within the sight of foragers at its retention limit of 505 nm. The movement was communicated as rate decrease of DMPD.

16. **B-Carotene Linoleic Acid Method/Conjugated Diene Assay:** This is one of the fast technique to screen cell reinforcements, which ismainly dependent on the rule that linoleic corrosive, which is an unsaturated fat, gets oxidized by "Reactive Oxygen Species" (ROS) created by oxygenated water. The items framed will start the b-carotene oxidation, which will prompt staining. Natural Antioxidant declines the degree of staining, which is estimated at 434 nm and the movement is estimated.

17. **Xanthine Oxidase Method:** The xanthine oxidase movement with xanthine as sub-substrate can be estimated spectrophotometrical.

18. **Cupric Ion Reducing Antioxidant Capacity (CUPRAC) Method:** The chromogenic oxidizing reagent of the created CUPRAC technique, that is, bis-(neocuproine) copper (II) chloride [Cu (II) - Nc], responds with poly-phenols [Ar (OH) n] in the way.

19. **Metal Chelating Activity:** Ferrozine can shape a complex with a red tone by framing chelates with Fe^{2+}. This response is confined within the sight of other chelating specialists and results in a reduction of the red shade of the ferrozine-Fe^{2+} edifices. Estimation of decrease decides the chelating action to rival ferrozine for the ferrous particles.

In Vivo Methods

For all *in vivo* strategies the examples that are to be tried are generally regulated to the testing creatures (mice, rodents, and so forth) at an unequivocal measurement routine as portrayed by the particular technique. After a predefined timeframe, the creatures are generally forfeited and blood or tissues are utilized for the examine [23].

1. **Ferric Reducing Ability of Plasma:** It is one of the most fast test and extremely helpful for routine examination. The antioxidative movement is assessed by estimating the increment in absorbance brought about by the arrangement of ferrous particles from FRAP reagent containing TPTZ (2, 4, 6 tripyridyl-s-triazine) and $FeCl_2Æ6H_2O$. The absorbance is estimated spectrophotometrically at 593 nm.

2. **Reduced Glutathione (GSH) Estimation:** GSH is an intra-cell reductant and assumes significant part in catalysis, digestion and transport. It ensures cells against free extremists, peroxides and other harmful mixtures. Lack of GSH in the focal point prompts waterfall development. Glutathione additionally assumes a significant part in the kidney and participates in a vehicle framework engaged with the reabsorption of amino acids.

3. **Glutathione Peroxidase (GSHPX) Estimation:** GSHPX is a seleno-compound two third (in liver) is available in the cytosol and 33% in the mitochondria. It catalyzes the response of hydroperoxides with decreased glutathione to frame glutathione disulfide (GSSG) and the decrease result of hydroperoxide. GSHPx is found all through the tissues, being available as four distinct isoenzymes, cell glutathione peroxidase, extracellular glutathione peroxidase, phospholipid hydroperoxide glutathione peroxidase and gastrointestinal glutathione peroxidase. GSHPx estimation is considered specifically with patients who are under oxidative pressure under any circumstance; low movement of this catalyst is one of the early outcomes of an unsettling influence of the prooxidant/cancer prevention agent balance [24].

4. **Glutathione-S-transferase (GSt):** Glutathione-S-transferase is thought to assume a physiological part in starting the detoxication of potential alkylating specialists, including pharmacologically dynamic mixtures. These chemicals catalyze the response of such mixtures with the - SH gathering of glutathione, in this manner killing their electrophilic locales and delivering the items more water-dissolvable.

5. **Superoxide Dismutase (SOD) Method:** This technique is very much portrayed by Mccord and Fridovich (1969) and can be applied for assurance of cancer prevention agent action of an example. It is assessed in the erythrocyte lysate arranged

6. **Catalase (CAT):** Catalase movement not really set in stone in erythrocyte lysate.

7. **C-Glutamyl Transpeptidase Activity (Ggt) Assay**: The serum test is added to a substrate arrangement containing glycylglycine, MgCl2 and g-Glutamyl-p-nitroanilide.

8. **Glutathione Reductase (GR) Assay:** The universal tripeptide glutathione (GSH), which is the most plentiful low atomic weight thiol in practically all phones, is associated with a wide scope of enzymatic responses. A significant capacity of GSH is to fill in as a reductant in oxidation–decrease measures; a capacity bringing about the development of glutathione disulfide (GSSG). A warmth labile framework equipped for diminishing GSSG was found in liver. The catalyst straightforwardly associated with decrease of GSSG.

9. **Lipid Peroxidation (LPO) Assay:** LPO is an autocatalytic cycle, which is a typical outcome of cell demise. This interaction might cause peroxidative tissue harm in aggravation, malignancy and poisonousness of xenobiotics and maturing. Malondialdehyde (MDA) is one of the final results in the lipid peroxidation measure. Malondialdehyde (MDA) is framed during oxidative degeneration as a result of free oxygen extremists, which is acknowledged as a pointer of lipid peroxidation.

10. **LDL Assay:** The separated LDL is washed and dialyzed against 150 mmol/L NaCl and 1 mmol/L Na2EDTA (pH 7.4) at 4 0C. The LDL is then disinfected by filtration (0.45 IM), held under nitrogen in obscurity at 4 0C. LDL (100 lg of protein/mL) is hatched for 10 min at room temperature with tests [25].

DISCUSSION AND CONCLUSION

Antioxidants from natural sources are valuable bioactive compounds with well-demonstrated potentials for use in the food industry. Beyond their application in functional food products, attention has also been focused on their use as alternatives to their synthetic counterparts to increase product stability and avoid deterioration by oxidation during processing and storage. In the context of a circular economy, efforts are being dedicated to the use of natural antioxidants from food by-products generated by the agricultural industry and from underexploited plant materials. In addition, harmful effects on sensory attributes, especially flavour and taste, related by some natural compounds, have to be addressed. This will increase the consumer tendency to purchase food products containing natural antioxidants, ultimately contributing to fall off the prices of these products.

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Enhance Salt Tolerance Mechanism in Growth and Pigment Composition of Finger Millet (*Eleusine coracana* L.) under Sodium Chloride Stress by Soil Drenching Application of Hexaconazole and Melatonin

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ABSTRACT

Salt stress is one of the big major environment constraints reduction sasa result of the growth and yield of important crops around the world. The deficiency of other nutrients in the soil is due to the high concentration of Na+ that interacts with other environmental factors such as drought which exacerbate the problem. In crop plants, salt stress altered the characteristics of genetic to morphological levels. Plant growth regulators are used to regulate the growth of plants and they are important measures to ensure agricultural production. A Finger millet (*Eleusine coracana* L.) is a major food crop for millions of people in tropical and sub-tropical areas pot culture experiment was studied to investigate the impact of salt stress and othertreatments. Hexaconazole [HEX] is a triazole compound which normally used as a systematic fungicide with non-traditional plant growth regulator properties, under abiotic stress and Melatonin [MT] is involved in the physiological processes of the plant under abiotic stress. HEX [50mg/L] and Melatonin [100μm/L] regulators are treated by soil drenching in finger millet [*Eleusine coracana* L.] with and without under 200Mm sodium chloride stress. Plants are collected for randomly 40th, 50th, 60th, and 70th days after sowing, and to analyze the growth and estimate pigment content. Salinity stress causes reduced plant growth in root length, shoot length, fresh weight, dry weight, chlorophyll 'a', chlorophyll 'b', total chlorophyll, and carotenoid contents in all the treatments. Application of Hex and

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MTby soil drenching counteracted the 200mM NaCl stress in finger millet and induced tolerance towards NaCl stress and enhanced the growth and pigment contents.

Keywords: Sodium chloride stress, finger millet, growth regulators [Hexaconazole and Melatonin], and photosynthetic pigment.

INTRODUCTION

Soil salinity is one of the threatening environmental constraints and sustainability in the arid and semi-arid regions. Currently, the biggest challenge is to improve crop productivity, alleviating salinity stress without altering nutritional values. At this juncture, there is a need to develop an alternative strategy that is economical and eco-friendly. Studies (1,2,3) show that enhanced salt tolerance in plants can be achieved by the application of plant growth promoting Salinity is an issue of almost all continents under a wide range of climates [4]. It is frequently an underrated problem in the agriculture sector. About 20% of the world's total cultivable land is under the influence of salinity [5,6]. A number of studies have shown that environmental stresses such as salinity, increase the formation of reactive oxygen species [ROS], such as superoxide radicals, hydrogen peroxide, and hydroxyl radicals, [7,8,9]. These free radicals damage plants by oxidizing photosynthetic pigments, membrane lipids, proteins, and nucleic acids [10,11]. The formation of ROS is the consequence of plant metabolism, so controlling the ROS levels is essential for the normal function of plant cells [12,13]. Millets are native to semi-arid tropics, where salinity and drought are the most common phenomena [14]. Finger millet [*Eleusine coracana* L.] is grown worldwide on more than four million ha and it is a major food crop for millions of people in tropical and sub-tropical areas [15,16]. Millets are native to semi-arid tropics, [widely cultivated in dry areas of India and Sri Lanka from Asia; western Kenya; western and southern Tanzania and Uganda from Eastern Africa] where salinity and drought are most common.

Finger Millet is an important minor cereal crop in India, rich in calcium, and dietary fiber and they knowfor its health benefits but salinity is a major factor limiting its productivity [17]. The application of HEX and MT to finger millet in the study results in reduced NaCl stress. Hexaconazole HEX; the chemical name of [RS]-2-[2,4-dichloro-phenyl]-1-[1H-1,2,4-triazol-1yl] hexan-2-ol] is an active member of the triazole family with plant growth-regulating properties[18], and it can cause many morphological and physiological changes, such as reducing shoot growth, stimulating root growth[19,20]. Recent studies have shown that the application of uniconazole, a closely related triazole, enhances tolerance to stress induced by waterlogging [21], heat [22], and freezing [23] in canola plants. Melatonin (N-acetyl-5-methoxytryptamine) is an indole compound derived from an essential amino acid tryptophan[24]. The significant roles of melatonin in germination, flowering, photosynthesis, circadian rhythms, and senescence have been well-documented [25,26], and the primary role attributed to melatonin is to scavenge ROS under oxidative stress [27], consequently enhancing plant resistance against stress conditions such as drought, salt, cold, oxidative stress [28]. Melatonin, a tryptophan derivative, was first discovered in the plant in1995 [29,30]. Melatonin (MT) is involved in physiological processes in plants under abiotic stress. In their study, they investigated the effects of melatonin on maize photosynthetic and antioxidant capacities under salinity stress [31,32].

MATERIALS AND METHODS

Seed collection and Chemical reagents
Finger millet (*Eleusine coracana*L.) seeds (CO-15 variety) were purchased from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. Chemical regulator Hexaconazole and Melatonin and analytical reagent NaCl were purchased from Sisco Research Laboratories [SRL]- Chennai-600117

Experimental design

Finger millet experiment study was conducted at the Botanical Garden, Department of Botany, Annamalai University, Chidambaram, Tamil Nadu. The geographic coordinates of the experimental area was located at11°23'23.1"N/ 79°43'05.3"E. Healthy Seeds were surface sterilized with 0.2% mercuric chloride solution for 2 minutes and washed extensively with sterile double distilled water(ddH$_2$O). Finger millet seeds CO-15 cultivar had 90 pots divided into six groups. Each group, with ten replicates, was given mixed fertilizer once with manure. The soil composition was red soil: Sand: Farm yard manure in the ratio of 1:1:1. Plants were treated in Control, NaCl (200mM), NaCl (200mM) +HEX (50mg/L), NaCl (200mM) +MT (100µm/L), HEX (50mg/L)and MT (100µm/L). To maintain particular salinity levels in pots, the soil samples from each pot were checked with Electrical Conductivity Meter at regular intervals. Plants were harvested for analysed morphological and chlorophyll pigment analysis at the 40th, 50th, 60th, and 70th days after sowing [DAS].

Root length

The collected plant roots are thoroughly washed with tap water and waited for 15 minutes for drying the moisture. To calculate the root length by measuring below the point of root-shoot transition to fibrous root and the lengths of lateral roots were taken as total root length. The root lengths were expressed in cm plant^{-1}.

Shoot length

The length between the shoot tip and the point of the root stem transition region was taken as shoot length. The stem lengths are expressed in cm plant^{-1}.

Fresh weight

The plant samples that are collected, roots, and shoots were thoroughly washed with tap water and tissue paper was used to remove the excess moisture. The root and shoot fresh weights were taken by using an electronic balance (Model - XK3190-A7M) and the values were recorded and expressed in gm plant^{-1}.

Dry weight

After taking fresh weight, the plants were dried at 60°C in a hot air oven for 48 hours. After drying, the weights were measured and the material was kept in the same oven until the constant dry weight was obtained. The values were expressed in gm plant^{-1}.

Chlorophyll and Carotenoid Content

Collected plant samples in fresh leaf tissues of 500mg were measured and ground in pestle and mortar adding 10ml of 80% Acetone after complete extraction and centrifuge at 800g for 15 minutes, further, the extraction was repeated again and then the supernatant was collected and makeup to a final volume of 20ml of Acetone. The Spectrophotometer is used for absorption of reading @645, 663, 480nm, against 80% acetone blank. Chlorophyll and Carotenoid contents were extracted from the leaves and estimated according to the methods of Arnon's method 1949 [39] and Kirk and Allen 1965 [40] and expressed in mg/gram fresh weight.

Statistical Analysis

The experiment data were analyzed statistically using the SPSS Software {Version 22.0} followed by one-way ANOVA. The obtained data represented in bars are mean values of replicates. The P≤0.05 result was chosen as significance by Duncon's Multiple Range Test [DMRT].

RESULTS AND DISCUSSION

Root length

The plants treated with 200mM sodium chloride stress was a significant decrease in the root length of finger millet when compared to the control [fig. 1].NaCl+HEX treated plants show an increase the root length than the NaCl-

treated plants. Likewise, NaCl+MT treated plants also show high root lengths than NaCl-treated plants. But when the plants were treated HEX with NaCl 200mM the root length decreased than of control but increased than HEX plants. The same results followed by root length was significantly affected by salinity in sunflower [35]. Increasing salinity imposed a negative effect on root growth including root area, root volume, main root length, and total root length in purslane *Portulaca oleracea* L.[36].The Hexaconazole [HEX]with NaCl stress increased the root length when compared to NaCl stress. HEX-treated wheat seeds have reduced plant height of seedlings compared to those untreated ones. Paclobutrazol increased the diameter and length of the fibrous roots and enhanced the lateral formation in wheat seedlings [37,38].Hex-treated wheat seeds have reduced plant height of seedlings compared to those of untreated ones, which is attributed that Hex might be inhibited gibberell in synthesis *Crithmum maritimum* [39,40]. The retardation of plant height might be a possible potential phytotoxicity of the triazole compounds in practice *Triticum aestivum* L. [41,42]. Melatonin MT is a naturally occurring compound in plants.MT alleviated salt-induced growth inhibition, and the fresh weight, dry weight of seedlings treated withmelatonin increased by respectively, compared to those under salt stress. Also, root length of *Helianthus annuus* L., *Zea mays* L. and *Malus hupehensis* increased under salinity and control groups with melatonin treatments[43,44,45].Emphasized the importance of melatonin concentration that 100µM melatonin treatments decreased the *Brassica juncea*L. root [46].

Shoot length

In our study, NaCl salt stress causes a significant decrease in shoot length when compared to the control. [fig.2.]. Our results are related to previous results of cowpea [47],tomato[48], rice[49], maize[50],and genotype, and they found declined stem length under NaCl stress conditions.NaCl stress (200mM) caused a significant reduction in growth-related characters like root length and shoot length, fresh weight, and dry weight in finger millet plants.The shoot length ofNaCl-treated plants is reduced than other treated plants [51]. NaCl +Hex treated plants decreased shoot length than those treated with salinity. Triazoles alsoreduced the cell number, length, and weight of the xylem cells[52]. The triazole treatments were found to effectively inhibit plant height, and leaf expansion and alter the stem in *S. campanulatum*[53]. Difenoconazole treatments decrease the shoot growth and increase the root growth in *M. piperita* [54]. The increasing concentrations of NaCl developed a decline in the lengths of the plants, this study was done on *Vigna aconitifolia* L. [55], on *Raphanus sativus* L. [56], *Vigna unguiculata* L. [57], and on *Vigna mungo* L. [58]. Triadimefon-treated tomato plants showed a decrease in the shoot length of tomatoes [59], under salinity stress. NaCl+MTshoot length was increasing when compared to other treatments. However, the Mel+NaCl group had a remarkably higher average root length, shoot length, and fresh weight than the NaCl group [60]. HEX Shoot ratio decreased in triazole-treated plants as compared to the control in the absence of NaCl. MT cause shoot length increases in comparison to other treatment. The comparison of means of the effect of MT on shoot growth parameters showed that the highest shoot growth parameter was observed in 75 and 100 mM of MT treatments at 50 mM salinity level and the lowest of them was observed in control treatment at 150 mM salinity level[61].However, salinity-stressed plants at a melatonin concentration revealed increased plant height (4.3%), leaf length (13%), and leaf width (11.2%) ($p < 0.05$) in contrast to salinity-stressed plants alone[62].

Fresh weight and Dry weight

The plant height was significantly decreased after the addition of NaCl as compared to the control. From the present investigation, it was observed that NaCl treatment given at 200mM to Finger millet reduced whole plant biomass [FW and DW] more than control plants. Fresh weight and Dry weight decrease under salinity treatment with HEX and MT [fig.3 and fig.4.]. A Control plants show high FW and DW compared to other treatments of NaCl +HEX and NaCl +MT. Severe growth limitations in terms of shoot and root dry biomass were observed under salinity for both *Vicia faba* genotypes [63]. Applying Hexaconazole to the soil significantly increased root and dry weight [64]. The total FW of the root increased significantly in both triazole-treated plants. Inhibition of gibberellin biosynthesis and increase in cytokinin content induced by triazoles [65]. The plant height, fresh weight, and dry weight are highly affected by the triazole treatment in wheat *Triticum aestivum* L. [66]. However, all methods of melatonin application increased fresh weight, dry weight, and root length, under salt stress, suggesting that the application of melatonin effectively improves the growth of sugar beets under salt stress,similar to our results, [67].

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Chlorophyll contents

The NaCl-treated plants have all-time lower chlorophyll pigments than others. Control plants have higher pigments compared to NaCl +HEX and NaCl + MT treated plants. HEX-treated plants have less pigment contends than MT-treated plants. The chlorophyll-a, chlorophyll-b,and total chlorophyll are high value in the MT-treated plants [fig.5, fig.6 and fig.7.]. Salt stress causes a decrease in plant growth and productivity by disrupting physiological processes, especially photosynthesis [68,69]. The ability of plants to maintain a reasonable photosynthetic rate under environmental stress is fundamental for the maintenance of plant growth and development [70]. Chlorophyll is the principal agent responsible for photosynthesis and under adverse conditions, chlorophyll level is a good indicator of photosynthetic activity [71].Increased chlorophyll synthesis was observed with triazole treatment in Cucumiscotyledons [72] paclobutrazol treated plants [73].NaCl +HEX treated plants of control have higher pigments compared to NaCl +MT treated plants. HEX-treated wheat seeds have reduced plant height of seedlings compared to those of untreated ones [42]. NaCl + MT treatment resulted in a significant and substantial improvement in the contents of Chl a, Chl b, and Total chlorophyll, which increased by respectively compared to sweet corn seedlings subjected to salinity stress [32]. Which is attributed that Hex might be inhibited in gibberellin synthesis. It also showed that plants treated with paclobutrazol synthesized more cytokinin, which in turn enhanced chloroplast differentiation and chlorophyll biosynthesis, and prevented chlorophyll degradation [74]. In this study, salt stress did not cause significant changes in photosynthetic pigments, which might be attributed to the achieved adaptation against salinity due to gradually increased salinity levels. Moreover, the contents of photosynthetic pigments under salinity stress could be enhanced with exogenous Melatonin treatments[75,76]. However, the application of melatonin alleviated the decline in melatonin-treated plants with prolonged days. Melatonin in this study, salt stress did not cause significant changes in photosynthetic pigments, which might be attributed to the achieved adaptation against salinity due to gradually increased salinity stress [77]. The decline of chlorophyll concentration commonly acts as a biomarker of plant stress sensing.

Carotenoid pigment content

The carotenoid pigment is large in the plants of Hexaconazole treatment next to Melatonin treated plants.[fig.8] Plants treated with NaCl +HEX and NaCl +MT have a high level of carotenoid pigment than those treated with NaCl plants. Triadimefon treatment induced higher levels of carotenoid in cucumber cotyledons [78] and *Catharanthus roseus* [79]. Similar results were observed in uniconazole- and paclobutrazol-treated wheat seedlings [80]. Carotenoids protect plasma-membrane lipids from further oxidation and improve stress tolerance in the eared water moss *Salvinia auriculate* Aubl. plant by scavenging directly active oxygen species generated during stress [51]. Carotenoids are important antioxidants that protect the photosynthetic machinery from damaging environmental influences and are also precursors to important vitamins [81]. The soil drenching of HEX and MT alone showed an enhancement in carotenoid contents to the normal one. The application of 100μM melatonin significantly improved the carotenoid level under 150 mM NaCl these results indicated that exogenous melatonin treatment could promote the growth of maize plants exposed to salinity[50].

CONCLUSION

Salt stress is expected to improve the finger millet crop production in semi-arid areas. NaCl stress showed a negative impact on growth characters, biomass production and pigment composition. Photosynthetic reactions are affected by salinity and osmotic stress.MT seedlings stage improved photosynthesis, maintained the balance in ROS metabolism, and alleviated the damage caused by salinity stress. Therefore, treatment with exogenous melatonin might be a suitable approach in improving the tolerance of the finger millet plants. Overall the plants respond well to the exogenous application of HEX and MT. Photosynthetic reactions are affected by salinity and osmotic stress. Thus, soil drenching HEX and MT can be used to enhance salt tolerance in finger millet results enhanced in the growth and development. However, the molecular mechanism involved in function of stress protection remains to be explored.

ACKNOWLEDGMENT

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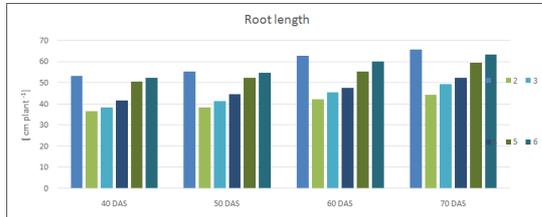
Fig. 1. Effect of exogenous application of HEX and MT on root length of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
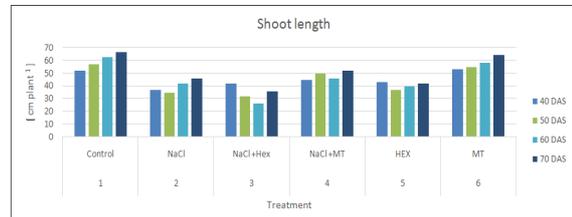

Fig. 2. Effect of exogenous application of HEX and MT on shoot length of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
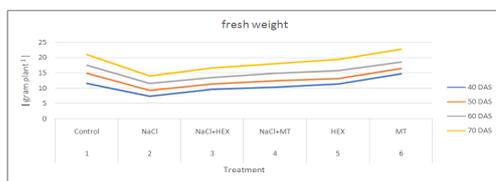
Fig. 3. Effect of exogenous application of HEX and MT on fresh weight of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
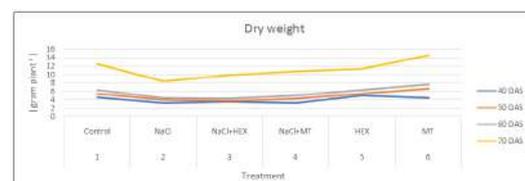
Fig. 4. Effect of exogenous application of HEX and MT on dry weight of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
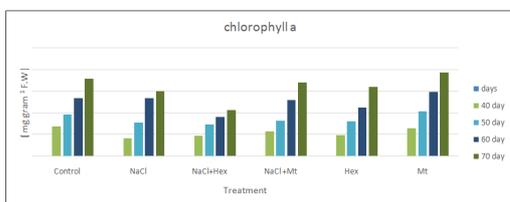
Fig. 5. Effect of exogenous application of HEX and MT on chlorophyll a of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
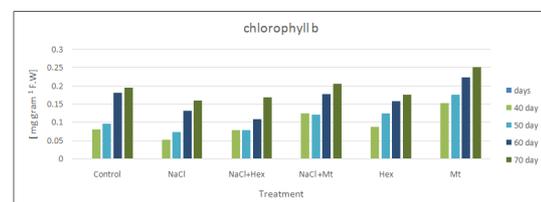
Fig. 6. Effect of exogenous application of HEX and MT on chlorophyll a of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
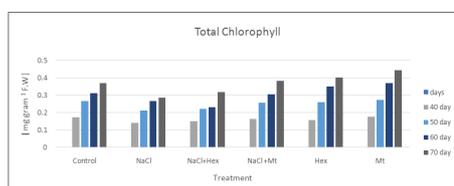
Fig. 7. Effect of exogenous application of HEX and MT on total chlorophyll of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error
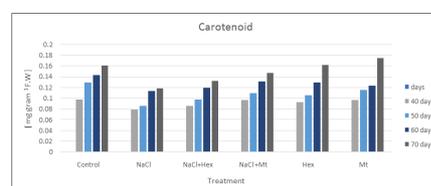
Fig. 8. Effect of exogenous application of HEX and MT carotenoid of finger millet [CO- 15 variety] under 200mM NaCl stress. Values represented in Bars are mean of three replicates [n=3] and [±] standard error

RESEARCH ARTICLE

Algorithms for Net Weight Calculations of Cartesian P-C-K Graphs and its Application Development

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ABSTRACT

In graph theory, Cartesian graphs form an important class of graphs [1]. In this paper, three types of Cartesian one-dimensional structures, namely, P-structure, C-structure, and K-structure are initially studied and algorithms were developed to calculate the total weights of each node based on their self-weights and self-weights of connected nodes. Similarly, the nine combinations of PCK structures, namely, $(P_m \times P_n)$, $(P_m \times C_n)$, $(P_m \times K_n)$, $(C_m \times P_n)$, $(C_m \times C_n)$, $(C_m \times K_n)$, $(K_m \times P_n)$, $(K_m \times C_n)$ and $(K_m \times K_n)$ are studied for developing algorithms for total weights based on self-weights. The associativity of the two-dimensional graphs was then explored only to find that they were indeed associative in nature. Using the algorithms developed, an application software named Cartesian Graph Calculator was developed to ease the process of calculation of total weights for any number of nodes only limited to the computational power of the PC. The algorithms and the software developed are intended to serve the graph mathematicians to explore the behavior of PCK graphs for different labeling of the nodes with the predefined pattern of self-weights.

Keywords: Cartesian one-dimensional structures, namely, P-structure, C-structure, and K-structure

INTRODUCTION

Apoint called a node characterizes a graph [2]. In this paper, each node is represented as x_i for one-dimensional graphs and x_{ij} for two-dimensional graphs. Each node is linked to another node through a link. Each node has its own weight called self-weight denoted as s_i for one-dimensional graph and s_{ij} for the two-dimensional graph. Similarly, the total weight of each node is represented as w_i for one-dimensional graphs and s_{ij} for two-dimensional graphs. The total weight of each node is the sum total of the self-weights of the nodes directly connected to it through links where the sum also includes its own self-weight. If the node considers its own self-weight in its total weight, it is considered an inclusive graph, otherwise, it becomes an exclusive graph. In this paper, only inclusive graphs are discussed. Three types of Cartesian structures are explored in this paper namely, P-structure, C-structure, and K-structure. These one-dimensional graphs or structures form the basis of construction for two-dimensional graphs and eventually multidimensional graphs.

P-structure or Sequential or Path Structure

This is the most basic form of one-dimensional structure wherein every node is related to its adjacent nodes only. The starting node or the ending node is related to only one adjacent node, while the rest of the nodes are connected to two nodes as shown in Figure 1. Each node x_i has its own self-weight s_i and the total weight w_i that is equal to the sum of its own self weight and the self-weights of all the nodes it is directly connected.

For P-structure, the total weights (w_i) can be formulated as $w_i = s_i + s_{i+1} + s_{i-1}, \forall 1 < i < n, w_i = s_i + s_{i+1}, \forall i = 1$ and$w_i = s_i + s_{i-1}, \forall i = n$.

C-structure or Cyclic Structure

When the starting node and the ending node of the P-structure is linked, it forms a ring like structure called as C-structure or cyclic structure as shown in Figure2.

For C-structure, the total weights (w_i) can be formulated as

$w_i = s_i + s_{i+1} + s_{i-1}, \forall 1 < i < n, w_i = s_i + s_{i+1} + s_n, \forall i = 1, w_i = s_i + s_{i-1} + s_1, \forall i = n$.

K-structure or Intertwined Structure

When every node is linked to every other node in the structure, then such a structure is known as K-structure or intertwined structure as shown in Figure 3. This is the most generalized form of structure since all the nodes are interlinked to each other. For K-structure, the total weights (w_i) can be formulated as $w_1 = \sum_{i=1}^{n} s_n, \forall 1 \leq i \leq n$.

Two-dimensional Cartesian Graphs

The above structures discussed in the previous section are one-dimensional graphs that can form building blocks of two-dimensional graphs. A two-dimensional Cartesian graph can be denoted by X_m x Y_n, where both $X_m = C_m$ or P_m or K_m and $Y_n = C_n$ or P_n or K_n consisting of m rows and n columns and mx n elements. Considering C, P and K structures as discussed in the previous section, there can be nine combinations of Cartesian two-dimensional graphs as in Table 1.

It starts with least dense networked graph of P_mx P_n to the densest networked graph of K_mx K_n. For the purpose of convenience, the nodes are classified as corner nodes, edge nodes, and middle nodes as shown in Figure 4. For the nine possible two-dimensional Cartesian graphs described in Table 1 above, there are only four corner nodes, namely, x_{11}, x_{1n}, x_{m1} and x_{mn}. Similarly, there are $2(m+n-4)$ edge nodes which can be expressed as x_{ij} where $i=m$ or 1 if and only if $1<j<n$ and $j=n$ or 1 if and only if $1<i<m$. The remaining nodes are termed as middle nodes, namely which can be expressed as $x_{22}, x_{23}, \ldots x_{32}, x_{32}..$ which can be generally expressed as x_{ij} where and $1<i<m$ and $1<j<n$. The net weight calculations for each of the nine combinations as in Table1 will be discussed in the following sections.

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Sequence –Sequence Cartesian Graph *(P$_m$ x P$_n$)*

The Sequence –Sequence Cartesian graph is the least dense networked graph consisting of a sequential relationship without any network between the starting nodes and the ending nodes of all rows and columns as shown in Figure 5.

The weights of the four corner nodes are given by $w_{11} = s_{11} + s_{12} + s_{21}$, $w_{mn} = s_{m,n-1} + s_{mn} + s_{m-1,n}$, $w_{1n} = s_{1,n-1} + s_{1n} + s_{2n}$ and $w_{m1} = s_{m1} + s_{m-1,1} + s_{m2}$. Since there are only four nodes, there is no need to generalize, but, if needed, the four corner nodes can be generalized as $w_{ij} = s_{ij} + s_{i\pm1,j} + s_{i,j\pm1}$, wherein ±1, we have + if top or left edge, - if right or bottom edge. In addition, we have $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i+1,j}$ for top edge, $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i-1,j}$ for bottom edge, $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j+1}$ for left edge and $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1}$ for right edge. For all the middle nodes, the weights can be given The weights of the four corner nodes are given by $w_{11} = s_{11} + s_{12} + s_{21} + s_{1n}$, $w_{mn} = s_{mn} + s_{m-1,n} + s_{m,n-1} + s_{m1}$, $w_{1n} = s_{1n} + s_{1,n-1} + s_{2n} + s_{11}$ and $w_{m1} = s_{m1} + s_{m-1,1} + s_{m2} + s_{mn}$. The weights of the edge nodes areas follows - Top edge (same as P$_m$ x P$_n$): $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i+1,j}$, Bottom edge (same as P$_m$ x P$_n$): $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i-1,j}$, Left edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j+1} + s_{i,n}$, Right edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{im}$. For all the middle nodes, the weights are the same as the middle nodes of P$_m$ x P$_n$ and are given by $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{i,j+1}$.

Sequence – Intertwined Cartesian Graph *(P$_m$ x K$_n$)*

The Sequence – Intertwined Cartesian graph is the next level dense networked graph consisting of sequential relationships without any network between the starting nodes and the ending nodes along with the columns and intertwined relationships along the rows as shown in Figure 7. In each row, every node is connected to every other node(an only few connections are shown as representation) in that row thus forming an intertwined relationship. by $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{i,j+1}$.

Sequence –Cyclic Cartesian Graph *(P$_m$ x C$_n$)*

The Sequence – Cyclic Cartesian graph is the next level dense networked graph consisting of sequential relationship without any network between the starting nodes and the ending nodes along the columns and cycling relationships along the rows as shown in Figure 6.

Here, we have the values of the first row $x_{ij}, i = 1, 1 \leq j \leq n$ as $w_{ij} = \sum_{j=1}^{n} s_{ij} + s_{i,j+1}$, values for middle rows are $x_{ij}, 1 < i < m, 1 \leq j \leq n$, $w_{ij} = \sum_{j=1}^{n} s_{ij} + s_{i+1,j} + s_{i-1,j}$, and   for all values of last row $x_{ij}, i = m, 1 \leq j \leq n$ and $w_{ij} = \sum_{j=1}^{n} s_{ij} + s_{i-1,j}$.

Sequence – Cyclic Cartesian Graph *(C$_m$ x P$_n$)*

The Sequence – Cyclic Cartesian graph *(C$_m$ x P$_n$)* is as shown in the Figure 8. It is different from a *(P$_m$ x C$_n$)* graph and is not truly associative. This will be dealt in detail later in this paper.

The weights of the four corner nodes are given by,

$w_{11} = s_{11} + s_{12} + s_{21} + s_{m1}$, $w_{mn} = s_{mn} + s_{m-1,n} + s_{m,n-1} + s_{1n}$, $w_{1n} = s_{1n} + s_{1,n-1} + s_{2n} + s_{mn}$ and $w_{m1} = s_{m1} + s_{m2} + s_{m-1,1} + s_{11}$. The weights of the edge nodes are given as follows - Top edge: $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i+1,j} + s_{mj}$, Bottom edge: $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i-1,j} + s_{1j}$, Left edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j+1}$, Right edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1}$. For all the middle nodes, the weights are the same as the middle nodes of P$_m$ x P$_n$ and is given by $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{i,j+1}$.

Cyclic-Cyclic Cartesian Graph *(C$_m$ x C$_n$)*

The Cyclic-Cyclic Cartesian graph *(C$_m$ x C$_n$)* is as shown in the Figure 9. It can be observed that only the middle nodes are unaffected by the cyclic behavior and remains generic as middle nodes of *(P$_m$ x P$_n$)* graph. The weights of the four corner nodes are given as follows: $w_{11} = s_{11} + s_{12} + s_{21} + s_{m1} + s_{1n}$, $w_{mn} = s_{mn} + s_{m-1,n} + s_{m,n-1} + s_{1n} + s_{m1}$, $w_{1n} = s_{1n} + s_{1,n-1} + s_{2n} + s_{mn} + s_{11}$, and $w_{m1} = s_{m1} + s_{m2} + s_{m-1,1} + s_{11} + s_{mn}$.

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The weights of the edge nodes are given by, Top edge: $w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i+1,j} + s_{mj}$,Bottom edge:$w_{ij} = s_{ij} + s_{i,j-1} + s_{i,j+1} + s_{i-1,j} + s_{1j}$,Left edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j+1} + s_{in}$, Right edge: $w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{i1}$. For all the middle nodes, the weights are same as middle nodes of P_mx P_n and is given by$w_{ij} = s_{ij} + s_{i-1,j} + s_{i+1,j} + s_{i,j-1} + s_{i,j+1}$.

Cyclic- Intertwined Graph *(Cₘ x Kₙ)*

The Cyclic- intertwined Graph *(Cₘ x Kₙ)* is similar to the transpose of *(Kₘ x Cₙ)* graph as shown in the Figure 10. The associativity will be discussed in the later section of this paper.

The weights of the four corner nodes are given by $w_{11} = \sum_{j=1}^{n} s_{ij} + s_{21} + s_{m1}$,$w_{1n} = \sum_{j=1}^{n} s_{ij} + s_{2n} + s_{mn}$, $w_{m1} = \sum_{j=1}^{n} s_{mj} + s_{m-1,1} + s_{11}$, $w_{mn} = \sum_{j=1}^{n} s_{mj} + s_{m-1,n} + s_{1n}$.The weights of the edge nodes are given by Top edge:$w_{ij} = \sum_{j=1}^{n} s_{1j} + s_{mj} + s_{i+1,j}$,Bottom edge:$w_{ij} = \sum_{j=1}^{n} s_{mj} + s_{1j} + s_{i-1,j}$,Left edge and right edge (both can have same formula):$w_{ij} = \sum_{j=1}^{n} s_{ij} + s_{i+1,j} + s_{i-1,j}$. For all the middle nodes, the weights are given by the same formula as left and right edges. Therefore, all vertical edges behave same except for the four corner nodes.

Intertwined- Sequential Graph *(Kₘ x Pₙ)*

Here, for Intertwined- Sequential Graph *(Kₘ x Pₙ)*, as shown in Figure 11,instead of four corner nodes, edge nodes and middle nodes, we classify the nodes in accordance with the first column, middle columns, and last columns.

First column, where, for all values of $x_{ij}, j = 1, 1 \leq i \leq m, w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{i,j+1}$,middle columns, where, for all values of $x_{ij}, 1 < j < n, 1 \leq i \leq m, w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{i,j+1} + s_{i,j-1}$,last column, where, for all values of $x_{ij}, j = 1, 1 \leq i \leq m, w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{i,j-1}$.

Intertwined- Cyclic Graph *(Kₘ x Cₙ)*

For the Intertwined- Cyclic Graph *(Kₘ x Cₙ)* ,as shown in Figure 12, the weights of the four corner nodes are given by $w_{11} = \sum_{i=1}^{m} s_{i1} + s_{12} + s_{1n}$, $w_{1n} = \sum_{i=1}^{m} s_{in} + s_{1,n-1} + s_{11}$, $w_{m1} = \sum_{i=1}^{m} s_{i1} + s_{m2} + s_{mn}$ and $w_{mn} = \sum_{i=1}^{m} s_{in} + s_{m,n-1} + s_{m1}$. The weights of the edge nodes are given by Top edge: $w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{i,j+1} + s_{i,j-1}$ Bottom edge:$w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{m,j+1} + s_{m,j-1}$,Left edge:$w_{ij} = \sum_{i=1}^{m} s_{i1} + s_{in} + s_{i,j+1}$ and Right edge:$w_{ij} = \sum_{i=1}^{m} s_{in} + s_{i1} + s_{i,j-1}$. For all the middle nodes, $w_{ij} = \sum_{i=1}^{m} s_{ij} + s_{i,j+1} + s_{i,j-1}$.

Intertwined- Intertwined Graph *(Kₘ x Kₙ)*

Intertwined- Intertwined Graph *(Kₘ x Kₙ)* ,as shown in Figure 13 is the highest related node structure among the nine combinations and hence complex where every node is related to every other node along its horizontal edge and vertical edge.For every node x_{ij} , where for all values of $x_{ij}, 1 \leq i \leq m, 1 \leq j \leq n$, we have $w_{ij} = \sum_{i=1}^{m} s_{ij} + \sum_{j=1}^{n} s_{ij} - s_{ij}$.

Associativity Tests

Associativity tests were conducted for different numbers and it was observed that,$(C_m \text{x}P_n)(X) = (P_m \text{x}C_n)(X^T)$,$(K_m \text{x}P_n)(X) = (P_m \text{x}K_n)(X^T)$, and$(K_m \text{x}C_n)(X) = (C_m \text{x}K_n)(X^T)$, hence proving the associativity. Thus one can consider either {(Pₘ x Pₙ), (Cₘ x Cₙ), (Kₘ x Kₙ)} and {(Cₘ x Pₙ)OR (Pₘ x Cₙ), (Kₘ x Pₙ)OR (Pₘ x Kₙ), (Kₘ x Cₙ)OR (Cₘ x Kₙ)}for analyses

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Application Software Development

An open-source application software titled Cartesian Graph Calculator (CGC) [3] was developed to compute all the nine Cartesian combinations {$(P_m$ x $P_n)$,$(C_m$ x $C_n)$, $(K_m$ x $K_n)$, $(C_m$ x $P_n)$, $(P_m$ x $C_n)$, $(K_m$ x $P_n)$, $(P_m$ x $K_n)$,$(K_m$ x $C_n)$,$(C_m$ x $K_n)$}for any input matrix X. Although associativity was proved, the software was developed for all nine combinations to enable users to understand ease of computation without the need of transposing the values. The open-source software was developed as a Windows Forms .NET solution and can be downloaded in GitHub [3] under CC license. The initial graphical user interface of the application software is as shown in the Figure 14. It consists of two tabs - one for one-dimensional Cartesian graph and other for two-dimensional Cartesian graph.

Steps for Calculating Weights of One-dimensional Cartesian Graphs in CGC

The steps of using the CGC software to calculate the total weights of one-dimensional graphs (P-graph, C-Graph, K-Graph) by inputting the self-weights of nodes is shown in Figure 15.

The steps are as follows:

Step1: Enter the total number of nodes you want in the one-dimensional Cartesian graph and click "create input matrix" as shown in (1). The software automatically creates the input number of nodes in the input box as shown in (2).

Step2: Enter the self-weights of all the nodes in the input box created as shown in (2).

Step3: In the output box, click the drop-down menu as shown in (3) and select one of the three types of graphs (P-graph, C-Graph or K-Graph)

Step4: Click "compute total weights" as shown in (4). The output matrix with total weights is created in output box as shown in (5). One can export the total weight values to excel for further data processing by clicking "export to excel" button. The CGC is designed to be dynamic in nature. You can change the graph type in the output box from P-graph to C-Graph and the output dynamically is updated to the latest total weights.

Steps for calculating weights of two-dimensional Cartesian graphs in CGC

To calculate the total weights of the two-dimensional graphs (Eg: $(P_m$ x $P_n)$, $(P_m$ x $C_n)$), one has to click the "Two dimensional Cartesian Graphs" tabs and input the self-weights of nodes as shown in Figure 16.

The steps are as follows: Step 1: Enter the total number of rows and columns as shown in in (1), you want in the two-dimensional Cartesian graph and click "create input matrix" as shown in in (2). The software automatically creates the input matrix in the input box as shown in (3).Step 2: Enter the self-weights of all the nodes in the input box created as shown in (3).Step 3: In the output box, click the drop-down menu as shown in (4) and select one of the nine types of 2 D Cartesian graphs ((P_m x $P_n)$, $(P_m$ x $C_n)$, $(P_m$ x $K_n)$, $(C_m$ x $P_n)$, $(C_m$ x $C_n)$, $(C_m$ x $K_n)$, $(K_m$ x $P_n)$, $(K_m$ x $C_n)$, $(K_m$ x $K_n)$).Step 4: Click "compute total weights" as shown in (5). The output matrix with total weights is created in output box as shown in (6). One can export the total weight values to excel for further data processing by clicking "export to excel" button. You can change the graph type in the output box from one 2D graph, say $(P_m$ x $P_n)$ to other 2D graph, say $(C_m$ x $K_n)$ and the output dynamically gets updated to the latest total weights. The intent of the software is to reduce the burden of calculations of the nodes for pure mathematicians and accelerate the exploration of labeling of the nodes with unique patterns of self-weights.

CONCLUSIONS

The P-structure, C-structure and K-structures are very important part of the Cartesian graph family. Hence, suitable algorithms were developed to calculate the total weights of each of the nodes of both one-dimensional PCK structures as well as their Cartesian two-dimensional combinations, namely,((P_m x $P_n)$, $(P_m$ x $C_n)$, $(P_m$ x $K_n)$, $(C_m$ x $P_n)$, $(C_m$ x $C_n)$, $(C_m$ x $K_n)$, $(K_m$ x $P_n)$, $(K_m$ x $C_n)$ and $(K_m$ x $K_n)$. Then, the associativity of the two-dimensional graph combinations were explored and it was found that they were associative. An open-source application software called Cartesian Graph Calculator using these algorithms wasdeveloped to compute the total weights of the nodes for given self-weights. For future research, this software can serve for further research on the labeling of graphs with

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different patterns of self-weights and observing the behaviour of graphs. Further, the group is intending to work on other Cartesian graphs to expand this software in its future versions.

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Table.1:Nine Possible Cartesian graphs of C, P and K structures

	P_n	C_n	K_n
P_m	P_m x P_n	P_m x C_n	P_m x K_n
C_m	C_m x P_n	C_m x C_n	C_m x K_n
K_m	K_m x P_n	K_m x C_n	K_m x K_n

Figure.1: P-structure	**Figure.2: C-structure**

Figure.3: K-structure	**Figure.4 : Naming convention of the two-dimensional Cartesian graph nodes in this paper**

Figure.5:Sequence –Sequence Cartesian graph (P_m x P_n)	**Figure.6:Sequence –Sequence Cartesian graph (P_m x C_n)**

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Figure.7:Sequence –Sequence Cartesian graph *(Pₘ x Kₙ)*

Figure.8:Sequence – Cyclic Cartesian graph *(Cₘ x Pₙ)*

Figure .9: **Cyclic-Cyclic Cartesian graph** *(Cₘ x Cₙ)*

Figure.10: Cyclic- intertwined Graph *(Cₘ x Kₙ)*

Figure.11:Intertwined- Sequential Graph *(Kₘ x Pₙ)*

Figure.12: Intertwined- Cyclic Graph *(Kₘ x Cₙ)*
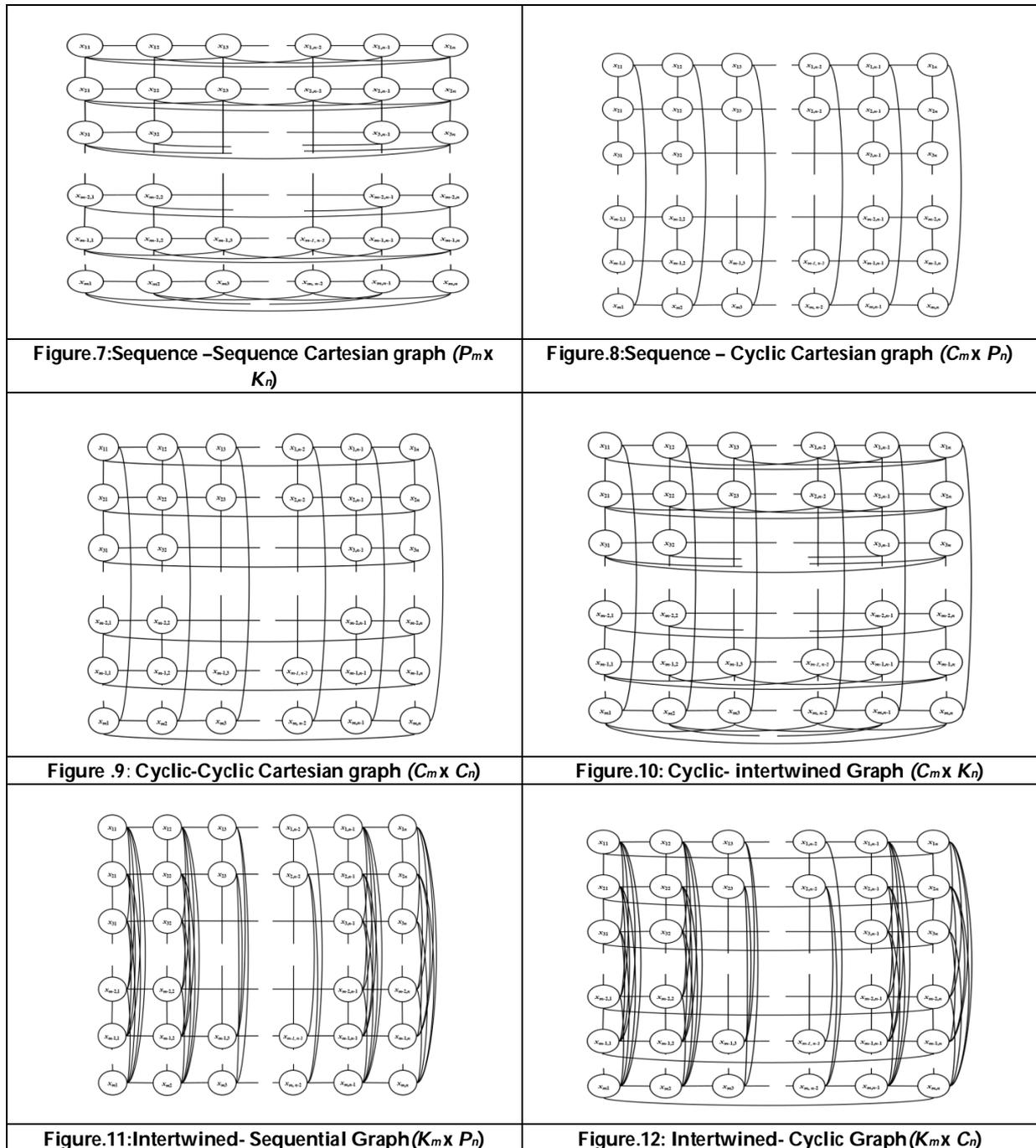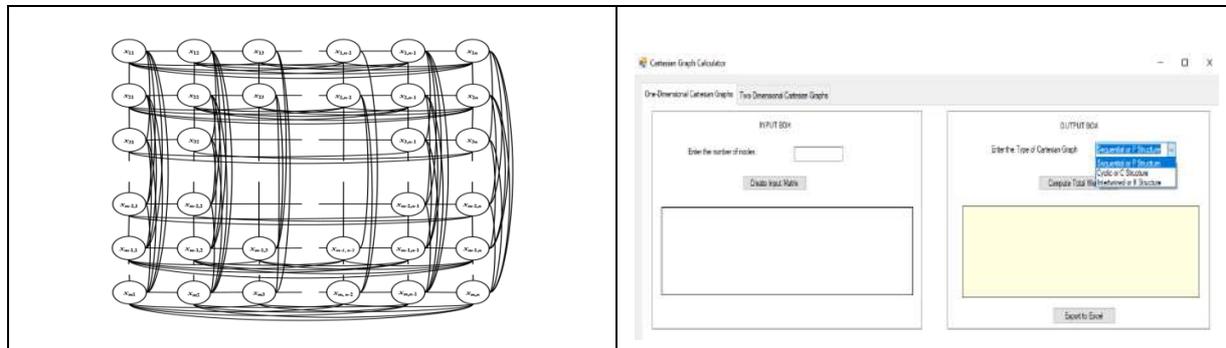
Figure.13: Intertwined- Intertwined Graph(K_m x K_n)	**Figure.14: Graphical user interface of the developed CGC**
Figure.15: Steps for using the one-dimensional Cartesian graph in CGC	**Figure.16: Steps for using the two-dimensional Cartesian graph in CGC**
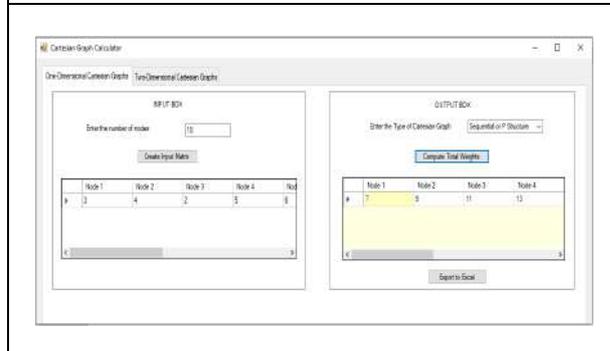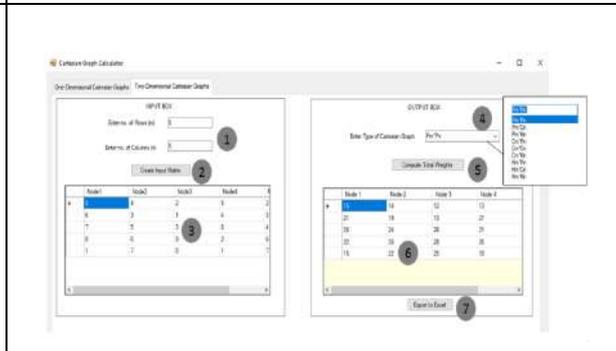
RESEARCH ARTICLE

$\mathcal{M}$icro-Λ-Generalized Closed Sets and Properties of $\mathcal{M}$icro-Λ-Sets in Micro Topological Spaces

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ABSTRACT

In this paper, we introduced the stronger form of $\mathcal{M}$icro-Λ-g-cld sets and a weaker form of $\mathcal{M}$icro-Λ-g-cld sets and study of the properties of $\mathcal{M}$icro-Λ-set, $\Lambda_{m\alpha}$-set, Λ_{mp}-set, Λ_{ms}-set, $\Lambda_{m\beta}$-sets and also introduced the new notion of $\mathcal{M}_{(\Lambda,\alpha)}$-set, $\mathcal{M}_{(\Lambda,p)}$-set, $\mathcal{M}_{(\Lambda,s)}$-set, $\mathcal{M}_{(\Lambda,\beta)}$-sets and then investigated the characterization of the properties.

Keywords: $\mathcal{M}i\mathcal{C}$-Λ-set, $\mathcal{M}i\mathcal{C}$-λ-cld set, $\mathcal{M}i\mathcal{C}$-Λg-cld set,$\mathcal{M}i\mathcal{C}$-Λ-g-cld set,$\Lambda_{m\alpha}$-set, Λ_{mp}-set, $\mathcal{M}_{(\Lambda,s)}$-cld,$\mathcal{M}_{(\Lambda,\beta)}$-cld.

INTRODUCTION

As a generalization of closed sets, Levine [8] presented generalized closed sets in general topology. The idea was to compare a subset's closure to its open sets. Maki [9] described generalized Λ-sets and the closure operator that goes with them. C.Boonpok and C.Viriyapong [2] defined (Λ, p) –closed set and the related notation in topological spaces. Caldas *et al.* [3] used the principles of λ-open and λ-closure operator to define the concept of λ-open and investigate new separation axioms. M. L. Thivagar and C.Richard [10] introduced the on nano forms of weakly open sets. Caldas et al.[4] examine particular forms of on Λ-generalized closed sets in topological space and create new classes of sets termed on Λ-generalized closed sets. $\mathcal{M}$icro topological spaces were introduced by Chandrasekar [6], who also highlighted some of its features. In $\mathcal{M}$icro topological spaces, Bhavani [1] defined strong forms of generalized closed

sets. In this paper, we introduced the stronger form of $\mathcal{M}$icro-Λ-g-cld sets and a weaker form of $\mathcal{M}$icro-Λ-g-$c$ld sets and study of the properties of $\mathcal{M}$icro-Λ-set, $\Lambda_{m\alpha}$-set, Λ_{mp}-set, Λ_{ms}-set, $\Lambda_{m\beta}$-sets and also introduced the new notion of $\mathcal{M}_{(\Lambda,\alpha)}$-set, $\mathcal{M}_{(\Lambda,p)}$-set, $\mathcal{M}_{(\Lambda,s)}$-set, $\mathcal{M}_{(\Lambda,\beta)}$-sets and then investigated the characterization of the properties.

