REVIEW ARTICLE

An Overview on Veterinary Herbal Medicine

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ABSTRACT

Plant-based medications used for therapeutic, preventative, or diagnostic purposes in animal healthcare are referred to as veterinary herbal medications. In India's rural areas, veterinary medications cover the small-scale farmers' knowledge, abilities, techniques, practices, and beliefs around the care of their livestock. From the perspectives of drug safety and effectiveness, the proper conversion of drug dosage, such as from animal dose to human dose, is crucial. There are many herbs that are used in veterinary medicine, including catechu, liquorice, pepper, garlic, and neem. To guarantee their quality, uniformity, and reproducibility, veterinary herbal remedies (crude drugs/extracts) must be standardized. Only a veterinarian with a licence or under the direct supervision of a veterinarian may prescribe herbal medicine. To ensure the quality of veterinary medications, the pharmacopoeias may also think about establishing monographs for plants and herbal compounds used specifically in veterinary medicines.

Keywords: Veterinary herbal medicines, therapeutic, monographs, pharmacopoeias

INTRODUCTION

The use of herbal medicine dates back to early civilizations. It entails the use of plants as medicines to cure illness and improve people's overall health and wellness. An rising number of people are turning to herbal medications since they are thought to have negligible or no negative effects [1]. The World Health Organization (WHO) defines

traditional medicine (herbal medicine) as "the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness" [2]. Herbal remedies used in veterinary medicine include plant-based medications used for therapeutic, preventative, or diagnostic purposes in animal healthcare. In India's rural areas, veterinary medications cover the smallholders' knowledge, abilities, methods, practises, and beliefs around the care of their animals. When synthetic medications are used over an extended period of time, their byproducts and harmful metabolites become a cause for concern. For example, the presence of antibiotic residues in animals can result in the development of antibiotic resistance. Since herbal medicines are less expensive and safer than current systems for caring for animals, problems like these have led to the quest for alternatives [3-5]. In this article we can overview the herbal medicine which are used for the veterinary purposes and also other parameters.

Relationship Between Animal Dose and Human Dose [6]
From the perspectives of pharmacological safety and effectiveness, the correct translation of drug dosage from one animal species to another and the translation of animal dose to human dose are both crucial. In addition, giving medications to animals is typically done under duress and by combining them with food. The Food and Drug Administration has suggested that the extrapolation of animal dose to human dose is correctly performed through normalization to body surface area (BSA), which often is represented in mg/m^2 is tabulated in the table:1.

Herbal Drugs used in Veterinary Practice [7]
Here are the very important herbal drugs which are being routinely used in veterinary treatment is given in the table: 2.

Preparation Of Veterinary Herbal Medicines [8]
Herbal medicines for veterinary use can be given or prepared in a various ways:
- Chopped fresh herbs are combined with cuisine. When herbs are accessible, it may be the best way to offer them.
- Adding dried herbs to food or preparing them as infusions or decoctions with hot water for internal or exterior usage are two ways to consume them.
- Alcoholic tinctures are administered orally with care using a syringe or dropper, either straight up or diluted with water.
- Externally administered oil infusions or lotions include application to painful joints.
- The most prevalent type of herbal treatment is commercially produced tablets or powders.

Who must practice the herbal medicine?
According to local laws, only a veterinarian who is certified to practice medicine may prescribe herbal therapy, or therapy administered directly under a veterinarian's supervision. After a precise diagnosis has been made, herbal medicine should only be used. Only a properly qualified veterinarian should give herbal remedies due to the differences in physiology between animal species and humans and the potential for injury if herbs are administered improperly. Veterinary herbalism is regarded as veterinary medicine by both the American Veterinary Medical Association and the Canadian Veterinary Medical Association. There are more and more veterinarians in private practice who have the required education and experience in herbal medicine as veterinary herbal treatment develops as a specialty. Referrals are frequently not required, however they should be taken into account when using herbs to treat extremely risky, difficult-to-treat diseases, or those that are refractory.

Conditions At Which Animals Often Treated With Herbal Therapy
Almost all conditions that currently pose a challenge to conventional veterinary medicine can be managed using herbal remedies, including epilepsy, chronic kidney failure, chronic lameness, hormonal imbalances, behavioural issues, allergic skin diseases, liver failure, and inflammatory bowel diseases. Other herbs might merely serve as "tonics," supporting the regular operation of healthy organs.

Effectiveness, Safety and Cost of Veterinary Herbal Medicines

The age of the patient, history of prior treatments, and diagnosis all affect how well a herbal remedy works. Even practitioners who have received scientific training in herbology must draw on their clinical experience and traditional knowledge when prescribing herbs because the science of herbology hasn't yet caught up with herbal practice. Use of high-quality herbs from reliable suppliers results in more uniform dosing and predictable results. Currently, there are many nations where there are neither quality control regulations for herbs nor any criteria for proving their safety and efficacy. Herb quality will vary depending on a number of variables, including as growing circumstances, age at harvest, time of harvest, handling following harvest, and storage. Other plants may get contaminated or adulterated during harvest or processing, while many plants will absorb and concentrate ambient chemicals inside their parts. As a result, veterinary herbalists prefer to use items that have an organic certification. Herbs have a shelf life of anything between six months after harvest for bulk herbs, three years for Chinese herb granular extracts, and up to five years for tinctures. An expiration date should be printed on the label of reliable products. The patient's condition could get worse if the incorrect herb is used, or if the dosage is off. Adverse effects are rare and typically mild when administered by a skilled veterinary herbalist, although they are nevertheless possible. Animals who are pregnant, receiving various therapies, or severely unwell should all be treated with caution. The cost of the veterinary herbal therapy is not out of reach. It frequently turns out to be less expensive than traditional medicine over the long run [9].

Standardization and Regulatory Aspects of Veterinary Herbal Medicines

- To ensure that one or more of the veterinary herbal medicine's important phytochemical constituents or other substances are present in a specific amount, it is necessary to standardize veterinary herbal medicines (crude drugs/extracts).
- To ensure that one or more of the veterinary herbal medicine's important phytochemical constituents or other substances are present in a specific amount, it is necessary to standardize veterinary herbal medicines (crude drugs/extracts)[10].
- The determination of the dose of plant-based medications and the identification of physiologically active components in herbs are both crucial for quality control.
- Additionally, understanding the right dosage for these plant-based medications is necessary since, while some plants, like *Abrus precatorius,* are poisonous in large doses, they are effective as veterinary medicines when used sparingly.

Standardizing herbal medications is a challenging task because these medications contain intricate blends of many ingredients. Thus, it is frequently uncertain which herbs provide the medical effect. Knowledge of the physicochemical properties of herbal medicines, along with other preformulation data, is necessary for the standardization and validation of active constituents. Various chemical, spectroscopic, and biological methods are also employed for the standardization. Some examples include infrared spectroscopy, liquid chromatography, high performance thin layer chromatography (HPTLC), nuclear magnetic resonance, mass spectroscopy, etc [11].GMP covers every facet of production, from raw materials, facilities, and machinery to employee training, safety precautions, and personal hygiene. Additionally, it makes sure that the right standard operating procedures are followed, the work environment is maintained, and the packing, labelling, and quality assurance processes adhere to the specifications [12,13]. There are monographs for many herbs used for human medicine in a number of different pharmacopoeias, including the IP, Chinese Herbal Pharmacopoeia, British Herbal Pharmacopoeia, BP, USP, European Pharmacopoeia, Japanese Standards for Herbal Medicine, and the Ayurvedic Pharmacopoeia of India, but none of them mention the herbal monographs used as veterinary medicines. To preserve the quality of these pharmacopoeias, monographs for herbs and herbal compounds specifically used in veterinary medications may be considered.

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Pharmacological Action and Therapeutic uses of Some Drugs
Allium sativum **(Garlic,Lasan)[14]**

Part: Bulb and oil
Active principal: More than 160 compounds, acrid volatile oil, allicin (allyl propyl disulphide and other organic sulphide and sulphur compounds)

Good antibacterial, antifungal and antiparasitic:
- In China : garlic is being frequently used against fever.
- Louis Pasteur was the first to discover its antibacterial properties in 1858. There have been 2,500 scientific reports to date.
- Garlic has been used to treat dysentery, typhoid, cholera, and bacterial food poisoning with success.
- Garlic cooked in coconut or mustard oil works wonders as an antiseptic against scabies and ulcer-infesting maggots.
- Garlic juice is used as a lotion for cleansing wounds and nasty ulcers when combined with three or four parts of distilled water.
- This was used to guard against fungus, the common cold, and the flu.

Effect on blood Pressure and vascular System
- It lowers triglycerides and cholesterol while raising HDL (the good cholesterol) levels in the blood.
- It acts as a vasodilator, lowers blood pressure, enhances blood flow, and provides more nutrients to tissues.
- It shields blood vessels from the damaging effects of free radicals.
- Allicin is unstable and breaks down into various strongly scented "S" compounds, including ajoenes, which has an antithrombotic effect.
- Allicin also has antilipemic and antiplatelet effects.
- Probably affects calcium-dependent processes is how it works. It also has an impact on the thiol groups found in many enzymes. Total effect on lipid profile: It decreases

Total cholesterol	:	6-9%
Low density Lipoprotein	:	11 %
Triglycerides	:	17 %

Effect on Gastrointestinal & respiratory System:
- Garlic decreases GIT cancer, if taken regularly.
- It stimulates bile and other digestive secretions.
- It improves irregular intestinal motility.
- It causes the pancreas to release more insulin to treat hyperglycemia.
- It has expectorant qualities.
- Garlic is a volatile oil that is expelled through the lungs, sterilizing the bronchial tube and lung in the process.
- Garlic's allicin, which is contained in it, dilates the blood vessels in the lungs.
- Garlic breath results from the intestinal conversion of allicin into allyl mercaptan, which enters the bloodstream and travels to the lungs.

Other Pharmacological Action of Garlic:
- It is good antioxidant, anti-inflammatory and immunostimulant.
- Garlic also acts as Anti Cancer agent

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Mode of Action
It lowers the nitrate level in body. And it is established nitrate is high in meat & other food. In body nitrate is converted into nitrosamine, which is carcinogenic.

Preparation & Dose of Garlic
- Dose: 4 g of fresh garlic cloves daily.
- Preparation: 100, 200, 400 mg tablets (enteric coated).
- Since raw garlic irritates the digestive system, it should only be consumed with meals.
- In stomach fluid, allin and allicin are unstable. Enteric coated pills or capsules containing dried garlic powder are the best garlic preparations.

Side Effect of Garlic
Excess use of garlic may decrease the sight, cause flatulence, injure the stomach and cause thirst. High doses not used in children & pregnant (increase uterine contraction).

Azadirachata indica (Neem)[15]
Parts: Every part of the plant (Bark, leaves, flowers, seed oil) is used as medicine. Active principles Penta-nortriterpene, Nimbolin A & B, azadirone, arachidic acid, linolic acid etc.

Pharmacological activities of Neem:
Antifungal, insecticidal, antiseptic, anthelmintic, spermicidal, diuretic, antipyretic, antiviral, antimalarial, antineoplastic, hypoglycaemic, antipyretic.

Clinical therapeutic uses
Glandular tumour, postural eruption, itching, eczema, ringworm, scabies, mange, boils, ulcer, liver ailments, leucoderma, diabetes, TB, leprosy, pruritis, loss of hair, night blindness, and piles are among the conditions that are successfully treated with neem. *Allium cepa* (Onion).
Part: Bulb and seeds

Pharmacological activities
Oil contained in bulb is stimulant, diuretic and expectorant.

Clinical therapeutic uses:
❖ Locally in insect bites, scorpion bites and other skin diseases. In highly infected and inflammatory swelling (it is applied mixed with mustardoil)
❖ Acts as demulcent both (internally and externally) if used roasted.

Ocimum album (Tulsi)
Part: leaves and seed.
- Leaves contain a yellowish green essential oil and known as 'Basil camphor'. Essential oil contains a newterpene.
- The leaves made into paste are used to cure parasitic diseases of skin especially the ring worm.
- 12% decoction of the Tulsi plant is used as parasiticide and antiseptic.

CONCLUSION

This article covers the wide scope of herbal drugs that can be used in the treatment of animal diseases. Manufacturers are encouraged to use the IP standards with respect to these herbal medicines for the manufacture of veterinary herbal formulations. Regardless of the extensive modern programs implemented by government

organizations and hospitals to uplift rural health care, these traditional treatments have endure popular. In some rural areas, people have great undocumented traditional knowledge about animal diseases, herbal treatments, formulations, etc., But due to modernization, this traditional veterinary knowledge is on the brink of extinction. The only way to learn this information is from what has been handed down through the centuries, and the current generation's lack of interest in traditional veterinary knowledge is causing it to disappear. Therefore, there is a exigency to emphasize the veterinary herbal sector. In comparison to current medications, the majority of herbal veterinary medications are offered at a reasonably inexpensive price. While the herbal products are cheaper, the active ingredients of the medicinal plants are becoming increasingly expensive. As a result, herbal veterinary medicines are losing their edge over the allopathic drugs. Thus, there is also an urgent need to encourage research in this sector. Moreover, the quality specifications of veterinary herbal medicines need to be developed and the possibility of harmonization/collaboration efforts may be explored to take care of animal health care at the national and international levels. It can thus be concluded that there is still a need for both the validation of traditional claims (detailed pharmacognostical, phytochemical, and pharmacological investigations, etc.) and safety evaluations in appropriate models of these medicinal plants for their development and use as veterinary medicines.

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Table: 1 Relationship Between Animal Dose And Human Dose

SPECIES		WEIGHT(Kg)	BSA(Mg/M²)	K_M FACTOR
Human	Adult	60	1.6	37
	Child	20	0.8	25
Baboon		12	0.6	20
Dog		10	0.5	20
Monkey		3	0.24	12
Rabbit		1.8	0.15	12
Guinea pig		0.4	0.05	8

Rat	0.15	0.025	6
Hamster	0.008	0.02	5
Mouse	0.02	0.007	3

Table: 2 Herbal Drugs Used In Veterinary Practice

COMMON NAME	BOTANICAL NAME	PHARMACOLOGICAL ACTION	USES
Katha	*Acacia catechu*	astringent	Inpersistent diarrhoea & dysentery
Sirka	*Acidum aritiucm*	Rumen acidifer	Indigestion where rumen
Arusha	*Adhatoda vasica*	Expectorant, diuretic andanti spasmodic	Cold, cough, bronchitis & catarrhal affections
Aniseed	*Pimpinella anisum*	Aromatic, stimulant and lessen grippling effect of cathartics	Indigestion and tympanites
Caster oil	*Ricinus communis*	Puragative External Protective	Constipation, indigestion and impaction
Asafoctida	*Ferula foetida*	Carminative, stimulant andantispasmodic. Externally antiseptic	Flatulence, colicindigestion, coughbronchitis, asthma
Kapur	*Camphora officunarum*	Stimulant, carminative and antispasmodic externally antiseptic	Couth, timpany, stimulant to heart and brain, wounds, ulcer & sprains
Liquorice	*Glycyrrhiza glabra*	Expectorant & demulcent	Cough, bronchitis and asthma
Ipecac	*Cephaelis ipecacuana*	Antibacterial, emetic, diaphoretic	Amoebic dysentery, loss of appetite, cough
Madagaskar periwinkle	*Catharanthus roseus*	Stomachic, sedative & tranquilizing property	Loss of appetite, hypertension sedation
Pepper	*Piper longum*	Anti inflammatory analgesic loss ofappetite	Pneumatic pains chronic bronchitis

REVIEW ARTICLE

Heteropolyacid Salts as Eco-Benign Catalyst in Organic Reactions: A Review

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ABSTRACT

In the preceding two decades, Heteropolyacid has drawn a lot of attraction due to its distinctive physicochemical properties such as Bronsted acidity, oxidizing properties, proton mobility, etc. There are many liquid mineral acid catalysts used in a chemical reaction that have adverse effects on the environment. Heteropolyacids have greater no. of acidic sites and higher catalytic activity than mineral acids. Their mobility is very high so that the exchange of protons with other metals becomes easy and increases the reactivity of the catalyst. Therefore, the discovery of heteropolyacid proved to have significant importance over conventional acid catalysts. Many features of heteropoly acid made it different from the simple acid catalyst; Easy to prepare, handholding, easily separated, and most important fact is reusability. The most interesting thing is that these catalysts can be separated easily and reused several times without any change in catalytic activity. Therefore, numerous reactions can be catalyzed by using heteropolyacid salts. In this study, we have tried to compile reactions literature of the last decade which have been catalyzed by different types of heteropolyacid salts. Reactions take place under ideal conditions without any acid wastage. This review article highlighted the synthesis of various organic compounds by using different types of heteropolyacid salts as reaction elevators.

Keywords: Heteropolyacid Salts, Catalyst, Organic reactions, Cesium-based catalyst, Miscellaneous catalyst.

INTRODUCTION

Since the industrial revolution, factories have revolutionized the manufacturing process. Insignificant little things to heavy complex machinery- manufacturing of everything has been overhauled several times. We have become more efficient, precise, and reliable in the mass production of everyday items which has enhanced the quality of life to a great extent. The chemical industry has played a pivotal role in this journey of modernization of manufacturing processes. The use of chemicals has proved to be economical along with saving time and effort [1]. The various benefits of the chemicals are focused upon to an extent that the harmful effects of the same are marginalized. The adverse effects of chemicals on the environment have created a challenge to adapt to develop the sustainable synthesis of chemicals [2]. The treatment of chemical waste has been neglected for a long time. It is high time we addressed the need to transform the fundamental principle for sustainability. In recent years, researchers have paid more attention to the utility of heteropolyacid in organic transformation. HPA catalysts are heterogeneous solid catalysts. These are also referred to as polyoxometalates having well-defined structures. They are used as a catalyst in various types of reactions like alkylation, acylation, dehydration, esterification, and many multi-component oxidation reactions, etc. [3]. The main advantage of these salts was a catalytic activity which is enhanced due to the change of counter ion by respective the metal. They have high thermal and water tolerant capacities [4] and can catalyzed both homogeneous and heterogeneous reactions. These solid catalysts are environment friendly also known as green catalysts. By using these catalyst reactions carried under a milder condition with better yield and higher selectivity. The remarkable properties of HPA are Bronsted acidity, higher oxidizing agent, higher mobility, and reusability [5]. This review compiles various types of heteropolyacid salt and applications in various types of reactions with different reaction conditions like temperature, solvent, etc. The report   and also describes advancements in the role of heteropolyacids in concern with catalytic behavior from a period of 2010 to 2021.

Literature

In this review, the latest investigation on the catalytic application of heteropolyacids salts is summarized, although there are different modes of classifications of heteropolyacid salts depending upon structure, etc. In the upcoming section, these are grouped on the basis of metal atoms associated. Though a concise segment of the various reactions where heteropolyacid salts monitor rates under variable environments has also been compiled in respective figures.

Silver-based heteropolyacid salts as the catalyst (Figure 1)

Silver exchanged silicotungstic heteropolyacid catalyst has been used for the   production of 5-HMF (5-hydroxymethylfurfural)   with 10% weight of catalyst (scheme 1) and sucrose into HMF at 120°C temperature yielding 87.5%[6]. Silver substituted silicon tungstic acid salt was also used to synthesize 1,5-benzodiazepine derivatives in absence of solvent. By using 10% weight of catalyst in 40 min. 88% yield of 1,5 benzodiazepine was achieved (Scheme 2) [7]. Heterogeneous catalyst $Ag_3PW_{12}O_{40}$ has been used for the conversion of glucose and fructose into 5-hydroxy methyl furfural[8]. The almost similar composition was assembled by Matachowski et al and used for ethanol conversion to ethylene in the gas phase atmosphere at 473 k temperature gave excellent performance with 99% selectivity of ethylene [9]. The silver salt of 12-tunstophosphoric acid was also prepared by Holclajtner-Antunovic and tested for dehydration of ethanol [10]. Conversion of glycerol to lactic acid was carried out by silver exchanged phosphomolybdic acid catalyst without mixing any base giving oxidation of glycerol with O_2 which acts as an oxidant. $Ag_{3.5}(NH_4)_{1.5}PMo_{12}O_{40}$ showed greater selectivity of 93% at 60°C temperature [11]. $Ag_{3.5}(NH_4)_{1.5}PMo_{12}O_{40}$ showed higher catalytic activity in the oxidation of starch and was reused many times without a major loss in catalytic activity. A change in a molar ratio of Ag^+/NH_4^+ provides a change in surface area which cause different activity of catalyst [12]. $(NH_4)_{0.5}Ag_{0.5}H_2PW_{12}O_{40}$ was used to synthesize n butyl Levulinate from Levulinic acid and provide excellent yield up to 99% within 120°C minutes. Comparative studies of $(NH_4)_{0.5}Ag_{0.5}H_2PW_{12}O_{40}$ with Ag or NH_3 doped catalyst were also investigated and proved comparatively better efficiency than the former one [13].

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Aluminium-based heteropolyacid salts as the catalyst (Figure 2)

AlPW and FePW Benzylation of arenes using benzyl alcohol and benzyl chloride based on the effect of supported and unsupported catalyst AlPW and FePW has been studied (Scheme 3). was found that there was a lot of difference when Fe and Al salts of tungstophosphoric acid with or without the support of catalyst like K-10, Zeolites used which may cause the "pseudo liquid phase" behavior of heteropoly compounds [14]. $AlPW_{12}O_{40}/Mg(OH)_2$ Friedel craft acetylation of furan with carboxylic acid was carried out by using a heterogeneous catalyst $AlPW_{12}O_{40}/Mg(OH)_2$ to give a good yield of 2-furyl alkyl ketones. The reaction was carried out under mild conditions like reaction temperature of 0°C and solvent-free (Scheme 4) [15] .

Conversion of m-cresol into chromanes was carried out by using Al and Cu salt of molybdic phosphoric acid $H_3PMo_{12}O_{40}$. $AlPMo_{12}O_{40}$ showed 98% conversion of m-cresol to Chromanes and having high acid sites with maximum acidic strength (Scheme 5)[16]. Acetylation of 2 Methoxy naphthalene using Cu /Al salt of tungstosilicic acid had been carried out. Al salt of TPA possessed higher acidic sites and maximum acidic strength [17]. $Al_{4/3}SiW_{12}O_{40}$ was the most active catalyst for the oxidation of camphene and formed a mixture of a product; Borneol,1-(3-(2-hydroxypropan-2yl) cyclo pentyl ethane-1-one, and 3-(3-hydroxycyclopentyl)-3-methyl butan-2-one at 333k temp (Scheme 6)[18]. Al modified salt of $H_4SiW_{12}O_{40}$ is used for the production of alkyl levulinate from cellulose. The activation energy was also studied for cellulose degradation at 180°C [19]. $Al_3PW_{12}O_{40}$ catalyst performed excellent activity due to its higher Lewis acid site. The catalyst acts as a heterogeneous catalyst, is eco-friendly, and provides a higher yield of product pyrido [1,2-a] pyrimidines -4-one derivatives above 90% under mild condition[20]. $Al0.66DTP/K-10$ showed higher catalytic activity other than Al exchanged DTP catalyst or Cs-DTP/K-10 (Scheme 7) [21]. A series of phosphotungstate salt were prepared with metal cation and used for the synthesis of methyl levulinate from biomass-derived. Among all, aluminum phosphotungstate showed greater efficiency for conversion of carbohydrates at 160°C temperature under conventional and microwave heating. Reaction conditions were temperature at 160°C, methanol to glucose ratio of 7.5:1, and time of 30 min [22].

Cesium-based heteropolyacid salts as the catalyst (Table:1)

In recent studies hydrogenation of cellulose was carried out by using $H_3PW_{12}O_{40}$ and $H_4Si W_{12}O_{40}$ heteropoly acid and Ru/c produced a good yield of Hexitols. When Cs salts of HPA was used, besides its catalytic performance catalyst was successfully retained at 170°C without using an extra solvent just simply by crystallization [23]. $Cs_{2.5}PW_{12}O_{40}$ showed higher catalytic efficiency and provided excellent yield in the Friedlander reaction of quinoline. Due to its higher surface acidity catalyst can be used even after the fourth cycle giving a 76% yield (Scheme 8) [24]. 2-Benzylic -1,3- Di carbonyl compound produced when benzylic alcohol is reacted with 1,3 Di carbonyl compound in the presence of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$, catalyst which was reused and recovered at the end of reaction without a change in catalytic activity (Scheme 9)[25] . Transesterification was carried out by Cs salt of heteropoly acid catalyst in supercritical methanol for the production of Biodiesel at 260°C, a quantity of fatty acid methyl esters obtained 92% in 40 min, and the catalyst used in this reaction is only 3% [26] . Cesium salt of phosphotungstic acid is used to prepare nanocomposite membranes from polyethylene oxide and polyvinylidene fluoride–chlorotetrafluoroethylene polymer. At temperature 90°C membrane conductivity is $1.05×10^{-4}$ S cm^{-1} when a 10% cesium salt and the ratio of PVDF/PEO=95.5 w/w was present [27].

Ferrocene and its derivatives have many useful properties. Among all derivatives, Acetylferrocene has been used as an intermediate in many reactions like polymerization, charge transfer complexes, chiral catalysts, and pharmaceuticals (Scheme 10) [28] . Synthesis of acrolein from dehydration of glycerol was carried out by using different content of Rh and Cs metal cations with heteropoly acid whose concentration remains unchanged. When they are supported on alumina gives 90% selectivity of acrolein at 100% glucose conversion. these catalysts have higher acidic sites to provide an excellent yield of acrolein (Scheme 11)[29]. Cesium salt of cobalt substituted lacunary Phosphotungstate supported on K-10 montmorillonite showed higher catalytic activity towards esterification and oxidation of benzyl alcohol. In the esterification process, yield of the product was 94%and towards oxidation reaction conversion and selectivity rate are respectively 91% and 99% [30]. Oxidation of cyclohexane with H_2O_2 was found by using cesium salt of polyoxometalate with or without vanadium support on MCM-41 giving cyclohexanol and

cyclohexanone as a product [31]. Cs salt of phosphomolybdic acid was prepared and supported on silica used as a catalyst for nitration of toluene. Catalyst has higher stability and selectivity towards nitration of toluene with the highest conversion rate[32]. Cs salt of heteropoly acid and organic-inorganic dual modified $Cs_{2.5}(MIMPS)_{1.5}PMo_{11}VO_{40}$ were prepared the catalyst was analyzed by FTIR/ESR/XRD/N_2 and NMR spectroscopy. H_2O_2 acts as an oxidant in the hydroxylation reaction of benzene to phenol. The catalyst was prepared by exchanging Cs^+ salt and immobilization of 3-(1-methyl imidazolium-3-yl) propane-1-sulphonate [33]. Bi cationic cesium-based salt of aluminum and gallium were synthesized, characterized, and then tested for conversion of ethanol. Among these $CsGa_{0.5}H_{0.5}PW_{12}O_{40}$ and $CsAl_{0.5}H_{0.5}PW_{12}O_{40}$ found higher catalytic activity for ethanol conversion [34]. Various types of heteropoly insoluble salt were synthesized and used as a catalyst for the production of β amino ketones in solvent water. Among them, $Cs_{2.5}H_{0.5}PW_{12}O_{40}$ showed better catalytic activity for the reaction of benzaldehyde, aniline, and cyclohexanone in water as a solvent.

Reaction conditions were graded up by using various types of aldehydes, ketones, and amine s[35]. Hydrogenation of ketones to alkanes in the gas phase was studied by using metal support Cs salt of tungstophosphoric acid $Pt/Cs_{2.5}H_{0.5}PW_{12}O_{40}$. The catalyst showed higher catalytic activity as compared to Ru, Ni, and Copper salt at 100 degrees centigrade by giving a 100% yield of alkane at low pressure (Scheme 12)[36]. Various content of Cs salt of molybdic phosphoric acid has been synthesized and supported on SBA-15. Adsorption and desorption were studied by using TGA for unsupported and supported catalysts. By using supported catalyst dehydration of ethanol becomes higher and gave a higher yield of ethylene and acetaldehyde[37]. Friedel craft acetylation of 1,2 dimethoxy benzene with benzoic anhydride produces 3,4 di methoxy benzophenone in the presence of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$/K-10 clay. Catalyst gave an 83% conversion rate and selectivity of 100%. Catalyst characterization and reusability were also investigated. The effect of various parameters on the reaction rate was also deduced and the kinetics of the reaction was also studied (Scheme 13)[38] Transition metal-based Cs salts of heteropoly acid were prepared and analyzed the effect of metal on catalyst activity, Different techniques, and various transition metals are studied to check out the behavior of catalysts like XRD/FTIR. $Cs_1Cu_{0.3}H_2P_{1.2}Mo_{11}Vo_{40}$ showed greater performance for oxidation of methacrolein to methacrylic acid [39].

$CsHPW_{12}O_{40}$ with varying elemental composition of cesium and hydrogen was used in Claisen-Schmidt reaction for large-scale production of chalcones, Alkoxylation of monoterpenes and Bisphenol A/Bisphenol F, Acetalization of glycerol with acetone, production of 5-HMF from sucrose, glycerol acetalization with formaldehyde, cycloaddition reaction of monoterpene, Hydroxylation of arenes with benzaldehyde (Scheme 14), synthesis of N acetylation sulphonamides (Scheme 15)⸍ cyclic imides, Synthesis (s)-(-) propranolol, synthesis of 1,3,4-oxadiazole derivatives, etherification reaction of monoterpenes with alkyl alcohols, furfural acetalization, synthesis of Florol® from isoprenol and isovaleraldehyde (Scheme 16), isomerization of α pinene oxide, esterification of castor oil in presence of methanol[40-56]. Vanadium substituted Cs salt of Keggin type heteropoly acid used as a catalyst to synthesize acrylic acid from glycerol. Substitution of vanadium species is beneficial for the conversion of glycerol to acrylic acid in the gas phase. The above-said catalyst provides yields up to 60% of acrylic acid. The identification procedure of the catalyst was accomplished with XRD/FTIR/TPR analysis [54]. Palladium-supported Cs salt of heteropolyacid was prepared and characterized. A Comparative study of mono metallic Cu or Cu-Pd with $Cs_{2.5}H_{0.5}PW_{12}O_{40}$., Cu-CsPW, and 0.5 wt.% $Pd/Cs_{2.5}H_{0.5}PW_{12}O_{40}$ were also investigated. However, 0.5% $Cs_{2.5}H_{0.5}PW_{12}O_{40}$ showed lower efficiency towards the degradation of H_2O_2 (Scheme 17) [57] $Cs_8SiW_{11}O_{39}$ was the efficient catalyst for oxidation and provided epoxides and aldehyde main product which has fragrance properties and is used in the pharmaceutical industry.

The influence of various parameters on the reaction was also investigated [58] . Hydroxylation of 2,5 dimethyl hydro furan was found by using a bifunctional metal acid catalyst at 90°C. Pt- $Cs_{2.5}H_{0.5}PW_{12}O_{40}$ catalyst carried hydroxylation under mild conditions with 99% selectivity of n-hexane[59]. Synthesis of ethyl benzene from the hydrogenation of styrene was obtained in the presence of Cs salt of iron swapped places with phosphomolybdate. A detailed study was demonstrated for 99% conversion of styrene to ethyl benzene under room temperature with a low amount of catalyst and an equal ratio of ethanol to H_2O. Isotope labeling and mechanism of reaction were also studied (Scheme 18) [60]. Formation of sorbitol from cellulose was investigated by using Ru-Cs salt of heteropoly

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acid **1%** Ru/Cs$_3$SiW$_{12}$O$_{40}$ catalyst showed better performance with 59% yield for conversion of sorbitol to the cellulose provided 94% selectivity [61]. Carbonylation of dimethyl Ether with CO on Rh promoted cesium salt of 12-tungstophosphoric acid had been investigated. Rhodium catalysts play an important role in the trapping and transfer of CO to the active center of DME. The catalyst Cs$_2$HPW$_{12}$O$_{40}$ provides two active centers facilitating the insertion of CO group from rhodium carbonyl into a C-O bond of methoxy group to produce acetate group attached to kegging anion. At the latter stage, intermediate methoxy groups are restored and methyl interacts with DME (Dimethyl ether) [62]. A series of different weights of Cs salt of heteropoly acid ordered mesoporous were prepared by the wet impregnation method. Catalyst Pd/20Cs$_{2.5}$H$_{0.5}$PW$_{12}$O$_{40}$/OMC showed higher catalytic activity and was used for the synthesis of monocyclic compounds from 2,3-dihydro benzofuran. It was investigated that by increasing the catalytic acidity, a yield of a product also increases [63]

Iron-based heteropolyacid salts as the catalyst (Figure 4)
The Benzylation reaction of arenes has been studied using supported and unsupported catalysts AlPW$_{12}$O$_{40}$ [14]. Various metal exchanged kegging-type heteropoly acid salt was synthesized and compared their catalytic efficiency towards the etherification reaction of β-pinene. Among all these, FePW$_{12}$O$_{40}$ showed greater activity and selectivity towards the reaction of β-pinene with alkyl alcohol provided α terpinyl methyl ether. The influence of various variables like temperature, loading catalyst, and nature of alcohol used were also assessed [64]. Iron silicotungstic were prepared and used for the synthesis of Solketal from glycerol were ketones. The catalytic action of Fe$_{4/3}$SiW$_{12}$O$_{40}$ was compared with other catalysts towards the acetalization reaction of glycerol with acetone but this catalyst showed higher conversion toward solketal formation [65].

Potassium-based heteropolyacid salts as the catalyst (Figure 5)
Various Keggin heteropoly acid salt and used for the preparation of benzoic acid by oxidation of benzaldehyde with H$_2$O$_2$. Among all potassium lacunary salt K$_6$SiW$_{11}$CoO$_{39}$ catalysts have higher efficiency and activity in this oxidation reaction[66]. Potassium substituted heteropoly salt was used for oxidation of benzyl alcohol with H$_2$O under homogeneous and heterogeneous catalysts. K$_5$PW$_{11}$NiO$_{39}$ was the most active and efficient catalyst used for oxidation which provides benzaldehyde and benzoic acid as the main product [67].

Copper-based heteropolyacid salts as the catalyst (Figure 6)
Conversion of m-cresol into chromanes was carried out by using Cu salt of molybdic phosphoric acid [16]. Copper and cerium Phosphotungstate supported on MCM-41 were used to prepare 80% selective dehydration of ethanol to diethyl ether. Ce and Cu salt of HPA was supported by MCM-41 and character by XRD/FTIR. It was investigated that 30 CeHPW/MCM catalyst showed higher conversion 88.3% and 85% selectivity towards diethyl Ether [72]. Different metal cation exchanged silicotungstic acid salts were synthesized and used as a catalyst for the oxidation reaction of furfural with H$_2$O$_2$ during the opening ring process. Cu2SiW12O40 provided furoic acid and alkyl furoate main products and furfural acetate as other products [73]. Acetylation of 2-Methoxy naphthalene using Cu /Al salt of tungstosilicic acid had been carried out. The analysis of these catalysts was carried out FTIR, XRD, DSC, and acidity was also measured by potentiometric titration. Al salt of TPA possessed higher acidic sites and maximum acidic strength. The effect of solvent was also signified in this reaction [74].

Cerium-based heteropolyacid salts as the catalyst
Dehydration of fructose into 5- HMF has been investigated in the presence of CePW$_{12}$O$_{40}$. Various parameters for a reaction like concentration of fructose, temperature and reaction time were also demonstrated. The kinetic study, Activation, and pre-exponential factor were also deduced. The optimal condition for the reaction to take place was 158^{0}C temperature,164min. time and 5.48mg/ML fructose showed a 99.40% yield of HMF [75]. Cerium salt of tungstophosphoric acid was synthesized and characterized by FTIR/XRD/SEM. The activity of the catalyst was demonstrated in the synthesis of n butyl acetate which was produced by the reaction between acetic acid and n butanal. The effect of different parameters on the reaction has been evaluated. The optimum condition for the reaction was temperature 120 and time 150 and the weight of the catalyst is 1.44% of the total amount of mixture. These reaction conditions provide a 94.8% rate of conversion. The catalyst was the most efficient providing

selectivity of nearly 100% of n butyl acetate [76]. Ce-based heteropoly acids were prepared with strong Bronsted and Lewis acidity. To make catalyst temperature responsive CHCl is combined with catalyst. Various solvent reactions provided an excellent yield of 5-HMF 67.5% at 140◌c for 6h. Higher efficiency and stability of catalyst due to Bronsted and Lewis acidity and temperature-responsive property [77].

Tin-based heteropolyacid salts as the catalyst (Figure 7) Sn exchanged phosphotungstic acid was used for glycerol etherification with tert butyl alcohol. $Sn_{1.5}PW_{12}O_{40}$ catalyst showed reaction at 363k temperature provided higher selectivity after 4h. Selectivity towards mono or di-substituted glyceryl tert butyl ether depends on the reaction parameters [78]. Sn exchanged heteropoly acid salt catalysts were prepared and used for the synthesis of alkyl Levulinate or angelica lactone from levulinic acid and ethyl alcohol. $Sn_{1.5}PW_{12}O_{40}$ showed higher catalytic efficiency towards esterification reaction with 90% conversion and selectivity [79]. Sn (II) exchanged heteropolyacid salts were synthesized and used as catalysts for esterification of glycerol with acetic anhydride. The catalyst was characterized by various techniques. $Sn_{1.5}PW_{12}O_{40}$ is most active in the esterification of glycerol [80].

Sodium-based heteropolyacid salts as the catalyst
Synthesis of linalool oxide and dioxide under mild conditions was carried out by Lacunar Keggin type heteropolyacid salt. $Na_7PW_{11}O_{39}$ was active and had higher catalytic activity towards the oxidation of linalool and was characterized by various techniques [81]. Oxidation of camphene with hydrogen peroxide was found using Lacunary Keggin heteropoly acid salts ($Na_7PW_{11}O_{39}$) in which sodium is taken as the counter ion. The reaction was carried out 333k in acetonitrile solvent. Reaction parameters like catalyst loading, temperature, and camphene molar concentration were also investigated [82].

Nickel-based heteropolyacid salts as the catalyst
Ni salt of molybdic phosphoric acid was supported on SBA-15 with different conc. of salt by weight was prepared and used to carry out dehydration of alcohol. The activity of the catalyst is due to increase pore-supported volume and area [83]. Conversion of an aldehyde into ester in the presence of NiHPMA was carried out [84]. Ni salt of silicotungstic acid supported on SiO_2 is used as a catalyst for the synthesis of biodiesel from oleic acid. The condition for a reaction was a temperature of 70°C, catalyst loading of 3%, and the ratio of oleic acid to methanol 1:22 provided 81.4% conversion of oleic acid to Biodiesel [85].

Chromium-based heteropolyacid salts as the catalyst
Chromium exchanged dodeca tungstophosphoric acid supported on K-10 were prepared. The catalyst used for the synthesis of 2 acylfuran from furan and acetic anhydride (Scheme 21) [86].

Antimony-based heteropolyacid salts as the catalyst
Antimony substituted ammonium salt of 12-molybdophosphoric acid was used for oxidation of chlorobenzene. The catalyst was also tested thermally at different temperatures [87].

Gallium-based heteropoly acid salts as the catalyst (Figure 8)
Gallium salt of molybdo phosphoric acid was prepared and then Physicochemical characterization of catalyst was studied by using various techniques like FTIR/XRD/DSC/SEM/TEM. The optimum condition for the reaction is to obtain the maximum yield of levulinic acid from glucose temperature 448k, time, 10h, and 1.5 ratios of catalyst to glucose [88]. Friedel craft benzylation of anisole with benzyl alcohol was carried by gallium exchanged phosphotungstic acid catalyst which was supported on ZnO_2. During Ga+3 exchange Keggin structure remain unchanged. The molar ratio of benzyl to anisole effect the conversion and selectivity of the product. Effects of various parameters were also assessed [89].Unsymmetrical ethers were prepared by using $GaPW_{12}O_{40}$ and $InPW_{12}O_{40}$ salt of 12-tungstophosporic heteropoly acid as a catalyst by the reaction of 1-phenyl ethanol with C1-C4 alkanols. Catalytic properties /characterization and preparation of catalyst were also investigated. At 650C the catalyst showed higher selectivity towards unsymmetrical ether formation [90].

Cobalt-based heteropolyacid salts as the catalyst

A series of different Keggin-type compounds were investigated and characterized by FTIR and XRD. Among all $Co_{1.5}PW_{12}O_{40}$ is the best-suited catalyst for DMC synthesis. Synthesis was carried out by examining different support catalysts like $Al_2O_3/SiO_2/TiO_2$ at 80°C [91]. Immobilized HPA salt $Co_4HP_2Mo_{15}V_3O_{62}$ on porous support was tested to carry out the oxidation of ethyl benzene. The catalyst was prepared by grating 3-amino propyl tri ethoxy silane. The

CoHPAs/ATPATPES showed higher catalytic activity and higher selectivity towards acetophenone 95.4% with 72.7% Conversion of ethyl benzene [92].

Miscellaneous reactions (Figure 9)

There are certain other heteropolyacid catalysts having organic or some other groups as supporting material was also used as reaction promoter for organic reactions as given in [93-105].

CONCLUSION

It is very well known that many organic compounds have a wide range of applications in pharmaceutical, chemical, and biological industries. Since the procedures used for the synthesis of these compounds are adaptable. Due to extensive application, the discovery of these compounds with improved protocols has recently drawn a lot of attraction. Heteropoly acid and its compounds are a field of growing importance day to day. HPAs possess acidic and suitable redox properties which encouraged no. of oxidation and acid-catalyzed reactions in both homogeneous and heterogeneous mediums. Oxidative properties of this can be managed by changing the chemical composition of heteropoly anions. As can be observed in this article, these catalysts showed excellent catalytic activity since most of the reactions were carried out under mild conditions without using any solvent and provided a quantitative yield of the desirable product.

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Table 1: Various reactions where Cesium based heteropolyacid salts monitor rates under variable environments.

Sr. No	HPA Sal	Reactant	Product	Solvent	Temp. °C	Yield	Ref.
1	$Cs_{3.5}SiW_{30}$	Cellulose	Hexitols	Water	190	66	[23]
2	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	2-Aminoacetophenone & Ethyl acetoacetate	Quinoline derivatives	-	100	91	[24]
3	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Benzylic alcohol + 1,3 Di carbonyl Com.	2-Benzylic-1,3 Di carbonyl Com.	-	80	89	[25]
4	$Cs_{2.5}PW_{12}O_{40}$	Vegetable oils	Biodiesel	-	260	92	[26]
5	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Ferrocene + Acetic anhydride	Acetyl ferrocene	1,2 di chloroethane	140	-	[28]
6	$CsTSA/Al_2O_3$-2	Glycerol	Acrolein	-	300	88	[29]
7	$CsCoPW_{11}@K$-10	Oleic acid +methanol	Methyl oleate	-	100	94	[30]
8	CsVPOM	Cyclohexane + H_2O_2	Cyclohexanone+ cyclohexanol	-	80	58/42	[31]
9	$Cs_{2.5}H_{0.5}PMoO_{40}/SiO_2$	Toluene	Nitrobenzene	-	70	95.4	[32]
10	$Cs_{2.5}(MIMPS)_{1.5}PMo_{11}VO_{40}$	Benzene	Phenol	Acetonitrile	65	-	[33]
11	$CsGa_{0.5}H_{0.5}PW_{12}O_{40}/$ $CsAl_{0.5}H_{0.5}PW_{12}O_{40}$	Ethanol	Ethylene + diethyl ether	-	150	18/45 17/39	[34]
12	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Benzaldehyde+ aniline & Cyclohexanone	β Amino ketones	Water	-	86	[35]
13	$Cs_{2.5}H_{0.5}PW_{12}O_{41}$	Benzaldehyde+ aniline & Cyclohexanone	β Amino ketones	Water	-	15	[36]
14	$CsMoPW_{12}O_{40}/SBA$-15	Ethanol	Ethylene + Acetaldehyde	-	190-300	-	[37]
15	$CsH_2P_2W_{12}O_{40},$ $Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Benzaldehyde + Cyclohexanone	Chalcones	-	50	95, 74	[40]
16	$Cs_{2.5}H_{0.5}PW_{12}O_{41}$	Monoterpenes	Isobornyl ether	Butane 1-ol	100	80-85	[41]
17	CsTPA/ZTP	Acetone+ Phenol Formaldehyde+ Phenol	Bis phenol A Bis phenol F	Acetonitrile	70	-	[42]
18	$Cs_{2.5}H_{0.5}PW_{12}O_{40}/KIT$-6	Glycerol + acetone	Sol ketal	-	25	95	[43]

19	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Crotonaldehyde + α terpine	Oxabicyclo [3.3.1] nonene	-	60	68	[46]
20	$Cs_5HP_2W_{18}O_{62}$	4 methyl phenyl sulphonamic + Succinic anhydride	N-acyl sulphonamide	Water	25	90	[48]
21	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	β Pinene +Methyl alcohol	α- Terpeinyl methyl ether	Acetonitrile	60	-	[51]
22	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	Furfural + Methyl alcohol	Furfural dimethyl acetal	-	25	-	[52]
23	$H_{0.1}Cs_{2.5}(VO)_{0.2}(PMO_{12}O_{40})_{0.25}$	Glycerol	Acrylic acid	-	340	53.1	[54]
24	$Cs_{2.5}H_{0.5}PW_{12}O_{40}$	α- Pinene Oxide	Trans carveol/Trans sobreol/Pinol	Acetone	25	60-80	[55]
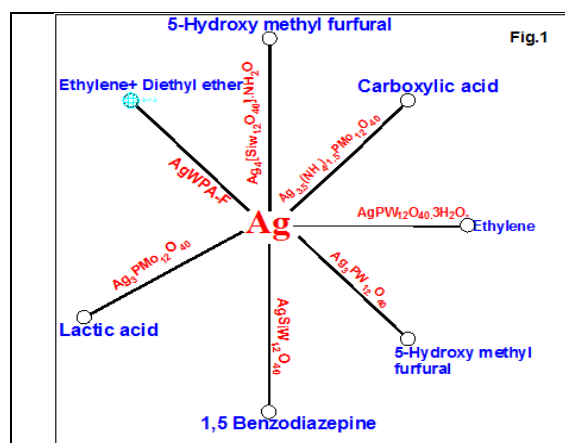
Figure 1: Layout of products formed by catalytic activity of Silver based heteropolyacid salts
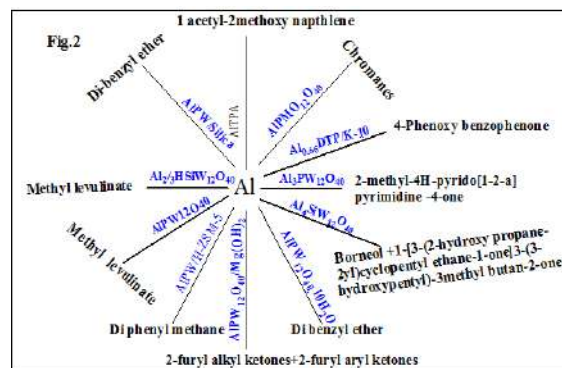
Figure 2: Layout of products formed by catalytic activity of Aluminium based heteropolyacid salts
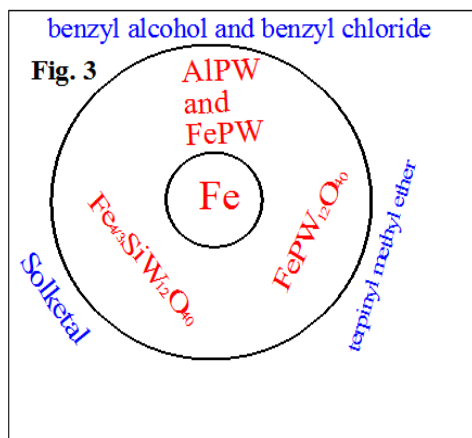
Figure 3: Diversity in catalytic action of Cesium
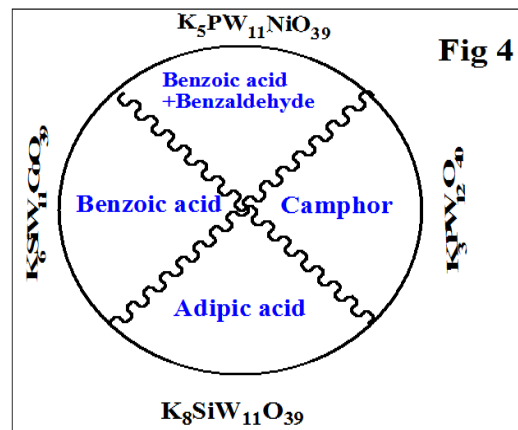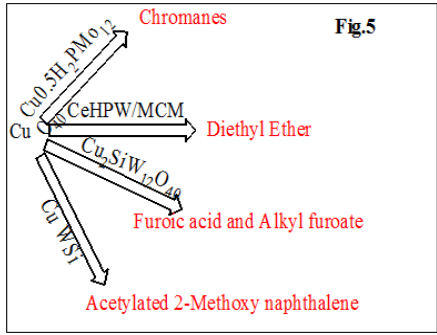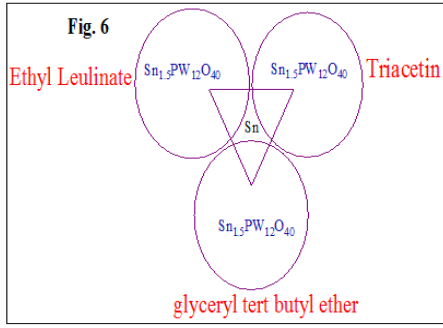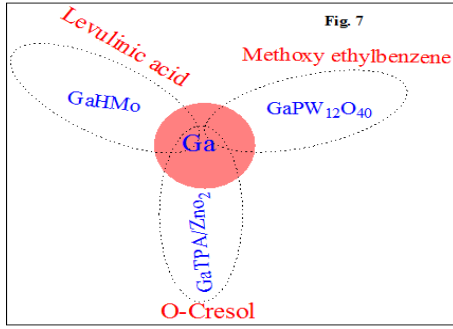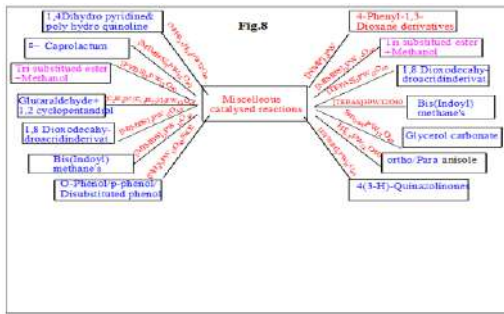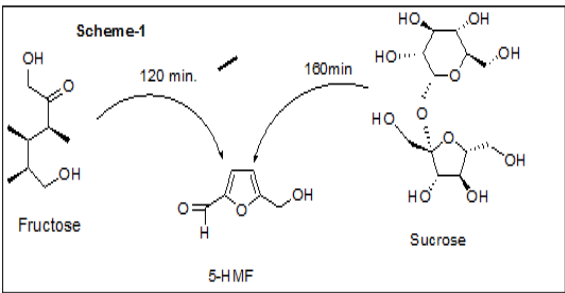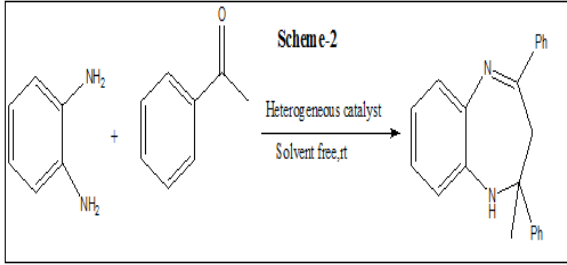
Figure 4: Diversity in catalytic action of Iron based

based heteropolyacid salts	heteropolyacid salts
Figure 5: Diversity in catalytic action of Potassium based heteropolyacid salts	**Figure 6: Diversity in catalytic action of copper based heteropolyacid salts**
Figure 7: Diversity in catalytic action of tin based heteropolyacid salts	**Figure 8: Diversity in catalytic action of Gallium based heteropolyacid salts**

Scheme 1: Formation of Sucrose via 5-hydroxymethylfurfural as intermediate using Silver exchanged silicotungstic heteropoly acid salt as catalyst.	**Scheme 2: Formation of 1,5 benzodiazepine using silver substituted silicon tungstic acid as catalyst.**
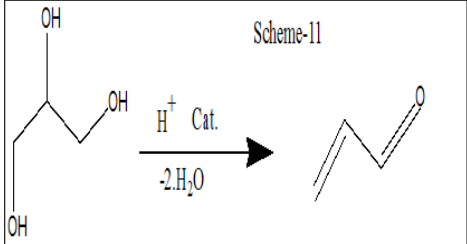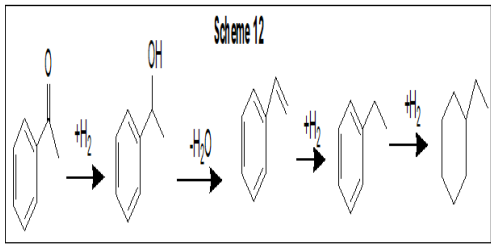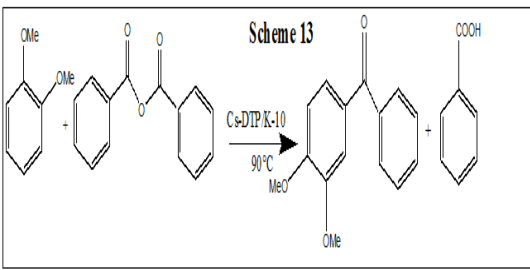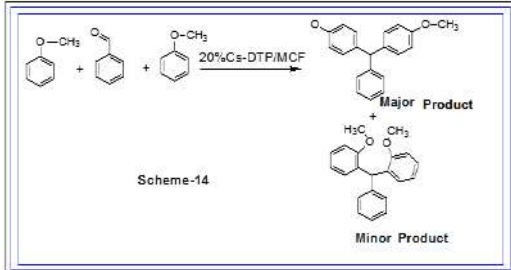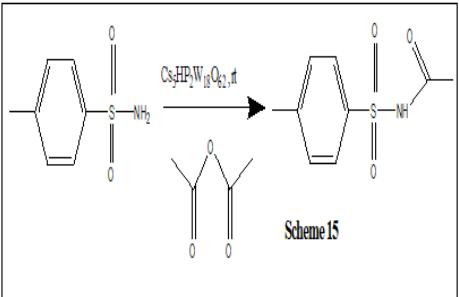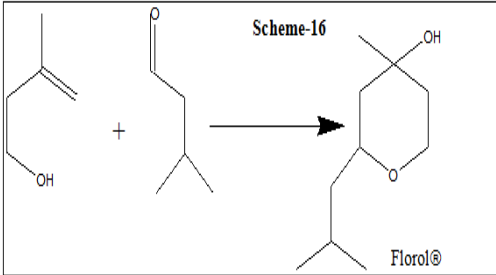
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Scheme 3: Benzylation of arenes in presence of catalyst AlPW and FePW

Scheme 4: Friedel craft acetylation of furan with carboxylic acid in presence of $AlPW_{12}O_{40}/Mg(OH)_2$.

Scheme 5: Conversion of m-cresol into chromanes using Al and Cu salt of molybdic phosphoric acid $H_3PMo_{12}O_{40}$.

Scheme 6: Catalytic action of $Al_{4/3}SiW_{12}O_{40}$ on camphene.

Scheme 7: Formation of 4-Phenoxy benzophenone using $Al_{0.66}DTP/K-10$/ Cs-DTP/K-10 heteropoly acid salts as a catalyst.

Scheme 8: Catalytic action of $Cs_{2.5}PW_{12}O_{40}$.

Scheme 9: Catalytic action of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$.

Scheme 10: Formation of Acetylferrocene using CsHPWO heteropoly acid salts as a catalyst.

Scheme 11: Formation of acrolein from dehydration of glycerol using Rh and Cs-based HPA's

Scheme 12: Hydrogenation of ketones to alkanes in presence of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$

Scheme 13: Friedel craft acetylation of 1,2 dimethoxy benzene with benzoic anhydride produces 3,4 di methoxy benzophenone in the presence of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$/K-10 clay.

Scheme 14: Catalytic action of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$ heteropoly acid.

Scheme 15: Synthesis of N acyl sulphonamides in presence of $Cs_5HP_2W_{18}O_{62}$.

Scheme 16: Catalytic action of $Cs_{2.5}H_{0.5}PW_{12}O_{40}$.

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Scheme 17: Catalytic action of Cs salt of iron substituted phosphomolybdate.

Scheme 18: Catalytic action of Cs$_{2.5}$H$_{0.5}$PW$_{12}$O$_{40}$.

Scheme 19: Schematic diagram showing catalytic action of K$_6$SiW$_{11}$CoO$_{39}$

Scheme 20: Schematic diagram showing catalytic action of K$_5$PW$_{11}$NiO$_{39}$

Scheme 21: Schematic diagram showing catalytic action of Cr0.66DK-10.

RESEARCH ARTICLE

Ethno-Zootherapeutic Traditional Knowledge of Fish among Central Himalayan Tribes of District Pithoragarh, Uttarakhand

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ABSTRACT

Ethnozoological study involves the interactions between animal resources and human societies as it remains the most cost-effective and affordable treatment among low-income tribes. The use of fish for zootherapy has existed since the beginning and continues to be a significant aspect of traditional medical procedures in many communities all around the world. The objectives of this study deal with the fish zootherapeutic practices and the present state of knowledge among the tribes, while also trying to list the fish that were used for medicinal purposes among the tribes. This study was mainly aimed at fulfilling the literature gap regarding this study in the area. The study area of this study lies between latitude 29°34'48''N and longitude 80°13'12''E. The ethnozoological data were collected through questionnaires, interviews, and focus group discussion with selected tribal residents. Tribes of this are a have good knowledge of fish for zootherapy but they least use fishes as for the medicinal purpose. Various body parts, or whole body were used for treating various disease conditions. In this report, we found nine different fish species which were mainly used for treating various disease conditions by the tribes, which were *Tor putitora*, *Schizothorax richardsonii*, *Channa channa*, *Labeo rohita*, *Catla catla*, *Puntius sp*., *Cyprinus carpio*, *Tor tor*, and *Barilius bandelisis* respectively.

Keywords: Zootherapeutic, Ethnozoology, Tribes' practices, Uttarakhand

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INTRODUCTION

Animals have played a very important and integral role in the healing of human beings, and the use of zootherapy has now become ingrained in the cultures of many tribes of people in different parts of the world. Animal-based medicines are generally derived from three different sources; i.e., the parts or whole of the animal body; derived metabolic products of the animals (Costa-Neto, 2005). Zootherapy involves the use of various body parts of different animals and their derived metabolic products, such as urine and animal faeces, for the treatment of various diseases (Alves and Rosa, 2005). Ethnozoological study deals with the interactions between human societies and the animal resources of their environment. This zootherapeutic treatment is also referred to as traditional or folk medicine, which the indigenous people have used as a disease treatment for centuries. For low-income tribes, traditional medicine is still the most practical and affordable form of treatment (WHO, 1993). Zootherapy is the practise of treating human ailments with medicines made from various animals and their byproducts such as blood, meat, skin, bones, feathers, tusks, hooves, etc. (Borah, 2016). Zootherapeutic resources are the key components of any traditional medical system (Alves, 2007; Lohani, 2008). In magical rituals, religious societies, and curative practises all throughout the world, the use of zootherapy to treat human illness plays a significant role (Mahawar, 2008). Since prehistoric times, animals, their parts, and products have contributed to the inventory of medicines used by many cultures (Lev, 2003). According to the World Health Organization, up to 80% of the world's more than six billion people primarily rely on animal-based medicine (WHO 1993). Fish species also play an integral role and form a key component in various traditional healing practises in various places. Sowunmi (2007) reported the use of fish for medicinal purposes, where the fish species included various species from fresh, marine, and brackish water. Ethnomedicinal uses of various fishes and other aquatic animals have been described by Deb and Haque (2011).

Together, it can be said that the use of fish for zootherapy has existed since the beginning of time and continues to be a significant aspect of traditional healing in many cultures around the world (Khatun, 2013). Zootherapy is a form of traditional knowledge that is being discussed more and more in relation to public health issues, biological prospection with patents, conservation biology, and the sustainable use of natural resources (Alves, 2005). Zootherapy has long been a fundamental component of many traditional pharmacopoeia, including those of well-known traditional medical systems (Lev 2003; Alves and Rosa 2006; Mahawar 2008). Thus, among other known therapies used around the world, zootherapy is a significant alternative treatment for a variety of diseases in modern culture (Vijayakumar, 2015). Records of the medicinal use of animals and their by-products date back to the invention of writing (Lev 2003, 2006). Many ethno-biologist have gathered data on zootherapeutic practises from various tribes or ethnic groups in India. S.K. Sharma describes how the tribes of Rajasthan use animals to treat human and domestic animal illnesses (Sharma 2002). Additionally, immense knowledge has come to the modern world about the practise of traditional or folk medicine to cure different diseases. Studies on the therapeutic uses of animals and their parts have been neglected when compared to plants (Solovan *et al.* 2004). Hence, the objectives of this present study deal with the fish zootherapeutic practices and the present state of knowledge regarding these medicinal practises among the tribes of Pithoragarh, Uttarakhand in India. An attempt has also been made in this work to make a systemetic taxonomical list of the fish that are used for medicinal purposes among the tribes of Pithoragarh. Therefore, this study aims to fill the literature gap regarding this aspect and to provide information on the ethno-medicinal uses of fish for a variety of common diseases in the area of our study site.