PRELIMINARIES

Definition 2.1 [1]
Let $\tilde{U}$ be a set of non-empty set finite elements known as the "universe" and permit R be the equivalence relation on $\tilde{U}$ termed as "the indiscernibility relation". Elements belonging to the same equivalence class are said to be indiscernible with one another. Then ($\tilde{U}$, R) is stated to be the approximation space.Let$X_* \subseteq \tilde{U}$.

1.The lowest approximation of X_* relative to R is the set of all objects. R may be categorized as X_*w.r.t ' R' and it an indicated through $L_R(X_*)$.

$L_R(X_*) = {}^{U}_{x \in \tilde{U}}\{R(x):R(x) \subseteq X_*\}$.where R(x) denoted the "equivalence class" determined by x.

2.The upper approximation of X_*w.r.t ' R' is the set of all elements. It can be classified along with R and it is represented by $U_R(X_*)$.

$U_R(X_*) = {}^{U}_{x \in \tilde{U}}\{ R(x):R(x) \cap X_* \neq \varphi\}$.

3.The boundary region ofX_* w.r.t 'R' is the set of all elements. Which can be classified neither as X_*nor as not -$X_*$with respect to R and it is designated by $B_R(X_*)$.

$B_R(X_*) = U_R(X_*)\text{-}L_R(X_*)$.

Property 2.2[1]
Let ($\tilde{U}$,R) is an approximate space and S,T$\subseteq \tilde{U}$:then

1.$L_R(T) \subseteq T \subseteq U_R(T)$:

2.$L_R(\varphi) = U_R(\varphi) = \varphi$ and $L_R(\tilde{U}) = U_R(\tilde{U}) = \tilde{U}$:

3.$U_R(T \cup S) = U_R(T) \cup U_R(S)$:

4.$U_R(T \cap S) \subseteq U_R(T) \cap U_R(S)$:

5.$L_R(T \cup S) \supseteq L_R(T) \cup L_R(S)$:

6.$L_R(T \cap S) \subseteq L_R(T) \cap L_R(S)$:

7.$L_R(T) \subseteq L_R(S)$ and $U_R(T) \subseteq U_R(S)$ Whenever $T \subseteq S$:

8.$U_R(T) = [L_R(T)]^c L_R(T) = [U_R(T)]^c$:

9.$U_R U_R(T) = L_R U_R(T) = U_R(T)$:

10.$L_R L_R(T) = U_R L_R(X) = L_R(X)$.

Definition 2.3[1,6]
Let $\tilde{U}$ be universal. R is the equivalent relationship between$\tilde{U}$ and $\tau_R(X_*)=$ $\{\tilde{U},, L_R(X_*),U_R(X_*),B_R(X_*)\}$ where $X_* \subseteq \tilde{U}$. Then by the Prop 2.2,$R(X_*)$ satisfies the following axioms:

1.$\tilde{U}$ and $\varphi \in \tau_R(X_*)$.

2.The union of the elements of any subcollection of $\tau_R(X_*)$ is once more in $\tau_R(X_*)$.

3.The intersection of the elements of any finite sub collection of $\tau_R(X_*)$ is once more in $\tau_R(X_*)$. Then $\tau_R(X_*)$ is a topology on $\tilde{U}$ called the nano topology on $\tilde{U}, \varphi$ with respect to X_*.

we denoted ($\tilde{U},\tau_R(X_*)$) because the nano topological space.The elements of $\tau_R(X_*)$ are known as nano open sets.

Definition2.4 [7, 9]
The $\mathcal{M}$icro topology $\mu_R(X_*)$ satisfies the following axioms

1. $\tilde{U}, \varphi \in \mu_R(X_*)$

2.The union of the elements of any sub collection of $\mu_R(X_*)$ is again in $\mu_R(X_*)$. The intersection of the elements of any finite sub collection of $\mu_R(X_*)$ is again in $\mu_R(X_*)$.Then $\mu_R(X_*)$={NU$(N'\cap\mu)$:N, $N'\in\tau_R(X_*)$ and $\mu\notin\tau_R(X_*)$} is called the $\mathcal{M}icro$ topolopy on $\hat{U}$ with respect to X.The triplet$(\hat{U},\tau_R(X_*),\mu_R(X_*))$ is called $\mathcal{M}icro$ topological space (briefly $\mathcal{MTS}$) and the elements of $\mu_R(X_*)$ are called $\mathcal{M}$icro-open set and the complement of a $\mathcal{M}$icro-open set is called a $\mathcal{M}$icro-closed (briefly, $\mathcal{M}$icro-cld) set. The complement of $\mathcal{M}$icro-cld set is known as$\mathcal{M}$icro- open set.

Definition2.5 [1]

The $\mathcal{M}icro$ closure of a set K is represented by $\mathcal{MiC}$-cl(K) and is defined as $\mathcal{MiC}$-cl(K) = $\cap$\{L:L is $\mathcal{M}$icro-cld and K $\subseteq$ L\}. $\mathcal{MiC}$ –int (K) = \{L : L is $\mathcal{M}$icro-open and K $\supseteq$ L\}.

Definition2.6 [1]

Let $(\hat{U},\tau_R(X_*),\mu_R(X_*))$ be a $\mathcal{MTS}$. A subset A of a $\mathcal{MTS}$ $\hat{U}$ is called $\mathcal{M}$icro-g-closed set (briefly, $\mathcal{M}$icro-g-cld) if $\mathcal{MiC}$-cl(A) $\subseteq\hat{U}$ Whenever A $\subseteq\hat{U}$ and $\hat{U}$ is $\mathcal{MiC}$-open. The complement of $\mathcal{M}$icro-g-cld set is called $\mathcal{M}$icro-g-open set.

Definition2.7 [1, 6]

For any two $\mathcal{M}$icro sets E and F in a $\mathcal{MTS}$ $(\hat{U},\tau_R(X_*),\mu_R(X_*))$

1.Let E is a $\mathcal{M}$icro closed set iff $\mathcal{MiC}$-cl(E) = E.

2.Let E is a $\mathcal{M}$icro open set iff $\mathcal{MiC}$-int(E) = E.

3.E $\subseteq$ F $\implies$ $\mathcal{MiC}$-int(E) $\subseteq$ $\mathcal{MiC}$-int(F) and $\mathcal{MiC}$-cl(E) $\subseteq$ $\mathcal{MiC}$-cl(F).

4.$\mathcal{MiC}$-cl($\mathcal{MiC}$-cl(E)) =$\mathcal{MiC}$-cl(F) and $\mathcal{MiC}$-int($\mathcal{MiC}$-int(E)) = $\mathcal{MiC}$-int(F).

5.$\mathcal{MiC}$-cl(EUF) $\supseteq$ $\mathcal{MiC}$-cl(E) U $\mathcal{MiC}$-cl(F).

6.$\mathcal{MiC}$-cl(E$\cap$F) $\subseteq$ $\mathcal{MiC}$-cl(E) $\cap\mathcal{MiC}$-cl(F).

7.$\mathcal{MiC}$-int(EUF) $\supseteq\mathcal{MiC}$-int(E) U $\mathcal{MiC}$-int(F).

8.$\mathcal{MiC}$-int(E$\cap$F) $\subseteq$ $\mathcal{MiC}$-int((E) $\cap$ $\mathcal{MiC}$-int(F).

9.$\mathcal{MiC}$-cl(E$^{C)}$ = $[\mathcal{MiC}$-int(E)$]^c$

10.$\mathcal{MiC}$-int(E^C) = $[\mathcal{MiC}$-cl(E)$]^c$

Definition 2.8 [3,5]

A subset H of a topological space $(X_*,\tau_R(X_*))$ is called λ- closed if H= L$\cap$D , Where λ is a $\wedge$ -set and D is a closed set.

Definition 2.7 [5]

A subset K is said to be $\mathcal{M}$icro-α-open if K$\subseteq$ $\mathcal{MiC}$ -Int($\mathcal{MiC}$-cl($\mathcal{MiC}$ -Int(K)). Then $\mathcal{M}\alpha$O($\hat{U}$, $\mu_R(X_*)$) is denotes the collection of all $\mathcal{M}$icro-α-open sets.

Definition 2.8 [5]

A subset K is said to be $\mathcal{M}$icro-pre-open if K$\subseteq$ $\mathcal{MiC}$-Int($\mathcal{MiC}$ -cl(K)). Then $\mathcal{M}$PO($\hat{U}$,) denotes the collection of all $\mathcal{M}$icro-pre-open sets.

Definition 2.9 [7]

A subset K is said to be $\mathcal{M}$icro-semi-open if K$\subseteq$ $\mathcal{MiC}$-cl($\mathcal{MiC}$ -Int(K)). Then $\mathcal{M}$SO($\hat{U}$, $\mu_R(X_*)$) denotes the collection of all $\mathcal{M}$icro-semi-open sets.

Definition 2.10 [7]

A subset K is said to be $\mathcal{M}$icro-β-open set if K$\subseteq$ $\mathcal{MiC}$ -cl($\mathcal{MiC}$ -int($\mathcal{MiC}$ -cl(K)) . Then $\mathcal{M}\beta$O($\hat{U}$, $\mu_R(X_*)$) denotes the collection of all $\mathcal{M}$icro-β-open sets.

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Remark 2.11 [5, 7]

1.Each $\mathcal{M}$icro-open set is $\mathcal{M}$icro-α-open set.

2.Each $\mathcal{M}$icro-α-open set is $\mathcal{M}$icro-pre-open set.

3.Each $\mathcal{M}$icro-α-open set is $\mathcal{M}$icro-semi-open set.

4.Each $\mathcal{M}$icro-pre-open set is $\mathcal{M}$icro-β-open set.

5.Each $\mathcal{M}$icro-semi-open set is $\mathcal{M}$icro-β-open set.

Micro-$\wedge$-GeneralizedClosed Sets

Definition 3.1

1.A $\mathcal{M}$icro $\wedge$- set is a set A which is equal to its kernel (= saturated set)

$\mathcal{M}$icro $\wedge$- set $=^{\cap_{A \subseteq U_m}} U_m$(where U_m is $\mathcal{M}$icro-open super sets of A).

2.Let $(\check{U},\tau_R(X_*), \mu_R(X_*))$ be a $\mathcal{M}TS$ and $F \subseteq \check{U}$.The $\mathcal{M}$icro-ker(F) = $\cap$ {$\check{U}$:F $\subseteq \check{U},\check{U} \in \mu_R(X)$} is called the $\mathcal{M}$icro-kernel of F and is defined by $\mathcal{M}$Ker(F).

3. A $\mathcal{M}$icro-$\wedge$-set F is equal to $\mathcal{M}$Ker(F).

Definition 3.2

A subset H of a $\mathcal{M}TS(\check{U},\tau_R(X_*), \mu_R(X_*))$ is called $\mathcal{M}$icro-λ-closed (briefly,$\mathcal{M}$icro-λ-cld) if H = L $\cap$ D, where L is $\mathcal{M}$icro-$\wedge$-set and D is $\mathcal{M}$icro-cld set.

The complement of $\mathcal{M}$icro-λ-$c$ld set is $\mathcal{M}$icro-λ-open.

Definition 3.3

Let A be the $\mathcal{M}TS(\check{U},\tau_R(X_*), \mu_R(X_*))$ is said to be $\mathcal{M}$icro-$\wedge g$- closed briefly, $\mathcal{M}$icro-$\wedge g$-cld) if $\mathcal{M}i\mathcal{C}$-cl(A) $\subseteq \check{U}$, whenever A $\subseteq \check{U}$, where $\check{U}$ is Micro-λ-open.

Definition3.4

Let A be the $\mathcal{M}TS$ $(\check{U},\tau_R(X_*), \mu_R(X_*))$ is said to be $\mathcal{M}$icro-$\wedge$-g- closed (briefly, $\mathcal{M}$icro-$\wedge$-g-cld) if $\mathcal{M}i\mathcal{C}$-clλ(A) $\subseteq \check{U}$, whenever A $\subseteq \check{U}$, where $\check{U}$ is $\mathcal{M}$icro -λ-open.

Definition 3.5

Let A be the $\mathcal{M}TS$ $(\check{U},\tau_R(X_*), \mu_R(X_*))$ is said to be $\mathcal{M}$icro-g$\wedge$-$c$losed (briefly, $\mathcal{M}$icro-g$\wedge$-cld) if $\mathcal{M}i\mathcal{C}$-clλ(A) $\subseteq \check{U}$,whenever A $\subseteq \check{U}$,where $\check{U}$ is Micro-open.

Proposition 3.6

Each $\mathcal{M}$icro-cld set is $\mathcal{M}$icro-λ-cld.

Proof:

Let D is a $\mathcal{M}$icro-cld subset of $\check{U}$ and N is any $\mathcal{M}$icro-λ-cld set containing H and L is $\mathcal{M}$icro-$\wedge$-set.Then N= L $\cap$ D.Hence N is $\mathcal{M}$icro-λ-cld.

The following example shows that proposition 3.6 conversely need not be true.

Example 3.7

Let $\check{U}$ = {m_1, m_2, m_3, m_4},with $\check{U}$/R={{m_1, m_4},{m_2},{m_3}}, X_*= {m_1, m_3}and $\tau_R(X_*)$ ={φ,$\check{U}$,{m_3},{m_1, m_4}, {m_1, m_3, m_4}}then the $\mathcal{M}TS$ $\mu_R(X_*)$ = {φ ,$\check{U}$,{m_1},{m_1, m_2},{m_3},{m_1, m_3},{m_1, m_2, m_3},{m_1, m_4},{m_1, m_2, m_4},{m_1, m_3, m_4}.Then {m_1, m_2, m_3} is $\mathcal{M}$icro-λ- cld but not $\mathcal{M}$icro-cld.

Proposition 3.8

Each $\mathcal{M}$icro-λ-cld set is $\mathcal{M}$icro-$\wedge$-g-cld set.

Proof

If A is a $\mathcal{M}$icro-λ-cld subset of $\bar{U}$ and H is -$\wedge$-g-cld set containing A.

We have A $\subseteq$ H = $\mathcal{M}i\mathcal{C}$-cl(A), where $\bar{U}$ is $\mathcal{M}$icro-λ-$\mathcal{O}$pen.

Hence A is $\mathcal{M}$icro-$\wedge$-g-cld set.

The following example shows that proposition 3.8 conversely need not be true.

Example 3.9

Let $\bar{U}$ = {m_1, m_2, m_3, m_4, m_5},with $\bar{U}$/R = {{m_1, m_2, m_3},{m_4},{m_5}}, X_*= {m_2, m_4}and $\tau_R(X_*)$ ={φ ,$\bar{U}$,{m_4}, {m_1, m_2, m_3, m_4},{m_1, m_2, m_3}} then the $\mathcal{M}TS$ $\mu_R(X_*)$ = {φ ,$\bar{U}$,{m_3},{m_4},{m_4, m_3},{m_1, m_2, m_3, m_4}, {m_1, m_2, m_3}}.Clearly the set {m_1, m_3, m_4, m_5} is $\mathcal{M}$icro-$\wedge$-g-$c$ld set but not $\mathcal{M}$icro-λ-$c$ld set.

Proposition 3.10

Each $\mathcal{M}$icro-$\wedge$-g-cld set is $\mathcal{M}$icro-g$\wedge$-cld set.

Proof:

Let A is a $\mathcal{M}$icro-$\wedge$-g-cld subset of $\bar{U}$ and H is any $\mathcal{M}$icro-λ-cld set containing A.

We have, A $\subseteq$ H = $\mathcal{M}i\mathcal{C}$-cl(A). Hence A is$\mathcal{M}$icro- g$\wedge$-cld set.

The following example shows that proposition 3.10 conversely need not be true.

Example 3.11

Let $\bar{U}$ = {n,o,p,q},with $\bar{U}$/R ={{n},{o}{p,q}}, X_*= {p,q}and $\tau_R(X_*)$ ={φ , $\bar{U}$,{p,q}} then the $\mathcal{M}TS$ $\mu_R(X_*)$ = {φ,$\bar{U}$,{n,p},{p},{p,q},{n,p,q}}. Then A={n,o,p}is $\mathcal{M}$icro-g$\wedge$-cld set but not $\mathcal{M}$icro-$\wedge$-g-cld.

Propostion3.12

Each $\mathcal{M}icro$-g –cld set is $\mathcal{M}icro$-g$\wedge$-cld set.

Proof

If J is a $\mathcal{M}$icro-g-cld subset of $\bar{U}$ and H is any $\mathcal{M}$icro-g$\wedge$-cld set containing J.Since Each $\mathcal{M}$icro-cld set is $\mathcal{M}$icro-λ-cld by proposition 3.6, we have A $\subseteq$ H = $\mathcal{M}i\mathcal{C}$-clλ(J). Hence J is $\mathcal{M}$icro-g$\wedge$-cld.

The following example shows that proposition 3.12 conversely need not be true.

Example 3.13

Let $\bar{U}$ = {p, q, r, s} with $\bar{U}$/R = {{p,r},{q},{s}}, X_* = {p,q} and $\tau_R(X_*)$ = {φ,$\bar{U}$,{q}, {p,q,r},{p,r}} then the $\mathcal{M}TS$ $\mu_R(X_*)$ = {φ,$\bar{U}$,{q},{ r, q},{r},{p, r},{p, q, r}}. Then the set {p,q} is $\mathcal{M}$icro -g$\wedge$-cld set but not $\mathcal{M}$icro-g-cld set.

Proposition 3.14

Each $\mathcal{M}$icro-$\wedge_g$-cld set is $\mathcal{M}$icro-g-cld.

Proof:

If J is $\mathcal{M}$icro-$\wedge_g$-cld set subset of $\bar{U}$ and H is $\mathcal{M}$icro-g-cld set containing J.We have A $\subseteq$ H = $\mathcal{M}i\mathcal{C}$-cl(A). Hence A is $\mathcal{M}$icro-g-$c$ld.

The following example shows that proposition 3.14 conversely need not be true.

Example 3.15

Let $\bar{U}$={n,o,p,q} with $\bar{U}$/R={{n,p},{o},{q}} X_*={o,q} and $\tau_R(X_*)$ ={φ,$\bar{U}$, {o,q}}then the $\mathcal{M}TS$ $\mu_R(X_*)$ ={φ,$\bar{U}$,{o, p},{o},{o,q},{o,p,q}}.Then A={n,o,q} is $\mathcal{M}$icro-g-cld but not $\mathcal{M}$icro-$\wedge_g$-cld set.

Proposition 3.16

Each $\mathcal{M}$icro-cld set is $\mathcal{M}$icro -$\wedge_g$-cld.

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Proof

It is obviously.

The following example shows that proposition 3.16 conversely need not be true.

Example 3.17

In Example 3.9. Then $\{m_2, m_5\}$ is $\mathcal{M}$icro -Λ_g-cld but not $\mathcal{M}$icro-cldset.

Proposition 3.18

In a space $(\bar{U}, \mu_R(X_*))$,the union of two $\mathcal{M}$icro-Λ_g-cld set is $\mathcal{M}$icro-Λ_g-cld.

Proof:

Let $H \cup G \subseteq \bar{U}$ Then $H \subseteq \bar{U}$ and $G \subseteq \bar{U}$ where $\bar{U}$ is $\mathcal{M}$icro-λ-open.

As H and G and $\mathcal{M}$icro-Λg-cld. $\mathcal{M}i\mathcal{C}$-cl(G) $\subseteq \bar{U}$ and $\mathcal{M}i\mathcal{C}$-cl(H) $\subseteq \bar{U}$. Hence $\mathcal{M}i\mathcal{C}$-cl(H∪G) = $\mathcal{M}i\mathcal{C}$-cl(H) ∪ $\mathcal{M}i\mathcal{C}$-cl(G) $\subseteq \bar{U}$.

Remark 3.19

The Intersection of two $\mathcal{M}$icro-Λg-cld sets need not be $\mathcal{M}$icro-Λg-cld as can be verified from the following example.

Example 3.20

In Example 3.9, then A = $\{m_1, m_2, m_3, m_5\}$and B = $\{m_1, m_3, m_4, m_5\}$ are $\mathcal{M}$icro -Λg-cld set but A ∩ B = $\{m_2, m_4\}$ is not $\mathcal{M}$icro-Λg-cld

Remark 3.21

In a space $(\bar{U}, \mu_R(X_*))$,The Intersection of two $\mathcal{M}$icro-Λg- open sets need not be $\mathcal{M}$icro-Λg-open as can be verified from the following example.

Example 3.22

In example 3.9, then A=$\{m_1, m_2, m_3, m_4\}$ and B=$\{m_2, m_3, m_4\}$ are $\mathcal{M}$icro -Λg-open set. But A ∩ B = $\{m_2, m_3, m_4\}$ is not $\mathcal{M}$icro-Λg-open.

Remark 3.23

We obtain the following diagram, where A →B (resp.A ⟷ B) represents A implies B but not conversely (resp. A and B are independent of each other).
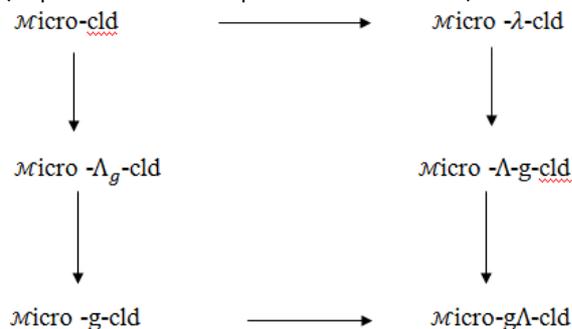
Properties of $\mathcal{M}$icro-Λ-Set

In this section, we have Introduced some properties of $\mathcal{M}$icro-Λ-set.

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Definition 4.1
Let K be a subset of a $\mathcal{M}TS$ then $\Lambda_{m\alpha}$(K)-set is defined as follows $\Lambda_{m\alpha}$(K) $=\cap\{O \in \mathcal{M}\alpha O(\hat{U}, \mu_R \ (X_*))/K\subseteq O\}$.

Definition 4.2
Let K be a subset of a $\mathcal{M}TS$ then Λ_{mp}(K)-set is defined as follows Λ_{mp}(K) $= \cap\{O \in \mathcal{M}PO(\hat{U}, \mu_R \ (X_*))/K\subseteq O\}$.

Definition 4.3
Let K be a subset of a $\mathcal{M}TS$ thenΛ_{ms}(K)-set is defined as follows Λ_{mp}(K) $= \cap\{O \in \mathcal{M}SO(\hat{U}, \mu_R \ (X_*))/K \subseteq O\}$.

Definition 4.4
Let K be a subset of a $\mathcal{M}TS$ then $\Lambda_{m\beta}$(K)-set is defined as follows $\Lambda_{m\beta}$(K) $= \cap\{O \in \mathcal{M}SO(\hat{U}, \mu_R \ (X_*))/K\subseteq O\}$.

Definition 4.5
Let K be a subset of a $\mathcal{M}TS$ is called $\mathcal{M}_{(\Lambda,\alpha)}$- cld if K $= E_1 \cap E_2$, where E_1 is a $\Lambda_{m\alpha}$(K)-set and E_2 is a $\mathcal{M}$icro-α-cld set. The collection of all $\mathcal{M}_{(\Lambda,\alpha)}$-cld set in a $\mathcal{M}TS$ $(\hat{U},\tau_R(X_*),\mu_R(X_*))$ is denoted $\Lambda_{m\alpha}C(\hat{U}, \mu_R \ (X_*))$.

Definition 4.6
Let K be a subset of a $\mathcal{M}TS$ is called $\mathcal{M}_{(\Lambda,p)}$-cld if K $= E_1 \cap E_2$, where E_1 is a Λ_{mp}(A)-set and E_2 is a $\mathcal{M}$icro-pre-cld set.The collection of all $M_{(\Lambda,p)}$-cld set is a$\mathcal{M}TS$ $(\hat{U},\tau_R(X_*),\mu_R(X_*))$ is denoted $\Lambda_{mp}C(\hat{U}, \mu_R \ (X_*))$.

Definition 4.7
Let K be a subset of a $\mathcal{M}TS$ is called $\mathcal{M}_{(\Lambda,s)}$-cld if K $= E_1 \cap E_2$, where $E_1$is a Λ_{ms}(A)-set and E_2 is a $\mathcal{M}$icro-semi-cld set. The collection of all $\mathcal{M}_{(\Lambda,s)}$-cld set is a $\mathcal{M}TS$ $(\hat{U},\tau_R(X_*),\mu_R(X_*))$ is denoted $\Lambda_{ms}C(\hat{U},\mu_R \ (X_*))$.

Definition 4.8
Let K be a subset of a $\mathcal{M}TS$ is called $\mathcal{M}_{(\Lambda,\beta)}$-cld if A $= E_1 \cap E_2$, where $E_1$is a $\Lambda_{m\beta}$(A)-set and E_2 is a $\mathcal{M}$icro-β-cld set. The collection of all$\mathcal{M}_{(\Lambda,\beta)}$-cld set is a $\mathcal{M}TS$ $(\hat{U},\tau_R(X_*),\mu_R(X_*))$ is denoted $\Lambda_{m\beta}C(\hat{U}, \mu_R \ (X_*))$.

Proposition 4.9
Each Λ_m-set is $\Lambda_{m\alpha}$-set.

Proof:
Let G be a Λ_m-set in $\hat{U}$. We have Λ_m(G) $= \cap\{T_1 \in \mathcal{M}O(\hat{U}, \mu_R \ (X_*))/G\subseteq T_1\}$. Each $\mathcal{M}$icro-open set is $\mathcal{M}$icro-α-open set. It follows that $\cap\{T_1 \in \mathcal{M}O(\hat{U}, \mu_R \ (X_*))/G\subseteq T_1\}$ $\hat{U},\mu_R \ (X_*))/G\subseteq T_1\{T_1 \in \mathcal{M}\alpha O(\hat{U}, \mu_R \ (X_*))/ \ G \subseteq T_1\}$. Hence G is $\Lambda_{m\alpha}$-set.

Example 4.10
Let $\hat{U}$={n, o, p, q}, $\hat{U}$ / R ={{n, p}, {o}, {q}}, X_* = {o, q}, then $\tau_R(X_*)$ = {φ, $\hat{U}$, {o, q}}, μ_R $\mu_R(X_*)$ ={φ, $\hat{U}$, {o}, {o, p}, {o, q}, {o, p, q}}, then {n, o, q} is $\Lambda_{m\alpha}$-set but not Λ_m-set.

Proposition 4.11
Each $\Lambda_{m\alpha}$-set is Λ_{mp}-set.

Proof:
Let G be a $\Lambda_{m\alpha}$-set in $\hat{U}$. We have$\Lambda_{m\alpha}$ (G) = {$T_1 \in \mathcal{M}\alpha O(\hat{U}, \mu_R \ (X_*))/ \ G \subseteq T_1$}.Each $\mathcal{M}$icro-α-open set is $\mathcal{M}$icro-pre-open set. It follows that $\cap\{T_1 \in \mathcal{M}\alpha O(\hat{U}, \mu_R \ (X_*))/ \ G \subseteq T_1\}\subseteq \cap\{T_1 \in \mathcal{M}PO(\hat{U}, \mu_R \ (X_*))/ \ G \subseteq T_1\}$. Hence G is Λ_{mp}-set.

Example 4.12

Let $\check{U}$= {e, f, g, h, i}, $\check{U}$ / R = {{e}, {f}, {g, h}, {i}}, X_* = {e, g, i}, $\tau_R(X_*)$={∅, $\check{U}$, {e, i}, {g, h}, {e, g, h, i}}, $\mu_R(X_*)$ ={ ∅, $\check{U}$, {h}, {f, h}, {e, i}, {g, h}, {g, h}, {e, i, h },{f, g, h}, {e, g, h, i}, {e, f, i, h}}, then {g, h, i} is Λ_{mp}-set but not $\Lambda_{m\alpha}$-set.

Proposition 4.13

Each $\Lambda_{m\alpha}$-set is Λ_{ms}-set.

Proof:

Let G be a $\Lambda_{m\alpha}$-set in $\check{U}$. We have $\Lambda_{m\alpha}(G)$ = ∩{$T_1 \in \mathcal{M}\alpha O(\check{U}, \mu_R (X_*))$ (/ $G \subseteq T_1$}. Each $\mathcal{M}$icro-α-open set is $\mathcal{M}$icro-semi-open set. It follows that ∩ {$T_1 \in \mathcal{M}\alpha O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$} $\subseteq$ {$T_1 \in \mathcal{M}S O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$} Hence G is Λ_{ms}-set.

Example 4.14

From Example 4.10, then {n, p, q} is Λ_{ms}-set but not $\Lambda_{m\alpha}$-set.

Proposition 4.15

Each Λ_{mp}-set is $\Lambda_{m\beta}$-set

Proof:

Let G be the Λ_{mp}-set in $\check{U}$. We have $\Lambda_{mp}(G)$ = ∩{$T_1 \in \mathcal{M}PO(\check{U}, \mu_R (X_*) / G \subseteq T_1$}. Each $\mathcal{M}$icro-α-open set is $\mathcal{M}$icro-semi-open set. It follows that {$T_1 \in \mathcal{M}pO(\check{U}, \mu_R (X_*)) / G \subseteq T_1$}$\subseteq$ ∩ {$T_1 \in \mathcal{M}\beta O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$}. Hence G is $\Lambda_{m\beta}$-set.

Example 4.16

Let $\check{U}$= {1, 2, 3, 4, 5}, $\check{U}$ / R ={{1, 2, 3}, {4}, {5}}, X_* = {2,4}, $\tau_R(X_*)$ = {∅, $\check{U}$, {4}, {1, 2, 3, 4}, {1, 2, 3}}, $\mu_R(X_*)$ ={ ∅, $\check{U}$,{3}, {4}, {4, 3}, {1, 2, 3, 4}, {1, 2, 3}}, then {1, 2, 3, 5} set is $\Lambda_{m\beta}$-set but not Λ_{mp}-set.

Proposition 4.17

Each Λ_{ms}-set is $\Lambda_{m\beta}$-set.

Proof:

Let G be the Λ_{ms}-set in $\check{U}$. We have $\Lambda_{ms}(G)$ = ∩{$T_1 \in \mathcal{M}S O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$}. Each $\mathcal{M}$icro-semi-open set is $\mathcal{M}$icro-β-open set. It follows that ∩{$T_1 \in \mathcal{M}S O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$} $\subseteq$ ∩ {$T_1 \in \mathcal{M}\beta O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$}.Hence G is $\Lambda_{m\beta}$-set.

Example 4.18

From Example 4.16, then {3, 4, 5} is $\Lambda_{m\beta}$-set but not Λ_{ms}-set.

Proposition 4.19

Each $\Lambda_{m\alpha}$-set is $\mathcal{M}_{(\Lambda,\alpha)}$-cld set.

Proof:

Let G be the $\Lambda_{m\alpha}$-set in $\check{U}$. We have $\Lambda_{m\alpha}(G)$ =∩ {$T_1 \in \mathcal{M}\alpha O(\check{U}, \mu_R (X_*)) / G \subseteq T_1$} . From the definition 4.5, $\mathcal{M}_{(\Lambda,\alpha)}$ -cld is contains Λ_{mp}-set. Therefore, G is a subset of $\mathcal{M}_{(\Lambda,\alpha)}$ -cld. Hence G is $\mathcal{M}_{(\Lambda,\alpha)}$ -cld.

Example 4.20

From Example 4.16, then {1, 2, 4, 5} is $\mathcal{M}_{(\Lambda,\alpha)}$-cld set but not $\Lambda_{m\alpha}$set.

Proposition 4.21

Each Λ_{mp}-set is $\mathcal{M}_{(\wedge,p)}$-cld.

Proof:

Let G be the Λ_{mp}-set in $\hat{U}$. We have $\Lambda_{mp}(G) = \cap\{T_1 \in \mathcal{M}pO(\hat{U}, \mu_R(X_*)) / G \subseteq T_1\}$. From the definition 4.6, $\mathcal{M}_{(\wedge,P)}$-cld is contains Λ_{mp}-set. Therefore, G is a subset of $\mathcal{M}_{(\wedge,P)}$-cld. Hence G is $\mathcal{M}_{(\wedge,P)}$-cld.

Example 4.22

From Example 4.16, then {2, 4, 5} is $M_{(\wedge,p)}$-cld but not Λ_{mp}-set.

Proposition 4.23

Each Λ_{ms}-set is $M_{(\wedge,s)}$-cld.

Proof:

Let G be the Λ_{ms}-set in $\hat{U}$. We have $\Lambda_{ms}(G) = \cap\{T_1 \in \mathcal{M}S\,O(\hat{U}, \mu_R(X_*)) / G \subseteq T_1\}$. From the definition 4.7, $\mathcal{M}_{(\wedge,s)}$-cld is contains Λ_{ms}-set. Therefore, G is a subset of $\mathcal{M}_{(\wedge,s)}$-cld. Hence G is $\mathcal{M}_{(\wedge,s)}$-cld.

Example 4.24

From Example 4.16, then {1, 2, 4} is the $\mathcal{M}_{(\wedge,s)}$-cld but not Λ_{ms}set.

Proposition 4.25

Each $\Lambda_{m\beta}$-set is $\mathcal{M}_{(\wedge,\beta)}$-cld.

Proof:

Let G be the $\Lambda_{m\beta}$-set in $\hat{U}$. We have $\Lambda_{m\beta}(G) = \cap\{T_1 \in \mathcal{M}S\,O(\hat{U}, \mu_R(X_*)) / G \subseteq T_1\}$. From the definition 4.7, $\mathcal{M}_{(\wedge,\beta)}$-cld is contains $\Lambda_{m\beta}$-set. Therefore, G is a subset of $\mathcal{M}_{(\wedge,\beta)}$-cld. Hence G is $\mathcal{M}_{(\wedge,\beta)}$-cld.

Example 4.26

From Example 4.12, then {1, 4, 5} is $\mathcal{M}_{(\wedge,\beta)}$-cld but not $\Lambda_{m\beta}$-set.

Proposition 4.27

Each $\mathcal{M}_{(\wedge,\alpha)}$-cld is $\mathcal{M}_{(\wedge,p)}$-cld.

Proof:

Let G be the $\mathcal{M}_{(\wedge,\alpha)}$-cld in $\hat{U}$. We have G contains $\Lambda_{m\alpha}$-set. Since every $\Lambda_{m\alpha}$-set is Λ_{mp}-set and also each Λ_{mp}-set is $\mathcal{M}_{(\wedge,p)}$-cld. Hence G is $\mathcal{M}_{(\wedge,p)}$-cld.

Example 4.28

From Example 4.12, then {e, f} is $\mathcal{M}_{(\wedge,p)}$-cld but not $\mathcal{M}_{(\wedge,\alpha)}$-cld.

Proposition 4.29

Each $\mathcal{M}_{(\wedge,p)}$-cld is $\mathcal{M}_{(\wedge,\beta)}$-cld.

Proof:

Let G be the $\mathcal{M}_{(\wedge,p)}$-cld in $\hat{U}$. We have G contains Λ_{mp}-set. Since every Λ_{mp}-set is $\Lambda_{m\beta}$-set and also each $\Lambda_{m\beta}$-set is $\mathcal{M}_{(\wedge,\beta)}$-cld. Hence G is $\mathcal{M}_{(\wedge,\beta)}$-cld.

Example 4.30

Let Û= {e, f, g, h, i}, Û / R = {{e}, {f}, {g, h}, {i}}, X_* = {e, g }, $\tau_R(X_*)$ = {∅, Û, {e}, {g, h}, {e, g, h}}, $\mu_R(X_*)$ ={ ∅, Û, {f}, {e}, {e, f}, {g, h}, {f, g, h}, {e, g, h}, {e, f, g, h}}, then{e, g, h, i} is $\mathcal{M}_{(\Lambda,\beta)}$-cld but not $\mathcal{M}_{(\Lambda,p)}$-cld.

Proposition 4.31

$\mathcal{M}_{(\Lambda,\alpha)}$-cld and $\mathcal{M}_{(\Lambda,s)}$-cld.

Proof:

Let G be the $\mathcal{M}_{(\Lambda,\alpha)}$-cld in Û. We have G contains $\Lambda_{m\alpha}$-set. Since every $\Lambda_{m\alpha}$-set is Λ_{ms}-set and also each Λ_{ms}-set is $\mathcal{M}_{(\Lambda,s)}$-cld. Hence G is $\mathcal{M}_{(\Lambda,s)}$-cld.

Example 4.32

Let Û= {1, 2, 3, 4, 5}, Û / R = {{1, 2, 3}, {4}, {5}}, X_* = {2,5}, $\tau_R(X_*)$ = {∅, Û, {5}, {1, 2, 3}, {1, 2, 3, 5}}, $\mu_R(X_*)$ ={ ∅, Û, {2}, {5}, {5, 2}, {1, 2, 3}, {1, 2, 3, 5}}, then {1, 3, 4} set is $\mathcal{M}_{(\Lambda,S)}$-cld but not $\mathcal{M}_{(\Lambda,\alpha)}$- cld.

Proposition 4.33

Each $\mathcal{M}_{(\Lambda,S)}$-cld is $\mathcal{M}_{(\Lambda,\beta)}$-cld.

Proof:

Let G be the $\mathcal{M}_{(\Lambda,S)}$-cld in Û. We have G contains Λ_{mS}-set. Since every Λ_{mS}-set is $\Lambda_{m\beta}$-set and also each $\Lambda_{m\beta}$-set is $\mathcal{M}_{(\Lambda,\beta)}$-cld. Hence G is $\mathcal{M}_{(\Lambda,\beta)}$-cld.

Example 4.34

From Example 4.16, then {3, 4, 5} is $\mathcal{M}_{(\Lambda,\beta)}$-cld but not $\mathcal{M}_{(\Lambda,S)}$-cld.

Remark 4.35

We obtain the following diagram, where A → B represents A implies B but not conversely.
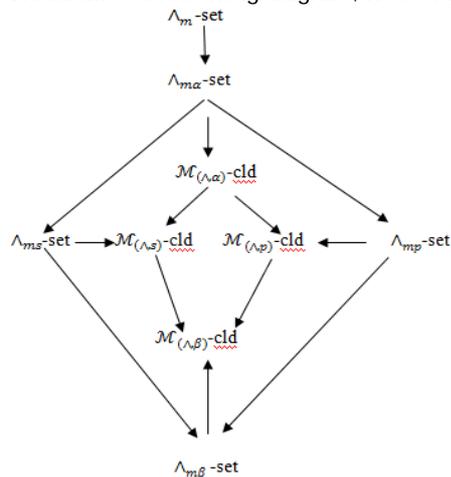
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RESEARCH ARTICLE

A Wavelet based Approach for Numerical Inversion of a Generalized Integral Transform

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ABSTRACT

This article proposes a unified approach for the numerical inversion of a generalized integral transform using the operational matrix of the Haar wavelets. The numerical inverse of a generalized integral transformations in terms of the Haar wavelets operational matrix is established for a number of rational, irrational, and transcendental transfer functions. The suggested approach forgoes conventional and complex integration in favour of a few sparse matrix manipulations.

Keywords: Haar wavelets, Operational matrix, Numerical inverse generalized integral transform.

AMS Subject Classification(2010): 44A10, 65T60.

INTRODUCTION

Fractional calculus, a new branch of mathematics, extends differentiation and integration of integer orders to non-integer orders. Compared to classical calculus, it offers more realistic mathematical modelling of a variety of significant phenomena, such as social and natural occurrences. Over the past few decades, numerous applications were reported in a variety of scientific and technical fields. Although fractional differential equations are quite interesting, analytical solutions aren't always possible. Numerical techniques therefore become more important for

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solving such equations. There are various numerical methods have been developed for solving fractional differential euations in literature such as Predictor-corrector method [5], Adomian decomposition method [22], Laplace transforms [19], Taylor collocation method [3], Haar wavelet collocation method [10], Variational iteration method [29], Q-homotopy analysis transform method [26], Homotopy perturbation method [29], Inverse Laplace transform [20], Homotopy analysis method [16], Conformable Laplace transform [24], Finite difference method [7], Tau method [25], Shifted Legendre-tau method [23], Fractional multi-step differential transform method [1], Fractional B-splines collocation method [18], Generalized block pulse operational matrix [12] and so on.

Several orthogonal functions as well as Haar wavelet operational matrices are employed to find the inversion of the Laplace transform. In 1977, C.F. Chen et al used Walsh operational matrices for solving various distributed parameters systems such as heat conduction and percolation problem [4]. Later, Wang Chi-Hsul constructed the generalised block pulse operational matrices [27] using a more rigorous approach. Wang claims that generalised block pulse operational matrices are more accurate than Chen's earlier work when it comes to inversions of the Laplace transform for rational and irrational transfer functions [4]. Aside from these numerical approaches, much interest has been generated in redesigning numerical algorithms for discovering the inverse Laplace transform utilising operational matrices. Along these lines, to solve a few nonlinear differential equations, D. Rani and V. Mishra[14,21] employed a numerical inverse Laplace transform based on operational matrix of Bernoulli and chebyshev polynomials . Our renewed interest in the problem was driven by J. Wu et al.[28], who proposed a new method for performing numerical inversion of Laplace transform using Haar wavelet operational matrices. In[15], V. Mishra and D. Rani used a Laplace transform inversion method based on Bernstien operational matrix of integration to solve a few differential and integral problems. C. H. Hsiao solved ordinary and partial differential equations using numerical inversion of the Laplace transform using wavelets in [8,9]. S. M. Aznam and A. Hussin[2] discussed a numerical method for inverse Laplace transform using Haar wavelet operational matrix to solve ordinary differential equations.

The primary goal of this work is to obtain the numerical inversion of a generalized integral transform for a number of rational and irrational transfer functions via Haar wavelet operational matrices. The manuscript is divided into the following sections. In Section 2, we briefly go over some necessary definitions and the core ideas of fractional calculus. In Section 3, an operational matrix of fractional integration based on Haar wavelets is derived. In Section 4, we provide the numerical analysis of the inversion of a generalized integral transform. In Section 5, the proposed method is applied on some rational and irrational transfer functions. The last section offers a concluding statement.

Preliminaries
Here, fractional order integral and differential operators along with some fundamental concepts of fractional calculus are covered.

Definition 2.1 *[6,13,17,19]The Riemann-Liouville integral of fractional order $\lambda \geq 0$, of the function $g(x) \in L^1([0,\infty))$, is given by*

$$I^\lambda g(x) = \begin{cases} g(x), & \lambda = 0. \\ \dfrac{1}{\Gamma(\lambda)} \displaystyle\int_0^x (x-v)^{\lambda-1} g(v) dv, & \lambda > 0. \end{cases}$$

Let $g(x), h(x) \in L^1([0,\infty))$, $a, b \in \mathbb{R}$, $v > -1$, $\lambda \geq 0$.

Then the following properties are attained.
(i) $I^\lambda(ah(x) + bg(x)) = aI^\lambda h(x) + bI^\lambda g(x)$.
(ii) $I^\lambda x^v = \dfrac{\Gamma(v+1)}{\Gamma(v+\lambda+1)} x^{\lambda+v}$.

Definition 2.2 *[6,13,17,19]The Caputo fractional derivative of fractional order $\lambda \geq 0$, of the function $g(x) \in L^1([0,\infty))$, is given by*

$$D^\lambda g(x) = I^{m-\lambda}(D^m g(x)) = \begin{cases} \dfrac{d^m}{dx^m} g(x), & \lambda = m \in \mathbb{N}. \\[2mm] \dfrac{1}{\Gamma(m-\lambda)} \displaystyle\int_0^x \dfrac{g^{(m)}(v)}{(x-v)^{\lambda-m+1}} dv, & m-1 < \lambda < m, m \in \mathbb{N}. \end{cases}$$

Let $g(x), h(x) \in L^1([0,\infty))$, $a, b \in \mathbb{R}$, $\lambda \geq 0$.
Then the following properties are attained.

(i) $D^\lambda a = 0$, *where a is a constant.*

(ii) $D^\lambda(ah(x) + bg(x)) = a(D^\lambda h(x)) + b(D^\lambda g(x))$.

(iii) $D^\lambda(I^\lambda g(x)) = g(x)$.

(iv) $I^\lambda(D^\lambda g(x)) = g(x) - \displaystyle\sum_{j=0}^{m-1} g^{(j)}(0^+) \dfrac{x^k}{j!}$, $m-1 < \lambda \leq m$,

where $m \in \mathbb{N}$, $x > 0$ and $g^{(j)}(0^+) := \lim_{x \to 0^+} D^{(j)} g(x)$, $j = 0,1,2,\ldots,m-1$.

Definition 2.3 *Let $f(t)$ represent an integrable function defined for $t \geq 0$ and $u(s) \neq 0$, $v(s)$ be any positive real functions. The generalizedized integral transform of $f(t)$ is defined as*

$$G\{f(t)\} = \hat{G}(u(s), v(s)) = u(s) \int_0^\infty f(t) e^{-v(s)t} dt,$$

assuming that the integral is valid for some $v(s)$. This generalized integral transform includes many existing integral transforms for various $u(s)$ and $v(s)$ values, such as the Laplace, Elazaki, and Kamal transforms as in table 1.

Haar wavelets approximations of functions
The Haar wavelet and its fractional integration operational matrix are presented here.

Haar wavelets
Alfred Haar, a Hungarian mathematician, developed the Haar functions in 1910. The haar wavelet family for $x \in [0,1)$ is defined as

$$h_i(x) = \sqrt{\dfrac{\hat{m}}{2^{J+1}}} \begin{cases} 1, & for\ x \in \left[\dfrac{k}{\hat{m}}, \dfrac{(k+0.5)}{\hat{m}}\right), \\[3mm] -1, & for\ x \in \left[\dfrac{(k+0.5)}{\hat{m}}, \dfrac{(k+1)}{\hat{m}}\right), \\[3mm] 0, & otherwise. \end{cases}$$

where $\hat{m} = 2^l$, $l = 0,1,2,\ldots,J$, $J \in \mathbb{N}$, indicates the level of resolution and $k = 0,1,2,\ldots,\hat{m}-1$ is the translation parameter. The maximum level of resolution is J. The index i is calculated using $i = \hat{m} + k + 1$. The minimal value of i is 2 and the maximal value of i is $N = 2^{J+1}$.
The scaling function $h_1(x)$ for the family of Haar wavelets is defined as

$$h_1(x) = \begin{cases} \dfrac{1}{\sqrt{N}}, & for\ x \in [0,1), \\[3mm] 0, & otherwise. \end{cases}$$

Square integrable functions approximation

Every function $f(t)$ from $L^2([0,1))$ with regard to Haar wavelets can be expressed as

$$f(t) = \sum_{i=1}^{\infty} c_i h_i(t), \qquad (1)$$

where the following inner product resolves the coefficients c_i.

$$\langle f(t), h_i(t) \rangle = \int_0^1 f(t) h_i(t) dt.$$

If the series (1) is truncated, $f(t)$ can be roughly calculated as

$$f(t) \simeq \sum_{i=1}^{N} c_i h_i(t) = C_{1 \times N} H(t), \qquad (2)$$

where $C = [c_1, c_2, \ldots, c_N]_{1 \times N}$ is the coefficient vector and $H(t) = [h_1(t), h_2(t), \ldots, h_N(t)]$. Discretizing (2) at $t_i = \frac{(2i-1)}{2N}$, $i = 1,2,3,\ldots,N$, we attain

$$F \simeq C_{1 \times N} H_{N \times N}, \qquad (3)$$

where $F = [f(t_1), f(t_2), \ldots, f(t_N)]_{1 \times N}$ and $H_{N \times N} = [H(t_1), H(t_2), \ldots, H(t_N)]$, a Haar wavelet coefficient matrix of order N. Especially, for $J = 2$, the Haar wavelet coefficient matrix becomes

$$H_{8 \times 8} = \begin{pmatrix} 0.3536 & 0.3536 & 0.3536 & 0.3536 & 0.3536 & 0.3536 & 0.3536 & 0.3536 \\ 0.3536 & 0.3536 & 0.3536 & 0.3536 & -0.3536 & -0.3536 & -0.3536 & -0.3536 \\ 0.5000 & 0.5000 & -0.5000 & -0.5000 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.5000 & 0.5000 & -0.5000 & -0.5000 \\ 0.7071 & -0.7071 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.7071 & -0.7071 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.7071 & -0.7071 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.7071 & -0.7071 \end{pmatrix}$$

Haar wavelets operational matrix of fractional integration

According to [11], the N Block pulse functions(BPFs) on [0,1] are given by,

$$b_m(t) = \begin{cases} 1, & \dfrac{(m-1)}{N} \le t < \dfrac{m}{N}, \\ 0, & otherwise, \end{cases}$$

where $N \in \mathbb{N}$, $m = 1,2,3,\ldots,N$.

For $0 \le t < 1$,

$$b_n(t) b_m(t) = \begin{cases} 0, & m \ne n. \\ b_m(t), & m = n. \end{cases}$$

and

$$\int_0^1 b_n(t) b_m(t) dt = \begin{cases} 0, & m \ne n. \\ \dfrac{1}{N}, & m = n. \end{cases}$$

Every function $f(t) \in L^2[0,1)$ can be written in terms of BPFs as

$$f(t) \simeq \sum_{m=1}^{N} f_m b_m(t) = f B_N(t),$$

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where $f = [f_1, f_2, \ldots, f_N], f_m = N \int_{\frac{(m-1)}{N}}^{\frac{m}{N}} f(t) b_m(t) dt$ and $B_N(t) = [b_1(t), b_2(t), \ldots, b_N(t)]'$.

The relationship between the Haar wavelets and BPFs is given by

$$H(t) = H_{N \times N} B_N(t). \qquad (4)$$

According to [11], the integration I^λ, with fractional order $\lambda \geq 0$ of $B_N(t)$ is approximated as

$$I^\lambda(B_N(t)) \simeq E^\lambda_{N \times N} B_N(t), \qquad (5)$$

where $E^\lambda_{N \times N}$ is the Block pulse operational matrix of $I^\lambda(B_N(t))$ given by

$$E^\lambda_{N \times N} = \left(\frac{1}{N}\right)^\lambda \frac{1}{\Gamma(\lambda + 2)} \begin{pmatrix} 1 & \Omega & \Omega_2 & \Omega_3 & \ldots & \Omega_{N-1} \\ 0 & 1 & \Omega_1 & \Omega_2 & \ldots & \Omega_{N-2} \\ 0 & 0 & 1 & \Omega_1 & \ldots & \Omega_{N-3} \\ 0 & 0 & 0 & 1 & \ldots & \Omega_{N-4} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \ldots & \Omega_1 \\ 0 & 0 & 0 & 0 & \ldots & 1 \end{pmatrix}$$

with $\Omega_\ell = (\ell + 1)^{\lambda+1} - 2\ell^{\lambda+1} + (\ell - 1)^{\lambda+1}$.

The integration I^λ with fractional order $\lambda \geq 0$ of $H(t)$ is approximated as,

$$I^\lambda(H(t)) \simeq R^\lambda_{N \times N} H(t), \qquad (6)$$

where $R^\lambda_{N \times N}$ is referred to as the Haar wavelets operational matrix of order N for fractional integration with order $\lambda \geq 0$.

Using (4) and (5), we arrive

$$I^\lambda(H(t)) = I^\lambda(H_{N \times N} B_N(t)) = H_{N \times N} I^\lambda(B_N(t)) \simeq H_{N \times N} E^\lambda_{N \times N} B_N(t). \qquad (7)$$

Thus, combining (6) and (7), we attain

$$R^\lambda_{N \times N} H(t) \simeq I^\lambda(H(t)) \simeq H_{N \times N} E^\lambda_{N \times N} B_N(t) = H_{N \times N} E^\lambda_{N \times N} (H_{N \times N})^{-1} H(t)$$

and so

$$R^\lambda_{N \times N} \simeq H_{N \times N} E^\lambda_{N \times N} (H_{N \times N})^{-1}. \qquad (8)$$

Especially, for $J = 2$ and $\lambda = 0.5$, the Haar wavelets operational matrix for fractional integration becomes,

$$R^{0.5}_{8 \times 8} = \begin{pmatrix} 0.7523 & -0.2203 & -0.1102 & -0.0580 & -0.0551 & -0.0290 & -0.0224 & -0.0189 \\ 0.2203 & 0.3116 & -0.1102 & 0.1623 & -0.0551 & -0.0290 & 0.0878 & 0.0391 \\ 0.0580 & 0.1623 & 0.2203 & -0.0350 & -0.0779 & 0.1148 & -0.0275 & -0.0045 \\ 0.1102 & -0.1102 & 0 & 0.2203 & 0 & 0 & -0.0779 & 0.1148 \\ 0.0189 & 0.0391 & 0.1148 & -0.0045 & 0.1558 & -0.0247 & -0.0026 & -0.0009 \\ 0.0224 & 0.0878 & -0.0779 & -0.0275 & 0 & 0.1558 & -0.0247 & -0.0026 \\ 0.0290 & -0.0290 & 0 & 0.1148 & 0 & 0 & 0.1558 & -0.0247 \\ 0.0551 & -0.0551 & 0 & -0.0779 & 0 & 0 & 0 & 0.1558 \end{pmatrix}$$

Riemann-Liouville fractional integral of Haar wavelet functions

The Riemann-Liouville fractional integral with order $\lambda > 0$ of Haar wavelet scaling function $h_1(t)$ is given by

$$
\begin{aligned}
I^{\lambda} h_1(t) &= \frac{1}{\Gamma(\lambda)} \int_0^t (t - t_1)^{\lambda-1} h_1(t_1) dt_1 \\
&= \frac{1}{\Gamma(\lambda)} \frac{1}{\sqrt{N}} \int_0^t (t - t_1)^{\lambda-1} dt_1 \\
&= \frac{1}{\sqrt{N}} \frac{t^{\lambda}}{\Gamma(\lambda + 1)}.
\end{aligned}
$$

Thus

$$
\begin{aligned}
\frac{t^{\lambda}}{\Gamma(\lambda + 1)} &= \frac{\sqrt{N}}{\Gamma(\lambda)} \int_0^t (t - t_1)^{\lambda-1} h_1(t_1) dt_1 \\
&= \frac{\sqrt{N}}{\Gamma(\lambda)} \int_0^t (t - t_1)^{\lambda-1} [1\ 0\ 0\ 0 \ldots 0]_{1 \times N} H(t_1) dt_1 \\
&= e \frac{1}{\Gamma(\lambda)} \int_0^t (t - t_1)^{\lambda-1} H(t_1) dt_1
\end{aligned}
$$

Where $e = [\sqrt{N}\ 0 \ldots 0]_{1 \times N}$.
Then

$$
\frac{t^{\lambda}}{\Gamma(\lambda+1)} = e\, R_{N \times N}^{\lambda} H(t). \tag{9}
$$

The expression in equation (9) is very helpful while finding the numerical inversion of the generalized integral transform later in irrational transfer function expression.

Numerical analysis for inversion of the generalized integral transform

The generalized integral transform of n-fold integration is given by
$$
G\left\{ \int_0^t \ldots \int_0^{t_3} \int_0^{t_2} f(\tau) d\tau_1 d\tau_2 \ldots d\tau_n \right\} = \frac{\hat{G}(u(s), v(s))}{v(s)^n}.
$$

Let

$$
\hat{G}(u(s), v(s)) = \frac{u(s)\left(a_0 + \frac{a_1}{v(s)} + \frac{a_2}{v^2(s)} + \ldots + \frac{a_n}{v^n(s)}\right)}{v^{\lambda+1}(s)\left(b_0 + \frac{b_1}{v(s)} + \frac{b_2}{v^2(s)} + \ldots + \frac{b_n}{v^n(s)}\right)} = \hat{\hat{G}}\left(u(s), \frac{1}{v(s)}\right), \tag{10}
$$

where $\lambda \geq 0$, $a_i, b_i \in \mathbb{R}$, $i = 0,1,2,\ldots,n$, $n \in \mathbb{N}$.
Then
$$
\left(b_0 + \frac{b_1}{v(s)} + \frac{b_2}{v^2(s)} + \ldots + \frac{b_n}{v^n(s)}\right) \hat{G}(u(s), v(s)) = \frac{u(s)}{v^{\lambda+1}(s)}\left(a_0 + \frac{a_1}{v(s)} + \frac{a_2}{v^2(s)} + \ldots + \frac{a_n}{v^n(s)}\right) \tag{11}
$$

By applying the inverse generalized integral transform on (11), we get

$$
\begin{aligned}
b_0 f(t) + b_1 \int_0^t f(\tau) d\tau + \cdots + b_n \int_0^t \ldots \int_0^{t_3} \int_0^{t_2} f(\tau_1) d\tau_1 d\tau_2 \ldots d\tau_n \\
= \frac{a_0 t^{\lambda}}{\Gamma(\lambda + 1)} + \frac{a_1 t^{\lambda+1}}{\Gamma(\lambda + 2)} + \cdots + \frac{a_n t^{\lambda+n}}{\Gamma(\lambda + n + 1)}.
\end{aligned} \tag{12}
$$

The result of discretizing (12) at the collocation points is

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$$C_{1 \times N}(b_0 I_{N \times N} + b_1 R_{N \times N}^1 + b_2 R_{N \times N}^2 + \ldots + b_n R_{N \times N}^n)H_{N \times N}$$
$$= e R_{N \times N}^\lambda (a_0 I_{N \times N} + a_1 R_{N \times N}^1 + a_2 R_{N \times N}^2 + \ldots + a_n R_{N \times N}^n)H_{N \times N} \qquad (13)$$

and so

$$C_{1 \times N}\, g_2(R_{N \times N}) = e\, R_{N \times N}^\lambda\, g_1(R_{N \times N}), \qquad (14)$$

where $g_1(R_{N \times N}) = a_0 I_{N \times N} + a_1 R_{N \times N}^1 + a_2 R_{N \times N}^2 + \ldots + a_n R_{N \times N}^n$ and
$g_2(R_{N \times N}) = b_0 I_{N \times N} + b_1 R_{N \times N}^1 + b_2 R_{N \times N}^2 + \ldots + b_n R_{N \times N}^n.$

Thus
$C_{1 \times N} = e\, R_{N \times N}^\lambda\, g_1(R_{N \times N})\, g_2(R_{N \times N})^{-1}.$
Now, the numerical inverse generalized integral transform of $\hat{G}(u(s), v(s))$ is given by

$$
\begin{aligned}
F &\simeq C_{1 \times N} H_{N \times N} \\
&= e R_{N \times N}^\lambda\, g_1(R_{N \times N})\, g_2(R_{N \times N})^{-1} H_{N \times N} \\
&= e R_{N \times N}^{-1} H_{N \times N} H_{N \times N}^{-1} R^{\lambda+1}\, g_1(R_{N \times N})\, g_2(R_{N \times N})^{-1} H_{N \times N} \\
&= e H_{N \times N} E_{N \times N}^{-1} H_{N \times N}^{-1}(I_{N \times N} R_{N \times N}^{\lambda+1}\, g_1(R_{N \times N})\, g_2(R_{N \times N})^{-1})H_{N \times N}
\end{aligned}
$$
$$= [2N \;\; -2N \ldots \; -2N]_{1 \times N} H_{N \times N}^{-1} \hat{\hat{G}}(I_{N \times N}, R_{N \times N}^1)H_{N \times N}, \qquad (15)$$

where $\hat{\hat{G}}(I_{N \times N}, R_{N \times N}^1) = I_{N \times N} R_{N \times N}^{\lambda+1}\, g_1(R_{N \times N})\, g_2(R_{N \times N})^{-1}$ is attained by replacing $u(s)$ by $I_{N \times N}$ and $\frac{1}{v(s)}$ by $R_{N \times N}^{(1}$ in $\hat{G}(u(s), v(s))$.

Following is a summary of the steps involved in determining the numerical inverse generalized integral transform of $\hat{G}(u(s), v(s))$.

Step 1:Express $F(u(s), v(s))$ in terms of $u(s)$ and $\frac{1}{v(s)}$.

Step 2:Replace $u(s)$ and $\frac{1}{v(s)}$ by the identity matrix $I_{N \times N}$ and the operational matrix $R_{N \times N}^1$ respectively to obtain $\hat{\hat{G}}(I_{N \times N}, R_{N \times N}^1)$.

Step 3:Calculate F by $F_{1 \times N} = [2N \;\; -2N \ldots \; -2N]_{1 \times N} H_{N \times N}^{-1} \hat{\hat{G}}(I_{N \times N}, R_{N \times N}^1)H_{N \times N}.$

The discrete forms of the numerical inversion of generalized integral transforms in terms of Haar wavelet operational matrix for some rational, irrational and transcendental transfer functions are listed out in the table 2.

Illustrative Examples
The following examples provide an insight into the applicability and the effectiveness of the proposed numerical approach based on Haar wavelets.

Example 5.1 Let us examine the irrational transfer function
$$\hat{G}(u(s), v(s)) = u(s)v(s)^{-\frac{3}{2}}. \qquad (16)$$

Inverse of the generalized integral transform (16) is $2\sqrt{\frac{t}{\pi}}$. Expressing (16) in terms of $\frac{1}{v(s)}$, we attain

$$\hat{G}(u(s), v(s)) = u(s)\left(\frac{1}{v(s)}\right)^{\frac{3}{2}}. \qquad (17)$$

Replacing $u(s)$ by the identity matrix $I_{N \times N}$ and $\frac{1}{v(s)}$ by the operational matrix $R_{N \times N}^{(1)}$ in (17), we obtain

$$\hat{\hat{G}}(I_{N \times N} R_{N \times N}^1) = I_{N \times N} R_{N \times N}^{\frac{3}{2}}. \qquad (18)$$

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We achieve the numerical inversion of generalized integral transform of (16) using (15) and (18). Table 3 shows the absolute errors and also demonstrates the accuracy of the proposed method.

Example 5.2 Let us examine the irrational transfer function

$$\hat{G}(u(s), v(s)) = \frac{u(s)a\ exp^{-\frac{a^2}{4v(s)}}}{2\sqrt{\pi}v(s)^{\frac{3}{2}}} \qquad (19)$$

Inverse of the generalized integral transform (19) is $\frac{sina\sqrt{t}}{\pi}$. Expressing (19) in terms of $\frac{1}{v(s)}$, we attain

$$\hat{G}(u(s), v(s)) = \frac{u(s)a}{2\sqrt{\pi}}\left(\frac{1}{v(s)}\right)^{\frac{3}{2}} exp\left(\frac{-a^2}{4}\frac{1}{v(s)}\right) \qquad (20)$$

Replacing $u(s)$ by the identity matrix $I_{N\times N}$ and $\frac{1}{v(s)}$ by the operational matrix $R_{N\times N}^{(1)}$ in (20), we obtain

$$\hat{\hat{G}}(I_{N\times N}R_{N\times N}^1) = I_{N\times N}\frac{a}{2\sqrt{\pi}}R_{N\times N}^{\frac{3}{2}}exp\left(\frac{-a^2}{4}R_{N\times N}\right). \qquad (21)$$

We achieve the numerical inversion of generalized integral transform of (19) using (15) and (21). Table 4 shows the absolute errors and also demonstrates the accuracy of the proposed method.

Example 5.3 Let us examine the irrational transfer function

$$\hat{G}(u(s), v(s)) = \frac{u(s)exp^{\frac{1}{v(s)}}}{v(s)\sqrt{v(s)}}. \qquad (22)$$

Inverse of the generalized integral transform (22) is $\frac{Sinh2\sqrt{t}}{\sqrt{\pi}}$. Expressing (22) in terms of $\frac{1}{v(s)}$, we attain

$$\hat{G}(u(s), v(s)) = u(s)\left(\frac{1}{v(s)}\right)^{\frac{3}{2}}exp^{\frac{1}{v(s)}}. \qquad (23)$$

Replacing $u(s)$ by the identity matrix $I_{N\times N}$ and $\frac{1}{v(s)}$ by the operational matrix $R_{N\times N}^{(1)}$ in (23), we obtain

$$\hat{\hat{G}}(I_{N\times N}R_{N\times N}^1) = I_{N\times N}R_{N\times N}^{\frac{3}{2}}exp(R_{N\times N}) \qquad (24)$$

We achieve the numerical inversion of generalized integral transform of (22) using (15) and (24). Table 5 shows the absolute errors and also demonstrates the accuracy of the proposed method.

Example 5.4 Let us examine the Exponential transfer function

$$\hat{G}(u(s), v(s)) = \frac{u(s)exp^{2\sqrt{v(s)}}}{v(s)}. \qquad (25)$$

Inverse of the generalized integral transform (25) is $erfc\left(\frac{1}{\sqrt{t}}\right)$. Expressing (25) in terms of $\frac{1}{v(s)}$, we attain

$$\hat{G}(u(s), v(s)) = u(s)\frac{1}{v(s)}\exp{-2\left(\frac{1}{v(s)}\right)^{-\frac{1}{2}}}. \qquad (26)$$

Replacing $u(s)$ by the identity matrix $I_{N\times N}$ and $\frac{1}{v(s)}$ by the operational matrix $R_{N\times N}^1$ in (26), we obtain

$$\hat{\hat{G}}(I_{N\times N}R_{N\times N}^1) = I_{N\times N}R_{N\times N}exp\left((-2R_{N\times N}^{\frac{-1}{2}}\right). \qquad (27)$$

We achieve the numerical inversion of generalized integral transform of (25) using (15) and (27). Table 6 shows the absolute errors and also demonstrates the accuracy of the proposed method.

CONCLUSION

In this article, a unified method for finding the numerical inversion of a generalized integral transform employing the Haar wavelets operational matrix was proposed. The numerical inverse of a generalized integral transforms in terms of Haar wavelet operational matrix for some rational, Irrational and transcendental transfer functions have been determined and the absolute errors demonstrate the high degree of accuracy of the proposed method. In

contrast to many conventional methods, the proposed method just involves a few sparse matrix manipulations and avoids the need of conventional and complex integration

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Table 1:Relationship between the new generalized integral transform and other integral transforms.

S.No	Values for $u(s)$ and $v(s)$	Existing integral transform
1	$u(s)$=1 and $v(s)$=s	Laplace transform
2	$u(s)$=1 and $v(s)=\frac{1}{s^\alpha}$	α-Laplace transform
3	$u(s)=\frac{1}{s}$ and $v(s)=\frac{1}{s}$	Sumudu transform
4	$u(s)=\frac{1}{s}$ and $v(s)$=1	Aboodh transform
5	$u(s)$=s and $v(s)=s^2$	Pourreza transform
6	$u(s)$=s and $v(s)=\frac{1}{s}$	Elzaki transform
7	$u(s)$=u and $v(s)=\frac{s}{u}$	Natural transform
8	$u(s)=s^2$ and $v(s)$=s	Mohand transform
9	$u(s)=\frac{1}{s^2}$ and $v(s)=\frac{1}{s}$	Sawi transform
10	$u(s)$=1 and $v(s)=\frac{1}{s}$	Kamal transform
11	$u(s)=s^\alpha$ and $v(s)=\frac{1}{s}$	G-transform

Table 2: The discrete forms of the numerical inversions of generalized integral transforms in terms of operational matrix.

S.No	u(s),v(s) –Domain $\widehat{G}(u(s),v(s))$	t-Domain $f(t)$	The discrete form of $f(t)$
1	$\dfrac{u(s)ae^{-\frac{a^2}{4v(s)}}}{2\sqrt{\pi}v(s)^{\frac{3}{2}}}$	$\dfrac{Sina\sqrt{t}}{\pi}$	$P \cdot I_{N\times N}R_{N\times N}^{\frac{3}{2}}\dfrac{a}{2\sqrt{\pi}}exp\left(\dfrac{-a^2}{4}R_{N\times N}\right)\cdot \Phi_{N\times N}$
2	$\dfrac{u(s)e^{\frac{1}{v(s)}}}{v(s)\sqrt{v(s)}}$	$\dfrac{Sinh2\sqrt{t}}{\sqrt{\pi}}$	$P \cdot I_{N\times N}R_{N\times N}^{\frac{3}{2}}exp(R_{N\times N})\cdot \Phi_{N\times N}$
3	$\dfrac{u(s)e^{-2\sqrt{v(s)}}}{v(s)}$	$erfc(\dfrac{1}{\sqrt{t}})$	$P \cdot I_{N\times N}R_{N\times N}exp\left(-2R_{N\times N}^{\frac{1}{2}}\right)\cdot \Phi_{N\times N}$

4	$u(s)v(s)^{-\frac{3}{2}}$	$2\sqrt{\dfrac{t}{\pi}}$	$P \cdot I_{N\times N} R_{N\times N}^{\frac{3}{2}} \cdot \Phi_{N\times N}$
5	$\dfrac{u(s)}{v(s)^{\lambda+1}}$	$\dfrac{t^{\lambda}}{\Gamma(\lambda+1)}$	$P \cdot I_{N\times N} R_{N\times N}^{\lambda+1} \cdot \Phi_{N\times N}$
6	$\dfrac{u(s)a}{a^2 + v(s)^2}$	$sin at$	$P \cdot I_{N\times N} aR_{N\times N}^2 (I_{N\times N + a^2 R_{N\times N}^2})^{-1} \cdot \Phi_{N\times N}$
7	$\dfrac{u(s)}{v(s)-a}$	exp^{at}	$P \cdot I_{N\times N} R_{N\times N} (I_{N\times N} - aR_{N\times N})^{-1} \cdot \Phi_{N\times N}$
8	$\dfrac{u(s)v(s)}{v(s)^2 - a^2}$	$cosh at$	$P \cdot I_{N\times N} R_{N\times N} (I_{N\times N} - a^2 R_{N\times N}^2)^{-1} \cdot \Phi_{N\times N}$
9	$\dfrac{u(s)}{(v(s)-a)^n}$	$\dfrac{t^n exp^{at}}{n!}$	$P \cdot I_{N\times N} R_{N\times N}^n (I_{N\times N} - aR_{N\times N})^{-n} \cdot \Phi_{N\times N}$
10	$\dfrac{u(s)}{v(s)\sqrt{v(s)+a}}$	$\dfrac{erf\sqrt{at}}{\sqrt{a}}$	$P \cdot I_{N\times N} R_{N\times N}^{\frac{3}{2}} (I_{N\times N} + aR_{N\times N}^1)^{-\frac{1}{2}} \cdot \Phi_{N\times N}$

Table 3: The achieved absolute errors of Example 5.1 using the proposed strategy for J = 4.

t	Exact	Numerical solution	Absolute error
0.1	0.35682	0.35908	2.2528e-03
0.2	0.50463	0.49848	6.1473e-03
0.3	0.61804	0.62295	4.9119e-03
0.4	0.71365	0.71232	1.3268e-03
0.5	0.79788	0.80405	6.1618e-03
0.6	0.87404	0.87514	1.1004e-03
0.7	0.94407	0.94087	3.1959e-03
0.8	1.00930	1.01220	2.9763e-03
0.9	1.07050	1.06960	9.0942e-04

Table 4: The achieved absolute errors of Example 5.2 using the proposed strategy for J = 4.

t	Exact	Numerical solution	Absolute error
0.1	0.09899	0.09819	8.0285e-04
0.2	0.13765	0.14421	6.5564e-03
0.3	0.16576	0.16048	5.2783e-03
0.4	0.18816	0.18911	9.4914e-04
0.5	0.20679	0.21179	5.0046e-03
0.6	0.22263	0.22187	7.6521e-04
0.7	0.23632	0.23879	2.4760e-03
0.8	0.24823	0.24600	2.2360e-03
0.9	0.25867	0.25919	5.1085e-04

Table 5: The achieved absolute errors of Example 5.3 using the proposed strategy for J = 4.

t	Exact	Numerical solution	Absolute error
0.1	0.3811	0.3762	4.9178e-03
0.2	0.5747	0.6113	3.6640e-02
0.3	0.7493	0.7159	3.3403e-02
0.4	0.9198	0.9300	1.0178e-02

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0.5	1.0917	1.1462	5.4406e-02
0.6	1.2681	1.2581	1.0008e-02
0.7	1.4506	1.4867	3.6072e-02
0.8	1.6405	1.6045	3.5991e-02
0.9	1.8388	1.8518	1.3033e-02

Table 6: The achieved absolute errors of Example 5.4 using the proposed strategy for J = 5.

t	Exact	Numerical solution	Absolute error
0.1	0.0000	0.0001	7.0993e-05
0.2	0.0016	0.0019	2.9441e-04
0.3	0.0098	0.0095	3.4299e-04
0.4	0.0253	0.0236	1.7297e-03
0.5	0.0455	0.0488	3.3465e-03
0.6	0.0679	0.0700	2.1044e-03
0.7	0.0910	0.0917	6.8239e-04
0.8	0.1138	0.1131	7.3674e-04
0.9	0.1360	0.1340	2.0668e-03
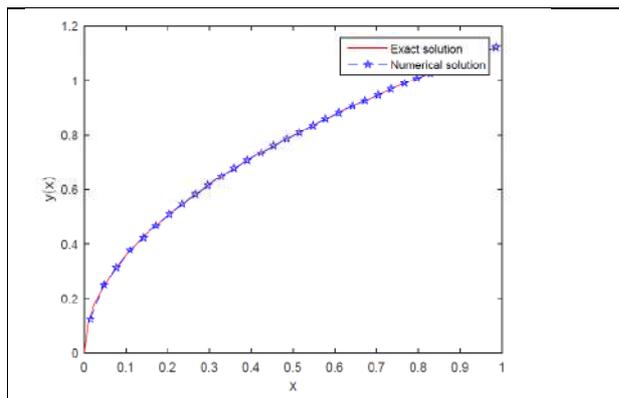
Figure 1: A Comparison of the numerical inverse generalized integral transform with the inverse generalized integral transform of Example 5.1 for J = 4.	**Figure 2: A Comparison of the numerical inverse generalized integral transform with the inverse generalized integral transform of Example 5.2 for J = 4.**
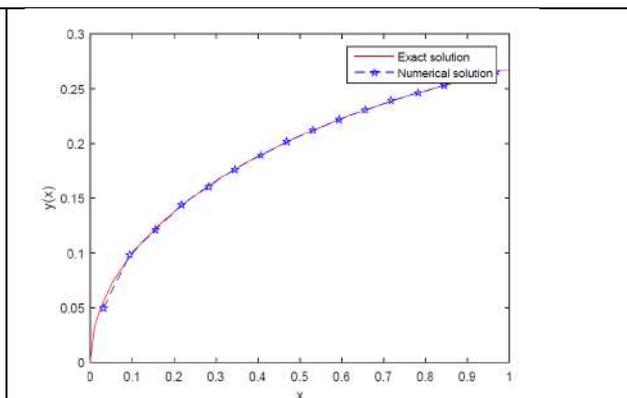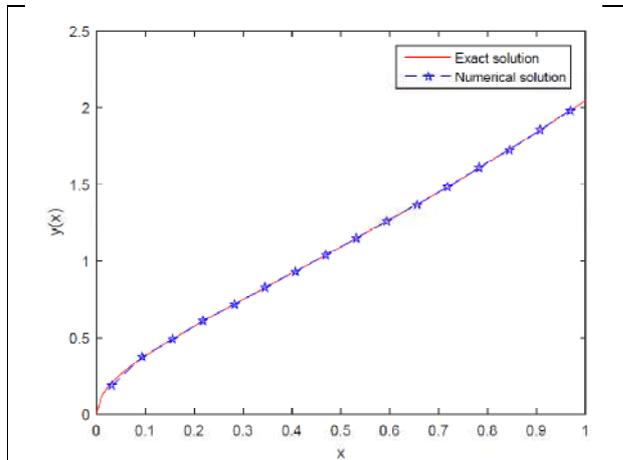
Figure 3: A Comparison of the numerical inverse generalized integral transform with the inverse generalized integral transform of Example 5.3 for = 4.
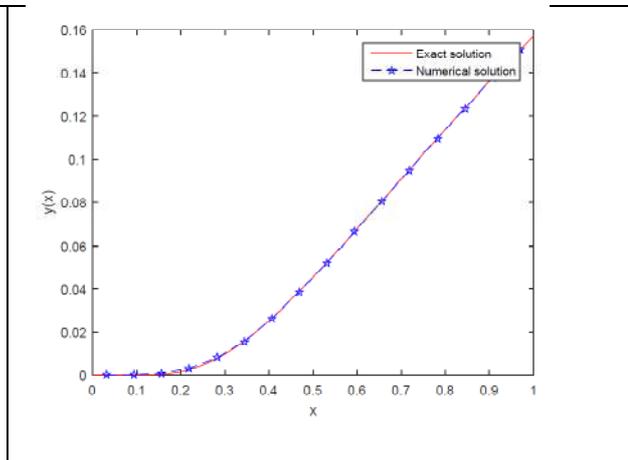
Figure 4: A Comparison of the numerical inverse generalized integral transform with the inverse generalized integral transform of Example 5.4 for J = 4.

RESEARCH ARTICLE

Development of Novel Starch based Nanocomposite Biofilms using Copper Oxide Nanoparticles - A Green Approach

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ABSTRACT

Copper Oxide nanoparticles were processed using extract of *Citrus limetta* leaves as a reducing agent, and Copper Sulphate Penta Hydrate as a precursor. Green synthesis was admissible as depressed charge, viable and green effective. For the preparation of Copper Oxide nanoparticles 0. 1mM Copper Sulphate solution were prepared. Adding 25ml leaf extract to 100ml of Copper Sulphate solution with the volume ratio 1:4.Starch-based biofilm and their nanocomposites were prepared by using solution casting method. This biofilm and their nanocomposites were analysed using mechanical, physical chemical and soil burial degradation properties. Antifungal activity of starch-based biofilm and their nanocomposites of Copper Oxide nanoparticles was evaluated against, *Candida albicans, Aspergillus niger* and *Candida tropicalis.*

Keywords: Antifungal, Biofilm, *Citrus limetta*, Copper oxide Nano composites, Starch

INTRODUCTION

Nanomaterial Research has been growing interest due to their advance properties and wide spread applications in various aspects [1].Copper and Copper Oxide nanoparticles attract much attention because of their distinguished

catalytic, electric, thermal properties, in adding to their versatile applicability in many field including agricultural, industrial, environmental and medical applications [2].Green synthesis were employed for the synthesis of Copper Oxide nanoparticles using plant parts such as leaf [3], fruit [4], bark [5], which produced with the use of less expensive & less toxic chemicals [6]. Many researchers reported plant extract having the antiviral, antibacterial, antifungal activities, which may be helpful for the synthesis of nanoparticles [7]. Biopolymer have been developed to replace the conventional non-biodegradable petroleum-based plastics, especially in the food packaging industries, due to their safety, renewability and environmentally friendly nature [8]. Biopolymer-based packaging materials have not been extensively used in the packaging trade, because of their poor mechanical properties and high construction cost. To increase these mechanical properties bio nanocomposite film was developed. Recently, the incorporation of metallic nanoparticles such as silver,TiO_2,CuO,ZnO into biofilm as reinforcing fillers has emerged due to their high thermal, and mechanical properties, large surface to volume ratio and strong antimicrobial activity [9].

The plant family Rutareae is also known as citrus fruit family which is the rich source of antioxidant, the fruits and leaves infusion has wisely been used as blood pressure modulator, decreasing cholesterol level and helping to reduce inflammation [10]. In this present work Copper Oxide nanoparticles were prepared simple green method by using *Citrus limetta* leaf extract. Raw banana powder has taken source of starch. These prepared Copper Oxide nanoparticles were incorporated with Starch-based biofilm and their mechanical, physical, chemical properties and antifungal studies evaluated. Starch based biofilm and their nanocomposites which might be used for the purpose of food packaging due to high thermal stability and mechanical properties, low water solubility and moisture content.

MATERIALS AND METHODS

Preparation of leaf extract from *Citrus limetta*
$CuSO_4$, Distilled water, Ethanol, Glycerol, Acetic acid was purchased from S A Chemicals, Tirunelveli. *Citrus Limetta* leaves were collected from Nagercoil.The leaves were collected washed with distilled water and are cut into small pieces. Take 20 g of leaf and 100 ml of deionized water in 500 ml beaker and it was kept at 70^0 C on magnetic stirrer. The extract was filtered and stored.

Preparation of green Copper Oxide nanoparticles
Preparation of Copper Oxide nanoparticles was carried out using $CuSO_4$ as a Precursor. 100 ml from 0.1mM of Copper Sulphate Penta hydrate was taken in a beaker. Add 25 ml of prepared *Citrus limetta* leaf extract drop wise into the beaker. This setup was stirred at 70^0 C on magnetic stirrer for 2 hours and let it kept at room temperature for 24 hours. The solution allowed to cool and centrifuged 7000 rpm, Nanoparticles are washed with deionized water and are allowed to dry oven at 90^0 C for 3 hours.

Preparation of Starch based biofilm and their Nano composites
Starch based nanocomposite synthesized by solution casting method. In this method, first raw banana powder (3g) dispersed in de-ionized water (30ml), which was gelatinized by stirring and heated up to 75^0 C. A clear viscous solution was obtained. To this solution, CuO nanoparticles with different % weight (0.02, 0.04, and 0.06) has been dispersed. Then the solutions were casted into the petri dish coated with petroleum jelly the system was kept aside for two days at room temperature, Nanocomposite films were obtained.

Determination of Water absorption percentage (WA %)
Each starch-based biofilm was put in 5 ml of distilled water for 24 hrs. After 24 hrs, the excess solvent on the outside of starch-based biofilm was detached by using filter paper. Then it was weighed and the solvent absorption percentage was calculated using the following equation,

Water Absorption $= \frac{(W_2 - W_1)}{W_1} \, x \, 100$

$W_1 =$ Weight of the starch-based composites, $W_2 =$ Weight of the starch-based composites after absorption of the solvent.

Evaluation of mechanical properties
Tensile strength of the prepared novel starch-based biofilm and its nanocomposites were evaluated by Universal Testing Machine at across speed of 100 mm for minute using rectangle shaped samples (10 x 3 cm) punched out from starch-based biofilm and its nanocomposites as for ASTM D6100. 3cm. The gauge length was set at 3cm in each test. The Young's modulus, tensile strength and elongation at break were evaluated using standard methods.

Soil burial degradation test
Thenovel starch-based biofilm and its nanocomposites (5 x 3 cm) were buried in the soil at a base of 25 cm from the ground surface for 60 days, inoculated with compost having the capacity to grip and degrade the starch-based nanocomposites. At fixed time, the samples were removed, washed with water in order to ensure the stop of the degradation, dried out at 30ºC weighted and stored in dark.

RESULT AND DISCUSSION

UV-Vis and FT-IR Spectroscopy
The optical properties of Copper Oxide nanoparticles were studied by absorption spectroscopy. Addition of $CuSO_4$ solution reacts with leaf extract of,*Citrus limetta* the intensity of color converted to brown black color. This colour indicates the presence of Copper Oxide nanoparticles due to surface Plasmon resonance phenomenon. Copper Oxide nanoparticles were observed around in 250 - 350 nm [11]. FT-IR gives the information about functional groups present in the Copper Oxide nanoparticles. *Citrus limetta* leaf extract contains the following functional groups shown in Figure 2. A broad band at 3450 cm^{-1} and 1030 cm^{-1} due to hydrogen bonded O-H stretching and C-O stretching of alcohols and phenols [12]. The medium peak at 2923 cm^{-1} due to O-H stretching of carboxylic acid. Amide 1 band of proteins at 1644 cm^{-1}. A band at 1561 cm^{-1} due to stretching vibrations of -C-C- in aromatic rings. Appearance of band at 846 cm^{-1} due to cl-cl stretching of halo compound. FT-IR Spectrum of copper Oxide nanoparticles indicates a peak at 601 cm^{-1} due to Cu-O bond [13].

X-Ray Diffraction and SEM Analysis
The peaks were recorded from 200-800 at 2 theta scale and the prominent peaks are observed at 32.19^0, 34.92^0, 38.09^0, 48.22^0, 52.87^0, 57.62^0, 60.83^0, 65.39^0, 67.50^0corresponds to the crystal lattice plane of (110), (002), (111), (202), (020),(202), (113), (311), (113), which was in CuO crystals and possess monoclinic structure (JCPDS Card no:801268) of Copper Oxide nanoparticles [14]. SEM analysis were employed to visualize the size and shape of the nanoparticles. SEM micrographs of Copper Oxide nanoparticles are given in Figure.3 with different approbation. It was observed that the particles are spherical in shape with a uniform size about 20-50 nm. The particle size attained from SEM images is well correlated with the particle size resolute from XRD using confer to the Scherrer formula and the average of the synthesized nanoparticles was in the range of 35.38 nm.

EDAX and TEM Analysis
Elemental composition of copper nanoparticles synthesized using *Citrus limetta* extract was determined by using EDAX analysis. It was observed that the percentage of copper is 81.01% and Oxygen is 18.99%. TEM analysis was employed to measure nanoparticle size and distribution which is shown in figure.4 with different approbation. It was observed that the particles are spherical in shape with a uniform size about 40 nm.

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Physical and chemical properties of starch-based nanocomposites
The result of the water solubility (ws), water vapor permeability (wvp), water absorption (wa) and moisture content of the newly prepared starch-based biofilm and their nano composites are shown in Table.1. The water solubility, moisture content, and water absorption of different concentration (0.02 Cu, 0.04 Cu, and 0.06 Cu) of starch-based nanocomposite decreased significantly compared to the neat starch-based biofilm. These decreasing properties probably due to the addition of CuO nanoparticles having hydrophobic character, which reduced the hydrophilicity of starch-based biofilm. Comparing different concentration of biofilm 0.02 Cu have highest ws,wvp,wa than 0.06 Cu.When increasing concentration of nanoparticles incorporated with biofilm the hydrophilicity character reduces. The water vapor permeability of the starch-based film decreased when CuO nanoparticles incorporated with starch-based biofilm. The decrease in the wvp of composite films was attributed to the distribution of CuO nanoparticles as a discontinuous phase in the film matrix, which prevented the diffusion of water vapor resulting in an increase in the tortuous path [15].

Mechanical properties of starch-based nanocomposites
The mechanical properties such as young's modulus, tensile strength, elongation at break of newly prepared starch-based biofilm and their nanocomposites are given in Table 2. It is observed that the concentration of starch-based Iron nanocomposites possesses greater mechanical properties than starch biofilm due to small size and large surface to volume ratio of nanoparticles. It is also detected that the concentration of 0.04 Cu starch-based nanocomposites possesses greater mechanical properties than 0.02 Cu and 0.06 Cu starch-based nanocomposites. In starch-based biofilm, the concentration of Iron Oxide nanoparticles increases from 0.02 to 0.04 which improve the tensile strength and young's modulus significantly, above 0.06 the mechanical property gradually decreases. It concluded that the 0.04 Cu starch-based composites possesses high tensile strength and young's modulus than other nanocomposites.

Soil burial testand Antifungal of starch-based nanocomposites
Soil burial test was used to found the environmental resistance of the starch-based biofilm and their nanocomposites. Surface morphology was analysed using SEM analysis shown in Figure (5,6,7). The weight loss percentage of newly prepared starch-based biofilm and their nanocomposites in soil burial test is depicted in Table 3. As the percentage of Copper Oxide nanoparticles increases from 0.02 to 0.06 the degradation rate slightly decreases. It concluded that the starch-based biofilm and their nanocomposites possesses lower degradation than neatstarch-based biofilm. The plain starch biofilm has higher degradation rate due to the hydrophilicity in nature. Antifungal activity was analysed for starch-based biofilm and their nanocomposites against fungal strains *Candida albicans*, *Aspergillus Niger* and *Candida Tropicalis* by surface inoculation method [16]. Starch based biofilm and their nanocomposites showed moderate zone of inhibition for all fungal strains shown in Figure 8. The maximum zone of inhibition showed for 0.06 Cu nanocomposites.

CONCLUSION

The green synthesis of Copper Oxide nanoparticles has been achieved using the bio reducing agent *Citrus limetta* leaf extract. The concentration of copper Oxide nanoparticles played an important role in maintaining film properties such as mechanical, water solubility, water vapor permeability and antimicrobial properties. Starch based biofilm and their nanocomposite possesses greater mechanical properties and lower water solubility, moisture content, and water absorption. The results suggested that the starch-based composite films can be used as an active food packaging or edible coating materials.

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Table.1: Physico chemical properties of starch-based biofilm and their nanocomposites

Starch based nanocomposites	Absorption of water	Solubility in water	Moisture content	Water Vapor permeability
starch	37.5	29.37	19.68	3.56
0.02 Cu	34.57	22.50	19.23	3.25
0.04 Cu	29.16	19.76	18.63	3.08
0.06 Cu	22.53	16.86	18.51	2.85

Table.2: Mechanical properties of starch and their nanocomposites

Polyesters and their composites	Tensile strength (MPa)	Elongation at break (%)	Young's modulus (MPa)
starch	14.2	95.70	11.8
0.02 Cu	15.6	72.10	12.6
0.04 Cu	16.8	68.72	13.5
0.06 Cu	16.1	71.27	12.8

Table.3:Weight loss % of starch-based nanocomposites under soil burial test

Starch based nanocomposites	Weight loss%
starch	89.38
0.02 Cu	80.23
0.04 Cu	62.57
0.06 Cu	42.72
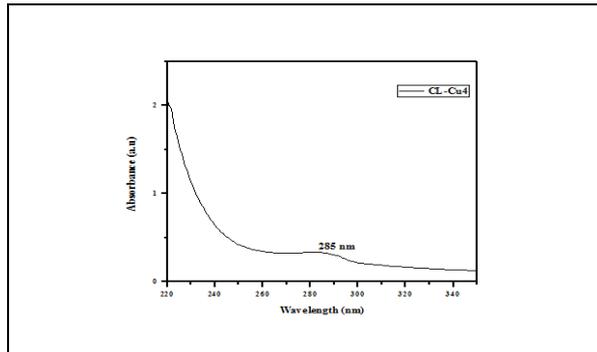
Figure.1: UV-Visible spectrum of Copper Oxide Nanoparticles
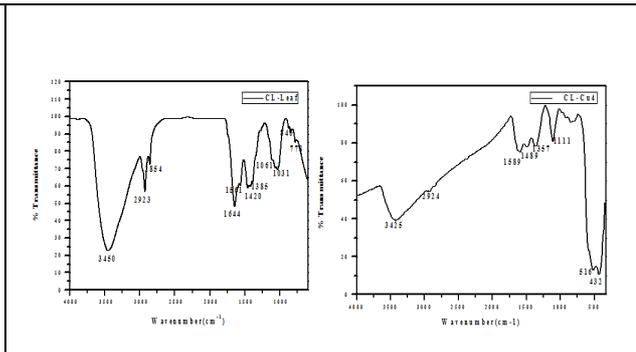
Figure.2: FT-IR spectra of CL Leaf extract and Copper Oxide nanoparticles by using CL Leaf extract
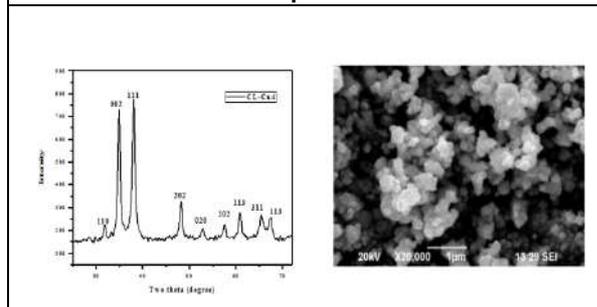
Figure.3: XRD and SEM Analysis of Copper Oxide nanoparticles
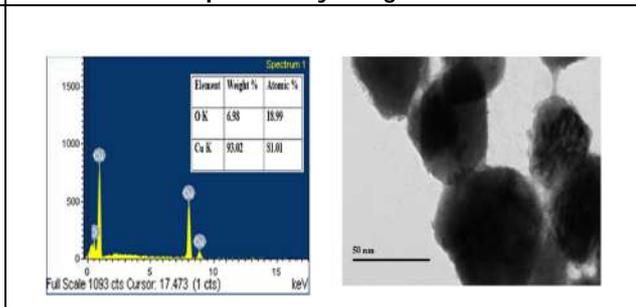
Figure.4: EDX and TEM spectra of Copper Oxide nanoparticles
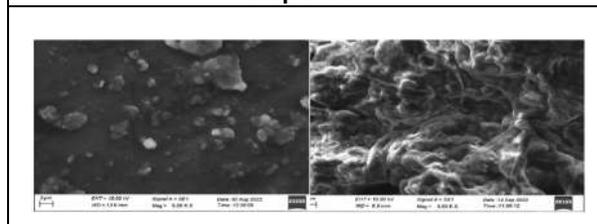
Figure.5: Before and after soil burial 0.02 g concentration of Copper Oxide nanocomposites
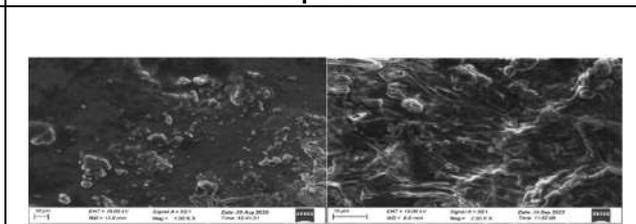
Figure.6: Before and after soil burial 0.04 g concentration of Copper Oxide nanocomposites

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Figure.7: Before and after soil burial 0.06 g concentration of Copper Oxide nanocomposites	**Figure.8: Antifungal activity of Copper Oxide nanocomposites with different concentration**

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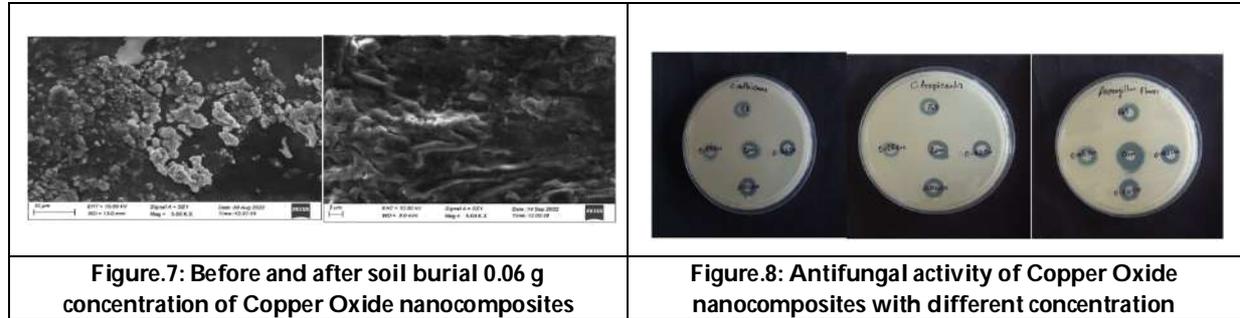
Role of National Green Tribunal in Sustaining River Ecosystem

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ABSTRACT

The world has begun to realise that environmental justice is key to the survival of the global ecosystem. The last 20 years have seen a sharp increase in environmental courts. In order to expeditiously handle environmental matters involving forest conservation and the enforcement of legal rights pertaining to environmental safeguarding, India established a National Green Tribunal in 2010. During its lifespan, the NGT played a pivotal role in upholding environmental justice in India. This research is a descriptive study with document analysis methods, especially the verdicts and directions given by the NGT from time to time. The study's focus is on the role of NGT in river conservation. The significant River Concern cases adjudicated by the National Green Tribunal and several instructions given to government officials were analyzed. The real task attributed to the NGT is environmental conservation, with an emphasis on sustainable development.

Keywords: Environment, Rivers, Tribunal, Verdicts, Concerns etc

INTRODUCTION

The vertical expansion of environmental courts supports the development of environmental justice. "Greening Justice: Creating and Improving Environmental Courts and Tribunals" (2009) by Pring and Catherine provides comprehensive and comparative analyses of the effectiveness of environmental courts and tribunals around the world1. Justice Antonio Benjamin of Brazil's High Court investigated whether or not the genuine essence of rule of law can coexist with independent judiciary and environmental protection. In 1970, the number of environmental

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courts was very low. In 2009, when the first study was done on environmental courts and tribunals, the number increased to 350 in 44 countries, especially in Europe. Today, mere environmental courts have increased to 2,115 in around 167 countries. India is a highly populated developing country. The tremendous development of science, technology, and lifestyle of people caused high environmental degradation, toxic pollution, and climate change. The Supreme court of India and other judicial institutions are incapable of giving the proper directions for ecological sustainability. Hence the specialized Environmental green tribunal has been introduced in an accessible place. Rivers are the principal victims of Environmental pollution. NGT controls the number of cases involving river contamination. Suo motto actions, cases brought by the Pollution Control Board, cases brought by the dyeing industries, and cases brought by the general public are the three groups into which the cases fall. This study examined the national green tribunal's authority in preserving sustainable rivers, as well as the key river-related disputes it has decided upon and the guidance it has provided to government officials throughout its existence. By analyzing the pronouncement of the specialized environmental courts we can identify constructive solutions for the issues of environmental degradation. This research will assist policy-makers in enhancing the environmental justice system to safeguard Indian rivers and promote sustainable development.

Research Objectives
1. To demonstrate the power of the National Green Tribunal in River Conservation.
2. To Analyze the Significant Cases Adjudicated by National Green Tribunal.
3. To bring out the Directions Given by NGT for sustaining Indian Rivers.

METHODOLOGY

Ex Post facto and analytical methods are used for this investigation. A historical descriptive approach is used for this study. For the qualitative analysis of this study secondary data like Books on Environmental justice, newspaper articles, journal articles, and Judgment of the Tribunal have been included. Hence the research is fully based on the quantitative method.

RESULT AND DISCUSSION

Powers and functions National Green Tribunal
The tribunal possesses a number of authorities, one of which is the capacity to independently control the process without being required to comply to the rules outlined in the civil procedure code. Instead, it is consistent with the idea of natural justice. The National Green Tribunal should implement the idea of sustainable development when issuing directives. Additionally, it is to put into practice the law that imposes financial penalties on polluters. Even the Indian Evidence Act's rules of evidence will not have any bearing on the NGT. All procedures that take place in front of the Tribunal will be considered to be judicial proceedings for the purposes of Section 196 of the Indian Penal Code, according to the definitions provided in Sections 193, 219, and 228. In accordance with Section 195 and Chapter XXVI of the Code of Criminal Procedure of 1973, the tribunal is granted the authority to perform the duties of a civil court. As a result of its extensive experience in mediating environmental disputes, it also deals with cross-disciplinary concerns. Its jurisdiction offers quick trials in environmental-related cases and lessens the workload for higher courts. The tribunal resolves environmental complaints within six months of the complaint being filed. The NGT must abide by all rules outlined in the Civil Procedure Code, but it is free to control the process on its own and apply the natural justice concept. Its purpose is to apply the "polluter pay" principle as well as sustainable development principles when awarding compensation or issuing instructions.

The Advent of the National Green Tribunal in India
The proliferation of environmental courts and tribunals around the world is transforming the practice of environmental justice. Justice Harlan says that interstate pollution issues are so complicated that the Supreme Court may not be able to decide them2.Environmental specialty courts are absolutely necessary if the natural environment

is to remain intact. The threat posed by climate change, the development of new environmental laws and principles on both the international and national levels, recognition of the connection between the protection of human rights and the environment, and public dissatisfaction with the general judicial forums are the primary factors that have led to the establishment of ecological courts. There are a variety of factors that contributed to the need for environmental courts to be established in India during a variety of eras. The Indian Supreme Court said in the cases M.C. Mehta v. Union of India (AIR 1987 SC 965), Indian Council for Enviro-Legal Action v. Union of India (1996 3 SCC 212), and A.P. Pollution Control Board v. Professor M.V. Nayudu (1992 2 SCC 718) that setting up regional environmental courts with a judge who knows the law and two experts would help speed up The 186th Report of the Law Commission from 2003 called for environmental courts to be set up in India

The premise of this recommendation was that judges lack sufficient knowledge of environmental issues' scientific and technical aspects. They also looked at the technical and scientific issues that the courts had to deal with. On July 31, 2009, the National Green Tribunal Bill of 2009 was discussed in the Lok Sabha. After a conversation between the Chairman of the Rajya Sabha and the Speaker of the Lok Sabha, the Bill was sent to the Parliamentary Standing Committee. Members of the Ministry of Environment and the Ministry of Forests attended the 24th meeting of the Science and Technology, Environment, and Forests Committee for investigations and reports.

The committee praised the Ministry for taking the initiative and made the following comments and suggestions about the Bill: The committee found that Clause 1(2) of the Bill said, "The National Green Tribunal Act shall come into force on such date or dates as the Central Government may, by notification, designate, and different dates may be set for different States." The committee was informed that the National Environment Tribunal Act, which was enacted in 1995, was the source of such a clause when they inquired about the reason for its existence. The Bill defines "an instance where a direct breach of a statutory environmental requirement by a person caused harm to the community as a whole rather than to an individual or group of individuals" as a "substantial question relating to the environment."You can find this definition in clause 2(1)(m).The committee was of the opinion that the circumstances in which the term "serious environmental question" may be used may still be somewhat unclear. It is possible that this will be clarified by the planned tribunal, but it is also possible that the ambiguity will persist over time as higher courts attempt to determine its meaning.

The committee also looked at the tribunal's composition, which included judicial and expert members. The Ministry first claimed that it had not determined the precise number of total judicial and expert members since it was unsure of the volume and form of litigation that the National Green Tribunal would handle over time. However, the Ministry then reconsidered this matter and proposed the following revision to the Bill: "The Tribunal must comprise at least 5 and not more than 10 judicial members. The number of expert members must be between 10 to 20 ". These recommendations are given by the National Green Tribunal

Directions given to government Authorities
The Hon'ble NGT went through the following items at the hearing in the case of OA No. 593 of 2017, which was held on September 21, 2020

1. OA No. 673 of 2018 (In Re: News item published in "The Hindu" authored by Shri Jacob Koshy);
2. OA No. 829 of 2019 (Lt. Col. Sarvadaman Singh Oberoi v/s Union of India & Ors.);
3. OA No. 148 of 2016 (Mahesh Chandra Saxena v/s South Delhi Municipal Corporation & Ors.)

On September 21, 2020, the Honourable NGT issued the following orders
If they take the necessary steps to ensure the establishment of the required number of operational Effluent Treatment Plants (ETP), Common Effluent Treatment Plants (CETP), and Sewage Treatment Plants (STP), as directed, it is possible for all States and Union Territories to address deficiencies in the generation and treatment of sewage and effluents.

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River Rejuvenation Committees should monitor the execution of action plans as prescribed in OA 673/2018. The aforementioned committees may also be referred to as "River Rejuvenation Committees" in coastal areas. The action plans must include a budgetary assistance clause in accordance with the Supreme Court's guidelines. No untreated sewage or effluent should be let into any water body, it must be ensured. The State Pollution Control Boards may take prompt corrective action against non-compliant ETPs/CETPs by stopping or restricting the effluents generating activity, recovering damages, and adopting other coercive actions after following the proper legal procedures. The directions given by the NGT may be implemented by the States/UTs, and the Central Monitoring Committee (CMC), at the national level, will oversee their compliance. The concerned coastal States and UTs may execute the directives specified in this document, and the CMC at the national level will oversee their compliance. OA No. 829/2019 is no longer in effect, and OA 593/2017 and OA 673/2018 will now be used for future monitoring of the issue.

The States/UTs may carry out the instructions provided that the Chief Secretaries at the States should monitor the river Repudiation Policies for every quarter. The OA No. 148/2016 has been disposed of, and OA Nos. 593 and 673 will now be used for further monitoring of the issue. The Central Monitoring Committee may think about creating a suitable app to make it simple to file and resolve complaints about the illegal discharge of sewage and effluents. The CMC may monitor for the purpose of reducing pollution loads and enhancing river and coastal area water quality.

The decrease of pollution loads and enhancement of river and coastal area water quality may be the goals of the CMC's monitoring. The CMC should keep a watch on the creation of biodiversity parks, artificial wetlands, and other pollution load reduction strategies. The CMC should monitor the boundaries of flood plains. By creating the necessary action plans and submitting regular reports to the Central Pollution Control Board, the treated sewage water may be properly used for secondary purposes. CMC may provide its comprehensive update report, which includes everything mentioned above, before the subsequent date. These are the important directions given by the National Green Tribunal to make the Bureaucracy maintain the river's sustainability.

Important Verdicts
M C Mehta vs Union of India on 6 August 2018
The issue of river Ganga environmental pollution was decided by the Supreme Court of India and later assigned to the National Green Tribunal of India. In the past thirty years, the Honourable Supreme Court of India has issued at least six orders. Those orders were unable to effectively control government officials or monitor pollution mitigation. The national green tribunal was later given the task of deciding this case by the Indian Supreme Court.

The Tribunal stated that despite the Central Government's Ganga Action Plans I and II and the subsequent establishment of the NMCG, Ganga pollution continues unabated. In its verdict, the tribunal states that neither a gradual improvement in the prevention of the discharge of sewage and other effluents nor a decrease in the load of pollutants is evident. There are a number of planned but unfinished projects aimed at reducing pollution. The success of public awareness campaigns has not been sufficiently demonstrated. The Honourable Tribunal listed the shortcomings of the government's environmental protection apparatus for the Ganga River. Additionally, offer some guidelines for resolving oversights in river pollution control efforts.

The Environment (Protection) Act of 1986, citing List 1, Entry 14 of Schedule 7 of the Constitution and Article 253 to carry out International Obligations, accomplishes the goal of the Central Government. Any decision regarding the issue can be made by the Central Government, which has ample legislative and administrative authority. The Indian Constitution's Articles 48A, 51, and 51A, in conjunction with the 11th and 12th Schedules, as well as the Constitutions' Articles 243G and 243W, impose equal obligations on the states. In addition, public authorities are obligated by the "Public Trust Doctrine" and the fact that a clean environment is part of the Right to Life under Article 21 of the Constitution. To ensure compliance, a copy of the verdict has been sent to CPCB, NMCG, and MoJS via email. Additionally, the Executive Chairmen of the Legal Services Authorities of Uttarakhand, Uttar Pradesh, Jharkhand, Bihar, and West Bengal will receive a copy of this decision via email. The Hon'ble Supreme Court has been provided with a copy of this judgment.

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Suo moto case no 673/2018 of National Green Tribunal

The National Green Tribunal is proceeding with this matter on its own initiative. More River Stretches Now Critically Polluted" was the headline of a news article that was just published in the Hindu newspaper. In this particular instance, the National Green Tribunal asked the Central Pollution Control Board (CPCB) to take various activities to control the pollution in Indian Rivers. Additionally, the National Green Tribunal ordered the CPCB to randomly review the progress of action plans. The CPCB has requested the action plan reports from each and every state and territory that makes up the union. When determining the level of pollution in rivers, each state and territory that is part of the Union is responsible for ensuring that the scientific standard is maintained. In order to facilitate the development of the Action Plan Tribunal, the deadline has been extended until January 31, 2019. However, there will be a penalty proposed by NGT in the event that neither the state nor the union territories report. The National Green Tribunal reserves the right to push back the submission deadline to April 1, 2019, in the event that fifty percent of the states do not meet the aforementioned deadline for submitting their action plans.

Despite the fact that the central pollution control board failed a consolidate status report with dates of July 24, 2019 and November 18, 2019 regarding compliance with honorable national green tribunal directions from April 8, 2019, it is possible that the central monitoring committee will provide the board with its report by the 31st of July in 2019.The matter was brought before the National Green Tribunal on December 6, 2019, where it was heard, and the National Green Tribunal made a decision about what the Central Pollution Control Board should do.

Through this judgment, the Honorable Tribunal activated the purpose of the Pollution Control Board and created the essential framework for the environmental preservation of rivers. As a result of this verdict, the Central Pollution Control Board is particularly sensitive to river pollution.

Jawaharlal Shanmugam V/S Tamil Nadu Pollution Control Board

The Tamil Nadu government has come under criticism from the National Green Tribunal's Principal Bench and may potentially face a fine of $100 crore in restitution for repeatedly failing to stop the pollution of the Adyar and Cooum rivers and the Buckingham Canal. The Chief Secretary has been called before the tribunal to brief it on the status of a river cleanup. In a ruling on a request made by Jawaharlal Shanmugam, the bench consisting of the chairman, Adarsh Kumar Goel, the Justice K. Ramakrishnan, and the expert member, Nagin Nanda, stated that "there is river pollution and the State of Tamil Nadu has repeatedly failed in its duty." Corrective action is necessary.

The Bench continued by noting that, given the history of recurrent failures, it was not wise to accept at face value the current position of the Tamil Nadu government that it would undertake the eco-restoration plan within eight years and that its main activities would be finished in three years. However, the bench directed the establishment of a joint committee consisting of representatives from the Madras School of Economics, the Indian Institute of Science in Bangalore, the CPCB, the Tamil Nadu Pollution Control Board, the National Environmental Engineering Research Institute, and the Madras School of Economics. This was done prior to the bench making a decision. The committee will look at why and how much damage has been done to the environment, as well as any additional steps that need to be taken to restore the environment but aren't covered in the action plan. Within three months, the committee will publish its findings and recommendations. In a ruling on a request made by Jawaharlal Shanmugam, the bench consisting of the chairman, Adarsh Kumar Goel, the judge Justice K. Ramakrishnan, and the expert member, Nagin Nanda, stated that "there is river pollution and the State of Tamil Nadu has repeatedly failed in its duty." Corrective action is necessary. Instruct the appropriate authorities to maintain the Coovum in place. Order the respective authorities to take all necessary steps to ensure that to control the river pollution. The upstream channel of the Coovum River has been rebuilt, and the flow has increased, so freshwater should be conserved. Instructed the appropriate authorities to halt stand mining in Kosasthalaiyaru, Thiruvallur district's Coovum Tank, and the adjacent region along the Coovum River's route in order to protect the river's integrity. The issue a continuous mandamus order,

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Form a high-level panel to manage the Coovum and Adayar rivers
These are the directions given by the national green tribunal to maintain the sustainability of Cooum River. It reflects the power of the national green tribunal in the maintenance of river sustainability.