MATERIALS AND METHODS

Study area
The state of Uttarakhand covers an area of 53,483 km², accounting for 1.69% of the total geographical area and nearly 15.5% of the Western Himalayas. The present study was conducted among the tribes of Pithoragarh district in Uttarakhand, which is in the north of India. An ethnozoological study was conducted at designated study sites in the Pithoragarh district (lies between latitude 29°34′48′′N and longitude 80°13′12′′E) to document the diverse uses of fish among the district's tribal residents (Figure 1).

Sampling and data collection

In the study area, questionnaires, interviews, and focus groups were used to collect the ethnozoological data (method of preparation and administration, as well as the section of the animal used). Positively, informants were chosen at random, and within these tribes, polls, interviews, focus groups, and surveys were conducted. Fish conservation status was conformed and discovered by (IUCN, 2014).The data used to compile the information came from tribes of either sex who were visited frequently, and information was obtained from the market, hotels, and coffee shops.

Group discussion

Before giving thorough questionnaires on the significance of Pisces in traditional medicine and related topics to the study site's chosen informants, brief group talks were held at each location (Huntington, 2000). An effort was made to motivate the healers and enlist their support throughout the discussions. The informed permission of the population was obtained prior to data collection. As a result, the vast majority of the information gathered is dependent on verbal interpretations offered by the local populations. In particular, the use of fish parts and products for medications used in the treatment of diseases and illnesses in humans and livestock received special attention while recording techniques were still in use.

Interviews

Interviews with tribes were arranged in advance, according to Borah and Prasad (2016). The interviews were conducted using this checklist as a guide, and certain issues were rapidly elevated based on the informant's comments. Each respondent had a one-to-two-hour long interview. Based on the informants' notification, the meeting location and time were determined while the entire interview took place in the regional tongue. Throughout the course of the research, extensive fieldwork was regularly conducted, and data were gathered through questionnaires, interviews, and on-site inquiries.

Species identification

For each species, the local names and accompanying characteristics of the therapeutic fish were recorded. Utilizing 'Fish-base' database and comparison with gathered plates and pictures, the medicinal fish were identified. Finally, fish species identification was completed, by Jayaram (2010).

RESULTS AND DISCUSSIONS

Nine freshwater fish species are reported, which were mainly used for medicinal purposes by different communities of tribes in various parts of the Pithoragarh district of Uttarakhand. These freshwater fish species used for zootherapy by these tribes were *Tor putitora*, *Schizothorax richardsonii*, *Channa channa*, *Labeo rohita*, *Catla catla*, *Puntius sp.*, *Cyprinus carpio*, *Tor tor,* and *Barilius bandelisis* (Table 1). These tribes have good knowledge of these fish species, which are also edible fish species, having medicinal properties among them, mainly used for treating various medical illnesses. Fish as a whole or any body part were widely used for treatment for various medicinal purposes by the tribal communities of Pithoragarh district in Uttarakhand. Different communities were using nine different species of freshwater fish for medicinal purposes by using their whole bodies or their body parts like vertebra, bile, gills, gastro-intestinal tract, eyes, fat, liver, gall bladder, operculum, head, and scales etc.

These were most commonly used for treating various disease conditions like asthma, eye disease, gastritis, rheumatism, facial paralysis, night blindness, gastric ulcer, urine blockage problems, common cold, blood purifier, plague, headache, fever, tooth cavity, and constipation, and also to be used as a healthy tonic, etc (Table 2). According to the IUCN, all fish species are endangered, vulnerable, or near threatened (IUCN, 2014). However, religious factors and modernity have had a huge impact in more recent times and have led to a decline in traditional practices. Therefore, all this knowledge came to light, as a sense of urgency for ethno-biologists to record and interpret this data before it is lost forever. According to the locals, their knowledge of fish and its uses as part of their tradition and customs was passed down from generation to generation by their forefathers. Fish species have also been used as

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medicines for the treatment of illnesses like rheumatism, cardiac conditions, blood pressure control, asthma, rickets, calcium metabolism, nervousness, and giddiness, as well as for the provision of deficient vitamins and minerals (Mahata, 2002). Zootherapy, one of the well-known therapies used around the world, is a significant alternative treatment for many diseases among other known therapies practised worldwide (Jaroli *et al.*, 2010, as well as Quave *et al.*, 2010). Therefore, there is a large potential for fishing in terms of their medicinal value, and these resources must be wisely utilised on a commercial basis to create employment opportunities and increase the income of the local population.

In our finding, we found that the tribal communities of district Pithoragarh in the state of Uttarakhand have good knowledge of zootherapeutic practices, which was also supported by the study of (SEEDS, 2006), who stated that the tribal communities use animal products for their livelihood. In the report, we found nine different fish species, which were *Tor putitora, Schizothorax richardsonii, Channa channa, Labeo rohita, Catla catla, Puntius sp., Cyprinus carpio, Tor tor*, and *Barilius bandelisis.* Costa (2005) also recorded 24 different fish species as having some therapeutic use. Other animals with medicinal properties were also found. This statement is also supported by some other studies like Brazil (Alves 2009; Mahawar and Jaroli, 2008), which both documented the use of 250 and 109 animal species as zootherapeutic, respectively. During our study, we used interviews and questionnaire methods to get the report about the fish species that are being used for treating various medical illnesses. As Costa (2005) noted, they used these methods when they were questioned about their folk medicine, although interviews focused on fish-based remedies. Rao (1968), who studied the considerable scope with respect to the fisheries for their medicinal value, also supports our result that these resources need judicious utilisation on a commercial basis to generate employment opportunities and enhance the income of the local people. In our study, it was also found that fish were least used by the tribes of the study area; instead, they had indigenous knowledge of zootherapeutic practises among their community. As they treated fishes as children of Lord Shiva and Goddess Parwati, they had the belief that they should not be harmed for any purpose.

Therefore, fish is rarely used as a medicine, as Radha *et al*. (2015) found that the Bhotiya tribe of Uttarakhand uses mainly plants for medicine. In the study of Betlu (2013), he noted that while fish were least known to the tribes, they had indigenous knowledge of zootherapeutic practices. As we observed, in the whole body of fish, several compounds or their body parts like vertebra, bile, gills, gastro-intestinal tract, eyes, fat, liver, gall bladder, operculum, head, and scales are most commonly used for treating various disease conditions, which have been extracted from fish, and these are employed as remedies in the official medicine. These findings were also supported by the research report of (Hamada and Nagai, 1995) (Verma, 2021) and (Verma *et al*. 2021). Folk traditions commonly use various fishes for ailments such as night blindness, abdominal pain, common cold, Kala-azar, anaemia, weakness, stomach aches, joint pain, small-pox, dysmenorrhea, etc. (Gupta, 2017). Along with this, tribal people lack knowledge and hold a lot of tradition-related superstitions and myths that are harmful to animal life. Therefore, these traditional medicinal therapies and animals' by-products should be tested for their potential medicinal value. If they are found to be indefensible, people should be made aware of the protected and endangered animal species and their importance and value in biodiversity. Traditional healers should be aware of the protected and endangered animal species and their importance in maintaining a biodiversity balance.

Proper awareness and scientific management of these animal resources may help in biodiversity conservation (Chakravorty *et al*. 2011). Nine of the species documented in these field studies fall under the category of threatened species on the IUCN red list of threatened species (Solovan, *et al*. 2004). Therefore, the socio-ecological system has to be strengthened through sustainable management and conservation of biodiversity (Kakati, 2006). Towards conclusion we can say that the Pithoragarh tribes had traditional knowledge of fish ethno-zoology and used a few threatened fish species for a variety of medicinal purposes. Fish, either whole or in parts, are used to treat a variety of diseases. As many of the species used for zootherapeutic purposes are under the threatened category, a proper conservation plan is needed for both such practises and fish.

ACKNOWLEDGEMENTS

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Table1.List of edible fishes used for Zoo-therapeutic practices

S.No	LOCAL NAME	ClASS	ORDER	FAMILY	GENUS	SPECIES	IUCN status
1.	Golden Mahaseer	Actinopterygii	Cypriniformes	Cyprinidae	*Tor*	*putitora*	EN
2.	Mahaseer	Actinopterygii	Cypriniformes	Cyprinidae	*Tor*	*tor*	NT
3.	Asala	Actinopterygii	Cypriniformes	Cyprinidae	*Schizothorax*	*richardsonii*	VU
4.	Chabadiyal	Actinopterygii	Cypriniformes	Cyprinidae	*Channa*	*channa*	EN
5.	Rohu	Actinopterygii	Cypriniformes	Cyprinidae	*Labeo*	*rohita*	EN
6.	Catla	Actinopterygii	Cypriniformes	Cyprinidae	*Catla*	*catla*	LC
7.	Bhuri	Actinopterygii	Cypriniformes	Cyprinidae	*Puntius*	*gelius*	LC
8.	Common carp	Actinopterygii	Cypriniformes	Cyprinidae	*Cyprinus*	*carpio*	VU
9.	Dhaur	Actinopterygii	Cypriniformes	Cyprinidae	*Barilis*	*bandelesis*	LC

Table2.List of fishes uses as medicinal purposes by tribal communities of study area

S.No.	Scientific name	Fish parts use	Traditional use in	Method of application
1.	*Tor putitora*, (Hamilton, 1822)	Bile	Asthma	Fresh bite taken orally
		Whole body	Eye problem	Cooked with black pepper
2.	*Tortor*(Hamiliton 1822)	Bile	High fever	Fresh bile taken orally
		Scale	Toothe cavity	Boil, glue formed
3.	*Schizothorax richardsonii* (Gray, 1832)	Vertebra	Wound healing	Dried before taken
		Gills	Stomach ache	Dried then eaten
		Gastro-intestinal tract	Gastritis and loss of appetite	Eaten after being boiled in water with the contents of the gastrointestinal tract.
		Bile	Body ache, Headache	Bile is taken orally

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4.	*Channa channa* (Bloch, 1973)	Eyes	Dead skin	Using the eyes and a salt solution, remove corns from the affected area.
		Fat	Wound healing	Dried then taken
5.	*Labeo rohita* (Hamilton, 1822)	Whole body	Loss of sexual vigour, Whooping cough, rheumatoid arthritis	Make a dish 'Fish Curry'
		fat	Paralysis in any part of face	Warmed, massaged externally for three weeks
		Eye	Partial night blindness	The boiled decocation of eye and fish oil is given 2/3 times in a week
		Liver	Partial or full night blindness	Boiled in water, soup drunk
		Gall Bladder /Bile	Gastric enteritis, Gastric ulcer, Intestinal cancer	Alternatively, mix 8–10 drops of bile with one glass of water and drink it on an empty stomach.
		Cervical vertebra	Urine blockage Problem	Rubbed with water and may taken with water
6.	*Catla catla* (Hamiliton 1822)	Operculum-um	Ripening of boils	Crushed operculum is made in to paste and applied to affected area
7.	*Puntius* sp.(Hamiliton 1822)	Whole body	Eye problem	Taken before cooked with black pepper and water
			Blood Purifier	Taken before cooked with bamboo shoot and water
			Common cold	Cooked with chili
			Plague, Ulcer(gastric)	Cooked rice and fermented fish are combined to make a paste that is consumed for a week before meals.
8.	*Cyprinus carpio* (Linnaeus 1758)	Bile, Fat	Fever, Headache	Bile is ingested, as well as fat.
9.	*Barilius bendelisis* (Hamiliton 1807)	Whole body	Constipation, deworming	Cooked and taken
		Head	Healthy tonic	Cooked eaten

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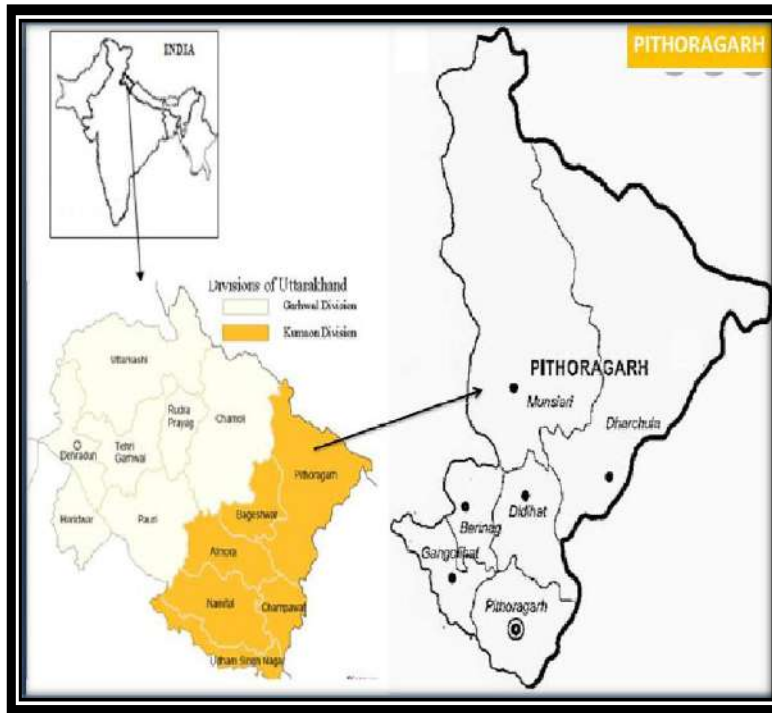
Figure 1.Map of the study area, the district Pithoragarh, Uttarakhand, India.

RESEARCH ARTICLE

Virtual Fence : Design and Development of Mobile Application using Location Based Service

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ABSTRACT

The number of people using smartphones and mobile devices is steadily expanding. In today's world, mobile phones are becoming increasingly crucial. Changing the profile mode based on location could be a time-consuming process for mobile users. In a public setting such as a conference room, meeting room, or classroom, when a user forgets to change the profile mode on their phone, it causes a disruption for others. Geo-fencing is a technology, which enables mobile apps to benefit from location-based marketing. Marketers can utilize geo-fence technology to collect information as app users enter, exit, or stay in certain geographic zones. For users who need to change their mobile profiles regularly, the android program gives an option to alter silent mode based on location in some circumstances, such as those in seminar halls, conference rooms, or classrooms. Geo-fences come in a variety of sizes and designs, including circular and polygonal, and can be as small as a business or as huge as a metropolis. Geo-fences can be spherical for simple applications or polygonal for more complicated ones.

Keywords: Virtual fence, Location based service, Geo Fence, GPS.

INTRODUCTION

This program allows Android phone users to minimize their workload by eliminating the need to go into their settings to alter their silent mode, making it easier to work at the office, during meetings, or while in college. They can change the mode with a simple tap on the screen [2]. The "Phone Weaver" program is available for Android as well as Windows Smart Phones. This program not only transforms the profile to ringer mode but also intelligently adjusts the complete sound profile to the user's chosen location. It does, however, have some restrictions [12]. The user must first locate the place in this program, after which it switches profiles at that spot. That is to say, it is not entirely automated [8]. This new application will allow users to switch profiles automatically based on their location.

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Using SMS technology, this application will allow the device to convert to 'Silent Mode' in specific locations. There will be no need to physically establish them by default [17]. This application also offers User Defined approach, when the device is at a location, which does not belong to any of the aforementioned categories, it can use 'User-Defined Switching mode' for automatic switching. Similarly, in "Phone Weaver," User-Defined Switching Mode, the user selects a location that is not part of any of the Default Switching Locations, such as the user's home or gym [10].

Virtual Fence

Geofencing is a mechanism featured in many location-based smartphone apps that allows users to set virtual geographic borders. It operates by employing global positioning system (GPS) or radio frequency identification (RFID) technology to detect and demarcate the actual location of a person or facility, and then create a virtual zone surrounding that area [18]. These virtual gates may be created for a little cost, and the people inside can be targeted for internet advertising [6]. Apps that employ geofencing technology can calculate their geographical location using GPS or the IP address of the device they're using, such as a smartphone or tablet. The app can then serve the user with a unique set of offers or information based on the user's location. For a real-world geographic area, a virtual fence is a virtual perimeter or a virtually fenced area. A geo-fence can be dynamically generated—for example, a radius in the order of a point location or it might be a set of established borders or restrictions (such as school zones or neighborhood boundaries). To use geofencing, the developer must first create a virtual boundary or edge using RFID-enabled software or using GPS to approximate the intended area [4]. The geofence was already activated and will behave as a virtual perimeter [18]. When an authoritative device enters or exits the territory, a reaction is triggered. Geo-fence technologies include cellular data, WiFi, Bluetooth, and geomagnetic data [9]. For out-of-doors or wider locations, cellular and WiFi data delivers superior outcomes. Furthermore, you could utilize the GPS, but the results would be less than ideal when compared to using WiFi [1].

Types of Geo-Fence

Geo-fence is divided into two classes, which are described below.

Active Geo-Fence

- To use this active geofencing strategy, the shopper's device must have the mobile application open.
- This group makes extensive use of GPS location technologies.
- This type depletes the battery more quickly.
- It's a faulty technique that's prone to bugs.
- It gives retailers and consumers less-than-ideal results.
- It can be used in a variety of situations.

Passive Geo-Fence

It is always turned on. Instead of RFID and GPS, passive geo-fencing relies on cellular data via mobile devices or WiFi internet connectivity. A geo-fence is a circle drawn roughly 100 feet around the selected place from Google Maps that works in the background when the location on a smartphone is switched on through an Application Programming Interface (API) [11] [17].

- This type works in the background and is always ON. It does not require the app to be turned on to function.
- It does not rely on GPS for location.
- It's made to be non-obstructive.
- It's used to gather information about customers.
- Using this method, delivering adverts to shoppers is challenging, if not impossible.

Location based Service

Geofencing is a location-based service in which a mobile device or RFID tag enters or exits a virtual boundary set up around a geographical area, known as a geofence, and an app or other software uses GPS, RFID, Wi-Fi, or cellular data to activate a pre-programmed action.

GPS Location Finding

It enables position retrieval from a GPS receiver or network-based location services. This module uses GPS to locate a person's location as recorded by satellite and then collect data and input it into the unit [15]. The Android Smartphones contain a wireless modem that can be used to track people. This modem is used to communicate with the Global Tracking systems. The GPS information is delivered straight from the user's device to our servers, where it is processed for the user. All of this occurs in a single real-time process [2].

GPS Navigation process

A GPS navigation gadget is receiving signals indicating the current location of a person. The GPS navigation gadget is utilized to determine the person's exact dynamic location change information.

Phone Mode getting using Audio manager

The Android system gives us full control over the ring profile. Using Audio Manager Class [3], may incorporate volume and ring mode organizers in our programs.

Location checking and profile Mode changing process

This module uses GPS navigation to dynamically check location information and compare it to the user-entered location. If both are correct, the mobile mode will change automatically to fit the user's selected profile. Set the ringer mode() method by supplying the type of ringer mode as a parameter to set the ringer mode that is invoked programmatically. The phone will be switched to ring mode if the manifest operation is set to Ringer Mode Normal. The relationship between the user, GPS position. The geo-fence region is depicted in Figure 1.

Implementation of Geo Fence

A geofence is a globular area defined by the radius and the position's longitude and latitude coordinates. Android Location Services will notify the Android app whenever a geofence transition occurs, such as when the Android device enters or exits a registered geofence[4]. The following procedures should be taken to ensure that the app user has a better comprehension. Figure 2 depicts the geofence.

Determine the Relevant Locations for the User

It is critical to select areas that are relevant to the individual user when a notice is triggered based on the location [5]. When it comes to identifying appropriate venues, user data can be really useful. Relevant data is frequently supported, such as if the user has previously visited this location, loyalty card transaction history, or whether the user has purchased a ticket for a location [6].

Control the Geo Fence Radius

The radius of each geofence can be modified to improve relevancy when dealing with geofencing technology. If the geofence's radius is too large for a given region (for example, a radius of 5km in a metropolitan area), the risk of unintended events increases if the user lives in the area or has to commute past it daily [2].

Control the events

At the most basic level, each geofence entry or exit can independently trigger an event [6]. However, to avoid sending too many unnecessary messages, it's necessary to establish a set of rules that define whether and what events are done. The following information can be included in the rules:

- Information about users obtained from a CRM system or a reliability program.
- Geofence location uniqueness
- Rate of recurrence with which the geofence is triggered in a given timeframe
- The number of times messages are sent to the user regularly.

Sensible alert/notification creation based on an entity's location and whether they are entering or exiting the geofence is at the heart of good geofencing [7] [15]. Here's an example of how to make entering and exiting easier.

- To determine whether an entity is entering or exiting a geofence, look at whether the entity's last location coordinates were inside or outside of the geofence [10].
- When an entity's prior position coordinate was outside of the geofence and its current location coordinate is inside the geofence, the entity is entering the geofence [19].
- When an entity's previous location coordinate is inside the geofence and its current position coordinate is outside the geofence, the entity is exiting the geofence [16].

This interrogation of a position coordinate occurs multiple times for the data to remain precise. There are also more challenging methods for determining if a place (latitude, longitude) is within or outside a geofence [17]. The Google Maps Geofence API offers rest APIs for creating and querying bespoke geofences based on longitude and latitude. Figure 4 presents example of Virtual Fence.

Application of Virtual Fence
Geofencing has been a standard practice for many firms as mobile devices have grown in popularity. Other common geofencing applications include:

Location Tracking
Location Tracking can display the amount of time a person spends entering or exiting a given site, which can be utilized to boost the ROI.

Monitoring Assets
It could be a technology that operates in a constrained environment or a vehicle that is speeding down the road [11]. When that particular asset falls into the area, it is feasible to read all of the data [20].

Traffic restrictions
It could be stationary equipment or a car driving down the road. When that exact asset falls into the area, it is feasible to read all of the data [9] [14].

Billing accuracy
The technology allows for easy tracking and documentation of the overall time spent at a certain site [18].

Social networking
Familiar social networking apps, most notably Snapchat are well-known uses for geofencing. Geofencing allows users to generate location-based filters, stickers, and other shared content. It's all credit to these virtual perimeters, whether you're using a promotional filter at a concert, a custom-made filter for a friend's birthday, or uploading to public, location-based stories.

Smart appliances
As more of our appliances become "smart," with Bluetooth capabilities, programming your fridge to warn you that you're out of milk the next time you pass by the grocery store is easier than ever. Alternatively, you can use a geofence to ensure that the thermostat is set to the ideal temperature when you get home from work.

Marketing
Aside from social media, geofencing is a popular tool for businesses to conduct in-store promotions by alerting you as you approach the store. Businesses can also use geofencing to target ads to a specific audience and determine which methods perform best based on user location data.

Audience engagement

Geofencing is used to engage groups of people at organized events such as festivals, concerts, fairs, and other gatherings. A music venue, for example, might utilize a geofence to crowd source social media posts or transmit venue or event information.

Security

Geofencing may appear intrusive, and it can certainly feel like an overreach depending on how it's implemented. Geofencing, on the other hand, can be utilized to enhance the security of your mobile device.

Human resources

Some businesses use geofencing to track personnel, particularly those who work off-site in the field. It's also a simple way to automate time cards, allowing you to clock staff in and out as they arrive and depart.

Telematics

Companies can use geofencing to create virtual zones around facilities, work areas, and secure areas for telematics. They can be activated by a vehicle or a person, and they provide alerts or warnings to the driver.

CONCLUSION

As a result, it may be regarded as the most fundamental stage in achieving a useful novel framework and providing the client with the assurance that the new framework will work and succeed. Finally, the suggested system successfully provides users who frequently update their mobile profile with location-based ring mode changing options using an Android application. When in a lecture hall, conference room, or classroom, the user may forget to alter the sound profile. The proposed Android application effectively provides a location-based ring mode switching option. Users can set their location points with the chosen profile using this app. Based on GPS position information, the application monitors and adjusts the profile mode automatically. This mobile application implementation is helping the user to save time by updating the mobile phone's profile manually.

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Figure1: Flow diagram	**Figure2 : Geofence**
Figure 3: Entering and Exiting	**Figure4: Example of Virtual Fence**

RESEARCH ARTICLE
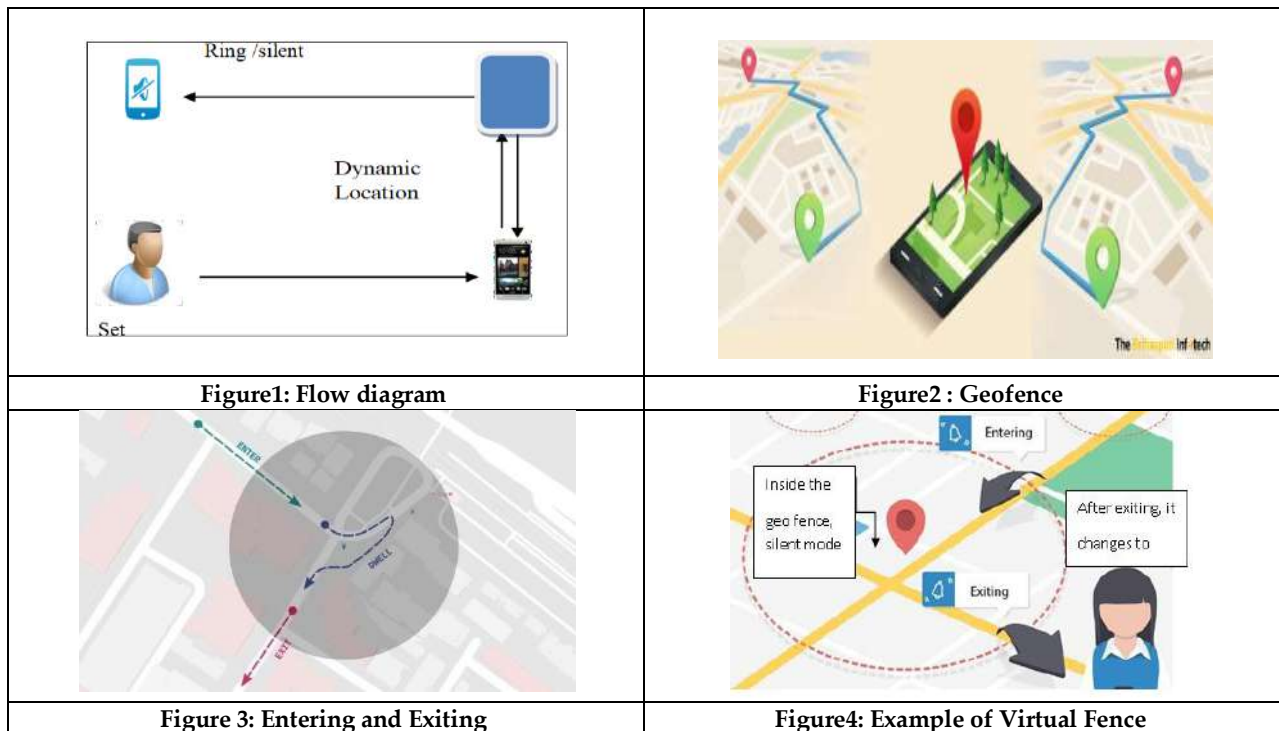
Assessment of Soil Quality Indices of Rice Grown Soil and Its Effects on Fallow Black Gram (*Vigna mungo*) Yield - A Three Year Study

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ABSTRACT

Soil quality indices are more important in maintaining soil fertility and productivity of crops. Nutrient management and cultivation practices followed for crops plays a major role in sustaining soil health. In the present study, black gram (*Vigna mungo* L.) grown after rice at the experimental farm, Faculty of Agriculture, Annamalai University for three years (January - April ; 2013 - 2015) to study the residual effect of integrated nutrient management (INM) practices implemented to rice on soil quality indices and its interventions on rice fallow black gram yield. From the three year data analysis, it was found that application of STCR based IPNS (144:64:60 NPK kg ha^{-1}+ FYM 12.5 t ha^{-1} + bio-fertilizers @ 2 kg ha^{-1}) proved its significance on improved soil quality indices that sustained the soil health along with profitable yield of residual black gram over other INM practiced to rice. INM practices significantly influenced soil quality indices like organic carbon, microbial population, enzyme activities but have less effect on soil physical properties. Further, cultivation practices implemented to rice have no significant effect on soil properties except a slight improvement in biological properties. From the study, it can be concluded that INM practices based on soil test crop response (STCR) values could be a viable option for sustainable productivity of rice fallow pulses in coastal clay soils.

Keywords: Black gram, Coastal clay soil, INM, Organic carbon, Soil quality indices.

INTRODUCTION

Soil quality indices (SQIs) play a key role in maintaining the soil fetility and productivity. Amongst the SQIs, soil organic carbon imparts better soil structural stability which in turn enhances the soil physical environment. OC helps to altering the soil bulk density, microbial load and adding organic matter to soil. Each and every crop needs its own nutrient requirement for their better growth and development (Patton *et al.,* 2017). Enhancing yield of any crop depends not only providing sufficient quantity of nutrients but also to stabilize the soil health to provide the mineral elements in right time and form (Nayak *et al.,* 2017). Fluctuation in soil organic carbon content can influences the soil properties and which directly or indirectly affects the nutrient cycling. Soil organic matter serves as a food for soil microbes and plays a key role in mineralization of various nutrient elements. When soil bulk density is favorably altered by organic matter addition, soil gaseous pipes will be adjusted towards facilitating soil aeration. An arable soil is more suitable crop production than anoxic soil i.e. when the soil is arable with higher soil organic carbon content which augments the microbial population (Jensen *et al.,* 2019). Consequently, the enzyme activities in the soil facilitated by the microbial activity cannot be ignored. Enzyme activities are the one which decides the availability and uptake of various nutrient elements in soil and plants. Different cropping systems prevailing in India under various agro-climatic regions   but rice – pulse cropping system is one of the most popular systems in low land areas. Compare to other cropping system rice-pulse cropping system has beneficial role in maintaining the soil health particularly in coastal regions. Rice being a cereal crop requires more nutrients than pulse crops. Continuous cultivation of rice will mine more and particular nutrients from the soil.

Crop removal and other nutrient losses have to be resorted possibly by addition of nutrient sources to sustain the soil health. Addition of nutrients through inorganic fertilizers or organic materials alone may not be sufficient to sustain the soil fertility and productivity (Borah *et al.,* 2019). Hence, integration of fertilizers with organic sources might be viable options for enhancing any cropping system productivity. When there is a reduction in available nutrients and organic matter in soil that leads to hamper the microbial load and their functions too. There is no doubt that inorganic fertilizer application boost up the crop productivity in a quick manner, however long term use causes the soil carbon stocks and fractions which ultimately affect the nutrient cycling. Whereas addition of different organic materials will be a low expensive option for reducing inorganic fertilizers partially and reduces the soil deterioration. Hence, there is a need for combined application of organic and inorganic materials to improving the soil biogeochemical properties i.e. enhancing microbial load and activity, soil enzyme activities and smoothened cycle of nutrients. Microbial load of the soil decides decomposition of organic matter (mineralization), nutrient releasing pattern and total soil environment. Deterioration of soil organic carbon impedes soil bulk density and microbial population which directly affects soil enzyme activities. As soil enzymes have vital role in nutrient cycling which ultimately hampers the plant physiological and biochemical processes.

These processes are responsible for plant nutrient uptake, utilization efficiency, crop growth and yield. Cultivation methods also play an important role in crop production. System of rice intensification (SRI) one of the proven and famous technique in rice cultivation as it have more advantages than conventional system of cultivation (CSC). Further, adoption of integrated nutrient management practices in rice –pulse cropping helps to maintain the soil health and crop productivity. In addition to that SRI method increased the rice yield up to 50 % and also has significant carry over effect on succeeding crop yields (Thakur *et al.,* 2013). Around 11.7 m ha remains fallow after rice harvest in India. By bringing one-third of these fallow areas brought under effective pulse cultivation, India can achieve its self sufficiency in pulse production (Narendra Kumar et al., 2018). This will apply to world rice production areas where water scarcity is a major concern. Black gram is an important pulse crop suitable to grown as rice fallows during the months of January - April in Cauvery Deltaic Zone of Tamil Nadu. Before harvesting the Rabi rice crop, black gram seeds either broadcasted or line sown using last irrigation provided to the rice crop. It needs to establish under paddy stubbles and survive with residual soil moisture and nutrients available along with weather benefits of crop growth period i.e. winter and pre-summer climatic effects. Where, the productivity of these rice fallows can be better achieved through nutrient management practices of preceding crops. Further, rice fallow pulse

crops are more important to the farmers of the Cauvery deltaic Zone to maintain their livelihood by means of additional income without input cost.

There are many research reports on just yield of rice fallow black gram but very few works were reported on preceding rice is grown soil quality indices or properties and its effect on fallow pulse crops. Hence, with the aim of increasing our knowledge in biogeochemical cycling and dynamics of soil organic matter (SOM) to maintain a better soil environment under integrated nutrient management practices on certain soil parameters and its interventions on the residual crop yields especially in rice–pulse cropping system. The present was study planned and carried out with the above background. Therefore, we evaluated the soil bulk density, percent pore space, soil organic carbon content, microbial population, and soil enzyme activities of urease, alkaline phosphatase, and dehydrogenase influences on black gram yield grown after Rabi rice in deep clay soil. Farmers practicing rice fallow pulse cropping system can pave a road to circular economic system (Fig 1.) and helps to attain the sustainable Development Goals (SDGs) through securing the soil, socioeconomic, and production constraints in certain agro-climatic regions.

MATERIALS AND METHODS

Experimental site
 Field experiments were carried out at Experimental Farm, Faculty of Agriculture, Annamalai University, Tamil Nadu, India taking two crops, black gram grown after Rabi rice in sequence during January - April (2013; 2014 and 2015) for three years. The study area falls under semi- arid climate. The soil at the experimental site is deep clay representing Vertisol (Typic Haplusterts).The experimental soil having bulk density (1.32 Mg m^{-3}), per cent pore space (49.5), pH 7.4 ,EC 0.37 dsMm^{-1}, OC 4.6 g kg^{-1}, and available N,P and K as 227; 19.9; 276 kg ha^{-1},respectively in soil collected after rice harvest. The DTPA extractable Fe, Mn, Cu and Zn contents of the soil were 21.2, 3.7, 2.1,and 1.1 mg kg^{-1},respectively (three year pooled values).

Experimental design and treatments
The experiments were carried out as the design used for preceding Rabi rice crop i.e. Split plot design with two methods of cultivation (SRI – M$_1$ and CSC – M$_2$) as main plot treatments and twelve fertilizer treatments in sub plots replicated thrice. The sub plot treatments were, T$_1$- 100% recommended dose of fertilizer,T$_2$ - STCR based recommended dose of fertilizer, T$_3$-LCC based N (recommended dose of fertilizer P and K),T$_4$- STCR based integrated plant nutrient supply (IPNS),T$_5$-75 % fertilizer N + 25 % organic N (FYM),T$_6$-75 % fertilizer N + 25 % organic N (GM),T$_7$-75 % fertilizer N + 25 % organic N (PM),T$_8$-75 % fertilizer N + 25 % organic N (POM),T$_9$-50 % fertilizer N + 50 % organic N (FYM),T$_{10}$-50 % fertilizer N + 50 % organic N (GM),T$_{11}$-50 % fertilizer N +50 % organic N (PM),T$_{12}$-50 % fertilizer N + 50 % organic N (POM). Black gram (var: ADT-3) was grown as residual crop from Jan-April of 2013, 2014 & 2015 without disturbing the experimental layout implemented for rice. The fertilizers and organics applied as follows, RDF : 150:50:50 NPK kg ha^{-1}, STCR : 144:64:60 NPK kg ha^{-1} (Target yield of 6 t ha^{-1}), LCC : 30 - 40 kg ha^{-1} (at tillering, panicle initiation and heading stages if 6/10 observation shows less than critical value[4] [* No basal N]), STCR (IPNS):144:64:60 NPK kg ha^{-1} + FYM 12.5 t ha^{-1} + bio-fertilizers @ 2 kg ha^{-1} and   ZnSO$_4$ @ 25 kg ha^{-1} was applied in all treatments to rice. No fertilizers and organics were supplemented to black gram except 2 % Di-ammonium phosphate (DAP) foliar spray for two times.

Collection and analysis of soil samples
Soil samples were collected when rice crop was in field before sowing the black gram in rows. Field- moist samples were divided into two sub samples. One soil sub sample was sieved to pass through 2mm mesh and stored zipped polythene bags in refrigerator at 2-4° C for biological and biochemical analysis. The air-dried soil samples were ground to pass through 2mm sieve and then stored in sealed polythene bags for physico-chemical analysis. Soil bulk density and porosity was estimated employing the method given by Gupta and Dakshinamoorthy (1981).Soil pH was determined in a soil –water suspension (1:2.5)with the help of pH meter, the EC was measured in the supernatant of the same suspension (Sparks,1996).The organic carbon was estimated employing wet oxidation

method (Walkley and Black,1934); available N by alkaline permanganate method (Subbiah and Asija,1956);available P by Olsen's method (Olsen et al.,1954); available K in 1N ammonium acetate extract using flame photometer (Stanford and English, 1949). Standard serial dilution plating technique of Pramer and Schemidt (1965) was adopted for the estimation of microbial population and expressed as colony forming unit (CFU) g^{-1} soil. The different types of microorganisms were enumerated using differential media favoring the growth of bacteria (Nutrient agar), fungi (Martin's rose Bengal agar), and actinomycetes (Kenknight's medium). Urease activity in soils was estimated by as per the procedure outlined by Tabatabai and Bremner (1972). Alkaline phosphatase and dehydrogenase activities were measured employing the method given by Page *et al*. (1982).

Black gram yield assessment
Yield components viz; halum weight/plant, seed weight/plant were recorded from the 5 sampled plants. After harvesting, grain weight/plot and straw weight/plot were measured, all the plants in the net plots were considered and the amounts converted into ha. The grains were measured at 14% moisture using the moisture meter.

Statistical analysis
The data were subjected to split plot anova using SPSS version 28.0.0.0 (190) and wherever the treatment differences were found significant (F test), critical differences were worked out at five per cent probability level and the values are furnished. Treatment differences which were not significant are denoted as "NS".

RESULTS

Soil bulk density and percent pore space

The effect of INM practices significantly influenced the soil bulk density, and percent pore space (Fig.2a & 2b) in rice grown soil. Bulk density values were concisely maintained under SRI (1.32 Mg m^{-3}) compared to CSC (1.26 Mg m^{-3}) from the initial value of experimental soil (1.32 Mg m^{-3}). Among treatments, bulk density values ranged from 1.26 to 1.32 Mg m^{-3}. Even though all treatments were statistically significant from one another, they were not in the length of altering the bulk density, and interaction effects on bulk density were found to be non-significant. Pore space was concisely increased in SRI (51.78 %) over CSC (50.26 %) but increased from the initial soil test values of 49.5 percent. Pore space percent values ranged from 49.85 to 52.34 and percent. The values increased around 4.7 to 4.8 percent and interaction effects were found to be non-significant.

Soil organic carbon content
The direct and residual effect of cultivation and INM practices on soil organic carbon (SOC) content was significantly improved in all the years of experimental soil (Fig.2c).The maximum SOC (3.37–10.09 g kg^{-1}) were recorded with SRI plots. Among the nutrient management practices, STCR based IPNS (T_4) found to be superior by registering higher SOC (10.09 g kg^{-1}) and it was followed by T_5>T_6>T_8>T_7>T_9, T_{10}, T_{12}, T_{11}>$T_2$and T_1. Lower SOC content (2.01 g kg^{-1}) was observed under treatment LCC based N application (T_3), respectively. Interaction effects between cultivation methods and nutrient management practices were significant. Maximum SOC content was observed under SRI in treatment received STCR based IPNS (10.09 g kg^{-1}) and minimum SOC values (2.01 g kg^{-1}) recorded in T_3 under CSC.

Soil microbial population
The Maximum microbial population (Bacteria x 10^6 CFU g^{-1}, fungi x 10^3 CFU g^{-1}, actinomycetes x 10^4 CFU g^{-1}) was recorded and in pooled data (Fig.3) under the SRI method (50, 13, and 9.4) and the minimum microbial population was noticed with CSC (45, 11.8 and 8.5). Among the integrated nutrient management practices, STCR based IPNS (T_4) was found to be superior by registering a higher microbial population of 72.3, 18.6, and 13.3, respectively and it was followed by T_5>T_6>T_8>T_7>T_9, T_{10}, T_{12}, T_{11}>$T_2$and T_1. A lower microbial population was observed under treatment LCC-based N application (T_3) 34.4, 9.1, and 6.6, respectively. Interaction effects between cultivation methods and

Nutrient management practices were significant. The maximum number of colonies formed under SRI in treatment received STCR based IPNS and minimum population recorded in T_3 under CSC in both years.

Soil enzyme activities

Enzymatic activities of urease (μg of NH_{4+} g^{-1} of soil 24 h^{-1}), alkaline phosphatase (μg of p-nitrophenol released g^{-1} of soil 24 h^{-1}), and dehydrogenase (μg of TPF released $g^{-1}$of soil 24 h^{-1}) after rice grown soil were increased significantly in SRI plots compared CSC plots and in pooled data (Fig. 4,5 & 6). Overall, SRI method followed plots were registered maximum soil enzyme activities (174.9, 135.4, & 53.4). Among the integrated nutrient management treatments, STCR based IPNS (T_4) applied plot soil samples were found to be superior by registering maximum enzyme activities of urease, phosphatase, and dehydrogenase 253.1, 193.8 & 75.9, respectively. And it was followed by T_5>T_6>T_8>T_7>T_9, T_{10}, T_{12}, T_{11}>$T_2$and T_1. Lower enzyme activities were observed in LCC-based N applied plots (T_3). Interaction effects between cultivation methods and nutrient management practices were found significant. Maximum activity under SRI in treatment received STCR based IPNS plots (253.1, 193.8 and 75.9) and the minimum was (98.6, 69.3 and 25.8) recorded in T_3 under CSC plots, respectively.

Seed and haulm yield of black gram

Concern with seed yield of black gram, the residual effect of INMPs under both cultivation methods applied to rice were found significant in both years and in pooled data (Table 1; Fig 8). The seed yield was noticeably higher under SRI (571 kg ha^{-1}) over CSC plots (505 kg ha^{-1}), respectively. Among treatments, the residual effect was higher with T_4, which obtained the seed yield of 732 and 634 kg ha^{-1}, respectively. It was on par with T_5 followed by T_6, T_8, and T_7; T_9 and T_{10} (on par); T_{12} and T_{11} (on par) and T_1 and T_2 (being on par).Very sparse residual effect on seed yield received by treatment T_3 (319 and 287 kg ha^{-1}). Cultivation methods and INMPs established a significant interaction on black gram seed yield. Irrespective of cultivation methods the highest seed yield was received with treatment T_4 (STCR based IPNS - fertilizer +12.5 t ha^{-1}+ biofertilizers) 732 kg ha^{-1} under SRI (M_1) plots and the lowest yield registered by T_3 of 287 kg ha^{-1} in CSC (M_2) plots, respectively. The residual effect of treatments under both cultivation methods applied to rice crops on haulm yield of black gram followed the same trend as in seed yield. The haulm yield was considerably higher under SRI plots (1952 kg ha^{-1}) over CSC plots (1761 kg ha^{-1}), respectively (Fig 8). The maximum haulm yield was produced by T4 (2259 kg ha^{-1}) however, it was comparable with T_5, T_6, and T_8. All other treatments were superior to T_3 which recorded minimum dry matter production 1403 kg ha^{-1}. Interaction effect of INMPs and of cultivation methods found to be non significant on haulm yield.

DISCUSSION

The agronomic principles used in SRI were not altering the physical properties of soil directly but indirectly through active soil aeration (vigorous root development) and more facilitated rhizospheric conditions attributable to ease bulk density and adjusted pore space percent. After paddy harvest, root biomass below ground undergoes decomposition which in turn make soil become rich in organic matter are less prone to erosion processes than soils with low content of root biomass. The organic matter stabilized the soil structure might be through increasing the inter-particle cohesion within aggregates and enhanced hydrophobicity, thus decreasing their breakdown. Particularly, the soil structural stability improvement through increased soil microbial activity in soil enriched with organic manures (Mondal *et al.*,2016). Here, in the present study, residual effect of STCR based IPNS (combined application of fertilizer along with 12.5 t ha^{-1} FYM and bio-fertilizers *viz.*, *Azospirillum* and *PSB* as soil treatment) resulted in greater improvement in soil physical properties(Fig.2) and it was followed by other INM practices. It might be due to readily decomposable huge addition of organic matter from rice debris, had an advantage of releasing various humic fractions which involved in aggregation of soil particles along with integrated application of nutrient sources. Prakash *et al.*(2008) and Tejada *et al.*(2009) have reported similar findings of INM practices enriched the soil properties which facilitated the growth and development succeeding crops in rice based cropping systems. Build up of organic carbon (SOC) in soil is a measured process especially in rice soils due to presence of oxic and anoxic conditions; lead to delayed mineralization results very slow addition of OC in rice soils.

As it is responsible for total or bulk density then directly hinders the SOC addition very slowly thus impart less or no cause on soil structural stability. In the present study, cultivation methods and INM practices used for rice distinctly maintained the soil health. This might be attributed by cultivation practices like SRI and combined application of organic and inorganic sources addition. Further, SRI practices adapted to rice might have improved the rhizospheric aeration thus healthier root structure potentially helped in balanced crop nutrient uptake and maintain the same in soil. This was evidenced by organics applications included in the INM practices in different combinations lead to improved soil structure and nutrient absorption. Consequently reduced the leaching losses and maintained soil fertility .These results are in line with those of Banger *et al.*(2010) and Kahlon *et al.*(2013). Microbial population (Bacteria x 10^6 CFU g^{-1}, fungi x 10^3 CFU g^{-1}, actinomycetes x 10^4 CFU g^{-1}) enhanced under organic manure application attributed to the higher organic carbon in biologically active phase of carbon which acted as source of energy for microbes proliferating in soil (Vishwanath et al. 2020). In the present study, implementations of cultural and INM practices to rice improved the soil health through enhanced microbial population is significantly. Which was realized in observing higher microbial load in all INM treated plots especially under SRI in STCR based IPNS (T_4) treated plots (Fig .3).

Incorporation of organics increase microbial population because it improved hydrothermal regime and supply of large amount of carbon, a major food source for several bacteria and all fungi involved in decomposition (Kumar et al. 2013). Kumar et al.(2016) reported that manures application enhanced the microbial counts in soil, which might be due to carbon addition and changes in physicochemical properties of soil. Microbial population increased due to lesser C: N ratio of manures which are rich in total N and P content (Upadhyay *et al.* 2011). The urease activity observed in the rice grown soil at higher rate in all the three years under INM treated plots compared to control and other low level organics applied plots. Maximum urease activity after rice was recorded in T_4 (STCR based IPNS) (Fig.4), as urease enzyme is highly depends on microbial origin in soils, which realized with treatment T_4 due higher population of microbes survived thus urease activity also. The higher organic levels applied with bio-fertilizers might be another key factor that influences SOC concentration, microbial load, and urease activity in STCR based IPNS supplementation. Further, added crop residues through rice cultivation in soil might have influenced the nutrient availability and act as substrate for urease activity and microbial motions. In addition to that enzymatic activities of soil amplified due to addition of organic carbon through organic manures also cited by Kumar et al. (2014). Integrated nutrient management practices followed in rice affected more residual effects than the non- INM trials in rice were also evidenced with the reports of Tida Ge *et al.* (2017) and Jat *et al.*(2021). A significant increase in alkaline phosphatase activity in rice-grown soil was recorded due to INM practices imposed on rice. And the maximum alkaline phosphatase enzyme activity was observed with STCR based IPNS applied to rice (Fig.5). Phosphatase enzyme activities swift up the conversion process of inert phosphorus to plant available form in soil solution, and ultimately enhance P uptake crop plants.

Almost all the rhizosphere regions are loaded with various microbes and they play a central role to augment enzyme activities and the phosphorus solubilization process. In the present study, cultivation methods and INM practiced to preceding rice crops might have enriched the biogeochemical properties of soil which in turn resulted in enhanced phosphatase activity significantly. However, it varies with crops under diverse crop cultivation, and nutrient management practices (Dotaniya *et al.,* 2014). Similar study reports were cited by Das and Dkhar (2011) and Recena *et al.*(2021).The commotion of the dehydrogenase enzyme was strongly affected by organic manures. Higher dehydrogenase enzyme activity in soils amended with organic sources was not only due to large microbial biomass but also to higher amounts of enzyme production by the microbial biomass. The soil quality indices observed for three years in rice-grown soil of the present experiments proved with enhanced indices like BD, PPS, SOC, MAs as projected in the tables of result section. Consequently, among all the organic sources in combination with inorganic nitrogen evaluated, the incorporation of STCR based IPNS (T_4) (combined application of fertilizer along with 12.5 t ha-1 FYM and bio-fertilizers viz., Azospirillum and PSB as soil treatment) performed better in improving the biochemical properties and thus improved the enzyme dehydrogenase activity (DH) (Fig .5). Also, dehydrogenase activity is related to oxidizing SOM, most likely this might the reason that dehydrogenase was higher with STCR based IPNS supplied plot both under two cultivations methods practiced to rice.

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Further, microbes are being a part of the oxidative respiration in soil which increased the DH activity in higher organics applied than other levels tried in the experiment. Present experimental results are in close agreement with the findings of Parewa *et al.* (2014) and Dutta *et al.* (2018) they opined that integrating organic sources with regular mineral fertilizers has maintained both soil fertility status and crop yields sustainably via improving soil characteristics in various cropping systems. Soil quality indices assessed in rice grown soil significantly increased the yield of black gram grown after rice. Assessed soil quality indices (Table 1, 2, 3 & 4) were, directly and indirectly, influenced various soil properties as discussed earlier by the implementation of INMPs to preceding rice crop. Cultivation methods followed too might have helped to improve the soil moisture-holding capacity as it depends on the soil bulk density, SOC, and other biophysical parameters thus initial germination of black gram well administered and shifted to reach the maximum plant population.

Further, assessed biochemical parameters of rice grown soil in all the three years greatly sustain the soil health, which in turn might have facilitated the nutrient availability to the residual black gram. Therefore, the uninterrupted supply of nutrients to residual black gram substantially increased the yield. This indicates a differential impact of soil quality indices i.e. BD, PPS, SOC, microbial population, and enzymatic activities on the soil-plant continuum of nutrients with available residual moisture, and confirmed that all these SQIs might have positive interaction with the bio-availability of nutrient elements which resulted in an elevated yield of black grown after rice (Fig. 5& 6). Further, there was a significant difference in the seed yield in INMPs treated plots compared to RDF alone. Almost, 2 - 2.5 times increase in seed yield was evidently recorded over inorganic alone tried and depicted in table 4. These results were in correspondence to those of Thakur et al. (2013) they opined that higher OM content in soil via organic inputs could be a better option for enhancing soil status that put forward to attain equilibrium in its health and allowed the soil to be produced sustainably.

CONCLUSION

The results of a three-year study on the soil quality indices like bulk density, percent pore space, soil organic carbon, microbial activities, and its effect on enzymatic activities in rice grown soil had significantly sustained the of soil health through integrated nutrient management practices. Further, with the application of STCR based IPNS shown higher residual effect and thus the yield black gram improved significantly. It can be inferred that choosing the best INM practices for preceding rice crop can helps to enhance the yield of rice fallows in coastal clay soil.

Author Contributions

Conceptualization, Methodology and writing- original draft preparation: Senthilvalavan Pitchamuthu (PS) Scientific assistance of research field work and Irrigation scheduling: APS, SK and CR Collection of literature & other analytical work assistance: RM and GSN *All authors provided their valuable support to prepare the final draft*

CONFLICT OF INTEREST

We declared that we have no conflict of interest.

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Table 1. Influence of INMPs and cultivation methods implemented to preceding rice crop on black gram yield (kg ha^{-1})

Crop	Black gram (kg ha^{-1})				* Per cent yield increase over CSC plots		* Yield difference with lowest value observed treatment (T$_3$)	
Parameters	Seed yield		Haulm yield				Seed	Seed
Treatments	M$_1$ (SRI)	M$_2$ (CSC)	M$_1$ (SRI)	M$_2$ (CSC)	Seed	Haulm	M$_1$(SRI)	M$_2$ (CSC)
T$_1$	472	419	1635	1485	11.23	9.17	153	132
T$_2$	488	434	1664	1512	11.07	9.13	169	147
T$_3$	319	287	1459	1347	10.03	7.68	-	-
T$_4$	732	634	2404	2113	13.39	12.10	413	347
T$_5$	700	612	2344	2080	12.57	11.26	381	325
T$_6$	660	577	2218	1970	12.58	11.18	341	290
T$_7$	600	535	2020	1833	10.83	9.26	281	248
T$_8$	608	542	2047	1858	10.86	9.23	289	255
T$_9$	591	527	2005	1820	10.83	9.23	272	240
T$_{10}$	587	523	2001	1816	10.90	9.25	268	236
T$_{11}$	535	477	1790	1626	10.84	9.16	216	190
T$_{12}$	549	489	1839	1670	10.93	9.19	230	202
	M	S	M x S	M	S	M x S	11.34	9.65	251.1	217.7
SEd ±	10.19	16.02	24.02	29.82	41.26	63.32		
CD (P=0.05)	43.87	32.29	NS	128.3	83.13	NS	* Values not statistically analyzed	

(Pooled mean of three years) [NS-Non-significant, CD-Critical difference]

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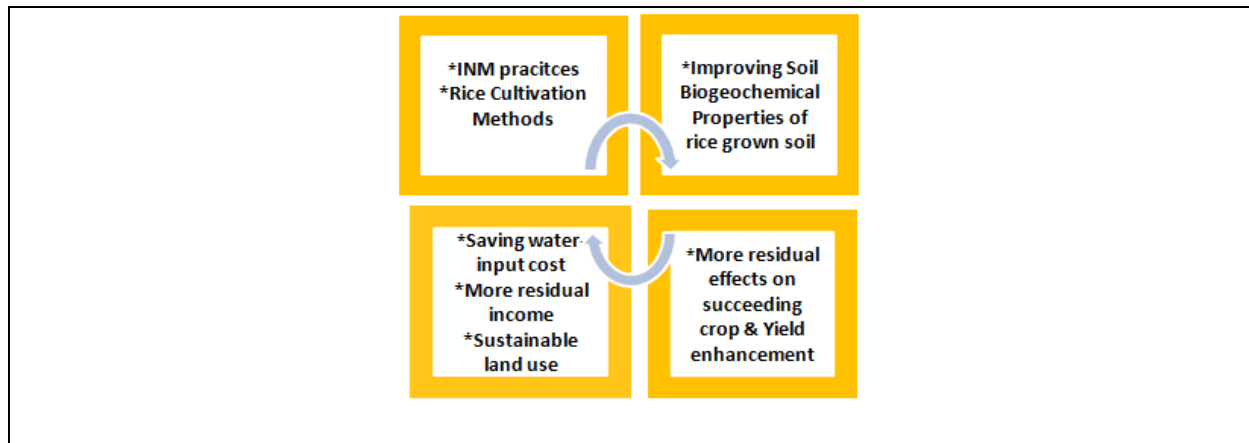
Fig 1. Role of integrated nutrient management practices on soil quality indices and its effects on rice fallow crop
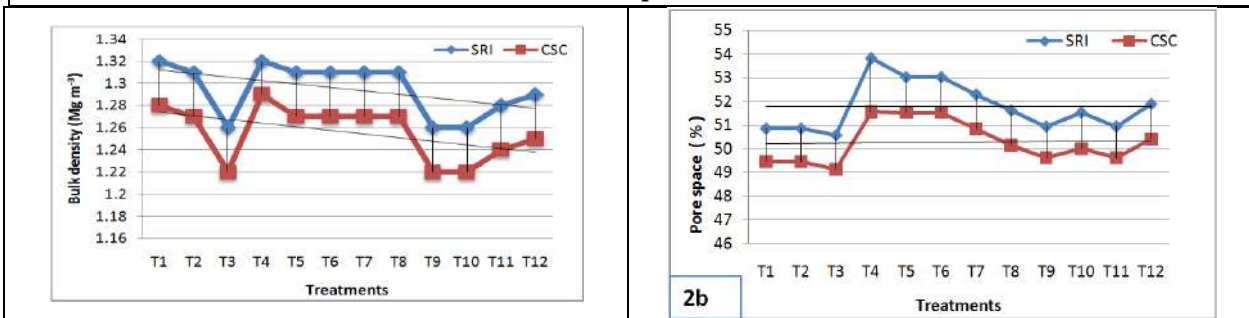
| a) Soil bulk density | b) pore space |
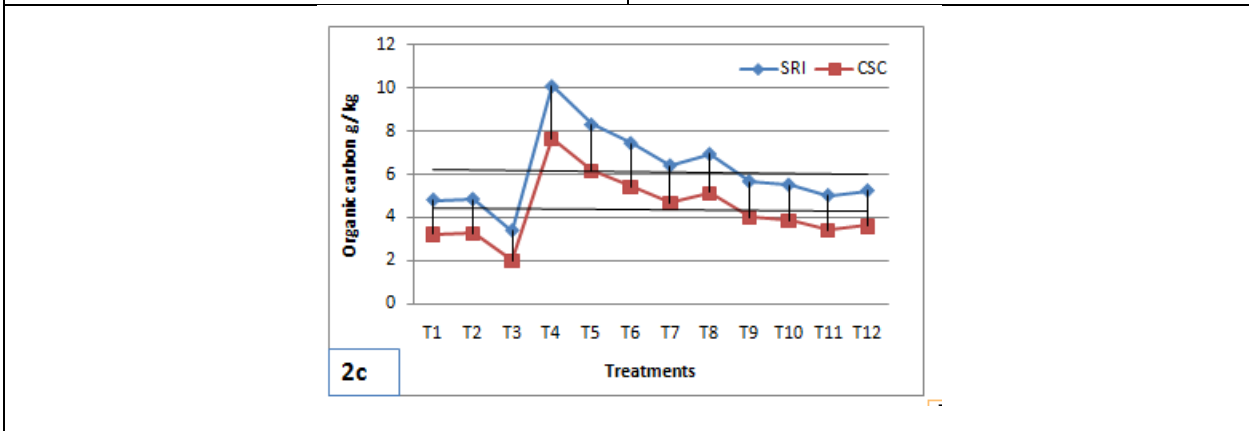
Fig. 2 .a) Soil bulk density b) pore space and c) organic carbon content of rice grown soil (representing three year pooled values)

Fig. 3. Microbial population of rice grown soil (three year pooled values)
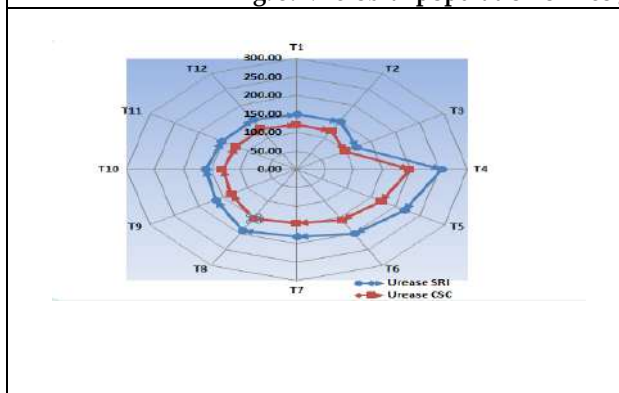
Fig 4. Residual effect of INM practices on urease activity in rice grown soil (three year pooled values)
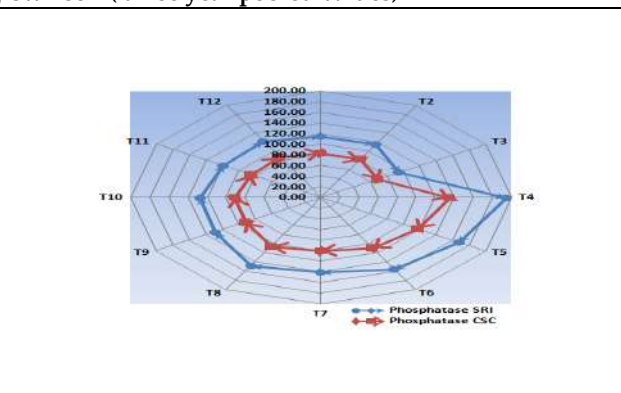
Fig 5. Residual effect of INMPs on phosphatase activity in rice grown soil (Three year pooled values)
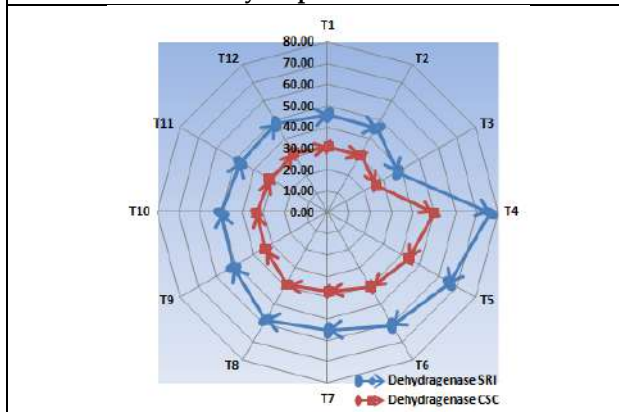
Fig 6. Residual effect of INMPs on dehydrogenase activity in rice grown soil (Three year pooled values)
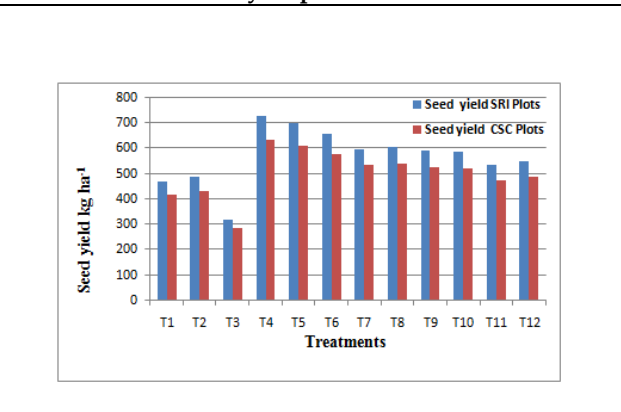
Fig 7. Residual effect of INM practices on seed yield rice fallow of black gram (Three year pooled values)

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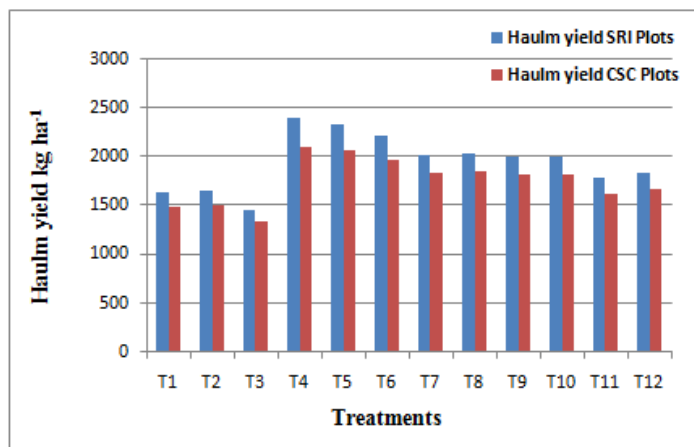
**Fig. 8. Residual effect of INMPs on haulm yield of rice fallow black gram
(Three year pooled values)**

RESEARCH ARTICLE

Effect of Physiotherapy Combined with Ergonomic Advice vs Ergonomic Advice on Pain and Quality of Life on low Back Pain among Fabricator Worker: A Comparative Study

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ABSTRACT

The incidence of occupational low back pain differs by occupation and employment, and there is an association between heavy physical labour, static work posture such as prolonged sitting, vibration, and psychosocial factors like job. The aim of the study was to determine the effect of ergonomic advice and ergonomic plus physiotherapy intervention on pain, function disability and quality of life on low back pain for fabricator worker. 30 patients were randomized control trial were fabricator workers aged 20-60 years old with low back pain. Participants were equally assigned into two groups. Both Group a and B was received ergonomic advice for 3 weeks. And group B was received physiotherapy intervention for 3 sessions per week for 3 week. Patients were assigned by visual analogue scale (VAS) and Oswestry disability index (ODI). In group a (ergonomic advice) and group B (ergonomic advice plus physiotherapy intervention). Results revealed that that means ± SD of both groups were significant (p=0.00) statically analysed using paired t test and independent t test to determine the statistical difference among the data. The patients are analysed on VAS and ODI. The data showed significant changes. Group B (ergonomic advice plus physiotherapy intervention) showed more effectiveness than group a (ergonomic advice). Group B showed less pain, functional disability and better quality of life after intervention.