Suo moto power of the national green tribunal
Examining suo-
Motu actions reveals that the courts are straying from the tight constitutional limit of law interpretation. Many peopl e criticized a significant number of suo motu actions for making administrative tasks more difficult and unpredictab le. The National Green Tribunal Act of 2010 does not mention the Suo moto power of the national green tribunal. However, in several petitions filed against the national green tribunal's suo moto power, the tribunal acts on this power. On October 7, 2021, Justice Hrishikesh Roy delivered the ruling, which stated that the NGT could use its suo motu powers to carry out the responsibilities outlined in the NGT Act, 2010.As a result, the number of suo moto cases decided by the NGT for river-related reasons plays a significant role in ensuring the government's efficient operation. The NGT's Suo moto power ensures the tribunal's independence in environmental protection.

Political Concern
Most of the industrial pollutants in the river basins are big elites and local politicians. So that's the reason the government authorities hesitate to take action against industrial pollutants. This is the reason pertaining to the lethargic activities of government officials. The National Green Tribunal changed this situation. Government machinery and their functions are seriously monitored. After the emergence of NGT, pollution control institutions are actively working towards the strengthening of environmental sustainability. After the emergence of the national green tribunal the government authorities took very serious action against the pollution like the imposition of penalties and the Electricity connection cut which resulted in the proper maintenance of the sewage effluent plants by Industries to prevent toxicity of river water. So the political interference in environmental conservation of the rivers has been mitigated. But still the government authorities don't want to give their effective participation in environmental protection.

CONCLUSION

With the effective utilization of NGT, environmental justice has advanced more rapidly in India. Although this shows that people's trust in the NGT is growing, it resolves the cases within six months. The NGT has issued several directives for the benefit of environment protection and justice for those harmed by environmental damages as a result of the consequences of sensitive environmental issues that arise from both natural and man-made sources. Procedurally, the National Green Tribunal strongly advocates for inclusivity in environmental decision-making. The river water concern cases occupy a crucial place in the adjudications of the national green tribunal. This is clear from the reworking of public hearings inside the project implementation. The judiciary's recognition that this is a type of participatory justice is a significant step forward. The Verdicts discussed in this paper are to cope with river pollution. The various directions given by the national green tribunal strengthens the river conservation policies at ground level.

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Table 1. State-wise Status of Action Plans (P–I to P-IV) Approved by CPCB

Name of the State / UT	Total No. of Identified Polluted River Stretches (PRS)	Priority I & II PRS		Priority III & IV PRS		Priority-V PRS*	Total Action Plans (P-I to P-IV PRS) Approved by CPCB Task Team along with conditions
		Priority-I PRS approved	Priority-II PRS approved	Priority-III & IV PRS received	Priority-III & IV PRS approved		
Andhra Pradesh	5	-	-	2	2	3	2
Assam	44	3	1	7	7	33	11
Bihar	6	-	-	1	1	5	1
Chhattisgarh	5	-	-	4	-	1	-
DD & DNH	1	1	-	-	-	-	1
Delhi	1	1	-	-	-	-	1
Goa	11	-	-	3	3	8	3
Gujarat	20	5	1	8	8	6	14
Haryana	2	2	-	-	-	-	2
Himachal Pradesh	7	1	1	1	1	4	3
J & K	9	-	1	4	4	4	5
Jharkhand	7	-	-	3	-	4	-
Karnataka	17	-	-	11	11	6	11
Kerala	21	1	-	5	5	15	6
Madhya Pradesh	22	3	1	4	4	14	8
Maharashtra	53	9	6	24	24	14	39
Manipur	9	-	1	-	-	8	1
Meghalaya	7	2	-	3	3	2	5
Mizoram	9	-	-	4	4	5	4
Nagaland	6	1	-	3	-	2	1
Odisha	19	1	-	5	5	13	6
Puducherry	2	-	-	1	1	1	1
Punjab	4	2	-	1	-	1	2
Rajasthan	2	-	-	1	-	1	-
Sikkim	4	-	-	-	-	4	-
Tamil Nadu	6	4	-	1	1	1	5
Telangana	8	1	2	4	4	1	7
Tripura	6	-	-	-	-	6	-
Uttar Pradesh	12	4	-	3	3	5	7
Uttarakhand	9	3	1	5	-	-	4
West Bengal	17	1	1	7	-	8	2
Grand Total	351	45	16	115	91	175	152

Note:- * Approval of CPCB Task Team is not required in case of P-V category PRS. These action plans to be approved by the RRC Constituted by the State Governments or UT Administrations

Source: Central Pollution Control Board

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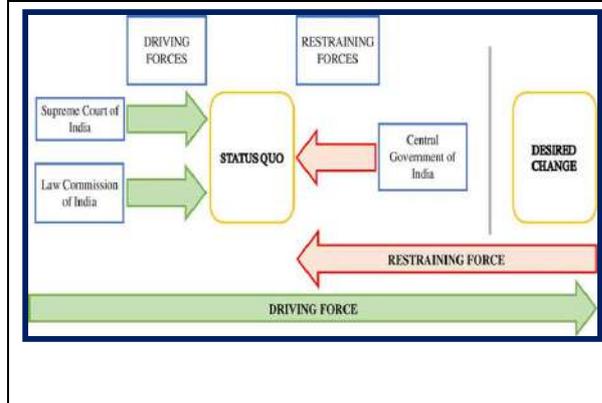
Fig. 1. Powers and functions National Green Tribunal	**Fig. 2. The Advent of the National Green Tribunal in India**
Fig. 3. Types of Cases	**Fig. 4. Pendency Troubies**
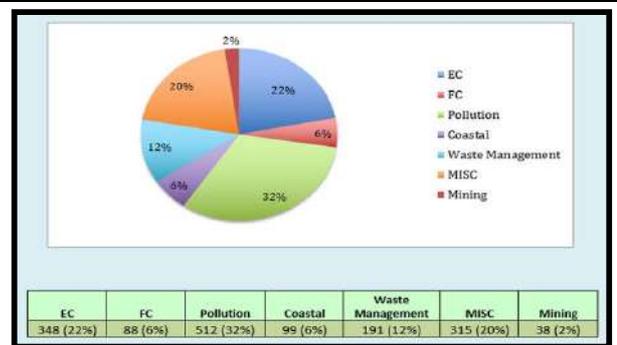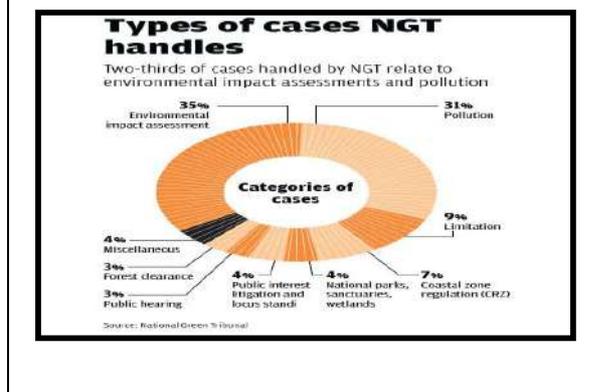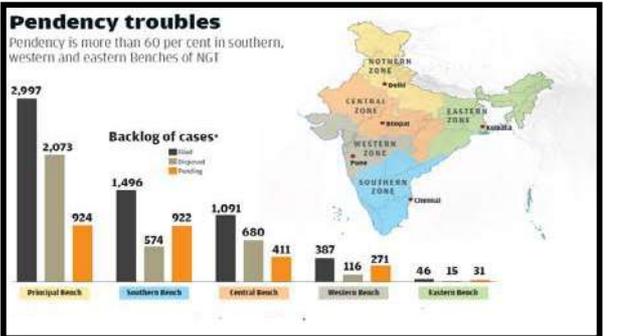
RESEARCH ARTICLE

Pharmacognostical Characterisation and Phytochemical Profiling of the Medicinal Plant, *Ehretia ovaliafolia* Wight

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ABSTRACT

Pharmacognostical characterisation and phytochemical profiling is more important for a plant before the plant was utilized in the drug industry. The plant, Ehretia ovalifolia, belongs to family Boraginaceae is an important medicinal plant. The present investigation was carried out to evaluate the pharmcognostical, phytochemical studies to explore the characters of this plant. The organoleptic characters of stem and leaf expressed with some characteristic bitter taste, odour, with brown and deep green in colour forms. Morphologically the plant with 23cm of Girth, 6.5 cm leaf area with 5-8 pairs of veins. The reaction of stem powders with various chemicals were made and some of the powders were well reacted and it was observed under various light sources. Some the powders appeared to be black under UV light of 256nm from Dark green. Similarly the green coloured leaf powder was also appeared to be black in colour. The qualitative phytochemical study showed presence of important phytochemical component like alkaloids, saponins, terpernoids, coumarins, flavonoids, tannins and phenols. The chloroform extract also expressed the presence of important phytochemicals like phenols and flavonoids with other phytochemicals. The leaf study showed the presence of all studied phytochemicals except glycosides and whereas the steroids and terpenoids were absent. The GCMS analysis of methanol extract was detected with some 6 important compounds i.e Ethyl. alpha. -d-glucopyranoside n-Hexadecanoic acid and 3,4-Secodammar-4(28)-en-3-oic-acid,20,24-epoxy-25-hydroxy-, (24s)-. The total ash value of stem is 8% and water soluble as of 6.67% and 0.7% of acid soluble ash. The ash value of leaf is 17.6% with 17% of water

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soluble ash and only 8.7% of acid soluble ash. The study completely explain the characteristic features of the study plant *E.ovalifolia* which may useful for pharma companies during drug manufacture.

Keywords: organoleptic study, phytochemicals, GC –MS, alkaloids, flavonoids.

INTRODUCTION

India is known as botanical garden of the world. The plants that are founded with medicinal properties are used in the indigenous treatment practices such as ayurveda, unani, siddha and also in modern medicines. According to WHO 80% people prefer tradition medicines for their health care. Pharmacognosy is the study of the physical, chemical, biochemical and biological properties of drugs, drug substances of natural origin as well as the search for new drugs from natural sources. Modern Pharmacognosy involves the broad study on natural products from various product including plants, Bacteria, Fungi, and marine organisms. The phytochemicals are naturally available bioactive compounds derived from plants with potential disease curing capabilities. The secondary constituents consisting of alkaloids, flavonoids, tannins, terpenoids, steroids, saponins, and other phenolic compounds etc. the various phytochemicals are present in medicinal plants are alkaloids, tannins, saponins, steroid, terpenoids, flavonoids, glycoside. Medicinal plants are involved in the discovering and screening of the new phytochemical constituents which are very helpful for the manufacturing of new drugs. The modern chromatographical techniques such as GC-MS were used widely for profiling of phytochemicals Kirshnananda (2017).

These constituents have beneficial aspect in therapeutic value of human. Plants are being used as medicine since ancient periods because drugs obtained from plants are easily available, safe, and when its intake it possesses less side effects. The bioactive materials obtained from extraction and their quantitative and qualitative analysis is considered as pharmaceutical activity. The genus *Ehretia* with a 150 species belongs to family Boraginaceae. Many species of this family distributed in tropical Asia, Europe and North America.The parts of leaves, barks, roots, branches, heartwood are used in traditional medicine in Japan, Indiaand China (Rajasekar and Saravana Ganthi (2019).These genus are may present the capability of curing capacities for anti- inflammatory, antibiotic and antibacterial activity. The present study was carried out on most widely distributed lesser known medicinal plant *Ehretia ovalifolia* for its pharmacognostical and phytochemical nature to understand and authenticate the species for drug making in Ayurveda, siddha and other indigenous way of treatment.

MATERIALS AND METHODS

The study material *Ehretia ovalifolia* was collected and characterized as is a small perennial tree growing to 12m with branches, leaves oblong or elliptic apex are obtuse, nerves are 6-8 pairs, pubescent in the nerve axis petioles are present. Inflorescence corymbs terminal and axillary flowers are white slightly pubescent pedicles. Tubular calyx corolla rotate filaments four, ovary four celled style two fused.

Collection of plant material
The leaves and stem of *Ehretia ovalifolia* were collected from the NGM campus, Pollachi Taluk, Coimbatore district, Tamil Nadu. The healthy parts were collected, shade dried and pulverized to powder, further the powder was stored in air tight container till further works to be carried out.

Preparation of Crude
Solvents *viz.*, chloroform and methanol were used to take the extract from leaves and stem powders according to Harborne (1998) method. The samples were sequentially extracted using a soxhlet apparatus and was subjected to

further studies as mentioned by (Kokate,1994). The extract was allowed to evaporate the excess solvent at room temperature and the crude consistent was obtained.

Organoleptic Studies: (**Aji** *et al.,* **2014)**
Microscopic and macroscopic observations of the study plant were carried out like plant shape, size, surface and physical characters like texture, colour, odour, taste etc was noted.

Preliminary analysis of phytochemicals
The crude was dissolved in respective solvents for working consistency and screened for the presence of some important phytochemical such as alkaloids, tannins, flavonoids, saponins, glycosides, steroids, phenol, terpenoid, coumarins and glycosides.

Test for Alkaloids: (Mayer's test) (Aji *et al.,* **2014)**
To a few drops of the plant extract, two drops of the Mayer's reagent is added along the sides of the test tube. The appearance of white creamy precipitate indicates the presence of the alkaloids.

Test for Phenols: (Shreya *et al.,* **2013)**
Ferric chloride test: The 50 mg of the extract in 5 ml distilled water. To this few drops of neutral 5% ferric chloride solution are added. A dark green colour indicates the phenolic compound.

Test for Flavonoids: (Shreya *et al.,* **2013)**
An aqueous solution of the extract is treated with few drops of H_2SO_4. Formation of orange colour indicates that the presence of flavonoids.

Test for Saponins: **(Kokate, 1999).**
The extract is dissolved with distilled water and make up to 20 ml. The suspension is shaken in a graduated cylinder for 15 minutes. A two cm layer of foam indicates the presence of the saponins (Kokate, 1999).

Test for Steroids: (Shreya *et al.,* **2013**)
The extract is treated with 2ml of chloroform and few drops of Con.H_2SO_4. Formation of reddish-brown ring indicate the presence of steroids

Test for Coumarin:(**Yadav** *et al.,***2014)**
To 2ml of extract was taken 3ml of 10% sodium hydroxide was added. Appearance of yellow coloration indicates the presence of coumarins.

Test for Glycosides: (Keller-Killiani test) (Sherya *et al.,***2013)**
To total of 1 ml of glacial acetic acid, few drops of ferric chloride solution and concentric H_2SO_4 (slowly through the sides of the test tube) were added to the extract. Appearance of reddish-brown ring at the junction of the liquids indicated the presence of deoxysugar.

Test for Terpenoids: (Yadav *et al.,* **2014).**
To 2ml of extract 2ml of acetic acid was added. Then concentrated sulphuric acid was added. Deep red colour development showed the presence of terpenoids

Test for Tannin: (Braymer's test) (**Edeoga** *et al.,* **2005and Harborne** *et al.,* **1973).**
To 1ml of extract was mixed with 2ml of water. To these, 2 drops of 5% ferric chloride solution was added. Appearance of dirty green precipitate indicated the presence of tannin.

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Anatomical study

The study on anatomical characterisation with normal sectioning and the section treated with various reagents, solvents were used to study the ergastic substances and exudates of the plant.

The free hand sections were taken from the fixed specimen of the study plant are used for the present study.

Fluorescence Powder analysis: (Kokashi *et al.,* 1958).

Fluorescence powder analysis of leaf and stem were performed as per standard procedures (Kokashi*e tal.,*1958). A small quantity of the leaf powder was placed on the microscopic slide and 1-2 drops of freshly prepared reagents was added, mixed by gently tilting of the slide and waited for few minutes. Then the slide were placed in normal light, white light, and in the UV chamber (256 nm) were observed to determine the fluorescence characters and details of foreign particles /objects present in the powder .

Ash test: (Madhubala and Shanthi 2019).

The 3g of powder material was accurately weighed and placed in crucible. The material was spread in even layer at the temperature of 550ºC until it was white indicating the absence of carbon.

Determination of water soluble ash:

The residual ash was allowed to cool, weighed ash material was washed with distilled water and filtered by Whatman filter paper and then it is dried.

Determination of alcohol soluble ash:

The dried powder is then filtered using concentrated hydrochloric acid and the substance that can extract from the acids are removed for the further process for the indication of heavy metals.

Gas chromatography (GC) and mass spectrometry (MS) analysis:

The chemical composition of the methanolic leaf extract of *E.ovalifolia* was analysed by GC-MS. The analytical work was carried using thermo GC-turbo mass version 5.4.2 coupled with thermo: MS DSQ11 instrument. . The Clarus 680 GC was used in the analysis employed a fused silica column, packed with Elite-5MS (5% biphenyl 95% dimethyl polysiloxane, 30 m × 0.25 mm ID × 250μm df) and the components were separated using Helium as carrier gas at a constant flow of 1 ml/min. The injector temperature was set at 260°C during the chromatographic run. The 1μL of extract sample injected into the instrument the oven temperature was as follows: 60 °C (2 min); followed by 300 °C at the rate of 10 °C min−1; and 300 °C, where it was held for 6 min. The mass detector conditions were: transfer line temperature 240 °C; ion source temperature 240 °C; and ionization mode electron impact at 70 eV, a scan time 0.2 sec and scan interval of 0.1 sec. The fragments from 40 to 600 Da. The spectrums of the components were compared with the database of spectrum of known components stored in the GC-MS NIST (2008) library.

RESULTS AND DISCUSSION

The pharmacognostical studies on medicinal plant considered to be more important to authenticate the species before preparing the herbal formulation. The present study was carried out on important tropical medicinal plant *Ehretia ovalifolia* of Boraginaceae. The morphological features of the study plant was observed as 23cm of GBH, Leaf surface area with 6.5 cm, Petiole length of 1.7 cm and internode length of about 0.4 cm and the veins of about 5-8 pairs in alternate pattern where tabulated in the Table: 2. The morphological features are very fundamental in all other activities regarding photosynthetic efficiency, Physiological perfection, The Table refers about powder characters and it is referred as organoleptic characters of the plant. This is first important characterisation made in pharmacogonostical studies. The stem powders appeared generally as standard brown in colours since it is rich in tannins and have characteristic odour with bitter taste and have a coarse texture. Similarly, the leaf powder will be very fine in nature since there will be absence of fibres. The type of fruit is berry type and no. of seeds per fruit is 4 and weight per 10 seeds is observed as 1.6 g. The powder samples of stem were treated with some selected chemicals

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like strong acids, strong bases, weak acids, and weak bases and with solvents. The stem powders when treated with KOH appeared to be yellowish green to brownish green in ordinary light sources and UV light source. The stem powder when added with Fecl3 the powder appeared to be in Dark green in normal light sources and it was appeared to blackish green in UV light sources. When the stem powder was treated with normal distilled water it appeared as dark brown from light brown in colour. The concentrated sulphuric acid also changes the powder completely to black in colour. The importance of pharmacognostical evaluation gains its importance to authenticate the species before using it for making formulations (Pooja Sharma *et al.,* 2021).

The leaf powder of the study plant *Ehretia ovalifolia* showed characteristic change in appearance in various light sources. The powders when treated with Conc. HNO3 it appears as deep brown which resemble the coffee brown in colour and in UV light sources it appeared as reddish brown in colour. The characteristic change was observed in by adding the KCL the colour appeared as reddish brown in colour in UV light sources. The powders treated with various solvents showed some changes and turns in reddish brown from green. The powder not reacted with water and remained as such. Hence drug manufacture and herbal formulation may be carried out using water in various forms. The results of qualitative phytochemical analysis were made on both stem and leaf powders with chloroform and methanol extract. Comparatively the methanol extract exhibited presence of major phytochemicals except steroids and glycosides. The phenolic and tannin compounds present comparatively more abundant than other phytochemicals. Similarly, the leaf extract also exhibited the presence of important phytochemicals except glycosides and flavonoids. The leaf also exhibited the presence of phenols and tannins. The other important phytochemicals also showed its presence in methanol extract. The above studies clearly suggests that the phytochemicals found to be more in the plant hence the study plant may use to prepare the medicines (Table: 7 and 8). The similar results were also proposed by many workers. The presence of polyphenols compounds may be responsible for antioxidants (Shahidi and Wanasundra,1992). Similar to the above studies the presence of flavonoids was reported in methanol extract in the plant parts which is responsible for many important biological effects such as antioxidant, anti-inflammatory, hepatoprotective, antiulcer, antiallergic, antiviral and anticancer activities (Umamaheswari and Chatterjee, 2008).

The ash values of the *E.ovalifolia* nutrition qualities and to understand the presence of foreign particles. The ash values result clearly exhibited that leaf has more ash values with Total ash value was 17.6% but in stem only 8% of ash value has been observed. The lowest acid soluble ash values were observed with 0.7% and leaf 8.7% (Table: 9). The GCMS analysis of methanolic leaf extract showed the presence of important 6 compounds and its IUPAC names with molecular weight and Area % was found to be present. The medicinally important compound Ethyl alpha – D Glucopyranoside had 13.581 area percentage at 16.579 RT value. The compound used as anti-inflammatory was found to be present with area percentage of 6.951 at RT value of 2.984. The two medicinally important compounds having potential anti-cancer activity called pyridine was found to be at RT value 2.984 and high antioxidant compound N- Hexadecanoic acid at 20.02 of RT value with area percentage of 6.951 and 5.088 were observed receptively. Comparatively, the above compounds are found to be lesser but the compounds are medicinally more important were reported in the study plant species *Ehretia ovalifolia*. The above GCMS analysis clearly exhibited the presence of medicinally important phytochemicals. Many volatile compounds are reported previously by many workers similar to that of the results the aromatic phytoconstituents and its importance were clearly explained by the (Akintayo*etal.,* 2016)

SUMMARY AND CONCLUSION

The present study clearly exhibits that pharmacognostical properties of the plant *Ehretia ovalifolia*. The genus *Ehretia* a well-adapted plant species of Boraginaceae where the plant can found only at typical dry deciduous forest as influenced by heavy monsoon rain. The poor regeneration capacity of the plant, fruit formation and seed setting habit of the plant leads to have very poor population in natural habitat. The present study clearly gives an idea on morphological nature of the plant, Phytochemical profile, pharmacognostical characters and GCMS analysis made to

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understand the plant in various criteria. The present study helps to avoid unnecessary adulteration and misguiding or mismatching species to be added in the important medicinal formulation made in the indigenous system of medicine.

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Table.1: Showing the organoleptic characters of the study plant *Ehretia ovalifolia*

S.No	Part	Colour	Odour	Taste	Texture
1.	Stem	Brown	characteristic	Bitter	Coarse
	Leaf	Green	characteristic	Bitter	Fine

Table.2: Showing the results of Morphological parameters of the study plant *Ehretia ovalifolia*

S.No.	GBH (cm)	Leaf length (cm)	Petiole length (cm)	Internode Length (cm)	Veins	No. of seeds /Fruit(Berry)
1.	23	6.5	1.7	0.4	5-8 pairs	4

Table.3: Showing the characters of stem powder of the study plant *Ehretia ovalifolia*

S.NO	Treatment	Light	White light	UV Light (256 nm)
1	Powder + Con.HCL	Brown	Muddy Brown	Dark Brown
2	Powder + Dil.HCL	Light Brown	Muddy Brown	Brown
3	Powder + Con.H$_2$SO$_4$	Black	Reddish Brown	Black
4	Powder + Dil.H$_2$SO$_4$	Muddy Brown	Muddy Brown	Muddy Brown
5	Powder + Con.HNO$_3$	Reddish Brown	Reddish Brown	Dark Brown
6	Powder + Dil.HNO$_3$	Light Brown	Light Brown	Muddy Brown
7	Powder + CH$_3$COOH	Light Brown	Dark Brown	Deep Brown
8	Powder + NaOH	Dark Brown	Dark Brown	Black
9	Powder + KOH	Yellowish Brown	Yellow	Brownish Green

10	Powder + FeCl₃	Dark Green	Dark Green	Black
11	Powder + KCl	Muddy Brown	Light Brown	Brown
12	Powder + Acetone	Muddy Brown	Light Brown	Dark Brown
13	Powder + Pet Ether	Light Brown	Muddy Brown	Brown
14	Powder + Chloroform	Brown	Light Brown	Muddy Brown
15	Powder + Ethanol	Light Brown	Light Brown	Muddy Brown
16	Powder + Methanol	Muddy Brown	Dark Brown	Light Brown
17	Powder + Water	Light Brown	Light Brown	Dark Brown

Table.4: Showing the characters of leaf powder of the study plant *Ehretia ovalifolia*

S.NO	Treatment	Light	White Light	UV Light (256 nm)
1	Powder + Con.HCL	Green	Green	Black
2	Powder + Dil.HCL	Dark Green	Dark Green	Dark Green
3	Powder + Con.H₂SO₄	Black	Dark Green	Black
4	Powder + Dil.H₂SO₄	Dark Green	Light Green	Dark Green
5	Powder + Con.HNO₃	Coffee Brown	Brown	Reddish Brown
6	Powder + Dil.HNO₄	Dark Green	Light Green	Dark Green
7	Powder + CH₃COOH	Deep Green	Green	Black
8	Powder + NaOH	Green	Dark Green	Black
9	Powder + KOH	Green	Blackish Green	Black
10	Powder + FeCl₃	Green	Blackish Green	Black
11	Powder + KCl	Dark Green	Dark Green	Reddish Brown
12	Powder + Acetone	Dark Green	Brown	Black
13	Powder + Pet Ether	Dark Green	Black	Green
14	Powder + Chloroform	Dark Green	Deep Green	Dark Black
15	Powder + Ethanol	Dark Green	Deep Green	Reddish Black
16	Powder + Methanol	Dark Green	Black	Black
17	Powder + Water	Dark Green	Light Green	Dark Green

Table.5: The Qualitative phytochemical analysis of the stem and leaves of study plant *Ehretia ovalifolia* **using chloroform and methanol extract.**

S.NO	Phytochemical Compounds	Stem		Leaf	
		Chloroform	Methanol	Chloroform	Methanol
1.	Alkaloids	+	+	+	+
2.	Steroids	-	-	-	+
3.	Saponins	+	+	+	+
4.	Terpenoids	+	+	-	+
5.	Coumarins	-	+	+	+
6.	Glycosides	-	-	+	-
7.	Flavonoids	+	+	+	+
8.	Phenols	+	+	+	+
9.	Tannins	+	+	-	-

Table.6: Components detected through GC–MS analysison the methanolic leaf extract of the study plant *Ehretia ovalifolia*

S.No	RT	Compound name	Mol wt.	Molecular formula	Area %	CAS.No	Medicinal Properties
1	2.984	Pyridine	79	C_5H_5N	6.951	110-86-1	Anticancer, antimicrobial
2	15.759	Diethyl phthalate	222	$C_{12}H_{14}O_4$	10.001	84-66-2	-
3	16.579	Ethyl. alpha. -d-glucopyranoside	208	$C_8H_{16}O_6$	13.581	900127-29-4	Anti-inflammatory
4	20.02	n-Hexadecanoic acid	256	$C_{16}H_{32}O_2$	5.088	57-10-3	Anti-inflammatory, antioxidant
5	25.347	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester	278	$C_{16}H_{22}O_4$	38.279	4376-20-9	-
6	27.083	3,4-Secodammar-4(28)-en-3-oic-acid,20,24-epoxy-25-hydroxy-, (24s)-	474	$C_{30}H_{50}O_4$	26.101	56421-13-7	-

Table.7: The ash content of the study plant *Ehretia ovalifolia*

S.NO.	Ash type	% of Ash content	
		Stem	Leaf
1	Total ash value of powder	8	17.6
2	Water soluble ash	6.67	17
3	Acid soluble ash	0.7	8.7

RESEARCH ARTICLE

Applications of Wavelet Operational Matrix for Numerical Inversion of Laplace Transform

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ABSTRACT

This article proposes a computationally efficient numerical algorithm based on Legendre wavelet operational matrix for finding numerical inversion of Laplace transform. Numerical inverses of rational, irrational and transcendental transfer functions are discussed to elucidate the simplicity of the proposed algorithm. The great accuracy of the proposed algorithm is demonstrated by all error tables and graphical displays

Keywords: Legendre wavelets, Operational matrix, Numerical inverse Laplace transform.

INTRODUCTION

One of the most prominent integral transforms, namely the Laplace transform, plays a significant part in calculus and facilitates to solve arbitrary order differential and integral equations. It is widely used in various scientific fields such as quantum physics, nuclear physics, optics, fluid flow, mechanical vibration, communication engineering, electric circuit analysis, control engineering and in many other fields. However, the analytical inversion of Laplace transform is generally very difficult to achieve in the closed-form manner whenever the solutions in the Laplace domain exist in the complicated form. Alternatively, numerical methods are called in to govern the inversion of Laplace transform. But, numerical inversion of Laplace transform is normally an ill-posed problem and so there is no universal numerical inverse Laplace transform method working well for all the problems. A plenty of numerical inverse Laplace transformation methods are published in the literature. William Weeks[20] discussed the numerical

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inversion of Laplace transform using orthonormal Laguerre functions. L. D'amore *et al.*[4] implemented the fourier series for the numerical evaluation of the inverse Laplace transform. Joseph Abate *et al.*[1] used Laguerre method to calculate the numerical inversion of Laplace transform of a real valued function on the non negative real line. G.A. Frolov *et al.*[5] improved the accuracy in numerical methods for inverse Laplace transform based on Post-Widder formula. S. Cuomo *et al.*[3] developed a numerical algorithm for inverse Laplace transform based on Laguerre polynomials. J. Sastre *et al.*[16] proposed an application of Laguerre matrix polynomials to the numerical inverse Laplace transform of matrix functions. Sheng *et al.*[17] discussed some applications of the numerical inverse Laplace transform algorithm in fractional calculus. Q. Wang and H. Zhan [19] solved the solute transport problem by numerical inverse Laplace transform. K. Nouri [12] solved fractional order Bagley-Torvik and Basset equations using numerical inverse Laplace transform based on Gaussian quadrature formulas. G. Horväth[6] investigated the numerical inversion of Laplace transform based on concentrated matrix exponential distributions.

Apart from these numerical methods, notable interest is initiated for reforming numerical algorithm in finding inverse Laplace transform using operational matrices. D. Rani and V. Mishra[13] used a numerical inverse Laplace transform based on an operational matrix of Bernoulli polynomials to solve a few nonlinear differential equations. In[11], V. Mishra and D. Rani used a Laplace transform inversion method based on Bernstien operational matrix of integration to solve a few differential and integral problems. J. Wu *et al.*[21] proposed a new method for performing numerical inversion of Laplace transform using Haar wavelet operational matrices. S. M. Aznam and A. Hussin[2] discussed a numerical method for inverse Laplace transform using Haar wavelet operational matrix to solve ordinary differential equations. In[7, 8], C. H. Hsiao used numerical inversion of Laplace transform via wavelets to solve ordinary and partial differential equations. The main goal of this work is to derive the numerical inverse Laplace transformations of irrational transfer functions via Legendre wavelet operational matrices, which facilitate the calculation over many traditional approaches. The work is described as follows. The Legendre wavelet and its operational matrix for fractional integration are briefly presented in section 2. The numerical approach for inverting the Laplace integral transform using the Legendre wavelet operational matrix is covered in section 3. In section 4, the applicability of the proposed strategy is assessed using some numerical examples and additionally, graphical demonstrations are provided. Finally we draw our conclusion in section 5.

Legendre Wavelets

The Legendre wavelets[14, 15, 18] are described over [0,1) as

$$
\psi_{pq}(t) = \begin{cases} \left(q + \frac{1}{2}\right)^{\frac{1}{2}} 2^{\frac{k}{2}} L_q(2^k t - \hat{n}), & t \in \left[\frac{\hat{n}-1}{2^k}, \frac{\hat{n}+1}{2^k}\right). \\ \\ 0, & otherwise, \end{cases} \tag{1}
$$

where $p = 1$ to 2^{k-1}, $q = 0$ to $M - 1$, $M, k \in \mathbb{N}$ and $\hat{n} = 2p - 1$. The coefficient $\left(q + \frac{1}{2}\right)^{\frac{1}{2}}$ in (1) is utilised for the condition of orthonormality. Additionally, $L_q(t)$ are mutually perpendicular Legendre polynomials of order q with respect to the weight function $w(t) = 1$ over $[-1, 1]$ and fulfil the following recurrence formulae,

$$
L_0(t) = 1, L_1(t) = t, L_{q+1}(t) = \left(\frac{2q+1}{q+1}\right) t L_q(t) - \left(\frac{q}{q+1}\right) L_{q-1}(t), \qquad q = 1,2,3,\dots
$$

Legendre wavelets can be used to approximate any function $h(t)$ in $L^2([0,1))$ as

$$h(t) \simeq \sum_{i=1}^{N} c_i \psi_i(t) = C^T \chi(t), \tag{2}$$

where $N = 2^{k-1}M$, $\psi_i(t) = \psi_{pq}(t)$, $\chi(t) = [\psi_1(t), \psi_2(t), \dots, \psi_N(t)]^T$, $c_i = c_{pq} = \int_0^1 \psi_{pq}(t)h(t)dt$ and $C = [c_1, c_2, \dots, c_N]^T$. Moreover, the relation $i = M(p - 1) + q + 1$ determines the index i. By discretising (2) at the collocation points $t_i = \frac{2i-1}{2N}$, $i = 1$ to N, we accomplish

$$H \simeq C^T \Phi_{N \times N}, \tag{3}$$

where $H = [h(t_1), h(t_2), \dots, h(t_N)]_{1 \times N}$ and $\Phi_{N \times N} = \left[\chi\left(\frac{1}{2N}\right), \chi\left(\frac{3}{2N}\right), \dots, \chi\left(\frac{2N-1}{2N}\right)\right]$, a Legendre wavelet coefficient matrix of order N. Especially, for $k = 2$ and $M = 3$, the Legendre wavelet coefficient matrix becomes

$$\Phi_{6\times6} = \begin{pmatrix} 1.4142 & 1.4142 & 1.4142 & 0 & 0 & 0 \\ -1.6330 & 0 & 1.6330 & 0 & 0 & 0 \\ 0.5270 & -1.5811 & 0.5270 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.4142 & 1.4142 & 1.4142 \\ 0 & 0 & 0 & -1.6330 & 0 & 1.6330 \\ 0 & 0 & 0 & 0.5270 & -1.5811 & 0.5270 \end{pmatrix}$$

According to [9], the 'N' Block Pulse Functions(BPFs) on [0,1) are given by

$$b_m(t) = \begin{cases} 1, & \dfrac{m-1}{N} \le t < \dfrac{m}{N}, \\ 0, & otherwise, \end{cases}$$

where $m = 1\ to\ N$, $N \in \mathbb{N}$.

Every function $h(t) \in L^2([0,1))$ can be written in terms of BPFs as

$$h(t) \simeq \sum_{m=1}^{N} h_m\, b_m(t) = h^T B_N(t),$$

where $B_N(t) = [b_1(t), b_2(t), \ldots, b_N(t)]^T$, $h = [h_1, h_2, \ldots, h_N]^T$ and $h_m = \dfrac{1}{N}\displaystyle\int_{\frac{m-1}{N}}^{\frac{m}{N}} b_m(t)h(t)dt$.

The relationship between the Legendre wavelets and the BPFs is given by

$$\chi(t) = \Phi_{N\times N}B_N(t). \tag{4}$$

According to [9], the integration J^μ with fractional order $\mu \ge 0$ of $B_N(t)$ is approximated as

$$J^\mu(B_N(t)) \simeq F^\mu_{N\times N}B_N(t), \tag{5}$$

where

$$F^\mu_{N\times N} = \frac{1}{N^\mu}\frac{1}{\Gamma(\mu+2)}\begin{pmatrix} 1 & \xi_1 & \xi_2 & \xi_3 & \cdots & \xi_{N-1} \\ 0 & 1 & \xi_1 & \xi_2 & \cdots & \xi_{N-2} \\ 0 & 0 & 1 & \xi_1 & \cdots & \xi_{N-3} \\ 0 & 0 & 0 & 1 & \cdots & \xi_{N-4} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & \xi_1 \\ 0 & 0 & 0 & 0 & \cdots & 1 \end{pmatrix}$$

with $\xi_r = (r-1)^{\mu+1} - 2r^{\mu+1} + (r+1)^{\mu+1}$, is referred to as the Block pluse operational matrix of $J^\mu(B_N(t))$. The integration J^μ with fractional order $\mu \ge 0$ of $\chi(t)$ is approximated as,

$$J^\mu(\chi(t)) \simeq P^\mu_{N\times N}\chi(t), \tag{6}$$

where $P^\mu_{N\times N}$ is referred to as the Legendre wavelet operational matrix of order N for fractional integration with order $\mu \ge 0$. Using (4) and (5), we arrive

$$J^\mu(\chi(t)) = J^\mu(\Phi_{N\times N}B_N(t)) = \Phi_{N\times N}J^\mu(B_N(t)) \simeq \Phi_{N\times N}F^\mu_{N\times N}B_N(t). \tag{7}$$

Thus, combining (6) and (7), we attain

$$P^\mu_{N\times N}\chi(t) \simeq J^\mu(\chi(t)) \simeq \Phi_{N\times N}F^\mu_{N\times N}B_N(t) = \Phi_{N\times N}F^\mu_{N\times N}\Phi^{-1}_{N\times N}\chi(t).$$

Thus,

$$P^\mu_{N\times N} \simeq \Phi_{N\times N}F^\mu_{N\times N}\Phi^{-1}_{N\times N} \text{ and so } \left(P^\mu_{N\times N}\right)^{-1}\Phi_{N\times N} \simeq \Phi_{N\times N}\left(F^\mu_{N\times N}\right)^{-1}. \tag{8}$$

Especially, for $M = 3$, $k = 2$ and $\mu = 0.5$, the operational matrix for Legendre wavelets fractional integration becomes,

$$P^{0.5}_{6\times6} = \begin{pmatrix} 0.5282 & 0.1819 & -0.0298 & 0.4438 & -0.0871 & 0.0256 \\ -0.1452 & 0.2243 & 0.1329 & 0.0799 & -0.0449 & 0.0198 \\ -0.0598 & -0.0964 & 0.1688 & -0.0417 & -0.0002 & 0.0029 \\ 0 & 0 & 0 & 0.5282 & 0.1819 & -0.0298 \\ 0 & 0 & 0 & -0.1452 & 0.2243 & 0.1329 \\ 0 & 0 & 0 & -0.0598 & -0.0964 & 0.1688 \end{pmatrix}$$

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Numerical Algorithm for inverting Laplace transform

The method for inverting the Laplace transform numerically using the Legendre wavelet operational matrix is now established. For a function $h(t)$ defined on $[0,\infty)$, the Laplace transform $H(s)$ is given by

$$\{h(t)\} = H(s) = \int_0^\infty e^{-st} h(t)dt,$$

and so

$$L\left\{\int_0^t \int_0^t \cdots \int_0^t h\,(t)(dt)^n\right\} = \frac{H(s)}{s^n}.$$

Suppose

$$H(s) = \frac{a_0 + \frac{a_1}{s} + \frac{a_2}{s^2} + \cdots + \frac{a_n}{s^n}}{\left(b_0 + \frac{b_1}{s} + \frac{b_2}{s^2} + \cdots + \frac{b_n}{s^n}\right)s^{\mu+1}} = \widehat{H}\left(\frac{1}{s}\right), \tag{9}$$

where $a_i, b_i \in \mathbb{R}$, $i = 0$ to n, $n \in \mathbb{N}$ and $\mu \geq 0$.

Then

$$\left(b_0 + \frac{b_1}{s} + \frac{b_2}{s^2} + \cdots + \frac{b_n}{s^n}\right)H(s) = \frac{1}{s^{\mu+1}}\left(a_0 + \frac{a_1}{s} + \frac{a_2}{s^2} + \cdots + \frac{a_n}{s^n}\right). \tag{10}$$

By applying the inverse Laplace transform on (10), we arrive

$$b_0 h(t) + b_1 \int_0^t h\,(t)dt + \cdots + b_n \int_0^t \int_0^t \cdots \int_0^t h\,(t)(dt)^n = \frac{a_0 t^\mu}{\Gamma(\mu+1)} \quad + $$
$$\frac{a_1 t^{\mu+1}}{\Gamma(\mu+2)} + \cdots + \frac{a_n t^{\mu+n}}{\Gamma(\mu+n+1)}. \tag{11}$$

Let $E = [e_1, \cdots, e_M, e_{M+1}, \cdots, e_{2M}, \cdots, e_{(2^{k-1}-1)M+1}, \cdots, e_N]$,

where $e_j = \begin{cases} 1, & j = M(p-1) + 1, \ p = 1, 2, \ldots, 2^{k-1}, \\ 0, & otherwise. \end{cases}$

Now,

$$\begin{aligned} E P_{N \times N}^\mu \chi(t) &\simeq E J^\mu[\chi(t)] \\ &= \frac{1}{\Gamma(\mu)} \int_0^t (t-x)^{\mu-1} E\chi(x)dx \\ &= \frac{1}{\Gamma(\mu)} \int_0^t (t-x)^{\mu-1}[\psi_1(x) + \psi_{M+1}(x) + \psi_{2M+1}(x) + \cdots + \psi_{(2^{k-1}-1)M+1}(x)]dx \\ &= \frac{1}{\Gamma(\mu)} \int_0^t (t-x)^{\mu-1} \frac{2^{\frac{k}{2}}}{\sqrt{2}}dx \\ &= \frac{2^{\frac{k}{2}}}{\sqrt{2}} \frac{t^\mu}{\Gamma(\mu+1)} \end{aligned}$$

$$\frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu \chi(t) \simeq \frac{t^\mu}{\Gamma(\mu+1)}. \tag{12}$$

Using (2), (6) and (12) in (11), we attain

$$b_0 C^T \chi(t) + b_1 C^T P_{N \times N}^1 \chi(t) \quad + \cdots + b_n C^T P_{N \times N}^n \chi(t)$$
$$= a_0 \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu \chi(t) + a_1 \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^{\mu+1} \chi(t) + \cdots + a_n \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^{\mu+n} \chi(t),$$

$$C^T(b_0 I_{N \times N} + b_1 P_{N \times N}^1 + \cdots + b_n P_{N \times N}^n)\chi(t) = \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu (a_0 I_{N \times N} + a_1 P_{N \times N}^1 + \cdots + a_n P_{N \times N}^n)\chi(t).$$

Discretizing the above equation at $t_i = \frac{2i-1}{2N}$, $i = 1$ to N, we arrive

$$C^T[b_0 I_{N \times N} + b_1 P_{N \times N}^1 + \cdots + b_n P_{N \times N}^n]\Phi_{N \times N} = \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu [a_0 I_{N \times N} + a_1 P_{N \times N}^1 + \cdots + a_n P_{N \times N}^n]\Phi_{N \times N}$$

and so

$$C^T f_2(P_{N \times N}^1) = \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu f_1(P_{N \times N}^1). \tag{13}$$

where $f_1(P_{N \times N}^1) = a_0 I_{N \times N} + a_1 P_{N \times N}^1 + \cdots + a_n P_{N \times N}^n$ and $f_2(P_{N \times N}^1) = b_0 I_{N \times N} + b_1 P_{N \times N}^1 + \cdots + b_n P_{N \times N}^n$. Thus

$C^T = \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^\mu f_1 (P_{N \times N}^1) \left(f_2 (P_{N \times N}^1) \right)^{-1}.$

The approximate inverse Laplace transform say $\widetilde{H}$ of H(s) , in numerical form is given by

$$\begin{aligned} \widetilde{H} &= C^T \Phi_{N \times N,} \\ &= \frac{\sqrt{2}}{2^{\frac{k}{2}}} E P_{N \times N}^{-1} \Phi_{N \times N} \Phi_{N \times N}^{-1} P_{N \times N}^{\mu+1} f_1 (P_{N \times N}^1) \left(f_2 (P_{N \times N}^1) \right)^{-1} \Phi_{N \times N,} \\ &= \frac{\sqrt{2}}{2^{\frac{k}{2}}} E \Phi_{N \times N} F^{-1} \Phi_{N \times N}^{-1} \widehat{H} (P_{N \times N}^1) \Phi_{N \times N,} \end{aligned}$$

and so

$\widetilde{H} = R \widehat{H} (P_{N \times N}^1) \Phi_{N \times N,}$ \hfill (14)

where $R = [2^k M, \quad -2^k M, \quad 2^k M, \dots, -2^k M]_{1 \times N} \Phi_{N \times N}^{-1}$ and $\widehat{H}(P_{N \times N}^1) = P_{N \times N}^{\mu+1} f_1 (P_{N \times N}^1) \left(f_2 (P_{N \times N}^1) \right)^{-1}.$ The procedure described above can be summarized as follows to determine the numerical inverse Laplace transform of (s) .

Step 1. In terms of $\frac{1}{s}$, write H(s).

Step 2. Put the operational matrix $P_{N \times N}^1$ in the place of $\frac{1}{s}$ in H(s) to get $\widehat{H}(P_{N \times N}^1)$.

Step 3. Compute H using $H_{1 \times N} = [2^k M, \quad -2^k M, \quad 2^k M, \dots, -2^k M]_{1 \times N} \Phi_{N \times N}^{-1} \widehat{H}(P_{N \times N}^1) \Phi_{N \times N}.$

The discrete forms of the numerical inverse Laplace transforms in terms of Legendre wavelet operational matrix for some rational, Irrational and transcendental transfer functions are listed out in the table 1.

Numerical Examples

We here discuss some numerical examples to validate the applicability and the reliability of the proposed numerical algorithm.

Example 4.1 *Consider the rational transfer function*

$H(s) = \frac{2}{s+3}.$ \hfill (15)

The Laplace inverse of (15) is $2exp(-3t)$. Expressing (15) in terms of $\frac{1}{s}$, we attain

$H(s) = \frac{\frac{2}{s}}{1+\frac{3}{s}}.$ \hfill (16)

Using the operational matrix $P_{N \times N}^1$ in the place of $\frac{1}{s}$, we get

$\widehat{H}(P_{N \times N}^1) = \frac{2P_{N \times N}^1}{I_{N \times N}+3P_{N \times N}^1}.$ \hfill (17)

We obtain the numerical inversion of Laplace transform of (15) using (14) and (17). Table 2 demonstrates that the absolute errors decrease when the values of k are raised. From table 2, we can also infer that numerical solutions converge to the exact solution.

Example 4.2 *Consider the irrational transfer function*

$H(s) = \frac{1}{\sqrt{s^2+1}}.$ \hfill (18)

The Laplace inverse of (18) is $J_0(t)$, where J_0 denotes the bessels function of zeroth kind. Expressing (18) in terms of $\frac{1}{s}$, we attain

$H(s) = \frac{1}{\sqrt{s^2+1}} = \frac{\frac{1}{s}}{\sqrt{1+\left(\frac{1}{s}\right)^2}} = \widehat{H}\left(\frac{1}{s}\right).$ \hfill (19)

Using the operational matrix $P_{N \times N}^1$ in the place of $\frac{1}{s}$, we get

$\widehat{H}(P_{N \times N}^1) = \frac{P_{N \times N}^1}{\sqrt{I_{N \times N}+P_{N \times N}^2}}.$ \hfill (20)

Using (14) and (20), the numerical inversion of Laplace transform of (18) is obtained. According to table 3, which compares the relative errors obtained using the proposed technique and the Bernstein Operational Matrix Technique (BOMT)[11], the proposed strategy achieves a greater level of accuracy.

Example 4.3 *Consider the irrational transfer function*

$$H(s) = \frac{1}{s\sqrt{s+a}}. \tag{21}$$

The Laplace inverse of (21) is $\frac{erf\sqrt{at}}{\sqrt{a}}$. Expressing (21) in terms of $\frac{1}{s}$, we attain

$$H(s) = \frac{1}{s\sqrt{s+a}} = \frac{\left(\frac{1}{s}\right)^{\frac{3}{2}}}{\sqrt{1+\frac{a}{s}}} = \hat{H}\left(\frac{1}{s}\right). \tag{22}$$

Using the operational matrix $P_{N\times N}^1$ in the place of $\frac{1}{s}$, we get

$$\hat{H}(P_{N\times N}^1) = \frac{P_{N\times N}^{\frac{3}{2}}}{\sqrt{I_{N\times N}+aP_{N\times N}^1}}. \tag{23}$$

We obtain numerical inversion of Laplace transform of (21) using (14) and (23). According to table 4, which compares the absolute errors obtained using the proposed strategy and Second kind Chebyshev Polynomial Method(SCPM)[10], the proposed strategy is clearly superior that SCPM.

Example 4.4 *Consider the Exponential transfer function*

$$H(s) = exp\left(-a\sqrt{s}\right). \tag{24}$$

The Laplace inverse of (24) is $\frac{a\cdot exp\left(-\frac{a^2}{4t}\right)}{2\sqrt{\pi t^3}}$. Expressing (24) in terms of $\frac{1}{s}$, we attain

$$H(s) = exp\left(-a\left(\frac{1}{s}\right)^{-\frac{1}{2}}\right) = \hat{H}\left(\frac{1}{s}\right). \tag{25}$$

Using the operational matrix $P_{N\times N}^1$ in the place of $\frac{1}{s}$, we get

$$\hat{H}(P_{N\times N}^1) = exp\left(-aP_{N\times N}^{-\frac{1}{2}}\right). \tag{26}$$

We obtain numerical inversion of Laplace transform of (24) using (14) and (26). The achieved absolute errors using the proposed strategy and the Second kind Chebyshev Polynomial Method(SCPM)[10] are shown in table 5, which demonstrates that our proposed technique achieves a better level of precision than SCPM.

CONCLUSION

In this article, we described a computationally simple numerical algorithm for finding Laplace inverse of rational, irrational and transcendental transfer functions. This proposed method offers an alternate way of finding numerical inversion of Laplace transform for irrational transfer functions using Legendre wavelet operational matrix by reducing the complexity of computational work compared to the conventional approaches in a faster way. The main advantage of the suggested numerical approach is its high accuracy and fast convergence to the precise Laplace inverse. Additionally, this approach just uses sparse matrix manipulation rather than the conventional complex integration.

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Table 1: The discrete form of the numerical inversion of Laplace transform in terms of operational matrix.

S.No	s-Domain $H(s)$	t-Domain $h(t)$	The discrete form of $h(t)$
1	$\left(\frac{1}{s}\right)^{\mu+1}, \mu \geq 0$	$\frac{t^{\mu}}{\Gamma(\mu+1)}$	$R \cdot P_{N\times N}^{\mu+1} \cdot \Phi_{N\times N}$
2	$\frac{1}{(s-a)^n}, n = 1,2,3,\dots$	$\frac{t^{n-1}e^{at}}{(n-1)!}$	$R \cdot P_{N\times N}^n (I_{N\times N} - aP_{N\times N}^1)^{-n} \cdot \Phi_{N\times N}$
3	$\frac{a}{s^2 + a^2}$	$sin(at)$	$R \cdot aP_{N\times N}^2 (I_{N\times N} + a^2 P_{N\times N}^2)^{-1} \cdot \Phi_{N\times N}$
4	$\frac{s^3}{(s^2 + 4)^2}$	$cos(2t) - tsin(2t)$	$R \cdot P_{N\times N}^1 (I_{N\times N} + 4P_{N\times N}^2)^{-2} \cdot \Phi_{N\times N}$
5	$\frac{1}{s\sqrt{s+a}}$	$\frac{erf\sqrt{at}}{\sqrt{a}}$	$R \cdot P_{N\times N}^{\frac{3}{2}} (I_{N\times N} + aP_{N\times N}^1)^{-\frac{1}{2}} \cdot \Phi_{N\times N}$
6	$\frac{1}{\sqrt{s^2 + a^2}}$	$J_0(at)$	$R \cdot P_{N\times N}^1 (I_{N\times N} + a^2 P_{N\times N}^2)^{-\frac{1}{2}} \cdot \Phi_{N\times N}$

7	$s^{-\frac{3}{2}}$	$2\sqrt{\dfrac{t}{\pi}}$	$R \cdot P_{N\times N}^{\frac{3}{2}} \cdot \Phi_{N\times N}$
8	$\dfrac{e^{-a\sqrt{s}}}{\sqrt{s}}$	$\dfrac{e^{-\frac{a^2}{4t}}}{\sqrt{\pi t}}$	$R \cdot P_{N\times N}^{\frac{1}{2}} exp\left(-aP_{N\times N}^{-\frac{1}{2}}\right) \cdot \Phi_{N\times N}$
9	$e^{-a\sqrt{s}}$	$\dfrac{a}{2\sqrt{\pi t^3}}e^{-\frac{a^2}{4t}}$	$R \cdot exp\left(-aP_{N\times N}^{-\frac{1}{2}}\right) \cdot \Phi_{N\times N}$
10	$\dfrac{e^{-2\sqrt{s}}}{s}$	$erfc\dfrac{1}{\sqrt{t}}$	$R \cdot P_{N\times N}^{1} \cdot exp\left(-2P_{N\times N}^{-\frac{1}{2}}\right) \cdot \Phi_{N\times N}$

Table 2: The achieved absolute errors of Example 4.1 using the proposed strategy for $M = 3$ and various values of k.

t	$k = 4$	$k = 5$	$k = 6$	$k = 7$	$k = 8$	$k = 9$
0.1	2.2308e-03	5.6243e-04	1.4598e-04	3.6431e-05	9.0230e-06	2.2568e-06
0.2	1.1883e-03	3.2909e-04	8.1918e-05	1.9978e-05	5.0007e-06	1.2580e-06
0.3	7.0703e-04	1.5298e-04	3.8571e-05	1.0014e-05	2.4991e-06	6.1899e-07
0.4	2.6642e-04	6.5442e-05	1.4172e-05	3.5718e-06	9.2732e-07	2.3143e-07
0.5	2.3821e-04	3.1798e-05	4.1115e-06	5.2284e-07	6.5923e-08	8.2762e-09
0.6	1.4979e-04	3.6047e-05	7.7917e-06	1.9608e-06	5.0898e-07	1.2701e-07
0.7	2.1437e-04	4.6234e-05	1.1623e-05	3.0167e-06	7.5275e-07	1.8644e-07
0.8	1.9740e-04	5.4505e-05	1.3545e-05	3.3028e-06	8.2663e-07	2.0795e-07
0.9	2.0355e-04	5.1058e-05	1.3247e-05	3.3050e-06	8.1857e-07	2.0473e-07

Table 3: The obtained relative errors of Example 4.2 using the proposed approach and BOMT.

t	The proposed strategy$(M = 3, k = 8)$	BOMT
0.2	4.1315e-07	0.38e-05
0.4	3.8070e-07	0.47e-05
0.6	3.2391e-07	0.51e-05
0.8	2.3973e-07	0.35e-06

Table 4: The achieved absolute errors using the proposed strategy and SCPM of Example 4.3.

t	The proposed strategy$(M = 3, k = 5)$	SCPM
0.1	9.0522e-04	4.25468e-04
0.2	2.1039e-04	4.39976e-04
0.3	1.1070e-04	6.15681e-04
0.4	8.9900e-05	1.00171e-03
0.5	2.7655e-04	6.58504e-04
0.6	5.3624e-05	2.03301e-03
0.7	3.5259e-05	2.74431e-05
0.8	2.2588e-05	1.34359e-03
0.9	3.1917e-05	2.58831e-04

Table 4: The achieved absolute errors of Example 4.4 using the proposed strategy and SCPM for $a = 2$.

t	The proposed strategy$(M = 3, k = 6)$	SCPM
0.1	1.9371e-04	1.21641e-04
0.2	1.2698e-04	1.66526e-04
0.3	9.9686e-05	1.69753e-04
0.4	1.2709e-05	3.47028e-04

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0.5	1.8856e-05	4.28278e-04
0.6	1.9282e-05	3.64159e-04
0.7	1.6141e-05	8.40270e-05
0.8	1.2341e-05	7.50936e-04
0.9	8.7725e-06	9.29484e-04
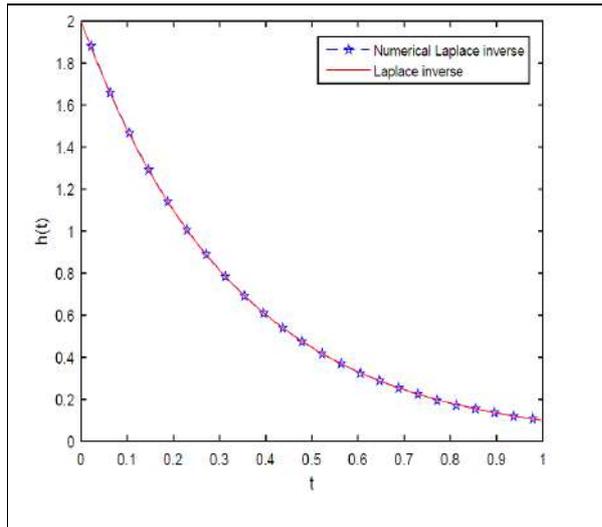
Figure 1:A Comparison of the numerical inverse Laplace transform with the inverse Laplace transform of Example 4.1 for $M = 3$, $k = 4$.
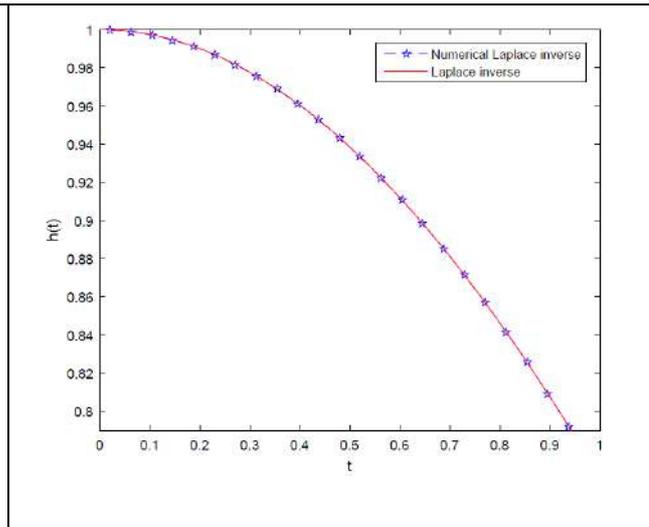
Figure 2:A Comparison of the numerical inverse Laplace transform with the inverse Laplace transform of Example 4.2 for $M = 3$, $k = 4$.
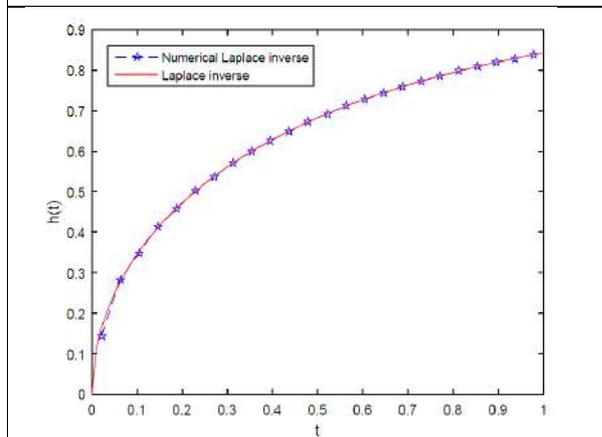
Figure 3:A Comparison of the numerical inverse Laplace transform with the inverse Laplace transform of Example 4.3 for $M = 3$, $k = 4$.
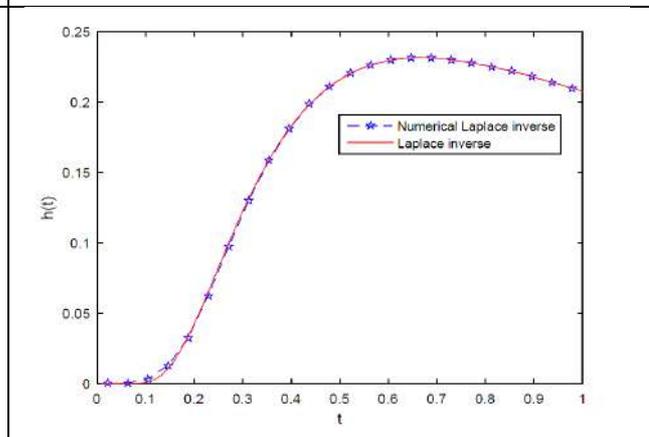
Figure 4:A Comparison of the numerical inverse Laplace transform with the inverse Laplace transform of Example 4.4 for $M = 3$, $k = 4$ and $a = 2$.

RESEARCH ARTICLE

Empirical Testing of Capital Asset Pricing Model using Generalized Method of Moments in Context of Bombay Stock Exchange

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ABSTRACT

The returns of an asset and the risk associated are inter-related and the asset pricing model attempts to find that relation. One such model is CAPM, which is the simplest of all asset pricing models and easy to use. The present study tests the applicability of CAPM on the Indian stock market using the data of selected sectoral indices listed in S&P BSE 500 Index. For the estimation of risk, regression along with generalized method of moment has been used. The study concludes that the assumption higher (lower) risk yields higher (lower) returns was contradicted in the study. The negative linear relationship was obtained between the risk and returns yet the returns could not be explained by the risk (beta). Hence, CAPM is irrelevant in the Indian stock market and is not a valid tool for investors to find the association between risk and return.

Keywords: CAPM, return, risk, generalized method of moments.

INTRODUCTION

Over the past few decades, globalization and international investments has made an investment domain tougher and investment decisions complicated. Making investment decisions for evaluating the risk and return associated, the investor should identify appropriate tools and be cautious as the markets today are highly volatile. Generally, the investors demand higher returns for assets having high risk. Thus the theory of asset pricing had been noticeable debate. Capital Asset Pricing Model (CAPM) is one of the most widely used assets pricing model, developed by Sharpe (1964) and Lintner (1965) describes the risk and return relationship. An investor faces two types of risk

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associated with the asset. One of them is systematic risk or non diversifiable risk and the other is unsystematic risk or diversifiable risk. The CAPM takes into account only systematic risk often denoted by beta (β), hence it is called as single factor model. CAPM states that there is positive and linear relationship between the expected rate of return of an asset and the risk related. The CAPM is theoretically simple and rational but still there are some notable restrictions which make the model difficult to practice. The CAPM is represented by the equation

$R_i = R_f + \beta_i (R_m - R_f)$ *(a)*

where R_i denotes stocks return, R_f denotes risk free rate of interest, β_i denotes beta of the stock and R_m denotes the market return. The beta value of 1 implies the assets return move according to the market. The beta value above 1 means the higher risk and the beta below 1 means the risk lower than the market average risk. The value of beta could be either positive or negative. The beta possessing high and positive value means the increased risk for investors for which in turn an investor demands higher return. The negative beta value reduces the risk related to an asset which makes an investor to accept lower returns.

Though CAPM is basic and reasonable theoretically yet it has some limitations which make it unsuitable to work practically as obtained in some empirical studies. The validity/applicability of CAPM was tested on different stock exchanges by various researchers and the results obtained by them were mixed. Some studies contradicted the model's applicability (Nikolaos, 2009; Dzaja, 2013; Oke, 2013; Kundu, 2016; Hussain et al., 2017; Wahab, 2017; Shinde et al., 2019) while some studies validated the applicability of the model (Yaseer, 2018; Ogiugo et al., 2020; Suraj et al., 2020). The tests of Generalized Method of Moments (GMM) model yielded plausible results of unknown parameters and performed relatively well and concluded that the transaction costs to be included in the asset pricing models (Gregoriou & Ioannidis, 2003). CAPM was tested using Fama MacBeth (1973) and Pettengill et al. (1995) algorithm, Fama MacBeth (1973) algorithm showed no meaningful relationship between the risk coefficients and the ex-post risk premiums whereas Pettengill algorithm indicated strong risk-risk premium relationships Gürsoy & Rejepova (2007). The theoretical and objective aspect appears in the stock market and risk was proved to be a reliable asset measurement (Nikolaos, 2009). The indices of the security market do not lie on the efficient frontier using the Markowitz portfolio theory (Dzaja, 2013). The CAPM's assumption that high (low) risks are associated with high (low) yields was supported (Hundal et al., 2019; Ogiugo et al. 2020; while some studies contradicted the given assumption (Oke, 2013; Hussain *et al.* 2017).

In the present study, the regression equation of CAPM uses GMM as the estimation technique for estimating the stocks' beta. Since the Maximum Likelihood (ML) approach or the Least Squares (LS) approach are feasible when the population is small or follow normal distribution but when the population is large or follow non normal distribution then the results become inaccurate or unfeasible. GMM estimator is large sample estimator as its properties are achieved only in large samples more likely. Also GMM estimators are asymptotically efficient in large sample and rarely in finite samples. GMM is widely used in econometrics as it is computed after allocating suitable weights. GMM has all the properties as the ML estimator. The variance obtained using GMM is minimum as compared to all the other estimators.

The parameters' estimates are chosen such that the sample moments are close to the population counterparts. To represent an underlying moment model and the GMM estimator, let us suppose β p x 1 vector parameter with x_i data observation (i=1, 2, … , j) where j is the sample size. Let

$h_i (\beta) = h (x_i, \beta)$ *(b)*

be nx1 vector. The GMM estimator, for the true parameter value β_0 satisfies the moment condition given below:

$E[h_i (\beta_0)] = 0$ *(c)*

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The β is chosen in such a way that the sample average of h_i (β) is close to its population value i.e. 0. Let the sample average of h_i (β) be denoted by

$$\hat{h} \ (\beta) \stackrel{\text{def}}{=} \frac{1}{j} \sum_{i=1}^{j} h_i \ (\beta) \qquad\qquad (d)$$

Let m x m positive semi definite matrix be denoted by $\hat{B}$ so that the GMM estimator is given by

$$\hat{\beta} = arg \ min_\beta \ \hat{h} \ (\beta)' \ \hat{B} \ \hat{h} \ (\beta) \qquad\qquad (e)$$

$\hat{\beta}$ is the parameter which minimizes the quadratic form (given below) so that it is a GMM estimator.

$$\hat{h} \ (\beta)' \hat{B} \hat{h} \ (\beta) \qquad\qquad (f)$$

In empirical studies, rolling regression is often applied as a method to assess the stability of the model parameters with respect to time, basically of measures generated as a result of linear regression. The parameter of the model being constant with respect to time is the key assumption while analyzing financial time series. If at any point of time, parameter changes, rolling regression captures this variability. The parameters of the model are estimated across different sampling periods or window sizes.

Window size here refers to the time periods adjacent to the given data points whereas the step size here refers to the number of time periods the window to be proceeded each time on its execution. One of the drawbacks of the rolling regression is the choice of the window size as it heavily affects the behaviour of the estimates with respect to time. Due to its presence, the parameter estimates for the whole period of observation cannot be obtained by researchers. For example, if 200 successive data points in time are considered, then rolling regression defined with window size as 24 and step size as 1 will cause the software to perform regression using the data with time period from 1-24, 2-25, 3-26 and so on, finishing with the last period as 177-200.

The main objective of the current study is to empirically check the applicability of CAPM on Indian stock exchange with reference to Bombay Stock Exchange (BSE). The assumption whether the higher/lower risk yields higher/lower rate of return was also tested. BSE (formerly known as Bombay Stock Exchange), is located on Dalal Street in Mumbai was established in 1875. It is the oldest stock exchange in Asia and tenth oldest in the world with an overall market capitalization of more than ₹276.713 Lakh Crore (US$3.6 trillion) as in January 2022. BSE was the first stock exchange to be recognized by the Indian government in August 1957. It is also considered as one of the fastest stock exchange in the world with 6 micro seconds per transaction. Currently, it provides the following facilities for trading in equities, derivatives, currencies, debt instruments and mutual funds *etc*. The summary and comparative data for specific Indices or industries are provided by Sectoral Indices. The performance of stocks against specific Indices can be monitored by an investor with the help of Sectoral indices.

MATERIALS AND METHODS

The study was conducted using secondary data for a period of 10 years ranging from April 2011 to March 2021. The sample includes 10 Sectoral Indices of Bombay Stock Exchange listed in S&P BSE 500 index. There are 22 BSE Sectoral Indices out of which 10 indices (namely S&P Auto, Bankex, Capital Goods, Consumer Durables, Metal, Oil & Gas, Power, Psu (Public Sector Undertaking), Realty, Teck) were considered which had data for the entire period. The yield on the 91 days Treasury bill was incorporated as proxy for the risk free rate of return downloaded from Reserve Bank of India (RBI) website.

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The monthly returns (R_{it}) of stocks were calculated using the formula

$$Rit = \frac{P_{1t} - P_{0t}}{P_{0t}} \qquad\qquad (1)$$

where P_{0t} denotes previous closing price of stock, P_{1t} denotes current closing price of stock.
Similarly the returns of the market (R_{mt}) were calculated using the formula

$$Rmt = \frac{P_{1t} - P_{0t}}{P_{0t}} \qquad\qquad (2)$$

Before estimating the model, the descriptive statistics of the given data was computed. The normality of the given data was tested using Kolmogorov Smirnov (KS) test for which the results revealed that the given data does not follow normal distribution, thus, the use of GMM is appropriate. The data analysis involved two steps of regression method. In the first step, rolling regression was applied on the results of linear regression to obtain the rolling betas of the stocks and in the second stage cross sectional regression was used to examine the relationship between the risk factor and the returns. The two step testing procedure proposed by Fama and Macbeth (1973) has been used in the study.

The risk coefficients (beta) of the Indices were obtained using the model

$$R_{it} = \hat{\alpha} + \hat{\beta}_i (R_{mt}) + \mu_t \qquad\qquad (3)$$

Where $\hat{\alpha}$ denotes the intercept term, $\hat{\beta}_i$ denotes the estimated risk (beta) of stock i,
After the estimation of betas, the Indices were then arranged in ascending order of their beta and grouped into 5 portfolios such that the first portfolio contained the Indices having least beta values and the last (fifth) portfolio contained the stocks having highest beta values. Allocation of beta to the constructed portfolios was done to attain diversification to reduce any type of error which may occur due to the presence of unsystematic risk (Basu, 2010).
To empirically validate the CAPM theory, the cross sectional regression was carried out so that the following assumptions must hold:

$\hat{\alpha}$ = 0 i.e. the intercept term equals zero statistically or it should not be statistically significant
$\hat{\beta}_i$ > 0 i.e. the market risk premium should be positive and significant.
As per CAPM there exists a linear relationship between the systematic risk and the return on an asset. The Pearson correlation coefficient measures the degree and direction of linear relationship between the given two variables.
The following step tests the relevance of beta factor in the Indian stock market, which notifies whether the beta factor has any validity in the Indian stock market. The given equation test the beta relevance:

$$Z_{pt} = \gamma_0 + \gamma_1 (\beta_p) + e_{pt} \qquad\qquad (4)$$

where Z_{pt} denotes average excess return of portfolios, γ_0 denotes the intercept term, γ_1 denotes the risk premium (beta) coefficient for this equation and e_{pt} denotes the residual or error term.

RESULTS

The descriptive statistics for the considered sectoral indices were computed. The mean value for 9 stocks return obtained is positive with the highest value 0.014 for Index 4 and least value -0.33 for Index 8. The standard deviation (SD) obtained for all ten Indices are close to 0 which indicates that the data points are close to mean. The lower value of SD means an asset/Index is more stable and less volatile. The higher value of SD means an asset/Index has more fluctuations and is less volatile.

The skewness value for Indices 1, 2, 3 and 4 obtained are negative (negatively skewed) means that the left tail of the distribution is longer whereas the skewness value for Indices 5, 6, 7, 8, 9 and 10 obtained are positive (positively skewed) means that the right tail of the distribution is longer. The kurtosis tells the peakedness of the given data. The kurtosis value obtained for all 10 Indices are > 3 which is recognized as leptokurtic, having fat tails. The leptokurtic distributions are considered to be more risky while the mesokurtic distributions are considered to be moderately risky. Since the data points are > 50, the KS test has been used to test the normality of data. The KS p-value obtained for all 10 Indices is >0.05 thereby rejecting the null hypothesis. Hence the given data is not normal. In the first step regression, the returns data with market return as independent variable was used to estimate the beta of the individual indices using equation 3. The range of beta obtained is 1.339 with the minimum value 0.480 and maximum value 1.819. (Table 2).

It can be seen that out of ten Indices, eight Indices have beta value greater than 1 (β>1) which means that the fluctuation on assets' return rate is more than the fluctuation on market's return and two Indices have beta value less than 1 but greater than 0 (β<1) which means that the fluctuation on assets' return rate is less than the fluctuation on market's return or the assets' return is moving against the market return.. A beta value of 1 (β=1) means the rate of return on an asset increase or decrease equally with the market return. The second step regression is used to run the cross sectional regression to test the CAPM. The hypothesis of CAPM states that $\hat{\alpha}$ should be equal to zero and $\hat{\beta}$ should be positive and significant for CAPM to hold true. The cross sectional regression results showed that the value of $\hat{\alpha}$ obtained is 0.159 which is different from zero and the corresponding t-value obtained is 0.844 which is statistically insignificant at 5 percent significance level and the value of $\hat{\beta}$ obtained is -0.027 which is negative. Also the value of F statistics obtained is 0.887 which is insignificant. Hence it can be said that the results are challenging the above hypothesis as there is contradiction between the Indices' returns and beta. (Table 3)

Based on the beta values obtained from the regression equation (3), the beta values were sorted in increasing order of their rankings. The 5 portfolios were created each having 2 Indices such that the first portfolio P1 contained lowest beta values and the fifth portfolio P5 contained highest beta values (Table 4). The portfolio 5 has beta value of -0.163 and value of 1.484 average portfolio returns while portfolio 1 has beta value of -0.028 and value of 0.739. From the comparative analysis among these portfolios, it can be said that the portfolio returns cannot be explained by the beta alone as some of the portfolio having highest beta produced lowest returns while some having highest returns had lower beta. The Pearson's correlation coefficient between the average portfolio returns and portfolio beta obtained was -0.701 (negative linear relationship) which means as the beta value increases, the returns value decreases and vice-versa.

It can be seen that the strong negative linear relationship was obtained between the two variables. The trend line has a negative slope, which showed the negative relationship as the variable move in opposite direction. (Figure 1). Further the relevance of beta factor was tested using the equation (4). This equation suggests whether the beta value has any effectiveness in the Indian stock market. The intercept γ_0 obtained is 0.010 and the slope γ_1 (beta) obtained is 0.001. According to the theory, the intercept term should be zero and beta should be positive and significant. The p-value suggests that both terms are insignificant. R square as well as adjusted R square values are too low to explain the beta value. Thus we can say that beta is not a significant factor in the Indian stock market. (Table 5)

CONCLUSION

One of the most discussed facts is an investment decision which is also one of the key areas in finance. The present study tested the applicability of CAPM and linear relationship between risk and return using the data of selected 10 Indices listed in S&P BSE 500 index for the period from April 2011 to March 2021. The result of the study didn't support the assumption that higher/lower risk yields higher/lower returns which led to the non applicability of CAPM in the Indian stock market. The prediction of CAPM that the intercept should be equal to zero and the slope

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should be positive and significant was also contradicted in the study. Although, the negative linear relationship was obtained between the risk and return still the beta factor could not explain the risk return relationship. Hence it is not a valid factor in the Indian stock market.

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Availability of data and materials
The data used in the study that support the findings of this study have downloaded from BSE (https://www.bseindia.com/indices/IndexArchiveData.html) and RBI (https://www.rbi.org.in/Scripts/BS_NSDPD isplay.aspx?param=4) websites which is publically accessible.

Declaration of interest: The authors declare no conflict of interests.

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Table 1: Descriptive statistics and KS normality test

Indices	Average	Standard Deviation	Skewness	Kurtosis	KS p-value
Index 1	0.007	0.105	-0.625	6.298	0.800
Index 2	0.010	0.099	-0.390	5.946	0.091
Index 3	0.005	0.142	-0.090	3.990	0.200
Index 4	0.014	0.287	-0.703	5.011	0.061
Index 5	0.0001	0.200	0.174	4.193	0.200
Index 6	0.002	0.287	0.044	3.765	0.200
Index 7	-0.0005	0.176	0.549	4.732	0.200
Index 8	-0.003	0.158	0.289	4.529	0.186
Index 9	0.005	0.277	0.099	4.151	0.182
Index 10	0.009	0.153	0.163	4.176	0.063

Table 2: Estimated beta value of Indices from BSE S&P Index

Time period	Indices									
	Index 1	Index 2	Index 3	Index 4	Index 5	Index 6	Index 7	Index 8	Index 9	Index 10
Mar-16	1.610	1.117	1.553	1.049	1.304	0.974	1.400	1.237	1.888	0.464
Apr-16	1.609	1.117	1.553	1.049	1.310	0.975	1.402	1.240	1.895	0.461
May-16	1.630	1.107	1.555	1.051	1.305	0.966	1.400	1.232	1.910	0.455
Jun-16	1.631	1.105	1.554	1.049	1.311	0.968	1.406	1.238	1.914	0.450
Jul-16	1.617	1.110	1.549	1.051	1.320	0.975	1.399	1.245	1.919	0.434
Aug-16	1.673	1.148	1.560	1.066	1.318	1.002	1.434	1.277	1.945	0.363
Sep-16	1.658	1.154	1.568	1.075	1.303	1.004	1.436	1.277	1.965	0.368
Oct-16	1.688	1.137	1.583	1.091	1.295	1.002	1.452	1.298	1.973	0.339
Nov-16	1.700	1.150	1.567	1.090	1.227	0.991	1.412	1.285	2.011	0.331
Dec-16	1.662	1.160	1.578	1.097	1.217	0.970	1.426	1.296	2.020	0.335
Jan-17	1.655	1.194	1.537	1.150	1.167	0.974	1.456	1.310	2.016	0.336
Feb-17	1.650	1.166	1.541	1.143	1.159	0.984	1.429	1.298	1.995	0.347
Mar-17	1.654	1.166	1.538	1.157	1.144	0.965	1.417	1.286	1.989	0.341
Apr-17	1.653	1.175	1.543	1.158	1.136	0.969	1.414	1.292	2.009	0.319
May-17	1.691	1.109	1.559	1.163	1.129	0.981	1.415	1.310	2.068	0.318
Jun-17	1.671	1.119	1.563	1.199	1.122	0.988	1.403	1.315	2.093	0.322
Jul-17	1.659	1.108	1.571	1.187	1.138	1.003	1.394	1.323	2.092	0.323
Aug-17	1.660	1.114	1.571	1.167	1.112	0.985	1.393	1.318	2.083	0.333
Sep-17	1.642	1.088	1.562	1.159	1.108	1.011	1.403	1.347	2.038	0.323
Oct-17	1.637	1.072	1.544	1.148	1.112	1.027	1.394	1.369	2.039	0.333
Nov-17	1.659	1.078	1.541	1.089	1.131	1.054	1.413	1.390	2.012	0.315
Dec-17	1.657	1.080	1.531	1.094	1.138	1.050	1.411	1.381	2.013	0.325
Jan-18	1.659	1.072	1.537	1.089	1.137	1.051	1.404	1.379	2.011	0.334

Feb-18	1.649	1.086	1.552	1.108	1.063	1.050	1.380	1.388	2.017	0.371
Mar-18	1.635	1.074	1.542	1.066	1.097	1.052	1.365	1.378	2.005	0.384
Apr-18	1.609	1.056	1.512	1.025	1.112	1.011	1.347	1.334	1.992	0.454
May-18	1.610	1.070	1.485	1.046	1.117	1.003	1.350	1.319	1.998	0.459
Jun-18	1.643	1.077	1.480	0.963	1.100	1.052	1.359	1.325	2.000	0.457
Jul-18	1.609	1.065	1.438	0.968	1.034	1.069	1.326	1.295	1.945	0.526
Aug-18	1.567	1.072	1.408	0.922	1.164	1.062	1.337	1.283	1.935	0.572
Sep-18	1.516	1.096	1.403	0.980	1.084	0.994	1.292	1.240	1.962	0.553
Oct-18	1.437	1.111	1.318	0.966	1.085	1.025	1.299	1.245	1.938	0.551
Nov-18	1.451	1.119	1.316	0.958	1.069	1.012	1.291	1.231	1.945	0.541
Dec-18	1.449	1.126	1.321	0.964	1.063	1.010	1.285	1.228	1.944	0.533
Jan-19	1.458	1.149	1.286	0.945	1.061	1.009	1.271	1.233	1.900	0.535
Feb-19	1.445	1.132	1.287	0.938	1.075	1.011	1.280	1.241	1.905	0.532
Mar-19	1.391	1.091	1.247	0.946	0.995	0.995	1.271	1.225	1.866	0.581
Apr-19	1.393	1.091	1.251	0.946	0.993	0.994	1.273	1.229	1.865	0.574
May-19	1.324	1.109	1.235	0.860	0.849	0.958	1.110	1.107	1.698	0.645
Jun-19	1.319	1.114	1.259	0.802	0.822	0.990	1.085	1.092	1.686	0.619
Jul-19	1.337	1.160	1.251	0.881	0.877	1.020	1.070	1.113	1.643	0.591
Aug-19	1.342	1.128	1.258	0.866	0.909	1.015	1.092	1.123	1.680	0.589
Sep-19	1.361	1.142	1.261	0.890	0.928	1.047	1.086	1.129	1.638	0.566
Oct-19	1.325	1.170	1.236	0.907	0.923	1.055	1.062	1.129	1.662	0.559
Nov-19	1.323	1.164	1.226	0.919	0.946	1.069	1.069	1.134	1.653	0.555
Dec-19	1.317	1.163	1.236	0.908	0.937	1.049	1.068	1.138	1.641	0.542
Jan-20	1.292	1.154	1.250	0.882	1.005	1.073	1.064	1.178	1.589	0.530
Feb-20	1.310	1.198	1.231	0.850	1.047	1.095	1.075	1.193	1.631	0.537
Mar-20	1.255	1.211	1.291	0.960	1.114	1.003	0.961	1.105	1.557	0.572
Apr-20	1.200	1.271	1.245	0.891	1.151	1.047	0.921	1.052	1.447	0.589
May-20	1.201	1.269	1.248	0.892	1.154	1.045	0.926	1.051	1.457	0.584
Jun-20	1.190	1.266	1.241	0.887	1.144	1.042	0.923	1.054	1.456	0.581
Jul-20	1.163	1.268	1.220	0.883	1.162	1.036	0.900	1.039	1.432	0.619
Aug-20	1.169	1.279	1.225	0.900	1.153	1.012	0.892	1.031	1.440	0.617
Sep-20	1.167	1.278	1.230	0.896	1.155	1.015	0.893	1.036	1.444	0.615
Oct-20	1.169	1.274	1.237	0.891	1.151	1.012	0.894	1.036	1.449	0.617
Nov-20	1.211	1.281	1.278	0.902	1.212	1.003	0.924	1.065	1.440	0.591
Dec-20	1.214	1.262	1.264	0.916	1.226	1.000	0.914	1.073	1.471	0.611
Jan-21	1.187	1.249	1.260	0.938	1.231	1.011	0.914	1.065	1.464	0.611
Feb-21	1.192	1.251	1.268	0.918	1.325	1.014	0.930	1.106	1.471	0.576
Average	**1.474**	**1.149**	**1.401**	**0.999**	**1.120**	**1.014**	**1.233**	**1.220**	**1.819**	**0.480**

Table 3: Coefficients of alpha and beta for CAPM

Coefficient	Alpha (α)	Beta (β)	R square	Adjusted R square	F-statistic	p-value (F statistic)
Value	0.159	-0.027	0.350E-03	-0.017	0.020	0.887
t statistic	0.844	-0.142				
p-value	0.402	0.887				

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Table 4: Average portfolio returns (r_{pt}) and Estimated portfolio beta (β_p)

Portfolios	Average portfolio returns (r_{pt})	Rank(r_{pt})	Estimated portfolio beta (β_p)	Rank (β_p)	Correlation (r_{pt} & β_p)
P1	0.739	5	-0.028	1	
P2	1.123	4	-0.204	4	
P3	1.169	3	-0.050	2	-0.701
P4	1.437	2	-0.211	5	
P5	1.484	1	-0.163	3	

Table 5: Result of Relevance of beta

	Coefficients	t-statistic	p-value
γ_0	0.010	0.088	0.929
γ_1	0.001	0.006	0.994
R square	7.44E-07		
Adjusted R square	-0.017		
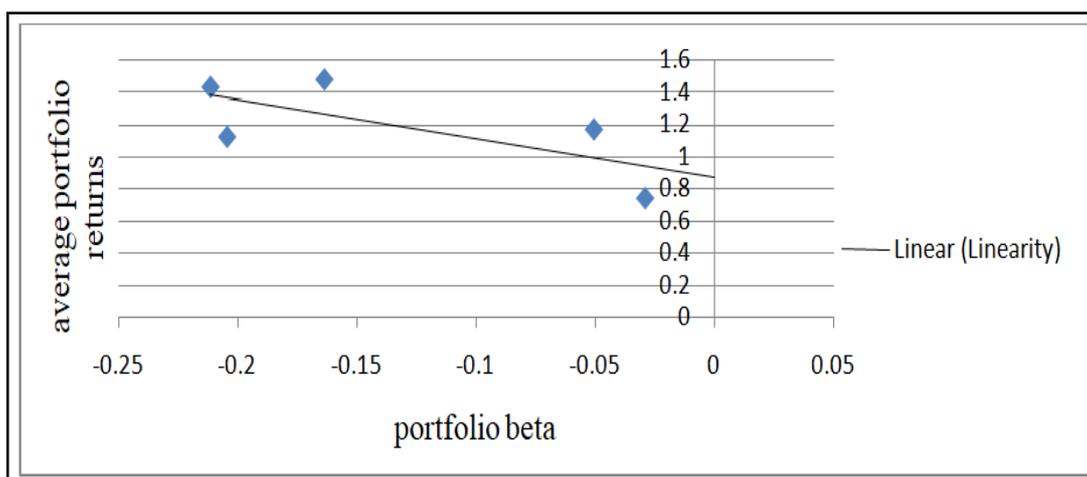
Figure 1: Plot for average portfolio returns against portfolio beta

RESEARCH ARTICLE

A Study to Find the Effect of Therapeutic Ultrasound Vs Dry Needling on Patient Rated Tennis Elbow Evaluation (PRTEE) Scale and Grip Strength in Patient with Subacute Lateral Epicondylitis

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ABSTRACT

Injuries to the elbow, specifically humeral epicondylitis, occur frequently in daily activities as a result of the repetitive loads encountered. It is a painful and debilitating musculoskeletal condition that affects health care industry. It is very common in individuals whose jobs necessitate frequent rotatory motion of the forearm which is characterized by degeneration of the tendon and frequently reported pain at the lateral aspect of the elbow. Conservative therapeutic options involve orthotics, cryotherapy, extracorporeal shock wave therapy (ESWT), ultrasound (US), laser, acupuncture, massage, manipulation immobilization, therapeutic exercises, and pharmacological treatment. So, the objective of the study is the comparison of effect of therapeutic ultrasound and dry needling on grip strength and patient rated tennis elbow evaluation (PRTEE) scale in patients of subacute lateral epicondylitis. Total 30 subjects were taken between age group 30-50. They were randomly divided into group A and group B equally. Group A was treated with dry needling (3 sessions) and conventional therapy in form of wrist eccentric exercise with help of flexbar and Group B was treated with help of therapeutic ultrasound (12 sessions) and conventional therapy for two weeks 6 days a week. Data were analyzed by SPSS statistics 21.00 software. Pre-treatment and post treatment comparison of PRTEE scale score and Grip Strength was done by paired t-test. Between group comparison of PRTEE scale score and Grip Strength was done by unpaired t-test. Result shows significant difference in PRTEE scale score (t=10.04, p<0.05) and Grip strength (t= -12.836, p<0.05) for group A. Also shows, significant difference in PRTEE scale score (t=6.49, p<0.05) and Grip strength (t= -7.574, p<0.05) for group B. between the group comparison of the data revealed

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significant difference between group A and group B for PRTEE scale score (t=4.293, p<0.05) and Grip strength (t=7.037, p<0.05) in patients with subacute LE. It can be concluded that the dry needling along with the conventional therapy has been found more helpful in reducing PRTEE scale score and improving grip strength in patients with subacute LE.

Keywords: Lateral Epicondylitis, Dry Needling, Eccentric Exercise, PRTEE scale score, grip strength, Flexbar, Ultrasound.

INTRODUCTION

Injuries to the elbow, specifically humeral epicondylitis, occur frequently in daily activities as a result of the repetitive loads encountered [1]. Lateral elbow pain is one of the most common sources of medical consultation for non-traumatic elbow disorders. The most frequent diagnosis is the tendinous disorder known as lateral epicondylitis (LE) or 'tennis elbow' [2]. Lateral Epicondylitis (LE) is a condition characterized by pain and tenderness at the lateral epicondyle of the humerus due to non-specific inflammation at the origin of the extensor muscle of the forearm [3]. Lateral epicondylosis is a musculoskeletal disorder also, characterized by degeneration of the tendon and frequently reported pain at the lateral aspect of the elbow [4]. Lateral epicondylitis is commonly called as tennis elbow, lateral epicondylalgia, or lateral epicondylosis depending on whether inflammation is present or not. Symptoms include pain in the common wrist extensor tendons along the lateral epicondyle and humero-radial(HR) joint with gripping activities, Activities requiring firm wrist stability, repetitive work tasks that require repeated wrist extension, such as computer keyboarding or pulling weeds in a garden[5] Lateral epicondylitis typically have pain that is worsened with activities that involve repetitive pronation and supination (e.g., tennis, throwing a ball, or plumbing) [6]. Lateral epicondylitis is a frequent complaint among musculoskeletal disorders affecting the upper extremities, with an annual prevalence of 1% to 3% in the active population. Sanders et al, in a 13-year epidemiological study, reported an overall annual age- and sex-adjusted 3 incidence of 3.4/1000 for lateral elbow tendinosis. A peak incidence is observed between 35 and 54 years of age, affecting slightly more women than men and having a higher prevalence for the dominant side [7]. The primary structure involved in lateral humeral epicondylitis as the tendon of the extensor carpi radialis brevis, the tendon of the extensor communis, additionally, the extensor carpi radialis longus and extensor carpi ulnaris can be involved. These tendons are originated from the lateral humeral epicondyle [4]Conservative therapeutic options involve orthotics, cryotherapy, extracorporeal shock wave therapy (ESWT), ultrasound (US), laser, acupuncture, massage, manipulation immobilization, therapeutic exercises, and pharmacological treatment [8].

Therapeutic Ultrasound
Ultrasound has a variety of physical effects that can be classified as thermal or non thermal. Increasing tissue temperature is its thermal effect. Acoustic streaming, micro streaming, and cavitation, which may alter cell membrane permeability, are its non thermal effects. In brief, ultrasound is a high-frequency sound wave that can be described by its intensity, frequency, duty cycle, effective radiating area (ERA), and beam non uniformity ratio (BNR) [9]. Ultrasound may be used in a continuous mode or in pulsed mode. In continuous mode, treatment head continuously produces ultrasonic energy. In pulsed mode, the periods of ultrasound are separated by periods of silence [10]. Continuous ultrasound is generally used to produce thermal effects, whereas pulsed ultrasound is used for non thermal effects. Both thermal and non thermal effects of ultrasound can be used to accelerate the achievement of treatment goals [9].

Dry Needling
Dry Needling is a skilled intervention performed by a physical therapist that uses a thin filiform needle to penetrate the skin and stimulate underlying myofascial trigger points (MTrP), muscular and connective tissue for the

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management of neuromuscular pain and movement impairment [11]. It is typically used to treat muscles, ligaments, tendons, subcutaneous fascia, scar tissue, peripheral nerves, for neuro-musculoskeletal pain syndrome [11].

Patient Rated Tennis Elbow Evaluation Scale (PRTEE)
The pain can be assessed using a self -reported measure such as the patient-rated tennis elbow evaluation (PRTEE) scale. It is a valid, reliable, and sensitive clinical instrument for individuals with chronic lateral epicondylosis. [4]FLEXBAR - It is a flexible rubber bar. The elastic Flexbar (Thera-band, Hygienic Corp, Akron, Ohio) produces an eccentric overload to wrist and forearm musculature by preloading the wrist and finger musculature followed by a slower eccentric contraction. [4] A twisting exercise using the Flexbar can be designed to eccentrically load the wrist extensors (pathologically affected in the lateral epicondylitis) [4]. JAMAR DYNAMOMETER - Good to excellent test–retest reliability (r = 0.88 to 0.93) and excellent inter-rater reliability (r = 0.99) have been reported. Jamar dynamometer has become the gold standard for the measurement of grip strength [12]. A wide variety of treatment protocols for lateral epicondylitis are available, however, the most effective management remains an area of debate. So, the basic need is to find treatment protocol for the better prognosis of the disease.

MATERIALS AND METHOD

A Randomized control trial was conducted on 30 patients with subacute lateral epicondylitis with age group of 30-50 years. Patient were selected for the study if they fulfilled the inclusion and exclusion criteria. The details and purpose of the study were explained to all patients and written consent was taken from them. Inclusion criteria were: Age Criteria: 30-50 years, Gender: Both Male and Female, Person having symptoms of lateral epicondylitis, Subjects with Positive MILL 'S MANEUVER, lateral epicondylitis more than 1 month. Exclusion criteria were: Trauma to the affected elbow in the preceding 6 weeks, Use of oral/systemic steroids, contraindication to injection therapy, Patients with hemorrhagic disease or on anti-coagulant, Local or systemic infection, Pregnancy, Local lymphoedema, Patient allergic to metals like nickel or chromium, Uncooperative patients, Patient with diabetes mellitus. MATERIALS USED were: Treatment Table, chair, pillow, Flexbar, Therapeutic ultrasound machine (electroson 709), Cotton, Aquasonic gel, Filliform needle, sterilizer, Jamar Hand held dynamometer (5030J1), PRTEE scale.

Procedure: The proposed title and procedure had been approved by ethical committee members of institute where the study was conducted. All the patients included in the study were explained priorly about the purpose of the study and about the procedure carrying out during the study before their enrolment in the study. Total 30 subjects were selected for the study, they were randomly divided into two group, GROUP A and GROUP B. Each group contains total 15 patients. 1) GROUP A: Dry needling and conventional therapy. 2) GROUP B: Therapeutic ultrasound and conventional therapy.   A pre - participation evaluation form consisting of basic assessment chart that was to be filled, which included name, age, gender, occupation, address, test for MILL 'S MANEUVER and ROM. After that the pre-data for outcome measures – PRTEE scale score, Grip strength (Figure1) were taken.

Group - A – Dry Needling (Figure2)
Dosage of dry needling: Patient received three sessions of the dry needling during the whole intervention protocol for the study at interval of 4 days. Patient has to sit on the chair and were asked to keep the affected hand on the table comfortably resting on pillow with shoulder slightly flexed and abducted and elbow flexed up to 70-90°. Therapist took the sitting position on the chair facing the affected side of the patient. Then therapist marks the tender point where the needling has to be given then with proper hygienic technique the needle was inserted at the marked point, here needle insertion can be done with the help of guide tube as well as without the help of guide tube. In the current study guide tube was used [13].

Group – B – Therapeuric Ultrasound (Figure3)
Dosage for therapeutic ultrasound was (1MHz, 1:4, 0.9W/cm2, 7minutes per session, 6 times weekly, for a total of 12 treatments), patient is asked to Sit on chair or couch with affected hand supported on pillow. Therapist was standing

in front of the patient facing the affected side of the patient. The ultrasound was given with the use of gel as conducting medium over the painful area near the lateral humeral epicondyle [8]. For the current study circular motion of the head was preferred for the ultrasound technique. Eccentric wrist exercise using flexbar was given to both the group as the conventional treatment after respective intervention. Following sequence (Figure 4) was followed for eccentric exercise – Patients were instructed to hold the flexbar with the affected hand from the one end of the flexbar with shoulder medially rotated, elbow 90° flexed and forearm in midprone position and another end with the unaffected hand with shoulder flexed up to 90°, elbow flexed 90° and forearm in pronation with wrist in neutral position after that ask the patient to extend both the elbows and fully pronate the forearm. Then ask the patient to flex the wrist of affected hand (as shown in figure with arrow) and then back to neutral. This is the whole one cycle of the eccentric wrist exercise with use of the flexbar, patients were instructed to perform this exercise in 3 sets of 10 repetitions with rest of one minute between each set of exercise [4].

Statistical Analysis
All statistical analysis was done by SPSS statistics version 21.00 for windows software. Microsoft excel was used to calculate mean and to generate graphs and tables Statistical test: Means and Standard Deviation (SD) were calculated as a measure of central tendency and measure of dispersion respectively. Pre-treatment and post treatment data of PRTEE scale score and grip strength was analysed by paired t test and comparison between two groups of PRTEE scale score and grip strength was analysed by unpaired t test. Level of significance (p value) was set to 0.05.

DISCUSSION

The present study was done with the purpose to find out the effect of dry needling Vs therapeutic ultrasound on PRTEE scale score and grip strength in the patient with the subacute lateral epicondylitis with conventional therapy in from of eccentric wrist exercises with help of flexbar for 6 days a week for consecutive 2 weeks. To Restore full function at the elbow, the wrist and the hand are the major goal of lateral epicondylitis rehabilitation. After the completion of the study, the result of the pre and post treatment PRTEE Scale score and grip strength for both the groups were analysed and the current study revealed that dry needling or therapeutic ultrasound combined with exercises for two weeks in patients with tennis elbow resulted in a significant decrease in pain intensity in the post-treatment, associated with significant increase in hand grip strength in both groups. In addition, it revealed that there was significant difference between dry needling and therapeutic ultrasound as regard to pain reduction and grip strength improvement, as dry needling allows a greater degree of pain relief and strength improved than the therapeutic ultrasound. Dry needling refers to insertion of thin monofilament needles without using a chemical agent. It is a new treatment modality used by physicians and physical therapists as a part of complex treatment of chronic musculoskeletal pain.

The result of present study was supported by the research done by Sudarshan Anandkumar *et. al*(2014) in which a single case of chronic elbow pain as a result of cyberchondria was treated using pain neuroscience education and dry needling, the working diagnosis for that patient was myofascial pain syndrome with Trigger point (Trp) of the brachioradialis, he exhibited symptoms of superadded central pain. It is known that TrPs, which are generators of peripheral pain, can individually also initiate central sensitization in patients.[14] This study also explains the possible mechanism by which the dry needling can be effective which are many that can reduce pain. Favourable treatment effects from dry needling are expected when Local twitch response (LTRs) are elicited. With LTRs, immediate reductions in pain and inflammatory chemicals (i.e., calcitonin gene related peptide, interleukins, substance p, tumour necrosis factor and bradykinin) have been found. Other than the chemical effect of dry needling on pain, it is postulated that dry needling has a mechanical as well as neurophysiological effect [14]. Another study which supports current study was done by M. A. WYMORE (2018), in which they have taken, A 61-year-old African American female with a 50 history of left non-dominant lateral elbow pain for 5 months was seen in department for treatment via dry needling six treatments over a 55-day period, and dry needling was added with the traditional stretches and activity modification. They concluded that after six additional visits with the use of dry needling, the

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patient in this case study was able to significantly improve objective and subjective measures. They had explained that the healing of the tissue occurs due to increase blood supply at the specific point [15]. Therapeutic US has been commonly used for lateral epicondylitis treatment and other musculoskeletal system diseases. There are studies reporting effectiveness of therapeutic US in lateral epicondylitis. One of the studies done by Hamza Shaheen *et. Al* (2019), they have seen effectiveness of therapeutic ultrasound and kinesio tape in patient with tennis elbow, twenty male and female patients with age from 20-50 years suffering from lateral epicondylitis were included for the study. Grip strength was measured by using hand held dynamometer and pain was measure using VAS scale, they found significant difference in grip strength and VAS scale score in both the group. But, effectiveness of Kinesio tape compared to therapeutic ultrasound was proved better.[16] Another study by, Bestami Yalvaç *et. al*(2018), in which Comparison of ultrasound and extracorporeal shock wave therapy in the patients of lateral epicondylosis, with total 50 patients they found Both EXTRA CORPOREAL SHOCK WAVE THERAPY (ESWT) and therapeutic US to be effective treatments for lateral epicondylitis, which evaluated patient pain levels, grip strength, functional status, and quality of life [8].

CONCLUSION

On bases of the results of the present study it can be concluded that the dry needling along with the conventional therapy has been found more helpful in reducing PRTEE scale score and improving grip strength in patients with subacute lateral epicondylitis. Also, ultrasound along with conventional exercise showed improvement but better results were found in group A. Hence it can be said that dry needling is an effective form of treatment.

Clinical Implication
The results of the present study suggest that treatment given in form of dry needling and conventional therapy and therapeutic ultrasound and conventional therapy both are effective but when both the protocols compared, dry needling and eccentric wrist exercise is found to be more helpful to improve PRTEE scale score and to improve grip strength in patients with subacute lateral epicondylitis. Hence dry needling can be considered as one form of treatment for the patient with lateral epicondylitis in clinical practice. Limitations of the Study were: hand dominancy was not considered, and in present study, long-term effects of dry needling were not investigated. Further Recommendation are Study can be done by taking a different group with patients of lateral epicondylitis and diabetes, follow up should be taken on regular interval to find out the chances of reoccurrence of lateral epicondylitis.

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Table 1: Intragroup Comparison of PRTEE Scale Score in Patients with Subacute Lateral Epicondylitis in Group A by paired t-test.

Table 1 PRTEE SCALE SCORE	MEAN	SD	t-test	p-value
Pre-Treatment	35.133	15.15	10.04	0.0001
Post-Treatment	12.7	7.34		

Table 2: Intragroup Comparison of PRTEE Scale Score in Patients with Subacute Lateral Epicondylitis in Group B by paired t-test.

Table 2 PRTEE SCALE SCORE	MEAN	SD	t-test	p-value
Pre-Treatment	30.333	8.287	6.49	0.0003
Post-Treatment	19.767	5.535		

Table 3: Intragroup Comparison of Grip Strength in Patients with Subacute Lateral Epicondylitis in Group A by paired t-test.

Table 3 Grip Strength	MEAN	SD	t-test	p-value
Pre-Treatment	10.86	6.65	-12.836	<0.0001
Post-Treatment	18.93	6.90		

Table 4: Intragroup Comparison of Grip Strength in Patients with Subacute Lateral Epicondylitis in Group B by paired t-test.

Table 4 Grip Strength	MEAN	SD	t-test	p-value
Pre-Treatment	13.80	7.50	-7.374	<0.0001
Post-Treatment	16.67	7.85		

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Table 5: inter group comparison of PRTEE scale score in patients with subacute lateral epicondylitis of Group A and Group B by unpaired t-test.

Table 5 PRTEE SCALE SCORE	MEAN	SD	t-test	P-value
Group A	22.433	8.654	4.293	<0.0001
Group B	10.567	6.302		

Table 6: inter group comparison of Grip Strength in patients with subacute lateral epicondylitis of Group A and Group B by unpaired t-test.

Table 6 Grip Strength	MEAN	SD	t-test	P-value
Group – A	8.07	2.43	7.037	<0.0001
Group -B	2.87	1.51		

Fig. 1 :PRTEE scale score, Grip strength

Fig. 2 : Group - A – Dry Needling

Fig. 3 : Group – B – Therapeuric Ultrasound

Fig. 4 : Eccentric Exercise

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Annexure
Patient Rated Tennis Elbow Evaluation Scale (PRTEE)

Patient Name: _____   Date: _____

The questions below will help us understand the amount of difficulty you have had with your arm in the past week. You will be describing your average arm symptoms over the past week on a scale 0–10. Please provide an answer for all questions. If you did not perform an activity because of pain or because you were unable, then you should circle a "10." If you are unsure please estimate to the best of your ability. Only leave items blank if you never perform that activity. Please indicate this by drawing a line completely through the question.

1. PAIN in your affected arm

Rate the average amount of pain in your arm over the past week by circling the number that best describes your pain on a scale from 0–10. A zero (0) means that you did not have any pain and a ten (10) means that you had the worst pain imaginable.

RATE YOUR PAIN:	No pain										Worst Imaginable
When you are at rest	0	1	2	3	4	5	6	7	8	9	10
When doing a task with repeated movement	0	1	2	3	4	5	6	7	8	9	10
When carrying a plastic bag of groceries	0	1	2	3	4	5	6	7	8	9	10
When your pain was at its least	0	1	2	3	4	5	6	7	8	9	10
When your pain was at its worst	0	1	2	3	4	5	6	7	8	9	10

2. FUNCTIONAL DISABILITY

SPECIFIC ACTIVITIES

Rate the average amount of difficulty you experienced performing each of the tasks listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0–10. A zero (0) means you did not experience any difficulty and a ten (10) means it was so difficult you were unable to do it at all.

	No difficulty										Unable to do
Turn a doorknob or key	0	1	2	3	4	5	6	7	8	9	10
Carry a grocery bag or briefcase by the handle	0	1	2	3	4	5	6	7	8	9	10
Lift a full coffee cup or glass of milk to your mouth	0	1	2	3	4	5	6	7	8	9	10
Open a jar	0	1	2	3	4	5	6	7	8	9	10
Pull up pants	0	1	2	3	4	5	6	7	8	9	10
Wring out a washcloth or wet towel	0	1	2	3	4	5	6	7	8	9	10

3. USUAL ACTIVITIES

Rate the amount of difficulty you experienced performing your usual activities in each of the areas listed below, over the past week, by circling the number that best describes your difficulty on a scale of 0–10. By "usual activities," we mean the activities that you performed before you started having a problem with your arm. A zero (0) means you did not experience any difficulty and a ten (10) means it was so difficult that you were unable to do any of your usual activities.

	No difficulty										Unable to do
1. Personal activities (dressing, washing)	0	1	2	3	4	5	6	7	8	9	10
2. Household work (cleaning, maintenance)	0	1	2	3	4	5	6	7	8	9	10
3. Work (your job or everyday work)	0	1	2	3	4	5	6	7	8	9	10
4. Recreational or sporting activities	0	1	2	3	4	5	6	7	8	9	10

Comments:

PRTEE Scoring Instructions

Minimize non-response by checking forms when the patient completes them. Make sure that the patient left an item blank because they could not do it, that they understand that should have recorded this item as a "10." If the patient is unsure because they have rarely performed an activity in the past week, then they should be encouraged to estimate their average difficulty. This will be more accurate than leaving it blank. If they never perform an activity they will not be able to estimate and should leave it blank. If items from a subscale are left blank, then you can substitute the average score from that subscale.

Pain Subscale—Add up 5 items. Best score = 0; Worst score = 50

Specific Activities—Add up 6 items. Best Score = 0; Worst Score = 60

Usual Activities—Add up 4 items. Best Score = 0; Worst Score = 40

Function Subscale—(Specific Activities + Usual Activities)/2 – Best score = 0; Worst score = 50

Total Score = Pain Subscale + Function Subscale (pain and disability contribute equally to score). Best Score = 0 Worst Score = 100

Reliability of subscales and total score are sufficiently high that both subscales and total are reportable.

RESEARCH ARTICLE

Survey of Ethnomedicinal and Ethnoveterinary Plants in Shekhawati Region of Rajasthan, India

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ABSTRACT

Ethno-botany is a special branch of natural science dealing with various aspects such as botany, anthropology, medicine, religious, agricultural, cultural, and various other disciplines. Traditional healers, local people, *Vaidyas* and tribal people are the only preservers of knowledge of ethno-medicine. Traditional system of medicine has been significant in health care for thousands of years since the ethno-medicinal plants are main source for the cure of various ailments. Present study was carried out to collect the information about ethno-medicinal and ethno-veterinary knowledge from locals and *Vaidyas* residing in villages of Shekhawati region of Rajasthan. Many wild plants are used by them to treat various ailments due to limited access to modern health care services. In this study 63 ethno-medicinal and 11ethno-veterinary plant specimens were collected, identified and information of their uses was documented. The source of information was based on interviewing with local people of the Shekhawati region and inputs from existing literature. Most of the species represent versatile importance and used to cure various ailments such as fever, wounds, diarrhea, ulcer, and skin diseases.

Keywords: Ethno-medicinal, Ethnoveterinary , Shekhawati, Traditional knowledge.