Keywords: Ergonomic Advice, Fabricator Workers, Non - Specific Low Back Pain, Physiotherapy Treatment

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INTRODUCTION

Low back discomfort is a prevalent ailment among industrial workers. Approximately 84 per cent of Fabricator Workers claim having experienced back pain at some point in their lives [1]. in a typical acute attack, the patient is abruptly struck with terrible pain in the lumbar region of the spine, commonly while stooping, lifting, turning, or coughing. The discomfort gradually subsides [2]. The prevalence of occupational low back pain varies by industry and employment, and there is a link between heavy physical labour, static work posture such as prolonged sitting, vibration, and psychosocial factors like job unhappiness [3]. Specific low back pain and non-specific low back pain are the two types of low back pain. [4] Non-specific low back pain has no clear symptoms, physical findings, or imaging findings. Furthermore, non-specific low back discomfort that is unrelated to the degenerative syndrome and neurological problems [5]. Non-specific chronic low back pain is significant problem in industrial worker due to its associated high health care utilization, raising costs of care, and preserved limitation of the effectiveness of intervention it is a significant source of long-term disability and work absence and accounts for approximately 80% for total costs of back pain care [6]. Due to the high global prevalence of non-specific LBP, which has significant health and socioeconomic effects, and the fact that currently available treatment choices are not always sufficient, preventive measures deserve special emphasis. Interventions aimed at preventing LBP are desirable for the workplace in principle, because preventing pain is generally preferable to treating it, as well as because of the difficulty in treating pre-existing LBP and the adverse effects of some analgesics, which may impact alertness or cognition, and thus workplace safety [7]. Numerous studies have already been carried out to assess non-specific low back pain. Pain assessment, trunk flexibility, functional capacity, and quality of life were the most common evaluations [8].

Those assessments appear to be linked to people who have nonspecific low back pain, because nonspecific low back pain is mostly associated with pain and limited mobility. Flexibility of trunk movement, functional limitations, and quality of life can all be impacted life [9]. Back pain has an impact on the quality of life of those who suffer from it, notably in terms of enjoyment of leisure activities, work productivity, difficulties doing home duties, and participation in sports [10]. Occupational dangers have increased in recent years as a result of a lack of healthcare understanding. Fabricator workers have been reported to be exposed to a variety of occupational risks. As a result of their demanding occupational labour, research into the problems faced by such workers is required.

The study of the relationship between work and health has taken place in occupational settings, with a primary focus on return to work. As a result of back pain, the health-related characteristics of primary care low back pain consults who reported regular employment, reduced duties, sick leave, and non-employment as a result of their low back pain were examined [11]. Self-care for the back is a great way to feel better about yourself. Back discomfort can be avoided or reduced. Exercise on a regular basis, maintaining a healthy weight, and adhering to a healthy diet is all good for patients with low back pain. Their quality of life improves when their posture is improved [12]. Ergonomics is concerned with the use of data about human behaviour, capabilities, and limitations in the design of systems, equipment, tools, tasks, or jobs, and settings for productive, safe, and effective human use in a variety of worker jobs, such as fabrication [13]. Exercises for spine posture and specific back exercises a few studies have looked at the physical and working circumstances of fabricators.

Ergonomics in the workplace, received instructions, and their impact on workplace issues, damage to the musculoskeletal system, and work-related injuries [14]. A longitudinal survey found that 51% of welders and metalworkers have missed work due to musculoskeletal issues. The most common reason is low back pain. Welders adopt several difficult postures and hold them for long periods of time throughout the welding process. During the workday, they are doing their job. It is required to execute trunk flexion movements. Excessive bending and twisting postures in confined spaces, such as welding, are considered risky. Welding requires a high level of concentration when it comes to reducing the problem of low back pain at work, ergonomic intervention is frequently used. It is not possible [15].

METHODOLOGY

- **Source of Data**
  - ➤ district Vadodara

- **Method of Collection of Data**
  - ➤ Sample method: convenient sampling method
  - ➤ Sample size: study was done on 30 subjects who were fulfilling the inclusion and exclusion criteria in fabricators.

- **Inclusion Criteria**
  - ➤ 20-60 years male
  - ➤ Only fabricators workers
  - ➤ Working hours minimum 35-45 per weeks

- **Exclusion Criteria**
  - ➤ Severe symptomatic disease like PIVD, sciatica etc. will be excluded
  - ➤ Any abdominal surgery last 2 years
  - ➤ History of low back pain below 6 months will be excluded
  - ➤ Any kind of congenital condition
  - ➤ Worsening neural signs, had any neurological that would interfere with treatment

- **Outcome Measues**
  - ➤ VAS (visual analogue scale)
  - ➤ Oswestry low back pain disability questionnaire

- **Material Use**
  - ➤ Pen & paper
  - ➤ Pencil
  - ➤ Informed consent form
  - ➤ Oswestry disability index scale
  - ➤ visual analogue scale

Procedure


```
30 Subjects were observed according to inclusion
                    criteria
                       ↓
After that 30 subjects were divided into 2 groups , in
       each groups 15 subjects are alloted
                       ↓
30 subjects were included inform consent when given
                       ↓
              ODI & VAS was taken
                       ↓
                 Data  Analysis
                       ↓
                     Result
```
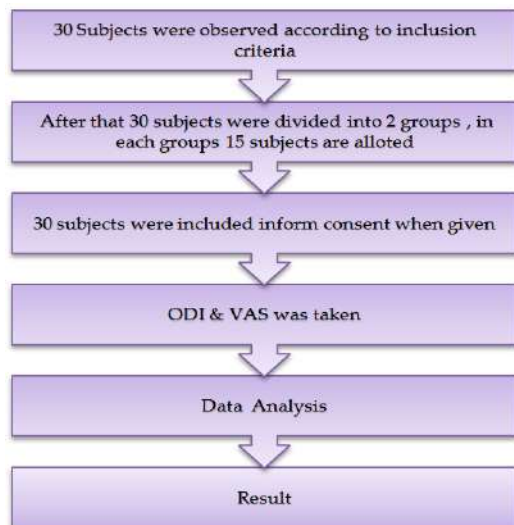
Group A (15 fabricators) ergonomic intervention, group B (15 fabricators) ergonomic plus physiotherapy intervention. Subjects were explained about research and treatment protocol. Inform consent form was signed by the subject before the treatment start. Subjects were screened using an assessment form and outcome measures before and after the program (after 3 week). Both group received ergonomic intervention.

Group A: ergonomic interventions [17][18]
[1] Every 20 min after work than can take rest.
[2] When lifting, keep the loads between hand level and shoulder level. Avoid lift from the floor or over shoulder level
[3] Squat with heels on the ground. Keep your back proper alignment, feet apart about a foot and toes pointed outward
[4] Strain on the lower back and legs are reduced by sitting down while working standing causes legs to swell. The best jobs are ones that allow workers to do different types of work, changing from sitting to standing, to walking & back again
[5] Try to avoid sitting in the same position for more than 30minute
[6] Lower your body to get close to close an object
[7] While lifting an object bend from hips & knees not back
[8] Take help an object bend from hips & knees not back
[9] "Dynamic sitting" which involves the use of both active & passive implements to encourage regular movement of seated position.

Group B: physiotherapy interventions plus ergonomic advice [19][20][21]
For three weeks, each participant received physiotherapy treatments three times a week. Manual therapy treatment included symptom management at the discretion of the treating physiotherapist, who could choose between spinal mobilization and other techniques. Lie down flat on your back with your heels on the surface. Bend one knee up to 120 degree then instruct the patient to raise the other leg up to 50 degree. The position is to be held for 5 seconds and repeat the whole procedure for 10 times. The patient is lying in supine lying position and both the hands are placed in the back. The force should be applied on both of the hands. This position is to be holded for 5 second and has to be repeated for 10 repetitions. The patient in lie on back and place feet on the surface with both knees bend. Extended arms to the turn head to the right, while letting your knees fall to the left. Allow the side to stretch for 15-30 seconds. Repeat by turning head and knees the opposite directions. Standing with the ulnar border of the hand between the pisiform and the hook of the hamate, directly over the spinous process on the right side of the patient. The therapist's shoulder was positioned exactly over the point of contact of the spinous process, and the forearm was kept in neutral between supination and pronation with complete wrist extension.

Direction
The direction of mobilization was poster anterior. Grade I and II joint oscillations hold for 30 seconds each. Grade I joint mobilizations were administered consecutively to the 3 spinous processes that surround the pathologic area with 30 seconds of rest in between, followed by grade II joint mobilizations performed. .Frequency: 6 repetitions to 3 spinous processes were given once in a day. After mobilization each patient received hydro collator pack to lumbar area for 10 min. to reduce the pain that may be produced as a result of increased Para spinal muscle activity owed to mechanical force use with mobilization. The patient lies down with the back, knees in full flexion and feet flat on the floor and close to the buttock. Then the patient lifts hip off the floor towards the sky as high as possible. Hold for 5 sec, and then slowly come down to the ground. Repeat 10 times.

RESULTS

Data were evaluated by MS excel 2010 and SPSS version 20 software. Paired-t test and unpaired-t-test were used to analyse the data. For pre and post comparison of within group, paired t-test was used and for the between group

comparison unpaired t- test was used 'p' value for analysed data was <0.05. Between Group Analysis of Group A And Group B For ODI Table.1 and graph.1 showed the pre-post intervention mean difference of ODI for group A and B unpaired t-test was used for analysis for data pre and post- test mean ± SD value for group A was 2.733±1.27988 and group B was 12.4667±5.05494. p value found was 0.000 and the p value considered was <0.05 which showed that there was a significant difference post intervention in both the group but group B result showed more improvement in ODI in comparison to GROUP A .Between Group Analysis of Group A And Group B For ODI Table.2 and graph.2 showed the pre-post intervention mean difference of VAS for group A and B. unpaired t-test was used for analysis for data, pre and post- test mean ± SD value for group a was0.6400 ±0.44849 and group B was0.44849 ±1.36678. p value found was 0.000 and the p value considered was <0.05 which showed that there was a significant difference post intervention in both the groups but group B result showed more improvement in VAS in comparison to GROUP A.

DISCUSSION

The current study show that a combined physiotherapy treatment for the reduced pain, increase range of movement, improve functional activity and can be assessed by VAS, ODI scores in patient with non- specific low back pain.
The present study was done on fabricator worker having occupational low back pain. The aim of the study to see the effect of ergonomic advice and ergonomic advice pulse physiotherapy intervention on pain and quality of life, range of motion and function in patient with non- specific low back pain. Where group A was received ergonomic advice and Group B was received ergonomic advice with physiotherapy intervention. The current result suggests that ergonomic advice pulse physiotherapy intervention is probably more effective than the ergonomic advice. However in both groups was received post intervention score for ODI and VAS. The study was concluded that the ergonomic advice and physiotherapy intervention showed significant improvement in ODI score and VAS scale; and mean value of pre- test ODI was 19.6000 and it improved to 7.1333; mean value of pre- test for VAS was 4.1400 and it reduced 1.5067. Murat dalkilinc, gonca bumin and hulya kaihan studied showed that preventive ergonomic training programs were effective in reducing the musculoskeletal pain, postural risk factors and work-related ergonomic and environmental risk factors. Sandipkumar. Parekh, Dr. N.R phatak studied showed that ergonomic plus physiotherapy intervention to give greater improvement in pain, and functional performance in chronic low back pain among fabricator worker. In both group, result showed that improvement in function disability range of motion, reduced pain. But ergonomic advice with physiotherapy intervention showed more effective than ergonomic advice.

CONCLUSION

In this study was aim to effect of ergonomic advice versus ergonomic plus physiotherapy on pain, functional disability and quality of life in low back pain among fabricator worker. It was conclude that group B (ergonomic advice with physiotherapy intervention) is more significant improvement for increased range of motion, decreased pain and improve functional disability than group B(ergonomic advice).

Limitation of the Study
➢ In this study only male patient is included.
➢ In this study sample size is very less.
➢ In this study treatment duration is small

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Table.1 Intergroup Comparison of Odi

GROUP	MEAN	±SD	T-VALUE	DF	P-VALUE
A	2.733	1.27988	7.229	28	0.000
B	12.4667	5.05494			

Table.2 Intergroup Comparison of Vas

GROUP	MEAN	SD	T-VALUE	DF	P-VALUE
A	0.6400	0.44849	5.367	28	0.000
B	2.6333	1.36678			
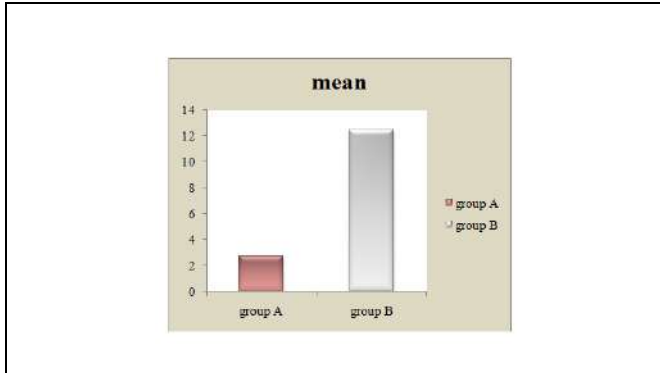
Graph.1 intergroup comparison of ODI
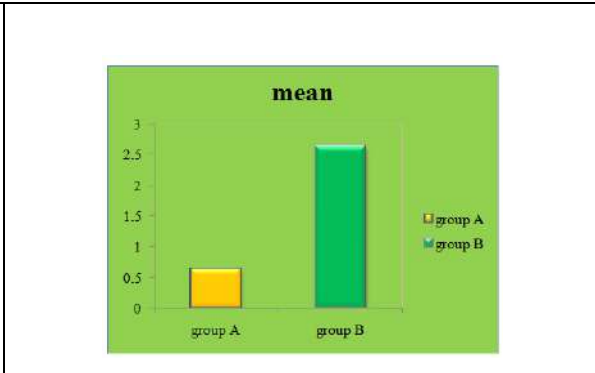
Graph.2 intergroup comparison of vas

Exercise 1: supine lying – Leg lifts

Exercise 2: isometric exercise of back

Exercise 3: trunk rotation

Exercise 4: spinal mobilization
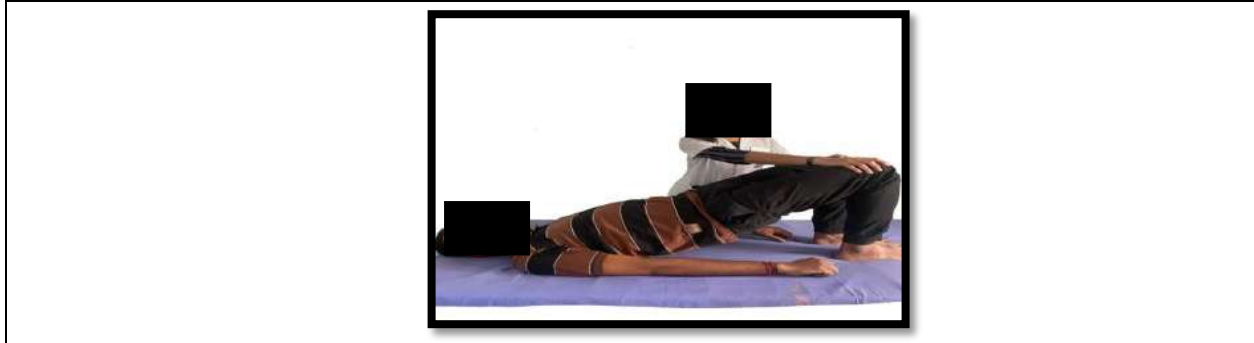
Exercise 5: trunk lift exercise

REVIEW ARTICLE

Freshwater Algal Diversity of the Northern Western Ghats of Maharashtra, India: A Review

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ABSTRACT

This is a comprehensive review survey of freshwater algae. A review study was undertaken for a better understanding of the freshwater algae diversity distribution of the Northern Western Ghats of Maharashtra. A survey study was embraced for a better comprehension of freshwater green growth. The algal flora documented regions of the Northern Western Ghats (NWG) such as Nandurbar, Dhule, Jalgaon, Nashik, Thane, Ahmednagar, Pune, Raigarh, Ratnagiri, Satara, Sangli, and Kolhapur district of Maharashtra State. Cyanobacteria, Chlorophyceae, and Bacillariophyceae were the most densely populated genera reported in NWG. A total of 2137 freshwater algae were recorded from various areas of the Northern Western Ghats of Maharashtra viz. Kolhapur (488), Nashik (474), Pune (346), Jalgaon (361), Dhule (306), Nandurbar (78), Dhule (47), Ahmednagar (35), and Satara (2). Diatoms belonging to the class of Bacillariophyceae total of 594 taxa were reported. Authors recently discovered new five species from the northern Western Ghats of India. The data acquired will be helpful in the abuse of freshwater algae for algal flora documentation, medicinal, biotechnological, and drug applications.

Keywords: **:** Northern Western Ghats, Freshwater algae, Documentation

INTRODUCTION

The Western Ghats is a major significant ecological region as it is one of the major biodiversity hot spots of the world. The Western Ghats are divided into three major parts such as Northern Western Ghats, Central Western Ghats, and Sothern Western Ghats (Figure 1) [1-5]. The main objective of the present review is to gather information on

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freshwater algal flora reported by researchers in past. The occurrence of a large number of algae in different parts of foreign, India and Maharashtra has been reported by various authors and this scientific knowledge is the result of many years of investigation. A brief account of algal biodiversity study in the Northern Western Ghats of Maharashtra where freshwater algae are extremely different in their form, color, habit, and habitats. F. E. Fritsch is known as the Father of Phycology. Classification of algae as per F. E. Fritsch (1935) in into 11 classes such as Chlorophyceae (Green algae), Xanthophyceae (Yellow-green), Chrysophyceae (orange algae), Bacillariophyceae (Diatoms/ yellow or golden brown algae), Cryptophyceae (nearly brown), Dinophyceae (dark yellow or brown), Chloromonadineae (bright green), Euglenophyceae, Phaeophyceae (brown algae), Rhodophyceae (red algae) and Myxophyceae (Cyanophyceae, blue-green algae) [6].The term 'Algae' refers to microscopically small, unicellular organisms, some are colonies form and thus reach sizes visible to the naked eye called macro algae forms.

 Microscopic algae organisms are generally finely dispersed throughout the water and may cause turbidity in water [7]. Algae of unusual habitats seen in nature such as benthic, epiphytic, periphyton, cryophytes, thermal algae, halophytic algae, lithophytes, and aerophytes. The epiphytic algae grow on a substratum, that substratum is specific such as tree trunk, stem, leaves, etc. [8-14]. Algae are the most widespread, cosmopolitan, and abundant photosynthetic autotrophic life existence in aquatic and terrestrial ecosystems. Freshwater ecosystems are varying in size and composition and contain a large diversity of organisms. Algae are a wide group of prokaryotic and eukaryotic autotrophic photosynthetic organisms found in many different forms such as unicellular cells, colonies, filaments, and macroalgae. They are found in freshwater bodies of nature like rivers, lakes, ponds, puddles, moist surfaces of soils, etc. Algae is an excellent bioindicator because of their cosmopolitan nature, abundance, eutrophication, and sensitivity to some chemical changes that happened in the environment [15-19]. Freshwater ecosystems, such as microalgae are resourceful and play a vital role in nutrient cycling. Algae are thallophytic and chlorophyll-bearing organisms thallus ranging from single-celled to multicellular or colonial forms that occur in aquatic ecosystems as well as terrestrial ecosystems. Algae is a primary producer, they can fix light energy through the process of photosynthesis and produce food material in the form of carbohydrates [20]. Algae are cosmopolitan in nature. Algae is a diverse group of autotrophic photosynthetic groups that ranges from freshwater, marine, desert, ice, and hot boiling springs. Algae thallus body structure from a single cell to complex multicellular.

 In nature, freshwater algae have played various environmental roles such as regarding nutrients recycling, primary producers level in the food chain, and the food web of water bodies and terrestrial regions; they are also very helpful tools for the evaluation of water quality [21]. Recorded some Cyanophyta freshwater algae of some selected regions Peruvannamuzhi forest and Janaki forest of Western Ghats Northern Western Ghats of Maharashtra [22]. Bacillariophyceae is commonly called the diatoms group. Diatoms are a significant group showed the link between autotrophic and heterotrophic organisms [23]. About 68 freshwater diatoms are recorded from the Panhalgarh Hill fort in the Kolhapur district and in that 23 are new records for India [24]. *Oricymba sagarensis* an endemic diatom has a reported distribution in the central and northern regions of the Western Ghats, India [25]. In this paper 402 taxa of diatoms documented in the Kolhapur district, have been recorded including 39 new species, 28 new varieties, and 14 new forms of division Chlorophyta [26]. The author recorded algal flora of Tapi river from Bhusawal town of Jalgaon district, Maharashtra 41 different algal species in that 32 species belong to Bacillariophyceae, 1 species Cyanophyceae, and 8 species to Chlorophyceae [27]. Cyanophyceae common algae commonly called blue-green algae were recorded in some taxa from the Suki Dam Soil, Jalgaon district, Maharashtra [28]. The author noted 21 taxa belonging to 2 genera of Euglenophyceae family of Yawal and Raver talukas, Maharashtra [29]. The macroscopic algae belong to class charophytes special empathies with *Chara* and *Nitella* genus reposted in some limited areas of Northern Western Ghats [26- 31]. Extensively carried out ecological studies of algae from Sonvad and Devbhane dam of Dhule district and reported a total of 306 algal taxa [32]. Canals of Wilson dam (Bhandardara dam) recorded 33 species belonging to the order Nostocales of which 20 are heterocystous and 13 are non-heterocystous [33]. Hydrobiological study of River Mutha, Pune, India [34]. The author noted four dominant genera from Jalgaon district of Maharashtra state viz. *Navicula, Cymbella, Gomphonema,* and *Nitzschia* belong to the family Bacillariophyceae [35]. Investigator recorded total 7 taxa belonging to *Oscillatoria* genera such as *O. geminate, O. fremyii*, *O. schultzii* var. *tergestina, O. margarififera, O. acuta, O. pseudogeminata* other than these seven taxa, more three

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taxa reported newly for Maharashtra such as *O. minimum*, *O. annae*, *O. limosa* var. *maxima* from Faizpur, Jalgaon District, India [36]. From Faizpur of Jalgaon district, Maharashtra noted about 117 algal species in these 91 algal species present in the acidic waste, 54 in alkaline waste, and 28 algal species in acidic as well as alkaline waste [37]. The author recorded 10 *Phacus* new species from Jalgaon district for the Maharashtra such as *P. segrettii P. acuminatus* var. *megapyrenoidea*, *P. rudicula*, *P. aenigmaticus*, *P.* agilis var. *okobojiensis*, *P. pulcherrimus*, *P. amoldii*, *P. cochleatus*, *P. helicoides*, and *P. longicauda* var. *insect* [38]. Dominant Chlorophycean and Cyanophycean algal class taxa were reported from some regions of Pune and Ahmednagar district, Maharashtra [39]. The author critically recorded 36 species belonging to the genus *Gomphonema* in new records from Jalgaon district, Maharashtra [40]. Reported 364 algal taxa which mainly belong to Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Eugleonophyceae form Girna reservoir of Nasik district [41]. From the north region of the Jalgaon district, about 26 unicellular Volvocales were recorded [42]. The author studied 45 species belonging to the blue-green algae, out of these 6 species were documented from Anjale, Jalgaon district, Maharashtra [43]. The investigator documented 13 taxa belonging to the family Nostocaceae, in which *Anabaena* was the dominant taxa from Dhule district, Maharashtra [44].

A total of 79 heterocystous and non- heterocystous ancient algae group Cynophyceae taxa was reported from the western region of Maharashtra [45].Total 539 algal taxa which mainly belong to Cynophyceae, Chlorophyceae, Bacillariophyceae, and Euglenophyceae reported from major lakes in Jalgaon district, Maharashtra (India) [46]. About 42 freshwater Diatoms species belonging to the four different genera such as *Anomoeneis*, *Caloneis*, *Diploneis*, *Neidium*, and *Stauroneis* recorded from the North Maharashtra region [47]. About 155 different diatoms taxa were recorded from the region of Junnar tehsil of Pune district, Maharashtra. During the year 2012 author identified algae up to the genus, species, variety as well as forma level and recorded taxa belonging to the family Oscillatoriaceae and Scytonemataceae from the order Nostocales of class Cyanophyceae; the family Oscillatoriaceae included 2 genera, 31 species while Scytonemataceae included only 1 genus and 6 species [48],[49]. In the year 2013 author investigated the algal population of Ambegaon tehsil, Pune district, and recorded 35 species, 3 varieties & 1 forma belongs 7 genera of family Oocystaceae of order Chlorococcales. During the investigatory author find out that *Oocystis* and *Tetraedron* frequently occurred [50]. In the year 2013 author find out 11 genera, 49 species, 11 varieties, and 1 forma belongs to the family Desmidiaceae. The frequently occurred genera such as *Closterium*, *Cosmarium*, and *Staurastrum* from Ambegaon tahsil, Pune [51].

 The important group Bacillariophyta belonging to 18 genera and 63 species has been recorded from Sakri and Navapur of Maharashtra state [52]. During the investigation author documented 21 species, belonging to 07 genera such as *Nostoc* (2), *Chroococcus* (2), *Merismopedia* (2), *Gloeocsapsa* (1), *Phormidium* (1), *Spirulina* (3), *Oscillatoria* (10) of Cyanophyceae of Abhora dam, Raver tahsil of Jalgaon district, Maharashtra [53]. A total of 18 freshwater diatoms were recorded from Rankala, Kalamba & Rajaram lakes of Kolhapur, Maharashtra [54]. About 78 different species, 6 varieties consisted belonging to 12 families from 9 orders of 4 classes from 3 divisions. Family Zygnemataceae includes 1 genus, 16 species, and 1 variety; while family Batrachospermaceae includes only 2 genera and 2 species; Spirogyra more predominantly occurred in the studied Junnar area [55]. About 344 different species, 99 varieties, 10 forma, 2 varieties belonging to 112 genera of 39 familes from 12 orders of 6 classes from 5 divisions. Here major taxa found belonging to the family Desmidiaceae include 10 genera, 38 species, and 9 varieties while the family Hyellaceae, Ceratiaceae, Chaetoceraceae, Chlorochytriaceae, Treubariaceae, Haematococcaceae and Chlorococcaceae [56]. About 45 genera of freshwater Diatoms were reported from the region of Haranbari dam of Baglan taluka, Nasik, (M.S.) India [57]. The genus *Luticola* D.G.Mann is one of the predominant genera observed in a soil sample of natural habitat [58]. About 13 genera belonging to Bacillariophyceae were reported from Panchgani, Satara district, Maharashtra [59]. The typification of *Luticola jogensis* and *Luticola gandhii*. In the genus *Navicula* Bory, were collected from Mahabaleshwar, the Northern Western Ghats of India. Specifically studied the dynamics of Chlorophyceae in phytoplankton of lake Varhala in Thane District, Maharashtra. They majorly reported Chlorophyceae Bacillariophyceae and Myxophyceae [4],[60]. During the survey, the author revealed the major Cyanophyta class of algae from Akkalpada dam, Dhule district. The author reveals the 15 genera and 34 species belonging to the class Cyanophyta, here observed genera such as *Osciallatoria*, *Aphanocapsa*, and *Merismopedia* were observed with more number species [61]. Two Charophytes were reported from Satara District [62]. The diatom genus *Luticola* under

nine different species recorded from the Northern Western Ghats of India, were used light microscopy and advanced scanning electron techniques [63]. The author investigated 8 genera, belonging to 15 species of Bacillariophyceae diatom class from Some Diatoms from the Nandurbar district [64]. *Navicula sensu stricto* described stream of the Kaas Plateau from the Northern Western Ghats of India [65]. Many workers including made attempts to study phytoplankton diversity of Benthic Algae of Junnar tehsil and also made attempts to study of algal diversity of families Naviculaceae and Cymbellaceae of order Pinnales of Pimplegaon joge dam from Junnar tehsil [55],[56],[66]. Eight taxa reported Euglenophyceae from Yawal and Raver talukas of Jalgaon district [67]. The Phytoplankton is unicellular, uniflagellate rigid with a true cell wall. The author reveals the 24 taxa during the investigation of *Phacus* genus from the region of the Nashik district [68]. Studied some aquatic macrophyte species of *Chara zylanica* L. and *Nitella mirabilis* L. from Bhandardara lake [69].

The author added new algal taxa to NWG
Recently described a new species, *Cryptomonas indica* from the Northern Western Ghats of India. These species described by using morphological and molecular characters [70]. Author recently described a new species, *Epithemia agharkarii* from the Mula river of Northern Western Ghats, India [71]. The three new diatoms discovered from the Northern Western Ghats of India, such as *Stauroneis datarii* sp. nov., *Stauroneis bahlsii* sp. nov., and *Stauroneis hamiltonii* sp. nov. coming under the genus *Stauroneis* Ehrenberg [72].

CONCLUSION

Algae are an excellent part of the freshwater ecosystem as they are a significant source of the food chain. This is evident from the review; the diversity of freshwater phytoplankton in the Northern Western Ghats of Maharashtra is strongly influenced by factors. Our review reveals a rich variety of freshwater algae in some districts such as Nandurbar (4 %), Dhule (2 %), Ahmednagar (2 %), Jalgaon (16 %), Nashik (22 %), Pune (16 %), and Kolhapur (23 %) (Figure 2) as well as in Bacillariophyceae class total 594 taxa (Figure 3) reported from the Northern Western Ghats of Maharashtra. Authors recently discovered new six species from the northern Western Ghats of India such as *Cryptomonas indica*, *Epithemia agharkarii*, *Stauroneis datarii* sp. nov., *Stauroneis bahlsii* sp. nov., and *Stauroneis hamiltonii* sp. nov. On the basis of existing review literature, more species of algae were reported in the Kolhapur district of Maharashtra.

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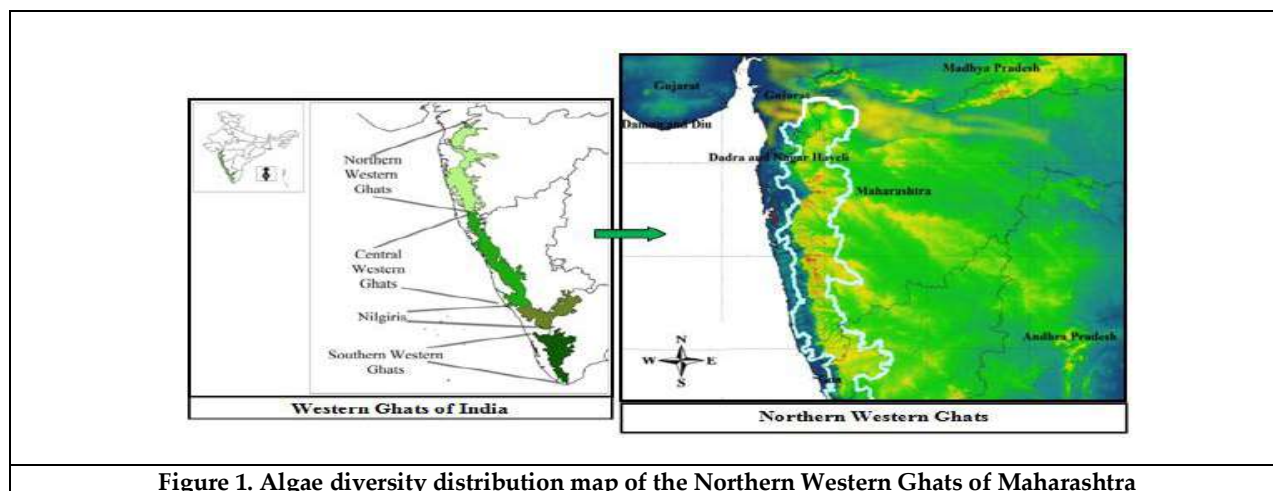
Figure 1. Algae diversity distribution map of the Northern Western Ghats of Maharashtra

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Figure 2. District wise algal taxa distribution in the Northern Western Ghats	Figure 3. Diatoms distribution in the Northern Western Ghats
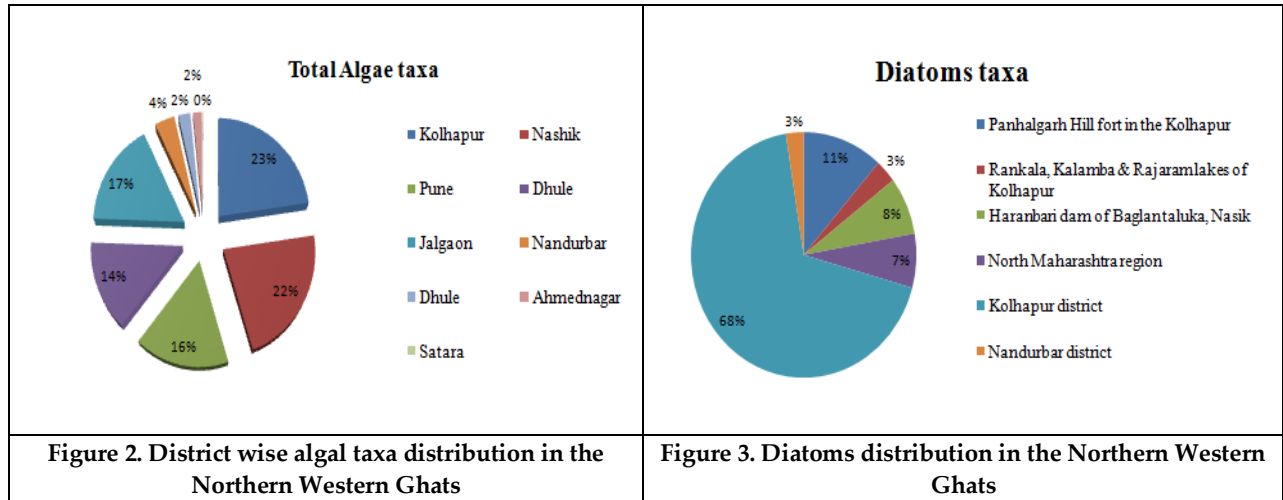
Teachers' Techno-Pedagogical Competencies in Social and Professional Contexts

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ABSTRACT

The widespread acceptance and application of technology in every discipline has led to a revolution in the digital field. Blended Learning/Hybrid Learning is a new style of learning that is now evolving as a result of the use of technology into the education sector. For this study, a descriptive survey was conducted on a sample of 47 teachers using both face-to-face and internet-based data collecting utilizing a standardized tool, the Techno-Pedagogical Competency Scale, designed and validated by Drs. S. Rajasekar and K. Sathiyaraj (2013). The results of the study revealed that there is a difference in techno-pedagogy competency among teachers based on social context, namely gender, but there is no significant difference based on the professional context of the teacher, namely teaching experience and holding a professional degree from a teacher education programme. According to the findings of the study, the new normal scenario in society following the Covid-19 pandemic prompted instructors and teacher educators to adopt digital platforms in order to develop alternative learning platforms for students.

Keywords: Technology, Pedagogy, Content, Competencies

INTRODUCTION

Technology is one of the important factors in today's modern world due to its continuous increase in the usage during the Covid-19 pandemic. Thus, it can be said that the information technologies will lead to have changes in not only in the area of communication but also in the field of learning and teaching (Erdogana& Sahin, 2010). Teachers presently play a significant role in education, serving as communicators, motivating factors, and promoters of humankind's eternal quest for knowledge. Furthermore, there was a period when teaching was regarded as an art, but with changes in societal needs as well as recent studies in the field of education, it can be claimed that teaching is

much more skillful in nature, requiring the training of individuals for the same (Dangwal & Srivastava,2016). According to the National Curriculum Framework (2005), ICT can also be used creatively for pre-service and in-service teachers' professional development and academic support. In this era of growth and development, teachers are expected to know how integrate various technologies in his/her subject in order to make the learning more worthful and optimal in nature. During the pre-service training of the individual there is definite development in the knowledge of the individuals as there is notion that during that particular period of training the exposure to the various ICT tools and techniques will definitely increase the interest and willingness to integrate technology in the classroom teaching (Sibichen, 2017). There is no doubt that technology will help in providing influential settings which is helpful in eliciting contemporary sights of teaching and learning but might not alter the belief and practice of teachers. In fact, that rest upon in what manner teachers will infer utilization of various tools and how they employed them for thetrans forming education in the real time teaching learning environment.

Kwong et al. (2007) done an experiment on the student teachers for the development of the Mathematics Pedagogical Content Knowledge. The investigators have taken a sample of 113 pre service teachers. The results of this investigation revealed that the student teachers' mathematics pedagogical content knowledge was generally insufficient at the beginning of their programmes as expected, and that after completing their mathematics pedagogy course, they showed significant improvement in all aspects of their MPCK. Erdogana& Sahina (2010) conducted a study of the association between the achievement levels and technological pedagogical and content knowledge of math teacher candidates' and revealed that there is significant difference amongst the different dimensions of TPACK in male and female teachers. It was also concluded in the paper that TPACK forms that base in order to increase the professional competencies of the teachers and will definitely be considered in the designing of teacher education programs. Joan (2013) examined the impact of learning package in e-content form in mathematics education for the future teachers by using an experiment design on a sample of 30 pre service teachers. The data was examined with the help of correlation and t-test which depicts that the learning package of e-content is effective than conventional method in teaching math education to pre service teachers. Besides this, this was also suggested in the study that sufficient training should be given to the prospective teachers to utilize the technological equipment. Prakash (2014) sought to explore the digital pedagogy arrival in the teacher education programme. It further explains that the simple usage and involvement of electronic tool within the teaching does means the digital pedagogy rather it requires specific skill and knowledge. Teachers integrate the technology in order to bring the educational change within the learning environment with a purpose to increase the optimal learning.

Thakur (2015) led the research work on the enlisting the challenges and role for the implementation of required techno-pedagogical skills at higher level of education. As per the insights of the researchers the most of the challenges which has been faced by higher education in the implementation of TPACK are insolvent ICT infrastructure, limited English language and online content competence, insufficient resources and consciousness among teachers, wrongdoings in research and innovation, tether while using software, confined techno-pedagogical assets, poor coordination among different department, common power cuts and fluctuations, and so on. Dangwal& Srivastava (2016) in their research paper tried to give insight about the digital pedagogy involvement in the teacher education and recommended that education for teachers must able for providing the suitable skills along with knowledge amongst the pre service teachers by infusing technology in an apt way as per pedagogy and the content. Qasem & Viswanathappa (2016) investigated the study that how approach of blended learning helps in developing the TPACK among teachers. The investigators have collected the data from a sample of 60 teachers' trainees of science by using the experimental design in the present study. The findings of the study explored that the teachers' ICT knowledge was above average in two groups, and there was a significant difference between the experimental and control groups on the ICT knowledge scale, indicating that TPACK is a useful tool for evaluating teacher knowledge in the field of technology integration. Sibichen (2016) in his research paper tries to discover skills in the techno-pedagogical aspects of students in teacher education programme at secondary level. The author has implemented survey method for the present study and results of the present research work revealed that significant difference in the techno-pedagogical skills of pupils who have done post graduate and those who have graduates only. Besides this it was also found that the significant difference was found between the students' teachers

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whosever attended some computer course and have not attended any computer course which enhance their learning, evaluation and techno-pedagogical skills. Byker et al.(2017) investigated the research study based on the perception of the teacher candidate's perception related to the educational technology and students' voice. For this purpose, the 63 teacher candidates' perception along with the practice for integrating digital technology and student voice had been taken as a sample. The mixed method design has been used by the authors in the present research work. The results revealed that the teacher candidates were disconnected as per their perception about what student voice is meant for and what different pedagogies have been taken into consideration to incorporated the students' voice with various digital technology. So, it was suggested in the research paper that such strategies should be adopted with in the teacher education programme which will provide guidance and help to the student teachers to integrate educational technology into their lesson plans so as to allow students for incorporating students' voice.

Leema and Saleem (2017), made a discussion concerning the perspectives and challenges of incorporating techno-pedagogy into the curriculum within the teacher education programme. Authors of the present research paper highlighted that revised and restructured curriculum of the teacher education programme definitely gave importance to the technological involvement but there are certain concerns like availability of the infrastructure, skill and competency among teachers, availability of time and resources etc. Yildiz (2017) used the descriptive research technique and examined the factors that influence preservice mathematics teachers' techno-pedagogical competencies and critical thinking skills. The data was collected from 552 pre service teachers studying in the elementary mathematics teaching undergraduate programs at four state universities. Albina (2018) experimented the e-content on the B.Ed. students in Teaching of mathematics education on a sample of 60 student teachers and emerged out with the findings that the e-content has provided the high level of academic achievement amongst pre service teachers. Further, it was also recommended that students teachers will be trained to give education by using various electronic mode so as to maximize learning. Kumar (2018) conducted a study for assessing the techno pedagogical skill of Hindi teachers from Kerala state revealed that there is a satisfactory skill of this framework but there is need to work more in this area as there is lack of awareness and knowledge among teachers related to this framework. On the other hand, Parkash & Hooda (2018) too found in their research work that the difference existed in competency of government and private school teachers with respect to their techno pedagogical skill. Along with this, this study tries to explore that there exists the difference in techno pedagogical competency skills as per gender of the teachers. In the research that was doneby Demirtaş & Mumcu (2021), the perception of pre service teachers with respect to the ICT and TPACK competencies emerged out with the findings that the pre service teachers do differ in proficiencies of TPACK and ICT with respect to grade, individual's professed potential to use technology whereas the difference has not seen in terms of gender.

 Further, it has been recommended in the present research study that teachers' perceptions of competence and pedagogical knowledge regarding the integration of ICT are significant while attempting to integrate ICT into teaching practices. Thappa & Bailya (2021) in their hypothetical paper made an effort to give the futuristic implications of the TPACK framework due to the immense infusion of technology in the teaching process. With this insight, the author(s) explained the framework along with its seven different components, besides this the importance of this framework is also described for different stakeholder who directly or indirectly involved in the field of education. Further, the present paper also recommended that curriculum and pedagogy to be reframed in pre service and in service programmes along with good infrastructural facilities and practical skill to be given with the respective teacher training programmes. Thappa & Baliya (2021) conducted research with the purpose of exploring the awareness of Technological Pedagogical and Content Knowledge in pre service teacher education programme. For this, the authors of the present paper employed descriptive exploratory research method on a sample 100 pre-service candidates both at under graduate and post graduate level. The findings of the study revealed that the students at under graduate as well as at post graduate level have individualized level of awareness about each component where as they were unaware of the integrated framework. It was also recommended that we should trained teacher with effective skill and competencies to integrate technology with respect to specific content of the appropriate pedagogy. In the light of the above review of the research paper it is evident to say that there is shift of role and responsibilities of teacher now a days or we can say in the post covid new learning environment that

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from imparting the mere content/subjective knowledge, teacher has to be competent and efficient enough to tackle the situation like as we are facing in the pandemic era at the global level. All the teachers at any level who belong to the field of education must know how built the interaction in three area related to technology, pedagogy and content. So, this paper made an attempt to know the TPACK competencies among teachers who are working at different levels and sectors in the field of education.

Theoretical Background

The techno-indulgence in the each and every field got much support and usage thereby leads to have a revolution in the digital field. Education sector also not untouched with this technological involvement thus, a new type of learning is now emerging that is Blended Learning/Hybrid Learning. It is time we took this critical moment as an opportunity to rethink our educational goals and possible pedagogies. With this in mind, it is necessary and urgent for teachers, educators, educational researchers and related stakeholders to keep up with the new normal in education. The scholarly field has examined the effectiveness of implementing sustainable and accessible learning models with the help of new technologies. It is important for educators to review and evaluate technology-based tools before implementing them in their classrooms to ensure that learning is optimized through the use of technology, and not just acted as empty expectation (Adams, 2019). As a result, any institution or educator intending to adequately implement technology into their programmes should use a model which is grounded on technological capabilities, pedagogical skills, content knowledge, and indeed the intersection of these bodies of knowledge(Trewartha, 2019).

Technological Pedagogical and Content Knowledge (TPACK)

Although the incorporation of technological components in to process of learning and teaching is indeed not novel, now it is being interwoven into some other crucial paradigm within education, Pedagogical And content Knowledge. Shulman was the first one to attempt to describe the PCK, then Mishra and Kohler (2006) added a new element called "Technology," that has become a fundamental aspect of daily activities in the development procedure. Because of its ever-changing and highly variable, technological inclusion in professional growth and progress of pre-service and in-service teachers is really a complicated task. As per the Mishra and Kohler (2006), there are three main components of the framework TPACK and also other four appeared out with an intersection and interaction as depicting in the figure 1:

- **Content Knowledge-** Content knowledge is related to a person's understanding of the subject matter or subject area which must be taught to the students.
- **Pedagogical Knowledge-** It incorporates understanding of a variety of methodologies, strategies, ideologies, laws, and principles that would be used in the classroom teaching and learning activities.
- **Technological Knowledge-** It focuses on the understanding of several advanced technologies that will also be implemented in education and make the attempting to teach process more effective and engaging, such as computers, mobile phones, tablets, instructional software and applications, so on and so forth.
- **Technological Content Knowledge-** It means that the students should also have the skills and knowledge to use a variety of accessible technologies in learning and teaching process, depending on the circumstances of the material and concept to be taught.
- **Technological Pedagogical Knowledge-** This includes the understanding regarding availability, elements, as well as the capabilities of technological applications in the context of teaching and learning.
- **Pedagogical Content Knowledge-** PCK exists at the nexus of pedagogy and content. Pedagogical Content Knowledge represents amalgamation of content and pedagogy into such an insight of where and how specific content material needs to be fully planned, adjusted, and expressed for lessons in front of students and therefore, seems to go much more than a basic cognizance of content and pedagogy in solitude from each other.
- **Technological Pedagogical and Content Knowledge-** The knowledge of in what way to combine technology with pedagogy and content domains is referred to as TPACK. Teachers should be able to utilize appropriate technologies to deliver content when they have a comprehensive understanding of the interaction between basic understanding of content and mastery of pedagogies.

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Online educationor any other sorts of technology-based teaching and learning is expected to be implemented as a consequence of the pandemic; teachers in such circumstances will have to make the necessary modifications (Chen & Hsu, 2021). The widespread COVID-19 pandemic has transformed conventional instructional activities to a digital manner of teaching process. This transformation not just to emphasizes the significance of the nation's educational facilities, but it also urges for instructors to successfully implement technologies within existing instructional strategies in improving students' academic learning. (Akram et al, 2021).

Statement of the Problem
The TPACK knowledge is the great as well as effectively model of the technology component along with the appropriate instructional methods of the specific content or material. Being a teacher of 21st century requires the extraordinary hands in the Knowledge, Skill and Aptitude of the digital innovation with which the learning become more interesting and effective thereby completing the desirable objectives of education. It definitely requires the instructors, teacher and other educators to a combine all the interconnections among material, instructional approach, creativity, and contextual knowledge. As a result, the study was entitled as Teachers' Techno-Pedagogical Competencies in Social and Professional Contexts.

Objectives of the Study
- To examine the techno-pedagogical competencies of in-service teachers.
- To find the difference in the techno-pedagogical Competencies among teachers with respect to gender, teaching experience and professional qualification.
- To suggest some educational implications regarding technological pedagogical competencies for teachers

Hypotheses of the Study
1. There is no significant difference in the techno-pedagogical competencies between male and female teachers.
2. There is no significant difference in the techno-pedagogical competencies between teachers with less than 10 years of teaching experience and with more than 10 years of teaching experience.
3. There is no significant difference in the techno-pedagogical competencies between teachers who have possessed the professional degree and have not possessed the professional degree in teaching.

RESEARCH METHODOLOGY AND PROCEDURES

In the present research work, the author has employed the descriptive survey method with both the medium that by face to face and by internet survey method.

Sample of the Study
The sample of 47 teachers, with different background and levels were selected by using simple random technique. These teachers were working in areas of Jammu region and in different sector of education like higher education, private sector, government sector and other educational sectors.

Tool Used
Techno-Pedagogical Competency Scale which was developed and validated by Dr.S.Rajasekar & K.Sathiyaraj (2013) employed by the author(s) for the data collection of the present research work.

Analysis and Interpretation
As per the table 1, it was revealed that the mean and standard deviation of techno-pedagogical competencies for the female teachers is 124.58 &29.36 respectively whereas the mean and standard deviation of male teachers is 139.00 & 20.69 respectively. Hence, the calculated t-value related to social variable viz gender is 1.96 that is equal to the counter value of 0.05 level of significance, therefore the difference in Techno-pedagogical competencies between

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male and female teachers derived out to be significant at 0.05 level. This leads to reject the hypothesis 1 of the study stating that there is no significant difference in techno-pedagogical competencies between male and female teachers. As you can see in the table 2, the mean &standard deviation of techno-pedagogical competencies for teachers who have less than 10 years of teaching experience is 124.62& 26.65 respectively whereas the mean and standard deviation of teachers who have teaching experience equal to or more than 10 years is 133.42& 27.70 respectively. The calculated t-value related to teaching experience is 1.106 which is lesser than the table value of 0.05 level of significance, therefore, it can be said that the difference in Techno-pedagogical competencies between teachers who have less than 10 years of teaching experience and more than 10 years of teaching experience teachers is not significant even at 0.05 level. This leads to accept the hypothesis 2 of the study stating that there is no significant difference in techno-pedagogical competencies between teachers who have less than 10 years of teaching experience and more than 10 years of teaching experience.

Data in the table 3 depicted that the mean and standard deviation of techno-pedagogical competencies for teachers who possess the professional degree is 124.87 & 29.69 respectively whereas the mean and standard deviation of teachers who have not possessed the professional degree in teaching 137.65 & 21.08 respectively. The calculated t-value related to professional qualification is 1.71 which is less than the table value1.96 at 0.05 level of significance, therefore, it is said that the difference in Techno-pedagogical competencies between teachers who possess the professional degree and who have not possessed the professional degree in teaching is not significant even at 0.05 level. Consequently, led to accept the hypothesis 3 of the study stating that there is no significant difference in techno-pedagogical competencies between teachers who possess the professional degree and have not possessed the professional degree in teaching.

DISCUSSION AND RECOMMENDATIONS

According to the findings of the study, there is a considerable disparity in techno-pedagogical competences among teachers based on gender at 0.05 significance level which goes with findings of Sang et. al., 2009; Lin et. al., 2013; Parkash & Hooda, 2018. Sang et. al., 2009 recommended in their research study that this difference may get vanished once the mediating factors like computer efficacy and attitude of the teacher to use it has been increased with various programme both at pre-service as well as in-service level of teacher education programme. On the other hand, when we talk about the difference of the techno-pedagogical competencies in terms of teaching experience, this was found that there is no such significant difference has been seen so as to develop these competencies during the growth and development of an individual being a teacher in the profession. So, it implies that the In service training does makes any difference with the professional growth of teachers. Here, it actually raised a challenge that there is dire need to revive or go through the current ongoing in-service practices in teacher education programmes at different levels and sectors so that it will develop such digital competencies as per the need and demand of the post covid new normal learning environments. It was suggested that teacher should be a competence instructional designer of learning and have knowledge, understanding and skill in three prominent fields in which they will have theconceptual level understanding of the specific subject matter, instructional strategies and the science of the teaching design so we have to rethink about continuing professional practices i.e., in-service education. (Kirschner, 2015).

Further, the present study also revealed that there did not exist any difference significantly between teachers who possess the professional degree in teaching profession and who have not possessed any professional degree in teaching which indicates that there is a gap between theory and practice in the pre service teacher education programme which goes with the finding of Nautiyal & Sinha (2015) and rethink about the pre service teacher education programme (Kirschner, 2015). The pre service teachers are reluctant in using the digital platforms foe teaching learning may have different factors related to material and non-material context like technology fear, infrastructure, less opportunities and so on (Thappa &Baliya, 2021). It's also noteworthy that pre-service teachers' TPACK competencies are connected with their attitude toward technology, use of technology, as well as digital

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literacy skills and methods for online learning and teaching (Altun, 2019).Further, it was also revealed that potential teachers graduate from education faculties with insufficient knowledge and skills for effectively use of technology in educational settings, failing to integrate technology and pedagogy principles while they begin their tasks. Under this context, prospective teachers should be trained in the use of technology and teaching methods before commencing his or her professional responsibilities. Such training exercises can be performed out not only by revising current course materials, but also by adding new ones (Sezer, 2015). This can also be done by designing and developing the model and ideal modules in different subject by various agencies in order to integrate the digital platform successively in teaching learning process (Thappa & Baliya, 2021).

CONCLUSION

As per findings of the study, it was revealed that the new normal situation in the country led the teachers of the country to adapt the digital platforms to make the alternate learning for the students. But there exists a gender difference in terms of techno-pedagogical competencies among teachers working at different levels and sectors of education. Besides it is also evident that proper training of the teacher both at pre service as well as in service needs reflection so that efficient skills and pedagogy can be develop during their professional growth.

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Table 1: Depicting the t-value of Techno-pedagogical Competencies with respect to Gender

Variable under Study		Mean	S. D	t-value	Result
Gender	Female	124.58	29.36		Hypothesis 1 rejected
	Male	139.00	20.69	**1.96***	

Significant at 0.01 level　　　　　　　　* Significant at 0.05 level**

Table 2: Depicting the t-value of Techno-pedagogical Competencies with respect to Teaching Experience

Variable		Mean	S. D	t value	Result
Teaching Experience	Less than 10 years	124.62	26.65		Hypothesis 2 accepted
	More than 10 years	133.42	27.70	**1.106**	

Significant at 0.01 level　　　　　　　　* Significant at 0.05 level**

Table 3: Depicting the t-value of Techno-pedagogical Competencies with respect to Qualification

Variable		Mean	S. D	t value	Result
Qualification	With Professional Degree	124.87	29.69		Hypothesis
	Without Professional degree	137.65	21.08	1.71	3accepted

Significant at 0.01 level　　　　　　　　* Significant at 0.05 level**

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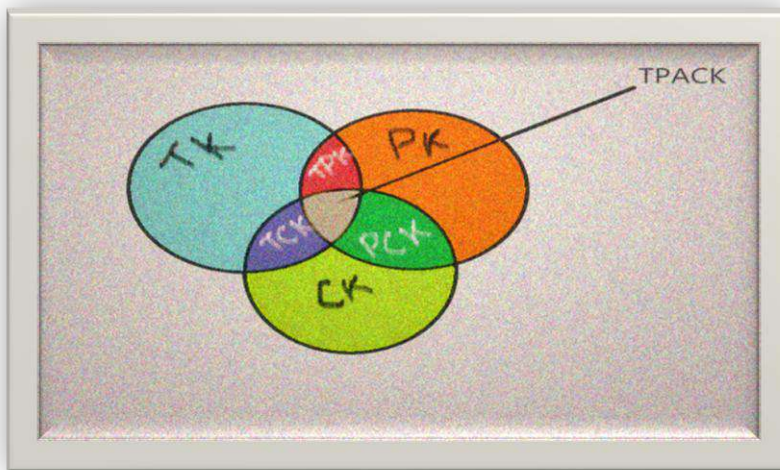
Figure 1. Showing the Components of Technological Pedagogical and Content Knowledge

RESEARCH ARTICLE

Dilute Acid Pre-Treatment Technology for Mixed Algal Biomass for Lipid and Fermentable Sugars based Biofuel Production

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ABSTRACT

The utilization of biomass for biohydrogen production is a promising option to generate alternative energy. The composition and complex structure of biomass are the major hurdles for its utilization as a substrate in biohydrogen production. To release the fermentable sugars for the production of biohydrogen, it is imperative to hydrolyze the biomass by using various pre-treatment processes. In this study, mixed algal biomass was pre-treated with acid (0.5-3.5%, v/v) H_2SO_4 to release the fermentable sugars. The results obtained indicated that acid pre-treatment with 2.5 % (v/v) is most suited for hydrolysis of algal biomass for biohydrogen production. The economics of pre-treatment is also discussed in this paper.

Keywords: Algal biomass, Carbohydrate, Pre-treatment, Acid hydrolysis, Economics.

INTRODUCTION

Hydrogen, is considered as a clean energy carrier having potential to replace fossil fuels [1]. It has high energy density of 142 kJ/g [2]. It could be produced by biological methods involving bio-photolysis, photo-fermentation and dark fermentation [3]. The rate of H_2 production depends upon the nature of substrate and method employed. To lower down the production cost, abundant and inexpensive substrates e.g. glycerol, glucose, and cellulose could be utilized for biohydrogen production [4, 6]. Algal biomass has great potential to replace feedstock for producing biofuels as a renewable energy source [7]. Bio-hydrogen, biodiesel and bio-oil are various biofuels being produced using algal biomass [8]. The substrate pre-treatment, a crucial step in bio-hydrogen production, breaks the algae cell wall releasing fermentable sugars [3, 9]. As the complex biopolymers like microfibrillar polysaccharides, matrix

polysaccharides and proteoglycans lead to the recalcitrant nature of cell wall which acts as a major obstruction in the production process. Besides dilute acid, there are various other chemical pre-treatment agents such as concentrated acid, alkali, BES, BESA, chloroform, iodopropane, acetylene, etc. but amongst all dilute acid hydrolysis is widely preferred pre-treatment method for algal biomass due to its low cost and high efficiency [3]. During acid pre-treatment, the acid concentration is one of the significant factor that can affect the release of fermentable sugars and conversion yield. The acid H_2SO_4, most commonly used acid for pre-treatment as the anion (SO_4^{2-}) released during pre-treatment acts as the nutrient for algal biomass growth [10]. Thus, the main objective of the present work is to optimize the acid concentration (v/v) for efficient pre-treatment of algal biomass. Also, the economics of pre-treatment is described in brief. This study will contributes to the development of a cost-effective and commercial outlook for the efficient pre-treatment of algal biomass in near future.

MATERIALS AND METHODS

Biomass
Mixed algal biomass, used in this experiment was collected from Chilika lake and local rice field of Odisha. The collected algae samples were cleaned by removing sand and other undesirable particles by using water. The samples were purified by repetitive sub-culturing on solid (soft agarose, 0.8%) and liquid culture media alternately. In order to reduce contaminants, a two-step centrifugation was adopted. The sample (1 mL) was centrifuged (150 g for 30 min, at 20°C), followed by high-speed centrifugation (1000-4000 g for 5 min, at 20°C). The surface layer was withdrawn with a micropipette and plated on BG-11 agar plate and incubated at $25 \pm 0.5°C$. After incubation for 10-12 days, a contaminant-free individual colony was picked up and transferred to the culture tubes containing 10 mL BG-11 medium.The BG-11 medium contains: 0.075g $MgSO_4.7H_2O$; 0.036 g $CaCl_2.2H_2O$; 0.04 g K_2HPO_4; 6.0 mg citric acid; 1.0 mg EDTA; 6.0 mg ferric ammonium citrate; 0.02 g Na_2CO_3 and 1 mL of trace metal solution. The trace metal solution contains: 2.86 mg H_3BO_3; 0.222 mg $ZnSO_4.7H_2O$; 1.81 mg $MnCl_2.4H_2O$; 0.39 mg $Na_2MoO_4.2H_2O$; 0.079 mg $CuSO_4.5H_2O$ and 0.0494 mg $Co(NO_3)_2.6H_2O$ per 1L. The culture was illuminated with cool white fluorescent lights (80 µmol of photons/m²/s, 18 h light/6 h dark). The basal culture medium and glassware were sterilized at 1.0546 kg cm⁻² (15 lbs) and 121°C for 15 minutes.

Dry weight analysis
The wet biomass was lyophilized to obtain a volumetric biomass dry weight and was subsequently used for compositional analysis. The biomass was diluted with DI water to make up (solid to liquid ratio, 1:15, w/v) the final volume of working stock solution for all pre-treatment experiments.

Analytical techniques
Protein analysis
The total intracellular protein contents were determined by Lowry *et al.* (1951) utilizing bovine serum albumin (BSA) used as standard as it is widely available in high purity and cost-effective [11].

Carbohydrate analysis
The total carbohydrate analysis was done by using phenol-sulfuric method, according to (Dubios*et al.*, 1956) with glucose as a standard. In brief; algal biomass hydrolyzed with 1M Sulfuric acid in autoclave- centrifuged (2000 rpm) for 10 min and then 1ml of supernatant reacted with 1 ml of 5 % phenol solution and 5 ml of conc. Sulfuric acid to create a characteristic yellow-orange colour. The absorbance was measured at wavelength of 490 nm with UV/VIS spectrophotometer [12].

Lipid analysis
Lipids were measured in triplicate as fatty acid methyl esters in both biomass and oils, through an in situ FAME preparation method (Laurens *et al.*, 2012). In brief, 4–7 mg of lyophilized microalgae biomass or extracted oil was added to a pre-weighted GC vial. An internal standard tridecanoic acid methyl ester, chloroform/ methanol (2:1) and

HCl methanol solution (5% v/v) was added the solution was heated at 85 °C for 1 h, extracted with 1 mL of hexane and analyzed by GC-FID with a DB-WAX column (Agilent, USA), 30m0.25mm ID and 0.25 μm FT, temperature program 100 °C for 1 min, then 25 °C min−1 to 200 °C, hold for 1 min, then 5 °C to 250 °C and hold for 7min, at a 1 mL/min He constant flow. The individual FAME concentrations was quantified using Chemstation B.04.02 (Agilent, USA), and normalized against the internal standard tridecanoic methyl ester [13].

RESULT AND DISCUSSION

Algal biomass pre-treatment

Prior to use of algal biomass as substrate for fermentation, algal biomass was pre-treated with different concentrations of acid. The parameters investigated are type of acid used [sulfuric acid (H_2SO_4)] and concentrations of acid [0.5%, 1%, 1.5%, 2%, 2.5%, 3%, and 3.5% (v/v)]. A sample without any acid pre-treatment was used as control.

Acid hydrolysis of algal biomass

The purpose of acid hydrolysis was to disorganize the polysaccharide complex, making algal sugars more amenable to acid hydrolysis. The Algal biomass hydrolysate followed by hydrolysis with H_2SO_4 concentrations (0.5-3.5%, v/v) for 60 min at 121° C temp, 15 lb/inch^2 pressure. Figure 1showsthe amount of protein obtained at different concentrations of H_2SO_4. The amount of protein obtained increases with increase in H_2SO_4 concentration. The maximum amount of protein obtained was 38% at 2.5%, v/v H_2SO_4. At 3.0%, v/v H_2SO_4 concentration, the protein release decreased to a value of 27% and further decreased to 22% at 3.5%, v/v H_2SO_4 concentration. Figure 2shows the variation in carbohydrate content released at different acid concentrations. The highest amount of carbohydrate content i.e. 16% was obtained at 2.5%, v/v H_2SO_4 concentration and decreased with further increase in acid concentration. Figure 3shows the lipid content release at different acid concentration. The highest amount of lipid (7%) was obtained at 2.5% and 3% acid concentrations and then decreased with further increase in acid concentration. The decrease in protein, carbohydrate and lipid content for H_2SO_4 concentrations above 2.5%, might be due to the formation of inhibitory by-products during hydrolysis.

ECONOMIC ANALYSIS OF PRE-TREATMENT PROCESS

Sustainable production of biohydrogen requires intensive pre-treatment technology for effective recovery of fermentable sugars without decomposition [3]. The selection of pre- treatment technology is a crucial step in biohydrogen production as the pre-treatment contributes about 30-35% of overall H_2 production cost. The economic assessment of pre-treatment process (figure 4). It involves the calculation of yield, economic parameters and cost associated with the capital and operation expenditures. Economic drivers influenced by pre-treatment are yield of (both five and six carbon) sugars, solids concentration, enzyme loading and its activity. Low cost pre-treatment reactors in some pre-treatment processes are often counterbalanced by higher costs associated with pre-treatment catalyst recovery or higher costs for final product recovery [14].Among the various pre-treatment methods, acid pre-treatment method has received considerable attention [15]. The main aspects of acid pre-treatment process (figure 5). It has been implemented in many pilot and commercial-scale facilities, primarily due to its cost-effectiveness and easy availability of acid [16, 17]. Furthermore, in addition to disrupting the cell wall of algal biomass, acid itself hydrolyze the biomass to release fermentable sugars [18]. Baral and Shah (2017) reported that the annual operating cost was minimum for acid pre-treatment ($145 million) as compared to other pre-treatment methods of steam explosion ($153 million), AFEX ($240 million), and biological pre-treatment ($547 million) [19]. Thus, each pre-treatment has its own limitation in economical perspective However, there is still a significant scope to reduce the operating costs of acid pre-treatment through systematic optimization studies.

CONCLUSION

This study proved that the dilute acid pre-treatment of mixed algal biomass is more effective over concentrated acid. The use of dilute acid is an environmental friendly and cost-effective approach for biomass pre-treatment. The study

showed that the hydrolysis of mixed algal biomass with 2.5% (v/v) H_2SO_4 at 121°C for 60 min. is most effective in releasing the fermentable sugars from the biomass. The result suggested that the pre-treatment resulted into the release of maximum protein, carbohydrate and lipid along with the lesser amounts of inhibitory by-products formation.

CONFLICT OF INTEREST
There were no conflicts of interest among the authors.

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Table 1: Comparison of some pre-treatment methods.

Pre-treatment process	Operational cost	Sugar recovery	Applicability to wide range of biomass	Pilot scale operation	Additional remarks	References
Dilute Acid	Low	90% (approx.)	Yes	Yes	No acid recovery steps are required	[20]
Hot liquid	High	61.4%	No	Yes	High H_2O consumption and energy input	[21]
Microwave	High	73-89%	Yes	Yes	Increase sugar recovery than the conventional heating process	[22]
Ionic liquid	High	83.7%	-	-	Cost of ILs is very high	[23]
Ozonolysis	High	88.6%	No	No	O_2 and electricity cost around 0.135 €/kg of ozone generated	[24]

Figure 1: Protein content of algal biomass hydrolysate following hydrolysis by H₂SO₄.

Figure 2: Carbohydrate content of algal biomass hydrolysate following hydrolysis by H₂SO₄.

Figure 3: Lipid content of algal biomass hydrolysate following hydrolysis by H₂SO₄.

Figure 4: Outline showing the economic assessment of pre-treatment process.
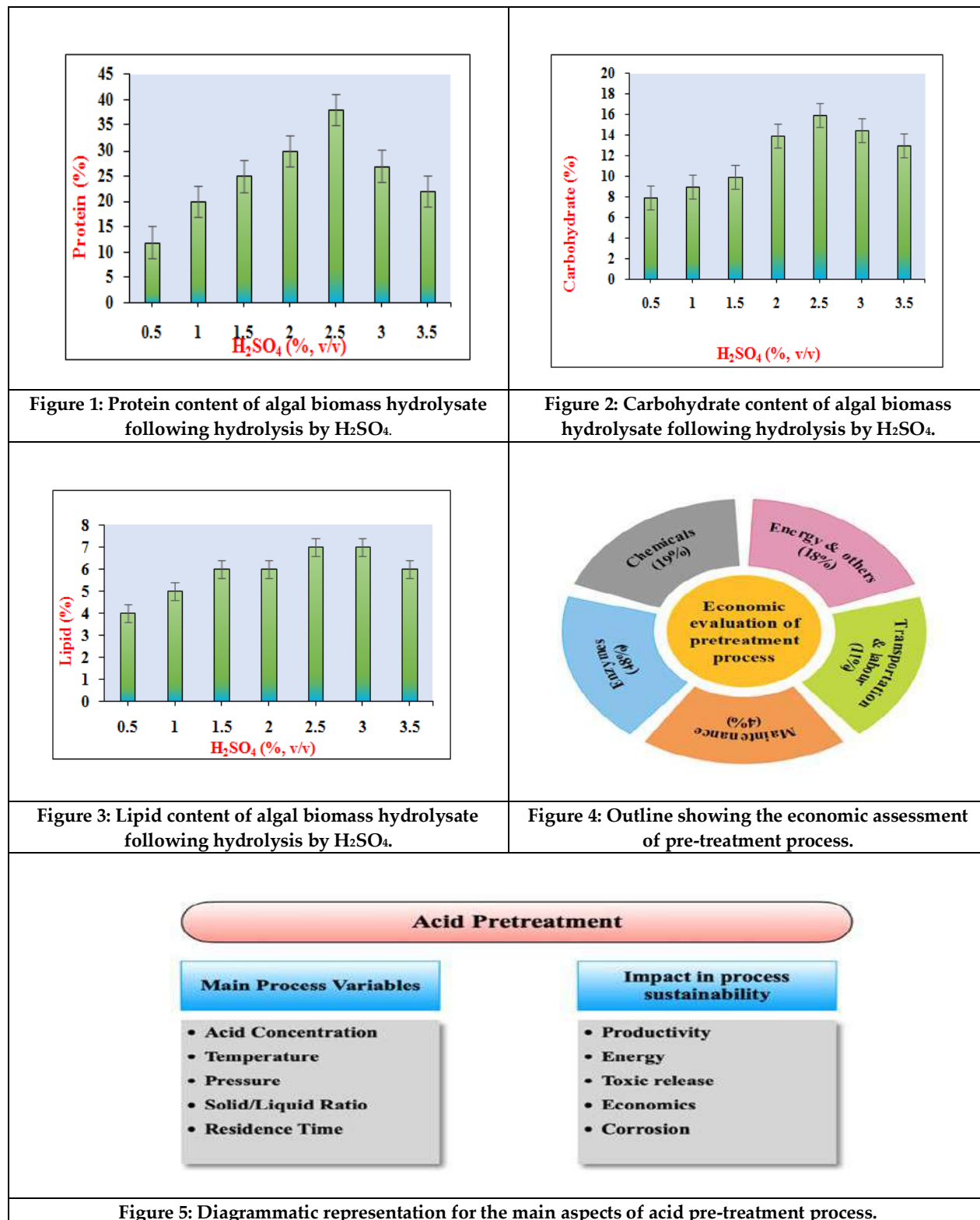
Figure 5: Diagrammatic representation for the main aspects of acid pre-treatment process.

Right M-Ideals in Semirings

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ABSTRACT

The notions of right-ideal and left-ideal in semiring is generalized into right m-ideal and left n-ideal. The relationship between right m(left n)-ideals with (m,n)bi-ideal and (m,n)quasi-ideals are established. The regular semiring is characterized by right m-ideals and left n-ideals.

Keywords: Quasi-ideal, (m, n)quasi-ideals, (m,n) bi-ideals, right m-ideals, left n- ideals

INTRODUCTION

Chinram[5] generalized right(left)-ideal into right m(left n)-ideal. But it coincides with right ideal if S has unit element since $S^2 = S$. On this line, we generalize right-ideal into right m-ideals which varies even if S has unit element. In this paper, right and left-ideals are generalized which is generalization of right(left)-ideal and right m-ideal by Chinram[5].

Preliminaries
By a semiring, we mean $(S, +, .)$ in which $(S, +)$ is commutative semigroup and $(S, .)$ is a semigroup that satisfy two distributive laws. A is a subsemiring [SS(S)] of S if it is itself a semiring. A additive subsemigroup R of $S(R \in ASS(S))$ is called right(left)ideal (RI(S))[LI(S)] if $RS \subseteq S(SR \subseteq S)$. A $Q \in SS(S)$ is called quasi-ideal if $QS \cap SQ \subseteq Q$. An element a of a semiring A is called regular if $axa = a$ for some $x \in A$.

Right m-ideals.

Here, we generalize right(left) into right m(left n)-ideals:

Definition 3.1 A $R \in ASS(S)$ is said to be $R \in RmI(S)[LnI(S)]$ if $R^m S \subseteq R(SR^n \subseteq R)$ for the positive integers m and n.

Definition 3.2 [2] A $Q \in SS(S)$ is said to be $Q(m,n)I(S)$ if

$Q^m S \cap SQ^n \subseteq Q$ for the positive integers m and n.

Definition 3.3 [1] A subset B of S is called $(m,n)BI$ if i)$B + B \subseteq B$ ii)$B.B \subseteq B$ iii)$B^m SB^n \subseteq B$, for positive integers m and n

Theorem 3.4 The $\{r_1 a + r_2 a^2 + \ldots + r_m a^m + a^m S | r_i \in \mathbb{Z}^*\}$, is RmI(S) generated by 'a' denoted by $\langle a \rangle_{r-m}$.

Proof: Let $R = \{r_1 a + r_2 a^2 + \ldots + r_m a^m + a^m S | r_i \in \mathbb{Z}^*\}$

For $x, y \in R$, $x + y = (r_1 + t_1)a + (r_2 + t_2)a^2 + \ldots + (r_m + t_m)a^m + a^m S \in R$

$X \cdot y = \{r_1' a^2 + r_2' a^3 + \cdots + r_{m-1}' a^m + a^m S + a^m S(r_1 a) + \cdots + a^m S(r_m a^m) + a^m S a^m S | r_i' \in \mathbb{Z}^*\}$

$\quad = \{r_1' a^2 + r_2' a^3 + \ldots + r_{m-1}' a^m + a^m S + (r_1 a + \ldots + r_m a^m)a^m S\} + a^m S$

$\subseteq \{r_1' a^2 + \cdots + r_{m-1}' a^m + a^m S | r_i' \in \mathbb{Z}^*\}$

$\subseteq R$

$R^m = \{r_1 a + r_2 a^2 + \ldots + r_m a^m + a^m S\} \ldots \{r_1 a + r_2 a^2 + \ldots + r_m a^m + a^m S\}$ m times

$\quad = \{r_1' a^m + r_2' a^{m+1} + \ldots + r_m' a^{m^2} + a^i (a^m S)^{m-i} + (a^m S)^{m-j} a^j + (a^m S)^m | i,j = 1$ to $m-1\}$

If $1 \leq i \leq m$, $a^i (a^m S)^{m-i} \subseteq a^m S$

$x \in a^i (a^m S)^{m-i}$ implies $a^m (a^k S) \subseteq a^m S$

Thus, $a^i (a^m S)^{m-i} \subseteq a^m S, i = 1$ to $m-1$

Similarly, $(a^m S)^{m-j} a^j \subseteq a^m S, j = 1$ to $m-1$

$y \in (a^m S)$ implies $y^m = a^m (s_1 \ldots a^m s_1) \in a^m S$

Then, $(a^m S)^m \subseteq a^m S$

Therefore, $R^m S \subseteq a^m S \subseteq R$.

Thus, $R \in RmI(S)$.

Suppose that $B \in RmI(S)$ containing 'a', then $a^k \in B$ for all $k = 1$ to m. Now, $a \in B$ implies $a^m S \subseteq B$, then $R \subseteq B$.

Therefore, $R \in RmI(S)$ generated by 'a'.

Corollary 3.8 If $A \subseteq S$, then $A + AS + \ldots + A^m S \in RmI(S)$ generated by A.

Theorem 3.6 If $Q \in RmI(S)$, then $Q \in Q(m,n)I(S)$ for all n.

Proof: For any $Q \in RmI(S)$, $Q^m S \cap SQ^n \subseteq Q^m S \subseteq Q$ implies $Q \in Q(m,n)I(S)$.

Theorem 3.7 If $R \in RI(S)$ then $R \in RmI(S)$ for all $m \geq 1$.

Proof: For $R \in RI(S)$, $R^m S \subseteq RS \subseteq R$ for all $m \geq 1$.

Corollary 3.8 If $R \in RjI(S)$, then $R \in RmI(S)$ for all $m \geq j$.

Theorem 3.9 If $A \in RjI(S)$ and $B \in RkI(S)$, then $A \cap B \in RmI(S)$ for all $m \geq \max\{j,k\}$. **Proof:** By Corrollary 3.5, $A, B \in RmI(S)$ for $m \geq \max\{j,k\}$

$(A \cap B)^m S \subseteq A^m S \subseteq A$ and $(A \cap B)^m S \subseteq B^m S \subseteq B$ imply $(A \cap B)^m S \subseteq A \cap B$.

Corollary 3.10 $\bigcap_{i \in \mathbb{Z}^*} R_i \in RmI(S)$ if $R_i \in RmI(S)$ for all i.

Remark 3.11

(i)Chinram[5] defined RmI(S) as : "A $R \in SS(S)$ is called RmI(S) if $AS^m \subseteq A$".

But it coincides when S has unit element.

(ii)Every RmI(S) by Chinram[5] is also RmI(S) by us since $R^m S \subseteq RS^m \subseteq R$.

(iii)Example 3.12 contrasts RmI(S) by Chinram[5] from RmI(S) by us.

(iv)Example 3.12 contrasts RmI(S) from RI(S).

Example 3.12

Let, $S = \left\{ \begin{pmatrix} x_1 & x_2 & x_3 & x_4 \\ 0 & y_1 & y_2 & y_3 \\ 0 & 0 & z_1 & 0 \\ 0 & 0 & 0 & z_2 \end{pmatrix} | x_1, x_2, x_3, x_4, y_1, y_2, y_3, z_1, z_2 \in \mathbb{Z}^* \right\}$

Consider, $R = \left\{ \begin{pmatrix} 0 & a & b & 0 \\ 0 & 0 & c & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} | a, b, c \in \mathbb{Z}^* \right\}$ in S

Clearly, $R \in R2I(S)$.

Now, $RS = \left\{ \begin{pmatrix} 0 & ay_1 & ay_2 + bz_1 & ay_3 \\ 0 & 0 & cz_1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} | ay_1, ay_2 + bz_1, ay_3, cz_1 \in \mathbb{Z}^* \right\}$

implies that $R \notin RI(S)$. Now $S^m = S$ for all m, implies $R \notin RmI(S)$ by Chinram[5] for any m.

Theorem 3.13 Every $B \in RmI(S)$ is a $(m, n)BI$.
Proof: For $RmI(S)$, $B^m SB^n \subseteq B^m SS \subseteq B^m S \subseteq B$.
Thus $B \in (m, n)BI(S)$ for all n.

Left n-ideals.
Here we generalize left(right) into left n(right m)-ideals:
Theorem 4.1 The $\{t_1 a + t_2 a^2 + \dots + t_n a^n + Sa^n | t_i \in \mathbb{Z}^*\}$ is $LnI(S)$ generated by 'a' denoted by $\langle a \rangle_{l-n}$
Proof: Let $L = \{t_1 a + t_2 a^2 + \dots + t_n a^n + Sa^n | t_i \in \mathbb{Z}^*\}$
For $x, y \in L$, $x + y = (t_1 + p_1)a + (t_2 + p_2)a^2 + \dots + (t_n + p_n)a^n + Sa^n \in L$
$\qquad x \cdot y = \{t_1' a^2 + t_2' a^3 + \dots + t_{n-1}' a^n + Sa^n + (t_1 a)Sa^n + \dots + (t_n a^n)Sa^n + Sa^n Sa^n | t_i' \in \mathbb{Z}^*\}$
$\qquad\qquad = \{t_1' a^2 + t_2' a^3 + \dots + t_{n-1}' a^n + Sa^n + (t_1 a + \dots + t_n a^n)Sa^n\} + Sa^n$
$\qquad\qquad = \{t_1' a^2 + t_2' a^3 + \dots + t_{n-1}' a^n + Sa^n + Sa^n + Sa^n\}$
$\qquad\qquad \subseteq \{t_1' a^2 + \dots + t_{n-1}' a^n + Sa^n | t_i' \in \mathbb{Z}^*\}$
$\qquad\qquad \subseteq L$
$L^n = \{t_1 a + t_2 a^2 + \dots + t_n a^n + Sa^n\} \dots \{t_1 a + t_2 a^2 + \dots + t_n a^n + Sa^n\}$ n times
$\quad = \{t_1' a^n + t_2' a^{n+1} + \dots + t_n' a^{n^2} + a^i(Sa^n)^{n-i} + (Sa^n)^{n-j}a^j + (Sa^n)^n | i, j = 1 \text{ to } n-1\}$
$\ $ If $1 \leq i \leq n$, $a^i(Sa^n)^{n-i} \subseteq Sa^n$
$x \in a^i(Sa^n)^{n-i}$ implies $(a^k S)a^n \subseteq Sa^n$
$\ $ Thus, $a^i(Sa^n)^{n-i} \subseteq Sa^n, i = 1$ to $n-1$
$\ $ Similarly, $(Sa^n)^{n-j}a^j \subseteq Sa^n, j = 1$ to $n-1$
$y \in (Sa^n)$ implies $y^n = (s_1 a^n \dots s_1)a^n \in Sa^n$
Then, $(Sa^n)^n \subseteq Sa^n$
Therefore, $SL^n \subseteq Sa^n \subseteq L$.
Thus, $L \in LnI(S)$.
Suppose that $B \in LnI(S)$ containing 'a', then $a^k \in B$ for all $k = 1$ to n. Now, $a \in B$ implies.
$Sa^n \subseteq B$, then $L \subseteq B$.
Therefore $L \in LnI(S)$ generated by 'a'.

Corollary 4.2 If $A \subseteq S$, then $A + SA + \dots + SA^n \in LnI(S)$ generated by A.
Theorem 4.3 If $L \in LI(S)$, then $L \in LnI(S)$ for all $n \geq 1$.
Proof: For $L \in LI(S)$, $SL^n \subseteq SL \subseteq L$ for all $n \geq 1$.

Corollary 4.4 If $L \in LjI(S)$, then $L \in LnI(S)$ for all $n \geq j$.
Theorem 4.5 If $A \in LjI(S)$ and $B \in LkI(S)$, then $A \cap B \in LnI(S)$ for all $n \geq \max\{j, k\}$. **Proof:** By Corrollary 3.5, $A, B \in LnI(S)$ for $n \geq \max\{j, k\}$
$(A \cap B)^n S \subseteq A^n S \subseteq A$ and $(A \cap B)^n S \subseteq B^n S \subseteq B$ imply $(A \cap B)^n S \subseteq A \cap B$.

Corollary 4.6 $\bigcap_{i \in \mathbb{Z}^*} L_i \in LnI(S)$ if $L_i \in LnI(S)$ for all i.

Theorem 4.7 If $Q \in LnI(S)$, then $Q \in Q(m,n)I(S)$ for all m.

Proof: For any $Q \in LnI(S)$, $Q^m S \cap SQ^n \subseteq SQ^n$ implies $Q \in Q(m,n)I(S)$.

Theorem 4.8 $A \cap B \in (m,n)QI(S)$ for all $A \in RmI(S)$ and for all $B \in LnI(S)$.

Proof: For any $R \in RmI(S)$ and $L \in LnI(S)$,

$(R \cap L)^m S \subseteq R^m S \subseteq R$ and $S(R \cap L)^n \subseteq SL^n \subseteq L$

Then $(R \cap L)^m S \cap (R \cap L)^n \subseteq R \cap L$

Therefore $R \cap L \in (m,n)QI(S)$.

Corollary 4.9 $A \cap B \in (m,n)QI(S)$ for all m and n, for all $A \in RI(S)$ and for all $B \in LI(S)$.

Theorem 4.10 For a semiring S, the following statements are equivalent.

i) S is regular

ii) $R \cap Q \subseteq RSQ$ for any $R \in RmI(S)$ and for any $Q \in (m,n)QI$.

iii) $R \cap Q \subseteq RQ$ for any $R \in RI(S)$ and for any $Q \in (m,n)QI$.

iv) $R \cap Q \subseteq RSQ$ for any $R \in RmI(S)$ and for any $Q \in QI$.

v) $R \cap Q \subseteq RQ$ for any $R \in RI(S)$ and for any $Q \in QI$.

vi) $R \cap L \subseteq RSL$ for any $R \in RmI(S)$ and for any $L \in LnI(S)$.

vii) $R \cap L \subseteq RL$ for any $R \in RmI(S)$ and for any $L \in LI(S)$.

viii) $Q \cap L \subseteq QSL$ for any $Q \in (m,n)QI$ and for any $L \in LnI(S)$.

ix) $Q \cap L \subseteq QL$ for any $Q \in (m,n)QI$ and for any $L \in LI(S)$.

x) $Q \cap L \subseteq QSL$ for any $Q \in QI$ and for any $L \in LnI(S)$.

xi) $Q \cap L \subseteq QL$ for any $Q \in QI$ and for any $L \in LI(S)$.

xii) $R \cap L = RL$ for any $R \in RI(S)$ and for any $L \in LI(S)$.

Proof: We prove that $(1) \Rightarrow (2) \Rightarrow (3) \Rightarrow (5) \Rightarrow (12) \Rightarrow (1)$,

$(2) \Rightarrow (4) \Rightarrow (7) \Rightarrow (12),(2) \Rightarrow (6) \Rightarrow (8) \Rightarrow (12)$, $(8) \Rightarrow (9) \Rightarrow (11)$, $(8) \Rightarrow (10) \Rightarrow (11) \Rightarrow (12)$.

$(1) \Rightarrow (2)$ Let $x \in R \cap Q$. Then $x = xax \in RSQ$.

Therefore (2) holds.

$(2) \Rightarrow (3)$ By Theorem 3.7, (3) follows.

$(3) \Rightarrow (5)$ Straightforward.

$(5) \Rightarrow (12)$ By Theorem 4.3 and Theorem 4.7.

$(12) \Rightarrow (1)$ For any $a \in S$, $a \in \langle a \rangle_r \cap \langle a \rangle_l = \langle a \rangle_r \cdot \langle a \rangle_l$

Now, $\langle a \rangle_r \cdot \langle a \rangle_l = \{ra + aS | r \in \mathbb{Z}^*\} \cdot \{r_1 a + Sa | r_1 \in \mathbb{Z}^*\}$

$\qquad\qquad = \{r'a^2 | r' \in \mathbb{Z}^*\} + aSa + aSa + aSa$

$\qquad\qquad \subseteq \{r'a^2 | r' \in \mathbb{Z}^*\} + aSa$

Suppose, a $\quad = a(a^2 + a^2 + \ldots r \text{ times}) + a(a^2 + a^2 + \ldots r \text{ times}) + \ldots r \text{ times}$

$\qquad\qquad = r^2 a^3$

$\qquad\qquad \subseteq aSa.$

Therefore, S is regular.

$(2) \Rightarrow (4)$ Straightforwrd.

$(4) \Rightarrow (7)$ By Theorem 4.6, (7) holds.

$(7) \Rightarrow (12)$ By Theorem 3.7, $R \cap L \subseteq RL$ for any $R \in RI(S)$ and $L \in LI(S)$. Now, $RL \subseteq R \cap L$ implies $RL = R \cap L$.

$(2) \Rightarrow (6)$ By Theorem 4.7, (6) follows.

$(6) \Rightarrow (8)$ By Theorem 3.6, (8) follows.

$(8) \Rightarrow (12)$ By Theorems 3.6, 3.7 and 4.3, (12) follows.

$(8) \Rightarrow (9)$ By Theorem 4.3,(9) follows.

$(9) \Rightarrow (11)$ By Theorem 3.6 and 3.7,(11)follows.

$(8) \Rightarrow (10)$ Straightforward.

(10) ⇒ (11) By Theorem 4.3, (11) follows.
(11) ⇒ (12) By Theorem 3.6 and 3.7 (12) follows.

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REVIEW ARTICLE

Comprehensive Review on Gastro Retentive Drug Delivery System

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ABSTRACT

The pharmaceutical business has made great strides in recent years, particularly in the areas of adaptable drug formulation and cutting-edge dose-administering procedures for targeted therapeutic effects. Oral medications have a short half-life in the blood because they are absorbed rapidly in the stomach and interstine and then eliminated from the body's bloodstream. In order to increase the therapeutic effect, dosage more often is required. The pharmaceutical business has made great strides in recent years, particularly in the areas of adaptable medicine formulation and cutting-edge dose-administering procedures. Oral medications are able to be absorbed rapidly in the gastrointestinal tract and eliminated rapidly from the circulatory system. Increasing the frequency of dosages is the only way to boost therapeutic effectiveness. In the realm of site-specific, orally given, controlled release drug delivery systems, many gastro retentive tactics have emerged as state-of-the-art methodologies, and these strategies will be the subject of the current study.

Keywords: drug delivery system, gastro retentive, gastric retention time,

INTRODUCTION

The oral route is the most popular of the different medication delivery systems. A lot of progress has been made in the pharmaceutical industry in recent years in terms of flexible medication composition and advanced techniques of administering doses for specific therapeutic purposes. The pharmaceuticals that are taken by mouth are able to be absorbed swiftly in the gastro intestinal tract and quickly removed from the circulatory system within a short period of time. Only dosing more frequently will improve therapeutic efficacy. Drug industry recognised this trend and began developing oral continuous controlled release formulations that reduce GIT activity while keeping drug concentrations at steady levels in the body for extended periods of time.

However, fewer than two adverts per medicine are affected by various delivery systems.
• Short gastric retention time (GRT)
• Unpredictable short gastric emptying time

They cause an incomplete release of the drug from the dosage form into the area designated for absorption of the medicine. Any dosage administered in the stomach or upper section of the small intestine demonstrates impaired efficiency. site-specific oral administration of a controlled-release dosage form requires a prolonged stomach half-life and duration of stay determined by drug administration [3]. The goal of gastro retentive drug delivery is to increase the amount of time a drug remains in the stomach, allowing for more controlled and precise release of that medicine in the upper GIT, where it can have either local or systemic effects. The gastric retention time (GRT) of medications can be considerably increased by using gastro retentive dose forms, as these can remain in the stomach for extended periods of time. Several gastro retentive drug delivery methods have been developed over the past few decades. These include systems with a high density (sinking) that are retained at the stomach's base, systems with a low density (floating) that cause buoyancy in gastric fluid, mucoadhesive systems that cause bioadhesion to the stomach's mucosa, and systems with an unfold able, extendible, or swell able design that prevent the stomach from emptying the dosage forms too quickly Different gastro retentive strategies have emerged as cutting-edge methods in the field of site-specific, orally delivered, controlled release drug delivery systems, and these strategies are the focus of the present review [2,5,4].

Anatomy and Physiology of the Stomach
The stomach plays an important part in the Gastro Retentive Drug Delivery System, thus familiarity with its anatomy is essential to understanding stomach anatomy and physiology is crucial for making development of the dosage form of the gastro retentive system. Forms of medication dosing. The proximal stomach includes the fundus and body, whereas the distal stomach includes the antrum and pylorus. To temporarily preserve food, crush it up, and next, trickle it down into the duodenum. Storage generally occurs in the fundus and the body. Unprocessed food, meanwhile the antrum propels the stomach to empty itself. The phrase "migrating myoelectric complex" describes the movement pattern of the stomach. In both the fed and fasted stages, gastric emptying takes place; however, the sequence of gastric emptying is quite different in the fed and fasting states [26, 24]. In the fasting state, the stomach and small intestine undergo a cyclical interdigestive series of electrical events every 90-120 minutes. The pylorus's diameter grows to around 19 mm during the interdigestive phase. Therefore, during the inter digestive phase, particles smaller than the diameter of the pyloric sphincter are readily evacuated from the pylorus to the duodenum. When a person is fed, however, they begin to experience increased motor activity 5-10 minutes after eating, and this activity persists as long as food is present in the stomach. This may slow down the pace at which the stomach empties [26].

Factors Influencing Dosage Forms of Gastric Retention
When developing gastro retentive dose forms, it is important to take into account the anatomy and physiology of the stomach, which both include important factors. The size of the particles must be between one and two millimeters in order for them to be able to get past the pyloric valve and into the small intestine. A person's body position, sexual identity, age, sex, sleep, BMI, physical activity, and diseased states (such as chronic disease, diabetes, etc.) are some

of the most important factors that control the GRT of oral dosage forms. Other important factors include the administration of drugs that have an impact on gastrointestinal transit time, such as drugs that act as anticholinesterases, as well as the density, size, and shape of the oral dosage form (e.g. metoclopramide, cisapride.). In addition to this, it is essential to consider the drug's molecular weight as well as its lipophilicity, taking into account its ionization state [2].

Dosage form density

The density of a dosage form is one of the factors that dictates where the system will be located in the stomach and also influences the pace at which the stomach empties. In the stomach, dosage forms that have a density that is higher than the contents of the stomach may sink to the bottom, while dosage forms that have a density that is lower than the contents of the stomach can float to the top. Either location has the potential to separate the dosing system from the pylorus. For anything to have the quality of floating, its density must be less than 1.0 gm/cm^3 [6,4,2].

Size and shape of dosage form

When developing single-unit solid dose forms that are indigestible, it is essential to consider both the shape and amount of the dosage. There is a substantial amount of variation in the mean stomach residence durations of non floating dose forms. This variation is mostly caused by the fact that these dosage forms might come in large, medium, or tiny units. The majority of the time, the gastric retention time (GRT) will be longer if the dose form is bigger. This is because the larger size of the dosage form would make it impossible for the substance to swiftly pass through the pyloric antrum and into the intestine. When compared with dosage forms that have a diameter of 9.9 mm, dosage forms that have a diameter of greater than 7.5 mm exhibit a superior stomach residence time. In comparison to devices of various forms, those in the form of a ring or tetrahedron have a longer period of time spent within the stomach [12].

Nature of food and its intake

The consistency and quantity of food, as well as the caloric content and the number of times a meal is consumed, all have a significant influence on the period of time that dosage forms are retained in the stomach. The presence or absence of food in the gastrointestinal tract (GIT) may influence the gastric retention time (GRT) of a dosage form, and this influence can be either favourable or un favourable. The majority of the time, there is an increase in the stomach retention time of the dose form when there is food present in the gut. Since of this, there is an increase in the quantity of medicine that is absorbed because the dosage form is able to linger at the site of absorption for a longer period of time. Once again, an increase in acidity and caloric value reveals a reduction in gastric emptying time (GET), which may result in an improvement in the stomach's ability to retain dosage forms. This improvement may be the outcome of an improvement in the stomach's ability to retain dose forms [16].

Age, Body Position and Gender

In general, stomach emptying rates are slower in females than they are in men. The influence of posture does not have any significant effect on the individuals' mean gastric retention time (GRT), regardless of whether they are in an upright, ambulatory, or supine condition. The process of the stomach emptying out occurs more slowly in older people [17,18,19].

Drugs That Are Capability of Gastro retentive Drug Delivery System

1.Medications that exert their effects only in the stomach's surrounding environment.
2.Gastrointestinal (GI) absorption-window-limited drugs.
3.Medications that degrade in the colonic or intestinal environment.
4.Medication that alters the composition of normal gut flora.
5.Drugs which have high pH and low solubility character.

Drugs that don't have The Capability in Carrying Gastro Retentive System
1. Absorption in acid is quite low for these drugs.
2. The stomach's acidic environment might cause drug instability.
3. Medicines designed for controlled release just in the bowels.

Modalities for maintaining gastric retention structure
Drug delivery system with a high density (sinking) or non-floating structure This method necessitates the creation of dose forms with a density higher than that of typical stomach content (1.004 gm/cm3). Drugs are coated onto a heavy core or blended with inert elements like iron powder, barium sulphate, zinc oxide, titanium oxide, etc. to create these formulations. The materials may add as much as 1.5–2.4 gm/cm3 to the density of the material. To significantly lengthen time spent in the stomach, a density close to 2.5 gm/cm3 seems to be required. However, no evidence of its efficacy in humans has been found, and the system itself has not been commercialized [21].

Floating drug delivery system
One of the most effective methods to increase medication bioavailability is to use a drug delivery device that floats in the stomach. If a medicine is best absorbed in the stomach or the first part of the small intestine, then this delivery mechanism is an excellent choice. As a result of its lower bulk density compared to gastric fluids, it floats in the stomach for an extended amount of time without slowing the stomach's emptying pace, allowing the medicine to be delivered gradually and at the appropriate rate. Following medication administration, the stomach residual system is emptied. This led to a longer GRT and improved regulation of plasma medication concentration fluctuations. Essential features for a medicine delivery system that can float on water [24]. Because it has a bulk density that is lower than that of gastric fluids, stomach-specific FDDS is able to maintain buoyancy in the stomach for an extended length of time without affecting the pace at which gastric contents are expelled. However, since the system floats on the contents of the stomach, the medicine leaves the body gradually and at the pace that was determined to be optimal. After the medicine has been released, the leftover system in the stomach is drained out. As a consequence, the amount of time that a medication spends in the stomach increases, which leads to improved regulation of drug concentration in plasma. The floating SRDF exhibit many of the properties of hydrophilic matrices and are referred to as "hydrodynamically balanced systems" (HBS) because they are able to maintain their low apparent density. Despite this, the polymer hydrates and forms a gelled barrier on the surface of the floating SRDF. In the same way as it happens with traditional hydrophilic matrices, the medication is progressively released from the swelling matrix. Because of the lower bulk density of these forms compared to that of the contents of the stomach, it is predicted that they will float on top of the contents of the stomach for three to four hours without affecting the normal pace at which the stomach empties itself. Among the several hydrocolloids that are recommended for use in the formulation of floating form products, cellulose ether polymers are often used; in particular, hydroxyl propyl methyl cellulose (HPMC). The addition of a fatty substance with a bulk density of less than one to the formulation has the potential to both improve the buoyancy and decrease the amount of water that is taken in [25].

Single unit floating system

Effervescent Systems (Gas-Generating Systems)
The matrices utilised in these systems were either pre-prepared with a swellable polymer like chitosan, HPMC, citric acid, or tartaric acid; effervescent components like $NaHCO_3$; or chambers holding fluid that gasifies at body temperature. It has been found that a stoichiometric ratio of 0.76:1 between citric acid and sodium bicarbonate produces the most gas. When carbon dioxide is released, the formulation floats in the stomach. Multiple unit floating dosage forms that produce CO_2. It's also possible to build a system with several layers. The gas-generating material may be integrated into any of the layers, while the formulation of the drugs and excipients can be done separately. For further adjustments, a polymer covering that allows water through but blocks carbon dioxide has been added to the matrix. Finding a compatible medium between the polymers' elasticity, plasticity, and permeability is the major challenge of these formulations.

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Non-effervescent system

Typically, gel-forming or hyper swellable cellulose type hydrocolloids, polysaccharides, or matrix-forming polymers such as polyacrylate, polycarbonate, polystyrene, and polymethacrylate are used to prepare non-effervescent floating drug delivery systems. These systems are then suspended in a liquid medium. In one method, the drug is intimately mixed with a hydrocolloid that forms a gel. This approach brings the drug into contact with the fluid in the stomach after oral administration and allows it to keep its relative integrity of shape while also having a bulk density that is lower than unity within the stomach's environment. These dosage forms have a buoyant quality thanks to the air that is trapped within the inflated polymer. Excipients such as hydroxypropyl methylcellulose (HPMC), polyacrylates, polyvinyl acetate, carbopol, agar, sodium alginate, calcium chloride, polyethylene oxide, and polycarbonates are employed most often in these systems. In addition to this, they are broken down further into subtypes.

Hydrodynamically Balanced Systems

Systems with a hydrodynamic equilibrium, Sheth and Initially dubbed by Tossounian, the term "hydrodynamically balanced systems" is his invention. These pharmaceutical gel-forming system floating hydrocolloids are those whose purpose is to whatever is in one's gut. These are individual servings. Include one or more gel-forming polymers that are able to float in water. hydroxypropyl cellulose (HPC), Hydroxypropyl sodium carboxymethylcellulose (HPMC), Carrageenans, sodium carboxymethyl cellulose (NaCMC), hydroxyethyl cellulose (HEC), polyacrylate, agar, polycarbophil, polystyrene, and polystyrene are all examples of humectants. The excipient alginic acid is often used to create these structures. Polymer is blended. With medication, often within a capsule system with a hydrodynamic balance. When it is placed in water, the capsule's shell dissolves and the dosage form maintains its buoyancy in the stomach acid for a considerable length of time because the combination expands to create a gelatinous barrier. Because the outer layer is constantly being eroded, water is able to penetrate the inner layers, keeping the outer layer hydrated and buoyant. Fatty excipients allow for low-density formulations, which in turn reduces erosion. When delivering drugs, it's important to strike a good balance between drug loading and the polymer's impact on the release profile.

Micro balloons

Simple techniques of solvent evaporation or solvent diffusion/evaporation were used in the creation of micro balloons or hollow microspheres that were afterwards loaded with pharmaceuticals in their other polymer shelves. Polymers such as cellulose acetate, Eudragit S, polycarbonate, agar, calcium alginate, low methoxylated pectin, and others are often used in the process of developing these systems. Both the buoyancy of the dosage form and the rate at which the medicine is released are reliant on the amount of polymers, the ratio of plasticizer to polymer, and the solvent that was employed during formation. Over the course of more than twelve hours, the micro balloons floated constantly on the surface of an acidic dissolving medium that included surfactant. Because they combine the benefits of multiple-unit systems with superior floating, hollow microspheres are now regarded to be one of the most promising buoyant systems. This is due to the fact that hollow microspheres float well.

Alginate beads

Newly designed multi-unit floating systems use cross-linked alginate beads. They were created using Ca^{2+} with low methoxylated pectin, or Ca^{2+} with sodium alginate. Deposition of calcium alginate is achieved by adding a small amount of sodium alginate solution to a calcium chloride solution in water. Air flow and freeze drying are then used to separate the beads and dry them, resulting in a porous system that can keep its buoyancy for more than 12 hours. The GRT that is increased by these beads is more than 5.5 hours.

Micro porous compartment system

The idea relies on enclosing a drug reservoir in a microporous compartment that has pores in both its upper and lower sides. To avoid the undissolved medicine coming into touch with the stomach lining, the device's outer sides were hermetically sealed. To avoid sinking to the bottom of the stomach, the delivery system is equipped with an airtight flotation chamber that allows it to float freely in the gastric fluid. The medicine is exposed to gastric juice, which dissolves it and causes it to be continuously transported through the intestine, where it is absorbed.

Mucoadhesive or bio adhesive drug delivery systems

They are introduced into the human body as a delivery vehicle in order to improve medication absorption in a way that is site-specific. In this method, bioadhesive polymers are used, and these polymers have the ability to attach themselves to the epithelial surface of the stomach. Because of this, they are able to enhance the duration of gastric retention. The idea that a dose form may adhere to the mucosal surface via a distinct mechanism serves as the foundation of adhesion. This method works based on few mechanism, they are:

1) The idea of wetting, which is predicated on the capability of bioadhesive polymers to make contact with the mucous layer.

2) The diffusion hypothesis, which postulates that the strands of mucin get physically entangled with the chains of flexible polymer molecules.

3) According to the absorption hypothesis, the bioadhesion phenomenon is the result of secondary forces.

4) The electron hypothesis, which postulates the existence of electrostatically attractive forces between the mucin network of glycoprotein and the bioadhesive substance.

Expandable, unfoldable and swellable systems

If the dose form in the stomach is larger than the pyloric sphincter, then it will be able to endure gastric transit. Nevertheless, the dose form has to be manageable enough to be ingested, and it can't produce a blockage in the stomach either when taken individually or when taken in accumulation.

Therefore, their configurations are necessary in order to design a system that is extendable in order to lengthen GRT

1) a compact form for oral administration,

2) a larger form with gastro retentive properties, and

3) a third compact form that enables the patient to expel the medicine from the device once it has been released.

Therefore, the combination of a large size and a high stiffness of dosage form to resist the peristalsis and mechanical contractility of the stomach increases gastroretentivity. In order to create a medication delivery system that is both effective and safe in the stomach, researchers have lately sought to use a system that unfolds and swells. Biodegradable polymers are used to create the unfoldable systems. They are made of bioerodible polymer and come in a variety of geometric shapes, such as a tetrahedron, ring, or planner membrane (4-label disc or 4-limbed cross form). Also, the mechanical features of swellable systems ensure their retention in the GIT. The dose form is tiny enough to be ingested by the stomach fluid, and the swelling often arises through osmotic absorption of water. Expandable systems have several downsides, such as the difficulty in industrialising and the high cost, and the limited lifespan of the mechanical form memory for the unfolding mechanism. Rigid, big, single-unit expandable drug delivery dosage forms may induce temporary blockage, intestinal adhesion, and gastropathy if they are retained for an extended period of time.

Super porous hydrogel systems

These expandable systems are distinct enough from the more common ones to need their own categories. Super porosity hydrogels, with an average pore size >100 micro metre, are used in this method to increase gastric retention time (GRT). They rapidly absorb water by capillary wetting via their many interconnected open holes, reaching their equilibrium size in under a minute. They're designed to expand to big size (swelling ratio: 100 or more) and be sturdy enough to endure the force of stomach contraction. Combining hydrophilic particles with other ingredients is recommended for this purpose.

Magnetic Systems

An internal magnet in the dose form and an external magnet applied on the abdomen above the stomach's location are the foundation of this strategy for increasing GRT. Although it seems that the magnetic device is effective, precise positioning of the external magnet is required, which might reduce patient compliance.

Advantages of Gastro Retentive Drug Delivery

1) When compared to the administration of non- gastroretentive drug delivery, the GRDD approach has the potential to significantly improve the bioavailability of therapeutic agents, particularly those that undergo metabolism in the upper GIT. This is especially true for the agents that are metabolised in the upper GIT. The extent to which a medicine is absorbed is affected by a number of distinct elements that are connected to the drug's absorption and its passage through the gastrointestinal tract (GIT). These factors work together to have an effect.

2) For medications that have a half life that is relatively short, continuous release may result in a flip-flop in pharmacokinetics and also make it possible to lower the frequency of dose while simultaneously improving patient compliance.

3) They also have an advantage over their traditional method in that it can be employed to overcome the disadvantages of the GRT as well as the stomach emptying time. This is a benefit over their conventional system (GET). Since the bulk density of these systems is smaller than that of the gastric fluids, it is anticipated that they will continue to float on top of the stomach fluid without having an effect on the intrinsic rate at which they are used.

4) Drug administration by gastroretention may create a prolonged and sustained release of medications from dosage forms, allowing for more effective local treatment in the stomach and small intestine. Because of this, they are beneficial in the diagnosis of conditions that are associated with the stomach and the small intestine.

5) The gastroretentive dosage form, which allows for regulated and gradual release of the medication, offers adequate local action at the sick location, hence reducing or eliminating the possibility of systemic exposure to the drug. The administration of the medicine at a particular spot lessens the likelihood of unwanted side effects.

6) The variability of medication concentrations and effects is reduced to a minimum with the use of gastroretentive dosage forms. As a result, there is a possibility of presenting concentration-dependent deleterious effects that are related with peak concentrations. This characteristic is of utmost significance for medications that have a limited therapeutic index.

7) The use of gastroretentive drug administration may reduce the amount of interference caused by the body, which results in increased therapeutic efficacy.

8) A decrease in the amount of time that the medication concentration fluctuates makes it possible to achieve more selectivity in the activation of receptors.

9) The Gastroretentive dosage form's prolonged manner of drug release allows for an increase in the duration spent above a critical concentration, which in turn increases the pharmacological effects and chemical results.

CONCLUSION

It is possible to draw the conclusion, based on the research that was conducted, that gastroretentive drug delivery presents a number of potential benefits for drugs that have a low bioavailability. This is because the drugs' absorption is limited to the upper gastrointestinal tract (GIT), and because they can be delivered efficiently, which maximises their absorption and increases their absolute bioavailability. In order to determine the appropriate dose form for a particular medicine, in vivo investigations are usually necessary. This is because the pharmacokinetics and pharmacodynamics factors may be rather complicated. Eradicate Helicobacter pylori, which is now thought to be the bacteria that causes chronic gastritis and peptic ulcers. This is another interesting field of study for the gastroretentive drug delivery system. In spite of the fact that this pathogen responds well to a wide variety of antibiotics, in order to eradicate it completely, a high concentration of antibiotics must be maintained inside the stomach mucosa for an extended length of time. The physiology of the stomach is an essential aspect that must be taken into consideration. A significant factor to consider is whether the medication should be used before, after, or in the middle of a meal. The creation of a dosage form that is effective at gastroretention presents a significant challenge to the field of pharmaceutical technology. In point of fact, the drug delivery system has to stay in the stomach for a significant amount of time, which is incompatible with the normal physiology of the organ. Each of these gastroretentive drug delivery methods, such as swelling, floating, unfoldable, high density, bioadhesive, expandable magnetic system and so on, is fascinating and has its own set of benefits and drawbacks. At this time, a significant amount of effort is being put into the research and development of several gastroretentive delivery methods for

various medications. It is anticipated that in the not-too-distant future, they will become of growing significance, which will finally lead to improvements in the efficacy of different kinds of pharmacotherapies.

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Figure. 1. Anatomy Structure of Stomach (26)

Figure.2. Myoelectric complexes phases (26)

(A)

(B)

Figure.3. Effervescent Systems
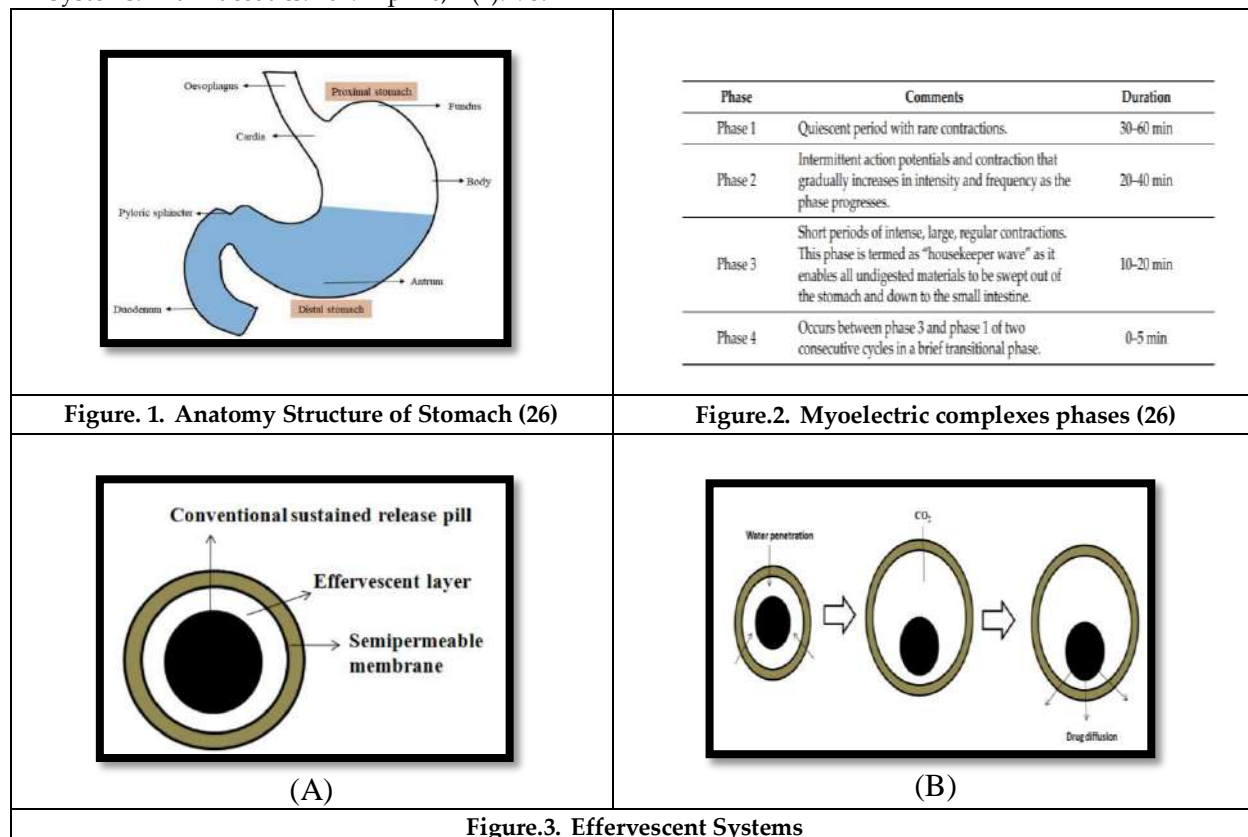
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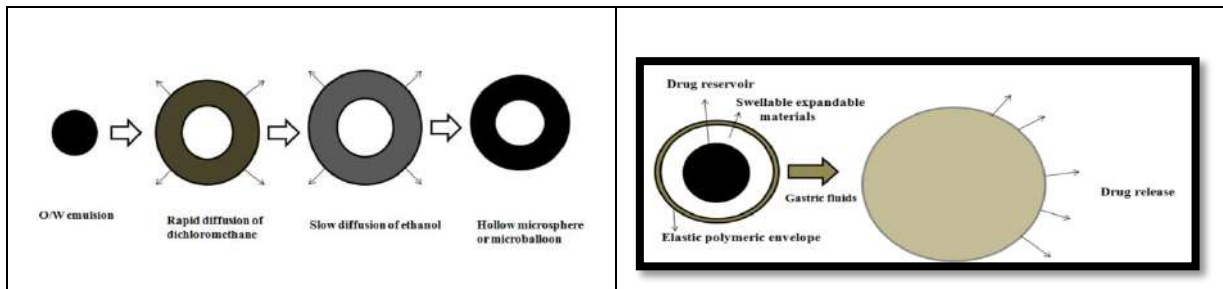
Figure.4.Micro Balloon Technique	**Figure.5.Swellable system**
Figure.6.Commercially available drug formulations used for gastro retentive doasge	**Figure.7. Gastro-retentive products available market**

RESEARCH ARTICLE

Effect of Explosive Training on Agility in Competitive Tennis Players

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ABSTRACT

Agility is the important component for the success of the tennis player. The fitness of the players have been compromised which led to decrease in their performance. Exercise is the best method to improve the general fitness among the athletes. Agility generally requires lower body strength and balance. A gradual and progressive increase in the exercise can lead to improvement in the performance and also reduce the chances of injury. The purpose of this study is to find out the effect of explosive training on agility in competitive tennis players. 30 competitive tennis players were selected on the basis of the selection criteria. The players were scattered into two equal groups of 15 players. Group A was the experimental group (explosive training given) and group B was the control group (no training given). The group A was given explosive training for 6 weeks and thrice a week. Hexagonal test was conducted to evaluate the agility in the players. The data was taken for pre and post study for both the groups. Group A shows agility improvement by 1.12 second faster than the group B by 1.25 seconds. Significant improvement was seen after the completion of the training. Explosive training proves to improve the agility of the tennis and also decreases the chances of injury.

Keywords: Tennis, Explosive exercise, Agility, Competitive, Hexagonal Test.

INTRODUCTION

➢ The ability of the tennis players to rapidly change the direction and repeatedly demanding the ability improvement. To maintain this quick changing of the position, it is necessary to analyze the most essential part of fitness for the specific sports training and assessment. Such known part of training needed in tennis is agility[1].

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➢ Agility is often considered the basic element of many team sports. In most research, the term agility has been applied to describe and rapid whole body movement with a change of velocity or direction in response to a stimulus [2,3]. Thus, the improving agility of Tennis players has become a focus training programmes and consequently, many studies have been conducted to enhance and assess this quality among athletes. Agility training can be performed with the help of explosive training protocol which re-enforces the motor program that is performed through neural adaptations and neuromuscular conditioning [4,5].

➢ Tennis is often seen as game of constant emergencies due to the type of play. The players has to move around the court according to the shot hit by the opponent players[6].This difficult twists and turns in different parts requires the players to have rapid RT (reaction time) and explosive speed. The players of tennis have to multidirectional movers along with straight and lateral movers [7]. As seen that tennis players requires such skills and abilities, so it is important to plan their training according to sports specific requirement. Training for such bio-motor abilities needs high specific training which fulfils the sports specific demand. Agility training performed through explosive protocols helps in improving the agility of players. Bio-motor abilities play a major in all sports for achieving the higher performance level by the athletes [8,9].

➢ Explosive force output is the essential part to improve the performance that needs high velocity by which the movements are done in a sequence [10-11]. Many activities such as kicking, jumping and throwing require explosive muscle motion. In sports such as football, volleyball and tennis requires rapid change in direction and sudden outburst of force [10].

➢ Lower body assessment should include strength, agility and muscle balance in order to prevent injury and enhance performance. Lower body in tennis is very important and has been elorabated by many researchers [11-13].

NEED OF THE STUDY

Tennis uses the bio-motor skills such as agility. Tennis player requires to change its direction according to the opponents shot like ascending, descending and pivoting. The change in direction needs to quick and speedy. Agility is termed as change in direction as fast as possible. The need of this study is to compare the effect of explosive training on agility among the competitive tennis players after 2, 4 and 6 weeks.

AIMS AND OBJECTIVES

Aims

The purpose of this study is to find out the effect of explosive training on agility in competitive tennis players.

Objectives

- To evaluate the effect of explosive training on agility in competitive tennis players.
- To compare the interventional group with the control group.

METHODOLOGY

- **Study Design:** A Comparative Study
- **Study Setting:** SAI Gandhinagar
- **Sampling Technique:** Convenient sampling
- **Study Population:** Male
- **Sample Size:** 30
- **Study Duration:** 6 Week/ 3 Session per week

SELECTION CRITERIA
INCLUSION CRITERIA

- Tennis Players since 2 years.
- Age –group between 14 to 24 years.
- Male tennis players.

- Players regularly playing for 3 hours daily

EXCLUSION CRITERIA
Any Recent Injury which makes them unable to practice or Play. Non cooperative Players.

PROCEDURE
Tennis players satisfying the inclusion criteria were selected for the study. Need of the study was explained to the tennis players and informed consent was taken from them. On the first visit, a complete physical assessment was done. Pre-participation evaluation consisted of an assessment form with demographic details. Pretreatment measurements were taken for all the subjects for the hexagonal test. Total 30 subjects who fulfilled the inclusion and exclusion criteria were selected and randomly divided into 2 groups, Group A- Experimental group and Group B- Control group with 15 tennis players in each group. Pre data were taken using outcome measures and the intervention was given and data were collected again post intervention for statistical analysis.

INTERVENTION
Explosive training was done for 3 days/week for 6 weeks. The exercises were performed with the help of body weight or free weights. Warm up was done before the training. The exercises were bended knee jump, squat jump, jump missile, lunges, calf raises.

RESULT

- The analysis for comparing the Pre and Post Data of intra group with the help of Paired T Test. The analysis for comparing the Pre and Post Data of inter Groups with the help of Independent Sample T Test.
- The data in table 1 compares the pre data and post data of the Group A for hexagonal test. The mean of pre data is 15.00 and of post data is 12.24 and the p value is 0.056. The result is significant.
- The data in table 2 compares the pre and post data of the Group B for hexagonal test. The mean of pre data is 14.13 and post data is 13.3 and the p value is 0.056. The result is significant.
- The table 3 shows the intra group analysis of hexagonal test which also shows result is significant.
- As seen, there is significant result for both groups but Group A has more improved results than the Group B.