INTRODUCTION

Ethno-botany is broadly considered as the science which has the interaction between human and plants and their environment. In recent times ethno-botany has been of notable significance in the developmentof healthcare [1]. From many years ago, plants have been important source of safe and effective medicine. Due to their inexpensive, safe and effective nature, indigenous knowledge of treatment and cure of various types of diseases are popular

among the people of India and several other countries [2]. It recorded that approx 80% population of the world depends on traditional medicine for the primary and healthcare services[3]. Ethno-botanical survey was conducted to investigate the traditional folklores. It aids to conserve the traditional knowledge. Thus, an essentially indeed is needed before customized the remains of folklores. Hence, the traditional knowledge of folklores conservation is required. The importance of herbal medicines to treat various types of ailments is more popularize[4]. The traditional systems of medicine practiced in India are mostly relying on the applications of plant parts [5]. The tribal and rural people of India, still exclusively depends instant on the local herbal resources to cure the different types of diseases[6]. Herbal medicines also play crucial emphasis in developing countries owing to lack of modern health services in relations to many disorders. Out of the total 420,000 flowering plantsreported from the world [7], more than 50,000 are used for herbal medicines [8]. In India more than 43% of the total flowering plant species are reported to be of medicinal importance[9]. India is one of the richest mega diversity regions and one of the oldest countries contributing to folk medicine [10,11]. In India along with the ethno-medicinal, ethno-veterinary medicine is frequently used for treatment of animal disease by various ethnic groups and local people in rural areas [12]. These medicines provide low cost and feasible accessibility contrary to modern drugs [13]. The efficacy of ethno-veterinary drug is gently being normalized in the recent time. In the present era, interests in ethno-veterinary medicine have been raised globally. Ancient ethno-botanical reports suggest that the tribal and non-tribal community have pre owned the native ethno-flora due to different ethno-botanical applications for different kind of diseases in animals [14]. Rajasthan is the largest state of India in terms of geographical area. It is in the north-western part of the country, expanded over 3,42,239 sq km which is 10.4% of the total area of India. In Rajasthan ethno-medicinal studies have been carried out by several botanical workers from different regions. However, the ethno-medicinal and ethno-veterinary studies including their phytochemical estimation in Shekhawati region of Rajasthan are not carried out so far. The present study regarding healthcare is based on interviews by local community inhabitants of the area. The current work was formulated with the following objectives (I): To record the ethno-medicinal and ethno-veterinary plants of the Shekhawati area, (II): To record the information about ethno- medicinal, and ethno-veterinary applications of plants, (III): To select the plants which have high medicinal value for further analysis of various phytochemicals. The present study would provide fundamental concepts to conservationists, pharmacologists, a n d phytochemists, for further studies. This study would also make valuable contribution to conserve the traditional knowledge.

The study area Shekhawati region is situated in the north eastern part of Rajasthan. Shekhawati region has geographical expansion from 27°7' to 28°53' N latitude and 75°41' to 76°05'E longitude on the map of Rajasthan state. The area covers three districts i.e., Sikar, Jhunjhunu and Churu. This study was mainly conducted in *Raghunathgarh*, *HarshMountain*, *Shakambari*, *Smriti van (Sikar)*, *Mansa Mata (Udaipurwati)*, *Fathepur beer*, *Sri Karan Narendra Agriculture University (Fathepur)*, *Jhunjhunu beer* and some villages of Jhunjhunu and Churu districts during October 2020 to October 2022 with the help of local people, *Vaidyas* and Ayurvedic doctors.

Figures 1 and 2: Mansamata in Shekhawati area.
The study was mainly based on structured questionnaire and interviews comprising of questions about the uses of plants, cure against various ailments of man as well as cattle for which plant is used, preparation of medicine and whether any harmful effects had been detected. The information from each person was noted in the field notebook. Plant specimens were collected in various field trips and herbarium sheets were prepared. All specimens were identified with the help of available literature and Herbarium of Department of Botany, University of Rajasthan, Jaipur and accession number for each plant was provided by the same.

RESULT

63 ethno-medicinal and 11 ethno-veterinary plant species were collected and identified during the course of study (Table 1,2). It was evaluated that out of these collected plants, only one was identified as Gymnosperm and

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remaining as Angiosperms. Moreover, habit of maximum plants was reported to be herbs (42), followed by shrubs (16), trees (8) and climbers (2) (Fig 3-14).

CONCLUSION

The use of plants as medicine is gradually increasing by the rural residents as well as urban people. World Health Organization (WHO) recorded that 80% population of global level are depends on herbal medicines for their primary healthcare. This study demonstrates that the ethnic communities of Shekhawati region still have a rich traditional knowledge of ethno-medicinal and ethno-veterinary plants as an important source of primary health care. Despite consistent socio cultural transformation, locals still possess substantial knowledge of plants and their uses. Ethno-veterinary medicines are most valuable and precious for domestic animals in developing countries, where allopathic veterinary medicines are beyond the reach of animal herders. They play a major role in rural farm development. From above studies, it is concluded that 63 ethno- medicinal and 11 ethno-veterinary plant species has long been used as traditional medicine to cure various ailments in humans as well as animals.

ACKNOWLEDGEMENT

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Table 1: List of Ethno-Medicinal Plants Reported [17-30].

S. No.	Botanical name	Family	Common name	Habit	Medicinal uses
1.	*Abutilon indicum* (L.) Sweet	Malvaceae	Kanghi	Under Shrub	Toothache, Piles, Gonorrhoea, Bronchitis Piles, Anthelmintic.
2.	*Acacia nilotica*(L.) Willd. exDelile	Fabaceae (Mimosoideae)	Babul	Tree	Joint pain, Inflammation, Infectionof Eyes, Asthma, Diarrhoea, Dysentery, Diabetes.
3.	*Acacia senegal* (L.) Willd.	Fabaceae (Mimosoideae)	Kumtha	Tree	Demulcent, Emollient, Haemorrhage, Intestinal mucous,Food for diabetic patients.
4.	*Achyranthes aspera* L.	Amaranthaceae	Chirchita	Herb	Eruption, Skin diseases, Colic, Piles.
5.	*Adhatoda zeylanica* Medik.	Acanthaceae	Adusa	Shrub	Diuretic bronchitis, Asthma, Sore,Emmenagogue, Gonorrhoea, Leucoderma, Tumors.
6.	*Aerva javanica* (Burm.f.) Juss.Ex. Schult.	Amaranthaceae	Bui	Herb	Rheumatism, Diuretic, urinarytrouble, Jaundice.
7.	*Alternanthera pungens* Kunth	Amaranthaceae	Khaki weed	Herb	Gonorrhoea, Diuretic.
8.	*Argemone mexicana* L.	Papaveraceae	Satyanashi	Herb	Malarial fever, ulcers and Skinproblems.
9.	*Asparagus racemosus* Willd.	Asparagaceae	Shatavari	Herb	Laxative, Night blindness, Diseases of kidney, liver, blood,eye & throat.
10.	*Azadirachta indica* A.Juss.	Meliaceae	Neem	Tree	Anthelmintic, Blood & Skin disease, Ulcers, Diuretic, Ophthalmia.
11.	*Balanites Aegyptiaca* (L.) Delile	Zygophyllaceae	Hingot	Smalltree	Leucoderma, Ulcers, Skin diseases,Antidysentric, Analgesic, Purgative.
12.	*Barleria Prionitis* L.	Acanthaceae	Pili katsaraiya	Shrub	Leucoderma, Bronchitis, Alexiteric, Inflammation, Skin disease.
13.	*Bidens biternata* (Lour.) Merr.&Sherff	Asteraceae	Chirchitta	Herb	Inflammation, Infection, Malaria,Leprosy, Ulcer and Digestive disorders.
14.	*Blainvillea acmella* (L.) Philipson	Asteraceae	Kanghi	Herb	Rheumatism and Headache.
15.	*Calotropis procera* (Aiton) W.T. Aiton	Asclepiadaceae	Aak	Shrub	Tonic, Piles, Asthma, Toothache.

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16.	*Capparis deciduas* (Forssk.)Edgew.	Capparaceae	Ker	Shrub	Ulcer, Cough, Asthma, Piles, Laxative, Biliousness, Rheumatism, Anthelmintic, Ulcer.
17.	*Cardiospermum halicacabum* L.	Sapindaceae	Kanphuta	Herb	Gonorrhoea, Diaphoretic, Diuretic,Emmenagogue, Rheumatism.
18.	*Catharanthus roseus* (L.)G.Don	Apocynaceae	Sadabahar	Herb	Anticancer, Hypotensive, Sedative.
19.	*Cassia fistula* L.	Fabaceae (Caesalpinioideae)	Amaltas	Tree	Leprosy, Skin diseases, Heart diseases, Purgative, Antipyretic,Laxative.
20.	*Cassia occidentalis* L.	Fabaceae (Caesalpinioideae)	Kasunda	Under Shrub	Conjunctivitis, Skin diseases, Opthalmia, Anthelmintic.
21.	*Celosia argentea* L.	Amaranthaceae	Gadrya	Herb	Gonorrhoea, Liver tonic, Diarrhoea, Pulmonary, Blood diseases.
22.	*Chenopodium album* L.	Chenopodiaceae	Bathua	Herb	Eye disease, Tonic, Piles, Laxative,Diuretic, Diseases of Blood, Heart & Spleen, Appetizer.
23.	*Citrullus colocynthis* (L.) Schrad	Cucurbitaceae	Tumba	Herb	Urinary disease, Purgative, Rheumatism, Jaundice.
24.	*Cleome viscose* L.	Cleomaceae	Bagro	Herb	Infection, Rheumatism, Fever andHeadache.
25.	*Clerodendrum phlomidis*L.f.	Lamiaceae	Arni	Shrub	Diabetics, Laxative, Piles, Inflammation, Anemia.
26.	*Cocculus pendulus* (J.R.Forst. &G.Forst.)Diels	Menispermaceae	Pilwan	Climber	Fever, Gonorrhoea, Diuretic, Leprosy, Healing, Skin diseases.
27.	*Crotolaria burhia* Buch.-Ham. exBenth.	Fabaceae (Papilionoideae)	Saniya	Under Shrub	Gout, Cooling medicine, Swelling.
28.	*Croton bonplandianus* Baill.	Euphorbiaceae	Kala bhangra	Herb	Cholera, Boils, Diarrhoea, Dysentery, Abdominal dropsy, Cold, Cough, Lung infection, Asthma, Jaundice, Reduce pain,Sprains, Headache.
29.	*Cynodon dactylon* (L.)Pers.	Poaceae	Doob	Herb	Diuretic, Astringent, Dropsy.
30.	*Datura stramonium* L.	Solanaceae	Jimsonweed	Herb	Antispasmodic, Narcotic, Asthma,Sedative, Intoxicant.
31.	*Dicliptera paniculata* (Forssk.) I.Darbysh	Acanthaceae	Atrilal	Herb	Bone fracture, Sprain, Cold, Coughand Fever.
32.	*Dicoma tomentosa* Cass.	Asteraceae	Vajradanti	Herb	Pyorrhoea and dental problems,Febrifuge.

33.	*Digera muricata* (L.) Mart.	Amaranthaceae	Khanjru	Herb	Astrigent, Laxative, Biliousness,Urinary discharge.
34.	*Echinops echinatus* Roxb.	Asteraceae	Oont-kateli	Herb	Alternative, Diuretic, Biliousness,Nerve tonic, Dyspepsia, Ophthalmia, Cough, Scrofula.
35.	*Euphorbia hirta* L.	Euphorbiaceae	Dudhi	Herb	Dysentry, Menorrhagia, Diarrhoea.
36.	*Ephedra foliata*Boiss ex C.A.Mey.	Ephedraceae		Herb	Colds, Coughs, Edema, Fever, Headaches, Nasal congestion , Respiratory disease, Rheumatism.
37.	*Jatropha gossypiifolia* L.	Euphorbiaceae	Ratanjoti	Shrub	Emetic, Insanity, Purgative, Itches,Emmenagogue.
38.	*Leptadenia pyrotechnica* (Forssk.) Decne	Asclepiadaceae	Khimp	Shrub	Constipation, Wound healing, Skindisease, Rheumatoid arthritis, Diabetes.
39.	*Leucas aspera* Willd.) Link	Lamiaceae	Chhota ghalkusa	Herb	Psoriasis, Chronic rheumatism.
40.	*Leucas urticifolia* (vahl) Sm.	Lamiaceae	Kannuthu mbai	Herb	Swelling, Cold and Cough.
41.	*Lindenbergia indica*(L.) Vatke	Orobanchacea e	Pili-buti	Herb	Toothache, Stone diseases.
42.	*Mollugo cerviana* (L.) Ser.	Molluginaceae	Chirimorio	Herb	Fever, Rheumatism, Gout, Jaundice, Stomach ache.
43.	*Mollugo nudicaulis* Lam.	Molluginaceae	Naked-stem Carpetwee d	Herb	Laxative, Stomachic, Antiseptc,Emmenagogue.
44.	*Moringa oleifera* Lam.	Moringaceae	Sainjana	Tree	Aphordisiac, Alexiteric, Analgesic,Muscular and Skin diseases, Anthelmintic, Ulcers, heart troubles, Ophthalmia.
45.	*Ocimum americanum* L.	Lamiaceae	Kali tulsi	Herb	Fever, Parasitic diseases, Antirheumatism, Expectorant,Nasal haemorrhage.
46.	*Oxalis corniculata* L.	Oxalidaceae	Khattibuti	Herb	Appetizer, Dysentry, Piles, Diarrhoea, Skin diseases.
47.	*Pedalium murex* L.	Pedaliaceae	Badagokhuru	Herb	Antispasmodic, Aphrodisiac, Diuretic, Demulcent, Gonorrhea,Dysuria, Emmenagogue.
48.	*Physalis minima* L.	Solanaceae	Papotan	Herb	Malaria, Toothache, Liver ailments including hepatitis, Rheumatism, Relaxant, Diuretic.
49.	*Portulaca oleracea* L.	Portulacaceae	Noniya	Herb	Laxative, Diarrhoea, Asthma,

				Ulcer, Piles, Dysentry, Leprosy,Kidney & Spleen Diseases.
50.	*Prosopis cineraria* (L.) Druce	Fabaceae (Mimosoideae)	Khejri	Tree	Astringent, Rheumatism.
51.	*Rhus mysorensis* G. Don	Anacardiaceae	Dansaro	Shrub	Antidiabetic, Hepatoprotective,Wound healing, Anti- inflammatory.
52.	*Sida acuta* Burm.f.	Malvaceae	Wireweed	Under shrub	Aphrodisiac, Anthelmintic, Demulcent in Gonorrhoea, Astringent.
53.	*Sida cordifolia* L.	Malvaceae	Kharinta	Under shrub	Emollient, Aphrodisac, Digestive,Blood diseases, piles, Diseases ofthroat.
54.	*Tecomella undulata* (Sm.)Seem.	Bignoniaceae	Rohida	Tree	Laxative, Anthelmintic, Ulcers, Blood & Eye diseases, Abdominaland liver complaints.
55.	*Tephrosia purpurea* (L.)Pers.	Fabaceae (Papilionoideae)	Sharpunkh a	Herb	Ulcers and wounds, Spleen complaints, Syphilis, Gonorrhoea,Antipyretic, Diseases of heart, Spleen, Liver, Leprosy, Asthma and Bronchitis.
56.	*Tinospora cordifolia* (Willd.) Hook. f.& Thomson	Menispermaceae	Neem-Giloi	Climber	Emetic, Rheumatism, Jaundice.
57.	*Tribulus terrestris* L.	Zygophyllaceae	Gokhru	Herb	Piles, Heart diseases, Diuretic, Aphrodisiac, Blood purifier, Leprosy, Diuretic.
58.	*Tridax procumbens* L.	Asteraceae	Kumra	Herb	Anticoagulant, Skin diseases. Thejuice extracted from the leaves is directly applied on wounds.
59.	*Triumfetta rhomboidea* Jacq.	Tiliaceae	Chikti	Shrub	Skin diseases, Dysentery, Conjunctivitis.
60.	*Vernonia cinerea* (L.) Less.	Asteraceae	Sahadevi	Herb	Diaphoretic, Conjuntivitis, Strangury, Promotes perspiration.
61.	*Withania somnifera* (L.)Dunal	Solanaceae	Ashwagandha	Under Shrub	Alternative, Narcotic, Bronchitis,Psoriasis, Ulcers, Aphrodisiac Rheumatism and Diuretic Tonic.
62.	*Xanthium strumarium* f.	Asteraceae	Sankhahuli	Herb	Rhinitis, Nasal sinusitis, Headache,Urticaria, Gastric ulcer, Rheumatism.
63.	*Zaleya govindia* (Buch. Ham. Ex G.Don) Nair	Aizoaceae	Santhi	Herb	Syphilis, Swellings of sex organs and Ladies take root extract to regularize menstruation.

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Table 2: List of plants used as ethno-veterinary medicine [31-33]

S. No.	Botanicalname	Family	Common name	Habit	Ethno-veterinary uses
1.	*Acacia nilotica*(L.) Willd. ex Delile	Fabaceae (Mimosoideae)	Babul	Tree	Indigestion and Gastricproblems
2.	*Allium cepa* L.	Liliaceae	Safedkanda	Herb	Febrifuge, Tonic.
3.	*Allium sativum* L.	Liliaceae	Lahsun	Herb	Gastric problem.
4.	*Brassica campestris* L.	Brassicaceae	Sarso	Herb	External lice, Gastricproblem.
5.	*Calotropis procera* (Aiton) W.T. Aiton	Asclepiadaceae	Aak	Shrub	Used in Khurpaka disease,wound healing.
6.	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Tumba	Herb	Abdomen pain, Gestations,and Skin infection.
7.	*Ricinus communis* L.	Euphorbiaceae	Arandi	Shrub	Stomach disorder, Gastricproblem, Throat disease.
8.	*Tinospora cordifolia* (Willd.) Hook. f. & Thomson	Menispermaceae	Neem -Giloi	Climber	Skin infections.
9.	*Tephrosiapurpurea* (L.)Pers.	Fabaceae (Papilionoideae)	Sharpunkha	Herb	Skin disease, Curehaematuria.
10.	*Trachyspermumammi* (L.) Sprague	Apiaceae	Ajwain	Herb	Gastric problem, cure indigestion, Diarrhea,Typhoid, Pneumonia.
11.	*Tribulus terrestris* L.	Zygophyllaceae	Gokhru	Herb	Chronic cough.

Fig: 1

Fig: 2

Figures 1 and 2: Mansamata in Shekhawati area

Fig: 3 *Leucas aspera*

Fig. 4 *Jatropha gossypifolia*

Fig. 5 *Bidens biternata*

Fig. 6 *Triumfetta rhomboidea*

Fig. 7 *Pedalium murex*

Fig. 8 *Cleome viscosa*

Fig. 9 *Euphorbia hirta*
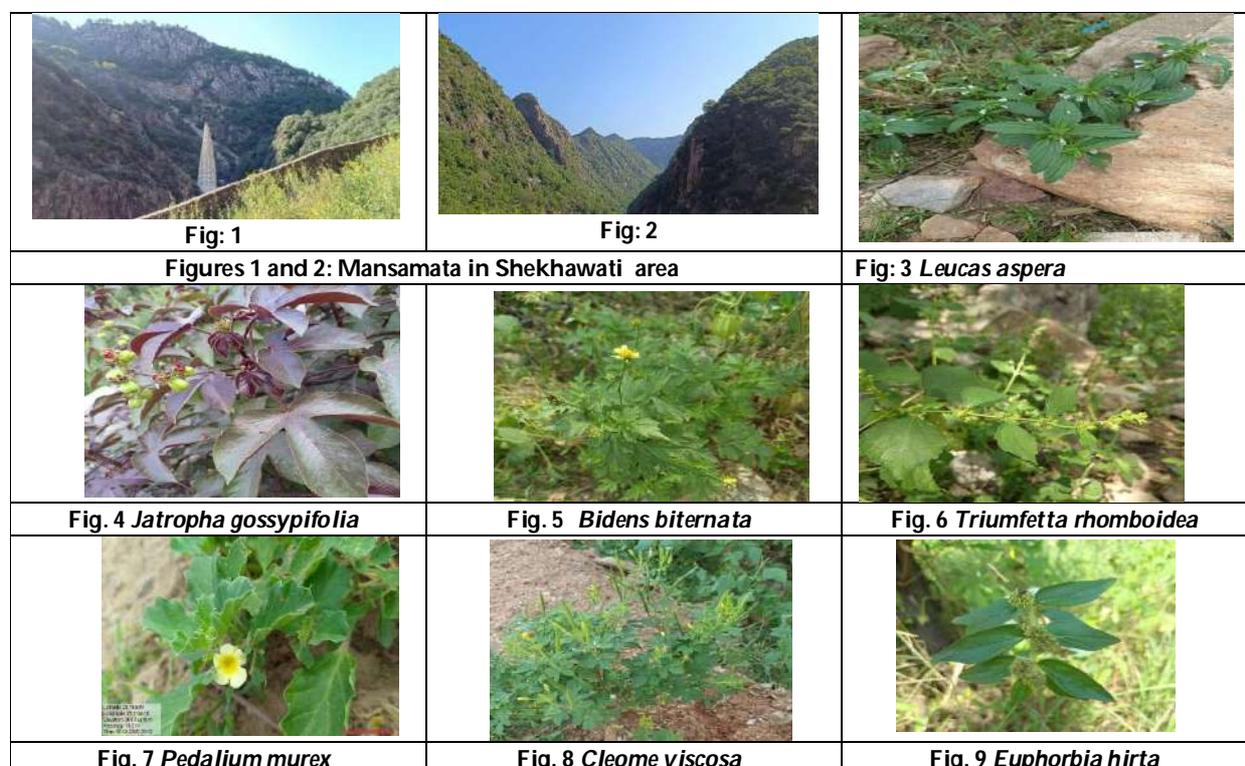
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Fig: 10 *Dicleptera paniculata*

Fig: 11 *Capparis decidua*

Fig: 12 *Barleria prionitis*

Fig: 13 *Celosia argentea*

Fig: 14 *Oxalis corniculata*

Chart 1. Diversity of Plants in India [15,16].
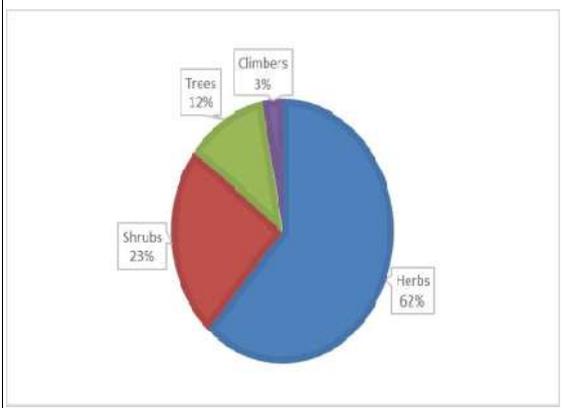
Chart 2: Distribution of plants under various life forms
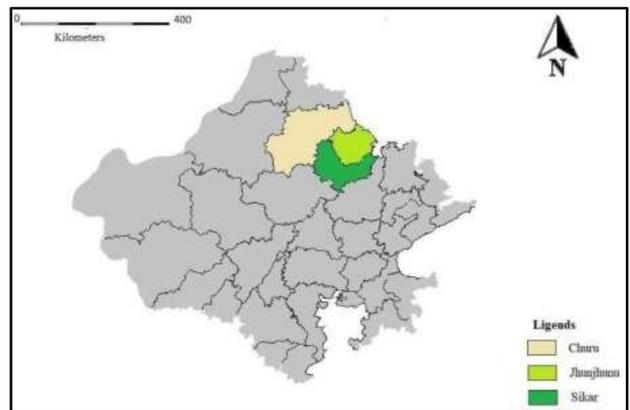
Map: showing the geographical locations of study area

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RESEARCH ARTICLE

Diagnosing Cardiovascular Disease in MRI Images using Machine Learning Algorithms

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ABSTRACT

Taking care of people's health is one of the most difficult tasks in the world. Cardiovascular disease is one of the most common causes of death. To diagnose this cardiac abnormality, researchers will need to develop a system that can predict its presence and prevent heart disorders, which are on the increase. Machine learning (ML) has been showing an effective support in making decisions and predictions from the large quantity of data produced by the healthcare industries and hospitals. In this work, we used a Cardiac MRI image and better processing steps to increase the quality of the cardiovascular disease prediction. It improves the evaluation of a patient's cardiac diseases and helps a doctor to determine whether a patient has cardiovascular disease. To back up our predictions, the accuracy is evaluated, precision, f1-score, and recall performance metrics of various machine-learning algorithms.

Keywords: Cardiac Magnetic Resonance (CMR) Imaging, segmentation, deep learning, U-net, Convolutional Neural Networks (CNN), Random Forest

INTRODUCTION

According to the World Health Organization, cardiovascular diseases (CVDs) constitute the leading cause of death worldwide (WHO).In 2016, 17.9 million deaths as a result of CVDs, primarily from heart disease and stroke. The number continues to rise every year. Significant progress has been made in cardiovascular practice and research in recent decades, with the goal of improving heart illness detection and treatment, as well as lowering CVD mortality.

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The work proposed in this paper is primarily concerned with various machine-learning approaches used in cardiovascular disease prediction. The human heart is the most important organ in the body. Essentially, it controls blood flow throughout our bodies. Any abnormality in the heart may induce suffering in other parts of the body. Heart disease can be defined as any interruption in the normal functioning of the heart. In today's world, heart disease is one of the leading causes of death. Heart disease can develop because of an unhealthy lifestyle, smoking, drinking, and a high-fat diet, which can lead to hypertension [1]. According to the World Health Organization, more than ten million people worldwide die because of heart disease every year. The primary challenge in today's healthcare is to provide high-quality services and accurate diagnoses [2]. Even while cardiac disease has been identified as the leading cause of death worldwide in recent years, it is also one that may be effectively controlled and managed. The entire accuracy of disease care is dependent on the correct time of detection. Machine Learning (ML), a branch of data mining, efficiently processes large-sized well-formatted datasets. Machine learning can be used in the medical industry to diagnose, detect, and forecast numerous diseases. The primary purpose of this work is to give doctors a tool for detecting cardiac disease at an early stage [3]. As a result, patients will receive more effective treatment while avoiding serious repercussions. The performance of efficient machine learning models is dependent on the availability of sufficient and correct data. Data preprocessing is a function that is required to generate results that pass internal and external validation. There is an increasing availability of quality sources of structured big data for cardiac imaging through different biobanks, bio resources, and databases. There really are two types of datasets: population-based and clinical datasets.

To attain adequate accuracy, they frequently require extensive feature engineering or prior knowledge. Deep learning (DL)-based algorithms, on the other hand, excel at automatically detecting and segmenting complex features from data. These features are directly learned from data in an end-to-end manner using a general-purpose learning method. This makes it simple to extend DL-based algorithms to various image analysis applications. DL-based segmentation algorithms have gradually outperformed previous state-of-the-art traditional methods, gaining more popularity in research, thanks to advanced computer hardware [e.g. , graphical processing units (GPUs) & tensor processing units (TPUs)] as well as increased available data for training. To our knowledge, multiple review papers that provide overviews of applications of DL-based techniques for general medical image analysis (5–7), as well as several surveys specializing in applications for cardiovascular image analysis, have been published (8, 9). However, none of them have provided a thorough overview of cardiac segmentation applications. The machine learning framework Random forests (RFs) [10-11] has recently gotten a lot of interest in the medical picture segmentation [12-14]. The RFs are designed to handle huge amounts of multiclass data with enormous data dimensions, and they've proven to be accurate and dependable for a range of cardiac tissue segmentation tasks [15]. Margeta *et al.* [16] proposed using context-rich criteria in combination with a decision forest technique to automatically distinguish the LA from other blood pools in three dimensions.

Image Segmentation
Segmentation is the technique of partitioning a digital image into various subsets (of pixels) called "Image Objects" in order to minimize the image's complexity and make analysis easier. Automatic or semi-automatic detection of boundaries inside a 2D or 3D image is the process of medical image segmentation. The high variability in medical images is a huge challenge when it comes to segmentation. To begin with, two primary types of variation may be seen in human anatomy. Additionally, medical images are created using a variety of modalities (X-ray, CT, MRI, microscope, PET, SPECT, endoscopy, OCT, and others). The segmentation results can then be used to gain additional diagnostic information. Organ measuring, cell counting, and simulations based on the extracted boundary are examples of possible uses.

Region Based Segmentation
There are two types of segmentation models: standard and ROI models. The first requires a standard image, while the second requires an ROI. The region of interest (ROI) is defined as the labeled area of an image slice, which in most cases is practically a small part of the image. Naturally, the question arises whether applications focusing only on this region might improve. To explore this idea further, it is defined two types of region-based segmentation,

namely: region splitting and region merging. Here the region splitting methodology is used. These algorithms begin with a whole image, and divide it up until each sub region is uniform. When the attributes of a newly split region do not differ by more than a threshold from those of the original region, the splitting procedure is often terminated. The preprocessing steps are performed as shown in fig.1.

Proposed Work
The series of steps involved in our proposed model are as follows: Data preprocessing, splitting datasets, Feature Extraction and Selection, Disease Prediction using Machine Learning algorithms as shown in fig.2.

Data Preprocessing
Data preprocessing is a required task for cleaning the data and making it suitable for a machine learning model, which also increases the accuracy and efficiency of the machine learning model. The steps to be taken are 1.Read image, 2.Resize image, 3.Remove noise(Denoise), 4.Segmentation, 5.Morphology(smoothing edges).

Convolutional Neural network (Cnn) Algorithm
A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning technique capable of taking an image as input, assigning importance (learnable weights and biases) to special attributes or objects in the image, and distinguishing between them. Other classification techniques require substantially more preprocessing than ConvNet. ConvNets can learn these filters and attributes with enough training, but fundamental methods require hand engineering.

Architecture of CNN
A cardiac MR image is sent into CNN, which learns structural features via a stack of convolutions and pooling processes. Through completely connected layers, these spatial feature maps are flattened and reduced into a vector. This vector can assume many different shapes depending on the task. They can be probabilities for a set of classes (image classification), bounding box coordinates (object localisation), a predicted label for the input's center pixel (patch-based segmentation), or a real value (regression problems) as shown in Fig.3. A patch-based segmentation method based on a CNN classifier. The CNN takes a patch as input and probabilities for four classes, with the class with the highest score acting as the forecast for provides the patch's center pixel (yellow cross). The whole image's pixel-wise segmentation map can be obtained by repeatedly feeding patches at different points into the CNN for classification.

Flow Chart For CNN
The first step is to import a cardiac MRI image and decrease noise using preprocessing techniques. After that, the image is segmented using image segmentation techniques. The feature map is extracted after that. As illustrated in Fig.4, these feature maps are given to the classification process as an input to discover abnormalities in images using CNN and Random Forest techniques.

Modified Random Forest Algorithm
Random Forest is a well-known supervised learning machine learning approach. Machine learning can be used to solve both classification and regression problems. It's based on an ensemble learning structure, which is a method for combining multiple classifiers to tackle a complex problem and improve the model's performance. A Random Forest is a classifier that averages the results of several decision trees on distinct subsets of a dataset to enhance the dataset's accuracy level. Instead of relying on a single decision tree, the random forest collects forecasts from each tree and predicts the ultimate output based on the majority of prediction votes. The architecture is shown in fig. 5.

Flowchart For Random Forest
Random Forest uses bagging to tackle the instability problem because it takes the average in regression rather than counting the number of votes like classification does. The random forest algorithm is an additive model that predicts outcomes by combining judgments from a number of different sources. A formal equation for this class of models is

g(x)=f0(x)+f1(x)+f2(x)+...The total of the simple base models fi is g. In this example, every base classifier is a decision tree. It's crucial to understand that the phrases regression and classification are notinter changeable. In comparison to classification, regression's default try is m/3, while the node size is1,therefore there is only one measure of variable importance instead of four in classifiers as shown inFig.5.

RESULT

Performance Evaluation
For the evaluation process, confusion matrix, accuracy score, precision, recall, sensitivity, and F1 score are used. A confusion matrix is a table-like structure in which there are true values and predicted values, called true positive and true negative. It is defined in four parts: the first one is true positive (TP) in which the values are identified as true and, in reality, it is also true. The second one is false positive (FP) in which the values identified are false but are identified as true. The third one is false negative (FN) in which the value was true but was identified as negative. The fourth one is true negative (TN) in which the value was negative and was truly identified as negative. The table is shown in Fig.6. Then for checking how well a model is performing, an accuracy score is used. It is defined as the true positive values plus true negative values divided by true positive plus true negative plus false positive plus false negative. The formula is

$$Accuracy \quad \frac{TP+TN}{TP+TN+FP+FN}$$

To evaluate the efficiency of the classification, the predicted type was compared with the original type. In the proposed methodology, for classification objective, the dataset was examined by four different classifiers mentioned as shown in table1. The Random Forest tree classifier has the best accuracy of 99.98. With the highest accuracy, the Random Forest tree classifier has been used. Convolutional Neural Networks is also evaluate and the Random Forest method seem to predicted cardiovascular disease with the most accuracy.

CONCLUSION

Many current algorithms are unsuitable for accurately predicting CVD illness. Doctors, too, are unable to correctly forecast the condition. As a result, the proposed method aids medicos in their forecasting efforts. In this script, we developed an illness prediction model based on convolutional neural networks and Random Forest. The study also included a comparison of the proposed work with current algorithms. Two convolutional layers, two dropout layers, and an output layer are the components of the proposed model. The planned network has to cope with a lot of information. Another benefit of this model is that it performs its own preprocessing, feature extraction, and prediction, whereas the previous algorithm employed distinct methods for each problem. Machine learning and other optimization approaches can also be applied to improve the evaluation findings. Different methods of normalizing the data can be applied, and the results can be compared. More techniques could be explored to integrate heart-disease-trained ML and DL models with specific multimedia for the benefit of patients and doctors.

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Table.1:Comparison of Performance Metrics

METHOD	DATARATIO	ACCURACY	SENSITIVITY	PRECISION
SVM	50:50	57%	38%	43%
KNN	50:50	75%	54%	63%
CNN	50:50	87%	90%	72%
RF	50:50	99.98%	92%	85%
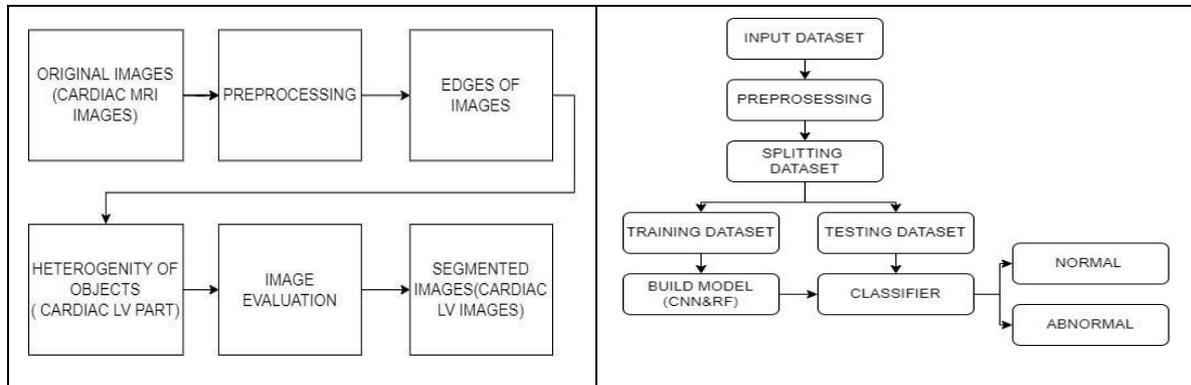
Fig.1:Block Diagram of Segmentation

Fig.2: Flow chart for Proposed Work
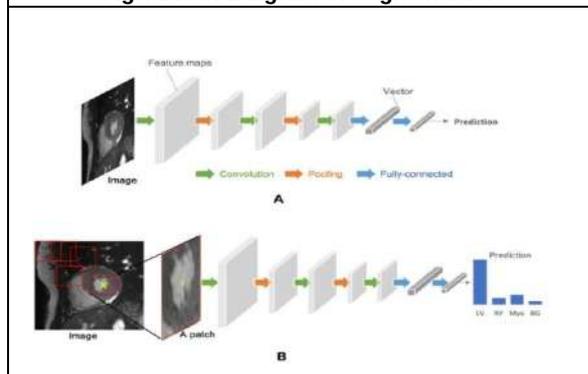
Fig.3: Architecture Of CNN
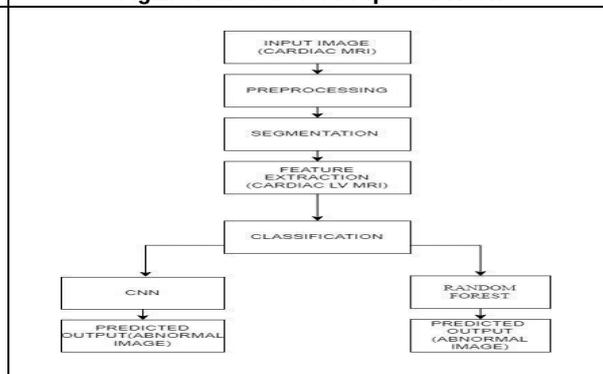
Fig.4: Flow chart for Proposed work
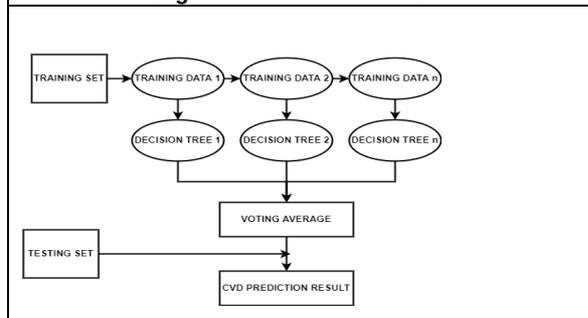
Fig.6: Architecture for Random Forest
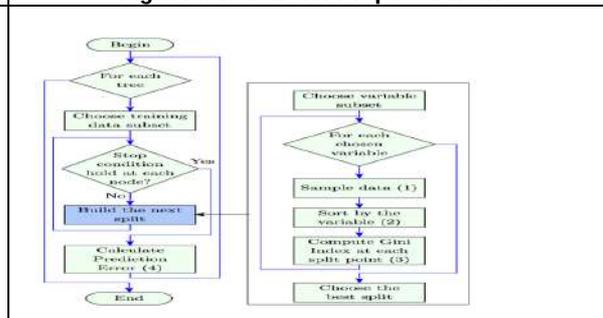
Fig.7: Flow chart for Random Forest

Fig.8: Confusion Matrix

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RESEARCH ARTICLE

Microbial Degradation of Low-Density Polyethylene (LDPE) by Bacteria Isolated from Landfill Soil

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ABSTRACT

This study aimed to formulate bacteria isolated from plastic waste dumped area and thereby develop an eco-friendly approach for enhanced degradation of low-density polyethylene (LDPE). The LDPE degrading bacteria were screened and morphologically characterized. The degradation products were analyzed by weight loss, CO_2 production, FTIR and SEM. The formulated bacterial isolates demonstrated as 3.278, 4.025 and 2.283% of weight reduction for LDPE films, over a period of 90 days. The end product analysis showed structural changes and formation of bacterial film on degraded LDPE film. The 16S rDNA characterization of bacterial isolates revealed that these organisms are designated as *Paracoccus pantotrophus* JB1C (GenBank accession: ON203112), *Chelatococcus caeni* JB2W (GenBank accession: ON203113) and *Mycolicibacterium phlei* JB4Y (GenBank accession: ON203114). The present investigation suggests that industrial scale-up of these microbial isolates indubitably provides better insights for waste management of LDPE and similar types of plastic garbage.

Keywords: Low density polyethylene (LDPE), Plastic-degrading bacteria, SEM analysis, FTIR, Pollution control.

INTRODUCTION

One of the hazardous threats to global ecosystem is the massive accumulation and bioamplification of synthetic plastic (Low density polyethylene) due to the lack of safe and efficient method for recycling and disposal [1]. The

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accumulation of plastic waste is a rising concern where the Central Pollution Control Board (CPCB), government of India furnished a data on plastic waste generation by 35 States/Union territories for the year 2019-2020, estimated approximately 34,69,780 Tonnes Per Annum (TPA). It is observed that maximum quantity of plastic waste generated in Maharashtra (13%) followed by Tamil Nadu (12%) and Gujarat (12%) [2]. In recent years, there has been serious concern in India over environmental destruction associated with the improper disposal of plastic wastes. The Central Pollution Control Board (CPCB 2019), government of India reported approximately 26,000 MT plastic waste are generated per day and out of this 15,600 MT are recycled (5.6 MMT per year) and 9,400 MT of waste are left uncollected plastic litter (3.8 MMT per annum) [3].

Natural and aesthetic approach through microbial biotechnology will more efficiently clean up plastic pollution than conventional physico- chemical method and greatly reduce the land filling. Bioremediation is one of the best approaches in which enrichment of nutrients for the growth of microorganisms present in the plastic contaminated soil by stimulating the activity or by incorporating through bioaugmentation method. This approach regarded as the best and safest method possibly releases less toxic substances [4, 5].The microbial enzymes plays a major role in degrading the various hydrocarbon derivatives of polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), and heterocyclic compounds by utilizing them as a carbon sources and releases into less toxic or nontoxic substances [6]. Formulation of efficient and eco-friendly degrading microbial isolates is gaining attention due to considerable advantages over the application of xenobiotic degradation. This approach is ideal and widely accepted, because of safe detoxified synthetic plastic degradation [7, 8].

MATERIALS AND METHODS

The materials needed for this research study are 20 micron thick low density polyethylene (LDPE) film purchased from Salem markets. Bushnell and Hass mineral salt readymade (MSM) media used for isolation of microorganism. The composition consist of Magnesium sulphate 0.2 g/L, Calcium chloride anhydrous 0.02 g/L, Potassium dihydrogen phosphate 1.0 g/L, Dipotassium hydrogen phosphate 1.0 g/L, Ammonium nitrate 1.0 g/L, Ferric chloride 0.05 g/L and bacteriological agar (5.0 g/L) added along with above composition. The MSM media was amended with polyethylene glycol (PEG) as the only carbon source in the media. All chemicals used in this study were procured from the Himedia, India.

Microbial degradation study by bacteria
The LDPE degrading bacteria was isolated from the soil of plastic dump landfill site at Omalur region of Salem City, Tamil Nadu, India. The purchased LDPE film sample was cut into square sized 3X3 cm introduced into the MSM media flask along with bacterial culture. After incubation period both LDPE films and culture broth were extracted at regular interval and studied for degradation activity.

Optimization of growth parameters
The isolated bacteria were grown under varied pH and temperature condition to optimize the growth parameters. The pH variation used for optimization, ranges from acidic to alkaline (5, 6, 7, 8 and 9). Similarly, temperature variation includes 25, 37, 45 and 50 °C. After treating with each optimization condition the OD value was measured using UV spectrophotometer [9].

Biodegradation assay
Weight loss analysis
To estimate the weight loss, LDPE films were removed after 30 and 90 days treatment with bacteria. Collected LDPE films were disinfected with 2% sodium dodecyl sulfate (SDS) for 3 hours to remove the bacterial bioflim from the LDPE surface. Further, the LDPE films were treated with 70% ethanol and washed with distilled water for three times. The washed LDPE film was dried overnight at 60ºC before weighing and the percentage of weight loss was determined using the formula [10].

$$Weight\ loss\ \% = \frac{Initial\ weight - Final\ weight}{Initial\ weight} \times 100$$

Evaluation of CO_2 Production

Dissolved CO_2 in the culture broth was determined by the titration method after 15 days of incubation. The supernatant of individual bacteria culture were collected. Then 25 ml of bacterial supernatant was mixed with 0.05 ml of 0.1 N sodium thiosulphate and 2 drops of methyl orange added as an indicator. The solution was titrated against 0.02M sodium hydroxide solution till a yellow colour appears. After that, two drops of phenolphthalein were added and titration was performed until a pink colour was observed. Volumes of the titrant (0.02 M sodium hydroxide) used were recorded. The amount of CO_2 in the broth was calculated using the following equation [11].

$$Dissolve\ CO2\ \frac{mg}{L} = \frac{[A \times B \times 50 \times 1000]}{V}$$

Where, A = volume of titrant NaOH in ml, B = normality of titrant NaOH and
V = volume of sample (culture broth) in ml.

Characterization Study
Scanning Electron Microscopy Analysis (SEM)

The LDPE films were taken out from the culture medium after 30 and 90 days of bacterial incubation and surface sterilized prior to examination. Scanning electron microscope was employed to examine the changes on the LDPE surface. These samples were visualized the distinctive changes of LDPE films, on post degradation between the control and treated sample [12].

Fourier Transform Infrared Spectroscopic Analysis (FTIR)

The LDPE film was withdrawn from culture medium after 90 days of incubation processed and air dried prior to analysis. The LDPE film was analyzed with FTIR spectrometer (Shimadzu, Japan). Any changes in the peaks intensity, formation and deformation of peak on bacterial treated films were compared with control film. The absorbance was taken in the mid-IR region of 4500–500 cm-1 wave number [13].

RESULTS AND DISCUSSION

Molecular Characterization and Phylogenetic Analysis of Bacterial Isolates

The three bacterial isolates showed better degradation ability were examined for 16s rDNA gene sequencing method for conformational identification. It was observed that isolate JB1C (GenBank accession: ON203112), JB2W (GenBank accession: ON203113), and JB4Y (GenBank accession: ON203114) were showed sequence similarity with *Paracoccus pantotrophus* (99.92%), *Chelatococcus caeni* strain (100%) and *Mycolicibacterium phlei* (99.82%) respectively through phylogenetic tree analysis (Fig 1-3).

Growth Parameter for Effective Degrading Bacteria

The turbidity of the MSM medium containing LDPE and bacterial cultures was measured at 600 nm (Fig 4 and 5). Within a week of incubation, there was an increase in the turbidity in the bacterial culture under optimized condition at 45°C with pH 8. Bacterial isolates *C. caeni* showed highest growth pattern from 5 to 15 days whereas *M. phlei* showed lowest growth pattern in all days. After 15 days due to the formation of biofilm on LDPE surface, no change in growth pattern was observed in all bacterial isolates. Thus it confirms that the thermophilic temperature and alkaline pH are enhancing the growth of LDPE degrading bacteria. There are many microbes (*Microbulbifer hydrolyticus, Pseudomonas fluorescens, Pseudomonas aeruginosa, Acinetobacter ursingii, streptoccus* sp *and streptobacil* sp) showed best growth rate in varied temperature and pH [14-16] except *Enterobacter cloacae, Enterobacter ludwigii* and *Pantoea agglomerans* at 45°C with the pH 8.5 [17] confirms the similarities with the present investigation.

Weight loss of LDPE film

The weight loss of LDPE films after 30 days of incubation were 1.146, 1.366 and 0.945% and after 90 days of incubation were 3.278, 4.025 and 2.283% for bacterial isolates *P. pantotrophus, C. caeni* and *M. phlei* respectively (Fig 6). The result indicated that bacterial isolates *C. caeni* showed significantly higher weight loss of LDPE between 30 to 90 days compared to other bacterial isolates. Therefore, LDPE films incubated with three bacterial isolates individually showed weight loss which is due to the consumption of the carbon as energy from the LDPE film provided in the medium. The previous study demonstrated that *Alcanivorax* sp, *Cobetia* sp, *Exigobacterium* sp and *Halomonas* sp showed 0.97, 1.4, 1.26 and 1.72 % of weight reduction of LDPE films over 90 days of incubation [18]. In addition, there are some exceptions observed in *Pseudomonas aeruginosa* for their degrading capacity between 10 to 30 days [19].

Evaluation of CO_2 Production

Generally, biodegradation is mineralization process i.e., it releases CO_2, CH_4 and H_2O as final product of degradation [20]. The three bacterial isolates of current study produced 0.43, 0.54 and 0.31 g/l of CO_2 respectively compared to control generated lowest amount of CO_2 (0.16 g/l). Hence release of carbon dioxide is the positive evident for LDPE film degradation by *P. pantotrophus, C. caeni* and *M. phlei* (Fig 7). However, the bacterial strains of *Pseudomonas fluorescens, Pseudomonas aeruginosa* and *Acinetobacter ursingii* showes 1.16, 1.02 and 0.93 g/ l amount of CO_2 release after 15 days of incubation at 35°C with pH 7 [15].

Characterization of the LDPE Films by SEM Analysis

The SEM analysis was conducted to study the surface morphological changes on LDPE surface from 30 to 90 days of treated stains of *P. pantotrophus, C. caeni* and *M. phlei* (Fig 8 and 9). The SEM image indicates surface damage on bacterial isolates *P. pantotrophus, C. caeni* and *M. phlei*. Treated film showed cracks, fragile, roughening and pits confirms the degradation due to enzyme activity of *P. pantotrophus, C. caeni* and *M. phlei*. The untreated control retained its smooth and clear surface. From SEM studies, it is confirmed that bacterial isolates favourably adhered to the surface and utilize the carbon source from LDPE film under carbon starvation condition [21].

FTIR Analysis of the LDPE Films

FTIR analysis of LDPE film treated with *P. pantotrophus, C. caeni* and *M. phlei* indicates a change in functional group as compared to control (without bacterial treatment) denote biodegradation [22]. Therefore chemical structure variation among control and bacterial treated polymer film were displayed on Fig 10- 13 and Table1. The LDPE control peak value 2848 cm-1 belongs to C-H stretch disappeared on bacterial treatment LDPE film over 90 days of incubation. This result is evident for uptake of carbon as energy source by microorganisms on degradation process. The appearance of new peaks were observed at region of 2000-2400 cm-1 corresponds to C≡C alkynes group, 1020-1075 cm-1 (=C-O-C symmetry), 1180-1260 cm-1 (C-O stretch), 1710-1780 cm-1 (C=O stretch), 1510-1560 cm-1 (N-H bend), 3500-4000 cm-1 (O-H stretching). The addition peak observed at *C. caeni* degraded LDPE film was 1772 cm-1, 1527 cm-1, 3603 cm-1 and 3724 cm-1. Likewise new peaks observed in *P. pantotrophus* and *M. phlei* treated LDPE were 1022 and1018 cm-1; 1182 and 1186 cm-1; 1743 and 1739 cm-1 respectively. Thus formation of new peaks strongly supports the formation of new functional group due to microbial activity. The LDPE control film peak at 719 cm-1 showed shift and reduction in peak intensity at 723 cm-1, 669 cm-1 and 725 cm-1 for isolates *P. pantotrophus, C. caeni* and *M. phlei*. However an absorption band 719 cm−1 undergoes no bond deformation after incubation represents the very strong nature of C-H bending bond. Therefore any conformational changes in the peaks of microbial treated LDPE films support the degradation [23].

CONCLUSION

The bacterial cultures *Paracoccus pantotrophus* JB1C, *Chelatococcus caeni* JB2W and *Mycolicibacterium phlei* JB4Y were isolated from the plastic dump landfill site at Omalur region of Salem City, Tamil Nadu, India. The efficient LDPE degrading microbial strains were screened for their degradation ability by various preliminary experiments such as

bacterial growth rate, weight reduction of LDPE film and amount of CO_2 production. To achieve a highest degradation activity, the growth parameters for the isolated bacteria were optimized at 45ºC and pH 8. The degradation was confirmed by SEM and FTIR analysis where significant physical and chemical structural variations are predicted. This study indicates that synthetic plastic pollution can be overcome by isolating microbes from the environment which can degrade synthetic plastics. However, biodegradation by microorganisms is a slow process, this degradation study need to be observed for long duration and effective degradation ability improved by developing microbial consortium.

ACKNOWLEDGEMENT

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Table 1: Characterization of FTIR peaks

Absorption (cm-1)	Assignment	Control Absorption band (cm-1)	*P. pantotrophus* Absorption band (cm-1)	*C. caeni* Absorption band (cm-1)	*M. phlei* Absorption band (cm-1)
2850-3000	C-H stretch	2910	2910	Disappearance of peak	2910
2850-3000	C-H stretch	2848	Disappearance of peak	Disappearance of peak	Disappearance of peak
1450-1470	C-H Bending	1460	1471	Disappearance of peak	1469
690-710	C-H bend	719	723	669	725
1020-1075	=C-O-C symmetric		1022 (New peak)		1018 (New peak)
1180-1260	C-O stretch		1182 (New peak)		1186 (New peak)
1510-1560	N-H bend			1527 (New peak)	
1710-1780	C=O stretch		1743 (New peak)	1772 (New peak)	1739 (New peak)
2000-2400	C≡C alkynes group			2318 (New peak)	
3500-4000	O-H stretching			3603 (New peak)	
3500-4000	O-H stretching			3724 (New peak)	
3500-4000	O-H stretching			3859 (New peak)	
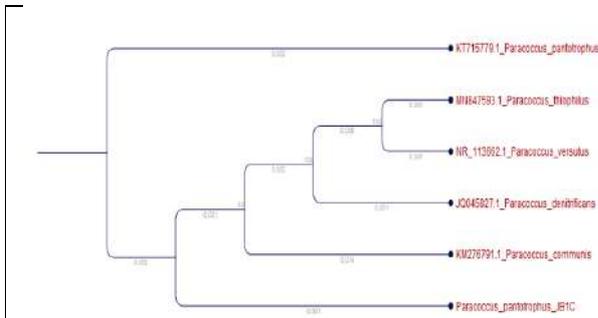
Fig. 1: A Phylogenetic tree based on the partial 16S rDNA gene sequences of isolates *Paracoccus pantotrophus* JB1C and evolutionary relationship of related species found by a BLASTn database search.
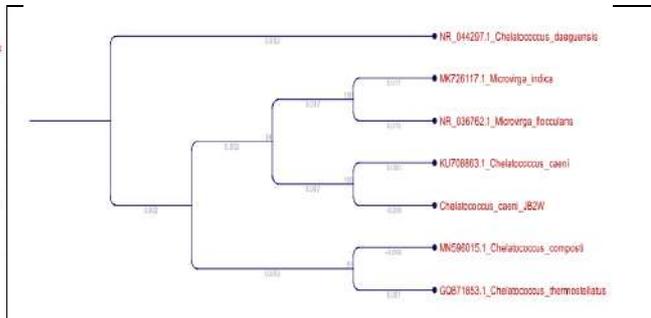

Fig. 2: A Phylogenetic tree based on the partial 16S rDNA gene sequences of isolates *Chelatococcus caeni* JB2W and evolutionary relationship of related species found by a BLASTn database search.
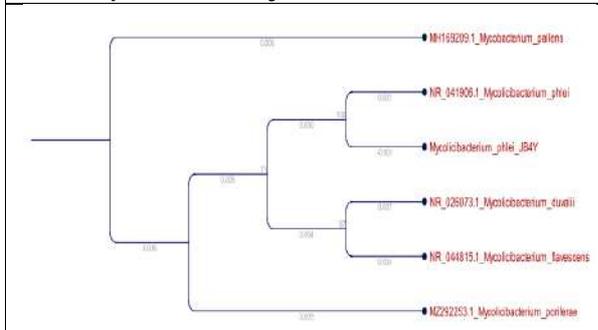
Fig. 3: A Phylogenetic tree based on the partial 16S rDNA gene sequences of isolates *Mycolicibacterium phlei* JB4Y and evolutionary relationship of related species found by a BLASTn database search.
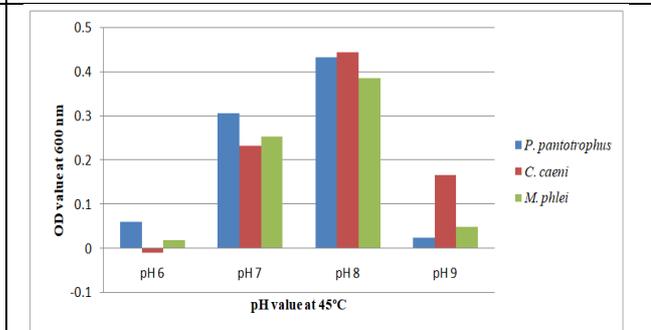
Fig. 4: Effect of temperature on bacterial growth of *P. pantotrophus*, *C. caeni* and *M. phlei* at pH 7 for 15 days.
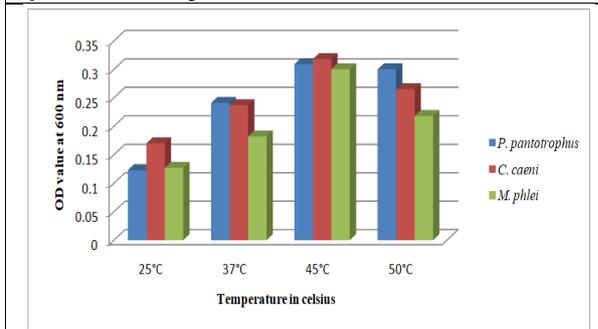
Fig. 5: Effect of pH on bacterial growth of *P. pantotrophus*, *C. caeni* and *M. phlei* at 45°C for 15 days.
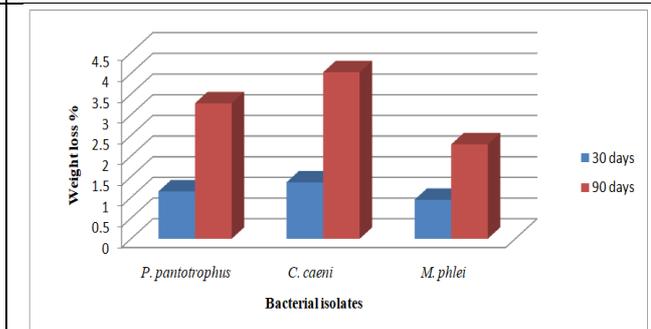
Fig. 6: Weight loss percentage of LDPE films cultured with *P. pantotrophus*, *C. caeni* and *M. phlei* after 30 and 90 days of incubation.