DISCUSSION

The present study was conducted with an objective to find the effect of explosive training on the bio motor abilities like agility. It has been carried out on 30 tennis players. The groups were divided equally into Experimental and Control group and the Pre and Post data for the outcome measures was taken. The study has met the desired objective and it comes up with various results for intra-group and inter-group analysis. Result was analyzed by using Statistical Package for the Social Science (SPSS) software version 21.0 of windows. Microsoft excel was used to generate graphs and tables. Explosive training helps in the better sports performance. Many benefits are there by performing the explosive training. It helps in core challenging, strengthens the legs, improves balance, reaction time and also cardiovascular efficiency. The duty of explosive training therefore seems to improve the performance at advanced level. The present study shows improvement by 1.12 seconds in experimental group than the control group. A study conducted by Leone et al concluded that agility and speed are specific and needs to be included in tennis training and assessment format to improve the performance. Improvement in agility can be done through neural adaptation and neuromuscular recruitments. Neural adaptations take place when the players react as a result of improved co-ordination between CNS and proprioceptive feedback [15]. Daniel J. Dodd, et al., (2007) studied number of explosive training protocols to enhance the lower body power in baseball players and concluded that acute explosive exercises alone or combined with other protocols enhances the agility of lower body by the help of neural adaptation and neuromuscular recruitment in baseball players [16]. Explosive training enhances agility as there is higher potential rise in muscle fibres (type II) and also increase in motor unit recruitment. The player

assumes the low ready position while directing tennis serve. For explosive motion, it is the best start position as the center of mass is low and the athlete requires to keep the hamstring contracted for prolonged period. Lower body strengthening and core strengthening helps in service precision which improves the agility of the players[17-18]. Current exercise program was designed with low muscular loading and was intended to increase the overall awareness and control of trunk and pelvis position. Many literatures exist to suggest that these exercises differentially activated local and global stability muscle system. The co-contraction of key muscles, play a very major role in the strengthening as well agility kind of activities.

CONCLUSION

The present study concluded that explosive training effective for improving Agility in Tennis players. Explosive training helps in improving the lower body strength and power which indirectly improves the agility in tennis players. Explosive training can be included in the training protocol to improve the performance and prevent injury.

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Table 1.Intra Group Analysis of Hexagonal Test for Group A

Hexagonal test	Mean	Standard Deviation	t-Value	p-Value
Pre	15.00	1.60	2.08	0.056
Post	12.24	5.75		

Table 2: Intra Group Analysis of Hexagonal Test for Group B

Hexagonal test	Mean	Standard Deviation	t-Value	p-Value
Pre	14.13	1.30	8.72	0.000
Post	13.3	1.27		

Table 3: Inter Group Analysis of Hexagonal Test

Hexagonal test	Mean	Standard Deviation	t-Value	p-Value
Group A	12.24	5.75	-0.74	0.001
Group B	13.3	1.27		
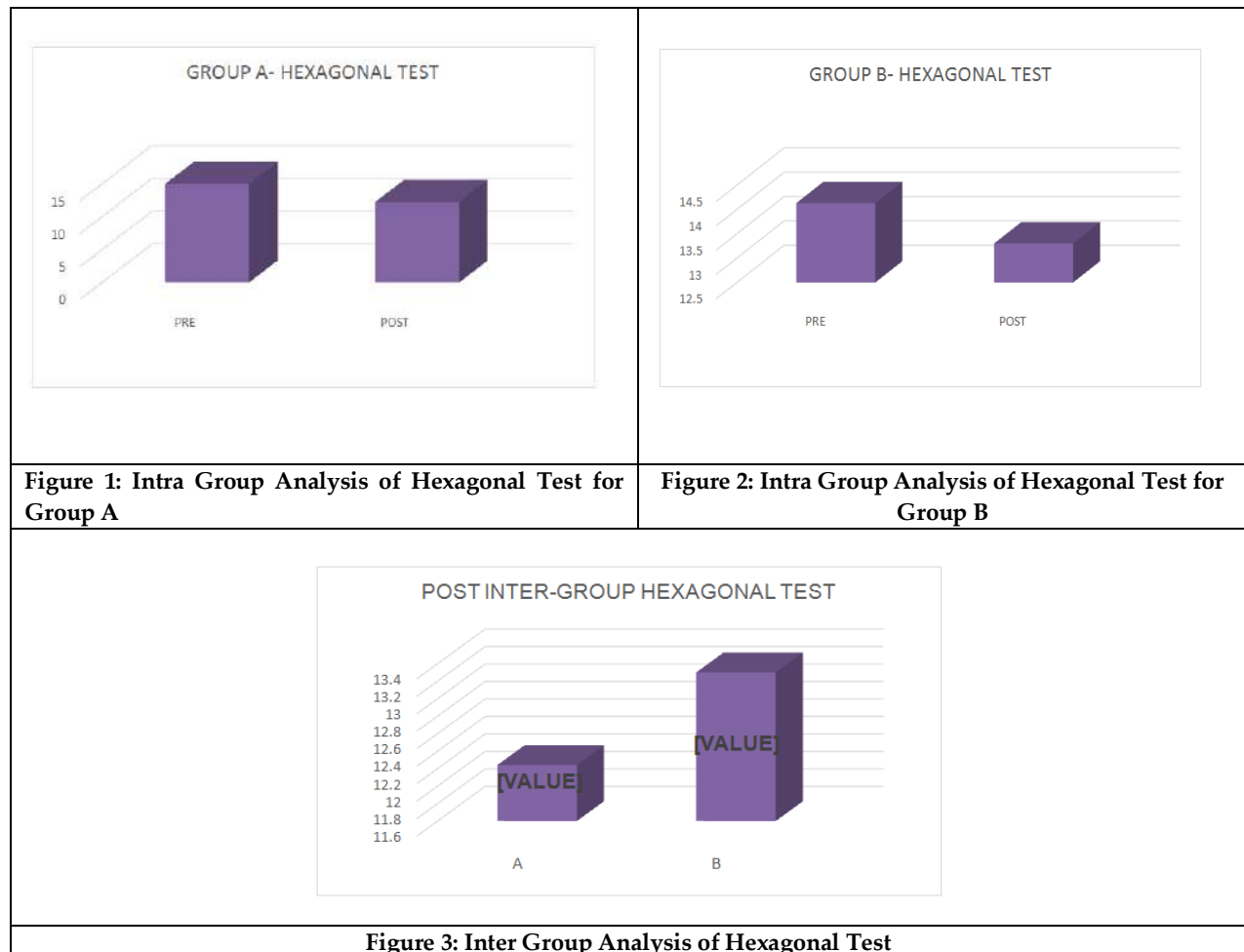
Figure 1: Intra Group Analysis of Hexagonal Test for Group A

Figure 2: Intra Group Analysis of Hexagonal Test for Group B

Figure 3: Inter Group Analysis of Hexagonal Test

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RESEARCH ARTICLE

Effect of Integrated Nutrient Management Practices on Yield, Nutrient Uptake and Economics of Irrigated Groundnut (*Arachis hypogaea L.*)

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ABSTRACT

A field experiment was conducted at farmer's field, Peruvalur, Melmalaiyanur taluk of Viluppuram district during *kharif* season, 2021 to study the **effect of integrated nutrient management practices on yield, nutrient uptake and economics of irrigated groundnut (***Arachis hypogaea L.***)**. The field experiment was laid out in randomized block design with nine treatments and three replications The treatments are T_1 – Control, T_2 – RDF (25:50:75 kg NPK ha^{-1}), T_3 – RDF + Sulphur @ 75 kg ha^{-1} through gypsum, T_4– RDF + *Rhizobium* (seed treatment-ST), T_5 – RDF + MN mixture (12.5 kg ha^{-1}), T_6 – RDF + Sulphur @7 5kg ha^{-1} through gypsum + *Rhizobium (*ST) , T_7– RDF + Sulphur @ 75 kg ha^{-1} through gypsum + MN mixture (12.5 kg ha^{-1}), T_8 – RDF + *Rhizobium* (ST) + MN mixture (12.5 kg ha^{-1}), T_9 – RDF + Sulphur @ 75 kg ha^{-1} through gypsum + *Rhizobium* (ST) + MN mixture (12.5 kg ha^{-1}). The combined application of RDF, sulphur, *Rhizobium* and MN mixture influenced the yield, nutrient uptake and economics of groundnut. Among the different treatments tried, application of RDF + Sulphur @ 75 kg ha^{-1} through gypsum + Rhizobium (ST) + MN mixture @ 12.5 kg ha^{-1} (T_9) recorded the maximum values of **nutrient uptake, yield and economics.**

Keywords: gypsum, MN mixture, Rhizobium (ST),Productivity, Economic, nutrient uptake

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a grain legume and an important oilseed crop. Groundnut is known as the "King of Oil Seeds," and it is the world's 13th most important food crop, 4th most important source of vegetable oil, and 3rd most important source of vegetable protein (Shete *et al.,* 2018). Groundnut is also referred to as peanut, earthnut, and monkey nut. Groundnuts are a good source of protein, fat, and other nutrients. On dry weight basis, groundnut kernel contains 44-56 percent oil and 22-30 percent protein. It contains lot of minerals (phosphorus, calcium, magnesium, and potassium) and vitamins *viz.,* E, K, and B (Ingale and Shrivastava 2011). Thus, groundnut provides nearly half of the 13 essential vitamins and seven of the twenty essential minerals required for human growth and development, in addition being a high-quality fodder for livestock (Sowmya *et al.,* 2022). The majority of crops respond rapidly to chemical fertilizers and increase their yield. It is essential for photosynthesis and plays a crucial function in green pigment and chlorophyll levels in plants. N promotes a flourishing growth of many green leaves. Low levels of nitrogen in plants result in stunted growth and decreased flowering. *Rhizobium* activity and N2 fixation are negatively affected when the system lacks phosphorus (P) since P serves as an energy source for the rhizobia (Asante *et al.,* 2020). Potassium is one of the major essential nutrient elements required by plants. Though potassium is not a constituent of any compound or structurally bound in groundnut, it is required for translocation of assimilates and involved in maintenance of water status of plant especially the turgor pressure of cells and opening and closing of stomata and increase the availability of metabolic energy for the synthesis of starch and proteins. Besides, it increased peg formation, nodulation, synthesis of sugar and starch, and help in pod growth and filling (Patel *et al.*, 2018).

Sulphur, one of the 17 essential elements for plant growth and development, plays a significant role in the nutrition of oilseed crops. It is one among the most important nutrients for all plants and animals and is regarded the fourth most important nutrient for agricultural crops after nitrogen, phosphorus, and potassium. Inadequate sulphur availability not only reduces the growth and output of oilseed crops but can also diminish the nutritional value of the produce (Hawkesford, 2000). *Rhizobium* boosts the biological fixation of atmospheric nitrogen and increases the crop's access to nitrogen. *Rhizobacteria* that promote plant growth are environmentally benign, inexpensive, and non-bulky agricultural inputs that play an important role in plant nutrition as a supplement and complement to mineral nutrition (Peix *et al.,* 2015). Micronutrients (boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc) are vital for plant growth and are required in minute amounts; the application of micronutrients increases agricultural product yield and quality (Tavakoli *et al.,* 2014).

MATERIALS AND METHODS

A field experiment was conducted at farmer's field, Peruvalur, Melmalaiyanur taluk of viluppuram district during kharif season, 2021 to study the effect of integrated nutrient management practices on yield, nutrient uptake and economics of irrigated groundnut (*Arachis hypogaea* L.). The experimental field was geographically situated at 12°40′ N latitude and 79°39′ E Longitude with an altitude of + 243m MSL. The texture of the experimental field soil was sandy clay loam with neutral pH, low in available nitrogen and medium in available phosphorus and potassium. The popular variety TMV 14 was chosen for the study. The experiment was laid out in Randomized Block Design (RBD) with nine treatments and three replications. The treatments are T_1 – Control, T_2 – RDF (25:50:75 kg NPK ha^{-1}), T_3 – RDF + Sulphur @ 75 kg ha^{-1} through gypsum, T_4– RDF + *Rhizobium* (seed treatment-ST), T_5 – RDF + MN mixture (12.5 kg ha^{-1}), T_6 – RDF + Sulphur @7 5kg ha^{-1} through gypsum + *Rhizobium* (ST) , T_7– RDF + Sulphur @ 75 kg ha^{-1} through gypsum + MN mixture (12.5 kg ha^{-1}), T_8 – RDF + *Rhizobium* (ST) + MN mixture (12.5 kg ha^{-1}), T_9– RDF + Sulphur @ 75 kg ha^{-1} through gypsum + *Rhizobium* (ST) + MN mixture (12.5 kg ha^{-1}). The recommended seed rate of 120 kg ha^{-1} was used for the trial. The seeds were sown by hand dibbling at the specified spacing of 30 X 10 cm. The fertilizers were applied to the experimental field as per the recommended manurial schedule of 25: 50: 75 kg N, P_2O_5 and K_2O ha^{-1}. Urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) fertilizers were used to supply N, P and K nutrients, respectively. The entire dose of phosphorus, half dose of nitrogen was applied

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basally, and the remaining half dose of nitrogen and potassium were applied as two equal splits on 25 and 40 days after sowing. Sulphur @ 75 kg ha^{-1} through gypsum was applied at two equal splits (basal and 40 DAS) to the respective treatment plots.MN mixture @ 12.5 kg ha^{-1}was applied basally to the respective treatment plots. Five plants were selected randomly in each plot. Then, the selected plants were tagged and used for recording all biometric observations in different growth stages of crop.

RESULTS AND DISCUSSION

Yield (Table 1)

Among the various treatments imposed in the study, application of 100 per cent RDF + Sulphur @ 75 kg ha^{-1} through gypsum + Rhizobium (ST) + MN mixture @ 12.5 kg ha^{-1} (T9) significantly resulted in the pod and kernal yield. The gypsum act as soil amendment and improves the soil physical, chemical, and biological condition, which in turn help to improve the nutrient availability for groundnut. Improvements in yield have resulted in favorable influence of sulphur on growth and efficient partitioning and translocation of metabolites to reproductive structures. These findings were in line with the results of Tejeswara Rao *et al*. (2013) and Naresha *et al*. (2014). Micronutrient plays an important role in cell division, sugar transport, flowering, fruiting and plant hormone regulation that led to improve the yield. These results are in harmony with these obtained by Bellaloui *et al*. (2013), Singh and Chaudhari (2015) and Sabra *et al.* 2019. Due to the integrated nutrient use of inorganic fertilizers, gypsum and bio fertilizers by providing cooperative effect and in turn upgraded the soil condition, stimulate root system with healthier absorption of nutrients, and expressed superior progress of plant growth resulting in higher photosynthetic activity and translocation of photosynthates to the sink which resulted in higher pod and kernal yield. The present findings are in close agreement with the results obtained of earlier (Joshi *et al.*, 2018, Purbajanti *et al.*, 2019, Kamalakann and Elayaraja, 2020).

Nutrient Uptake By Crop (Table 2)

Nutrient uptake (N, P, K) was significantly influenced by the combined application of NPK, sulphur, biofertilizer and micronutrient mixture. This was due to increase in growth characters, yield attributes and yield. The uptake of nutrients was increased with the application of NPKS was due to enhanced supply of plant nutrients by direct addition and it enhanced the better absorption and utilization of nutrients in balanced form (Choudhary *et al.*, 2011). Combined application of inorganic nutrient, biofertilizer and micronutrients had synergetic effect in availability of nutrient in soluble form throughout the growing period which in turn improved the utilization of applied nutrients and thus increased sink capacity and higher nutrient uptake by crop. This result is in concomitance with earlier work done by Mahapatra (2018).

Economics (Table 2)

Among the different nutrient management practices, application of 100 per cent RDF + Sulphur @ 75 kg ha^{-1} through gypsum(ST) + MN mixture @ 12.5 kg ha^{-1}(T$_9$) recorded the higher gross return of Rs. 156198, net return of Rs. 82981 and return rupee^{-1} invested of Rs.2.13. The enhanced nutrient availability in balanced manner by integration of RDF, sulphur through gypsum, biofertilizer and micronutrient resulted in improvement of yield attributing characters and yield. This ultimately led to increased gross return and profitability

CONCLUSION

The integrated nutrient management practices conspicuously influenced the growth and yield of irrigated groundnut crop. Based on the results of the field experiment, it is concluded that application of 100 per cent RDF + Sulphur @ 75 kg ha^{-1} through Gypsum +*Rhizobium* (ST) + MN mixture @ 12.5kg ha^{-1} is the most beneficial and cost-effective practice for augmenting higher groundnut yield. Also, this practice is found to be agronomically sound and economically viable and can be recommended to the groundnut growers for realizing better yield and returns.

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Table 1. Effect of Integrated Nutrient Management Practices on Yield of Irrigated Groundnut

	Treatments	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Oil yield (kg ha^{-1})
T$_1$	Control	1062	698.58	2205	333.71
T$_2$	RDF - NPK (25:50:75) kg ha^{-1}	1629	1145.19	2879	549.46
T$_3$	RDF + Sulphur @ 75 kg ha^{-1} through gypsum	1826	1284.04	3123	618.52
T$_4$	RDF + Rhizobium (ST)	1649	1169.14	2925	560.72
T$_5$	RDF + MN mixture (12.5 kg ha^{-1})	1782	1252.21	3048	602.43
T$_6$	RDF + Sulphur @ 75 kg ha^{-1} through gypsum + Rhizobium (ST)	1990	1405.34	3351	679.48
T$_7$	RDF+ Sulphur @ 75 kg ha^{-1} through gypsum + MN mixture (12.5 kg ha^{-1})	2088	1478.93	3472	716.10
T$_8$	RDF + Rhizobium (ST) + MN mixture (12.5 kg ha^{-1})	1923	1356.48	3253	654.09
T$_9$	RDF + Sulphur @75 kg ha^{-1} through gypsum + Rhizobium (ST) + MN mixture (12.5 kg ha^{-1})	2180	1545.84	3598	752.05
	SEm±	26.93	21.88	39.74	11.56
	CD (*p*=0.05)	80.02	65.00	118.00	34.02

Table 2. Effect of Integrated Nutrient Management Practices on Nutrient Uptake and Economics of Irrigated Groundnut

	Treatments	N	P	K	S	Net income (Rs. ha^{-1})	Return rupee^{-1} invested
T$_1$	Control	54.98	16.27	31.52	6.93	12547	1.19
T$_2$	RDF - NPK (25:50:75) kg ha^{-1}	74.16	20.23	43.18	9.02	45926	1.64
T$_3$	RDF + Sulphur @ 75 kg ha^{-1} through gypsum	85.31	23.96	50.69	11.52	58598	1.81
T$_4$	RDF + Rhizobium (ST)	76.32	21.03	44.23	9.25	47329	1.66
T$_5$	RDF + MN mixture (12.5 kg ha^{-1})	83.99	23.43	49.54	10.35	55976	1.77
T$_6$	RDF + Sulphur @ 75 kg ha^{-1} throughgypsum + Rhizobium (ST)	97.63	25.90	59.77	12.45	70163	1.96
T$_7$	RDF+ Sulphur @ 75 kg ha^{-1} through gypsum + MN mixture (12.5 kg ha^{-1})	101.35	27.16	62.68	13.05	76458	2.04
T$_8$	RDF + Rhizobium (ST) + MN mixture (12.5 kg ha^{-1})	95.18	25.46	58.75	11.26	66007	1.91
T$_9$	RDF + Sulphur @75 kg ha^{-1} through gypsum + Rhizobium (ST) + MN mixture (12.5 kg ha^{-1})	106.21	28.45	65.80	14.26	82981	2.13
	SEm±	1.09	0.37	0.69	0.17	-	-
	CD (*p*=0.05)	3.24	1.12	2.05	0.51	-	-

RESEARCH ARTICLE

Survey on Topological Indices of Armchair Polyhex Nanotubes

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ABSTRACT

A chemical graph G is a simple graph (V,E) with a non-empty set called as vertex set   and an edge set, where the nodes represents the atoms of the compound and edges are chemical bonds between them. A topological index of a chemical graph is a real number that is graph invariant. The motive of this paper is to briefly survey the topological indices of simple, connected graphs. Here we present some basic definitions and techniques that help to study various molecular descriptors. We also discuss the molecular descriptors for the Armchair Polyhex Nanotubes, and Carbon Nanotube networks.

Keywords: Topological indices, nanotubes, bond, connectivity, Zagreb index, Randic index.

INTRODUCTION

A chemical graph is a graph that consists of a set of nodes denoting the atoms of a particle and the lines between the nodes is the bonds between them. In the context of graph theory we represent these nodes and lines as vertices and edges. A function that correlates chemical compounds being represented as a molecular graph to the set of real numbers is termed as Topological index. The main advantage of topological indices is it is used as a numerical molecular descriptor to compare various parameters of molecules (physical, chemical or biological) in QSPR and in QSAR models. Molecular descriptor are distinguished depending upon their distance based or degree based properties. There are various indices like Weiner index, Randic index, Hosoya index, connectivity index, Zagreb index, Balaban index, Harary index etc.

2. Definition of various Topological Indices of a graph
Let us consider the graph G to be simple, finite and a connected graph. Let the order and size of G be m and n respectively. Let U(a) denote the open Neighbourhood of any node a in G and U(a)$\bigcup\{a\}$ be the closed

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neighbourhood of a. The number of lines that are connected to any node is called degree of that node denoted as d_a
The shortest path in between any two nodes a and b in G is denoted by d(a,b). The diameter of G, denoted as D(G) is the largest length in between any two nodes. The eccentricity E(a) of a vertex a in G, is the greatest length for any other vertex b in G. Also, the Total distance of a vertex a is $d(a) = \sum_{b \in V} d(a,b)$

(A) Some degree-based topological graph indices

(i) Zagreb index

The first & second Zagreb index (proposed by Gutman andTrinajestic) is defined as

$$Z^1(G) = \sum(d_a + d_b) \ \& \ Z^2(G) = \sum(d_a . d_b)$$

The general Zagreb index is defined as

$$Z^k(G) = \sum[d_a^{k-1} + d_b^{k-1}] \quad for \quad any \quad k \in R$$

The first and second Zagreb co-indices are defined as follows:

$$\overline{Z}^1(G) = \sum_{ab \notin E(G)}[d_a + d_b] \ , \ \overline{Z}^2(G) = \sum_{ab \notin E(G)}[d_a d_b]$$

The first & second multiplicative Zagreb index is given as

$$MZ^1(G) = \prod_{ab \in E(G)}[d_a + d_b] \quad , \quad MZ^2(G) = \prod_{ab \in E(G)}[d_a d_b]$$

Furtula introduced F-index when k =3 as $F(G) = \sum[d_a^2 + d_b^2]$

The reduced second Zagreb index is given by

$$RZ^2(G) = \sum[d_a - 1][d_b - 1]$$

(ii) Randic Index

Randic index R(G), also called as product connectivity index (introduced by Milan Randic) is given by R (G) =

$$\sum_{ab \in E(G)} \frac{1}{d_a + d_b} \text{ and } R^1(G) = \sum_{ab \in E(G)} \frac{1}{\sqrt{d_a + d_b}}$$

The general Randic index is given as

$$R_\beta(G) = \sum_{ab \in E(G)}(d_a d_b)^\beta \text{ for an arbitrary } \beta \in R.$$

The reciprocal Randic Index is RRI(G) = $\sum_{ab \in E(G)} \sqrt{d_a d_b}$

The reduced reciprocal Randic Index is RRR(G) = $\sum \sqrt{(d_a - 1)(d_b - 1)}$.

We can easily see that R₁ (G) = Z₂ (G).

The general product connectivity index or Randic co-index is defined as

$$\overline{R}_\beta(G) = \sum_{ab \notin E(G)}(d_a d_b)^\beta \text{ for an arbitrary } \beta \in R.$$

(iii) The ABC index or Atom bond Connectivity index (by Estrada) is defined as

$$ABC\ (G) = \sum_{ab \in E(G)} \sqrt{\frac{d_a + d_b - 2}{d_a d_b}}$$

(iv) The harmonic index (by Fajlowicz) is given by $H\ (G) = \sum_{ab \in E(G)} \frac{2}{d_a d_b}$

(v) The first geometric –arithmetic index proposed by Vukicevic is

$$GA\ (G) = \sum_{ab \in E(G)} \frac{2\sqrt{d_a d_b}}{d_a + d_b}$$

(vi) The sum connectivity and general sum connectivity indices (by Zhou & Trinajestic) as

$SC(G) = \sum_{ab \in E(G)} \frac{1}{\sqrt{d_a + d_b}}$ and $SC_P(G) = \sum_{ab \in E(G)} (d_a + d_b)^p$, where p is any real number

The general sum connectivity co-index is defined as

$\overline{SC_p}\ (G) = \sum (d_a + d_b)^p$, p being a real number

(B) Some Topological indices of a graph based on distance

The Wiener index named after Harry Wiener is defined as $W\ (G) = \sum_{(a,b) \subseteq V(G)} d(a,b)$.

The hyper Wiener index (Milan Randic) is defined as

$$HW\ (G) = \frac{1}{2} \sum_{(a,b) \subseteq V(G)} [d(a,b) + d(a,b)^2].$$

The reciprocal complementary Wiener index proposed by Ivanciuc is

$$RCW\ (G) = \sum_{(a,b) \subseteq V(G)} \frac{1}{D(G) - 1 + d(a,b)}$$

The Harary index named after Frank Harary is $H(G) = \sum_{(a,b) \subseteq V(G)} \frac{1}{d(a,b)}$

The additively weighted Harary index or reciprocal degree distance index is

$H_{AW}(G) = \sum_{a \neq b} \frac{[d_a d_b]}{d(a,b)}$ & multiplicatively weighted Harary index as

$H_{MW}(G) = \sum_{a \neq b} \frac{[d_a d_b]}{d(a,b)}$

The Schultz index or degree distance index is defined as $SI(G) = \sum_{a \neq b} [d_a + d_b d(a,b)]$

The Gutman index is given by $Gut\ (G) = \sum d_a d_b d(a,b)$, for $a \neq b$

The Sanskruti index is $\sum_{ab \in E(G)} \left(\frac{S_a S_b}{S_a + S_b - 2} \right)^3$ where $S_a = \sum d_u$.”

(C) Few topological indices of a graph based on eccentricity

Total eccentricity of a graph G is E (G) = $\displaystyle\sum_{a \in V(G)} e(a)$

The first and second Zagreb eccentricity indices are defined as

E_1 (G) = $\displaystyle\sum_{a \in V(G)} [e(a)]^2$ and E_2 (G) = $\displaystyle\sum_{ab \in E(G)} e(a)$ e(b)

The eccentric connectivity is EC (G) = $\displaystyle\sum_{x \in V(G)} e(a)d(a)$ and connective eccentricity index is given as CE (G) =

$\displaystyle\sum_{a \in V(G)} \frac{d_a}{e(a)}$.

The eccentric distance sum index ED (G) = $\displaystyle\sum_{(a,b) \subseteq V(G)} d(a,b)[e(a) + e(b)]$

RESULTS ON VARIOUS TOPOLOGICAL INDICES OF ARMCHAIR POLYHEX NANOTUBES

Let us consider Armchair Polyhex Nanotubes TUAC6. Let the first row or column of the two-dimensional TUAC6(m,n) lattice contain m and n hexagons respectively. The following image depicts this nanostructure's graphical illustration

CONCLUSION

This paper includes numerous topological indices definitions that will be useful to the researchers doing the investigation. There are some more indices that have not been presented in this paper. This paper also gives a brief work carried out in the study of armchair polyhex nanotubes.

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Table.1.Topological indices of ArmChair Polyhex Nanotubes

Topological Indices of Armchair Polyhex Nanotubes	Authors	Journal Name & Year	Results	Topological Index Value for (6,4)
Weiner Index	Mircea V. Diude , Monica Stefu , Basil Parv, Peter E. John	Crotica Chemica Acta (2004)	$\frac{m}{12}[m^2(12n^2-2m^2+8)+8mn(m^2+n^2-2)+3(-1+(-1)^m)],\ n\geq m$ $\frac{m}{12}[24m^2n^2+2m^4-8n^2+3(-1)^m(-1-(-1)^n)],\ n<m$	**16282**
Schultz Index	Mehdi Eliasi, Nfiseh Salehi	International Journal of Molecular Sciences, (2008)	$\frac{m}{6}[-48m^2n+72m^2n^2+3(-1)^{n+1}+3-8n^3-12n^2+6n^4+8n],m>n$ $\frac{-m^2}{3}[-18n^2m+3m^3-6m-12m^2n-12n^3+12n+4m^2-4+12mn+12n^2],m\leq n$	**35424**

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Eccentricity Connectivity Index	M. Saheli , Ali Reza Ashrafi	Macedonian Journal of Chemistry and Chemical Engineering, 2010	$\frac{9}{4}nm^2 - \frac{7}{2}mn + \frac{3}{2}n^2m - n^2 + \frac{5}{4}n$	373
First Connectivity Index (Randic Connectivity index)	M.R.Farahani	Le Mathematchie,2012	Randic Connectivity index $(n + \frac{2\sqrt{6}+1}{6})m$ First Sum Connectivity index $(\frac{\sqrt{6}n+1}{2} + \frac{2\sqrt{5}}{5} - \frac{\sqrt{6}}{6})m$	14.79 14.79
Zagreb Index	M.R.Farahani	Acta Chimica Slovenica (Academia), 2012	First Zagreb Index = 18mn+ 8m Second Zagreb Index = 27mn + 7m	480 690
Atom Bond Connectivity Index	M.R.Farahani	Le Mathematchie,2013	$(2n + \frac{3\sqrt{2}}{2} - \frac{2}{3})m$	64.72
Geometric Arithmetic Index	J. Hao	Journal of Computational & Theoretical Nano Science , 2013	$(9\sqrt{6}\,n + \frac{24\sqrt{5}}{5} - 3\sqrt{6} + 4)m$	573.37
Fourth Atom Bond Connectivity Index	M.R.Farahani	Proceedings of the Romanian academy, 2013	$(4n + \frac{2\sqrt{2}}{5} + \sqrt{\frac{11}{10}} + \frac{\sqrt{14}}{8} + \frac{\sqrt{30}}{6} - \frac{16}{9})m$	103.30
PI index	M.R.Farahani	International letters of Chemistry, Physics & Astronomy, 2014	$23[18mn^2 + 24mn - 5n^2 + 8m - 6n - 2]$	50.554
Second Connectivity Index	M.R.Farahani	International letters of Chemistry, Physics & Astronomy, 2014	2nd Connectivity Index = $(\frac{6n\sqrt{3} - 2\sqrt{3} + 12\sqrt{2}}{9})m$ 2nd Sum Connectivity Index = $(\frac{2n + 24\sqrt{7} + 84m\sqrt{2} - 112}{42})m$	36.71 96.02
Sd Index	M.R.Farahani	International letters of Chemistry, Physics & Astronomy, 2014	$[24m^2n + 16m^2 - 6mn - 4m]$	3864

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Fifth Geometric Arithmetic Index	M.R.Farahani	Le Mathematchie,2012	$(3n + \dfrac{8\sqrt{10}}{13} + \dfrac{24\sqrt{2}}{17} - 2)m$	83.65
Third Connectivity Index	M.R.Farahani	International letters of Chemistry, Physics & Astronomy, 2015	3rd Connectivity Index = $2m(\dfrac{6n + 3\sqrt{6} - 8}{9})$ 3rd Sum Connectivity Index = $2m(\dfrac{6}{\sqrt{10}} + \dfrac{6}{\sqrt{11}} + \dfrac{6n - 17}{\sqrt{12}})$	31.13 68.72
Hyper Zagreb Index	M.R.Farahani	International letters of Chemistry, Physics & Astronomy, 2015	6(18n+ 5) m	2772
Fifth Atom Bond Connectivity Index	K. Pattabiram, P. Kandan	J. Modern Technology & Engineering, 2016	$(\dfrac{\sqrt{10}}{6} + \dfrac{2}{3}\sqrt{\dfrac{11}{6}} + \dfrac{1}{9}\sqrt{\dfrac{17}{2}} + \dfrac{2}{9}\sqrt{\dfrac{43}{6}} + \dfrac{2n\sqrt{13}}{3} - \dfrac{8\sqrt{13}}{27})m$	92.29
Symmetric Division Index	Waqas Nazeer, Shazi Rafique, Shin Min Kang	Symmetric , 2016	$\dfrac{m}{3}(13 + 8n)$	170
Degree based Index	Vijayalaxmi Shigehalli, R. Kanabur	Journal of Mathematical Nano Science, 2016	(i) Geometric Arithmetic index = $(3n + \dfrac{10}{\sqrt{6}})m$ (ii) SK index = (9n + 8)m (iii) SK_1 index= $(\dfrac{27n}{2} - 7)m$ (iv) SK_2 index = (27n+ 15) m	965 264 282 738
Second Arithmetic Geometric Index	M.R.Farahani	Journal of Computational & Theoretical Nano Science, 2018	(9n – 2.0588)m	1221.9
Sanskruti Index	R. Kanabur	Journal of Mathematical Nano Science, 2016	(i) SK_3 index = (81n+ 7) m (ii) Sanskruti index = (1167.75n – 75.58m)	1986 4218

Figure 1. The 2D Lattice (left) and 3D Lattice (right) of Armchair polyhex nanotubes of $TUAC_6[m,n]$.

RESEARCH ARTICLE
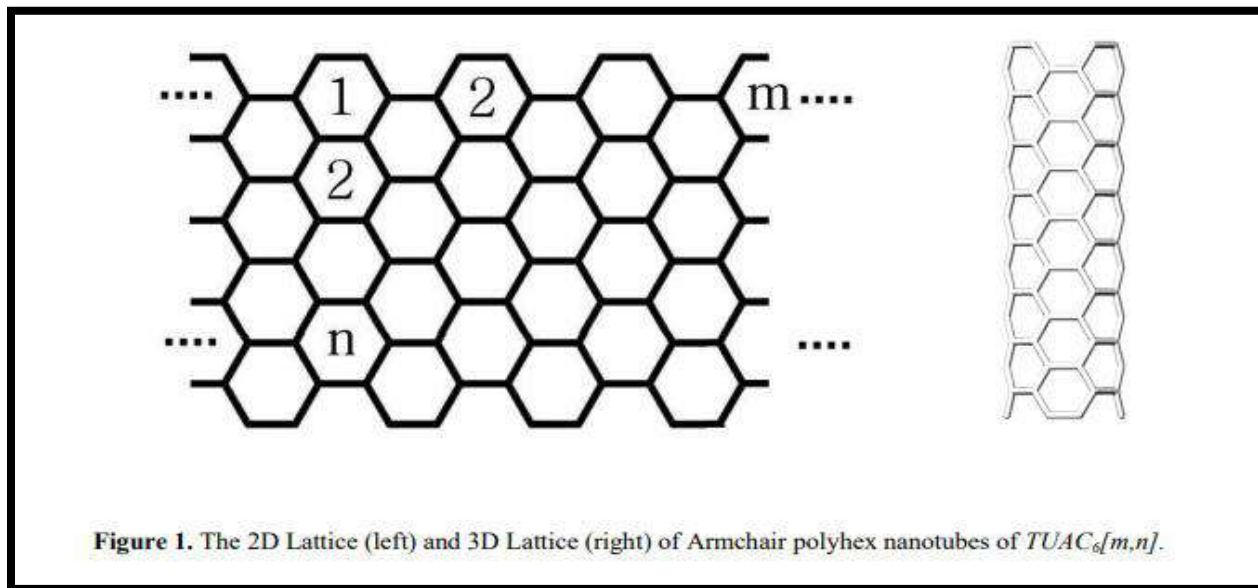
A Curated Database: the 3 and 2 Dimensional Structures and Pharmacological Activities of Anti-Inflammatory Phytochemicals in Plants

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ABSTRACT

Plants have long been utilized as a source of medicine, and several economically important medications are derived from them. Inflammation is a natural aspect of the immune system's reaction. Pain, redness, heat or warmth, and swelling are the four major symptoms of inflammation. Medicinal plants can produce a vast range of phytochemical compounds called as secondary metabolites, all of which have inflammatory properties. The most serious drawback of today's strong synthetic medications is their toxicity and the recurrence of symptoms when treatment is stopped. Screening and developing medications with anti-inflammatory action is an ongoing concern, and anti-inflammatory drugs from indigenous plants are desperately needed. As a result, we established an anti-inflammatory medicinal plant database system that stores information on plants to satisfy the above demands. A Data base of total of 220 medicinal plants with their phytochemical compounds were created for drug discovery purposes.

Keywords: Medicinal plants, anti-inflammatory plants, phytochemical compounds, database, diseases, treatment.

INTRODUCTION

Anti-inflammatory is a physiological process of human diseases with the signs of redness, swelling, heat, pain, loss of function and causes Vasodilation, Increased vascular permeability and increased granulation of tissues, Vasodilation, Physical and chemical stimulation of nociceptors, Pain reflex, muscle, inhibition, disruption of tissue structure structure, Fibroplasias and metaplasis [1]. Anti-inflammatory diseases are a long-term disorder [2].

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Inflammation can be of following types. 1) Microbial inflammation: - It can be caused by Bacteria, Fungi, Viruses, and Protozoa. Diseases caused are: - Pneumonia, sepsis, Abscess, etc 2) Autoimmune inflammation: - It can be caused by auto antibodies or auto reactive B and T cells. Diseases caused are: - Multiple Sclerosis, Psoriasis. 3)Allergic inflammation: - It can be caused by Allergens (e.g. pollen, dust, mites, insects, stings) Diseases caused are Hay Fever, Asthma, Anaphylaxis, Contact Dermatitis 4) Metabolic inflammation:- It can be caused by Accumulation of cholesteryl esters, or uric acid. Diseases caused are Gout, Atherosclerosis, Phenylketonuria 5) Physical inflammation: - It can be caused by Trauma, Burns. Diseases caused are traumatic injury, Burns, Radiation injury. Plants useful in joint inflammation are *Withania somnifera* (roots), *Annona squamosa* (stem), *Glycyrrhiza glabra* (roots), *Erycib eobtusifolia* (stem), *Malus domestica* (fruit peel), *Terminalia chebula* (fruits), *Clerodendrum phlomidis*(leaves). Plants useful in cardiovascular inflammation are *Andrographis paniculata, Cimicifuga racemosa, Allium sativum* [3]. Plants with Anti-inflammatory effect are *Curcuma longa, Zingiber officinale, Rosmarinus officinalis, Glycyrrhiza glabra*, *Ocimum tenuiflorum, Tinospora cordifolia* [4]. For millions of individuals in many countries, traditional medicinal herbs have acted as a potential source of alternative treatment for a variety of maladies. Plant parts such as stem, bark, leaves, flowers, can be used in preparing drugs and used in many purposes for human needs, as compared to synthetic drugs, phytochemicals from medicinal plants have no side effects [5]. Bioactive phytochemicals like polyphenols, alkaloids, coumarins, saponins, terpenoids, flavonoids, steroids are found to inhibit genetically and functionally diverse diseases [6]. Natural chemicals generated from plants, that have proven crucial in modern pharmacotherapy [7]. This provides detailed information of plants and phytochemical compounds on physicochemical properties, 3-dimensional structures, druggability properties which can be further used for docking [8]. Thus, medicinal plants are a valuable resource for a wide range of compounds that are important for human needs.

Medicinal Plant Uses
It can be used in skin disorders, detoxification, digestive disorders, removal of urinary stones, liver diseases like jaundice, liver cancer, cystitis infection, diabetes, hypertension, urinary tract infections, gastric diseases, malaria, appetizer, boosts immunity, respiratory problems, constipation, acne, treats cough, good for hair loss, purifies blood, beneficial for joint paints, improves eye sight, cure acidity, etc.

MATERIALS AND METHODS

List of Medicinal Plants
Anti-inflammatory plants were collected from various literature sources. 220 Medicinal plants were collected which have anti-inflammatory properties [9].

Phytochemical compounds of Medicinal Plants
After establishing a thorough list of Medicinal plants, information on phytochemical compounds were gathered using web sites like pubchem and Swiss ADME. Physicochemical Properties - Lipophilicity, water solubility, Pharmacokinetics and Drug likeness were studied.

RESULT

More than 1200 phytochemical compounds were studied. Their ligand properties were analysed. All the phytochemical compounds were calculated for their molecular weight, heavy atoms, hydrogen-bond acceptor, hydrogen bond donor, GI absorption, ALI class, BBB permeability, TPSA. Phytochemical properties of five varied categories were checked for more than 1200 compounds. https://in.docworkspace.com/d/sIDeB_f03frHlAY

Physicochemical properties

Heavy atoms, Aromatic heavy atoms, Rotatable atoms, H-bond acceptors, H-bond donor, MR, TPSA, iLOGP, XLOGP3, WLOGP, MLOGP, Silicos-IT Log P, Consensus Log P were studied under Lipophilicity. ESOL Log S, ESOL Solubility (mg/ml), ESOL Solubility (mol/l), ESOL class, Ali Log S, Ali Solubility (mg/ml), Ali Solubility (mol/l), Ali class, Silicos-IT LogSw, Silicos-IT Solubility (mg/ml), Silicos-IT Solubility (mol/l), Silicos-IT class were studied under Water Solubility. GI absorption, BBB permeability, Pgp substrate, CYP1A2 inhibitor, CYP2C19 inhibitor, CYP2C9 inhibitor, CYP2D6 inhibitor, CYP3A4 inhibitor, Log Kp (cm/s) were studied under Pharmacokinetics. Lipinski #violations, Ghose #violations, Veber #violations, Egan #violations, Muegge #violations, Bioavailability Score were studied under Druglikeness. PAINS #ALERTS, Brenk #alerts, Leadlikeness #violations, Synthetic Accessibility were studied under Medicinal chemistry. https://in.docworkspace.com/d/sIN-B_f037M3HlAY

Molecular Weight (MW)

In the analysis of MW, about more than 90% of the compounds had less than 500 Daltons. Maximum of 190 compounds (acids and steroids) were found in the range of 401-450 respectively. Maximum was observed with the compounds viscosin (1126.38 Da) and amino acids (1163.42 Da) (Figure 1).

Heavy Atoms

In the analysis of heavy atoms maximum of 90% had less than 50 heavy atoms. Maximum of 414 compounds (steroids, saponins, vitamins, acids and plants like *Andrographis paniculata, Alangium salvifolium, Alstonias cholaris)* were found in the range of 21-30 respectively. Greater than 70 heavy atoms was found in 6 compounds such as balanitin 5 (72 heavy atoms), balanitin 6 (73 heavy atoms), balanitoside (74 heavy atoms), rhenin (76heavyatoms), viscosin (79 heavy atoms), aminoacids (80 heavy atoms) (Figure1).

Hydrogen bond acceptor

As per Lipinski's rule, druggable compounds should have 10 hydrogen bond acceptors. In the analysis of hydrogen bond acceptor about, 85% of compounds had less than 10 hydrogen-bond acceptor and obey Lipinki's rule and possess 10 hydrogen bond acceptors. Maximum of 863 compounds (alkaloids, terpenoids, glycosides, flavonoids, antroquinone) were found in the range of 0-5 respectively. Compounds such as amino acids and phytic acid showed the presence of 26 and 24 hydrogen bond acceptors respectively (Figure 1).

Hydrogen bond Donor

Maximum of 1118 compounds (quinones, terpenoids, steroids, flavonoids, reducing sugars) were found in the range of 0-5 respectively. Compounds such as amino acids showed the presence of 19 hydrogen bond donor, lysine, punigluconin and glycoside showed the presence of 14 hydrogen bond donor (Figure 1).

TPSA (Total prostate-specific antigen)

Maximum of 549 compounds (Plants such as *Teucrium polium, Sida rhombifolia, Saussurea costus, Alstonias cholaris, Acorcus calamus L., Calotropis procera, Bambusa vulgaris, Balanites aegyptiaca, Ficus racemosa)*were found in the range of 0-50 resprctively. compounds such as amino acids were found to be had high i.e. (593.9 total prostate-specific antigen) and compound conessine was found to be had low total prostate-specific antigen i.e. 6.48 (Figure 2).

ALI-Class

Maximum of 382 compounds (aldehydes, alcohols, acids, flavonoids, quinones,) were found in the soluble region respectively.76 compounds were found in the highly soluble region some of them were dulcitol, alanine, phenyl alanine, alliin, linamarin, mycaminose, etc. 86 compounds were found in the insoluble region such as octacosanol, lupeol, cerebroside, glucocerebroside, cycloartenol, hyperforin, alpha-amyrin acetate, mono galactosyl diacyl acetate, beta-carotene, heptacosanol, etc (Figure 2).

GI (Gastrointestinal) Absorption

Maximum of 759 compounds (Plants such as *Zingiber officinale, Withania somnifera, Tylophora indica, Aloe vera, Solanuum nigrum, Rhynchosiacana, Piper sarmentosum, Piper ovatum, Ocimum basilicum, Nigella sativa, Curcuma longa, Achyranthes bidentata, Tinospora cordifolia, Viscum album, Jatropha curcas,* etc.) were found in high absorption respectively (Figure 2).

BBB (Blood-Brain Barrier) Permeant

Maximum of 819 compounds (O-acetyl ethanolamine, stigmasterol glucoside, lupeol, quercetin, allantoin, kaempferol, echinatine, dotriacontanol, betulinic acid, reticulatain-2, helminthosporin, etc.) were found that do not have BBB (Blood-Brain Barrier) Permeability. (Figure 2).

3-Dimensional structures

Maximum of 1161 compounds out of 1256 compounds have 3-dimensional structures respectively (Figure 3).

DISCUSSION

The search for bio-active compounds which can be used as non-conventional analgesics, anti-inflammatory has received considerable attention in recent times because of the increasing worldwide development of lasting solution to pain, inflammation, which are safe to human and with no side effects as seen with modern medicine. Thus, this study was designed to evaluate the curative capacity of medicinal plants against pain, inflammation. It has been reported that more than 70% of the developing world's population still depends on complementary and traditional medicine which were from medicinal plants. Traditional medicinal plants practice, both ancient and modern, has been considered as the key treatment options for the treatment of various human needs, over the centuries. *Glinus oppositifolius* is used for treating abdominal pain and jaundice, is also useful in treatment of joint pain, inflammation, skin disorders, etc. *Alafia barteri* as an anti-inflammatory remedy. Curcumin is a naturally occurring yellow pigment derived from curcuma longa [10]. It has used in Ayurvedic as an anti-inflammatory agent, also used in treatment for digestive disorders. *Pedalium murex L* useful in treating disorders of urinary systems. *Ocimum gratissimum* is useful in treating bacterial fevers [11]. *Ocimum sanctum* (Tulsi), also called as holy basil, has proven its therapeutic potential as anti-bacterial, anti-inflammatory, anti-diabetic, immune booster, etc. It has capability of curing different health diseases including bronchitis, pyrexia, asthma, skin diseases, etc [12].

For this, more than 1200 phytochemical compounds were studied. All the phytochemical compounds were checked for their molecular weight, heavy atoms, hydrogen-bond acceptor, hydrogen-bond bond, GI(Gastrointestinal) absorption, TPSA (Total prostate-specific antigen), BBB (Blood-Brain Barrier) Permeability, ALI class. Out of 1256 compounds 1161 compounds has 3-dimensional structures. Maximum of 190 compounds (acids and steroids) have less than 500 Dalton's of molecular weight. 414 compounds (steroids, acids, saponins, vitamins, etc.) have less than 30 heavy atoms of phytochemical compounds in the range 21-30 respectively. Most of the compounds (aldehydes, alcohols, acids and flavones) were found in soluble region of ali class. 759 compounds (Plants such as *Zingiber officinale, Withania somnifera, Tylophora indica, Aloe vera, Solanuum nigrum, Rhynchosia cana, Piper sarmentosum, Piper ovatum, Ocimum basilicum, Nigella sativa, Curcuma longa, Achyranthes bidentata, Tinospora cordifolia, Viscum album, Jatropha curcas,* etc.) were found that they have high absorption of GI.Maximum of 1118 compounds (quinones, terpenoids, steroids, flavanoids, reducing sugars) were found in the range of 0-5 with respect to hydrogen bond donor. Maximum of 819 compounds(O-acetyl ethanolamine, stigmasterol glucoside, lupeol, quercetin, allantoin, kaempferol, echinatine, dotriacontanol, betulinic acid, reticulatain-2, helminthosporin, etc.) were found that do not have BBB (Blood-Brain Barrier) Permeant. The discovery and study of various herbal medicines used for anti-inflammatory purposes has resulted from the investigation of traditional medicine's anti-inflammatory efficacy [13]. The information gathered from diverse sources is beneficial in the preservation of traditional indigenous knowledge as well as the finding of possible chemicals [14]. The information acquired from the data is used to create the report on toxicity profile and mechanism of action the extracts that were examined.

CONCLUSION

Plants are one of the most important sources of medicines. The present study has demonstrated the anti-inflammatory property of phytochemical compounds in medicinal plants. Medicinal plants have been used to treat different diseases due to their accessibility, availability, economic feasibility, perceived efficacy. They may serve as a valuable bio-resource for generating more potent herbal medicines that are more effective in treatment of pain, heat, swelling, etc. The present study, therefore, scientifically confirms and support the traditional use of extracts of bio-active compounds from medicinal plants for management of inflammation, painful, swelling, heat conditions.

ACKNOWLEDGEMENT

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Figure 1:Analysis of Molecular weight, Heavy atoms, Hydrogen bond acceptor, Hydrogen bond donor of Compounds

Figure 2: Analysis of Total prostate specific antigen, ALI class, Gastrointestinal absorption, Blood-brain barrier of Compounds

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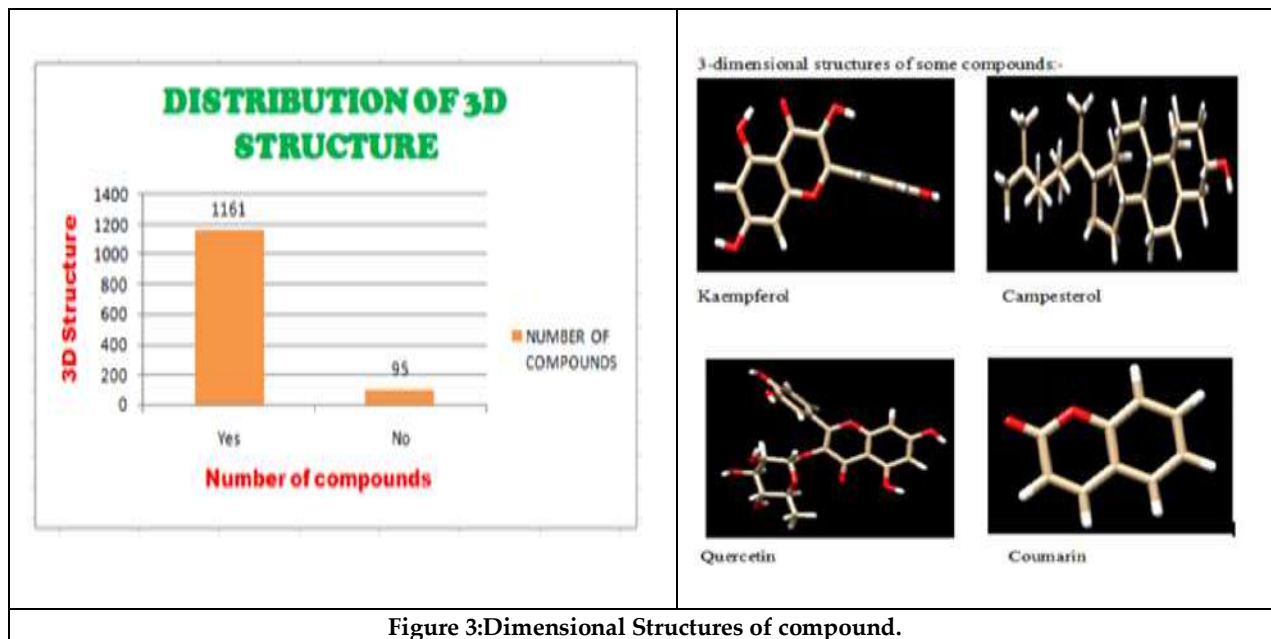
Figure 3:Dimensional Structures of compound.

RESEARCH ARTICLE

Assess the Quality of Life of Staff Nurses Working in Selected Hospitals, Tamil Nadu

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ABSTRACT

Nurses experience poor work-life balance. It is reported that only 2% of female nurses spend quality time with family members and 22% felt that they did overtime, worked for long hours and hence could not spend quality time with their families. Problem solving was the most prevalent coping style employed by nursing personnel in emergency care unit. The objectives are to assess the level of quality of life. The design selected for this study was non experimental descriptive design with cross sectional survey approach was used to conduct the study. The study was conducted in selected hospitals, Tamil Nadu. 20 nurses were selected through simple random sampling. The result shows that level of quality of life among nurses depicts that most of them 85% had average quality of life, 15 % of them had poor level quality of life and none of them had good quality of life level.

Keywords: Nurses, patients' , female, poor, life, hospitals

INTRODUCTION

Globally, the majority of nurses report low-to moderate Quality of work life (QWL). In the Gulf region, more than half of nurses (54.7%) employed at two tertiary healthcare institutions in Riyadh, Saudi Arabia, were dissatisfied with their work life; moreover, 94% indicated their intent to resign from their current roles. The nursing profession in India is facing the issue indicate that nurses still have challenging working conditions like abuse from employers, colleagues, and patients' families; very low salary, workplace restrictions, poor work environments and no social acceptance. It is highly essential to identify the challenges faced by the nurses in the work setting to address issues.

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Marzieh Kheiri *et al.,* (2021), did a correlational study on factors influencing nurse work-life quality. Using the purposive sampling technique, a total of 239 nurses were chosen. The information was gathered via a work-life quality questionnaire. The findings revealed that the majority of the participants were women (80.33 percent) and between the ages of 30 and 45. (71.54 percent). Working in different hospitals, having a second job, and obtaining health information were all significant predictors of nurse quality of life, accounting for 28.68 percent of the total variance in nurse quality of life. The study indicated that supporting nurses' health information-seeking behaviors could improve their work-life quality by allowing them to maintain a better work-life balance and acquire knowledge and skills that can help them manage their job and personal responsibilities more effectively.

Statement of Problem

A study to assess the quality of life among staff nurses working in selected hospital, Tamil Nadu.

Objectives

1. To assess the level of quality of life among staff nurses.
2. Associate the quality of life with selected demographic variables of the staff nurses

METHODOLOGY

The design selected for this present study was non experimental descriptive design with cross sectional survey approach was used to conduct the study. The study was conducted in hospitals, formal permission was obtained from the hospital authorities. The population of the study was all the staff nurses working in selected hospital. Sample size for the study was 20 staff nurses working in selected hospital. Non probability convenient sampling technique was used to select the subject for this study.

Description of the tool

It consists of two section the section A consists of demographic characteristics of staff nurses and the section B consists of WHO QoL - BRIEF scale. It is a standardized tool devised by WHO (1996) to measure the quality of life of individuals. It consists of 26 items. The items are rated on a five point scale.

Ethical consideration

Permission was obtained from concerned authorities of the hospital. The samples were selected using convenience sampling technique. Verbal consent was obtained from the subjects on day one.

Data collection period

The data was collected by the month of March 2020. The collected data was tabulated and analyzed by using descriptive statistics.

Analysis and Interpretation

A descriptive cross sectional survey approach was used to collect data from 20 staff nurses in selected hospitals to identify the quality of life among staff nurses. Data analysis was done using descriptive and Inferential statistical methods to identify quality of life and chi-square test was used to associate the demographic variables with quality of life.

Summary

Most of the staff nurses working in hospital had average quality of life and none of the staff nurses had good quality of life

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Table.1: Frequency and Percentage wise Distribution to Assess the level of Quality of life among Nurses Working in Selected Hospitals, Tamil Nadu.

Quality of life	Frequency f	Percentage %
Poor	6	15
Average	34	85
Good	0	0
Overall	40	100

Percentage wise distribution of level of quality of life among nurses depicts that most of them 85% had average quality of life, 15 % of them had poor level quality of life and none of them had good quality of life level**.**

RESEARCH ARTICLE

Range Extension of the Redskin Waspfish, *Ablabys binotatus* (Peters, 1855) (Scorpaeniformes: Synanceiidae) from Coromandel Waters, East Coast of India

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ABSTRACT

The present paper reports the new distributional record of the Redskin wasp fish, *Ablabys binotatus* from Coromandel waters, East Coast of India, indicating it's range extension to the northern Tamil Nadu coast. Two specimens (73.94 and 76.22 mm SL) were collected from the bycatch of bottom trawlers at Pazhayar and Nagapattinam fish landing centers in September 2019. This communication provides brief information on the systematics and a description of the collected specimens.

Keywords: Redskin wasp fish, Coramandal coast, India and Range extension.

INTRODUCTION

Fishes representing the subfamily *Tetraroginae* (family: *Synanceiidae*) belongs to the order *Scorpaeniformes*; the subfamily comprises 44 valid species under 17 genera (Fricke et al., 2022). The distribution range of this family is confirmed to the Indo-West Pacific region. These fishes are highly venomous species which has the ability to force a painful sting through their dorsal spines as part of their defense mechanism (Poss, 1986). They are nocturnal bottom-dwelling, free-swimming fishes adapted to live in deeper waters (up to 300m) of the tropical seas (Eschmeyer, 1998). *Tetrarogines* are small to medium-sized fishes with a size range of 2.5–23 cm, typically exhibiting the characteristic features of the *scorpioniformes*. The study species family is characterized through the appearance of a compressed body, having a spiny head, strong dorsal and anal fin spines, a mobile lacrimal bone, skin at the gill opening not broadly connected to the isthmus, and the lower pectoral fin not separated from other pectoral fin rays (Poss, 1986). In general, they inhabit rough sea bottoms of rocky nature, crevices or coral reefs, and mainly feed on small crustaceans and fishes (Froese and Pauly, 2022). Previous studies have distinguished five distinct Indo-West Pacific species of the genus Ablabys through the conventional taxonomical study; *A.binotatus* (Peters, 1855) (Redskin-fish; distributed in the western Indian Ocean), *A.gymnothorax* (Chungthanawong and Motomura, 2018) (Scaleless Spiny Waspfish; Japan, Vietnam, Thailand), *A. macracanthus* (Bleeker, 1852) (Spiny Waspfish; eastern Indian Ocean and western Pacific), *A. pauciporus* (Chungthanawong and Motomura, 2018) (Lesser-scaled Cockatoo Waspfish; Queensland, Australia) and *A. taenianotus* (Cuvier, 1829) (Cockatoo Waspfish; Indo-West Pacific) (Day, 1878; Fowler, 1934; Randall and Anderson, 1993; Randall and Spreinat, 2004; Prokofiev, 2008; Fricke et al., 2014). During our surveys on the fish diversity of Tamil Nadu coastal waters, India, we collected two specimens of *A. binotatus* from the trawl bycatch at Pazhayar and Nagapattinam fish landing centers (East coast of India), which was previously recorded from the coral reef ecosystem in Gulf of Mannar, India. (Varghese, 2013). The present record of the study species throws some insight into information that Coromandel Coast comprises rock shore substratum in the near shore waters. (Khan *et al.,* 2008). The description of the specimens is outlined in the present study.

MATERIALS AND METHODS

Field surveys were conducted on a monthly basis at various major trawl fish landing centres in Tamil Nadu, south eastern coast of India from June to September 2019. Two specimens of *A.binotatus* (73.94–6.22 mm SL) were collected from the bycatch of bottom trawlers targeting fish (mesh size of code end ranged from 20–45 mm) at Pazhayar (11°21′32′′N, 79°49′22′′E) and Nagapattinam (10°45′′28′′N, 79°50′58′′E) fish landing centers. Trawling was carried out near shore and offshore fishing grounds at depths ranging from 25 to 110 meters, at a distance of 04 to 60 Nautical miles from shore. After the collection of specimens from the landing centers, fresh photographs were taken, and the specimens were then preserved in 10% formaldehyde solution. Specimens were deposited in the Centre of Advanced Studies in Marine Biology, Annamalai University, Reference Museum (CASMBAURM), Parangipettai, India. Morphometric measurements were carried out using a digital Vernier caliper of 0.01 mm accuracy. Specimens were identified to species level by following previously published keys (Prokofiev, 2008; Chungthanawong and Motomura, 2018). The authorship of the sub-family follows previously published literatures (van der Laan *et al.,* 2014). Measuring methods follows previously published literatures (Varghese, 2013; Chungthanawong and Motomura, 2018; Motomura *et al.,* 2008). The results were expressed in % of standard length (SL), and measuring the head length (HL) and head spine follows previously published literatures (Randall and Anderson, 1993). Morphometric measurements were compared with holotype and the same species collected previously from Gulf of Mannar, India. The systematic position and description of *A. binotatus* recorded in this study is given in the result section.