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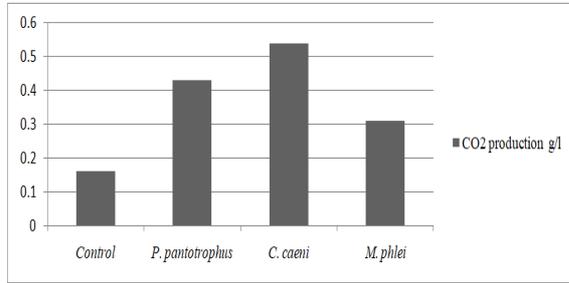
Fig. 7: Amount of CO₂ dissolved in *P. pantotrophus*, *C. caeni* and *M. phlei* culture broth after 30 days of incubation.
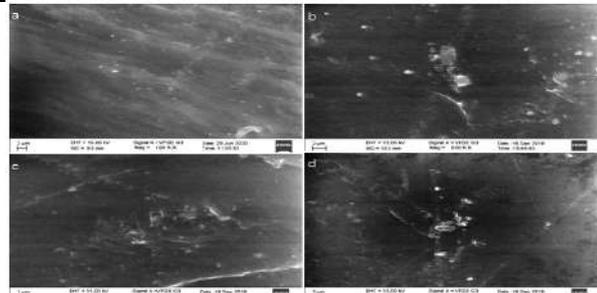
Fig. 8: SEM image of LDPE film treated with bacterial isolates after 30 days of incubation. a- control, b- *P. pantotrophus*, c- *C. caeni* and *d- M. phlei* treated LDPE films.
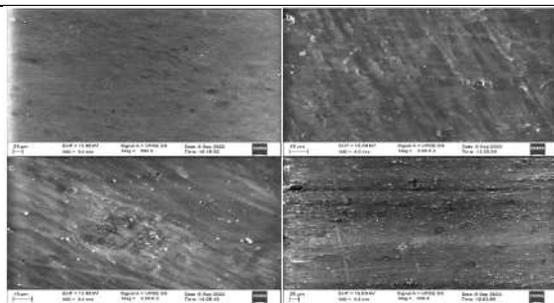
Fig. 9: SEM image of LDPE film treated with bacterial isolates after 90 days of incubation. a- control, b- *P. pantotrophus*, c- *C. caeni* and d- *M. phlei* treated LDPE films.
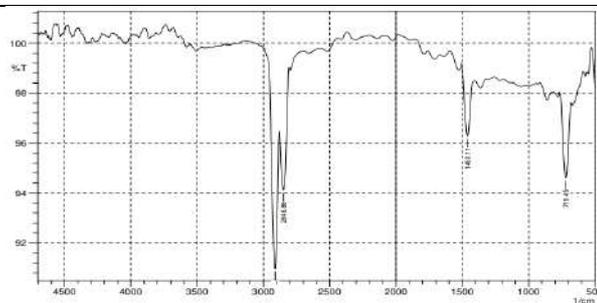
Fig. 10: FTIR spectra of untreated LDPE film Control(C)
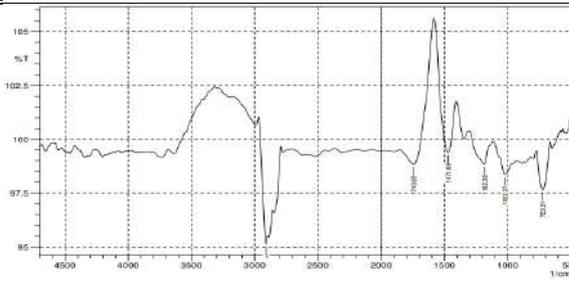
Fig. 11: FTIR spectra of LDPE film treated with *P. pantotrophus*
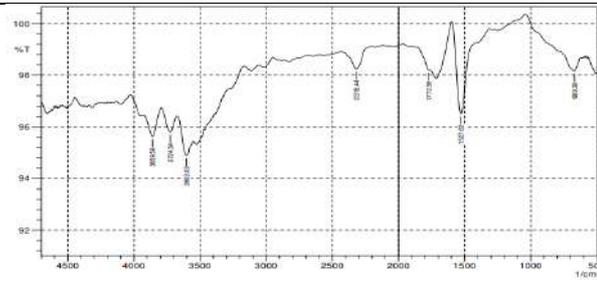
Fig. 12: FTIR spectra of LDPE film treated with *C. caeni*
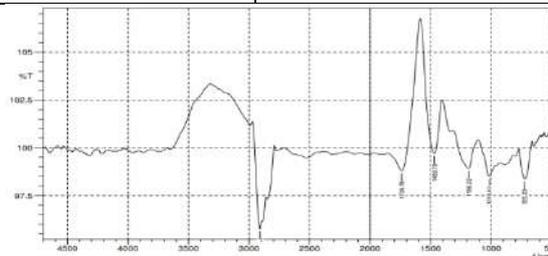
Fig. 13: FTIR spectra of LDPE film treated with *M. phlei*

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RESEARCH ARTICLE

Pathway of Poultry Waste and its Environmental Repercussions in South Andaman, India: A Discussion

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ABSTRACT

Protein demands of the mammoth global population are cratered by poultry meat when compared to other meat thus, generating massive organic waste. The objective of the present study is 1) to understand the pathway of poultry and its related waste, and 2) the implications due to the use of poultry and its related waste on the health of the environment and humans as well in south Andaman. Frequent eutrophication in the coastal waters of the study area was due to the presence of nitrate contents from the land runoff. Further, human encounters with saltwater crocodiles due to the use of poultry offals as feed to freshwater fishes. Also, eutrophication in the freshwater aqua ponds resulting in reduced dissolved oxygen levels increased pH and resulting in 80% mortality of the freshwater fishes. It is hereby concluded that an immediate ban on the use of poultry litter and its offals is the need of the hour to conserve the pristine environment of the study area.

Keywords: Human health, Environmental implications, poultry litter, poultry offals

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INTRODUCTION

The world population is expected to reach 8.5 billion, 9.7 billion, and 10.9 billion in the year 2030, 2050, and 2100 respectively (UN 2019). Despite the rapid increase in human population, a limited portion of arable agricultural land is available to grow food to feed the mammoth human population(Werth *et al.* 2014).Thus, dietary needs especially proteins are supplemented by various animal meat like dairy, fish, pork, poultry, etc. Poultry products play a major role in the fulfillment of the dietary needs of humans' (Singh *et al.* 2018). Globally the total poultry production reached 118 million tons in 2019. The American continent is the leader in poultry produce accounting for 40.7% (47.9 million tons) of the global chicken meat followed by Asia 36.3% (42.8 million tons). Globally India ranks fifth with a production of 4187706 tons. The contribution of poultry meat in India accounts for 47.05% of the total meat production (FAO 2021). The poultry industry generates large amounts of solid waste such as bedding material (sawdust), excreta, feed, feathers, guts, bones, hatchery waste, mortality waste, drugs, pesticide remnants, disinfectants of chicken houses, etc., (Singh *et al.* 2018). Thus, the waste generated at various stages of poultry production poses grave environmental challenges (Sims and Wolf 1994;Chapman 1996,Werth *et al.* 2014;Singh *et al.* 2018).

The Andaman and Nicobar islands (ANIs) is the union territory of India situated in the Bay of Bengal (BoB) comprising 572 islands. This group of islands has a geographical extent of 700 km trending North-South direction bounded by the coordinates (92° to 94° East and 6° to 14° North). Further, these archipelagos are close to a foreign land like Indonesia (150 km) in the south and Myanmar (150 km) in the north when compared to mainland India (1200 km). Out of the 572 islands, humans inhabit only in 31 islands according to the Census of India (2011). More than 50% (1,44,418) of the island's total population are residing in South Andaman, especially in Port Blair and adjoining villages (figure 1). Because this area is the center for all island's activities and the entry point for tourists as well. Owing to the tropical climate, the economy is tourism centric followed by fisheries. The cultural fabric of the study area comprises various ethnic groups like the Hindu, Christan, Muslim, Sikhs, Buddhists, Bahtus, Karen, Ranchiwala, etc., speaking different Indian dialects like Hindi, Bengali, Tamil, Telugu, Kannada, Malayalam, Punjabi, Nicobari, etc. Thus, it is known as mini India wherein, people live here in perfect harmony. Poultry meat caters the animal protein demands of the floating population like the tourists (national and international) and Indian defence personnel's apart from the inhabitants in the study area. Infact, cuisines made from poultry meat are invariably served in almost all social gatherings like weddings, birthday parties, etc. The massive utilization of poultry meat ensures a huge generation of waste as well. Thus, the present study aims at mapping the pathway of poultry wastes and its environmental implications in South Andaman.

Pathway of Poultry Waste

As per the 2020 census conducted by the Directorate of Animal Husbandry and Veterinary Services, there are around 12,89,160 poultry animals in ANIs. Sawdust is invariably used as a carpeting material in poultry farms. Firstly, the poultry farms are carpeted with sawdust and the hatchlings weighing around 42gm are loaded in the farm. In just 35-45 days of the time period, these chicks attain a marketable size of 1.8kg-2.0kg through the application of various drugs, vaccines, etc (table 1) apart from the poultry feed. After the birds are dispatched to the market, the birds dropping on the floor of the poultry farm are cleaned, packed, and utilized as manure in agriculture farms. Thereafter from agriculture farms branching of the pathway of contaminants takes place the first branch percolates down to the subsurface contaminating the groundwater. The second branch of contaminants as surface runoff reaches the adjacent sea causing eutrophication. The other significant pathways are the poultry processing waste are been utilized in piggery and freshwater aquaculture. The pathway of poultry and its processing waste is depicted in figure 2.

Implications

The poultry industry generates a significant amount of solid waste, including bedding material (sawdust), excreta, feed, feathers, guts, bones, hatchery waste, mortality waste, drugs, pesticide remnants, chicken house disinfectants,

etc.As a result, the waste generated at various stages of poultry production poses serious environmental issues (Sims and Wolf 1994; Chapman 1996; Werth *et al.* 2014; Singh *et al.* 2018). Thus, the implications of poultry waste on humans and the environment are discussed below in detail.

Soil and Agricultural Product Contamination

Poultry litter comprises fecal material, leftover feed, bedding material, feathers harmful microbes (Ngogang *et al.* 2021).The fecal content of broiler chicken is rich in nitrogen (35.5 kg/ tonne of excreta), phosphorus as its pentoxide (34.5 kg/ tonne of excreta) along with other vital minerals like calcium, carbon, copper, iron, potassium, manganese, zinc, etc., in comparison with layer chicken's litter (Sims and Wolf 1994;Williams 2013a). Owing to the rich nitrogen, phosphorus, and other vital elements in poultry litter they are extensively utilized as manure in agriculture farms globally (Gerber *et al.* 2005).However, the fecal content is also known to abundantly contain antibiotics like chlortetracycline that may be translocated from the soil to the food crops (Kyakuwaire *et al.* 2019). Human consumption of antibiotic-contaminated food crops can lead to antibiotic resistance, which can result in food poisoning or allergies, also it may reduce immunity and life expectancy as well. Further, chlorinated antibiotics may release dioxins due to a raise in temperature (Ewall 2007).Owing to the carcinogenic effect of dioxins on humans the International Agency for Research on Cancer declared it a carcinogen in the year 1997 because of its high toxicity efficacy even in small quantities (Yuan *et al.* 2000).A research by Kyakuwaire *et al.* (2019) indicate that poultry litter is the highest contributor of antibiotic-resistant microbes when compared to cow, goat, pig, etc., manures. The presence of persistent poultry antibiotics, metabolites, and their derivatives create an imbalance in the bio-geo cycle of the soil, inhibiting the growth of good microbes and ultimately affecting soil fertility and productivity as well (Ajit et al.2006).

Groundwater Contamination

Application of poultry litter to the agricultural fields may result in the sub-surface percolation of antibiotics into the groundwater and surface water bodies like streams, lakes, and ponds affecting the non-targeted organisms as well (Liu 2012). The Central Ground Water Board (CGWB) monitors the hydrochemistry of freshwater wells in ANIs every year. As per the CGWB (2020)report, there are 47 observatory wells in the area under investigation. The nitrate values in eight wells were below detectable levels, less than 10mg/l in 37 wells, and in two wells, the values were between 25mg/l to 29mg/l. The low levels of nitrate in the 47 observatory wells suggest that the concrete walls of the dugwell hinders the percolation of nitrate leachets into it. Also, the other factors such as soils, geology, and the depth of the water table do not provide ample scope for contaminating the groundwater. Further, importantly the prevalent high-intensity tropical rains in the area of the present investigation warrant mobility of poultry litter laden with antibiotics to a far destination like the adjacent seas.

Eutrophication

Radhan *et al.* (2015) reviewed previous publications from 1996 to 2014 carried out in ANIs and indicated that the coastal water quality was depleted due to anthropogenic influence and land runoff. A five-year research (2011-2015) by Franklin *et al.* (2018) suggests that the nitrate values ranged from 0.010 μmol/L to 7.840 μmol/L. The nitrate concentration in the coastal water of the study area ensures the proliferation of phytoplankton ranging from 0.050 mg/m³ to 32.260 mg/m³(Franklin *et al.* 2018). This phytoplanktonic proliferation is called eutrophication and several researchers reported this frequent activity in the area under present focus (eg: Begum *et al.* 2015; Jha *et al.* 2015; Radhan *et al.* 2015). Globally several researchers also reported about eutrophication due to mismanaged poultry waste (eg:Joardar *et al.* 2020; Shaji *et al.* 2021).

Piggery

The other poultry offals such as the gut are washed thoroughly, minced into pieces,and boiled before feeding the pigs (*Sus domesticus*)by the farmers. The antibiotics apparently present in the gut of the poultry offals enhances the growth of pigs in a short span of time (Perez-Aleman 2010).

Freshwater Aquaculture

According to ANIFP (2018) there are around 533 freshwater fish ponds in South Andaman catering to freshwater fish demands locally with an annual production of 220MT for the year 2017-2018. The major species cultivated are Catla (*Catla catla*), Rohu (*Labeo rohita*), Mirgal(*Cirrhinus cirrhosus*). Apart from the aforementioned freshwater fishes like Singhi (*Heteropneustes fossilis*), Magur/ walking catfish (*Clarias batrachus*), Tilapia (*Oreochromis urolepis),* Roop Chanda (*Piaractus brachypomus*), Silver carp (*Hypophthalmichthys molitrix),* Pangasius (*Pangasius pangasius*)and Grass carp (*Ctenopharyngodon idella*)are also cultivated. It is a common practice in the area under present investigation to feed freshwater fishes with poultry offals. These poultry offals contain ample amounts of nitrates and phosphates to trigger eutrophication (Figure 3) causing the drop in dissolved oxygen and increased pH resulting in 80% mortality of the fishes. Apart from the aforementioned nutrients, it also contains disease-causing pathogens and toxins as well. Owing to the deleterious impacts the department of fisheries, Andhra Pradesh imposed a ban on the useof poultry offals in the fresh water aquacilture in the year 2016.

Saltwater Crocodile Conflicts

There are 23 species of crocodile reported globally, of which the saltwater crocodile (*Crocodylus porosus*) is the largest (Patro and Padhi 2019). The disposal of poultry and other offals in the nallahs (streams) ensures the sighting and even human encounters with saltwater crocodiles. According to the forest records of the Manglutan range recently saltwater crocodiles are been frequently sighted in and around the freshwater fish ponds. Because most farmers feed freshwater fishes with poultry offals. Thus increasing the risk of human encounters with saltwater crocodiles.

Human Health

The harmful poultry antibiotics enter the human body through various pathways and thus reduce immunity and life expectancy as well. The majority of poultry antibiotics enter the human body due to the direct consumption of poultry meat. The other pathways are freshwater fishes, pork, and agricultural products at varying degrees. Because poultry offals are used as feed for pork and freshwater fishes. While the poultry excreta are used as manure for agriculture.

CONCLUSION

This discussion article enlightens the implications of poultry litter and offals over humans and the environment in the study area. It was understood from the study that the use of poultry litter and offals has irreparable implications on the health of the environment and humans as well. Also, it opens a broad avenue for future endeavors like 1) quantification of persistent poultry antibiotics in poultry droppings, soil, agricultural produce, pork meat, fish, and the poultry itself, 2) assessing the Physico-chemical characteristics of water in the freshwater fish ponds due to the application poultry offals, and 3) Quantification of dissolvable poultry antibiotics in the freshwater fish ponds. An immediate ban on the application of poultry litter in agricultural farms and as a feed for freshwater fishes and pork is the need of the hour.

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Table1: schedule of drugs/vaccines and their dosage for poultry chicken

Age in Days	Drug/Vaccine	Dosage
1st – 4th	1) Chicktonic	1-2ml/ 1 lt of water
	2) Ventriplus-M	1-2ml/ 1 lt of water
	3) Vendox	25gm/30 lt of water
5th	BI vaccine	One drop applied in the eye
6th – 8th	Toxal	500ml/day in drinking water
10th	IBD vaccine	One drop applied in the eye
11th – 17th	Safegaurd water purifier	200ml/500 lt of water
18th	Lasota vaccine	One drop applied in the eye
19th – 21st	Vitamin	
	1) Brotone	½ lt of Brotone + ½ lt of Enocine in 300lt of water
	2) Enocine	
22nd- 35th /45th	Safegaurd water purifier	200ml/500 lt of water
35th – 45th	Dispatched to the market	
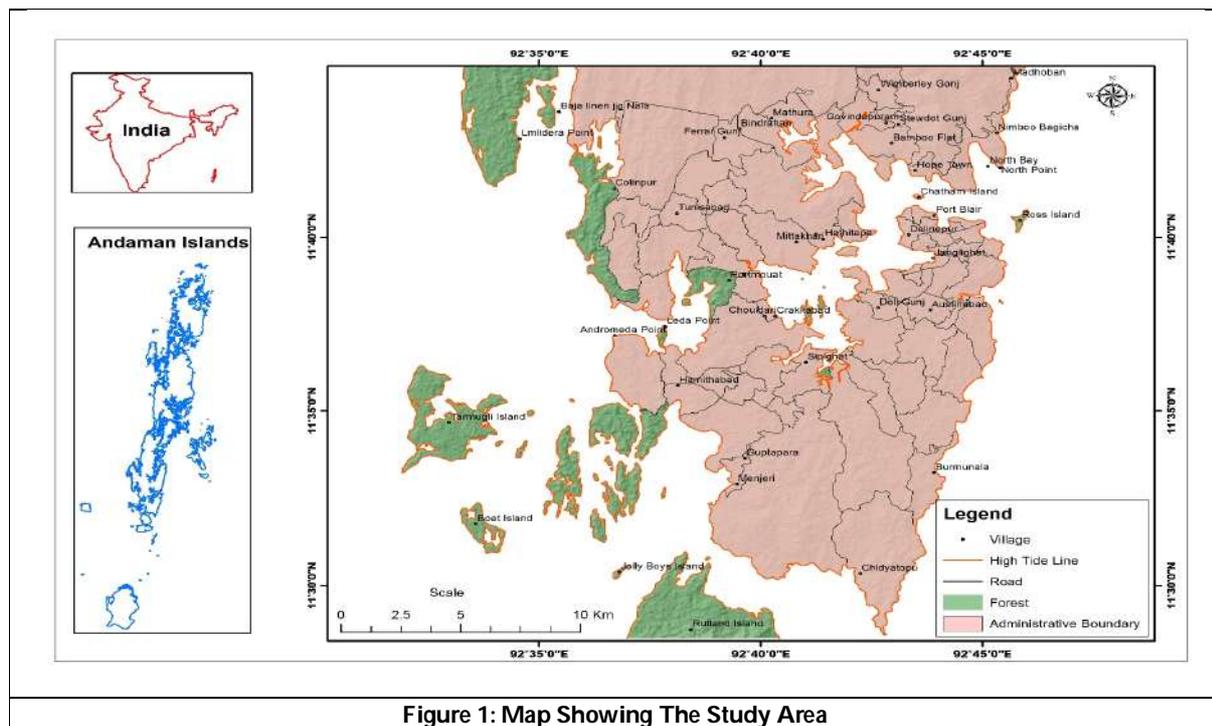
Figure 1: Map Showing The Study Area

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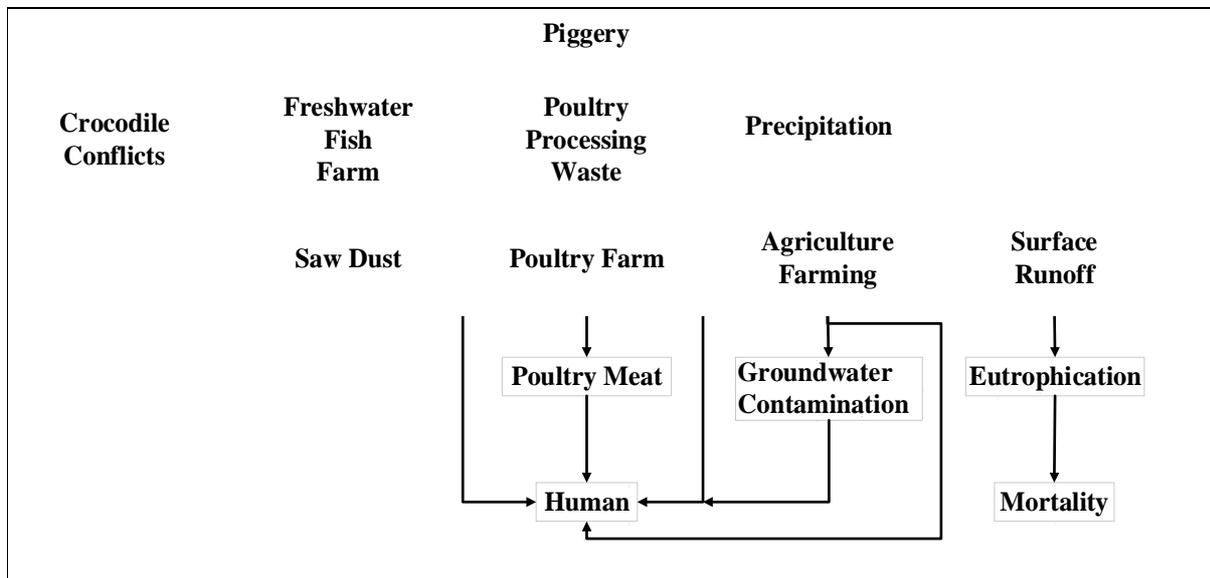
Figure 2: Pathway Poultry Waste

Figure 3: Field Evidence of Eutrophication in the Ponds Due to Application of Poultry Offals

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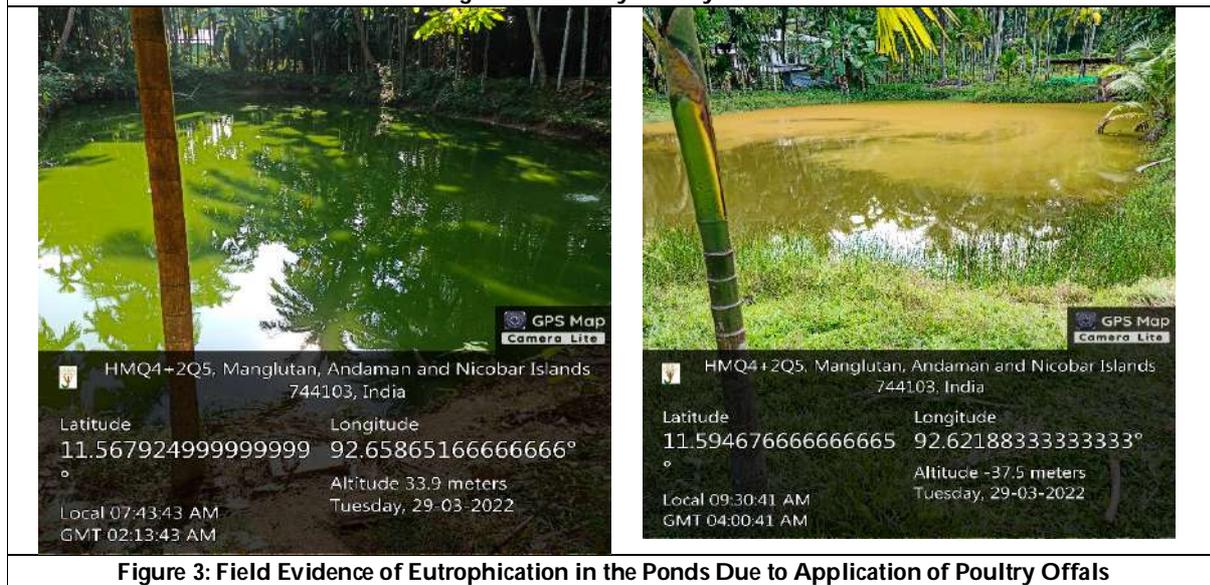
Assessment of the Employees' Work-life Balance during COVID-19 Pandemic: An Artificial Neural Network Approach

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ABSTRACT

Balancing the responsibilities of the profession and as well as the personal life is most required skill for everyone. It is referred to as Work-Life balance. During the COVID-19 pandemic most of the industries switched into 'work from home' mode. Since the employees had to play both the roles at the same place, the situation became more challenging in terms of work-life balance. This paper is an attempt to assess the employees' work-life balance by using a set of artificial neural network (ANN) techniques. The assessment is carried out by adopting two different approaches by using six types of artificial neural network. Artificial neural networks are efficient machine learning techniques to solve various kind of data mining problems. Here, two approaches namely classification analysis and clustering analysis are adapted to assess the work-life balance of employees. A set of three ANN techniques are applied to carry out the classification analysis. The aim of this approach is to classify the employees whether they have balanced the work-life or not. Another set of three ANN techniques are applied to carry out the clustering analysis. The aim of this approach is to group and analyze the level of the work-life balance. The first one follows the supervised machine learning approach and the later one follows the

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unsupervised machine learning approach. Data are collected through questionnaire method from around 718 professionals of various multi-national companies.

Keywords: COVID-19, Neural networks, Work-life balance, Data mining, Work from home.

INTRODUCTION

In the early 2020, the impact of corona virus started spreading all over the world and created enormous changes in the context of individual, social, economic, psychological, medical and more. One of the most observable changes as a result of the COVID-19 pandemic is tele-working, telecommuting, or the Working From Home (WFH) [1]. Work from home was suggested by the World Health Organization (WHO) to the Government and other organization all over the world as to perform the job and as well as to prevent the COVID virus spread [2]. The possibility of working from home has been considered as the means of increasing an individual's Work–Life Balance (WLB) because work from home provides an opportunity to take care of family members [3].

Balancing work and family has become pivot for the employees in the new phenomenon of WFH. In the present pandemic scenario global organization is working more time and 365 days a year [4]. Historically, most of the literature has focused on how the pursuit of work-life balance has affected women, not men. But in the present scenario of WLB it needs to be focused on both the gender. Lack of WLB can lead to various problems that can be addressed in counseling for both men and women, from depression, anxiety, and other mood disorders to problematic behaviour and marriage and or interpersonal struggles [5]. A lack of WLB may be associated with various mental and behavioural issues [6]. World Health Organization has defined "Mental Health as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" [7]. Health it also includes how one sleeps, eats, relax and enjoy. The 'normal life' of the individual is changed by the WFH, it brought several changes in eating, sleeping and in routine habits [8]. Due to WFH several physical and mental health risks have been identified on survey conducted in United States (2020). Person can live a happy life, healthy and successful when there is work-life Balance [9].

Working from home has been more popular in recent years. Work will be done from a distance it is predominantly dependent on tele-working /telecommunicating agreements in which an employee is not required to be with their company during business hours. Working from home is becoming more important in today's environment. In contrast to previous years, the home office has become an instant integrated and necessary component of the working environment [10].

Working from home (WFH), also known as tele-work, telecommuting, or remote work, has become a more prevalent practice in recent years and has established itself as a significant component of the future of work [11]. Working from Home systems should have qualities that enable them to achieve their goals of providing all essential services and resolving all stakeholder issues. Working from home often causes employees to blur the lines between work and personal life, resulting in job overload. Work from Home may be divided into two categories: WFH before the Covid epidemic and WFH after the pandemic. Even calling WFH before the outbreak may be considered a dream [12]. Factors influence employment from home, and it can be claimed that home workers are varied in terms of demographics, gender, skills, and income. When a flexible workplace approach is implemented, efficiency and productivity are boosted for most people and job categories. When left the choice to their own devices and free of the noise, interruptions, power, and politics of the office/workplace, most solitary workers increase their performance. When a company has a flexible working policy, employees' well-being automatically improves. This makes a person more creative, less uptight, and has a better work-life balance. Working from home may reduce workplace stress while also improving job satisfaction. Working from home has a positive impact on the environment.

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Fuel consumption is lower, resulting in fewer resources used, less pressure on infrastructure, and lower global green house gas emissions. Adapting to a new WFH standard, as well as work-life balance adjustments, may be difficult for certain workers. They need to know how to decline further job requests if they know they won't be able to handle them, since WFH should be run with constraints, based on schedules and responsibilities [13]. Tele-working was widely adopted in the European Union prior to the COVID-19 pandemic in domains such as information and communication services and knowledge-intensive business services, areas where tele-working has remained an optimal solution throughout the pandemic. During the COVID-19 epidemic, tele-working was embraced by both commercial and governmental organizations, namely in the domains of education, financial services, and public administration [14]. The COVID-19 pandemics sent shockwaves across the globe, with differing consequences for men and women. Women's employment, enterprises, wages, and broader living standards may be more vulnerable to the expected widespread economic consequences from the crisis than men's due to ongoing gender inequities across many dimensions. COVID-19 will exacerbate the unpaid job obligations faced by women [15]. The widespread closure of schools and childcare facilities, for example, would increase the amount of time parents must devote to child care and supervision, forcing many to oversee or lead homeschooling. Women are expected to bear the brunt of this added strain. Many parents, particularly those who are forced to continue working, may find it impossible to meet these responsibilities. Men's home obligations have grown as a result of the epidemic, although not as much as women's. As a consequence, dads are able to spend more quality time to their professions than moms.

Related Work

Work-life balance relates to how an individual prioritizes personal and professional activities in their lives, as well as how much of their work is done at home. Work-life balance has become a prevalent problem in the workplace in a culture packed with competing obligations and commitments, owing to three primary factors: a competitive corporate climate, interest in personal life, and the increasing variations in the workforce [16]. Work-life balance starts with the employee taking charge of his or her own health. A worker's personal wellness involves feeling excited to start work. Working from home relieves the stress of dealing with traffic and getting to work, enabling the employee to be more relaxed while starting his or her day. Next, the worker is given flexibility in accomplishing his or her activities, which makes the home environment suitable to work. As a result, work-life balance boosts employee productivity [17]. Work-life balance is defined as striking a balance between workers' personal and professional lives [18]. Work–life balance is based on the premise that one's professional and personal lives should complement one another in order to achieve excellence in one's life. The scientific discussion on 'work-life balance' began with the goal of overcoming the 'separate spheres' paradigm, which has a propensity to rectify the separation of social experience into public/male and private/female worlds while ignoring their interconnections [19].

We can map people's work–life demands within three separate but related aspects of their lives, according to Williams as referenced in [20]. First, there's personal time and space: what do we need for self-care and body, mind, and soul maintenance? Second, how much time and space do we need to effectively care for others? Finally, there's labour time and space: what do we need to achieve economic self-sufficiency? A balance between work and everyday life, may be considered to be attained when each of these domains is balanced together. Many workers find that working from home allows them to strike a balance between their job and their social lives. They may schedule their job activities around their everyday activities. Employees must strike a work-life balance in order to connect with their families while balancing works at home. Employees who work from home may be closer to their families and the environment, allowing them to achieve a better work-life balance. When he has strong job productivity, he can distribute time in line with their appropriate sections, achieving a balance between work and life is possible.

Work-Life Balance may be characterized in a variety of ways. An employee attempts to defend his most essential goals to his boss based on his job, grade wrapped in responsibility, and being a member of the family to spend quality time away from work. It implies that work and social life are intertwined and never impact one another if someone is prepared to make it happen with a sensible approach. The interplay between paid labour and other activities, such as unpaid work in families and the community, leisure, and personal growth, is referred to as work-

life balance. A healthy work environment requires a good work-life balance. Maintaining a work-life balance reduces stress and helps to avoid job burnout. Promoting work-life balance may seem to be a challenging task for a business. The goal of work-life balance is to achieve happiness and successful functioning in both the work and family domains while avoiding role conflict. Many working women, regardless of their industry, age group, number of children, income, or career, are unable to strike a balance between work and family life [21].

In their research [22] on Forsyth's four categories of work-life balance, Amir *et al.* reaffirm Forsyth's four categories. The absolutist is the first. The absolutist assortment is supported by an equal distribution of your time, engagement, and happiness across work and life domains. The second category is (b), which is utilitarian in character and tries to disclose what balance works best for the largest amount of people. The third (c) and fourth (d) categories are subjectivist and situationist, respectively. Inequalities in establishing work-life balance are the result of social constraints as well as workplace demands and expectations [23]. In countries where women are expected to be the primary caregivers, childcare facilities and parental leave rights, for example, might increase mothers' capacity to balance work and family life. Women may feel less entitled to strive to work-life balance if such facilities and privileges do not exist, and may be driven to leave the labour market during their childbearing years. M. Luo [24] has developed an evaluation system to assess the mental health and intelligence. A joint optimization algorithm was proposed and it consists of improved versions of a decision tree and a neural network. It is a data mining framework to analyze and classify the data collected to evaluate the mental health intelligence. C4.5 decision tree is applied and it is improved by incorporating the Taylor's and McLaughlin's formulas for simplifying the calculation of information gain. Softmax is applied to improve the performance of the neural network. The performance of the framework is evaluated by Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE).

A tree based approach was proposed by M.W. King to analyze the psychological treatments [25]. Correlation and Regression Tree (CART) algorithm is applied to predict the dropouts of psychological treatment i.e. patients who discontinue the treatment or counseling. It is also applied to analyze the severity of the symptoms during the psychotherapy. The performance of this approach is tested by RMSE. J.L.Pastrana et. al. [26] have applied data mining algorithms to analyze the sports psychology. The objective of this analysis is to check the relationship among the characteristics of the athletes such as self confidence, negative coping control, attention control, positive coping control, motivational control, visuoimaginative control, and attitude control against gender and age. IPED's (Psychological Inventory of Sports Performace) dataset which contains 10944 records was mined by decision tree in the Weka software.

Milk *et al.* [27] have proposed and applied a novel strategy to analyze the big data in the field of psychology. The sequence of the analytics is asplit, analyze, and meta-analyze. Two different data sets are used for this study. The first one is World values survey dataset which contains 343309 records and 1377 variables. The second one is airline data of US airports (from 1987 to 2008) which contains 123 million records and 29 variables. The frame is implemented in R programming language. Alexander [28] has introduced a novel field 'psycho-informatics'. It is a big data analytics approach to the field of psychology. Its applications are enormous such as prediction of stress disorders, prediction of anxiety disorders, monitoring the depression, monitoring the internet addiction, analyzing the addiction to online social networks etc. Shujun hou [29] has applied data mining methods to analyze the sports psychology of college students. It is a data clustering approach and a set of clustering algorithms are applied in order to evaluate the sports performance of the college students. K-means, Expectation Maximization, Density-based spatial clustering of applications with noise (DBSCAN), Cobweb clustering algorithms are applied in this approach. The influence of corona virus began spreading over the globe in early 2020, causing massive changes in the context of individual, societal, economic, psychological, medical, and other factors. Working from home is one of the most noticeable changes [30, 31]. In the event of a pandemic, the home office entails a survival plan from businesses. Depending on skills, education, activities, or sector, some studies have shown both good and negative impacts of WFH on productivity [32, 33]. Effective communication among workers in the business is critical for delegating and splitting workloads to reduce stress and strain. Employees must learn not to overwork themselves and to be

disciplined in their time management. One of the most common problems among the workers is, they don't know when to stop working. Many people fail to distinguish between family and job, and as a result, their work might infiltrate their personal lives [34]. WFH allows individuals to pick their own pleasant workplace while saving time and money on commuting. Flexibility in the workplace has been a popular topic of study throughout time, and a large number of studies have been conducted to investigate its association with health and happiness [35]. Flexible working is used in different ways by men and women, resulting in different results in terms of well-being and work–life balance [36]. Physical and mental health issues of workers who work from home must be researched in order to inform the establishment of recommendations to assist businesses in developing ideal working circumstances. Data mining techniques and machine learning methods are applied for many numbers of Covid related researches and also for the psychological analysis during Covid pandemic [37]. They are applied for different types of researches such as predicting the Covid disease [38], identifying the symptoms, and evaluating the impact of Covid [39], by using the diagnostic data, behavioral data, and some applications of neuroscience, optimizing the work-life, analyzing the attainment of life goals, analyzing the psychological motivation, and for some other types of psychological analyses. Particularly artificial neural networks are applied in different type of studied during the Covid pandemic [40, 41]

Proposed Approach

In order to assess the work-life balance of employees, the experiments are carried out by using two different machine learning approaches. In every approach three different kind of artificial neural networks are applied for analyzing the data. In the first approach supervised neural networks are applied, and in the second approach unsupervised neural networks are applied. The aim of the first approach is to carry out the classification analysis. In this, a set of three supervised neural network techniques are applied to classify whether the employee has 'balanced' or 'not balanced' the work-life. The output of these neural network classifiers will be the binary classification under the class label 'Yes' or 'No'.

The aim of the second approach is to carry out the clustering analysis. In this, a set of three unsupervised neural network techniques are applied to make clusters from the given dataset. The output of these neural networks will be some undefined groups of data values referred to as 'clusters'. They are generated based on the similarity measures used by the respective neural networks. Generally in cluster analysis, each cluster will be different in terms of the nature and values of data. But data are of same kind within a particular cluster. Hence, different clusters represent different characteristics. So, the diversity of the data attributes and their impact/influence could be understood after executing the cluster analysis. The data processing model is illustrated in the Figure 1. The dataset is processed individually by all the six neural networks. Then the results of supervised techniques and the results of unsupervised techniques are consolidated separately and interpreted.

Data Collection and Dataset

Questionnaire method is used to collect the data from the employees. In the questionnaire 32 questions are framed spanning across three factors namely; 1) Work interference with family, 2) Family interference with work and 3) Role confusion. The numbers of questions related to these factors are 11, 13, and 8 respectively. The responses are measured in 5-point scale. The questionnaire was distributed to around 800 professionals during COVID-19 pandemic period. Most of them are employed in multinational companies particularly in the software development field and 'working from home'. 718 responses were received out of 800 employees and the same was done through Google form.

Supervised Learning Approach to Assess the WLB

In machine learning approach, supervised learning is a sub-approach which trains the data processing models with training data (reasonable amount of examples). The machine learning model will use these examples for its learning (by comparisons) and will react accordingly. Since the examples are provided to train the model it is referred to as supervised learning. After the completion of training process the performance of such models will be measured by

using other set of data (testing data). The objective of the classification analysis is to group the values under well defined class labels (classes). The employees are classified whether they are balanced in terms of work and life. Here three supervised artificial neural networks are applied to assess the work-life balance. All these neural networks follow supervised learning methods and they are classic networks. The beginning steps of these neural networks are; feeding the input vectors, initializing the weights, initializing the bias value and learning rate. These steps are common to all the supervised neural networks. Every neural network or network model will be followed by the standard steps such as calculation of net input (summarizing the inputs), processing the input through an activation function (a mathematical equation), adjusting the weights according to the degree of learning, and checking for the stopping criterion (convergence point). Finally the same models will be tested to evaluate the performance by using a mathematical function. This is the working style of supervised artificial neural networks. The architectural specification, method to calculate the net input, the activation function, method to adjust the weights of the network, and testing function for all the supervised neural networks mentioned here. The networks are constructed and tested accordingly.

Perceptron Network – 1 (PN -1)

PN-1 is a single-layer feed forward network with 32 neurons in the input layer & 1 neuron in the output layer. Calculation of net input is done by using the equation 1. X is an input value of neuron i, W is a weight vector of neuron i and b is the bias value.

$$y_{in} = b + \sum_{i=1}^{n} x_i w_i \tag{1}$$

Then, the activation of the network (learning rule) is calculated by the equation 2. θ is the threshold value.

$$y = f(y_{in}) = \begin{cases} 1 \ if \ y_{in} > \theta \\ 0 \ if - \theta \ \le y_{in} \le \theta \\ -1 \ if \ y_{in} < -\theta \end{cases} \tag{2}$$

The weights and bias value are adjusted by the equation 3 and equation 4. Time is represented by **t** and learning rate is represented by **α**.

$$w_i(new) = w_i(old) + \alpha \ tx_i \tag{3}$$

$$b(new) = b(old) + \alpha \ t \tag{4}$$

Perceptron network – 2 (PN -2)

PN-2 is a single-layer feed forward network with 32 neurons in the input layer & 3 neurons in the output layer and the net input is calculated by using the equation 5. The activation of the network is calculated by the equation 6. The weights and bias value are adjusted by the equation 7 and equation 8.

$$y_{inj} = b_j + \sum_{i=1}^{n} x_i w_{ij} \tag{5}$$

$$y_j = f(y_{inj}) = \begin{cases} 1 \ if \ y_{inj} > \theta \\ 0 \ if - \theta \ \le y_{inj} \le \theta \\ -1 \ if \ y_{inj} < -\theta \end{cases} \tag{6}$$

$$w_{ij}(new) = w_{ij}(old) + \alpha \ t_j x_i \tag{7}$$
$$b_j(new) = b_j(old) + \alpha \ t_j \tag{8}$$

Adaptive Linear Neuron (Adaline)

Adaline is a single-layer feed forward network with 32 neurons in the input layer & 1 neuron in the output layer and the net input is calculated by using the equation 1. The activation of the network is calculated by the equation 9. The weights and bias value are adjusted by the equation 10 and equation 11.

$$y = \begin{cases} 1 \text{ if } y_{in} \geq 0 \\ -1 \text{ if } y_{in} < 0 \end{cases} \tag{9}$$

$$w_i(new) = w_i(old) + \alpha\,(t - y_{in})x_i \tag{10}$$

$$b(new) = b\,(old) + \alpha\,(t - y_{in}) \tag{11}$$

Unsupervised Learning Approach to Assess the WLB

Unsupervised learning methods are usually applied for cluster analysis in data mining. In the unsupervised approaches no examples are given to the model. The model itself will get trained by using distance measures (by checking the similarities) and will reach the convergence. Unsupervised approaches do not have testing phase or testing method. The performance of their learning will be measured by the optimality of the clusters (degree of membership to a cluster, differences between the clusters, and the number of clusters). In this cluster analysis the number of clusters is determined as three. The possible outcomes of the analysis of this dataset are the ability level of the employee to balance the work and life such as low level, moderate level, and high level. Hence it is decided to have three clusters. The objective of this analysis is to figure out the level of imbalance. Here three unsupervised neural networks are applied to carry out the cluster analysis on the employees' responses. All these unsupervised networks are fully interconnected.

Maxnet (MN)

In Maxnet, the net input is calculated by the equation 12, activation is calculated by the equation 13, and the weight adjustment is done by the equation 14. ε is the rate of omission in the learning based on weights.

$$w_{ij} = \begin{cases} 1 \text{ if } i = j \\ -\varepsilon \text{ if } i \neq j \end{cases} \tag{12}$$

$$x_j(new) = f[x_j(old) - \varepsilon \sum_{i \neq j} x_k(old) \tag{13}$$

$$x_j(old) = x_j(new) \tag{14}$$

Mexican Hat (MH)

Mexican hat is a hat structured neural network and the learning is carried out based on neighbors. The net input is calculated by the equation 15, activation is calculated by the equation 16, and the weight adjustment is done by the equation 17.

$$x_i = c1 \sum_{k=-R1}^{R1} x0_{i+k} + c2 \sum_{k=-R2}^{-R1-1} x0_{i+k} + c2 \sum_{k=R1+1}^{R2} x0_{i+k} \tag{15}$$

$$x_i = min\,[x_{max,}max(0, x_i)] \tag{16}$$

$$x_{0i} = x_i \tag{17}$$

Hamming Net (HN)

Hamming net is a two layered ANN. In the second layer it contains a Maxnet as its sub-layer. The net input is calculated by the equation 18, activation is calculated by the equation 13, and weight is adjusted by the equation 14.

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$$y_{inj} = b_j + \sum_{i=1}^{n} x_i w_{ij} \tag{18}$$

The cluster analysis is carried out by three unsupervised neural networks here. All the three are competitive networks with fixed weights. The output weight is called exemplar weight and it becomes exemplar after winning the competition which it faced with other weights. The theory behind this is to become most eligible vector/value to be placed in a cluster, by comparing with other values in terms of distance or contrast. Maxnet uses fixed weights which are symmetrical and interconnected over the network. All the neurons have recursive connection also. The largest value is finalized in every process cycle. Mexican hat works based on cooperative neighbors i.e. all the neurons are arranged in a linear order and every individual neuron will have neighbors at both sides to represent the contrast in positive and negative values. Based on these neighboring values, by comparing with other neurons' distance, clusters will be formed. In Hamming net two layers are used to make clusters; in the first layer hamming distance is calculated among the weights presented by the neurons. Then they are passed to the next layer which has a Maxnet. Here Maxnet functions as a sub layer. It finds out the exemplar value to be placed in the clusters. This is how all the unsupervised neural networks working in order to create clusters.

RESULTS AND DISCUSSION

The implementation of all the supervised neural networks, their training & testing, and all the unsupervised neural networks are done in python language. The classification analysis is carried out by three neural networks and their performance is evaluated by the accuracy of classification i.e. classifying an employee whether he/she balanced or not. Table 1 shows the results of the classification. PN-1 has only one output neuron, and it is suitable for binary classification. Hence it is applied for this research. PN-2 has multiple output neurons. The intention of using it for this classification problem is to find out the level of balance such as low level, moderate level, and high level. The values fall under moderate level and high level are considered as positive case/class and low level is considered as negative case/class. In this way the results of PN-2 is further understood in the style of binary classification. Adaline has only one neuron for producing the output. Since the connection between the input and the processing neuron is linear, it is found suitable for binary classification and is chosen for this research. The classification accuracy is measured by using the equation 19.

$$\text{Classifier's accuracy } A = (TP+TN) / (TP+TN+FP+FN) \tag{19}$$

Where TP is true positive, TN is true negative, FP is false positive, and FN is false negative.

The result of the cluster analysis is understandable by assuming the levels of work-life balance. The density of the clusters is compared in order to understand the level of membership of the values in that particular cluster. Distances between the values of two different clusters are analyzed in order to evaluate the separability of the clusters. The results of cluster analysis which is presented in the Table 2 reveals that most of the employees are able to balance the work and life in the moderate level. A small set of employees balance the same with high level ability. Another small set of employees are not able to balance as they are grouped under low level. In order to consolidate the performance of unsupervised neural networks, the average counts of all the clusters is taken for consideration. According to the cluster analysis it is clear that 14% of employees are not able to balance the work and life in the 'work from home' mode during covid19 pandemic. 86% employees are able to balance the work and life and within this positive group 14% employees are efficient in balancing the work-life, and 72% are moderate in balancing the same.

CONCLUSION

Working from home would be a major shift in the mindset of the employee of the twenty-first century, as it would allow them to overcome the ills of industrialization by allowing them to set their own pace in the workplace, have less supervision, have more creativity, have more opportunities for innovation, have personal satisfaction and

recognition, self-responsibility, gender identity, and self-respect. Employers should address and manage their workers' mental and physical health by offering psychological assistance and informing them of available resources for seeking help when required. Employers should give clear WFH instructions by implementing clear WFH rules to guarantee that workers transition smoothly from working in the office to working from home. Good worker productivity may be obtained when precise instructions and directions are delivered to the personnel. Employers continue to offer the greatest IT infrastructure for their workers, including robust networkconnection and speed.

The goal of this research is to assess the employees' work life balance during COVID-19 pandemic period. The assessment of the work life balance of the employees is carried out by applying a set of six different artificial neural networks. The research method is a mixture of the two machine learning domains; 1) data mining and 2) artificial neural networks. Two types of data mining task, data classification and data clustering are carried out by applying two sets of neural networks. The above said assessment is considered as data mining problems (classification & clustering) and neural networks are applied as solutions to those problems. Both supervised and unsupervised styles of machine learning are involved in research approach.

The neural networks which are applied in this research are found efficient. The neural networks have produced valid and reliable results. The same are verified by comparing the results of this approach with the results of the statistical approach. The limitations are; as the dataset contains the number of records lesser than a thousand it would be unsuitable to apply advanced neural networks. Hence, some simple neural networks are applied here. Since the original dataset contains multiple attributes which are equally significant, applying decision tree methods is challenging. But, there are much more scope for application of neural networks in the Psychology field. Instead of analyzing only the numeric data, text data could be analyzed by using deep neural networks.

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Table 1. Accuracy of Neural Network Classifiers

Classifiers	TP	TN	FP	FN	Accuracy
PN-1	603	84	9	22	95.68
PN-2	618	90	3	7	98.60
Adaline	620	89	4	5	98.74

Table 2. Results of Cluster Analysis

Methods /Clusters	Maxnet	Mexican Hat	Hamming Net	Average count
No. of elements in Cluster1: High	99	104	89	97
No. of elements in Cluster2: Moderate	517	523	526	522
No. of elements in Cluster 3: Low	102	91	103	99
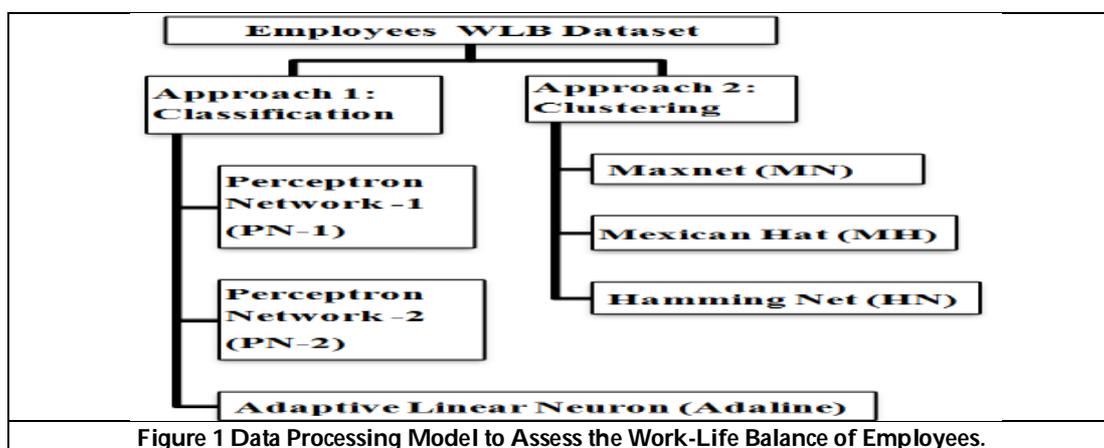
Figure 1 Data Processing Model to Assess the Work-Life Balance of Employees.

RESEARCH ARTICLE

Land use and Land Cover of Taraka Watershed, H.D. Kote Taluk, Mysuru District, Karnataka, India using Remote Sensing and GIS Techniques

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ABSTRACT

The current paper studies an attempt to how land use/land cover are important characteristics for watershed studies. Their is a hydrological phenomena depend upon characteristics. Remote sensing it has emerged as a tool for watershed characteristics and powerful spin-off from space exploitation and the area covering 429 sq km s comprising six types of Lu/Lc is classified, namely Agricultural land, Forest, Built-Up-Land, Wasteland, Water Bodies and Others. This study area is noticed based on Lu/Lc. absorbed data shows that Level 1, level 2 and level 3 were named as the normal category. Different types of shortwave were used, and Arc-Info and Arc -View GIS to analyse the classifications, there are different types of crop land. level 2 Level 3 is karif crop and Rabi (double crop). The Forest-degraded Forest, Forest Plantation Moist & Dry Deciduous Open Forest, level 3 is the same formation. Built –Up Land- towns/cities and villages, wasteland –land with scrub, water Bodies-River/streams and Lake/Tank and others Trees/Groves

Keywords: Wasteland, crop, Agricultural, River.

INTRODUCTION

Remote sensing applications are wide in all fields, especially on aspects of the surface covering a large area. Surface features are very useful for (Basavaraju and D Nagaraju,2020) Lu/Lc in areas of interest in terms of land use. The Remote sensing Application using software Arc GIS is very useful for analyzing the relationship between runoff, geomorphic and geographic characteristics (Basavaraju and D Nagaraju ,2020) of irrigation and non-irrigation land.

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The quantitative analysis of water bodies gives us an idea about many hydrological aspects (Basavaraju and D Nagaraju ,2020). Lithology and slope pedology play a major role in forming watersheds. This paper will explain detailed (Basavaraju and D Nagaraju ,2020) landuse and land cover aspects and it covers 429 km2. Arc GIS maps will be a better tool to understand the particular area under study of land use and land cover in the watershed expressed as quantitative analysis and its description of the karif and rabi pattern is classified. The establishing of different types of crops is sugarcane establishment. It is used in the rain season pattern in the behavior classes of the hydrological system of the area. The quantitative description and analysis of land forms of the drainage basin. The assessment of groundwater management and groundwater potential zones and physical changes in nature response over time to drainage systems to human impact (Basavaraju and D Nagaraju, 2020). A classification of watersheds based on (Basavaraju and D Nagaraju ,2020) level 1,level 2 and level 3 of the area.