RESULT

Systematic account
Order: *SCORPAENIFORMES* (Risso, 1827)
Family: *SYNANCEIIDAE* Swainson, 1839
Subfamily: *TETRAROGINAE* Smith, 1949
Genus: *Ablabys Kaup*, 1873
Species: *Ablabys binotatus* (Peters, 1855)

Synonyms
Apistus binotatus Peters, 1855
Amblyapistus binotatus (Peters, 1855)
Amblyapistus marleyi Regan, 1919
Amblyapistus taenionotus (Fowler, 1934)

MATERIALS EXAMINED

Material collected in this study
CASMBAURM/232116481, one specimen (73.94mm SL) Pazhayar fish landing centre, India: Tamil Nadu, coll. Selvakumar 14th September 2019. CASMBAURM/232116482, one specimen (76.22mm SL), Nagapattinam fish landing centre, India: Tamil Nadu, coll. A. Murugan, 24th September 2019.

Description
XVI, 9 dorsal-fin rays; III, 6 anal-fin rays; 11/11 pectoral-fin rays; I, 5 pelvic-fin rays and 25 lateral line pores (Table 2). The head and body are highly laterally compressed; the anterior profile of the head is almost vertical, slightly curved inwards in front of the eye. The jaws are of equal length; the mouth is terminal; teeth villiform; Vomerine tooth patch present; just above the mouth two pairs of nasal pores present; lacrimal bone with two spines, the upper is pointed than the other one and slightly longer than the other one; the lower spine is directed backwards and downwards. Preorbital and preopercular spines are shortly blunt. Operculum with two blunt V-shaped ridges ending in small spines. The lateral line continuous on body, extending from the preopercular spine to caudal-fin base, position of lateral line relative to dorsal fin base is well separated. The body is entirely covered with small non-overlapped scales, absent at head. First spine of dorsal and anal fins shorter than the following ones; first dorsal spine positioned above frontal margin of eye, second dorsal spine is longest among the others, twice as long as fifth and sixth spines, which are shortest. Pectoral, pelvic and anal-fin rays branched. Caudal fin rounded (Table 1). The fin membrane of last dorsal fin ray posteriorly connected to caudal peduncle and upper base of caudal fin (Fig.2).

Live coloration
Head and body dark brown, pectoral and caudal fin and posterior parts of soft dorsal and anal fins blackish, tips of dorsal-fin spines white. A prominent white blotch just above the pectoral- lateral line and below the IX & X[th] dorsal spines (Fig. 2).

Distribution
A. binotatus (Peters, 1855) has been previously reported from the western Indian Ocean: Maldives (Randall & Anderson, 1993), Mozambique, South Africa and Tanzania. It has been previously recorded from Mandapam group of Islands in Gulf of Mannar and the current record proves the distributional range extends to the Coromandel Coast of India (Fig. 1).

Remarks

A.binotatus differs from other representatives of the same genus by the number of dorsal-fin spines and anal-fin rays. *A. binotatus* is distinguished from *A. macracanthus*, *A. taenianotus*, *A. pauciflorus* and *A. gymnothorax* by having XVI, 9 dorsal-fin rays (vs. XV-XVI, 8–9 vs. XVII–XVIII, 6 – 7 vs. XVI–XVII, 5 or 6 vs. XVI, 9) and III, 6 anal-fin rays (vs. III, 8–9 vs. III, 6–7 vs III, 4–5 vs. III, 8 – 9) (Prokofiev, 2008; Varghese, 2013; Chungthanawong and Motomura, 2018).

ACKNOWLEDGEMENT

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Table 1. Ranges and means of morphometric characteristics of *A. binotatus* (n=2)

Parameters	Range	Mean	Parameters	Range	Mean
Total length (mm)	100.12 – 98.36	99.24	1st dorsal – spine length	10.30 – 11.51	10.95
Stranded length (mm)	76.22 – 73.94	75.08	2nd dorsal –spine length	27.29 -30.08	28.68
% of Stranded length			3rd dorsal – spine length	29.36–31.29	30.32
Head length	29.22 – 33.00	31.11	4th dorsal spine – length	20.82 -22.34	21.58
Length of dorsal-fin base	93.14 – 94.6	93.87	5th dorsal – spine length	16.66 – 20.19	18.42
Length of anal fin base	23.87-25.54	24.7	6th dorsal – spine length	14.48 -16.60	15.54
Body depth	30.514 – 34.64	32.58	1st anal-spine length	8.04 – 7.93	7.99
Pre –dorsal length	3.9-4.22	4.06	2nd anal – spine length	11.91 – 12.33	12.12
Pre – pectoral length	27.3 – 30.75	29.02	3rd anal – spine length	13.82 – 14.20	14.01
Pre – pelvic length	31.06 – 33.74	32.4	Least depth of caudal peduncle	10.17 – 10.35	10.26
Pre – anal length	64.44 – 67.59	66.01	**% of Head Length**		
Pectoral fin length	34.18 – 35.6	34.89	Head width	56.08 – 59.45	57.77
Pelvic fin length	23.57 – 27.97	36.19	Snout length	20.03 – 21.50	20.76
Pelvic spine length	17.39 – 19.95	18.67	Eye diameter	33.26 -34.28	33.77
			Upper Jaw length	31.28 – 37.32	34.30

Table 2. Ranges and means of meristic characteristics of *A. binotatus* (n=2)

Parameters	Present study CASMBAURM/232116471–72	GB.38.24.3.1 (Varghese, 2013)
Dorsal-fin rays	XVI, 9	XVI,9
Anal-fin rays	III, 6	III, 5
Pectoral-fin rays	11/11	11/11
Pelvic-fin rays	I, 5	I, 5
Caudal-fin rays	13	13
Lateral line pores	25	26
Gill rakers	6	6
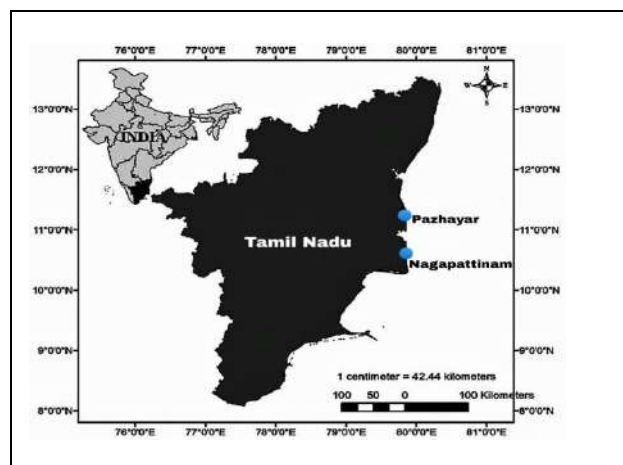
Fig.1. Map showing fishing harbours in Tamil Nadu coastal waters (Pazhayar and Nagapattinam), where *Ablabys binotatus* were collected in this study	**Figure 2: Fresh specimen of *Ablabys binotatus* CASMBAURM/232116482 (76.22mm SL), collected from Nagapattinam, Tamil Nadu, India**

REVIEW ARTICLE

Review of Artificial Floating Islands as Pollutant Removal Solution for Urban Lakes

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ABSTRACT

Artificial Floating Islands (AFI) or Floating Wetlands bio-mimics natural wetlands and are innovative nature-based product that can play a promising role in improving water quality of polluted urban lakes, treat wastewater, conserve ecosystem and add to landscape aesthetics. It is a sustainable low-cost, low-energy solution to remove contaminants in water and wastewater bodies, especially where finance is a constraint. This review paper examines the design and operations of AFI for various types of water and wastewater application. By studying the pattern of pollutant removal capacities of the vegetation used in AFI and their construction techniques, a framework to adopt this ecological engineering technology in the case of an urban lake is proposed for the Indian context. The floating mat design implanted with hydroponic plants are capable of removal of contaminants like heavy metals, nitrates and phosphates. This technology is gaining popularity worldwide due to its flexible, eco-friendly and economic design that does not put any burden on the existing land use. Comparing the performance of vegetations under various water conditions provides the basis for selection of appropriate plant for optimal performance.

Keywords: Artificial Floating Islands, Floating Wetlands, Water Pollution, Urban Lakes, Nutrient removal

INTRODUCTION

Need for the study

Artificial floating wetlands are largely popular and widely accepted stormwater quality improvement device. There are many terminologies used for this system like floating-bed constructed wetland (FBCW) and horizontal subsurface flow constructed wetland (HSFCW) (Bai *et al.,* 2020) 'Floating treatment wetland' (Gaballah *et al.,* 2021) or 'Constructed wetland treatment', Constructed floating wetlands (Nichols *et al.,* 2016), in this paper the term 'Artificial Floating Islands' (AFI) is used. The objective of this literature review study is

● To understand the operational factors for efficient functioning of the AFI's.

● To study the nutrient removal capacity of the AFI's in different types of water/wastewaters.

● Performance analysis of different types vegetation in AFI for different water quality parameters.

Operation and functions of AFI
Working principle of artificial floating islands

The methodology of this literature study is illustrated in the figure 1. For AFI to be sturdy and effective in design, they have to be carefully designed, constructed and operated with good level of maintenance. The main components of AFI are water, frame, floating mat, planting media, floating aquatic plants, leaf litter, microorganisms, invertebrates and climatic conditions. The chain of actions that ultimately leads to the purification of water are:

• Microorganisms converting nutrients to simpler forms that aid intake by plants.

• Release of bioactive substances by the roots that balance the pH and increases the humic content of water aiding adsorption of pollutants

• The dense network of the roots traps the particulate matter.

• Aerobic degradation of organic matter by rhizosphere bacteria.

• Reduction in BOD and COD due to oxidation of carbon compounds by microbes.

• Nitrification under aerobic condition transforms nitrate to nitrate nitrogen. Nitrate absorb all inorganic forms of nitrogen.

• Phosphorous is removed by sorption or by plant intake. The pollutants are moved from roots to upper part of the plants and regular pruning of the aerial parts would help in removal of the pollutants permanently. [1]

Water depth

Area of water and depth of water play an important role in interacting with the atmosphere through rainfall and evapotranspiration. The recommended depth is a between of 0.8-1.0m though it can be greater for stormwater type as the roots can grow longer and get fixed to the sediments, which poses a problem of getting submerged when water levels increase. [1] have mentioned that deeper depths of water results in greater removal efficiencies of AFI due to extended detention time during flow. On the other hand, very, deeper depths will prevent contact with roots of floating mat and hence not effective in removal of contaminants. AFIs are designed to act on fluctuating water levels.

Role of Vegetation

Eutrophication levels come down when the plants uptake the nutrients.[2]. Vascular plants are used in AFI. Usually, emergent plants like sedges, rushes and reeds are used which grow their stems and leaves above the mats and roots under the floating mat. These plants have number of functions. They slow the water velocity allowing the suspended solids to settle thus removing turbidity. They help in nutrient, carbon and metal elements intake. They help in exchange of gases between the atmosphere and the sediments. Their stem and roots provide sites for microbial activities. Plant species should acclimatize, must be perennial, should not be invasive, preferably buoyant and aesthetically pleasing. Very tall species may overturn the floating mat; hence size of the plant also is vital. Reeds, cattails and helophytes perform well in artificial and semi-natural conditions and sustain water-logged conditions. Regular harvesting helps in removal of pollutants from the system. It also helps in cleaning up of leaf detritus build up on mats and aid in plant regrowth.

Plant coverage and shading
The coverage of plant surfaces due to the AFI minimizes the sunlight from penetrating into the water column due to which the algal growth is limited. This also impacts the biofilm composition that are developed in the roots [3]. 5% to 10% plant coverage is also sufficient to remove nutrients significantly [4]. If more vegetation is there in AFI, aerobic conditions increase and anerobic metabolism like denitrification is affected. Dense plantings in AFI perform better than sparsely placed plants [1]. [5] finds from the mesocosm experiments that Ammonia levels increased in the stormwater ponds with coverage indicating that large mat surface area of AFI is not good for removal of ammonia. The same author noted that high surface area inhibits algal formation.

Buoyancy
AFI consists of a system that is kept buoyant by the materials used in the construction of framework for the mat and the plants self-supported on intertwined roots underneath the mat. The floating nature make its less vulnerable to changing water levels. According to [6] the floating mats should be completely organic in order to be buoyant. Understanding how the natural wetlands work to be buoyant helps in making the AFI to imitate the natural phenomenon. According to [7], the buoyancy of the wetland is mainly due to the air spaces between the rhizomes of the vegetation mass and the gases released due the anerobic metabolism of the organic matter.

Biofilm
The presence of bacteria in the AFI is effective in removal of contaminants from water[8]. The litter of vegetation that die and accumulates creating additional material and source for carbon, nitrogen and phosphorous to trigger the microbial process. The slimy material of algae, bacteria, fungi and protozoa form on the dense network of roots providing more area for biochemical reactions of contaminants by fixing trace particles to the particulate matter. Biofilms carriers like bamboo, polystyrene, plastic carriers can enhance the surface area 60-430 times greater compared to root area for microbial activity[9]. These carriers also help in equalizing the flow of water and thus help in entrapping pollutants. The figure 2 illustrates the main components of AFI.

RESULTS

Application fields of AFI
To improve the water quality, the application of artificially created floating islands are used in the field of stormwater and wastewater domestic effluent treatment in rivers, ponds, lakes and reservoirs, in industrial wastewater treatment, aquaculture and agricultural runoff. It is used for erosion control, to mitigate temperature and also as wildlife habitat.

Stormwater and wastewater treatment
AFI's are efficient for urban stormwater purification as it does not need any additional land and will not alter the land use of the region. Stormwater runoff can contain high contaminant loads from urban landscape which on entering waterways like lakes and rivers can cause eutrophication that can lead to algal blooms, which pose a threat to both human life and aquatic organisms. By retrofitting the shoreline with AFI's water quality can be improved considerably. Application of AFIs helped control the temperature in the pond due to its coverage and shading. This ability of AFI to keep the pond cooler would reduce the effect of heated waters on aquatic organisms and vegetation especially during summers [5].

Agriculture runoff
Agriculture wastewater lagoons have manure slurries that contain heavy nutrients and pathogens causing odor problems too. Agriculture wastewater includes diary, poultry and fertilizer runoffs [5]. 'Rising Sun' *Japanese iris* plant used in the experiment by [10] to test nutrient removal capacity of irrigation water under different pH conditions by AFI, showed good adaptability and removal efficiency for all pH conditions and was found to be resilient compared to bushy bluestem (*Andropogon glomeratus*), and maidencane (*Panicum hemitomon*).

Textile dye wastewater

Many industries release heavy metal contaminants like copper, nickel, lead, manganese and cadmium which can be very detrimental to water bodies. Textile industry wastewater has heavy metals in the dyes used. These metals when released into water bodies cause oxygen depletion, the dye color blocks sunlight and limits photosynthesis action and they are also found to be carcinogenic and mutagenic for all life forms [11]. The same authors emphasized the role of bacteria augmented AFI with the plant *Phragmites australis* in the removal of heavy metals in textile wastewater. The plants inoculated with the bacteria boosted the removal of heavy metals thus proving potential of AFIs.

Arsenic (As) contaminated water

Arsenic found in agricultural runoff poses great danger in developing nations. As conventional treatments can be expensive nature based solutions can provide good benefits for such contaminated water [12]. conducted the test for agricultural water reservoir using the AFI with Vetiver grass which showed survival rate of 92% with well-developed root and shoot system. The removal rate was 97% for arsenic in water, 84% for arsenic in sediment, 87% for iron in sediment, and the pH reached 6.37. Despite the environmental condition of very cold weather, Vetiver had the potential to rehabilitate arsenic contaminated water.

Swine lagoon waste water

Swine lagoons are generally treated an aerobically in lagoons that are cheap and simple to operate. [13] experimented with cattails, bullrush and maidencane on swine lagoons and found them to be very efficient in the removal of nitrogen, phosphorous and potassium. The authors research proved that animal producers can successfully use AFIs with cattails and maidencane with periodical biomass removal.

Acid mine drainage

[14] Enumerates that Acid Mine Drainage (AMD) is formed when sulphidic minerals are exposed to oxygen and water during mining operations. The mine drainage contains similar metals present in urban stormwater. The function of AFI in mine drainage water is to induce anoxic conditions and provide source of organic carbon for biomineralization of metals.

Polluted lakes and rivers

Point and non-point sources can cause eutrophication in lakes and rivers. The pollutants can be from the fertilizers and pesticides, toxic substances from industrial effluents, bacterial loads from the livestock and salts from surface runoff [5].

Water quality improvement by AFI

Typical characteristics of the pollutants present in wastewater are nutrient loads of nitrogen and phosphorous, salts, heavy metals, Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), high range of pH, temperature, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). We have analyzed a wide range of publications to study the performance of the AFI in different types of water bodies. Some of the water quality parameters from the reviewed literature are discussed here.

Nutrients: Nitrogen (N)

Total Nitrogen (TN) includes nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), ammonia-nitrogen (NH_4-N) and organically bounded nitrogen. Presence of Nitrate is due to anthropogenic activities like agriculture, sewage disposal, food industries and industrial effluents. It is an important nutrient that accelerates the growth of algae and macrophytes. If present in excess can be detrimental to health of humans and aquatic organisms [15]. According to [16] bacteria degrades organic nitrogen into ammonium, nitrite and nitrate and this can be absorbed by plants, algae and bacteria and the cycle continues when the dissolved nitrogen forms organic nitrogen again [17] has reported that both nitrate and ammonia nitrogen concentrations vary according to the seasonal cycles of the lake. The concentration will be low during the water column stability and increases during vertical mixing event. Both water

depth and plant coverage had significant impact on the removal of ammonia nitrogen. Nitrate and ammonia nitrogen is preferred by most algae and plants as the main source of nitrogen for their growth. Warmer climate promotes the functioning of the biological removal processes. In AFI nitrogen is removed by denitrification which is a plant-bacteria interaction. Both aerobic and hypoxic conditions are necessary for promoting nitrification and denitrification process for the removal of nitrogen(N) [16]. [1] reports that additional sulfur sources are an effective way of removing total nitrogen. The need for carbon sources is eliminated and produces less sludge and thus enhancing nitrogen removal. Addition of iron scraps is known to enhance efficiency of denitrification, it transfers electrons to nitrate, catalyzing enzyme activity.

Phosphorous(P)

The main form of phosphorous is organic phosphorous and orthophosphate. The concentration of orthophosphate is an index of amount of phosphate available for the algal growth [18]. The main removal of phosphorous is the biological uptake [16], [4] reported that total phosphorous removal also depends on the suspended solids in water. Total phosphorous removal is good in shallow water compared to deeper water which can be attributed of development of deep, fibrous and dense taproot system of water hyacinth. The study showed high total phosphorous removal capacity of *Pontederia crassipes* for the combination of low coverage of vegetation and a shallow water depth. Phosphorous removal can be increased by inoculating micro-organisms capable of concentrating phosphorous in the water body [1] [19] reported from their experiments that *I. aquatica* has good ability for phosphorous uptake, though the phosphorous that is liberated in the treatment system is difficult to predict.

Heavy Metals

Heavy metals in water body are detrimental to the environment and human health. Heavy metals have adverse effects on human health. Lead (Pb) can cause kidney and brain and nervous system accumulation that can have serious implications on health. Excessive Zinc can cause skin irritations, vomiting, nausea and anemia. High concentrations of Cadmium can cause abdominal pain and intestinal bleeding [20]. Rhizosphere and biofilms contain trapped particulate heavy metal where they are converted to non-toxic form and may settle in the benthic layer. To avoid reverse transfers of metals to water, the plants have to be harvested. The harvested plant can be used to harness biofuels and energy recovery through biomass. Plants with larger leaf will have more transpiration resulting in more water uptake hence more metal uptake. Larger leaf also means more photosynthetic activity which promotes root growth hence removes more metal [1]. As studied by [4], heavy metal like Iron(Fe), Copper (Cu), Nickel (Ni) and Lead (Pb) concentrations were significantly reduced for all plant coverages.

BOD

[4] Has observed that BOD removal was significant at varying depths and different coverages. The study with water hyacinth by the author showed that BOD removal of 75% was highest for plant coverage of P70 and shallower water depths D25. At higher depths the capacity to remove BOD5 was limited.

Dissolved Oxygen (DO)

Depletion of dissolved oxygen is due to nitrification and respiration of the aquatic organisms. A low DO is unfavorable for fishes and other organisms. Oxygen enters through either diffusion from atmosphere or transportation of oxygen from upper regions like leaves to the roots and rhizosphere. Presence of floating mats may inhibit this process. Hence plant coverage plays an important role in determining the efficiency of AFI. Conversely AFI's increase the oxygen levels in the root zone under the mats.

Pathogen removal

Presence of pathogens like bacteria, protozoa and viruses indicates poor quality of water that can pose danger to human health. The sources can be due to raw sewage and agricultural runoff. Pathogen's survival depends on other parameters of water like salinity, pH, temperature. Treatment of pathogens can be by disinfection by chlorine, Ultra Violet (UV) radiation and filtration process [5].

The study classifies the removal rates into TN, TP and NH₄-N as shown in Table 1 and along with removal rates studied for heavy metals from different treatment sites as shown in Table 2.

DISCUSSION

Factors affecting performance of AFI
The following main factors that affect the performance of AFI is discussed in detail.

Effect of season on plants and plant characteristics
Nutrient removal capacity varies according to seasons. Tropical climate, warmer temperature results in more nutrient uptake by plants due to good growth and increased plant biomass and improved microbial activity in the rhizosphere. Colder seasons show lower bacterial metabolism and reduced enzymatic activity [1]. Water Hyacinth, Common Duckweed and *Azolla filiculoides* is more suitable for tropical climates and may not survive cold regions[3]. *Azolla filiculoides* also may not develop enough root area for the biofilm to be formed and the plant tend to get washed off due to rain or wind. So special arrangements may be needed to hold the plants in place.

Growth media
Suitable growth media materials for AFI provides good water retention, porosity, capillary action and growth condition for the plants. The pH of growth media is suggested to be 5-6.5. The two common growth media are coconut fiber and peat. This can be enhanced with vermin compost and light weight bulking materials like vermiculite, pumice that increase the aeration in rhizosphere[3].

Aeration
Aeration increases the root development below the mats in AFI's which increases in turn the formation of biofilms that ultimately contributes to the removal of contaminants. Aerobic degradation of organic pollutant leads to removal of organic matter substantially. But in the case of Nitrogen, higher removal rates were observed in non-aerated systems. Surface coverage effects the availability of oxygen in the water. Impact of AFI's on oxygen levels in water is to be researched in depth.

Water losses
[4] Has reported water loss due to evapotranspiration especially during summer months is a known issue in AFI. Water loss was least in this setup and heavy metal absorption was higher in AFI than without a plant system.

Wildlife
As AFIs attract birds and aquatic animals to perch on them, excessive wildlife can be harmful for the floating islands and water quality with increase in nutrients due to fecal matter or plants getting trampled or eaten before full growth [3]. Plants may be susceptible to being eaten or destruction. Waterfowl, Canadian geese and ducks can cause destruction of seedlings in AFI. Grass carp was found to eat away at alligator weeds used as floating plants. A check on water fowl is important to save the AFI's.

Plant-bacteria partnership
[2] Observes that bacteria play a vital role in removing stress in plants due to contaminants by degrading the organic pollutants, they increase the disease resistance in the host plant. Rhizobacteria colonize on the roots of the plant and endophytic bacteria colonize in the plant interior. The author informs that *Typha angustifolia* and specific bacterial community are effective in biodegradation of hexachlorobenzene (HCB) found in the root zone. Similarly, vetiver grass contained rhizomicrobial growth concentrated in the roots which was three-fold effective in the degradation of phenol [11] reported that bacteria inoculated plant showed better growth in dye contaminated water when compared to plant only in dye water. *Phragmites australis* was inoculated with bacteria performed better in uptake of toxic metals from the dye contaminated water.

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Plant harvesting

In order to avoid nutrient recycling in the water, plant harvesting is essential activity as studies have shown that nutrients accumulate in the aerial shoots [2] recommends to harvest picker weed and soft-stem bulrush to be harvested in July/August and in October respectively for maximum nutrients to be removed.

Wind effect

Care should be taken to not let AFI to overturn due to wind or wave speeds. Hence high windy places can have low height plants preferably as thumb rule maximum height of the plant should be less than the width of the AFI to avoid tipping. In fact, the presence of AFI along shorelines will moderate the impact of erosion by dissipating the wave speed.

Advantages of AFI

The main advantage of using AFI is that they do not occupy additional space for treating water/wastewater. AFI can be built with materials that are economical and easily available. The vegetation used in AFI can be locally available variety.

Literature gaps

Studies show that AFIs work well in summer than in winter hence more studies can be done to optimize the AFI for efficient working in winter season [31]. The buoyant nature of AFI can overturn the vegetation or drift away from the position hence there is more scope to design efficiently. Harvesting the plant biomass based on the nutrient intake capacity can be varying for different plants, more studies are needed to understand intake capacities over the time taken to decide the harvesting period[1]. points out that due to most research of AFI undertaken in laboratory, testing on real conditions is limited which is a major drawback and reason for the absence of any design parameters for wastewater and stormwater treatment.

CONCLUSION

The system of AFI is multi-functional and sustainable concept that integrates water purification, ecological restoration and landscape beautification. The system can take heavy pollution load, has good operational stability with lower construction and maintenance cost. Thus, it can be recommended for use in urban rivers and lake water bodies successfully. For optimal performance, all the parameters must be considered for the design of AFI based on the type of pollutants released and the hydrological factors of the lake. This literature review focus on the design and management strategies of AFI that can be implemented in an urban lake body as one of the rejuvenation techniques.

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Table 1: Summary of removal rates for Total Nitrogen, Total Phosphorous and Ammonia Nitrogen from studies of treatment with AFI

Sl No.	Reference	Water/Wastewater type	Duration	Plant name	Removal rates (%)		
					Total Nitrogen (TN)	Total Phosphorous (TP)	Ammonia NitrogenNH$_4$-N
1	[4]	Polluted lake	7 days	*Pontederia crassipes*	82	84.2	2.85 g/m2/day,
2	[21]	Urban river		*Lythrum salicaria L., Iris pseudacorus L., Salix integra*	71.12	78.39	80.09
3	[22]	Mesocosm for Surface water	20 weeks	*Pontederia cordata* (pickerel weed) in High concentration	37	42	
4	[20]	Landfill leachate	6 days	Vetiver (South African variety)	58	78	
5	[23]	wastewater of Campus	2 months	*Allium porrum L. Brassica juncea L., Ipomoea aquatica Forsk. Capsicum annuum L. Zizania latifolia, Glebionis coronaria, Lactuca sativa, Brassica rapa, Oenanthe javanica DC*	6.7–62.70	60–81	13.13–80.32
6	[22]	Mesocosm for nursery irrigation runoff	Two 6 weeks periods	'Rising Sun' *Japanese iris (Iris ensata),* bushy bluestem *(Andropogon glomeratus),* and maidencane *(Panicum hemitomon)*	70	56	
7	[24]	pond water	6 days	*Cyprus scariosus,*	9.1	15	
				Typha minima	27.56	19.22	
				canna indica	36.58	21.52	
8	[25]	Urban catchment	2 years	*Carex appressa*	17	52	

9	[26]	Eutrophic Urban Pond	2 years	*Pontederia sagittata* and *Cyperus papyrus*	76		
10	[27]	Polluted river	5 days	Canna with Immobilized denitrifying bacteria and aeration	72.1		100
11	[28]	Urban catchment	12 months	*Carex appressa*	17	53	

Table 2: Summary of removal rates of Heavy metals from studies of treatment with AFI

Sl No.	Reference	Water/Wastewater type	Duration	Plant name	Removal rates (%)						
					Iron (Fe)	Lead (Pb)	Copper (Cu)	Nickel (Ni)	Arsenic (As)	Zinc (Zn)	Cadmium (Cd)
1	[4]	Polluted lake water, Marriot Lake, USA	7 days	*Pontederia crassipes*	62.5	80.4	88.74	81.71			
2	[11]	Dye-enriched textile wastewater	20 days	*Phragmites australis* inoculated with Bacteria	81	65.5	77.5	73.3			
3	[12]	Arsenic contaminated reservoir	120 days	Vetiver					97		
4	[20]	quarry site effluent	6 days	Vetiver (South African variety)		83			50	99	50
5	[29]	Acid mine drainage	1 year	Vetiver	81	81	8	38		35	
6	[30]	Lab experiment	12 days	*Ceratophyllum demersum* and *Lemna gibba*		96.4					

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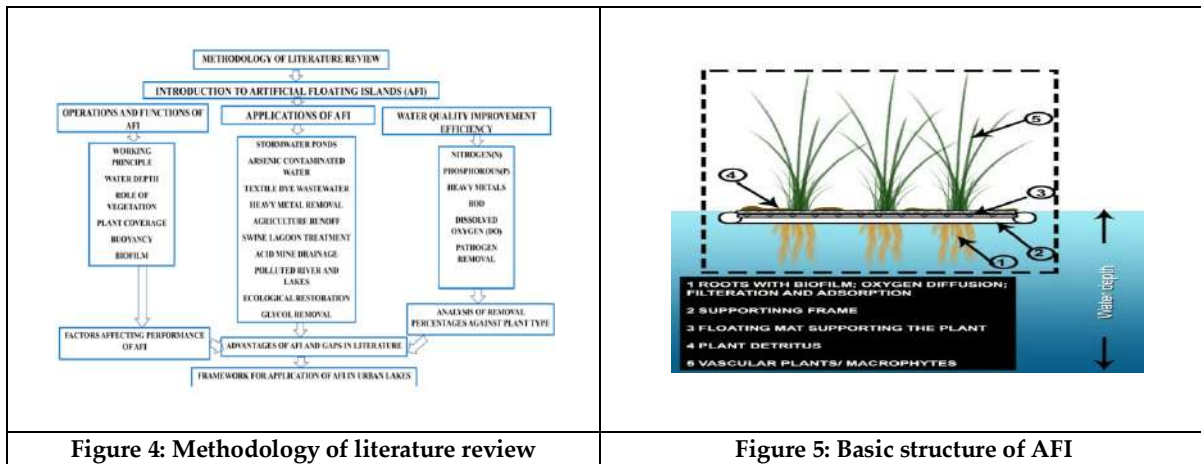
Figure 4: Methodology of literature review	**Figure 5: Basic structure of AFI**

RESEARCH ARTICLE

A Comparative Assessment of Phytochemicals and Antioxidant Properties of *Myrica esculenta* Buch.-Ham. ex D. Don Fruits at Different Stages of Maturation

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ABSTRACT

This study aims to evaluate the phytochemical and antioxidant properties of the fruits of *Myrica esculenta* at two different stages of maturation. The study showed that the unripe fruits contain higher amount of TPC and TFC as compared to the ripe fruits. Moreover, the unripe fruits exhibited higher antioxidant properties than the ripe fruits as found from all the three assays *viz*. ABTS, DPPH and H_2O_2 assay. There is significant difference in the TPC, TFC and antioxidant parameters among the different populations under study. Also, the antioxidant activity is significantly correlated to the TPC and TFC. The study has proved potential of *Myrica esculenta* fruits as a natural source of antioxidant to the body at different stages of growth.

Keywords: *Myrica esculenta*, antioxidant activity, phytochemicals, fruit maturation, correlation

INTRODUCTION

Phytochemicals are known for their several health benefits (Leitzmann, 2016). Particularly the ones having antioxidant potential are immensely useful in providing protection against diseases arising from oxidative stress. These include cardiovascular diseases, obesity, diabetes, cancer, alzheimer's disease etc. (Zhang *et al.*, 2015). Because of the presence of such polyphenols and flavonoids in the various fruits and vegetables, they can impart protection to the body against oxidative stress (Willett, 2002). *Myrica esculenta* Buch.-Ham. ex D. Don is one such species that is found in the north eastern states of India and in Uttarakhand and Himachal Pradesh (Hooker, 1876; Osmaston,1927). The fruits as well as the other parts of the plant are traditionally used in medicines for curing several ailments (Parmar *et al.*,1982; Kirtikar *et al.*, 1999; Chauhan, 1999; Nainwal *et al.*,2009; Rastogi *et al.*, 1995). Different parts of the

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plant have been found to be useful as antiallergic, anti-inflammatory, antiasthemic, antidiabetic, antimicrobial and have also been shown to have chemo protective properties (Patel *et al.,* 2010; Agnihotri *et al*., 2012; Rana *et al*., 2016; Rawat *et al*., 2013; Suryawanshi *et al.,* 2009; Alam *et al.,* 2000). The fruits of *Myrica esculenta* contain many phytochemical compounds such as gallic acid, myricanol, myricanone, myricetin etc (Sood *et al*., 2018). In Assam, *Myrica esculenta* is known as naga tenga. It is distributed in the Upper Brahmaputra Valley, mostly in the Sivasagar district. Although research on the species is being done in other countries like China and in other states of India, the populations occurring in Assam have not yet been evaluated for their potential benefits. Lack of knowledge on the importance and need for conservation of the plant is leading to overexploitation for commercial purposes (Sundriyal *et al*., 2001; Jeeva *et al.,* 2011). Moreover, growth and survival of the species in the wild is low as the seeds undergo physical dormancy (Bhatt *et al.,* 2000). In this study, assessment of the phenolic content, flavonoid content and antioxidant potential of the fruits of *Myrica esculenta* occurring in the different populations of Upper Brahmaputra Valley of Assam has been made. Also, a comparative analysis has been done for the presence of these properties of the fruits at different stages of maturation.

MATERIALS AND METHODS

Survey, Collection and Preservation of plant materials
Surveys were conducted in the different districts of Upper Brahmaputra Valley *viz*. Tinsukia, Dibrugarh, Sivasagar, Charaideo, Jorhat and Golaghat. Taxonomic literatures of Hooker (1876), Kanjilal (1934) and Wealth of India (1950) were used for identification of the species. For the study of phytochemical content at different stages of fruit growth, the sites where *Myrica esculenta* trees were recorded to be present were visited two times during the fruiting season from early February to middle of May during the period from 2019 to 2022. Collection of the fruits was made from the same locations twice and thus the unripe and ripe fruits were collected. The fruits were stored at -20^0 until further procedures were carried out.

Chemicals
Gallic acid, quercetin, ascorbic acid, DPPH (2, 2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) from Sigma-Aldrich (Steinheim, Germany); Folin-Coicalteu reagent, sodium chloride, potassium chloride, aluminium chloride, potassium acetate, potassium persulphate, sodium carbonate, disodium phosphate, or sodium hydrogen phosphate, potassium phosphate monobasic from Hi-Media and hydrogen peroxide and methanol from Merck Company (Darmstadt, Germany) were used.

Preparation of extracts
The seeds were separated from the fruits to obtain the pulp. 20g of the separated pulp was homogenized in a mixer grinder for 5 min to make homogeneous slurry. 10g of the slurry was mixed with 50mL of solvent and kept under shaking condition for 6 hours at room temperature. The extract was filtered and the filtrate was centrifuged at 8000 rpm for 10 minutes to obtain the clear supernatant. The extracts were stored at -20^0C for further analysis. (Rawat *et al*., 2011; Saini *et al*., 2013).

Estimation of total phenolic content (TPC)
The phenolic content in the methanolic extract of fruits was determined by Folin Ciocalteu's calorimetric method (Hatami *et al*., 2014). Samples were prepared in water to obtain a final volume of 500 µl. To the samples, 2.5 ml of 2 N Folin-Coicalteu reagent was added and allowed to incubate for 5 minutes. After that, 2 ml of 7.5% Na_2CO_3 was mixed and again incubated in the dark for 1.5 hours. The optical density was recorded at 765nm. The total phenolic content of the samples was quantified on the basis of the standard curve from different concentrations of gallic acid (1-20 µg/mL) and the results are expressed as GAE per gram fresh weight (fw) of fruits.

Estimation of total flavonoid content (TFC)

Total flavonoid content in the methanolic extract of fruits was determined by aluminium chloride calorimetric method (Vaghasiya *et al.*, 2011) with some modifications. To 0.5ml of plant extract, 1.5 ml of methanol was added. The solution was then mixed with 0.5ml of aluminium chloride (1.2%) and 0.5 ml potassium acetate (1M). The solution was then incubated for 30 minutes at room temperature. The absorbance was taken at 415nm. The total flavonoid content was quantified on the basis of the quercetin standard curve and the results are expressed as QE per gram fresh weight (fw) of fruits.

Antioxidant Activity

The antioxidant activity was determined following three assays *viz*. ABTS, DPPH and H_2O_2 Radical Scavenging Assays**.**

ABTS Radical Scavenging Activity

Total antioxidant activity was measured by ABTS method (Cai *et al.,* 2014) with some modifications. 7 mM ABTS was prepared in water and mixed with 2.45 mM potassium persulphate in 1:1 ratio. The solution was then incubated in dark for 12-16 hours to allow the oxidation of $ABTS^+$. The mixture was then diluted to get absorbance of ~0.7 at 734 nm. 5µl of extract and 3.395 ml of reagent were added and incubated in dark for 2 minutes. The absorbance was taken at 734 nm.Control was prepared by taking absorbance of ABTS and methanol. Standard curve of Ascorbic acid was prepared with standards dilution range from 1 to 5 µg/ml. Radical scavenging activity was expressed as inhibition percentage of free radical by the sample and was calculated using the following formula.

$ABTS^+$ scavenging effect (%) = (Ab-Aa/Ab)*100

where Ab= Ab. Of ABTS+ Methanol; Aa= ABTS+ sample / standard

CEAC (Vitamin C Equivalents Antioxidant Capacity) or ascorbic acid content of all the extract was estimated by standard curve of ABTS+ scavenging effect (%) linear curve equation.

DPPH Radical Scavenging Activity

The DPPH free radical scavenging activity of the crude extract, based on the scavenging of the stable 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical was determined (Adedapo *et al.,* 2008). 1.0 ml of 0.1 mM of DPPH in methanol and 0.1 ml of extract were mixed. The mixture was incubated in the dark for 30 min at room temperature. Degree of inhibition of DPPH was determined by monitoring the decrease in absorbance measured at 517 nm. Ascorbic acid was used as positive control. Radical scavenging activity was expressed as inhibition percentage of free radical by the sample and was calculated using the following formula:

%Inhibition=$((A_0-A_t)/A_0)$*100

where A_0 was the absorbance of control (blank without sample) and A_t was the absorbance in presence of sample.

H_2O_2 scavenging assay

Hydrogen peroxide scavenging potential of the plant extract was determined using the method described by Ebrahimzadeh *et al.,* (2010). An aliquot of 40 mM H_2O_2 solution (0.6 ml) was mixed with 0.1 ml of extract. To the mixture 2.4 ml of phosphate buffer (0.1 M, pH 7.4) was added and the mixture was shaken vigorously and incubated at room temperature for 2 min. Then, the absorbance of the reaction mixture was determined at 230 nm. The H_2O_2 scavenging activity was calculated as follows:

%Inhibition= $((A_1-A_2)/A_1)$*100

Where A_1 is the absorbance of the ascorbic acid, A_2 is the absorbance of the sample.

Statistical Analysis

The standard graph in each case was prepared by plotting the mean values of three replicas. All the tests for TPC, TFC and the three antioxidant assays were performed in triplicate and the mean values were taken. The values are expressed as mean ± SD.

ANOVA was conducted and the significant difference between the groups of populations were tested using Fisher's least significant difference test in SPSS (version 16) software. Pearson's correlation analysis was also carried out in

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SPSS. The regression graphs were plotted and coefficients of determination (R^2) for the different tests were determined in Microsoft Excel 2007 (Freund *et al.*, 2003).

RESULTS

Total Phenolic Content (TPC) and Total Flavonoid Content (TFC)
The total phenolic content of the unripe fruits varied from 1.827 to 2.555 mg GAE/ g fw with an average value of 2.184 mg GAE/ g fw. While the total phenolic content of the ripe fruits varied from 0.562 to 1.379 mg GAE/ g fw with an average value of 1.007 mg GAE/ g fw. ANOVA analysis revealed significant variation in the TPC between the groups of populations in case of unripe fruits (F= 4.332; p=0.046) as well as in ripe fruits (F=5.836; p=0.022). The total flavonoid content of the unripe fruits varied from 0.80 to 1.19 mg QE/g fw with an average value of 0.992 mg QE/ g fw. While the total flavonoid content of the ripe fruits varied from 0.19 to 0.58 mg QE/ g fw with an average value of 0.362 mg QE/ g fw. ANOVA analysis revealed significant variation in the TFC between the groups of populations in case of unripe fruits (F= 6.698; p=0.015) and in ripe fruits (F=6.070; p=0.001).

Antioxidant Activity
ABTS Assay
The percent inhibition values for ABTS assay ranged from 55.45 to 74.59 % with CEAC values of 0.309 to 0.984 mg/g in ripe fruits while that of unripe fruits ranged from 85.15 to 93.69% with CEAC values of 1.444 to 1.567 mg/g respectively.

DPPH Assay
The DPPH assay revealed a percent inhibition ranging from 43.620 to 69.708% with CEAC values of 0.346 to 1.095 mg/g in ripe fruits. For unripe fruits the percent inhibition ranges from 79.045 to 85.373% percent with CEAC values of 1.475 to 1.732 mg/g respectively.

H_2O_2 scavenging assay
In the H_2O_2 scavenging assay the percent inhibition of the ripe fruits ranged from 82.877 to 87.284% in ripe fruits while that in unripe fruits the range of inhibition is from 90.365 to 93.186%.

Correlation studies
The antioxidant properties showed high positive correlation with the phenolic and flavonoid compounds. The antioxidant assays also showed significantly positive correlation with each other. However, the phytochemicals and antioxidant properties did not show any relationship with the altitude indicating that the variation in these parameters across the populations is not dependant on the varying altitude.

DISCUSSION

The fruits undergo several changes including their biochemical composition during the stages of maturation. This study on the phytochemical content in the two stages of maturation revealed that for each accession the TPC and TFC were higher in the unripe fruits as compared to the ripe fruits. The fruits also showed high antioxidant capacity in all the three studied assays. Moreover, the antioxidant potential was also seen to be higher in the unripe fruits than the ripened ones. As revealed from the analysis of the relationship between the phytochemical composition, the antioxidant potential can be mostly attributed to the presence of phenolic and flavonoid compounds. This correlation was, however, seen higher in case of ABTS and DPPH assays than the hydrogen peroxide assay. *Myrica esculenta* is generally a wild edible fruit. The inhabitants from the study area are mostly seen to be harvesting the fruit at ripe stage. However, it is also seen that even the ripe fruits are capable of providing antioxidative protection to the body and thus preventing the diseases arising out of oxidative stress. From the study it could be concluded that the fruits at unripe state are the best time to harvest for maximum nutraceutical potential as well as antioxidant capacity. This

knowledge would help consumers and harvesters get the maximum benefits from the fruits. Even for formation of products, the unripe fruits could be considered in order to harness the potential of the fruits to the fullest. Though the variation in the TPC, TFC and antioxidant potential of the fruits between the different populations is not very high, it is seen that mostly the values from the districts Jorhat and Golaghat are significantly different from the rest of the districts. This pattern was observed while studying the morphological variation of the *Myrica esculenta* species from the same area (our unpublished work) in which these two districts clustered together and were separated from the four districts Tinsukia, Dibrugarh, Sivasagar and Charaideo which formed a different cluster in the neighbor joining tree. This indicates that some correlation might exist between the morphological variation and the phytochemicals and the same factors might be playing a role in bringing about such variation.

CONCLUSION

Myrica esculenta fruits, thus, would help in imparting protection against oxidative stress diseases upon consumption. The comparative determination of phytochemical and antioxidant capacity of *Myrica esculenta* fruits in two stages of maturation shows that the unripe fruits are best suited for extraction and purification of these compounds for any product formulation. The significant difference in the phytochemicals and antioxidant potential of the fruits between the different populations under study would help in determining the areas showing the highest values. Further studies can be carried out to find out the environmental or other factors that led to such a difference. This could prove beneficial in determining the conditions for crop improvement programmes targeting large scale production of *Myrica esculenta* trees.

ACKNOWLEDGEMENT

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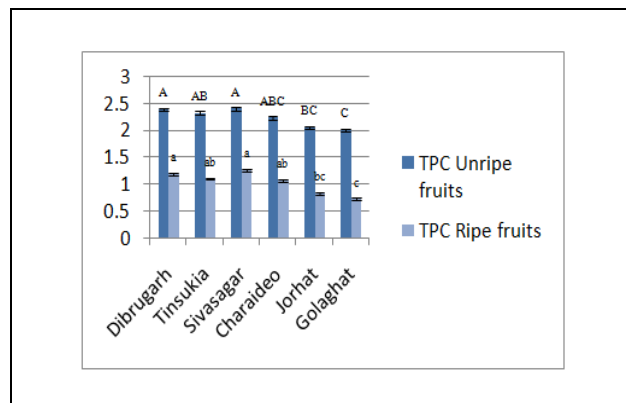
Figure: 1 Average values of TPC in Unripe fruits- F= 3.209* and Ripe fruits- F=4.051 in different districts.**
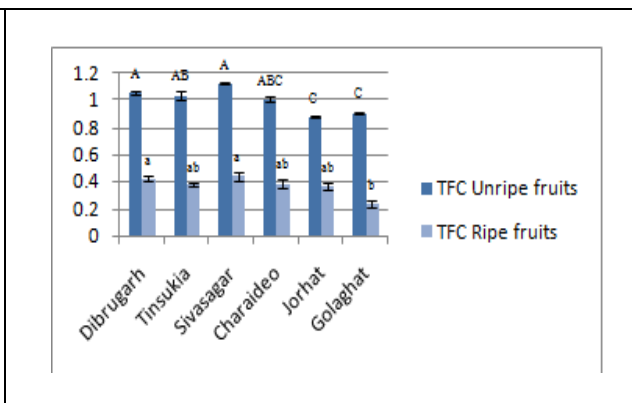
Figure: 2 Average values of TFC in Unripe fruits- F= 4.949 and Ripe fruits indifferent districts**
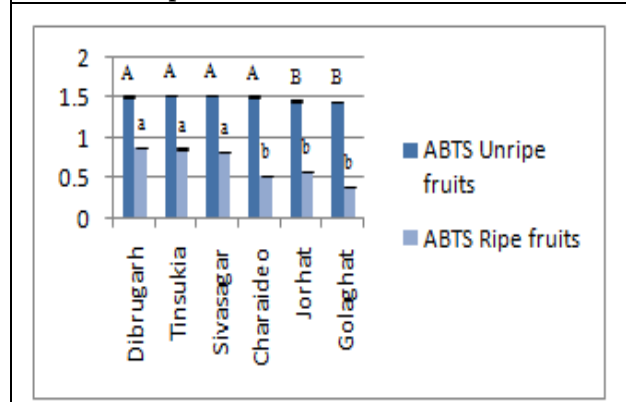
Figure: 3 Average values of CEAC from ABTS assay in Unripe fruits- F=4.984638 ** and Ripe fruits-F= 8.17348 in different districts.**
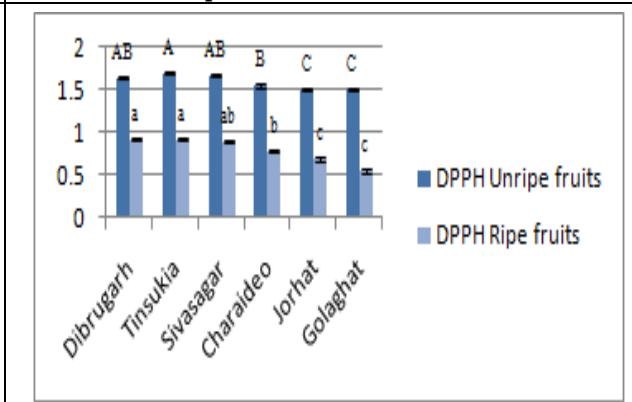
Figure: 4 Average values of CEAC from DPPH assay in Unripe fruits- F=4.655036 ** and Ripe fruits-F= 3.207463* in different districts
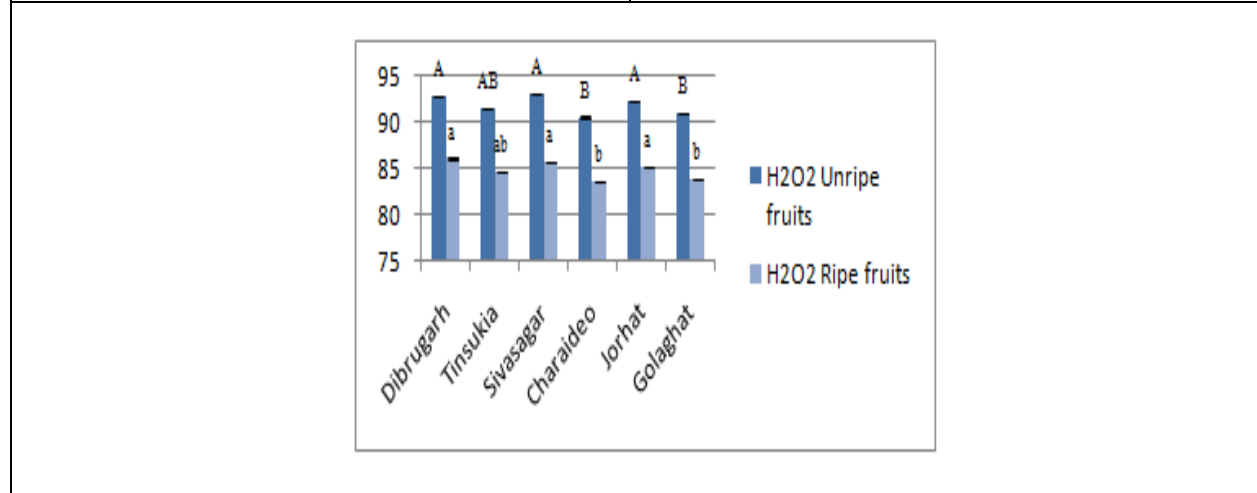
Figure: 5 Average values of % inhibition from H_2O_2 assay in Unripe fruits- F=4.655036 ** and Ripe fruits-F= 3.207463* in different districts

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		TPC		TFC		ABTS		DPPH		H_2O_2		altitude
		unripe	ripe	unripe	ripe	unripe	ripe	unripe	ripe	unripe	ripe	
TPC	unripe	1										
	ripe	.897**	1									
TFC	unripe	.824**	.789**	1								
	ripe	.696**	.728**	.614**	1							
ABTS	unripe	.832**	.791**	.748**	.674**	1						
	ripe	.823**	.747**	.687**	.651**	.811**	1					
DPPH	unripe	.800**	.694**	.737**	.612**	.932**	.877**	1				
	ripe	.881**	.880**	.674**	.599**	.832**	.870**	.793**	1			
H_2O_2	unripe	.595**	.562*	.501*	.700**	.541*	.663**	.602**	.534*	1		
	ripe	.585**	.540*	.468*	.641**	.547*	.662**	.589**	.515*	.966**	1	
altitude		.170	.118	.094	-.106	.281	.400	.397	.264	-.118	-.031	1

For all the figures from 1 to 5 (*P<.05; **P<.01). Different superscripts indicate significant difference in the respective character among the different populations

Figure: 6 Correlation between TPC, TFC, antioxidant assays and altitude
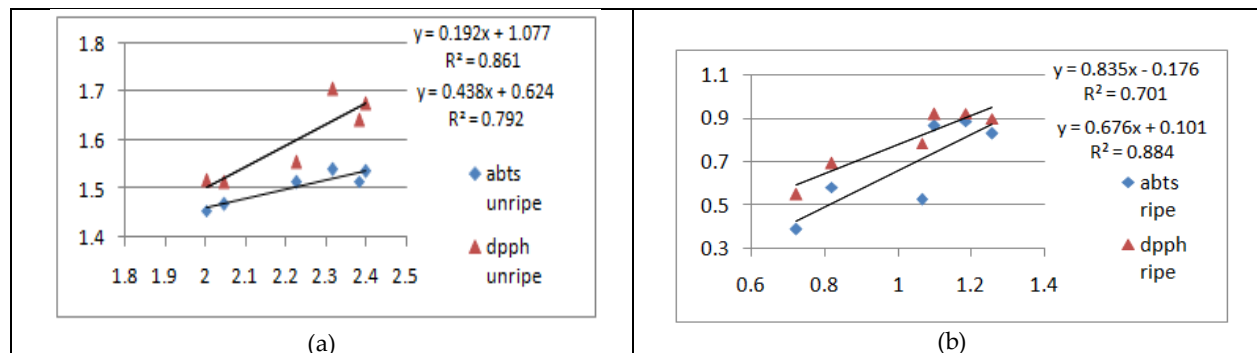
Figure: 7 Relation between total phenolic content (TPC) and antioxidant properties in (a) unripe fruits (b) ripe fruits
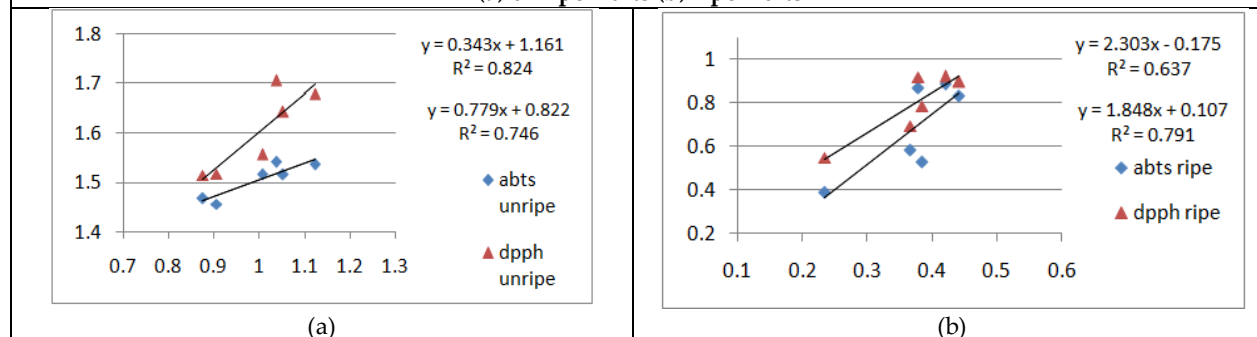
Figure: 8 Relation between total flavonoid content (TFC) and antioxidant properties in (a) unripe fruits (b) ripe fruits

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(a)

(b)
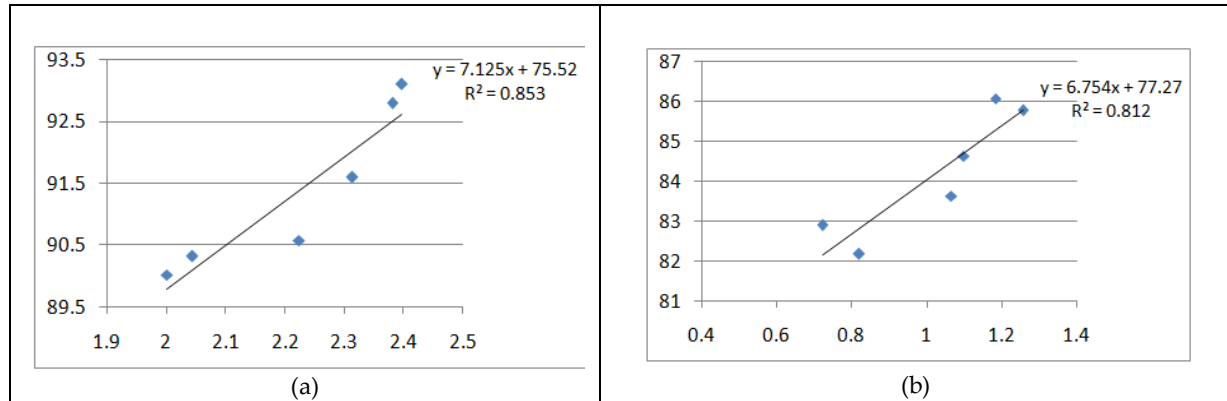
Figure: 9 Relation between total phenolic content (TPC) and H_2O_2 antioxidant activity in (a) unripe fruits (b) ripe fruits

(a)

(b)
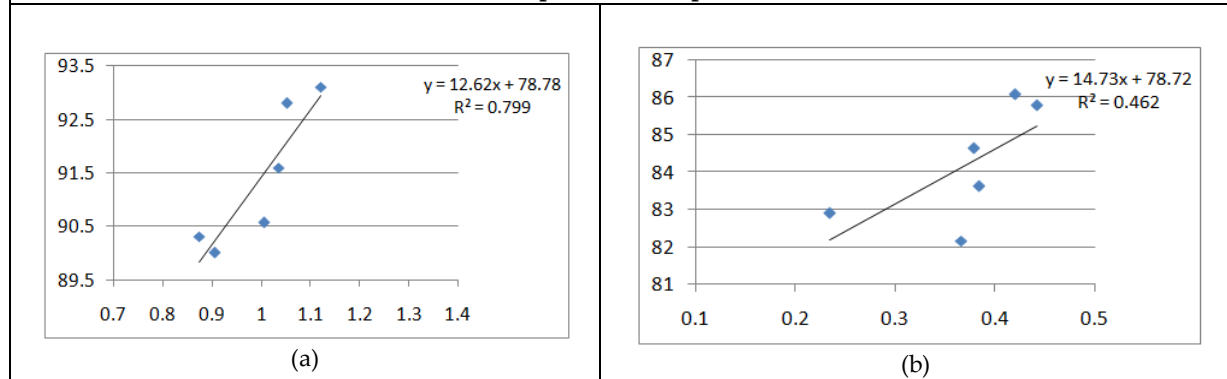
Figure: 10 Relation between total flavonoid content (TFC) and H_2O_2 antioxidant activity in (a) unripe fruits (b) ripe fruits

RESEARCH ARTICLE

Assessment of Water Quality using Physico-Chemical Parameters of Bophni Dam

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ABSTRACT

The Physico-chemical Parameters of Bhopni Dam water in Udgir, District Latur are studied and analysed in the current paper. Physical and Chemical Parameters on monthly basis are observed which include the study of Water Temperature, Turbidity, Total Dissolved Solids, pH, Dissolved Oxygen, Free Carbon dioxide and Total Hardness, Chlorides, Alkalinity, Phosphate and Nitrates. These were analysed for a period of one year from i.e. from 1st January 2017 to 31st December 2017. All Parameters were within the permissible and acceptable limits. The results indicate that the dam is safe, pure and non-polluted and can be used for Domestic, Irrigation and Fisheries.

Keywords: Physico-Chemical Parameters, Bhopni Dam, Monthly variation.

INTRODUCTION

Dam irrigation is one of the oldest and more important than any other sources of irrigation in India and particularly in Maharashtra. The dams play a vital role in the irrigation as well as the backbones of local ecosystem in the regions of Maharashtra. This perennial tank makes provision of multiple uses like source of drinking water for uncountable rural households, urban communities and livestock, fish culture, recharge of ground water, control of floods etc., (Gurunathan, 2006). Water is one of the most important compounds of the ecosystem, but due to increase in human population, rising industrialization, overuse of fertilizers and chemicals in agriculture, selfish and thoughtless man-made activities polluting it severly. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to pollution and harming water quality and depletion of aquatic biota. It therefore becomes a necessity to know the quality and purity of drinking water. It should be checked at a regular time of intervals. It seems clear that the use of contaminated drinking water makes humans suffer from varied water borne diseases. It is difficult to understand and draw any conclusion about the biological phenomena fully because the chemistry of water reveals much about the metabolism of the ecosystem and explain the general hydro biological relationship.

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The present study involves the Analysis of Water Quality in Terms of Physico-chemical parameters of Bhopni Dam in Udgir Dist. Latur. This tank water is basically distributed to five to six small villages nearby Udgir city for agriculture, fisheries and partially domestic activities.

MATERIALS AND METHODS

The Water Samples from Bhopni Dam were collected from two different stations in the morning hours between 10 to 12 am in glass bottle regularly for every month. The Water samples were immediately brought in to Laboratory for the Estimation of various Physico-chemical parameters, like water temperature and pH were recorded at the time of sample collection by using Thermometer and Pocket Digital ph. Meter. While other Parameters such as DO, TDS, Free CO2 Hardness, Alkalinity,Chlorides, Phosphate and Nitrate were estimated in the Laboratory by using Indian Standard procedures(Titration method, atomic Absorption Spectrophotometer. (AAS) (Trivedi and Goel, 1986, APHA 1985).

RESULT AND DISCUSSION

Physical Parameters of Water
Climate
The area under the project is in semidry zone. There is a rapid hike in temperature after the month of January, March and May. These are the hottest months of the year. The climate of the year is divided into four seasons viz hot season from March to May; monsoon season from June to September; Post-monsoon from October to November winter from December to February.

Water Temperature
Generally, the weather found in study area is quite cool, but it cannot be neglected that the water temperature plays an important factor which influences the chemical, bio-chemical body. The highest temperature of 280^0 C was recorded in May and a lowest of, 20° C was recorded in month of December in the year 2017. Water temperature found in summer was high due to low water level, high temperature and clear characteristics of water are observed in the maximum atmosphere (Salve and Hiware, 2008).

Turbidity
The turbidity of water fluctuates from 4.00 to 15.25 NTU. The highest value of 15.25 NTU was recorded in the month of March and it may be due to human activities, reduction in the water level and presence of suspended particulate matter and lowest value of 4.00 NTU in the month of October.