MATERIALS AND METHODS

The area for the present study, Remote sensing data of IRS-1B,-2020 were used with the SOI an scale of 1:50,000 and field surveys were carried out to collect the ground-truth check of the area.The main concept of the land use/land cove are Agricultural land, Forest, Built-Up-Land, Wasteland, Water Bodies and others. classification system and the basic LU/LC Dirsc 2/Level 2- Agricultural Plantation Crop land, Degraded Forest Plantation Moist & Dry Deciduous Open Forest, town / Cities Village Land with Scrub Lake/Tank River / Stream and Tree Groves and Dirsc3/Level3- Agricultural Plantation Kharif crop Kharif + Rabi (Double Crop).

Study Area
The watershed considered for this study is the drainage area of a small stream comprising a number of villages occupying a total geographical area of 429 km^2. It is located between 12^0 00′ to 12^0 15′ in the northern latitudes and 76^0 5′ to 76^0 25′ east in the longitudes. Mysore district, Karnataka state, the southern part and the southern part of the Survey of India topho are 57D/4, 57D/8, 58A/1 and 58A/05 are the numbers. The study area connected with an all-good weather motorable road (Fig.1). The River Cauvery is towards the north and H D Kote towards the south, as shown in Fig.1. The average rainfall is about 560mm (Basavaraju and D Nagaraju ,2020) and climatically, the area is semi-arid, having a mean maximum temperature of 150c.

RESULTS AND DISCUSSION

Level-1 : The LU/LC distribution has six major types, such as Agricultural Land , Forest, Built-Up land, wasteland, Water Bodies and other information are in fig 2 and fig 3

Level-2: The arrangement is divided into sub types of the following: Agricultural Plantation ,Crop land, Degraded Forest, Forest Plantation, Moist & Dry Deciduous Open Forest Town / Cities, Village, Land with Scrub, Lake/Tank,River / Stream and Tree Groves are in fig 4

Level-3. are find any detailed agricultural sub types and built land subtype and imfromentation tables are in fig 6

Classification of Lu/Lc at Level-1
Agricultural land
The land used formed food , crop land for commercial proposed total used in my study area is 196.69 km2 (45.79%), as shown in (Fig 2 & 3, Table.2).

Built –Up Land
The surface land, non agricultural land, uses building construction with small industries , transportation due to networking , communication , commercial complex, village ,collective cities and utilities and service in association with water, power line and habitate mask its area by 4.95 km2 (1.15%) as show in (Fig 2 & 3, Table.2)..

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Forest
The forest border area is predominantly (Manjunath et al., 2018) an association of timber and other forest products trees and other vegetation (Manjunath et al., 2018). The forest area is 204.3 km2 and 40% and more of the forest and vegetation land is used. As shown (Figures 2 and 3, Table. 2).

Wastelands
Area currently used for water and soil management. Wastelands may result from inherent/imposed inefficiencies such as location, environment, soil chemical and physical properties. It is described as degraded land that can be brought under vegetation cover (Manjunath et al., 2018) in an area of 3.37 km2 (Fig. 2 and 3, Table. 2) 0.79 %.

Water bodies
This category includes areas with surface water in the form of aquifers, ponds, lakes and tanks (NRSC, 2011). This category includes surface water bodies, in the form of ponds, lakes and reservoirs or runoff in the form of streams, rivers, canals (Manjunath et al., 2018). The area is 13.30 km2. The percentage is 3.09 (Figure 2 and 3, Table.2).

Others
It can be considered varied by their nature of occurrence, physical appearance and other characteristics (Mohammed Subhan Lone et al., 2013) in the comprehensive thematic layer covering an area of 6.98km2 1.63% as shown in the eastern and western parts (Figure 2 and 3, Table.2).

Classification of Lu/Lc Level-2
Agricultural Plantation
Areas exhibiting a pattern of agricultural adaptation where those agricultural tree crops are scattered, side by side plantings are managed techniques (NRSC, 2011). It includes various agricultural plantations (cotton, crop, teak etc.) plantations (coconut, groundnut, citrus fruits, orchards, fruits, ornamental shrubs and trees, vegetable gardens etc.) and agro-horticultural plantations (NRSC, 2011). Differentiation of plantations from cropland is possible with multi-temporal data corresponding to the inter-row cropping/flowering time of plantation crops. Overall, Rabi season data was found to be a good discriminator of plantations from cropland The total area under this category is 53.98km2 (6.7%) (Fig.4 &5)

Crop land
It includes Kharif, Rabi and Zaid crop lands and the area under double or triple crops (NRSC, 2011) including irrigated and non-irrigated, fallow, plantation etc. on standing crops as per satellite date (Manjunath *et al.*, 2018). Image acquisition using both Kharif and Rabi seasons. The cut areas appear bright red in different colors

Degraded Forest
Forest cover less than 10% is called degraded forest. Degradation is brought about by abuse caused by repeated felling, grazing and forest fires (Manjunath et al., 2015a). Conversely, if further irritated, it eventually collapses into a thorny variety and eventually dry grass predominates and bare rocks are exposed. These are indicated in the south-west corner (Manjunath *et al.,* 2018).

Forest Plantation
These are areas of tree species of forest importance, specially cultivated and managed in notified forest areas. The species mainly include teak, sal, eucalyptus, casuarinas, bamboo etc. (NRSC, 2011). These are areas artificially planted with tree cover, either in open spaces or by clearing existing forests for economically inferior species (Dinakar, 2005). New and young plantations can be easily separated from adjacent forest areas (Manjunath et al., 2018)

Moist & Dry Deciduous Open Forest:
Moist deciduous forests with teak, sal, sandalwood and other important species are most evident in areas recording rainfall between 100-200 cm (NCERT, 2019). Dry deciduous forest covers vast areas of the country where rainfall ranges between 70 -100 cm and is interspersed with patches of grass (Manjunath et al., 2018). As the dry season begins, the trees shed their leaves, leaving them covered with earthen bamboo, bamboo, eucalyptus plantations, etc.

Town / Cities
These include residential areas, mixed construction, recreational areas, public/semi-public utilities, communications, public utilities/facilities, commercial areas, reclaimed areas, vegetated areas, transportation, industrial areas and their dumps, and ash/cooling ponds (NRSC, 2011). . The land is used for human settlement of the population, of which more than 5000 0.15% are engaged in non-agricultural activities. This is called urban land use. Most covered by building structures

Village
These are built-up areas, small in size, mainly associated with agriculture and allied sectors and non-commercial activities. They can be found in uncapturable clusters (NRSC, 2011). Land used for human habitation is relatively less than urban settlements where more than 80% of people are engaged in agricultural activities (Pushpavati, 2010). Villages scattered with number of houses, trees and agricultural fields can be clearly observed from the toposheet and satellite images, especially the Mettikuppe forest. In the southwestern parts of the study area occupied by forest. The area occupied by this category is about (Manjunath et al., 2018) 4.30km2 (1.01%) (Fig-4).

Land with Scrub
Also included in this category are forest gaps, which are openings between forested areas without tree cover, and openings of similar sizes and shapes as those published in imagery (NRSC, 2011). The scrub forest of Dommanakatte forest part of Taraka watershed has a canopy density of less than 10% under extreme summer conditions (FAO, 2017). They appear as light red to dark brown tones in standard FCC due to canopy covers. This category covers an area of 7.73 km2 (0.96%) (Figure 7, Table 5). Kakanakote and mettikuppe forested is observed areas and settlements biotic interference is occurs.

Lake/Tank
It is a natural course of water flowing freely on the earth's surface along a specific channel occupied as seasonal or perennial river systems (Manjunath et al., 2018).

River / Stream
A reservoir is an artificial lake constructed by damming across a river, specifically for irrigation, water supply, hydro-electric power for domestic/industrial use and flood control (Dinakar, 2005). The introduction of large reservoirs disturbs the delicate balance between soil, water and vegetation through a rise in the groundwater table (water-logging) (Piyush Rautela et al., 2002). 2018 Manjunath et al. River Kaveri is the primary source of irrigation for domestic and industrial purposes in the study area.

Tree Groves
These are clumps of trees that do not have much undergrowth and occupy an area like a small orchard planted to grow fruits or seeds. Clusters of trees growing together were widely observed in the eastern and western parts of the study area, usually without many shrubs or other vegetation underneath (Manjunath et al., 2018). This category covers an area of 6.98 km2 (1.62%) (Figure-4 & 5, Table 3).

Classification of Lu/Lc Level-2:
Kharif crop: standing crops from June to September with rainfed crops under dry land cultivation and limited irrigation. Kharif crops are depicted in red tones in the standard FCC image. Major kharif crops grown are maize,

sorghum, bajra, cotton, sugarcane, pulses grown under rainfed conditions, while paddy is grown under irrigated conditions (CGWB, 2012). Land (Manjunath et al., 2018) occupies an area of 83.53 km2 (19.44%) (Figure-6& 7, Table 4).

Kharif + Rabi (Double Crop)

The main cropping season, Kharif, starts from May and ends by September. Crop intensity is very high due to physical factors like flat terrain, fertile soil and irrigation by canal systems. Most of the two crop areas are concentrated along the rivers flowing in the study area (Pushpavati, 2010). In FCC, the double crop shows a dark red tone with a square pattern representing soils covered with high moisture content near streams. Cultivated lands in high elevation zones represent bright red tones representing low moisture content and deep levels of groundwater prospect zones. This category has been identified and mapped using two-season satellite images, showing an area cover (Manjunath et al., 2018) of 101.82 km2 (23.7%) (Figure-6 & 7, Table 4).

CONCLUSION

The study highlights the potential of geospatial technology in extracting meaningful and valuable information, which is extremely important in monitoring and managing dynamic LULC features. Accurate and timely interpretation of LULC classification data is an effective tool in addressing regional changes, environment. The Geospatial approach provides a wide range of digital databank information in a synoptic, spatial and temporal manner for mapping and monitoring of land use/land cover in the most time and cost-effective manner. The morphological characteristics of the watershed were computed using the formulae and the results are presented in table.4 . The total level and each one of the levels of lu/lc are listed below.

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Table .1: Land use Pattern identified is the watershed

SI No	Level-1	Level-2	Level-3
1	Agricultural land	Agricultural Plantation Crop land	Agricultural Plantation Kharif crop Kharif + Rabi (Double Crop)
2	Forest	Degraded Forest, Forest Plantation, Moist & Dry Deciduous Open Forest	Degraded Forest, Forest Plantation, Moist & Dry Deciduous Open Forest
3	Built –Up Land	Town / Citie Village	Town / Cities Village
4	Wastelands	Land with Scrub	Land with Scrub
5	Water Bodies	Lake/TankRiverStream	Lake/Tank RiverStream
6	Others	Tree Groves	Tree Groves

Table.2: Classification of Level-1 Land use /Land cove

Lu/Lc Level-1	AREA	Per (%)
AG-L	196.69	45.79
W-B	13.30	3.09
W L	3.37	0.79
B-U-L	4.95	1.15
FOREST	204.23	47.55
OTHER	6.98	1.63
TOTAL AREA	**429.52**	**100**

Table.3:Classification of Level-2 Land use /Land cover

level-2	Area	Per (%)
Agricultural Plantation	11.34	2.64
Crop land	185.35	43.15
Degraded Forest	5.52	1.29
Lake / Tanks	11.19	2.6
Land with scrub	3.32	0.77
Moist & Dry Deciduous Forest	198.71	46.26
River / Stream	2.11	0.49
Salt Affected Land	0.05	0.011
Town / Cities	0.65	0.15
Tree Groves	6.98	1.62
Village	4.30	1.01
Total Area	**429.51**	**99.991**

Table.4. Classification of Level-2 Land use /Land cover

Level-3	Area	Percentage(%)
Agricultural Plantation	11.34	2.64
Kharif crop	83.53	19.44

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Kharif + Rabi (Double Crop)	101.82	23.7
Degraded Forest	5.52	1.29
Lake / Tanks	11.19	2.6
Land with scrub	3.32	0.77
Moist & Dry Deciduous Forest	198.71	46.26
River / Stream	2.11	0.49
Salt Affected Land	0.05	0.011
Town / Cities	0.65	0.15
Tree Groves	6.98	1.62
Village	4.30	1.01
TOTAL AREA	**429.51**	**99.981**

Level-1

Lu/Lc Level-1	AREA	Per (%)
AG-L	196.69	45.79
W-B	13.30	3.09
W L	3.37	0.79
B-U-L	4.95	1.15
FOREST	204.23	47.55
OTHER	6.98	1.63
Total Area	**429.52**	**100**

Level-2

level-2	Area	Per(%)
AGP	11.34	2.64
Crop land	185.35	43.15
Degraded Forest	5.52	1.29
Lake / Tanks	11.19	2.6
Land with scrub	3.32	0.77
Moist & Dry Deciduous Forest	198.71	46.26
River / Stream	2.11	0.49
Salt Affected Land	0.05	0.011
Town / Cities	0.65	0.15
Tree Groves	6.98	1.62
Village	4.30	1.01
Total Area	**429.51**	**99.99**

Level-3

Level-3	Area	Per(%)
AGP	11.34	2.64
KC	83.53	19.44
K +R(DC)	101.82	23.7
D F	5.52	1.29
L / T	11.19	2.6
L with s	3.32	0.77
Moist & Dry D F	198.71	46.26
R / S	2.11	0.49
Salt A Land	0.05	0.011

Basavaraju and Nagaraju

T/Cities	0.65	0.15
T/Groves	6.98	1.62
Village	4.30	1.01
T AREA	**429.51**	**99.98**
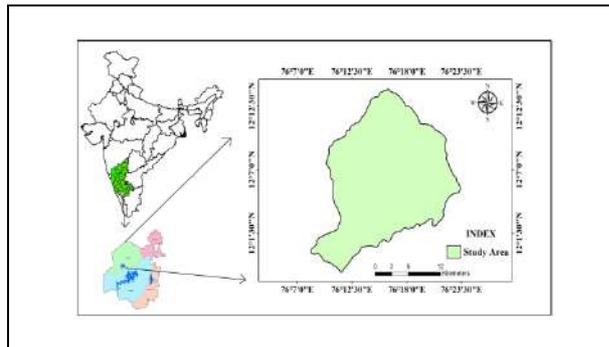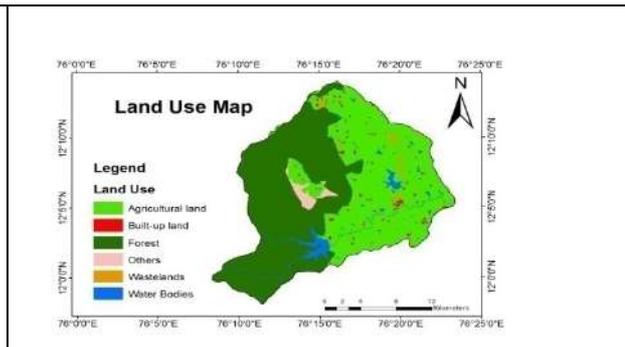
|	
Fig.1. Location Map of the Study Area	**Fig.2. Level-1 Lu/Lc Classification Map of Taraka Watershed**
Fig.3. Pie Chart of Level-1 Lu/Lc Classification of Taraka Watershed	
Fig.4. Level-2 Lu/Lc Classification Map of Taraka Watershed	**Fig.4. Level-2 Lu/Lc Classification Map of Taraka Watershed**
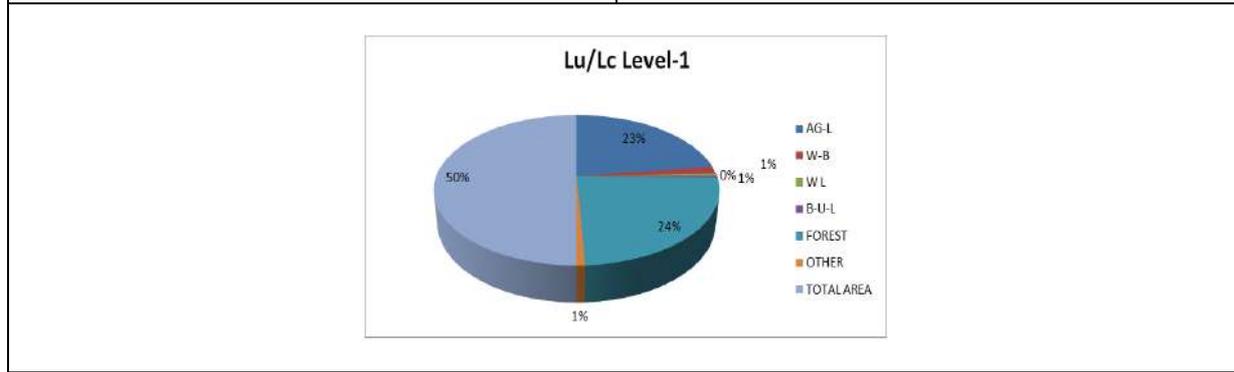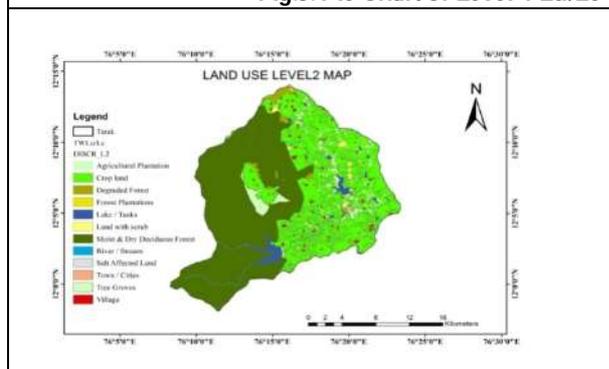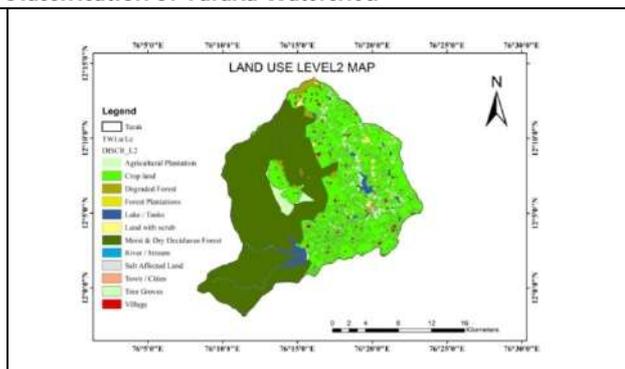
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Fig.5. Pie Chart of Level-2 Lu/Lc Classification of Taraka Watershed

Fig.5. Pie Chart of Level-3 Lu/Lc Classification of Taraka Watershed

Level-1

Level-1

Level-2

Level-2

Level-3

Level-3

RESEARCH ARTICLE

Pharmacological Evaluation of Hepatoprotective Activity of *Solanum seaforthianum* Extract on Serum Parameters in Carbon Tetrachloride Induced Hepatic Damage in Rats

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ABSTRACT

To estimate the hepatoprotective effects of the methanolic seed extract of *Solanum seaforthianum* in Wistar albino rats treated with carbon tetrachloride(CCl4). Liver damage in rats treated with CCl4 0.7ml/kg/Bw, administered, on alternate intraperitonially days for ten days) was studied by assessing parameters such as serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP), acid phosphatase (ACP) and bilirubin(total and direct). The effect of co-administration of *Solanum seaforthianum*. (doses 100 and 200mg/kg p.o.) on the above parameters were investigated. These biochemical observations were supplemented by weight and histological examination of liver sections. Silymarin was used as positive control. Data were analyzed by one way ANOVA, followed by Tukey-Kramer. Administration of *Solanum seaforthianum*(doses 100 and 200 mg/kg p.o) and the Pharmacognostical studies made on the powdered leaves of *Solanum seaforthianum* like ash values, extractive value, loss on drying gave valuable information. The preliminary phytochemical investigation showed the presence of, alkaloids, glycosides, flavonoids, and steroids, carbohydrate, fatty acids and proteins and phenolic compounds. in methanol extract. Based on the results obtained from the present study, it can be concluded methanolic extract of *Solanum seaforthianum* was found to be more potent and effective hepatoprotective and antioxidant activity. The study suggests preventive action of

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Solanum seaforthianum in carbon tetrachloride induced liver toxicity. Hepatic cell regeneration process was dose dependent.

Keywords: *Solanum seaforthianum* ,carbon tetrachloride, hepatoprotective, methanol extract.

INTRODUCTION

The fern, *Solanum seaforthianum* belonging to family solanaceae was selected for my project, on the basis of ethanobotanical information which reveals its uses against one of the most hazardous disease. *Solanum seaforthianum*, is commonly called as Brazilian nightshade, solanum potato creeper, St Vincent lilac herb found in almost throughout India. The present study was undertaken to determine the hepatoprotective and antioxidant effect of methanolic extract from leaf of *Solanum seaforthianum.* The Pharmacognostical studies made on the powdered leaves of *Solanum seaforthianum* like ash values, extractive value, loss on drying gave valuable information. This will help for correct identification of the plant. The preliminary phytochemical investigation showed the presence of, alkaloids, glycosides, flavonoids, and steroids, carbohydrate, fatty acids and proteins and phenolic compounds. in methanol extract. Histopathological studies on isolated liver revealed that methanolic extract of *Solanum seaforthianum* reversed the liver damage caused by CCl_4. Phytochemical screening revealed the presence of flavonoids. possess potent antioxidant and free radical scavenging effect. Example; *Solanum seaforthianum* contain 2-di-C-glcosylflavones of vicenin and lucenin type, anthocyanin-cynidin-3-glucoside, luteolin-7-glycoside and mono-C-glcosyl flavones – vitexin and orientin. Based on the results obtained from the present study, it can be concluded methanolic extract of *Solanum seaforthianum* is found to be more potent and effective hepatoprotective and antioxidant activity. Literature survey revealed that not much work has been done on this fern claiming maximum therapeutic uses. So we felt worthwhile to validate scientifically, the folk claim for its therapeutic activity. We have also taken its detailed Pharmacognostical and preliminary phytochemical investigations to prove its appropriate identification and rationalize its use as drug of therapeutic importance.

MATERIALS AND METHODS

Plant material and chemicals
The species for the proposed study that is leaves of *Solanum seaforthianum* were collected carefully from kottayam district, Kerala. The leaves *Solanum seaforthianum* were washed thoroughly with water to remove the mud or dust, then it was shade dried completely. The dried leaves of *Solanum seaforthianum* was powdered, which was used for further studies.

SILYMARIN (reference drug)
A mixture of the isomers Silibinin, Silicrystin and Silidianin and the active principle from the fruit of *Silybummarianum(Carduusmarianus)* (Compositae).The principle components are the Silibinin, silicrystin, silidianin and flavonolignans of which Silibinin is the major component

Extraction
About 200 gm of air dried powdered material was taken in 1000ml soxhlet apparatus and extracted with petroleum ether for 2 days to remove fatty substances. At the end of 2nd day the powder was taken out and it was dried. After drying it was again packed and extracted by using methanol (S.D. Fine Chemicals Ltd. Mumbai, India) as solvent, till colour disappeared. After that extract was concentrated by distillation and solvent was recovered. The final solution was evaporated to dryness.

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ANIMALS

Healthy male Wistar albino rats of 2 to 3 months of age and approximately weighing between 150-250g were used in the present study. Rats were housed in a polypropylene cages and allowed free access to feed and tap water under strictly controlled pathogen free conditions with room temperature 25±2°C. All the animals were followed the internationally accepted ethical guidelines for the care of laboratory animals. The experimental protocol has been approved by institutional animal ethics committee, JKKMMRF College of Pharmacy, B.Komarapalayam, Namakkal. (Regd. No. JKKMMRFCP / 1158 / PO / ac / 07CPCSEA)

Histopathology

Deparaffized the section by xylol 5 to 10 minutes and remove xylol by absolute alcohol, then wash in tap water. Stain with haematoxylin for 3-4 minutes and wash in tap water. Allow the sections in tap water 5-10 min and wash in tap water. Counter stain with 0.5% until section appears light pink (15 to 30seconds), and then wash in tap water. Blot and dehydrate in alcohol. Clear with xylol (15 to 30 seconds). Mount in Canada balsam or DPX Moutant. Keep slide dry and remove air bubbles.

Statistical Analysis

All the values of biochemical and antioxidant parameter estimations were expressed as mean ± standard error of mean (S.E.M) and was analyzed for significance by ANOVA and groups were compared by Tukey-Kramer multiple comparison test, using In Stat v.2.02 software (GraphPad Software Inc.).Differences between groups (p Value) were considered significant at $P<0.05$.

RESULTS

The fern, *Solanum seaforthianum* belonging to family solanaceae was selected for my project, on the basis of ethanobotanical information which reveals its uses against one of the most hazardous disease. *Solanum seaforthianum*, is commonly called as Brazilian nightshade, solanum potato creeper, St Vincent lilac herb found in almost throughout India. Literature survey revealed that not much work has been done on this fern claiming maximum therapeutic uses. So we felt worthwhile to validate scientifically, the folk claim for its therapeutic activity. We have also taken its detailed Pharmacognostical and preliminary phytochemical investigations to prove its appropriate identification and rationalize its use as drug of therapeutic importance. The analytical parameters were investigated and reported as, total ash value (9.1 %w/w), water soluble ash value (3.5%w/w), acid insoluble ash value (3.4 %w/w),, sulphated ash value (5.2 %w/w), water soluble extractive value (3.7 %w/w), alcohol soluble extractive value (4.5 %w/w), loss on drying (5.12 %w/w). The above studies were enabled to identify the plant material for future investigation and form an important aspect of drug studies.

Assessment of serum biochemical parameters

Methanol extract of *Solanum seaforthianum* possessed a good hepatoprotective activity on rats as shown in the table. At varying dose levels, (100 mg/kg and 200 mg/kg), this extract attenuated altered biochemical parameters produced by CCl_4 was dose dependent. This extract possessed significant hepatoprotective activity at both 100 and 200 mg/kg dose level Values are given as mean ± Standard error mean (S.E.M) for five groups of six animals each. Values are statistically significant at * p<0.05, **p<0.01, ***p<0.001. Group II compared with group I and Groups III, IV & V were compared with group II.

Assessment of Lipid profiles

The serum lipid profile such as total cholesterol, triglycerides, LDL & VLDL were elevated, and this indicated deterioration in hepatic function due to the damage caused by CCl_4 administration. Whereas treatment of *Solanum seaforthianum* extract significantly declined the effect of CCl_4 induced damage and it was evidenced by the decreased level of total cholesterol, triglycerides, LDL & VLDL and increased level of HDL in extract group.

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Values are given as mean ± Standard error mean (S.E.M) for five groups of six animals each. Values are statistically significant at * p<0.05, **p<0.01, ***p<0.001. Group II compared with group I and Groups III, IV & V were compared with group II.

Assessment of antioxidant parameters
The effects of extract at two dose levels (100 and 200 mg/kg, p.o.) on liver antioxidant enzymes in CCl_4 -induced hepatic injury are shown in Table 2. Hepatic injury induced by CCl_4 caused significant increases in liver antioxidant enzymes such as catalase, superoxide dismutase, glutathione peroxidase and lipid peroxidase. Administration of MEAI at different dose levels shows significant dose-dependent decreases, when compared with diseased control animals. Results were shown in table 6. Values are given as mean ± Standard error mean (S.E.M) for five groups of six animals each. Values are statistically significant at * p<0.05, **p<0.01, ***p<0.001. Group II compared with group I and Groups III, IV & V were compared with group

Description of histopathological examination
Group -I
Group I rat Liver tissue section shows normal lobular architecture of liver cells. Hepatocytes, hepatic sinusoids, portal tract, show normal size & Shape. The central vein and sinusoids are normal. There are no inflammation fatty change

Group - II
Group II rat Liver tissue section shows extreme degeneration of hepatic architecture by necrosis, foci of hemorrhage, fatty changes, crowding of vein. The perivenular region shows extensive fatty changes with the areas of lobular inflammation with hepatocytes (fatty change++++,lobular inflammation ++)

Group -III
Group III Liver Tissue section shows mild degree of liver necrosis. Hepatocytes are compact. Hepatic sinusoids appear in normal. The Hepatocytes are well arranged like clusters. There is no inflammation seen, The portal tracts are normal (Fatty change +)

Group - IV
Group - IV Liver tissue section shows hepatocytes with fatty change. Hepatic sinusoids appear in normal. There are areas of lobular inflammation seen along with fatty changes in the perivenular region. There no fibrosis seen (fatty change+++,lobular inflammation +)

Group - V Liver (e)
Group - IV Liver tissue section shows that hepatocytes were regenerative and showed no visible changes and prominent nuclei, reduced score of necrosis and there is no inflammation. The portal tract are normal and there is no fibrosis seen.(Fatty change+, No lobular inflammation) Thus, confirming the safety of the extract.

DISCUSSION

Carbon tetrachloride is metabolized by cytochrome P 450 in endoplasmic reticulum and mitochondria with the formation of CCl_3O^-, a reactive oxidative free radical, which initiates lipid peroxidation and induces liver damage. Damage induced in liver by carbon tetrachloride is accompanied by increase in the activity of some serum enzymes. The study of different enzyme activities such as SGOT, SGPT, ALP, Total Bilirubin, Total Protein, Cholesterol, Triglycerides, HDL, LDL and VLDL have been found to be of great value in the assessment of clinical and experimental liver damage. The liver is the largest organ in the vertebrate body, and is the major site of xenobiotic metabolism and excretion. Liver injury can be caused by toxic chemicals, drugs, and virus infiltration from ingestion or infection. The toxins absorbed from the intestinal tract gain access first to the liver resulting in a variety of liver ailments. Thus liver diseases remain one of the serious health problems (Karan *et al.,* 1999; Chaterrjee, 2000). Carbon

tetrachloride (CCl4) has been widely used in animal models to examine chemical toxin- induced liver damage and the most remarkable pathological characteristics of CCl4-induced hepatotoxicity are fatty liver, cirrhosis and necrosis, which have been thought to result from the formation of reactive intermediates such as trichloromethyl free radicals metabolized by the mixed function cytochrome p450 in the endoplasmic reticulum (Recknagel *et al.,* 1989). Usually, the extent of hepatic damage is assessed by the increased level of cytoplasmic enzymes (ALT, AST and ALP), thus leads to leakage of large quantities of enzymes into the blood circulation. This was associated by massive centrilobular necrosis, ballooning degeneration and cellular infiltration of the liver (Plaa and Charbonneau, 1989). The aim of the present study was to investigate whether the extract from the fern *Solanum seaforthianum* possesses any preventive as well as curative role against CCl$_4$ induced hepatic damages. It is well documented that CCl$_4$ is biotransformed under the action of microsomal cytochrome-P450 of liver to reactive metabolites 31, 32. These free radicals bind covalently to unsaturated lipid membrane, provoking a sharp increase of lipid peroxides followed by pathological changes such as elevated levels of serum marker enzymes like SGOT, SGPT and SALP, depletion of GSH, decreased protein synthesis, triglyceride accumulation, and increased lipid peroxidation, destruction of ca2+ homeostasis and finally hepatocyte damage. This suggests that CCl$_4$ induces liver injury by sharing a common property of free radical mechanism.

Hepatocellular necrosis or membrane damage leads to very high levels of serum SGOT and SGPT released from liver to circulation. Among the two, GPT is a better index of liver injury, since SGPT catalyses the conversion of alanine to pyruvate and glutamate, and released in a similar manner, thus liver GPT represents 90% of the total enzyme present in the body. The elevated levels of serum marker enzymes are indicative of cellular leakage and loss of functional integrity of cellular membrane and liver. ALP activities on the other hand are related to functioning of hepatocytes, its increase in serum is due to increased synthesis in the presence of increased biliary pressure. It is well known that toxicants like CCl$_4$ produce sufficient injury to hepatic parenchyma cells to cause elevation in serum bilirubin, and in contrast decrease the level of total plasma protein content. The activity of serum lipid profile such as total cholesterol, triglycerides, LDL & VLDL were elevated, and this indicated deterioration in hepatic function due to the damage caused by CCl$_4$ administration. Whereas treatment of *Solanum seaforthianum* extract significantly declined the effect of CCl$_4$ induced damage and it was evidenced by the decreased level of total cholesterol, triglycerides, LDL & VLDL and increased level of HDL in *Solanum seaforthianum* treated group. The efficacy of any hepatoprotective drug is dependent on its capacity of either reducing the harmful effect or restoring the normal hepatic physiology that has been disturbed by a hepatotoxin.

Necrosis or membrane damage releases the enzyme in to the circulation and hence it can be measured in serum. A high level of SGOT indicates liver damage, such as that caused by viral hepatitis as well as cardiac infraction and muscle injury. SGPT catalyses the conversion of alanine to pyruvate and glutamate and is released in similar manner. Therefore SGPT is more specific for detecting liver injury. Elevated levels of serum enzymes are indicative of cellular damage and loss of functional integrity of cell membrane in liver. The ability of the methanolic extract of leaves of *Solanum seaforthianum* prevent the increase in the activities of these enzymes is primary evidence indicative of hepatoprotective activity.

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Table.1:Effect of *Solanum seaforthianum* extract on serum parameters in CCl₄ induced hepatic damage in rats

Treatment	SGOT (U/L)	SGPT (U/L)	ALP (U/L)	TOTAL BILIRUBIN (mg/dl)	TOTAL PROTEIN (mg/dl)
GROUP I	97.00 ± 1.41	82.73 ± 1.47	142.00 ± 1.42	0.66 ± 0.01	10.06 ± 0.04
GROUP II	238.5 ± 1.50	363.00 ± 0.89	397.70 ± 0.75	2.14 ± 0.03	6.73 ±0.08
GROUP III	117.56 ± 1.86	106.73 ± 0.98	166.00 ± 1.41	0.76 ± 0.02	9.48 ± 0.17
GROUP IV	204.40 ± 1.37	209.0 ± 1.42	215.00 ± 1.40	1.05 ± 0.04	8.41 ± 0.07
GROUP V	102.20 ± 1.03	105.06 ± 0.98	159.00 ± 1.42	0.79 ± 0.05	8.05 ± 3.51

Table.2:Effect of *Solanum seaforthianum* extract on liver lipid profiles in CCl₄ induced hepatic damage in rats

Treatment	CHOLESTEROL (mg/dl)	TRIGLYCERIDES (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
GROUP I	72.73 ± 1.60	80.73 ± 1.47	39.00± 1.41	31.40 ± 1.51	14.00 ± 0.89
GROUP II	126.50 ± 1.21	125.23 ± 0.81	13.23 ± 1.03	74.20 ± 0.51	36.56 ±1.36
GROUP III	8372 ± 0.75	87.23 ±1.03	29.00± 0.89	45.73± 0.75	17.56 ± 0.51
GROUP IV	95.00 ± 0.89	93.00 ± 0.89	25.73 ± 1.16	48.73 ± 1.32	21.73 ± 1.16
GROUP V	68.23 ± 1.03	83.4 ± 1.51	51.73 ± 0.75	38.00 ±1.41	14.4 ± 1.04

Table.3: Effect of *Solanum seaforthianum* extract on antioxidant parameters in CCl₄ induced hepatic damage in rats

| Treatment	CATALASE (U/mg protein)	SUPEROXIDE DISMUTASE (U/mg protein)	LIPID PEROXIDASE (nmol/mg of protein)
GROUP I	291.56 ± 1.36	92.40 ±1.51	4.56± 0.51
GROUP II	237.23 ± 0.81	81.73± 1.16	8.40 ± 0.54
GROUP III	287.06 ± 0.98	76.00 ± 1.26	2.73 ± 0.40
GROUP IV	195.73 ± 0.75	67.06 ± 0.75	4.56 ± 0.51
GROUP V	277.73 ± 1.16	74.24 ± 1.36	3.56 ± 0.51
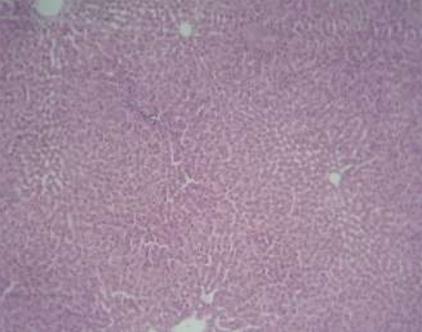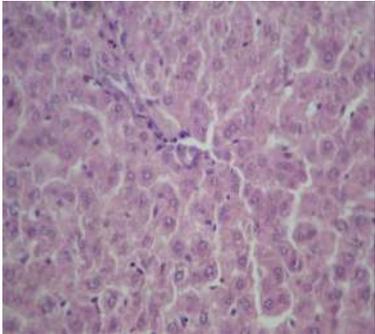
Group I 10x Liver with normal lobular architecture

Group I 40x Normal portal tract and hepatocytes
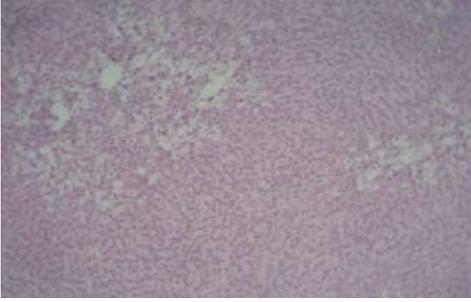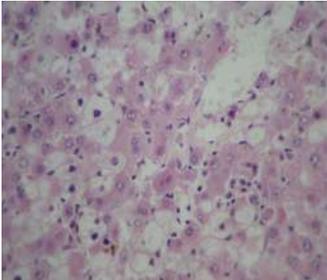
Group II 10x Liver showing parenchyma with fatty change lobular and lobular inflammation

Group II 40x Perivenular region showing fatty change (++++) and inflammation
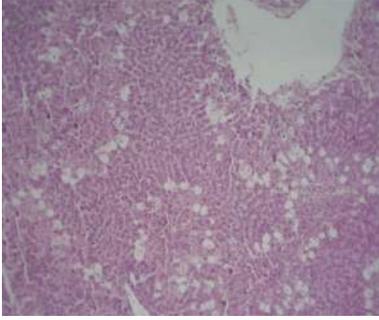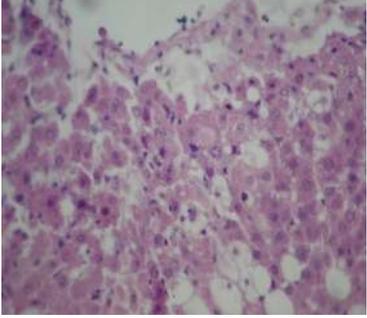
Group III 10x Liver showing parenchyma with fatty change(+)

Group III 40x Perivenular region showing fatty change.

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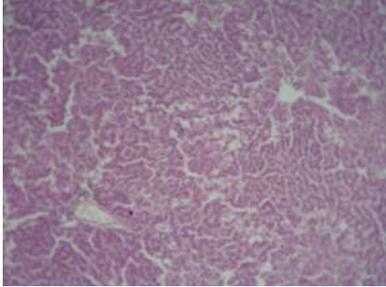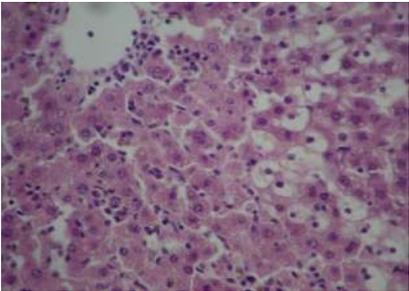
Group.IV.10x Liver showing parenchyma with fatty change (+++)and lobular inflammation

Group.IV.40x Perivenular region showing fatty change(+++)and inflammtion
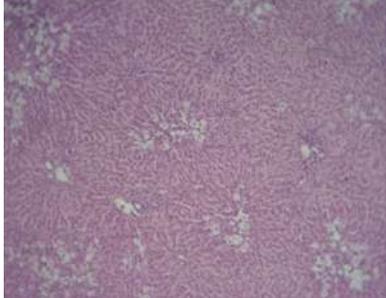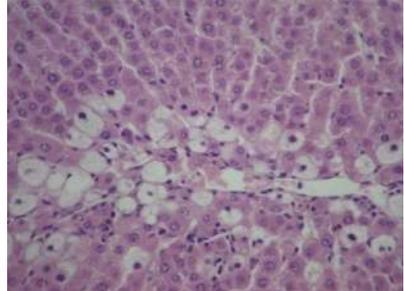
Group V.10x Liver showing parenchyma with fatty change(+)

Group V.40x Perivenular region showing fatty change(+)

RESEARCH ARTICLE

Accurate Analysis of Mixing Intensity for Transesterification Reaction between Sal (*Shorea robusta*) Oil and Methanol

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ABSTRACT

The present research investigation analyses the precise effect of mixing intensity for biodiesel production from Sal (*Shorea Robusta*) oil. The investigation was done for the transesterification reaction between sal oil (viscous liquid) and methanol (normal liquid)along with enzyme catalyst (solid).The reaction parameters were maintained at 63°C for 9hrswith 7.5% biocatalyst Novozyme 435 (*Candida antarctica*) at 6:1 molar ratio of methanol to oil. The initial mixing intensity identified was 550 rpm which gives maximum production (94.17%). After that, stirring rate was studied from 545 rpm to 555 rpm to find out the exact mixing intensity for product maximization. Finally, it was found that 547 rpm is the optimum mixing intensity for maximum conversion which can also reduce energy cost to some extent.

Keywords: Biodiesel, Mixing intensity, Sal oil, Transesterification, *Candida antarctica*

INTRODUCTION

Reaction parameters play an important role in the maximum conversion of any reaction product. The preparation of biodiesel from different raw materials also depends on important reaction parameters like molar ratio of reactants, mixing intensity, temperature, catalyst concentration etc. Among the parameters, mixing intensity or stirring rate contributes significantly as it determines the fastness of contact between reactants with the catalyst which plays a major role for getting the optimum product. Peiter *et al* [1]studied the stirring and mixing of ethylic biodiesel

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production and identify the period where the variables had more influence during the reaction and the period where no such effect is present. Brásio *et al* [2]studied the effect of mixing in biodiesel production through modelling technique and quantified the effect of mixing intensity on the transesterification reaction. Stamenkovic *et al* [3] analysed the effect of different agitation intensity on alkali-catalysed methanolysis of sunflower oil.Nandi *et al* [4] analysed the effect of mixing intensity for biodiesel production from palm fatty aciddistillate and showed that 700 rpm is the optimum stirring rate for 93.2% biodiesel production. Nandi and Mitra[5] also analysed the effect of mixing intensity for biodiesel production from coconut acid oil and showed that 600 rpm is the optimum stirring rate here. Production of biodiesel from rice bran and karanja oils was studied in a stirred tank reactor at different agitator speeds by Lakshmi et al[6] and they showed that minimum critical speed of agitator for rice bran was 700–750 rpm and for karanja was 550–650 rpm. A study with mathematical modelling for the mass transfer kinetics of biodiesel production from jatrophacurcas oil was done by present author [7]and it was shown that mass transfer rate determines the conversion rate of biodiesel production. The rate of mixing speed was also studied by many researchers [8-12]. Hasan *et al* [13] studied the impact of mixing speed and reaction time on biodiesel production from sunflower oil and identified the shaking time with reaction duration. Asheminezhad *et al* [14]used stirred batch reactor for biodiesel production from waste cooking oil and identified 650 rpm is the optimum stirring velocity for maximum production. Frascari *et al* [15] optimized the mechanical agitation and evaluated of the mass-transfer resistance in the oil transesterification reaction. But very few studies have been made for the identification of exact mixing intensity for the biodiesel production from cheap sources. In the present research investigation, after identification of reaction parameters for the enzymatic production of biodiesel from sal oil, exact mixing intensity was determined. Sal (*Shorea Robusta*) oil, extracted from sal seed (Figure1), is used for the purpose of production of biofuel. The composition of glycerides in the reaction mixture was also analysed during a particular range of mixing intensity and finally, the characteristics of sal biodiesel were compared with diesel fuel according to ASTM D6751.

MATERIALS

Sal oil was collected from Angura Oils Pvt Ltd, Kolkata, West Bengal. Novozyme 40013, an immobilized nonspecific lipase from *Candida antarctica* was used as catalyst in the reaction with ester synthesis activity of 10000 propyl laurate unit/g. Methanol was purchased from Scientific and Laboratory Instrument Co., Kolkata. Except otherwise specified all other chemicals were A.R. Grade.

METHODS

Transesterification of sal oil: 500 mL of sal oil was filtered and taken in an Erlenmeyer flask and heated up to 80°C to drive off moisture by continuous stirring for about 1 h. After that, methanol was added to it for transesterification reactionthrough stepwise manner in an appropriate proportion (1:6 molar ratio of oil to methanol) using solvent hexane at a specified temperature of 63°C for 9 hours. Enzyme Novozyme 40013 (7.5% w/w) was added to the reaction mixture. The progress of reaction or production of biodiesel was monitored by thin layer chromatographic (TLC) method and the typical yield of each reaction product was determined separately by column chromatography using silicic acid as an adsorbent and 160 mL of hexane diethyl ether (99:1) as eluting solvent. At the end of the reaction, the product was filtrated through separating funnel to remove the enzyme and allowed to separate. The lower layer was then evaporated under vacuum in order to remove excess methanol and the final product was collected. The enzyme was washed with hexane, dried and reused for the next experiment. Biodiesel characterization was done according to the American Standard Testing Method (ASTM). Values are reported as mean ± s.d., where n = 3 (n = no of observations). Identification of mixing intensity: Initially 550 rpm was identified as mixing intensity for transesterification reaction. For identifying exact mixing intensity, the reaction was done by applying mixing intensity of 545 rpm to 555 rpm maintaining same reaction conditions. The product in each case was identified and characterized.

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RESULTS AND DISCUSSIONS

Physicochemical Properties of Sal Oil

The physicochemical properties of sal oil are shown in Table 1. It has been observed from Table 1 that sal oil has a calorific value of nearly 37.19 MJ/Kg with higher flash point at nearly 247°C. Lower iodine value shows the presence of higher percentage of saturated part of this oil. Higher flash point indicates its safe use as fuel after conversion.

Analysis of Reaction Parameters

The reaction parameters are important for the overall control of the reaction which ultimately contribute maximum conversion. Identification of accurate mixing intensity is not only important for optimization but also controls the collision of reactant molecules with the active sites of enzyme catalyst. So for this purpose, initially, different reaction parameters like molar ratio, temperature, enzyme concentration and mixing intensity were analysed for the production of biodiesel. Figure 2, 3, 4 and 5showed the analysis of these parameters. From Figure 2, it has been observed that increasing amount of alcohol enhances the conversion and 6:1 molar ratio is the optimum molar ratio for maximum conversion of product. Thereafter increasing amount of alcohol did not enhance the product. Figure 3 shows the similar pattern of enhancing the product and 63°C is the ideal temperature for this transesterification reaction. Each enzyme is specifically active up to a certain temperature and after that it has been deactivated. Here also, after 63°C temperature, there is a decrement of conversion may be due to the inactivation of enzyme. Figure 4 shows the required enzyme concentration for maximum conversion of biodiesel. 7.5% has been identified as the ideal concentration of enzyme. Beyond that conversion decreases may be due to agglomeration of enzyme which hides the active sites of enzyme. Figure 5 shows the required mixing intensity in this reaction. Initially, increasing the mixing intensity enhances the product due to increasing no of collision or contact between reactants and enzyme. By this way, 550 rpm has been identified as the optimum mixing intensity. So, at the beginning, it has been detected that 6:1 molar ratio of methanol to sal oil contributes maximum conversion (94.17%) of biodiesel at temperature 63°C with enzyme concentration of 7.5% and a mixing intensity of 550 rpm.

Identification of Accurate Mixing Intensity

After identifying the reaction parameters, it has been tried to find out optimum no of collisions between reactants and enzyme particles through mixing intensity. So, accurate mixing intensity has been analysed by maintaining other reaction parameters unchanged. For this purpose, experiments were done in eleven batches by varying mixing intensity from 545 to 555 rpm as graphically shown in Figure 6. It has been observed from Figure6 that at the mixing intensity of 545 rpm, the conversion is 92.38%. By increasing the rpm, conversion of biodiesel enhances and at 547 rpm, maximum amount of conversion (94.17%) has been achieved. After that, there is a minute changes in the percentage conversion till 550 rpm. Then if rpm increases, the % conversion decreases. At 551, 552, 553, 554 and 555 rpm, the conversions are 93.89, 93.17, 92.72, 91.55 and 90.03% respectively. It may be due to the fact that higher mixing rate decreases the proper contact between active sites of enzyme and reactants. Hence conversion decreases. Also, electricity consumption decreases at lower mixing rate which is helpful for energy saving during the process. So mixing intensity plays an important role for the enzymatic conversion of biodiesel from sal oil.

Analysis of Reaction Composition

The concentration of triacylglycerols (TAG), diacylglycerols (DAG), monoacylglycerols (MAG) and methyl ester (biodiesel) have also been analysed at different mixing intensity starting from 545 rpm to 555 rpm as shown in Table 2. It has been observed from Table 2 that increasing rpm from 545 to 547 enhances the conversion of methyl ester or biodiesel and at 547 rpm, maximum conversion has been achieved. During this time, amount of TAG, DAG and MAG decreased which indicates that these three glycerides have significantly converted to biodiesel and maximum conversion (94.17%) has been achieved. After that, increasing rpm decreases the conversion of biodiesel but again increases to 94.17% at 550 rpm. This may be due to the breakage of TAG molecules. After 550 rpm, increasing mixing rate (550 to 555 rpm) decreases the biodiesel conversion along with the TAG molecules. During this time, amount of DAG and MAG enhanced rapidly which results in less biodiesel production.

Characterization of Biodiesel

After the formation of biodiesel from sal oil in the enzymatic process, it was characterized based on physicochemical properties as shown in Table 3. It has been observed from Table 3 that the characteristics of biodiesel are comparable with biodiesel standards in most of the properties. Higher flash point of sal biodiesel is significant and desirable also due to safe handling than diesel fuel. The calorific value of diesel fuel is higher than biodiesel but with regard to other characteristics, sal biodiesel can be used safely without modification of engines.

CONCLUSION

Accurate mixing intensity has been studied for the enzymatic preparation of biodiesel from sal oil. Initially, reaction parameters have been identified for maximum conversion of biodiesel and 550 rpm was identified as proper mixing intensity. After that, details analysis of identified mixing intensity from 545 to 555 rpm was conducted and experiment showed that 547 rpm is the accurate stirring rate for biodiesel production from sal oil. The composition of reaction mixture w.r.t. glycerides and biodiesel were identified. The study would be helpful for the production of biodiesel from other sources by utilising accurate mixing intensity which is energy saving too.

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Table 1: Physicochemical properties of sal oil

Properties	Values	Test methods
Iodine Value (g I_2/100 g)	42.11 ±0.115	ASTMD 5554
Peroxide Value (Eq. O2/kg)	17.22 ±0.026	------------------
Acid Value (mg KOH/g)	17.29 ±0.066	-----------------
Saponification Value (mg KOH/g)	187.74 ±0.139	----------------
Kinematic Viscosity at 40°C (mm^2/s)	59.21 ±0.107	ASTM-D445
Refractive Index	1.466 ±0.011	-------------------
Density at 15°C(Kg/m3)	898 ±0.218	ASTMD 5002
Calorific value (MJ/Kg)	37.19±0.101	ASTMD-4868
Flash point (°C)	247±0.208	ASTMD-93

Table 2: Analysis of glycerides w.r.t. mixing intensity

[Time: 9 hrs, Temperature: 63^0C, Enzyme concentration: 7.5%, Molar ratio: 6:1]

RPM	TAG	DAG	MAG	Biodiesel
545	1.82±0.011	1.57±0.051	2.64±0.012	92.38 ±0.239
546	1.51±0.008	1.49±0.019	2.37±0.027	93.09±0.187
547	1.14±0.012	1.34±0.018	1.76±0.033	94.17±0.201
548	1.13±0.017	1.35±0.022	1.77±0.044	94.13±0.182
549	1.08±0.019	1.39±0.031	1.77±0.051	94.16±0.222
550	1.06±0.021	1.42±0.021	1.78±0.022	94.17±0.201
551	1.02±0.011	1.57±0.031	1.94±0.031	93.89±0.197
552	0.97±0.003	1.93±0.017	2.32±0.026	93.17±0.162
553	0.96±0.004	2.12±0.023	2.62±0.011	92.72±0.159
554	0.94±0.007	2.88±0.022	3.01±0.028	91.55±0.155
555	0.93±0.008	3.12±0.028	3.33±0.022	91.03±0.181

Table 3: Comparative characteristics of sal biodiesel

Properties	Diesel fuel	Sal biodiesel	ASTM D6751
Density at 15°C(Kg/m3)	841	877±0.211	860-900
Calorific value (MJ/Kg)	45	38±0.107	------
Kinematic viscosity at 40°C (mm^2/s)	3.17	3.76±0.102	1.9-6.0
Flash point (°C)	63	211±0.117	Min 130
Cetane no	51	56±0.053	--------

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Figure 1: Sal seeds

Figure 2: Analysis of molar ratio of MeOH and sal oil for biodiesel production

Figure 3: Analysis of temperature for biodiesel production from sal oil
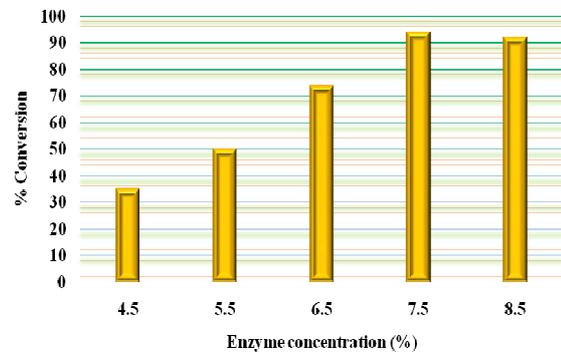

**Figure 4: Analysis of enzyme concentration for biodiesel production from sal oil**

**Figure 5: Analysis of mixing intensity for biodiesel production from sal oil**
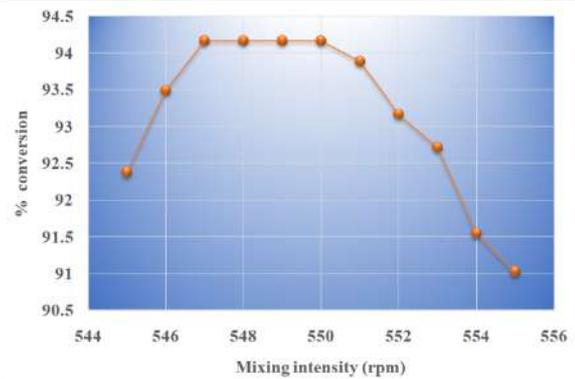
Figure 6: Analysis of mixing intensity from 545 to 555 rpm