Total Dissolved Solids
The total dissolved solids change from 130 mg/l to 246.4 mg/l. The highest value (246.4 mg/l) was recorded in the month of June. It is due to heavy rainfall and lowest value (130 mg/l) in the month of May and August.

pH
pH alkaline values range from 7.40 to 8.40. The maximum pH value (8.40) was recorded in the month of April (summer) and minimum (7.40) in the month of October. Most of bio-chemical and chemical reactions are influenced by the pH. The reduced rate of photosynthetic activities reduces the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low Oxygen values coincided with high temperature during the summer months. (Kamble, S. M. et al.). The factors like air temperature bring changes in the pH of water. The higher pH values observed suggests carbon dioxide. Carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition (Karanth, 1987; Tiwari et al, 2009).

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Free Carbon dioxide

The value of free CO_2, ranges from 0.6 mg/l to 17.8 mg/l. The maximum value (17.8 mg/l) was recorded in the month of December (winter) and minimum value (0.6mg/l) in the month of February. This may be depending upon alkalinity and hardness of water body. The value of CO_2 was high in December. This could be related to the high rate of decomposition in the warmer months.

Chemical Parameters of Water
Dissolved Oxygen

The value of DO varies from 7.10 mg/l to 15.75 mg/l. The highest value (15.75mg/l) was recorded in the month of April and lowest value (7.10 mg/l) in the month of November. The high DO in summer is due to increase in temperature and duration of bright sunlight has influence on the % of soluble gases (O_2 & CO_2). The long days and intense sunlight during summer seem to accelerate photosynthesis by phytoplankton, utilizing CO_2, and giving off oxygen. This possibly accounts for the greater qualities of O_2 recorded during summer. (Krishnamurthy R., et al, 1990).

Hardness

The value of hardness fluctuates from 75 mg/l to 140 mg/l. The maximum value (140mg/l) was recorded in the month of April (summer) and minimum value (75 mg/l) in the month of October. (Hujare, M. S. 2008): It has reported total hardness high during summer than monsoon and winter. High value of hardness during summer can be attributed to decrease in water volume and increase of rate of evaporation of water.

Alkalinity

Total alkalinity ranges from 105 mg/l to 160 mg/l the highest value (160 mg/l) was recorded in the month of May (summer) and lowest value (105 mg/l) in the month of January (winter). The alkalinity value was highest in April (summer) due to increase in bi- carbonates in the water. (Hujare, M. S. 2008) also reported similar results and observations that it was maximum in summer and lowest in winter due to high photosynthetic rate.

Chlorides

The values of chlorides range from 20 mg/l to 36.5 mg/l. The highest value (36.5 mg/l) was recorded in the month of May (summer) and lowest value (20 mg/l) in the month of January. In the current study highest value of chloride goes high in summer (Swarnalatha and Narsing Rao, 1990).

Phosphate

The value of phosphate fluctuates from 0.25 mg/l to 5.25 mg/l. The highest value (5.25mg/) was recorded in the month of August (monsoon) and lowest value (0.25) in the month of November (winter). The high values of phosphate in August (monsoon) months are mainly because of rain, surface water runoff, agriculture run off; washer man activity could have also contributed to the inorganic phosphate content.

Nitrates

The values of nitrate range from 2.10 mg/l to 13.02 mg/l. The highest value (13.02mg/l) was observed in the month of August and lowest (2.10 mg/l) in the month of December.

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Table 1: **Physical Parameters of Bhopni Dam Water**

Month	Temperature in 0c	Turbidity NTU	TDS Mg/L	pH
Jan	22	11.25	210.8	8.05
Feb	25	12.61	212.4	8.02
Mar	26	15.25	218.2	8.30
Apr	22	09.50	160.0	8.40
May	28	09.00	130.0	7.80
Jun	26	05.50	246.4	7.90
July	24	08.50	220.0	8.00
Aug	22	05.10	130.0	7.90
Sept	23	05.50	140.0	7.70
Oct	24	04.00	155.0	7.40
Nov	22	06.10	210.0	7.80
Dec	20	08.50	170.3	8.10

Pravin S. Shete

Table 2: Chemical Parameters of Bhopni Dam Water

Month	Free CO_2	Dissolved oxygen	Hardness	Alkalinity	Chlorides	Phosphate	Nitrate
Jan	0.8	10.25	76.5	105,0	20.0	0.90	02.20
Feb	0.6	09.25	80.0	110.0	30.0	1.22	02.30
Mar	1.0	14.20	90.0	125.0	28.2	1.80	02.70
Apr	3.5	15.75	140.0	120.0	30.5	2.80	08.10
May	4.6	15.00	132.0	160.0	36.5	1.50	10.10
Jun	7.8	14.25	126.0	135.0	28.0	2.80	09.50
July	8.8	09.20	110.0	120.0	34.0	3.60	08.00
Aug	4.2	08.10	76.0	135.0	27.0	5.25	13.02
Sept	14.6	08.00	95.0	148.0	30.5	0.91	05.20
Oct	10.8	07.20	75.0	115.0	21.0	0.90	04.20
Nov	15.2	07.10	85.0	108.0	22.0	0.25	05.20
Dec	17.8	09.10	90.0	120.0	31.0	4.50	02.10

RESEARCH ARTICLE

Regional Disparity in Socio-Economic Development of Scheduled Tribes in Salem District, Tamil Nadu, India

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ABSTRACT

The Scheduled Tribe population is one of the most economically impoverished and minority group in India. Tamil Nadu has the lowest percentage of scheduled tribes, at 1.1 per cent. Salem district has the largest tribal population size in Tamil Nadu, with 15.02 per cent. This paper aims to identify the block-wise Intra-regional disparities in education (literacy) and regional disparity between workers and non-workers of Scheduled Tribes. The study reveals that Scheduled Tribes rural female literacy rates are lagging behind their Scheduled Tribes rural male literacy rates counterparts in the rural blocks of Salem district. According to Sopher's Disparity Index, the tribal concentrated blocks such as Pethanaickenpalayam, Valapady, Panamarathupatti and Gangavalli were having medium Scheduled Tribes educational disparity. Work Participation Rate for Scheduled Tribes of persons, male and female were 61.15 per cent, 63.23 per cent and 59.01 per cent respectively. Also reveals that, the tribal concentrated blocks such as Pethanaickenpalayam, Yercaud, Valapady, Panamarathupatti and Ayothiyapattinam were having low Scheduled Tribes regional disparity between workers and non-workers. Powerful democratic responsibility at the government level was indeed urgently required to enhance services to the community. The allocation of qualified and experienced female teachers, along with established infrastructure including separate toilets for girls in schools and colleges, drinking water, roadways, etc., will assist in increasing female literacy levels.

Keywords: socio-economic, tribes, regional disparity, literacy, workers, work participation rate

INTRODUCTION

India has a diverse population of indigenous people. The Scheduled Tribe population is one of the most economically impoverished and minority group in India. The Primitive tribal communities have been identified by the Govt. of India on the basis of (a) pre agricultural level of technology, (b) extremely low level of literacy; and (c) small, stagnant or diminishing population [1]. There are 550 different tribes in India. According to 2011 census, 8.6% of the total population of the country was tribal. Rural areas accounted for 11.3 per cent of the total tribal population, while urban areas accounted for 2.8 percent. Tamil Nadu has the lowest percentage of scheduled tribes, at 1.1 percent (Census, 2011)[2]. There are 36 sub tribes in Tamil Nadu, with most of their jobs being cultivators, agricultural labourers, or forest dwellers. "Malayali", "Irulars" and "Kattunayakans" are the major tribes of Tamil Nadu State. Tribes in India are widely different from each other, geographically, culturally and in terms of their levels of social as well as economic and educational development, and their problems vary from region to region within their own groupings. Several commissions and committees have recently advocated a number of initiatives to address the social and economic disparities among tribes, as well as to break down the tribal territories' long-standing psychological barriers. Since independence, the Indian government has taken numerous steps to improve tribal livelihoods. A variety of programmes are in place to help them maintain their livelihoods. In order to achieve sustainability, the tribes' development policy has altered several times. On the basis of distances and composite indices of development, we can identify the potential targets of different indicators and classify the areas.

Rationale: Salem as a Study Area
Tamil Nadu has 22nd rank among tribal population in India. In percentage, it has the lowest tribal concentration in its population. As per 2011 Census, it has the 1.10 per cent of tribal population in India/ State to total population of India/ State and 0.8 per cent Scheduled Tribes in the State to total Scheduled Tribes population. Based on different socio-economic conditions, there are significant disparities in the state among the districts. In this research paper, an attempt has been made to investigate the present socio-economic conditions and spatial disparity at block levels in terms of caste and gender in Salem district. This district has the largest tribal population in Tamil Nadu with 15.02 per cent (highest number of population among districts) and has 4th highest (concentration) proportion of Scheduled Tribes (3.43 per cent) to district total. Major Tribal communities in Tamil Nadu, namely Irulas, Malayalis and Muthuvans, have been cultivating traditional cultivars of paddy, millets, pulses and vegetables (Anburaja, 2012)[3]. In Salem District, Major tribes are Malayali, Kondareddies, Kurumans and Malakkuravan have been cultivating traditional cultivars of pulses, millets, minor millets, vegetables and fruit crops. Even though they are cultivators and workers, but they are suffered for education, health care, basic amenities, electricity and road connectivity.

Objectives
- To analyse the concentration and socio-economic conditions of tribes in Tamil Nadu and Salem district.
- To identify block-wise intra-regional disparities in education (literacy) and regional disparity between workers and non-workers of Scheduled Tribes in Salem district.
- To analyse the dominant and distinctive economic activity of tribes and its level in different blocks of Salem district.
- To suggest the remedial measures required to overcome the problems of socio-economic as well as human development.

MATERIALS AND METHODS

Salem district was purposively selected for this study, since it has the largest tribal population in Tamil Nadu with 15.02 per cent and has 4th highest proportion of Scheduled Tribes with 3.43 per cent to district total in Tamil Nadu. The research methods followed in this work includes consultation of literature, data collection from secondary sources, statistical analysis, and preparation of pie charts. From some available books, reports and papers, we have retrieved the basic ideas and data about the study area. Secondary data are obtained from different sources includes

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(i) District Human Development Report, Salem: 2011, (ii) District Statistical Handbook, Salem: 2021, (iii) Tamil Nadu Government Portal (http://www.tn.gov.in), (iv) Census of India: 2011, (v) Government of Tamil Nadu, Department of Tribal Welfare, and (vi) www.census.tn.nic.in. For better understanding of the interpretation of socio-economic conditions and disparities among the tribes of Salem district, we use different statistical techniques like

Sophers' Disparity Index

David E Sopher (1974) [4] developed Sophers' Disparity Index to measure the disparity between two groups in their possession of a particular property in terms of the logarithm of the odds ratio. The objective of taking log is to reduce the leveling of effect that is regions with higher rate of the indicator may show a lower level of disparity than the region having low rate of indicator even though the gap is the same for both region. This index is to identify: the disparity between rural-urban literacy group, the disparity between male-female literacy, the disparity between rural-urban population and the disparity between workers and non-workers population etc.

Disparity Index (DI) = Log (X2/X1)+Log(100-X1)/(100-X2)
Where, DI = Disparity Index,
X1 = Percentage of Workers or Percentage of Female Literacy (ST),
X2 = Percentage of Non-Workers or Percentage of Male Literacy (ST),
i.e. X2>X1

The value of Disparity Index is zero in case of perfect equality. Thus, the greater the value of Disparity Index, the higher the extent of disparity occurs. And lower the value, the lower the disparity (Sopher, 1980)[5].

Descriptive Analysis

The descriptive analysis was undertaken using simple averages and percentage analysis to study the distribution of population, spatial disparity in literacy, educational disparity between tribes and others, diversity of health status, workers participation, and dominant economic activity of Scheduled Tribes in Tamil Nadu and Salem district.

Nelson's Method to identify dominant and distinctive functions

Harris (1943)[6] made the first attempt towards identification of the dominant economic characteristics of an area. H. J. Nelson (1955)[7] used almost similar method with a threshold which could be worked out from the mean and standard deviation (SD) of the occupational structure of a given area (Jana and Ghosh, 2015)[8]. According to Nelson's method, first percentages of each occupation to the total labour force of the area are worked out for each unit area. The mean and Standard Deviation of these percentages among all the unit area is then calculated separately for each occupation. Dominant function means the attribute which shares the highest proportion (percentage) is identified as the dominant one. So, each block has its own dominant function. The areas are then classified according to their percentage of each occupation being more than or equal to mean + SD, mean + 2SD, mean + 3SD. Distinctiveness is a character which makes an area/region different from others. According to him, distinctive functions can be identified with the help of arithmetic mean and standard deviation. Nelson considered any function having percentage of workers greater than arithmetic mean +1 Standard Deviation as the benchmark for being considered as a distinctive function. The percentage of a function less than its mean+SD is not considered as significant. According to Nelson, the scale of distinctiveness is listed in Table 1.

Work Participation Rate

Work Participation Rate is defined by following formula, WPR = Percentage of Scheduled Tribes Total Workers (Main + Marginal) / Total Scheduled Tribes Population × 100. Chart diagrams and Graphs have been prepared based on secondary data using GraphPad Prism software application v.9.3.1. Diagrams and Calculations are prepared with the help of Microsoft Office Excel v.2007. The field survey for the secondary data as well as this work was conducted during the months of February to May 2022 and the procedures used in organizing the data are detailed below.

RESULTS AND DISCUSSION

Spatial Distribution of Scheduled Tribes in Salem District

Among 32 districts of Tamil Nadu, Salem district has the highest concentration of Scheduled Tribes with 15.02 per cent. Among 9 sub-districts (Taluks) of Salem district, Attur Taluk has the highest concentration of Scheduled Tribes population with 34.72 per cent followed by Yercuad, Salem, Vazhapadi, Gangavalli, Mettur, Omalur, Sankari and Edappadi Taluks with 23.56, 10.12, 8.93, 8.91, 7.96, 4.69, 0.88 and 0.24 per cent respectively. Among 22 blocks of Salem district Pethanaickenpalayam, Yercaud, Gangavalli, Ayothiyapattinam, Kolathur and Panamarathupatti blocks have secured top six places based on the percentage of Scheduled Tribes with 31.72, 23.88, 9.21, 8.40, 7.25 and 5.96 per cent respectively. And nine blocks (Mallasamudram, Tharamangalam, Veerapandi, Konganapuram, Sankari, Nangavalli, Salem, Mecheri and Idappady) of Salem district have less than 0.1 per cent tribal population with respect to its total population (Fig 1). Based on the highest percentage of tribal population, we identified six blocks as tribal dominated blocks such as Pethanaickenpalayam, Yercaud, Gangavalli, Ayothiyapattinam, Kolathur and Panamarathupatti. The Fig. shows the following spatial pattern.

- Higher level of concentration (Percentage value between 31.72 – 5.96) - Pethanaickenpalayam, Yercaud, Gangavalli, Ayothiyapattinam, Kolathur and Panamarathupatti.
- Medium level of concentration (Percentage value between 5.00 – 0.1) - Kadayampatti, Valapady, Attur, Thalaivasal, Not under any CD block, Omalur, and Mac Donal Choultry.
- Lower level of concentration (Percentage value is < 0.1) – Mallasamudram, Tharamangalam, Veerapandi, Konganapuram, Sankari, Nangavalli, Salem, Mecheri and Idappady (Fig. 2).
  -

Literacy Status of Salem District

As per 2011 census, Tamil Nadu Scheduled Tribes literacy rate is 54.34 per cent which is below the national average of 59 per cent, which is less than the overall literacy rate of the country (73 per cent). As per 2011 census, Salem Scheduled Tribes total literacy rate is 51.85 per cent and whereas the Rural Scheduled Tribes literacy rate is 49.83 per cent and having 25th rank among districts of Tamil Nadu. Salem Scheduled Tribes male literacy rate is 60.39 per cent (rural-58.44 per cent) and whereas the female literacy rate is 43.17 per cent (rural-41.10 per cent).

Block-wise Spatial Disparity in Literacy Rate

It could be seen from the Figure 3 that the male literacy rates of Scheduled Tribes in the blocks of Salem district ranges from 50.11 per cent in Pethanaickenpalayam Block to 83.33 per cent in Salem and Sankari Blocks, while Veerapandi, Tharamangalam and Nangavallai blocks having the lowest male population and all are literates so these blocks having 100 per cent literacy rate. The female literacy rate ranges from 33.33 per cent in Tharamangalam Block to 65.96 per cent in Mac.Donal Choultry Block, while 100.00 per cent in Nangavallai, Idappady and Konganapuram Blocks. Nangavalli block having minimum female with literates and other two blocks having only literates of female scheduled tribes. This signals that rural female literacy rates are less than the rural male literacy rate, which indicates that overall schedule tribe female literacy rates are lagging behind their scheduled tribe male counterpart in the rural blocks of Salem district.

Block- and Gender-wise Educational Disparity

In Salem district, Scheduled Tribes literacy rate is 49.83 per cent as per 2011 census. Scheduled Tribes male literacy rate is 58.44 per cent, whereas Scheduled Tribes female literacy rate is 41.10. Scheduled Tribes rural female literacy rates are lagging behind their Scheduled Tribes rural male literacy rates counterparts in the rural blocks of Salem district. A gender-wise Scheduled Tribes literacy rate between different blocks in Salem district indicates that Attur and Salem blocks are having very high educational disparities among scheduled tribes gender according to Sophers' Disparity Index. It could be seen from the Table 2 that, blocks of Attur and Salem are having very high disparity among Scheduled Tribes. Index values reveal that the blocks of Not under any Community Development(CD) block, Mac-Donal Choultry, Ayothiyapattinam, Omalur and Yercaud are having high Scheduled Tribes educational

disparity. Blocks of Kadayampatti, Valapady, Pethanaickenpalayam, Panamarathupatti and Ganagvalli are having medium education disparity. Only Mecheri and Sankari blocks are having low Scheduled Tribes educational disparity. According to Sophers Disparity Index, the tribal concentrated blocks such as Pethanaickenpalayam, Valapady, Panamarathupatti and Gangavalli are having medium Scheduled Tribes educational disparity. However, these blocks are having low female Scheduled Tribes literates than male Scheduled Tribes literates. The literacy rates of females belonging to Scheduled Tribes continues to be a major problem in this district.

Work Participation of Scheduled Tribes in Salem District

The issue of livelihood security of Scheduled Tribes is closely linked to employment status of the people. As per the 2001 Census, the Work Participation Rate (WPR) of Scheduled Tribes in Salem district was 46.23 per cent. With the control of birth rate, the value reaches up to 61.15 per cent in 2011. In Salem District, the Work Participation Rate for Scheduled Tribes of persons, male and female are 61.15 per cent, 63.23 per cent and 59.01 per cent respectively. It could be seen from the Table 3 that, the different blocks of Salem district WPR ranges from 16.67 per cent to 72.73 per cent. Scheduled Tribes male WPR for different blocks ranges from 12.50 per cent to 71.76 per cent, whereas Schedule Tribes female WPR for different blocks ranges from 10.27 per cent to 69.39 per cent.

Block-wise Regional Disparity of Workers and Non-Workers of Scheduled Tribes in Salem District

In Salem district, the percentages of workers for Scheduled Tribes of persons, males and females are 61.15 per cent, 63.23 per cent and 59.01 per cent respectively. It could be seen from the Table 4 that, the percentages of non-workers for Scheduled Tribes of persons, males and females are 38.85 per cent, 36.77 per cent and 40.99 per cent respectively. The percentage of scheduled tribes total workers population is high in the blocks of Sankari, Not under any CD block, Attur, Gangavalli and Kolathur whereas low in the blocks of Konganapuram, Salem, Nangavalli, Omalur, Veerapandi and Mecheri. There is no scheduled tribes total workers population in the block of Idappady. The percentage of scheduled tribes non-worker population is high in the blocks Idappady, Konganapuram, Salem, Nangavalli and Omalur whereas low in the blocks Sankari, Attur, Not under any CD block, Gangavalli and Kolathur. Absence of urban centre, inaccessible physiographic conditions, umeployment etc. is the underlying causes for the same. This unemployment results in the emergence of poverty in certain blocks. It could be seen from the table 4 that, blocks of Salem and Konganapuram are having very high Scheduled Tribes regional disparity between workers and non-workers. An Index value reveals that the blocks of Sankari and Nangavalli are having high Scheduled Tribes regional disparity between workers and non-workers. Blocks of Kolathur, Ganagvalli, Not under any CD block and Attur are having medium regional disparity between workers and non-workers among Scheduled Tribes. Blocks of Yercaud, Kadayampatti, Omalur, Panamarathupatti, Thalaivasal, Pethanaickenpalayam, Mac-Donal Choultry, Ayothiyapattinam, and Valapady are having low regional disparity between workers and non-workers among Scheduled Tribes. Only Veerapandi block is having very low Scheduled Tribes regional disparity between workers and non-workers. Also, Mecheri and Tharamangalam blocks have no regional disparity between workers and non-workers. According to Sophers Disparity Index, the tribal concentrated blocks such as Pethanaickenpalayam, Yercaud, Valapady, Panamarathupatti and Ayothiyapattinam are having low Scheduled Tribes regional disparity between workers and non-workers.

Dominant and Distinctive Economic Activity

Dominant and Distinctive analysis is an important technique to study and identify the dominant and distinctive attributes from the Scheduled Tribes group of attributes in a particular block. Based on the percentage of different types of ST workers, we have tried to identify the dominant economic activity and its level in different blocks of Salem district. In this regard, we have used H.J. Nelson's Method (1955) to identify dominant and distinctive functions. According to Nelsons' method, if percentages of cultivator of a particular block leave behind the overall mean plus standard deviation value, then that block will be considered as cultivator dominant block. If the value surpasses the overall mean plus three standard deviation values, then it will be CL3 (Cultivatiors 3) or the block's economy is highly depended on cultivation. If the percentages of different types of workers such as Cultivators, Agricultural Labourers, Household Industry Workers and Other Workers did not cross the overall mean plus standard deviation value, then it will be a block with diversified economy (Jana and Ghosh, 2015) [8]. It could be

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seen from the table 5 that, the dominant economic activity of maximum blocks of Salem district is other workers that are Salem, Veerapandi, Yercaud, Tharamangalam, Sankari, Konganapuram and Mac.Donal Choultry. The blocks of Ayothiyapattinam, Valapady, Pethanaickenpalayam, Attur, Gangavalli and Thalaivasal are having the dominant economic activity of cultivators. The blocks of Panamarathupatti, Kolathur, Mecheri, Omalur, Kadayampatti and Not under any CD block are having the dominant economic activity of agricultural labourers. Only Nangavalli block having equal proportion of dominat economic activities of cultivators, household industry workers and other workers. It could be seen from the table 5 that, the distinctive economy of maximum blocks in Salem district is diversified that are Panamarathupatti, Ayothiyapattinam, Yercaud, Mecheri, Omalur and Sankari. The blocks of Valapady, Pethanaickenpalayam, Attur, Gangavalli and Thalaivasal are depended on cultivation with CL1 distinctive function. The blocks of Salem, Veerapandi, Tharamangalam and Konganapuram having OW1 distinctive function with the dependency of other workers. The blocks of Kolathur, Kadayampatti and Not under any CD block having AL1 as agricultural labourers dependency. Only Mac. Donal Choultry block having HIW2 distinctive function with highly dependent on household industry workers. And also only Nangavalli block having HIW3 distinctive function with highly dependent on household industry workers.

CONCLUSION

At present, Salem district has enriched with various natural resources and one of the industrialised districts in Tamil Nadu. However, it has not yet been developed on the tribal areas as expected. In the case of tribal households living in the hilly region of Salem district, physical barriers and insufficient infrastructure such as road communication, railway links, telecommunication facilities and lack of education using modern technology have been identified as constraints for establishing large industries and sustainable rural livelihoods. For appropriate development with social and economic justice in Salem and Tamil Nadu, a knowledgeable developed society is needed to enhance tribal groups' abilities to engage in contemporary economic and social development. Powerful democratic responsibility at the government level was indeed urgently required to enhance services to the community. The allocation of qualified and experienced female teachers, along with established infrastructure including separate toilets for girls in schools and colleges, drinking water, roadways, etc., will assist in increasing female literacy levels. Infrastructural development will support in the development of large industries, which will generate career opportunities. Finally, it should have been noted that improved educational infrastructure on a wider scale is preferable. Instead that, the district's and state's rapid economic development will be brought to a halt, and tribal groups will continue to stay a most ignored group in society. In this circumstance, expanding education by providing various tribes art and craft seem to be essential for tribes' social and economic development. Several factors may have contributed to their local knowledge's persistence. The lack of modern and government facilities, as well as the various tribes area's remote geographical features, as well as a strong belief in folk knowledge, all make a contribution to their priority for traditional knowledge for their culture.

ABBREVIATIONS

ST – Scheduled Tribes, DI – Disparity Index, SD – Standard Deviation, WPR – Work Participation Rate, CD – Community Development, CL - Cultivators, AL – Agricultural Labourers, HIW – Household Industry Workers, OW- Other Workers.

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Table 1 Scale of distinctiveness

S. No	Range of percentage of workers	Scale of distinctiveness
1.	Mean + SD to Mean + 2SD	1st Order
2.	Mean + 2SD to Mean + 3SD	2nd Order
3.	Above Mean + 3SD	3rd Order

Source: Nelson, 1955[7])

Table 2 Block- & Gender-wise Disparity in Literacy

S.No	DI Value	Community Development Blocks	Category
1.	0.01-0.20	Mecheri and Sankari	Low Disparity
2.	0.21-0.30	Kadayampatti, Valapady, Pethanaickenpalayam, Panamarathupatti and Ganagvalli	Medium Disparity
3.	0.31-0.40	Not under any CD block, Mac-Donal Choultry, Ayothiyapattinam, Omalur and Yercaud	High Disparity
4.	>0.41	Attur and Salem	Very High Disparity

(Source: Authors Calculation)

Table 3: Total Workers to Total Population and Non-Workers Population in Blocks of Salem District (in percentage)

S. No	Community Development Blocks	Total Workers Population	Non-Workers Population
1.	Salem	23.31	76.69
2.	Veerapandi	48.48	51.52
3.	Panamarathupatti	59.99	40.01
4.	Ayothiyapattinam	62.59	37.41
5.	Valapady	63.49	36.51
6.	Yercaud	57.77	42.23
7.	Pethanaickenpalayam	61.22	38.78
8.	Attur	67.89	32.11
9.	Gangavalli	66.64	33.36
10.	Thalaivasal	60.56	39.44
11.	Kolathur	64.92	35.08
12.	Nangavalli	25.00	75.00
13.	Mecheri	50.00	50.00
14.	Omalur	41.39	58.61
15.	Tharamangalam	50.00	50.00
16.	Kadayampatti	58.20	41.80
17.	Sankari	72.73	27.27
18.	Idappady	0.00	100.00
19.	Konganapuram	16.67	83.33
20.	Mac.Donal Choultry	62.11	37.89
21.	Not under any CD Block	67.27	32.73

(Source: Authors Calculation) Figures in the parentheses represent percentage to total

Table 4: Regional Disparity of Workers and Non-Workers of Scheduled Tribes in Salem District

S.No	DI Value	Community Development Blocks	Category
1.	0.00	Mecheri and Tharamangalam	No Disparity
2.	0.01-0.25	Veerapandi	Very Low Disparity
3.	0.26-0.50	Yercaud, Kadayampatti, Omalur, Panamarathupatti, Thalaivasal, Pethanaickenpalayam, Mac-Donal Choultry, Ayothiyapattinam, and Valapady	Low Disparity
4.	0.51-0.75	Kolathur, Ganagvalli, Not under any CD block and Attur	Medium Disparity
5.	0.76-1.00	Sankari and Nangavalli	High Disparity
6.	>1.00	Salem and Konganapuram	Very High Disparity

(Source: Authors Calculation)

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Table 5: Block-wise Dominant and Distinctive Economic Activity of Scheduled Tribes in Salem District

S. No	CD Blocks	Total ST Workers	Percentage of Scheduled Tribes Workers				Dominant Function	Distinctive Function
			Cultivators	Agricultural Labourers	Household Industry Workers	Other Workers		
1.	Salem	62	1.61	9.68	1.61	87.10	OW	OW1
2.	Veerapandi	48	2.08	6.25	4.17	87.50	OW	OW1
3.	Panamarathupatti	3953	36.86	52.26	0.33	10.55	AL	Diversified
4.	Ayothiyapattinam	5808	46.30	42.51	0.40	10.80	CL	Diversified
5.	Valapady	3033	54.63	40.69	0.56	4.12	CL	CL1
6.	Yercaud	16245	12.25	19.34	0.40	68.01	OW	Diversified
7.	Pethanaickenpalayam	21404	53.49	41.47	1.01	4.02	CL	CL1
8.	Attur	2324	65.10	31.67	0.39	2.84	CL	CL1
9.	Gangavalli	6766	58.44	36.70	0.19	4.67	CL	CL1
10.	Thalaivasal	654	70.95	19.27	3.98	5.81	CL	CL1
11.	Kolathur	5190	28.30	63.08	0.21	8.40	AL	AL1
12.	Nangavalli	3	33.33	0.00	33.33	33.33	CL, HIW and OW	HIW3
13.	Mecheri	9	0.00	55.56	0.00	44.44	AL	Diversified
14.	Omalur	113	20.35	49.56	0.88	29.20	AL	Diversified
15.	Tharamangalam	4	0.00	25.00	0.00	75.00	OW	OW1
16.	Kadayampatti	2825	12.07	76.81	0.28	10.83	AL	AL1
17.	Sankari	8	12.50	25.00	0.00	62.50	OW	Diversified
18.	Konganapuram	1	0.00	0.00	0.00	100.00	OW	OW1
19.	Mac.Donal Choultry	218	8.72	24.77	30.28	36.24	OW	HIW2
20.	Not under any CD Block	222	7.66	67.12	0.00	25.23	AL	AL1
	Mean		26.23	34.34	3.90	35.53		
	Standard Deviation (SD)		24.27	22.19	9.63	32.89		
	Mean + SD (1st order)		50.50	56.52	13.53	68.42		
	Mean + 2SD (2nd order)		74.77	78.71	23.16	101.31		
	Mean + 3SD (3rd order)		99.05	100.89	32.79	134.20		

(Source: Authors Calculation)

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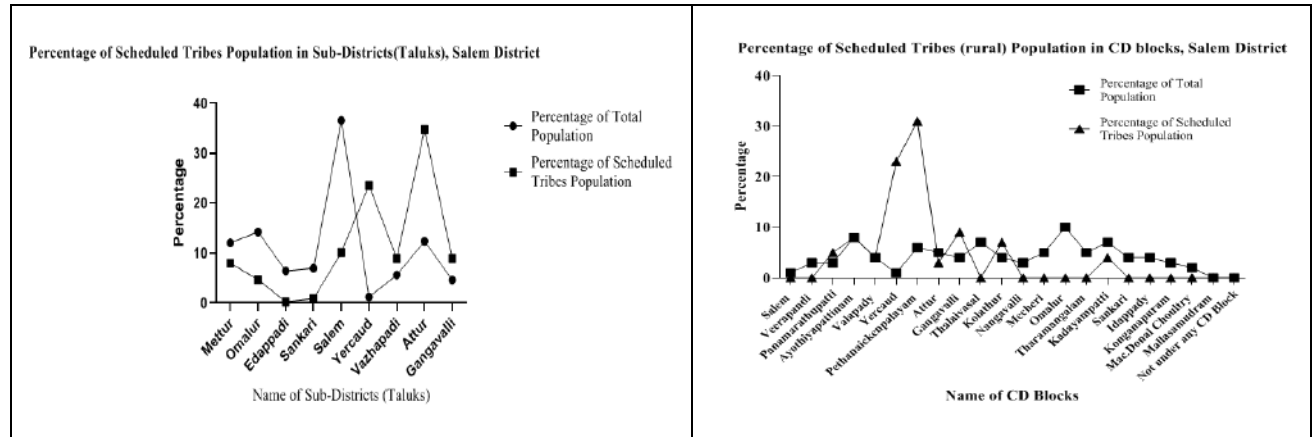
Fig 1. Percentage of Scheduled Tribes population in Sub-Districts (Takluks), Salem District

Fig. 2 Percentage of Scheduled Tribes Population in Community Development Blocks, Salem District
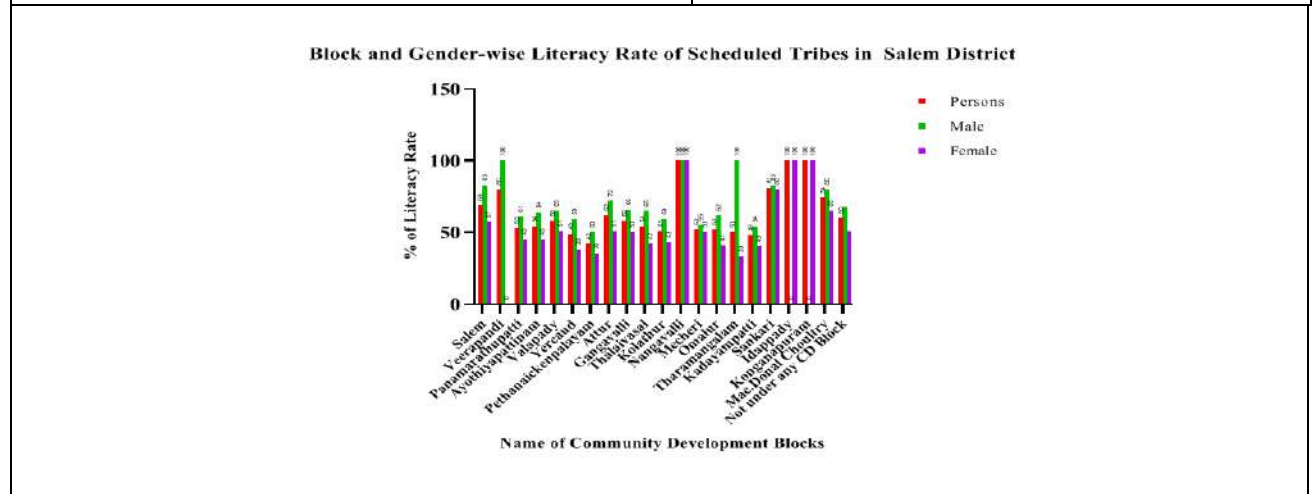
Fig. 3. Block and Gender-wise Literacy Rate of Scheduled Tribes in Salem District

RESEARCH ARTICLE

On Mean Square Exponential Stability of Second Order Neutral Impulsive Stochastic Differential Equations with Poisson Jumps

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ABSTRACT

The proposed work is to explore the exponential stability of mild solution of the second order neutral impulsive system with Poisson jumps. The sufficient conditions are attained by a new impulsive integral inequality. With the aid of integral inequality and cosine family theory we examine the stability of the system. The efficacy of the derived results are exemplified with an example.

Keywords: Examine the stability, Poisson jumps, cosine family theory.

INTRODUCTION

The deterministic model periodically oscillates because of disruption in the environment. As a result, dealing with stochastic differential equations (SDEs) is vital for us. Second order SDEs have a significant part in designing as a mathematical model for dynamical systems. The observation reveals that delays are unpreventable in controller design process. In the form of impulses, sudden and rapid changes occur in an instant and it is impossible to categorize as discrete or continuous models. In man-made systems and nature, noise or stochastic perturbation is ubiquitous and inevitable. Impulsive differential equations are used in mathematical modeling of these types of systems. Poisson jumps have extensively used to model many of the real life events includes economics, finance sectors, medical fields, physical and biological sciences. Moreover, many practical systems include stock market crashes, notification made by central banks, natural disorder, may be subjected to stochastic disturbances of the jump kind. On that account the stochastic models must incorporate a jump term. Neutral stochastic partial differential

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equations (NSPDE) are essential to explain many intricate dynamical systems in science, social sciences ,aero elasticity and medicine [1–5]. The existence, uniqueness and stability bahavior of mild solutions for Neutral stochastic partial functional differential equations(NSPFDE) deliberated in [5–12, 18]. Existence, uniqueness and some sufficient conditions for the exponential stability of infinite dimensional stochastic systems with Markovian switching by Lyapunov-Razumikhin technique explored in [13]. Stamovaa and Stamov [14] investigated the asymptotic stability of control system for neutral type with impulsive delay using the Lyapunov-Razumikhin technique. Using impulsive integral inequality sufficient conditions for global attracting set and exponential p-stability of NSPFDE with im- pulses are interrogated by Long *et al* [15]. Chen *et al* [16] examined the exponential stability of mild solution of NSPFDE by impulsive inequality technique. Chen [17] exploit the integral inequality technique to study the exponential and asymptotic stability for second order NSPDE with infinite delay . Using the principle of contraction mapping, Sakthivel and Ren [19] derived set of sufficient conditions for the mean square exponential stability of mild solutions to the non- linear stochastic evolution equations of second order with infinite delay and Poisson jumps. Chen[18] established the existence, uniqueness and the sufficient conditions for mean square exponential stability for mild solution for NSPDE with infinite delay and Poisson jumps. The author [22] described the asymptotic stability of NSPFDE by the principle of contraction mapping. Arthi *et al*. [20] probed the exponential behavior of mild solutions of second order NSPDE with impulses. Anguraj *et al* [23] verified the existence and stability of NSPFDE driven by Poisson jumps of first order. Rangasamy *et al*. [25,26] studied the modelling of disease by fractional differential equations. To best of my knowledge there is no work reported to exponential stability of second order systems with Poisson jumps.

Preliminaries

The purpose of this article is to explore the mean square exponential stability of mild solutions for the neutral impulsive SDEs of second order with infinite delay and Poisson jumps of the form

$$d\big[x'(t) - h(t, x_t)\big] = [Ax(t) + f(t, x_t)]dt + g(t, x_t)dw(t)$$

$$+ \int_Z \sigma(t, x(t-), z)\widetilde{N}(dt, dz) , t \geq 0, t \neq t_k ,$$

$x\ (s) = \varphi(s) \in \mathcal{B}, s \in [-r, 0] , x'(0) = \eta, \qquad k = 1,2, \ldots,$

$\Delta x(t_k) = I_k\big(x(t_k)\big), \ \ \Delta x'(t_k) = \tilde{I}_k\big(x(t_k)\big), \qquad k = 1,2, \ldots,$ (2.1)

where $A: D(A) \subset H \to H$ is the infinitesimal generator of a strongly continuous cosine family of bounded linear operators $(C(t))_{t \in R}$ defined on H. The history $x_t: (-\infty, 0] \to H, x_t (\theta) = x(t + \theta)$ for $t \geq 0$ belongs to the space phase $\mathcal{B}$. Assume that $f: [0, \infty) \times \mathcal{B} \to H, h: [0, \infty) \times \mathcal{B} \to H, g: [0, \infty) \times \mathcal{B} \to L_2^0(K, H)$ and $\sigma: [0, \infty) \times H \times (Z - \{0\}) \to H$ are appropriate mappings. Here $I_k, \tilde{I}_k: \mathcal{B} \to H$, the initial data φ is an $\mathcal{F}_0$-measurable $\mathcal{B}$-valued stochastic process independent of the Wiener process w and the Poisson point process $k(\cdot)$ with finite second moment and η is a $\mathcal{F}_0$-measurable H-valued random variable independent of the Wiener process w and the Poisson point process $p(\cdot)$ with finite second moment. The fixed moments of time t_k are given such that $0 \leq t_1 < t_2 \ldots < t_k < \ldots$ and $\lim_{k \to \infty} t_k = +\infty; \Delta x(t_k) = x(t_k{}^+) - x(t_k{}^-), \Delta x'(t_k) = x'(t_k{}^+) - x'(t_k{}^-), x(t_k{}^+)$ and $x(t_k{}^-)$ denote the right and left limits of x at time t_k. Similarly $x'(t_k{}^+)$ and $x'(t_k{}^-)$ denote the right and left limits of x' at time t_k. Moreover $I_k, \tilde{I}_k$ represents the size of the jump.

Let $(\Omega, \mathcal{F}, \{\mathcal{F}_t\}_{t \geq 0}, P)$ be a complete probability space with some filtration $\{\mathcal{F}_t\}_{t \geq 0}$ satisfying the usual conditions that is the filtration is right- continuous while $\mathcal{F}_0$ contains all P - null sets. Let $(H, \|\cdot\|_H)$ and $(K, \|\cdot\|_K)$ be two real separable Hilbert spaces with inner product $\langle \cdot, \cdot \rangle_H$ and $\langle \cdot, \cdot \rangle_K$ respectively. Suppose $\{p(t): t \geq 0\}$ is a Poisson point process taking values in a measureable space $(Z, \mathcal{B}(Z))$ with a σ-finite intensity measure $\lambda(dz)$. The random measure N_p defined by $N_p\big((0, t] \times \Lambda\big) := \Sigma_{s \in (0,t]} 1_\Lambda\ p\big((s)\big)$ for $\Lambda \in B(z)$ is called the Poisson random measure induced by $p(\cdot)$. We can define the measure $\widetilde{N}$ by $\widetilde{N}(dt, dz) = N_p(dt, dz) - \lambda(dz)dt$, where λ is the characteristic measure of N_p, which is called the compensated Poisson random measure. Let w be a Q -Wiener process, independent of the Poisson point process $\{p(t): t \geq 0\}$ on $(\Omega, \mathcal{F}, P)$ with the linear bounded covariance operator Q such that $trQ < \infty$. We assume that there exists a complete orthonormal system $\{e_n\}$ in K, a bounded sequence of non negative real numbers $\{\lambda_n\}$ such

that $Qe_n = \lambda_n e_n$, $n = 1,2,3, ...$, and a sequence $\{\beta_n\}$ of independent Wiener process such that

$\langle w(t), e \rangle = \sum_{n=1}^{\infty} \sqrt{\lambda_n} \langle e_n, e \rangle \beta_n(t)$, $e \in K$,

Let $\xi \in L(K, H)$ and define $\|\xi\|_{L_2^0}^2 = tr(\xi Q \xi^*) = \sum_{n=1}^{\infty} \left\| \sqrt{\lambda_n} \xi e_n \right\|^2$. If $\|\xi\|_{L_2^0}^2 < \infty$ then ξ is called a Q-Hilbert-Schmidt operator and let $L_2^0(K, H)$ denote the space of a Q-Hilbert-Schmidt operators from K to H. Let $C((-\infty, 0], H)$ be the space of all bounded and continuous functions φ from $(-\infty, 0]$ to H with the sup norm $\|\cdot\|_C = \sup_{-\infty < \theta \leq 0} \|\varphi(\theta)\|$ and the space $\mathcal{B}$ represent the family of all $\{\mathcal{F}_t\}_{t \geq 0}$ measurable and $C((-\infty, 0], H)$ valued random variables.

Let $\mathscr{P}^2([0, T] \times Z; H)(T > 0)$ be the space of all predictable mappings $X: [0, T] \times Z \times \Omega \to H$ for which $\int_0^T \int_Z E\|X(s, z)\|^2 dt \, \lambda(dz) < +\infty$. we may then define the H-valued stochastic integral $\int_0^T \int_Z X(t, z) \tilde{N}(dt, dz)$.

The one parameter family of bounded linear operators $(C(t))_{t \in R} \in L(H, H)$ is called a strongly continuous family if
(i) $C(0) = I$,
(ii) $C(t)x$ is continuous in t on R, for each fixed $x \in H$,
(iii) $C(t + s) + C(t - s) = 2C(t)C(s)$ for all $s, t \in R$.

The corresponding strongly continuous sine family $(S(t))_{t \in R} \in L(H, H)$ is defined by $S(t) x = \int_0^t C(s)x ds, t \in R, x \in H$.

The infinitesimal generator of a strongly continuous cosine family $(C(t))_{t \in R}$ is the operator $A: H \to H$ by $Ax = \left(\frac{d^2}{dt^2} \right) C(t)x \Big|_{t=0}$, for all $x \in D(A) \{x \in H : C(\cdot)x \in C^2(R; H)\}$.

It is well known that the infinitesimal generator A is a closed, densely defined operator on X. Such cosine and sine families and their generators satisfy the following properties.

Lemma 2.1 [21]
Suppose that A is the infinitesimal generator of a cosine family of operators $\{C(t), t \in R\}$. Then the following holds.
(i) There exists $M^* \geq 1$ and $\alpha \geq 0$ such that $\|C(t)\| \leq M^* e^{\alpha t}$ and hence
$\|S(t)\| \leq M^* e^{\alpha t}$.
(ii) $A \int_s^{\hat{r}} S(u)x du = [C(\hat{r}) - C(s)]x$ for all $0 \leq s \leq \hat{r} \leq \infty$.
(iii) There exists $N^* \geq 1$ such that $\|S(s) - S(\hat{r})\| \leq N^* \left| \int_s^{\hat{r}} e^{\alpha|s|} ds \right|$ for all
$0 \leq s \leq \hat{r} \leq \infty$.

Lemma 2.2 [2]
For any $r \geq 1$ and for arbitrary $L_2^0(K, H)$- valued predictable process $\varphi(\cdot)$ such that
$\sup_{s \in [0, t]} \leq (r(2r - 1))^r \left(\int_0^t \left(E\|\varphi(s)\|_{L_2^0}^{2r} \right)^{\frac{1}{r}} ds \right)^r$, $t \in [0, +\infty)$.

Lemma 2.3 [13]
Let the space $M_\lambda^\theta([0, T] \times Z \times \Omega, H)(\theta \geq 2)$ be the set of all random process $J(t, z)$ with values in H, predictable with respect to $\{\mathcal{F}_t\}_{t \geq 0}$ such that

$$E \left(\int_0^T \int_Z \|J(t, z)\|^\theta \lambda(dz) \, dt \right) < +\infty.$$

Supposed that $J \in M_\lambda^2([0, T] \times Z \times \Omega, H) \cap M_\lambda^4([0, T] \times Z \times \Omega, H)$, then for any $t \in [0, T]$,

$$E \left[\sup_{s \in [0, t]} \left\| \int_0^s \int_Z S(s - u)J(u, z) \tilde{N}(du, dz) \right\|^2 \right]$$

$$\leq C \left\{ E \left(\int_0^t \int_Z \|J(s, z)\|^2 \lambda(dz) ds \right) + E \left(\int_0^t \int_Z \|J(s, z)\|^4 \lambda(dz) ds \right)^{1/2} \right\}$$

For a positive number $C = C(T) > 0$, dependent on $T > 0$.

Definition 2.4
A stochastic process $\{x(t), t \in R^+\}$ is called a mild solution of the system (1) - (4) if
(i) $x(t)$ is an $\mathcal{F}_t(t \geq 0)$ adapted process,
(ii) $x(t) \in H$ has a $c\grave{a}dl\grave{a}g$ path on $t > 0$ almost surely,
(iii) For arbitrary $t \in [0, +\infty)$, $p\left\{\int_0^t \|x(t)\|^2 dt < +\infty\right\}$ and almost surely, $x(t)$ satisfies the following integral equation

$$x(t) = C(t)\varphi + S(t)[\eta - h(0, \varphi)] + \int_0^t C(t-s)\, h(s, x_s)ds$$

$$+ \int_0^t S(t-s)\, f(s, x_s)ds + \int_0^t S(t-s)\, g(s, x_s)dw(s) + \sum_{0 < t_k < t} C(t-t_k)I_k\big(x(t_k^-)\big)$$

$$+ \sum_{0 < t_k < t} S(t-t_k)\tilde{I}_k\big(x(t_k^-)\big) + \int_0^t S(t-s)\int_Z \sigma(s, x(s-), z)\tilde{N}(ds, dz).$$

Definition 2.5
The mild solution of the system (2.1) is said to be exponentially stable in mean square if there exist two positive constants $\gamma > 0$ and $M^* > 0$ such that
$$E\|x(t)\|^p \leq M^* E\|\xi\|_C^2\, e^{-\gamma t}, t \geq 0.$$

MAIN RESULTS

In order to obtain our main results ,we need the following assumptions.
(H_1) The cosine family of operators $\{C(t); t \geq 0\}$ on H and the corresponding sine family $\{S(t); t \geq 0\}$ satisfy the conditions $\|C(t)\| \leq Me^{-bt}, \|S(t)\| \leq Me^{-at}$, for some constants $M \geq 1$ and $a > 0, b > 0$.
(H_2) The mappings h, f, g satisfy the following conditions, there exist two positive constants $C_i > 0$ $(i = 1,2,3)$ and a function $k : (-\infty, 0] \to [0, \infty)$ with two important properties $\int_{-\infty}^0 k(t)dt = 1$ and $\int_{-\infty}^0 k(t)e^{-lt}dt < +\infty$ for some $l > 0$ such that

$$\|h(t, x) - h(t, y)\|_H \leq C_1 \int_{-\infty}^0 k(\theta)\|x(t+\theta) - y(t+\theta)\|d\theta, \quad h(t, 0) = 0,$$

$$\|f(t, x) - f(t, y)\|_H \leq C_2 \int_{-\infty}^0 k(\theta)\|x(t+\theta) - y(t+\theta)\|d\theta, \quad f(t, 0) = 0,$$

$$\|g(t, x) - g(t, y)\|_{L_2^0} \leq C_3 \int_{-\infty}^0 k(\theta)\|x(t+\theta) - y(t+\theta)\|d\theta, \quad g(t, 0) = 0,$$

for any $x, y \in \mathcal{B}$ and $t \geq 0$.
(H_3) The mappings $\sigma(t, \cdot, \cdot)$ satisfies the following condition there exist three positive constants $C_4, C_2', \ C_4' > 0$ and a function $k'(\cdot, \cdot) : H \times Z \to H$ such that

$$\|\sigma(t, x, u) - \sigma(t, y, u)\| \leq C_4 \int_{-\infty}^0 k(\theta)\|k'(x, u) - k'(y, u)\|d\theta, \quad \sigma(t, 0, 0) = 0,$$

and for any given $z \in Z$,

$$\int_Z \|k'(x, u) - k'(y, u)\|^i \lambda(du) \leq C_i' \|x - y\|^i, i = 2, 4, k'(0, u) = 0,$$

for any $x, y \in H$ and $t \geq 0$.
(H_4) The impulsive functions $I_k, \tilde{I}_k (k = 1,2, \dots,)$ satisfy the following conditions. There exist some positive numbers $a_k, b_k (k = 1,2, \dots,)$ such that
$$\|I_k(x) - I_k(y)\| \leq a_k\|x - y\|, \|I_k(0)\| = 0,$$
$$\|\tilde{I}_k(x) - \tilde{I}_k(y)\| \leq b_k\|x - y\|, \|\tilde{I}_k(0)\| = 0,$$
for each $x, y \in H$ and $\sum_{k=1}^\infty a_k < \infty, \sum_{k=1}^\infty b_k < \infty$.
(H_5) For any scalar $p \geq 2$, we have

$8M^2 \left[C_1^2 b^{-2} + C_2^2 a^{-2} + C_3^2 a^{-1} + \sum_{k=1}^{\infty}(a_k + b_k)^2 + C_4^2 (C_2')^2 \right] < 1$

Remark

Under the conditions,$(H_1) - (H_5)$,the system (2.1) has a trivial solution when $\varphi = 0$.

Lemma 3.1

For $\gamma_1, \gamma_2 \in (0,l]$,there exist some positive constants $\sigma_i > 0 (i = 1,2,3,4), c_k, d_k (k = 1,2,\dots,)$ and a function $y: (-\infty, +\infty) \to [0, +\infty)$. If $\frac{\sigma_3}{\gamma_1} + \frac{\sigma_4}{\gamma_2} + \sum_{k=1}^{\infty} c_k + \sum_{k=1}^{\infty} d_k < 1$,

the following inequality

$$y(t) \le \sigma_1 e^{-\gamma_1 t} + \sigma_2 e^{-\gamma_2 t} + \sigma_3 \int_0^t e^{-\gamma_1(t-s)} \int_{-\infty}^0 k(\theta) y(s + \theta) d\theta ds$$

$$+ \sigma_4 \int_0^t e^{-\gamma_2(t-s)} \int_{-\infty}^0 k(\theta) y(s + \theta) d\theta ds + \sum_{t_k < t} c_k e^{-\gamma_1(t-t_k)} y(t_k^-)$$

$+ \sum_{t_k < t} d_k e^{-\gamma_2(t-t_k)} y(t_k^-), \quad t \ge 0,$ (2.2)

and

$y(t) \le \sigma_1 e^{-\gamma_1 t} + \sigma_2 e^{-\gamma_2 t}, t \in (-\infty, 0],$ (2.3)

holds. Then, we have $y(t) \le M_2 e^{-\mu t}, t \in (-\infty, +\infty)$, where $\mu \in (0, \gamma_1 \wedge \gamma_2)$ is a positive root of the equation

$\left(\frac{\sigma_3}{\gamma_1 - \mu} + \frac{\sigma_4}{\gamma_2 - \mu} \right) \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta + \sum_{k=1}^{\infty} (c_k + d_k) = 1$ and

$$M_2 = \max \left\{ \sigma_1 + \sigma_2, \frac{\sigma_1(\gamma_1 - \mu)}{\sigma_3 \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta}, \frac{\sigma_2(\gamma_2 - \mu)}{\sigma_4 \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta} \right\} > 0.$$

Proof

Let assume that $F(\lambda) = \left(\frac{\sigma_3}{\gamma_1 - \mu} + \frac{\sigma_4}{\gamma_2 - \mu} \right) \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta + \sum_{k=1}^{\infty} (c_k + d_k) - 1,$ we have

$F(0)F(\gamma -) < 0$ holds. That is, there exists a positive constant $\mu \in (0, \gamma_1 \wedge \gamma_2)$, such that $F(\mu) = 0$.Let

$C_\varepsilon = \max \left\{ \sigma_1 + \sigma_2 + \varepsilon, \sigma_1 + \varepsilon \frac{\gamma_1 - \mu}{\sigma_3 \int_{-\infty}^0 k(\theta)e^{-\mu\theta}d\theta}, (\sigma_2 + \varepsilon) \frac{\gamma_2 - \mu}{\sigma_4 \int_{-\infty}^0 k(\theta)e^{-\mu\theta}d\theta} \right\} > 0,$for any$\varepsilon > 0.$ (2.4)

In order to prove the result, we first assume that (2.2) and (2.3) imply

$y(t) \le C_\varepsilon \ e^{-\mu \ t}, t \in (-\infty, +\infty).$ (2.5)

It is easily seen that (2.5) holds for any $t \in (-\infty, 0]$. By contradiction, that there exists a $t_1 > 0$ such that

$y(t) < C_\varepsilon e^{-\mu \ t}, t \in (-\infty, t_1), y(t_1) = C_\varepsilon e^{-\mu \ t_1}.$ (2.6)

Then (2.2) and (2.3)together infer that

$$y(t_1) \le \sigma_1 e^{-\gamma_1 t} + \sigma_2 e^{-\gamma_2 t} + \sigma_3 C_\varepsilon \int_0^{t_1} e^{-\gamma_1(t_1-s)} \int_{-\infty}^0 k(\theta) e^{-\mu(s+\theta)} d\theta ds + \sigma_4 C_\varepsilon \int_0^{t_1} e^{-\gamma_2(t_1-s)} \int_{-\infty}^0 k(\theta) e^{-\mu(s+\theta)} d\theta ds$$

$$+ C_\varepsilon \sum_{t_k < t_1} C_k e^{-\gamma_1(t_1-t_k)} \times e^{-\mu t_k}$$

$+ C_\varepsilon \sum_{t_k < t_1} d_k e^{-\gamma_2(t_1-t_k)} \times e^{-\mu t_k}.$

$$= \left(\sigma_1 - \frac{C_\varepsilon \sigma_3}{\gamma_1 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta \right) e^{-\gamma_1 t_1} + \left(\sigma_2 - \frac{C_\varepsilon \sigma_4}{\gamma_2 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta \right) e^{-\gamma_2 t_1}$$

$+ \left(\frac{\sigma_3}{\gamma_1 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta + \frac{\sigma_4}{\gamma_2 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta + \sum_{k=1}^{\infty} (c_k + d_k) \right) C_\varepsilon e^{-\mu \ t_1}.$ (2.7)

From the definition of μ and C_ε, we obtain

$$\frac{\sigma_3}{\gamma_1 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta + \frac{\sigma_4}{\gamma_2 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta = 1,$$

$$\sigma_1 - \frac{C_\varepsilon \sigma_3}{\gamma_1 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta = \sigma_1 - \frac{\sigma_3}{\gamma_1 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta(\sigma_1 + \varepsilon) \frac{\gamma_1 - \mu}{\sigma_3 \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta} < 0,$$

$\sigma_2 - \frac{C_\varepsilon \sigma_4}{\gamma_2 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta = \sigma_2 - \frac{\sigma_4}{\gamma_2 - \mu} \int_{-\infty}^0 k(\theta) e^{-\mu\theta} d\theta(\sigma_2 + \varepsilon) \frac{\gamma_2 - \mu}{\sigma_4 \int_{-\infty}^0 k(\theta)e^{-\mu\theta} d\theta} < 0.$ (2.8)

Thus from (2.7) we have $y(t_1) = C_\varepsilon e^{-\mu \ t_1}$

which contradicts (2.6), that is (2.5) holds.

As $\varepsilon > 0$ is arbitrarily small, from (2.5),it follows

$$y(t_1) = M_2 e^{-\mu\ t}, t \geq 0. \tag{2.9}$$

Theorem 3.1

Assume that the conditions $(H_1) - (H_4)$ hold and $a, b \in (0,\ 1]$ then the mild solution to the system (1.1) is mean square exponentially stable.

Proof

In order to prove the exponential stability results, we assume that the mild solution of (2.1) exists and it is of the form (2.24).we have

$$E\|x(t)\|^2 = E\left\| C(t)\phi + S(t)[\eta - h(0,\phi)] + \int_0^t C(t-s)\,h(s,x_s)ds \right.$$

$$+ \int_0^t S(t-s)\,f(s,x_s)ds + \int_0^t S(t-s)\,g(s,x_s)dw(s)$$

$$+ \sum_{0<t_k<t} C(t-t_k)I_k\big(x(t_k{}^-)\big) + \sum_{0<t_k<t} S(t-t_k)\widetilde{I_k}\big(x(t_k{}^-)\big)$$

$$\left. + \int_0^t S(t-s)\int_Z \sigma(s,x(s-),z)\widetilde{N}(ds,dz) \right\|^2$$

$$\leq 8E\|C(t)\varphi\|^2 + 8E\|S(t)[\eta - h(0,\varphi)]\|^2 + 8E\left\| \int_0^t C(t-s)\,h(s,x_s)ds \right\|^2$$

$$+ 8E\left\| \int_0^t S(t-s)\,f(s,x_s)ds \right\|^2 + 8E\left\| \int_0^t S(t-s)\,g(s,x_s)dw(s) \right\|^2$$

$$+ 8E\left\| \sum_{0<t_k<t} C(t-t_k)I_k\big(x(t_k{}^-)\big) \right\|^2 + 8E\left\| \sum_{0<t_k<t} S(t-t_k)\tilde{I_k}\big(x(t_k{}^-)\big) \right\|^2$$

$$+ 8E\left\| \int_0^t S(t-s)\int_Z \sigma(s,x(s-),z)\widetilde{N}(ds,dz) \right\|^p$$

$$= 8^{p-1}(I_1 + I_2 + I_3 + I_4 + I_5 + I_6 + I_7 + I_8) \tag{3.1}$$

Now we estimate the terms on the right-hand side of (3.1).From the condition (H_1) we get

$$I_1 = E\|C(t)\varphi\|^2 \leq M^2 E\|\varphi\|^2 e^{-bt}. \tag{3.2}$$

$$I_2 = E\|S(t)[\eta - h(0,\varphi)]\|^2 \leq M^2 E\|\eta - h(0,\varphi)\|^2 e^{-at}. \tag{3.3}$$

Now by using the condition (H_2), we obtain

$$I_3 = E\left\| \int_0^t C(t-s)\,h(s,x_s)ds \right\|^2$$

$$\leq E\left(\int_0^t \|C(t-s)\|\|h(s,x_s)\|\,ds \right)^2$$

$$\leq M^2 \left(\int_0^t e^{-b(t-s)}\,E\|h(s,x_s)\|\ ds \right)^2$$

$$\leq M^2 C_1^2 \left(\int_0^t e^{-b(t-s)} \right) \; \int_0^t e^{-b(t-s)} \, E \left(\int_{-\infty}^0 k(\theta) \|x(s+\theta)\| d\theta \right)^2 ds$$

$$\leq M^2 C_1^2 b^{-1} \int_0^t e^{-b(t-s)} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^2 d\theta \, ds. \tag{3.4}$$

Similarly by using the condition (H_2), we get

$$I_4 = E \left\| \int_0^t S(t-s) \, f(s,x_s) ds \right\|^p$$

$$\leq E \left(\int_0^t \|S(t-s)\| \|f(s,x_s)\| \, ds \right)^2$$

$$\leq M^2 \left(\int_0^t e^{-a(t-s)} E\|f(s,x_s)\| \; ds \right)^2$$

$$\leq M^2 C_2^2 \left(\int_0^t e^{-a(t-s)} \right) \; \int_0^t e^{-a(t-s)} \, E \left(\int_{-\infty}^0 k(\theta) \|x(s+\theta)\| d\theta \right)^2 ds$$

$$\leq M^2 C_2^2 a^{-1} \int_0^t e^{-a(t-s)} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^2 d\theta \, ds. \tag{3.5}$$

From lemma (2.2) and from (H_2) we obtain

$$I_5 = E \left\| \int_0^t S(t-s) \, g(s,x_s) dw(s) \right\|^2$$

$$\leq M^2 \int_0^t e^{-2a(t-s)} \; E\|g(s,x_s)\|_{L_2^0}^2 ds$$

$$\leq M^2 C_3^2 a^{-1} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^p d\theta \, ds. \tag{3.6}$$

From (H_4) we obtain

$$I_6 = E \left\| \sum_{0<t_k<t} C(t-t_k) I_k\big(x(t_k{}^-)\big) \right\|^2$$

$$\leq M^2 E \left(\sum_{0<t_k<t} e^{-a(t-t_k)} a_k \|x(t_k{}^-)\| \right)^2$$

$$\leq M^2 \left(\sum_{k=1}^{\infty} a_k \right) \; \sum_{0<t_k<t} e^{-a(t-t_k)} a_k \, E\|x(t_k{}^-)\|^2. \tag{3.7}$$

Similarly

$$I_7 = E \left\| \sum_{0<t_k<t} S(t-t_k) \tilde{I}_k\big(x(t_k{}^-)\big) \right\|^2 \tag{3.8}$$

$$\leq M^2 \left(\sum_{k=1}^{\infty} b_k \right) \sum_{0<t_k<t} e^{-b(t-t_k)} b_k \, E\|x(t_k{}^-)\|^2.$$

Now by using the condition (H_3), we obtain

$$I_8 = E \left\| \int_0^t S(t-s) \int_Z \; \sigma(s,x(s-),z) \widetilde{N}(ds,dz) \right\|^2$$

$$\leq E \left\| \int_0^t M e^{-a(t-s)} \int_Z \; \sigma(s,x(s-),z) \lambda(dz) \, ds \right\|^2$$

$$\leq M^2 C_4^2 \; E \left\| \int_0^t M e^{-a(t-s)} \int_Z \left(\int_{-\infty}^0 k(\theta) \| k'(x,u) \| d\theta \right) \lambda(dz) \, ds \right\|^2$$

$$\leq M^2 C_4^2 \, (C_2')^2 E \left(\int_0^t e^{-a(t-s)} \int_{-\infty}^0 k(\theta) \| x(s+\theta) \| d\theta \right)^2 ds$$

$$\leq M^2 C_4^2 \, (C_2')^2 \left(\int_0^t e^{-a(t-s)} \right) \int_0^t e^{-a(t-s)} E \left(\int_{-\infty}^0 k(\theta) \| x(s+\theta) \| d\theta \right)^2 ds$$

$$\leq M^2 C_4^2 \, (C_2')^2 a^{-1} \int_0^t e^{-a(t-s)} E \left(\int_{-\infty}^0 k(\theta) \| x(s+\theta) \| d\theta \right)^2 ds. \tag{3.9}$$

$$E\|x(t)\|^p \leq 8M^2 E\|\varphi\|^2 e^{-bt} + 8M^2 E\|\eta - h(0,\varphi)\|^2 e^{-at}$$

$$+ 8M^2 C_1^2 b^{-1} \int_0^t e^{-b(t-s)} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^2 d\theta \, ds$$

$$+ 8M^2 C_2^2 a^{-1} \int_0^t e^{-a(t-s)} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^2 d\theta \, ds$$

$$+ 8M^2 C_3^2 a^{-1} \int_{-\infty}^0 k(\theta) E\|x(s+\theta)\|^2 d\theta \, ds$$

$$+ 8M^2 \left(\sum_{k=1}^{\infty} a_k \right) \sum_{0 < t_k < t} e^{-a(t-t_k)} a_k \, E\|x(t_k{}^-)\|^2.$$

$$+ 8M^2 \left(\sum_{k=1}^{\infty} b_k \right) \sum_{0 < t_k < t} e^{-b(t-t_k)} b_k \, E\|x(t_k{}^-)\|^2$$

$$+ 8M^2 C_4^2 \, (C_2')^2 a^{-1} \int_0^t e^{-a(t-s)} E \left(\int_{-\infty}^0 k(\theta) \| x(s+\theta) \| d\theta \right)^2 ds. \tag{3.10}$$

and there exist two positive constants $M_1' > 0$ and $M_2' > 0$ such that $E\|x(t)\|^2 \leq M_1' e^{-at} + M_2' e^{-bt}$ for any $t \in (-\infty, 0]$, where $M_1' = 8M^2 E\|\varphi\|^2, M_2' = 8E\|\eta - h(0,\varphi)\|^2$.

By lemma (2.4) we have that $E\|x(t)\|^2 \leq M_1 e^{-\mu t}, t \in (-\infty, 0] \left(\mu \in \left(0, \gamma_1 \wedge \gamma_2 \right) \right)$,

where $M_1 = \{ 8M^2 \left(E\|\varphi(0)\|^2 + E\|\eta - h(0,\varphi)\|^2 \right), 8M^2 C_1^2 b^{-2}, 8M^2 \left(C_2^2 a^{-2} + C_3^2 a^{-1} + C_4^2 (C_2')^2 a^{-1} \right)$ \hfill (3.11)

Hence the mild solution of the system (2.1) is exponentially stable in p-th moment.

Example

Let $X = L^2[0,\pi]$ and $Y = R^1$ with the norm $\|\cdot\|$ and let $e_n = \sqrt{\frac{2}{\pi}} \sin(n\xi)$, $n = 1,2,\dots,$ is a complete orthonormal basis in X. Let $w(t) = \sum_{n=1}^{\infty} \sqrt{\lambda_n} \beta_n(t) e_n \, (\lambda_n > 0)$, where $\beta_n(t)$ are one dimensional standard Brownian motion mutually independent on a usual complete probability space $(\Omega, \mathcal{F}, \{\mathcal{F}_t\}_{t\geq 0}, P)$. $\tilde{N}(\cdot, \cdot)$ is a compensated Poisson measure on $[1, +\infty]$ with parameter $\lambda(dz) dt$ such that $C_i' = \int_1^{\infty} y^i \lambda(dz) < +\infty, (i = 2, 4)$. Assume moreover that the Wiener process $w(t)$ is independent of $\tilde{N}(\cdot, \cdot)$. Define $A: X \to X$ by $A = \left(\partial^2/\partial \xi^2 \right)$ with the domain $\{ D(A) = h \in X: h, (\partial/\partial \xi) h \text{ are absolutely continuous } (\partial^2/\partial \xi^2) h \in X, h(0) = h(\pi) = 0 \}$.

$$\text{Then } Ah = \sum_{n=1}^{\infty} n^2 (h, e_n) e_n, h \in D(A),$$

where e_n, $(n = 1,2,3,\dots,)$ is also the orthonormal set of eigen vector of A. It is well known that $\|C(t)\| \leq \exp(\pi^2 t)$ and $\|S(t)\| \leq \exp(-\pi^2 t), t \geq 0$.

Now we consider the following second order neutral impulsive SDEs with infinite delays and Poisson jumps of the form

$$\partial \left[\frac{\partial}{\partial t} \omega(t,\xi) - \frac{\alpha_0}{\pi\sqrt{\pi}} \int_{-\infty}^0 (-\theta)^{-\frac{1}{2}} e^{\pi^2 \theta} \omega(t+\theta, \xi) \, d\theta \right]$$

$$= \left[\frac{\partial^2}{\partial \xi^2} \omega(t,\xi) + \frac{\alpha_1}{\pi\sqrt{\pi}} \int_{-\infty}^0 (-\theta)^{-\frac{1}{2}} e^{\pi^2 \theta} \omega(t+\theta, \xi) \, d\theta \right] dt$$

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$+\frac{\alpha_2}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\omega(t+\theta,\xi)\,d\theta d\omega(t)$

$+\frac{\alpha_3}{\pi\sqrt{\pi}}\int_{-1}^{\infty}y\left[\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\omega\big((t+\theta)-,\xi\big)yd\theta\right]d\,\tilde{N}(dy,dt), t\geq 0, \xi\in[0,\pi],$ (4.1)

subject to the initial conditions

$$\omega(t,0)=\omega(t,\pi)=0,\qquad t\geq 0,$$

$\frac{\partial}{\partial t}\omega(0,\xi)=\omega_1(\xi),\xi\in[0,\pi],$

$$\omega(0,\xi)=\varphi(0,\qquad\xi),\qquad\theta\in[-\infty,0],\qquad\xi\in[0,\pi],$$

$$\Delta\omega(t_k{}^-)(\xi)=\frac{\nu_1}{k^2}\omega(t_k{}^-),\qquad t=t_k(k=1,2,\dots,),$$

$\Delta\omega'(t_k{}^-)(\xi)=\frac{\nu_2}{k^2}\omega(t_k{}^-),t=t_k(k=1,2,\dots,).$

Define

$$h(t,\omega_t)=\frac{\alpha_0}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\omega(t+\theta,\qquad\xi)\,d\theta, h(t,\qquad 0)=0,$$

$$f(t,\omega_t)=\frac{\alpha_1}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\omega(t+\theta,\qquad\xi)\,d\theta, f(t,\qquad 0)=0,$$

$$g(t,\omega_t)=\frac{\alpha_2}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}z(t+\theta,\qquad\xi)\,d\theta, g(t,\qquad 0)=0,$$

$$\sigma(t,\qquad x(t-),z)=\frac{\alpha_4}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}x(t+\theta,\qquad\xi)y\,d\theta,$$

$\Delta x(t_k)=\frac{\nu_1}{k^2}\omega(t_k{}^-),\Delta x'(t_k)=\frac{\nu_2}{k^2}\omega(t_k{}^-)(k=1,2,\dots,).$

It is easily verified that

$$\|h(t,\omega_t^1)-h(t,\omega_t^2)\|\leq\frac{\alpha_0}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\|\omega^1(t+\theta,\xi)-\omega^2(t+\theta,\xi)\|\,d\theta, h(t,0)=0,$$

$$\|f(t,\omega_t^1)-f(t,\omega_t^2)\|\leq\frac{\alpha_1}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\|\omega^1(t+\theta,\xi)-\omega^2(t+\theta,\xi)\|\,d\theta,\qquad f(t,0)=0,$$

$$\|g(t,\omega_t^1)-g(t,\omega_t^2)\|\leq\frac{\alpha_2}{\pi\sqrt{\pi}}\int_{-\infty}^{0}(-\theta)^{-\frac{1}{2}}e^{\pi^2\theta}\|\omega^1(t+\theta,\xi)-\omega^2(t+\theta,\xi)\|\,d\theta,\qquad g(t,0)=0,$$

$$\int_{1}^{\infty}y^2\big\|\sigma(t,\qquad x_1(t-))-\sigma(t,\qquad x_2(t-))\big\|^2\lambda dz\leq C_2'\|x_1(t+\theta)-x_2(t+\theta)\|^2,$$

$$\int_{1}^{\infty}y^4\big\|\sigma(t,x_1(t-))-\sigma(t,x_2(t-))\big\|^2\lambda dz\leq C_4'\|x_1(t+\theta)-x_2(t+\theta)\|^4,$$

$$\Delta\omega_1(t_k{}^-) - \Delta\omega_2(t_k{}^-) \le \frac{v_1}{k^2}\big(\omega_1(t_k{}^-) - \omega_2(t_k{}^-)\big),$$

$$\Delta\omega_1^{'}(t_k{}^-) - \Delta\omega_2^{'}(t_k{}^-) \le \frac{v_1}{k^2}\big(\omega_1^{'}(t_k{}^-) - \omega_2^{'}(t_k{}^-)\big),$$

for any $\omega_t^1, \omega_t^2 \in \mathcal{B}$.

By Theorem 3.1, the mild solution of 4.1 is exponentially stable in mean square, provided that

$$8\left[\alpha_0^p \pi^{-2} + \alpha_1^2 \pi^{-2} + \pi^{-1}(\alpha_2^2 + C_2^1) + \frac{(v_1\pi^2)^2}{7} + \frac{(v_2\pi^2)^2}{7}\right] < 1.$$

CONCLUSION

In this article the exponential stability in p-th moment for impulsive second order neutral stochastic system with infinite delay and Poisson jumps has been studied. Sufficient conditions are obtained by integral inequality. An example is given to illustrate the effectiveness of the result obtained.

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RESEARCH ARTICLE

On Neutrosophic P – Spaces and Neutrosophic Almost P – Spaces

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ABSTRACT

The concept of Neutrosophic P – space and Neutrosophic almost P – space are introduced and the characterizations are explained with examples.

Keywords: Neutrosophic F_σ - set, Neutrosophic G_δ - set, Neutrosophic P – space, Neutrosophic Almost P – space,

INTRODUCTION AND PRELIMINARIES

The concept of Neutrosophic set was introduced by F.Smarandache[5]. After the introduction of neutrosophic set neutrosophic set operation have been investigated. Many researchers have studied topology on neutrosophic sets such as smarandache, Lupianez and Salama. In 1954 L.Gillman and M.henriksen defined and characterised the classes of P – spaces. A.K.Mishra introduced the concept of P – spaces as a generalisation of ω_α additive spaces of Sikorshi. The concept of P – space in fuzzy theory was introduced by G.Thangaraj and G.Balasubramaniam. Almost P – spaces in classical topology was introduced by A.I.Veksler and was also studied by R.Levy. In this paper we introduce the concept of Neutrosophic P – space, Neutrosophic Almost P – space. Also we discuss the several characterisations of neutrosophic P – spaces and Neutrosophic Almost P – spaces.

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The following definitions Neutrosophic Topological Space ($\mathbb{NT}S$),Neutrosophic open set($\mathbb{NOS}$) , Neutrosophic closed set($\mathbb{NCS}$), Neutrosophic interior $\mathbb{N}(Int)$, Neutrosophic closure $\mathbb{N}(Cl)$, Neutrosophic Dense set($\mathbb{NDS}$), Neutrosophic Nowhere dense set ($\mathbb{NNDS}$)are taken from the paper[3].

Definition 1.1.A Neu. Set $\mathbb{U}$ in $\mathcal{N}e^{\tau s}(\mathcal{D}, \mathcal{N}e^{\tau})$ is called *neutrosophic $F_{\sigma} - set$* $(\mathbb{N}(F_{\sigma})\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$, if $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$,

where $1 - \mathbb{U}_{k_1} \in \mathbb{N}_{\tau}$ for $k_1 \in I$.

Definition 1.2.A Neu. Set $\mathbb{U}$ in $\mathcal{N}e^{\tau s}(\mathcal{D}, \mathcal{N}e^{\tau})$is called *neutrosophic$G_{\delta} - set$* $(\mathbb{N}(G_{\delta})\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$, if $\mathbb{U} = \bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1}$,

where $\mathbb{U}_{k_1} \in \mathbb{N}_{\tau}$ for $k_1 \in I$.

2.Neutrosophic P - Spaces

Definition 2.1.A neutrosophic topological space($\mathbb{NT}S$) is called neutrosophic P – Space   ($\mathbb{N}(P)S$) if countable intersection of neutrosophicopen sets($\mathbb{NOS}$) in$(\mathcal{D}, \mathcal{N}e^{\tau})$ is $\mathbb{NOS}$. That is, every non – zero $\mathbb{N}(G_{\delta})\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

Example 2.1. Let $\mathcal{D}$ = {u,v}. Define the neutrosophic sets A and B on $\mathcal{D}$ as follows

$A = \{\prec a, 0.6, 0.3, 0.2 \succ, \prec b, 0.2, 0.5, 0.6 \succ, \prec c, 0.5, 0.4, 0.3 \succ\}$

$B = \{\prec a, 0.5, 0.3, 0.2 \succ, \prec b, 0.3, 0.5, 0.6 \succ, \prec c, 0.1, 0.5, 0.7 \succ\}$

Then the family $\mathbb{N}_{\tau} = \{0_N, 1_N, A \cup B, A \cap B\}$ is a neutrosophic topology on $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then $\mathcal{H} = A, B, A \cup B, A \cap B$ is a $\mathbb{N}(G_{\delta})\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.Therefore, $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a $(\mathbb{N}(P)S)$.

Proposition 2.1. If $\mathbb{U}$ is a non – zero $(\mathbb{N}(F_{\sigma})\mathbb{S})$ in a ($\mathbb{N}(P)S$)$(\mathcal{D}, \mathcal{N}e^{\tau})$, then $\mathbb{U}$ is a $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

Proof: Let $\mathbb{U}$ be a non – zero $(\mathbb{N}(F_{\sigma})\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ where $\mathbb{U}_{k_1}$'s are $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.Then

$1 - \mathbb{U} = 1 - \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1} = \bigcap_{k_1=1}^{\infty} (1 - \mathbb{U}_{k_1})$. Now $\mathbb{U}_{k_1}$'s are $\mathbb{NCS}$ in$(\mathcal{D}, \mathcal{N}e^{\tau})$, which implies $(1 - \mathbb{U}_{k_1})$'sare $\mathbb{NOS}$ in

(Y, N_{τ}).   Hence, we have $1 - \mathbb{U} = \bigcap_{k_1=1}^{\infty} (1 - \mathbb{U}_{k_1})$ where $(1 - \mathbb{U}_{k_1}) \in \mathbb{N}_{\tau}$.   Then $1 - \mathbb{U}$ is a $\mathbb{N}(G_{\delta})\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Since $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a ($\mathbb{N}(P)S$), then $1 - \mathbb{U}$ is a $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

Proposition 2.2. If $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a ($\mathbb{N}(P)S$),then $\mathbb{N}(Cl(\bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1})) = \bigcup_{k_1=1}^{\infty} \mathbb{N}(Cl(\mathbb{U}_{k_1}))$ where $\mathbb{U}_{k_1}$'s are non – zero $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

Proof: Let $\mathbb{U}_{k_1}$'s be a non – zero $\mathbb{NCS}$ in a ($\mathbb{N}(P)S$)$(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ is a non – zero $(\mathbb{N}(F_\sigma)\mathbb{S})$ on $(\mathcal{D}, \mathcal{N}e^\tau)$. By proposition 2.1, $\mathbb{U}$ is a $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence $\mathbb{N}(Cl(\mathbb{U})) = \mathbb{U}$, which implies that

$$\mathbb{N}(Cl(\bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1})) = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1} = \bigcup_{k_1=1}^{\infty} \mathbb{N}(Cl(\mathbb{U}_{k_1}))$$

Proposition 2.3. If $(\mathcal{D}, \mathcal{N}e^\tau)$ is a ($\mathbb{N}(P)S$), then $\mathbb{N}(Int((\bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1})) = \bigcap_{k_1=1}^{\infty} \mathbb{N}(Int(\mathbb{U}_{k_1}))$, where $\mathbb{U}_{k_1}$'s are non- zero $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}_{k_1}$'s be non- zero $\mathbb{NOS}$ in a ($\mathbb{N}(P)S$). Then $\mathbb{U} = \bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ is a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since, $(\mathcal{D}, \mathcal{N}e^\tau)$ is a ($\mathbb{N}(P)S$), the $\mathbb{N}(G_\delta)\mathbb{S}$ $\mathbb{U}$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, we have $\mathbb{N}(Int(\mathbb{U})) = \mathbb{U}$. This implies that

$$\mathbb{N}(Int(\bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1})) = \bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1} = \bigcap_{k_1=1}^{\infty} \mathbb{N}(Int(\mathbb{U}_{k_1})) \text{ (since } \mathbb{U}_{k_1} \in \mathbb{N}_\tau, \mathbb{N}(Int(\mathbb{U}_{k_1})) = \mathbb{U}_{k_1}) \text{ and hence}$$

$$\mathbb{N}(Int(\bigcap_{k_1=1}^{\infty} \mathbb{U}_{k_1}) = \bigcap_{k_1=1}^{\infty} \mathbb{N}(Int(\mathbb{U}_{k_1})), \text{ where } \mathbb{U}_{k_1}\text{'s are non- zero } \mathbb{NOS} \text{ in } (\mathcal{D}, \mathcal{N}e^\tau).$$

Proposition 2.4. If $(\mathcal{D}, \mathcal{N}e^\tau)$ is a ($\mathbb{N}(P)S$) and if $\mathbb{U}$ is a neutrosophic first category set in$(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{U}$ is not a neutrosophic nowhere dense set in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}$ be a neutrosophic first category set in a ($\mathbb{N}(P)S$)$(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ where $\mathbb{U}_{k_1}$'s are neutrosophic nowhere dense sets in $(\mathcal{D}, \mathcal{N}e^\tau)$. Now

$$\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}))) = \mathbb{N}(Int\mathbb{N}(Cl(\bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}) \supseteq \mathbb{N}(Int[\bigcup_{k_1=1}^{\infty} \mathbb{N}(Cl(\mathbb{U}_{k_1})]) \text{ and } \bigcup_{k_1=1}^{\infty} \mathbb{N}cl(\mathbb{U}_{k_1}) \text{ is a } (\mathbb{N}(F_\sigma)\mathbb{S})$$

in$(\mathcal{D}, \mathcal{N}e^\tau)$. Since $(\mathcal{D}, \mathcal{N}e^\tau)$ is a ($\mathbb{N}(P)S$), by proposition 2.1, $\bigcup_{k_1=1}^{\infty} cl(\mathbb{S}_{k_1})$ is a non – zero $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Also

interior of a $\mathbb{NOS}$ is a neutrosophic regular open set($\mathbb{NROS}$), $\mathbb{N}(Int[\bigcup_{k_1=1}^{\infty} \mathbb{N}(Cl(\mathbb{U}_{k_1})])$ is a non-zero $\mathbb{NROS}$

in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, we have $\mathbb{N}(Int[\bigcup_{k_1=1}^{\infty} \mathbb{N}(Cl(\mathbb{U}_{k_1})]) \neq 0_N$ which implies

$\mathbb{N}(Int[\bigcup_{k_1=1}^{\infty} \mathbb{N}Cl(\mathbb{U}_{k_1})]) \leq \mathbb{N}(Int \mathbb{N}(Cl(\mathbb{U})))$ which implies $\mathbb{N}(Int \mathbb{N}(Cl(\mathbb{U}))) \neq 0_N$. Therefore, $\mathbb{U}$ is not a $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 2.5. If $\mathbb{U}$ is a neutrosophic first category set in a neutrosophic P- space $(\mathcal{D}, \mathcal{N}e^\tau)$.such that $\mathbb{K} \subseteq 1 - \mathbb{U}$, where $\mathbb{K}$ is a non-zero $\mathbb{N}(G_\delta)\mathbb{S}$ in (x,T),then $\mathbb{U}$ is a $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}$ be a neutrosophic first category set in a neutrosophic P – space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ where $\mathbb{U}_{k_1}$

's are $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Now $1 - \mathbb{N}(Cl(\mathbb{U}_{k_1}))$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Let $\mathbb{K} = \bigcap_{k_1=1}^{\infty} [1 - \mathbb{N}(Cl(\mathbb{U}_{k_1})]$. Then $\mathbb{K}$

is a non-zero $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Now, we have

$$\bigcap_{k_1=1}^{\infty}[1 - \mathbb{N}(Cl(\mathbb{U}_{k_1})] = 1 - \bigcup_{k_1=1}^{\infty}\mathbb{N}(Cl(\mathbb{U}_{k_1}) \le 1 - \bigcup_{k_1=1}^{\infty}(\mathbb{U}_{k_1}) = 1 - \mathbb{U}.$$ Hence $\mathbb{K} \subseteq 1 - \mathbb{U}$. Then whave

$\mathbb{U} \subseteq 1 - \mathbb{K}$. Now $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U})) \subseteq \mathbb{N}(Int\mathbb{N}(Cl(1 - \mathbb{K})))$ which implies $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}) \subseteq 1 - \mathbb{N}(Cl\mathbb{N}(Int(\mathbb{K})) = 1 - 1 = 0_N$. Since $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P- space, $\mathbb{K}$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ and $\mathbb{N}(Int(\mathbb{K})) = \mathbb{K}$. Therefore, $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}) \subseteq 1 - \mathbb{N}(Cl(\mathbb{K}))) = 1 - 1 = 0_N$. (Since $\mathbb{K}$ is $\mathbb{NDS}$). Then $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}))) = 0_N$ and hence $\mathbb{U}$ is a $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Theorem 2.1[3]. Let $(\mathcal{D}, \mathcal{N}e^\tau)$ be a $\mathcal{N}e^{\tau\mathcal{S}}$. Then the following results are equivalent.
(1) $(\mathcal{D}, \mathcal{N}e^\tau)$ is a $\mathcal{N}e^{\mathcal{BS}}$.
(2) $\mathcal{N}e_{int}(\mathcal{K}) = 0_N$, for every $\mathcal{N}e_{\mathcal{S}}^{\mathcal{FC}}\mathcal{K}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.
(3) $\mathcal{N}e_{cl}(\mathcal{L}) = 1_N$, for every $\mathcal{N}e_{\mathcal{S}}^{\mathcal{R}}\mathcal{L}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 2.6. If $\mathbb{U}$ is a $\mathbb{NFCS}$ in a neutrosophic P- space $(\mathcal{D}, \mathcal{N}e^\tau)$ such that $\mathbb{K} \subseteq 1 - \mathbb{U}$, where $\mathbb{K}$ is a non-zero dense $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophicbaire space.

Proof: Let $\mathbb{U}$ be a $\mathbb{NFCS}$ in a neutrosophic P – space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ where $\mathbb{U}_{k_1}$'s are $\mathbb{NNDS}$ in

$(\mathcal{D}, \mathcal{N}e^\tau)$. As in proof 3.6, we have $\mathbb{N}(I nt\, \mathbb{N}(Cl(\mathbb{U}))) = 0_N$. Then we have $\mathbb{N}(I nt(\mathbb{U})) \subseteq \mathbb{N}(I nt(\mathbb{N}Cl(\mathbb{U})))$ implies that $\mathbb{N}(I nt(\mathbb{U})) = 0_N$ and hence by theorem 2.1, $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic baire space.

Proposition 2.7. If $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P- space and if $\mathbb{U}$ is a $\mathbb{NDS}$ and $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then there is no non-zero $\mathbb{N}(G_\delta)\mathbb{S}$ $\mathbb{K}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ such that $\mathbb{K} \subseteq 1 - \mathbb{U}$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NFCS}$ in a neutrosophic P – space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$ where $\mathbb{U}_{k_1}$'s are $\mathbb{NNDS}$ in

$(\mathcal{D}, \mathcal{N}e^\tau)$. Let $\mathbb{K}$ be a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ such that $\mathbb{K} \subseteq 1 - \mathbb{U}$. Then implies $\mathbb{N}(I nt(\mathbb{K})) \subseteq \mathbb{N}(I nt(1 - \mathbb{U}))$ implies that $\mathbb{N}(I int(\mathbb{K})) \subseteq 1 - \mathbb{N}(Cl(\mathbb{U})) = 1 - 1 = 0_N$ [Since $\mathbb{U}$ is a $\mathbb{NDS}$ $\mathbb{N}(Cl(\mathbb{U})) = 1_N$]. That is $\mathbb{N}(I nt(\mathbb{K})) = 0_N$. Since $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P- space $\mathbb{N}(I nt(\mathbb{K})) = \mathbb{K}$ and hence we have $\mathbb{K} = 0_N$. Hence, if $\mathbb{U}$ is a $\mathbb{NDS}$ and $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Then there is non-zero $\mathbb{N}(G_\delta)\mathbb{S}$ $\mathbb{K}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ such that $\mathbb{K} \subseteq 1 - \mathbb{U}$.

Theorem 2.2. If $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P- space and if $\mathbb{U}$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{U}$ is not a $\mathbb{NDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 2.8. If $\mathbb{U}$ is a $\mathbb{NRS}$ in a neutrosophic P- space $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $\mathbb{N}(I \operatorname{nt}(\mathbb{U})) \neq 0_N$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NRS}$ in a neutrosophic P- space$(\mathcal{D}, \mathcal{N}e^{\tau})$. Then $(1 - \mathbb{U})$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$ and by theorem 2.2, $(1 - \mathbb{U}))$ is not a $\mathbb{NDS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. That is, $\mathbb{N}(Cl(1 - \mathbb{U})) \neq 1_N$. This implies that $1 - \mathbb{N}(Int(\mathbb{U})) \neq 1_N$ and hence we have $\mathbb{N}(I \operatorname{nt}(\mathbb{U})) \neq 0_N$.

Theorem 2.3. If $(\mathbb{U}_{k_1})$'s are $\mathbb{NRCS}$ in a neutrosophic P- space $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $\mathbb{N}(Cl(\bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}) = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$.

Theorem 2.4[3]. If $\mathbb{U}$ is a $\mathbb{NDS}$ and $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $1 - \mathbb{U}$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

Proposition 2.9. If $\mathbb{U}$ is a $\mathbb{NDS}$ and $\mathbb{N}(G_\delta)\mathbb{S}$ in a neutrosophic P- space$(\mathcal{D}, \mathcal{N}e^{\tau})$, then $\mathbb{N}(I \operatorname{nt}(\mathbb{U})) \neq 0_N$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NDS}$ and $\mathbb{N}(G_\delta)\mathbb{S}$ in a neutrosophic P-space $(\mathcal{D}, \mathcal{N}e^{\tau})$. By theorem 2.4, $1 - \mathbb{U}$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Since,$(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – space , by theorem 2.2, then $1 - \mathbb{U}$ is not a $\mathbb{NDS}$ $(\mathcal{D}, \mathcal{N}e^{\tau})$ and hence $\mathbb{N}(Cl(1 - \mathbb{U})) \neq 1_N$. This implies that $1 - \mathbb{N}(Int(\mathbb{U})) \neq 1_N$ and hence we have $\mathbb{N}(I \operatorname{nt}(\mathbb{U})) \neq 0_N$.

3.Neutrosophic P – Spaces and Neutrosophic Sub maximal Spaces

Definition 3.1 [3]. A neutrosophic topological space S $(\mathbb{NTS})$ is called neutrosophic sub maximal Space $(\mathbb{NSMS})$ if for each neutrosophic set $\mathbb{U}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$ such that $\mathbb{N}(Cl(\mathbb{U})) = 1_N$, then $\mathbb{U} \in \mathbb{N}_\tau$.

Proposition 3.1. If each $\mathbb{N}(G_\delta)\mathbb{S}$ is a $\mathbb{NDS}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – Space.

Proof: Let $\mathbb{U}$ be a $\mathbb{N}(G_\delta)\mathbb{S}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then , by hypothesis $\mathbb{U}$ is a $\mathbb{NDS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Since, $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic sub maximal space, the set $\mathbb{S}$ in$(\mathcal{D}, \mathcal{N}e^{\tau})$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. That is, every $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Therefore, $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – space.

Proposition 3.2. If $\mathbb{N}(Int((\mathbb{U})) = 0_N$, where $\mathbb{U}$ is a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$, then $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – Space.

Proof: Let $\mathbb{U}$ be a $\mathbb{N}(G_\delta)\mathbb{S}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then $1 - \mathbb{U}$ is a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then, $\mathbb{N}(Int(1 - \mathbb{U})) = 0_N$. $\mathbb{N}(Cl(\mathbb{U})) = 1_N$ for a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then, $\mathbb{U}$ is a $\mathbb{NDS}$ in$(\mathcal{D}, \mathcal{N}e^{\tau})$. Since,$(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic sub maximal space, $\mathbb{U}$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. That is, every $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. Therefore, $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – space.

Proposition 3.3. If each $(\mathbb{N}(F_\sigma)\mathbb{S})$ is a $\mathbb{NNDS}$ in a neutrosophic sub maximal space$(\mathcal{D}, \mathcal{N}e^{\tau})$, then $(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – space.

Proof: Let $\mathbb{U}$ be a $(\mathbb{N}(F_\sigma)\mathbb{S})$ and $\mathbb{NNDS}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U})) = 0_N$. Now, $\mathbb{N}(Int(\mathbb{U})) \subseteq \mathbb{N}(Int(\mathbb{N}(Cl(\mathbb{U})))$ implies that $\mathbb{N}(Int(\mathbb{U})) = 0_N$. Now $\mathbb{N}(Int(\mathbb{U})) = 0_N$ for a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then, by proposition 3.2,$(\mathcal{D}, \mathcal{N}e^{\tau})$ is a neutrosophic P – space.

Proposition 3.4. If $\mathbb{N}(Cl\mathbb{N}(Int(\mathbb{U})) = 1_N$, where $\mathbb{U}$ is a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^\tau)$, then $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P – Space.

Proof: Let $\mathbb{U}$ be a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $1-\mathbb{U}$ is a $(\mathbb{N}(G_\delta)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. By hypothesis, $\mathbb{N}(Cl\mathbb{N}(Int(1-\mathbb{U})) = 1_N$. Then $1-\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U})) = 1_N$ That is, $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}))) = 0_N$ and hence $\mathbb{U}$ is a $\mathbb{NND}\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Thus, the $(\mathbb{N}(F_\sigma)\mathbb{S})$ is a $\mathbb{NND}\mathbb{S}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, by proposition 3.3, $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P – Space.

Proposition 3.5. If $\mathbb{U}$ is a $\mathbb{NRS}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{U}$ is a $(\mathbb{N}(G_\delta)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NRS}$ in a neutrosophic sub maximal space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $1-\mathbb{U}$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ and hence $1-\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$, where $\mathbb{U}_{k_1}$'s are $\mathbb{NND}\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since $\mathbb{S}_{k_1}$'s are $\mathbb{NND}\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ we have $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}_{k_1})) = 0_N$. Then $\mathbb{N}(Int(\mathbb{U}_{k_1}) \subseteq \mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}_{k_1})))$ which implies $\mathbb{N}(Int(\mathbb{U}_{k_1})) \subseteq 0_N$ and hence $\mathbb{N}(Int(\mathbb{U}_{k_1})) = 0_N$. This implies that $1-\mathbb{N}(Int(\mathbb{U}_{k_1})) = 1-0 = 1_N$ and hence $\mathbb{N}(Cl(1-\mathbb{U}_{k_1})) = 1_N$. Since, $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic sub maximal space, $1-\mathbb{U}_{k_1}$'s are $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Then, $\mathbb{U}_{k_1}$'s are $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, $1-\mathbb{U} = \bigcup_{k_1=1}^{\infty} \mathbb{U}_{k_1}$, where $\mathbb{U}_{k_1}$'s are $\mathbb{NCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ which implies $1-\mathbb{U}$ is a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Therefore, $\mathbb{U}$ is a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 3.6. If $\mathbb{U}$ is a $\mathbb{NRS}$ in a neutrosophic sub maximal and neutrosophic P – Space in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{U}$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NRS}$ in a neutrosophic sub maximal space and neutrosophic P – Space in $(\mathcal{D}, \mathcal{N}e^\tau)$. By proposition 3.5, $\mathbb{U}$ is a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since, $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic P – Space, the $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, $\mathbb{U}$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Neutrosophic Almost P - Spaces

Definition 4.1. A neutrosophic topological space $(\mathbb{NTS})$ is called neutrosophic almost P – Space if for every non – zero $\mathbb{N}(G_\delta)\mathbb{S}$ $\mathbb{U}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{N}(Int(\mathbb{U})) \neq 0_N$ in (X,T).

Proposition 4.1. If each non – zero $\mathbb{N}(F_\delta)\mathbb{S}$ in a neutrosophic almost P – Space $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{N}(Cl(\mathbb{U})) \neq 1_N$.

Proof: Let $\mathbb{U}$ be a non – zero $(\mathbb{N}(F_\sigma)\mathbb{S})$ in a neutrosophic almost P – Space $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $1-\mathbb{U}$ is a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic almost P – space, for the $\mathbb{N}(G_\delta)\mathbb{S}$, we have $\mathbb{N}(Int(1-\mathbb{S})) \neq 0_N$. This implies that $1-\mathbb{N}(Cl(\mathbb{S})) \neq 0_N$ and hence we have $\mathbb{N}(Cl(\mathbb{S})) \neq 1_N$.

Proposition 4.2. If each non – zero $\mathbb{N}(G_\delta)\mathbb{S}$ is a $\mathbb{NSOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic almost P – Space.

Proof: Let $\mathbb{U}$ be a non – zero $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since $\mathbb{U}$ is a $\mathbb{NSOS}$, then $\mathbb{U} \subseteq \mathbb{N}(Cl\mathbb{N}(Int(\mathbb{U}))$. We claim that $\mathbb{N}(Int(\mathbb{U})) \neq 0_N$. Assume the contrary that $\mathbb{N}(Int(\mathbb{U})) = 0_N$ This implies that

$\mathbb{N}(Cl\mathbb{N}(I\,\mathrm{nt}(\mathbb{U}))) = \mathbb{N}(Cl(0)) = 0_N$ and hence we will have $\mathbb{U} = 0_N$ a contradiction to $\mathbb{U}$ being a non – zero $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Hence, we must have $\mathbb{N}(Int(\mathbb{U})) \neq 0_N$ for a $\mathbb{N}(G_\delta)\mathbb{S}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ and therefore $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic almost P – Space.

Proposition 4.3. If $\mathbb{U}$ is a $\mathbb{NFCS}$ in a neutrosophic almost P –Space, then $\mathbb{N}(Cl(\mathbb{U})) \neq 1_N$

Proof: Let $\mathbb{U}$ be a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^\infty \mathbb{U}_{k_1}$, where $\mathbb{U}_{k_1}$'s are $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Now,

$\mathbb{U}_{k_1} \subseteq \mathbb{N}(Cl(\mathbb{U}_{k_1})$ implies that $\bigcup_{k_1=1}^\infty (\mathbb{U}_{k_1}) \subseteq \bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1}))$ and hence we have

$\mathbb{N}(Cl(\bigcup_{k_1=1}^\infty (\mathbb{U}_{k_1})) \subseteq \mathbb{N}(Cl(\bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1})))$. Then $\mathbb{N}(Cl(\mathbb{U}) \subseteq \mathbb{N}(Cl(\bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1})))$ -----(1). Now $\bigcup_{k_1=1}^\infty \mathbb{U}_{k_1}$ is

a $(\mathbb{N}(F_\sigma)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since $(\mathcal{D}, \mathcal{N}e^\tau)$ is a neutrosophic almost P – Space, by proposition 4.1, $\mathbb{N}(Cl(\bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1})) \neq 1_N$ ---(2). Now we claim that $\mathbb{S}$ is not a $\mathbb{NDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Assume the contrary that $\mathbb{U}$

is a $\mathbb{NDS}$ then $\mathbb{N}(Cl(\mathbb{U})) = 1_N$ implies from (1), that $1_N \subseteq \mathbb{N}(Cl(\bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1}))))$ which is a contradiction to

(2). Hence we must have $\mathbb{N}(Cl(\mathbb{U})) \neq 1_N$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 4.4: If each non – zero $\mathbb{NFCS}$ is a $\mathbb{NDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, then $(\mathcal{D}, \mathcal{N}e^\tau)$ is not a neutrosophic almost P – space.

Proof: Let $\mathbb{U}$ be a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $\mathbb{U} = \bigcup_{k_1=1}^\infty \mathbb{U}_{k_1}$, where $\mathbb{U}_{k_1}$'s are $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Since $\mathbb{U}$ is a $\mathbb{NDS}$

then $\mathbb{N}(Cl(\mathbb{U})) = 1_N$. Now $1 - \mathbb{N}(Cl(\mathbb{U}_{k_1}))$ is a $\mathbb{NOS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Let $\mathbb{K} = \bigcap_{k_1=1}^\infty 1 - \mathbb{N}(Cl(\mathbb{U}_{k_1}))$. Then $\mathbb{K}$ is a

$(\mathbb{N}(G_\delta)\mathbb{S})$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Now $\mathbb{K} = \bigcap_{k_1=1}^\infty 1 - \mathbb{N}(Cl(\mathbb{U}_{k_1})) = 1 - [\bigcup_{k_1=1}^\infty \mathbb{N}(Cl(\mathbb{U}_{k_1}))] \subseteq 1 - [\bigcup_{k_1=1}^\infty (\mathbb{U}_{k_1})] = 1 - \mathbb{U}$. That

is, $\mathbb{K} \subseteq 1 - \mathbb{U}$. Then $\mathbb{N}(Int(\mathbb{K})) \subseteq \mathbb{N}(Int(1 - \mathbb{U}))$ and hence $\mathbb{N}(Int(\mathbb{K})) \subseteq 1 - \mathbb{N}(Cl(\mathbb{U})) = 1 - 1 = 0_N$. that is, $\mathbb{N}(Int(\mathbb{K})) = 0_N$. Hence, for the $(\mathbb{N}(G_\delta)\mathbb{S})$ $\mathbb{K}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$, $\mathbb{N}(Int(\mathbb{K})) = 0_N$. Therefore, $(\mathcal{D}, \mathcal{N}e^\tau)$ is not a neutrosophic almost P – space.

Proposition 4.5. If $\mathbb{U}$ is a $\mathbb{NRS}$ in a neutrosophic almost P – Space $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{N}(Int(\mathbb{S})) \neq 0_N$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Then $(1 - \mathbb{U})$ is a $\mathbb{NFCS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$ and hence by proposition 4.3, $\mathbb{N}(Cl(1 - \mathbb{U})) \neq 1_N$ in $(\mathcal{D}, \mathcal{N}e^\tau)$. Therefore, $1 - \mathbb{N}(Int(\mathbb{U})) \neq 1_N$. Therefore, $\mathbb{N}(Int(\mathbb{U})) \neq 0_N$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proposition 4.6. If $\mathbb{U}$ is a $\mathbb{NRS}$ in a neutrosophic almost P – Space $(\mathcal{D}, \mathcal{N}e^\tau)$, then $\mathbb{U}$ is not a $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^\tau)$.

Proof: Let $\mathbb{U}$ be a $\mathbb{NRS}$ in a neutrosophic almost P – Space $(\mathcal{D}, \mathcal{N}e^{\tau})$. Then, by proposition 4.5, $\mathbb{N}(Int(\mathbb{U})) \neq 0_N$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$. We claim $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}))) \neq 0_N$. Assume the contrary that $\mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U}))) = 0_N$ and $\mathbb{N}(Int(\mathbb{U})) \subseteq \mathbb{N}(Int\mathbb{N}(Cl(\mathbb{U})))$ which imply $\mathbb{N}(Int(\mathbb{U})) = 0_N$ a contradiction. Hence $\mathbb{U}$ is not a $\mathbb{NNDS}$ in $(\mathcal{D}, \mathcal{N}e^{\tau})$.

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RESEARCH ARTICLE

Survey and Occurrence of Rice Sheath Blight Incited by *Rhizoctonia solani* Kuhn on Major Rice Growing Regions of Cauvery Delta Zone

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ABSTRACT

Rice is an important food grain and is a staple food for majority of the world's population. Sheath blight (ShB), caused by the soil borne necrotrophic fungal pathogen *Rhizoctonia solani* Kuhn, is an economically important disease in rice. This occurs near the water level, healthy plant parts results in development of water-soaked lesions leads to total crop loss various from 30 to 40 percent, A purposive disease survey was conducted during *Kharif*-2021 to assess the disease occurrence and endemic nature of rice sheath blight disease in Cauvery delta zone of Tamil Nadu. The percent disease incidence (PDI ranged from 20 to 80%). As a result of wide range of survey, Maximum PDI (83) was noticed at paddy field of sirkazhi Taluk of Mayiladuthurai district, followed by Melaiyur (81%), Annamalai Nagar (79%), Veera chozhapuram (77%) whereas, minimum PDI (09) was recorded at Lalgudi taluk from Trichy district. Among 25 locations, 36% showed very high incidence (>50), 28% location showed high per cent incidence (31-49) and 36 per cent location showed moderate per cent incidence (20-30). Disease severity of collected samples of rice sheath blight ranged from 3 to 9 score (SES Scale).The maximum severity (9 scale) was observed at Annamalai Nagar, Miralur, Sirkazhi, Melaiyur, Veera Chozhapuram and

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Thogaimalai. The disease was recorded from panicle initiation to grain hardening stage. Study on occurrence of disease in an area can offer an idea on current status of the disease in the various growing zones which is prerequisite to take decision regarding management practices of different diseases

Keywords: Sheathblight, Survey, Disease Incidence, Severity, SES- Standard Evaluation System

INTRODUCTION

Rice (*Oryza sativa* L.) is second most important cereal and the staple food for more than half of the world's population. It provides 20% of the world's dietary energy supply followed by Maize and Wheat. To meet the global demand, it is estimated that about 114Million tonnes of additional milled rice needs to be produced by 2035 with an increase of 26% in next 25 years. Worldwide the annual losses due to rice diseases estimated to be 10-15%. Depending upon the age of the plant, time of infection and severity, disease cause yield loss to the extent of 5.9 to 69 per cent (Venkat Rao et al.,1990; Naidu, 1992) In India Total production of rice during 2020-21 is estimated at 118.43 million tonnes. It is higher by 8.67 million tonnes than the five years, average production of 109.76 million tonnes, 437.80 Lakh hectare of Area with 2705 kg/hectare Yield. About 9.74 Lakh ha area has been reported compared to 9.38 lakh ha during the corresponding period of last year. Thus 0.36 lakh ha more area has been covered compared to last year. More area is reported from the states of Tamil Nau (0.85 lakh ha) and Karnataka (0.30 lakh ha.)(Directorate of Economics & Statistics DAC and FW- 2020-21). The increase in rice production in India is primarily contributed by adoption of semi dwarf, early maturing and fertilizer responsive high-yielding rice varieties coupled with improved management practices and increased cropping intensity. Such intensive and extensive cultivation systems have however, brought about a shift in pest and disease problems in rice. Rice is attacked by number of fungal, bacterial, viral and nematode diseases. Among all pathogenic organisms, fungal pathogens are limiting the rice productivity to great extent. Serious incidences of diseases such as blast, sheath blight and bacterial blight have been reported from many rice growing areas of India. Sheath blight (ShB) disease of rice caused by *Rhizoctonia solani* Kuhn is one of the destructive pathogens causing disease in rice and considered as world's significant disease, second most predominant to the blast disease (Zheng *et al.,* 2013; Molla*et al*., 2019). The disease is caused by *Rhizoctonia solani* Kuhn (Teleomorph: *Thanatophorus cucumeris* (Frank) Donk), a fungal pathogen of both rice and soybeans. The yield loss due to this disease is reported to range from 5.2-50 per cent depending on the environmental conditions, crop stages at which the disease occurs, cultivation practices and cultivars used (Marchetti, 1983). The sheath blight disease was spread to other Asia countries it is referred to different names such as 'oriental leaf and sheath leaf', 'sheath blight', 'pellicularia sheath blight', 'sclerotial blight', 'snake skin disease' and 'Banded blight of rice' (Swillocquet and Savary 2011).

 The natural infection of sheath blight disease occurs in the development of new short stature, active tillering stage, booting/flowering stage, early heading grain filling and also caused by seed infection (Acharya et al. 2004). The disease occurs in near the water level after the infection of sheath turn in to softness leads the infection spreads to healthy plant parts resulting development of water-soaked lesions and dormant sclerotia or mycelium presented in surface of the water and soil (Tsiboe et al. 2017). The pathogen survives as sclerotia under unfavourable condition and it may spherical or irregular shaped and measure 4-5 mm in diameter, dark brown to black in colour, basidia and basid iospores are produced in normal weather conditions and viability for up to 3 years by its saprophytic nature (Kumar et al. 2009). The maximum disease development was recorded at a temperature level of 25-30ºC and 80-100 per cent relative humidity (Bhunkal et al. 2015) also by applying high amount of nitrogenous fertilizer (Akash Datta et al. 2017). A total crop loss various from 30 to 40 percent, and may be 100 percent in endemic areas. If the disease spreads to upper parts of the plant and panicles (Srinivas et al. 2013). It has become more prevalent in most of the improved varieties currently growing in India (Prakasam*et al.,* 2013) The spread of disease has extensively increase in terms of both occurrence and intensity over last few decades (Yellareddygari*et al*., 2014). Currently, it is one of the major production limitations in the states of Tamil Nadu, Kerala, Eastern Uttar Pradesh, Punjab, Odisha, Uttarakhand, Bihar, Chhattisgarh, West Bengal, Haryana, coastal areas of Andhra Pradesh, and parts of Karnataka

(Prakasam*et al.,* 2013). Study on occurrence of disease in an area can offer an idea on current status of the disease in the various growing zones which is pre requisite to take decision regarding management practices of different diseases (Gangopdhyay and Chakrabarti1982). Therefore, present survey was led in major rice growing regions of Cauvery Delta Regions of Tamil Nadu, to know the incidence and severity of sheath blight in various agro-ecosystems, cropping systems, rice varieties, agronomic practices and management methods in the condition that is a pre requisite to take decision on sustainable disease management practices.

MATERIALS AND METHODS

Survey on occurrence and Collection of sheath blight samples

During *Kharif* 2021, A Field survey was conducted in various parts of Delta belts, to collect sheath blight infected rice samples for diversity studies in *R. solani.* Hence, it was carried out in five major rice-growing districts of Cauvery Delta regions *viz.,* Cuddalore, Mayiladuthurai, Pudukkottai, Ariyalur and Tiruchirappalli districts were selected to collect the infected rice sheath blight samples for the study of variation within *R. solani*AG-1 IA (Table 1). From each village randomly 3-5 rice fields were selected when the crop was at tillering to maturity stage. Three plots in each field having an area of one square meter were selected randomly. For assessing and scoring the disease, incidence typical assessment system for rice developed by the International Rice Research Institute (SES, 2002) was followed with the scale 0 as no infection and 1, 3, 5 ,7, 9 as vertical spread of the lesions with 20%, 21-30%, 31-45%, 46-65%, greater than 65% of plant height, respectively.

The disease incidence was worked out using the following formula,

$$\text{Disease incidence (DI)} = \frac{\text{Sum of Disease grades} \times \text{No. of infected tillers/hill}}{\text{Total No. of Tillers} \times \text{maximum disease grades} \times \text{No. of tillers assessed}} \times 100$$

Data was also collected on stage of the crop, Variety, soil type, diseasese verity and incidence in these areas. A sample often consisted of single rice tiller, which either had sheath blight lesion on the sheath/pseudo stem, or the leaves, or both. Symptoms on rice sheaths, leaves and sign (sclerotia) on the disease isolate a teach observation during the survey are documented. In addition, information like plant characters and geographical locations were compiled.

Data analysis

The Relative Lesion Height (RLH) (cm**)** was calculated for pertiller, by formula given by Sharma *etal.* (1990)

$$\text{RLH (\%)} = \frac{\text{Maximum length at which lesion appear}}{\text{Plant height}} \, x \, 100$$

The Disease Severity was calculated by ranking the RLHona0-9 scale of Standard Evaluation System (SES) which gives a measure of disease severity of each tiller.

Disease severity rating scale: (Source: IRRI,2014)

Disease rating scale	Relative lesion height to plant height (%)
0	No infection
1	lesion limited to the lower20%of plant height
3	lesion limited to the lower 20-30% of the plant height
5	lesion limited to the lower 31- 45% of the plant height
7	lesion limited to the lower 46- 65% of the plant height
9	lesion more than 65%of the plant height

RESULTS AND DISCUSSION

During the year of survey on the incidence of sheath blight of rice in major Cauvery delta regions of Tamil Nadu, it was observed that insect pests and diseases were the main biotic stresses causing significant losses to the rice production. Blast, brown spot, sheath blight and rot are the major diseases of rice in CDZ (Cauvery Delta zone), Sheath blight is a serious problem, most predominant in areas where the relative humidity is very high (> 95%), the temperature is moderate (28-32°C) and high nitrogen inputs. The maximum PDI was recorded in Sirkazhi, Mayiladuthurai district (36.5%). Generally, the crop grown in clayey soil and at panicle initiation stage of the crop recorded fairly higher incidence of disease. As a result of conducted survey, the data presented on the (Table 1.) The Fixed plot survey in some major rice growing areas of Cuddalore, Mayiladuthurai, Pudukkottai, Ariyalur and Tiruchirappalli districts, indicated that the Disease Incidence (PDI) varied with low to high level. PDI of all isolates ranged from 20% to 80% and assembled as four groups such as very high (>50), high (31-50%), moderate (20 to 30%) and low (<20%). Very high incidence noticed at paddy field of Sirkazhi (83%) followed by Melaiyur (81%), Annamalai Nagar (79%), Veera chozhapuram (77%) and Miralur (67%) Fig.1. Among 25 locations, 36% showed very high incidence (>50), 28% location showed high per cent incidence (31-49) and 36 per cent location showed moderate per cent incidence (20-30). Disease severity of collected samples of rice sheath blight ranged from 3 to 9 score (SES Scale). Very high severity (9 scale) was observed at Annamalai Nagar, Miralur, Sirkazhi, Melaiyur, Veera Chozhapuramand Thogaimalai. High disease severity (7 scale) recorded at Kattumannarkoil, Elandhangudi, ThiruNandriyur, Utkoattai, Gandarvakkottai and Vayalur. While moderate disease severity (5 scale) noticed at Parangipettai, Anathandavapuram, Jayankondam and NavalurKuttapattu. Low disease severity (3 scale) recorded at Pinnathur, Kuttalam, Thiruindhalur and Aranthangi. Very low disease severity was recorded in Malliyam, Lalgudi and Avudayarkovil. Similarly, Jia et al., (2012) reported that all the cultivars of rice are susceptible to sheath blight, but the degree of susceptibility varied and sheath blight is usually severe on cultivars that are short, high tillering and responsive to high fertilizer in comparison to tall cultivars with fewer tillers.

When the district averages were taken into account, the disease incidence (%) was found highest in Sirkazhi (83%) followed by Melaiyur (81%) and Annamalai Nagar (79%) also comparatively low in Mirzapur Malliyam (12%) and Lalgudi (9%) These results were in accordance with the findings of Deepak et al., (2018) where they observed highest percent disease incidence of 52.5% at Nalgonda district and recorded least per cent disease incidence of 20% in Rangareddy district at Telangana. However, the correlation between crop stages and percent disease incidence and /or disease severity was not detected. Similarly, Parshuram et al., (2017) surveyed in major rice growing areas of Chhattisgarh state for incidence. These results were in the accordance of Kapse et al. (2012); Pal et al. (2015); Thakuret al. (2017)reported that plant variety and nitrogenous fertilizers are the major factors influencing sheath blight disease and concurrence yield losses in rice, both during wet and dry seasons. Where as some other workers were found different growth stages susceptible for infection. Shahjahan et al., (1990) reported panicle initiation to booting; panicle initiation, flowering and booting; Sharma and Teng (1996) flowering and panicle initiation stage; Pal et al., (2016)found grain filling stage as most susceptible for sheath blight disease to occur. Relative humidity and temperature are considered to be the critical factors for sheath blight infection and therefore the disease is more common in wet season than in the dry season.

CONCLUSION

Survey on incidence and spread of rice sheath blight in major rice growing regions Cauvery delta zones disclosed that disease is a major constrains of the zone. Among the five districts surveyed Sirkazhi, recorded highest mean of incidence and followed by Melaiyur, Annamalai Nagar, Veera chozhapuram and comparatively low in lalgudi. The prevalence of sheath blight may be caused by the most favorable factors such as high relative humidity, lower temperature and water logging due to continuous rain at these locations during surveying. Large-scale cultivation of susceptible varieties as monocropping continuously in the same field could increase the potential for the pathogens

to remain in plant debris. The current study may serve as a harbinger for developing an effective management strategy for the region in an integrated manner for sustainable crop development in the state.

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Table 1. Survey report for disease incidence and severity of sheath blight incited by *R. solani* in different locality of Cauvery delta regions in Tamil Nadu

Isolate.No	Location	Latitude and Longitude	Variety	Crop stage	Soil type	DI (%)	Severity (%)	SES (%)
Cuddalore District (North)								
1.	Kattumannarkoil	11.2800° N, 79.5519° E	ADT 39	Milky stage	Clay	48[l]	45-65	7
2.	Annamalai Nagar	11.3921° N, 79.7147° E	ADT 36	Panicle initiation	Clay	79[c]	66-100	9
3.	Parangipettai	11.5084° N, 79.7568° E	TKM 9	Tillering stage	Clay loam	31[p]	31-45	5
4.	Pinnathur	11.4247° N, 79.73036° E	ADT 36	Flowering stage	Clay loam	29[g]	21-30	3
5.	Miralur	11.4553° N, 79.5645° E	ADT 43	Panicle initiation	Clay loam	67[f]	66-100	9
Mayiladuthurai District								
6.	Sirkazhi	11.2391° N, 79.7361° E	ADT 39	Milky stage	Clay	83[a]	66-100	9
7.	Anathandavapuram	11.1384° N, 79.6586° E	TKM 9	Grain filling	Clay loam	45[m]	31-45	5
8.	Elandhangudi	11.0557° N, 79.6488° E	TKM 9	Flowering stage	clay	61[h]	45-65	7
9.	Kuttalam	11.0711° N, 79.5588° E	ADT 36	Flowering stage	Clay loam	27[r]	21-30	3
10.	Malliyam	11.0836° N, 79.5976° E	ADT 36	Grain filling	Clay	12[v]	>20	1
11.	Thiruindhalur	11.1099° N, 79.6418° E	TKM 9	Panicle initiation	Clay loam	24[s]	21-30	3
12.	Melaiyur	10.9882° N, 79.5126° E	ADT 43	Grain filling	Clay	81[b]	66-100	9
13.	ThiruNandriyur	11.1444° N, 79.6986° E	BPT 5204	Tillering stage	Clay	51[k]	45-65	7
Ariyalur District (North West)								
14.	Utkoattai	11.2071° N, 79.3676° E	ADT 39	Flowering stage	Clay	64[g]	45-65	7
15.	Veera Chozhapuram	11.9444° N, 79.2966° E	BPT 5204	Panicle initiation	Clay loam	77[d]	66-100	9
16.	Jayankondam	11.2143° N, 79.3613° E	TKM 9	Grain filling	Clay	41[n]	31-45	5
Pudukkotai District (south)								
17.	Aranthangi,	10.1692° N, 79.0023° E	ADT 36	Grain filling	Clay loam	22[t]	21-30	3
18.	Gandarvakkottai,	10.5720° N, 79.0151° E	ADT 43	Tillering stage	Clay loam	58[i]	45-65	7

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19.	Avudayarkovil,	10.0875° N, 79.0306° E	BPT 5204	Panicle initiation	Clay	19^u	>20	1
Trichy District (west)								
20.	Lalgudi	10.8744° N, 78.8184° E	ADT 39	Milky stage	Clay	9^w	>20	1
21.	Thogaimalai	10.7137° N, 78.4130° E	BPT 5204	Tillering stage	Clay loam	71^e	66-100	9
22.	NavalurKuttapattu	10.7634° N, 78.5945° E	ADT 43	Grain filling	Clay	36°	31-45	5
23.	Vayalur	11.3598° N, 79.1118° E	ADT 36	Panicle initiation	Clay	54^j	45-65	7

* Mean of three replications

* Values in the column followed by common letters do not differ significantly by DMRT (P=0.05)
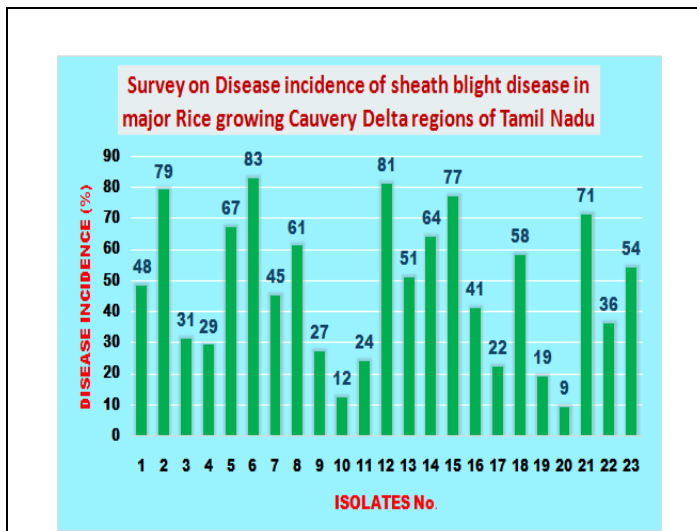
Fig. 1: Disease incidence of sheath blight in rice growing regions of Cauvery Delta Region of Tamil Nadu	Fig. 2: Infected plant showing Symptoms of *R. solani* near the water level, with water-soaked lesions

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REVIEW ARTICLE

Role of Serankottai (*Semecarpus anacardium*) in the Management of Vali Azhal Keel Vaayu (Rheumatoid Arthritis) - A Review

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ABSTRACT

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disease that arises more frequently in females. Nowadays incidence of arthritis is gradually increasing due to the sedentary lifestyle, environmental factors, etc. The treatment modality of RA on the modern side is non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid medications, and disease-modifying anti-rheumatic drugs (DMARDs). Because of the long-term usage of these medications leads to side effects like metabolic diseases and gastrointestinal complications. To reduce the complications of synthetic drugs, there is an urgent need to establish potent drugs from Natural sources. In Siddha, higher-order medicines like *parpam, chenduram,* and *mezhugu* are used to treat various types of arthritis. Rheumatoid arthritis is termed as *Vali azhal Keel vaayu* in siddha. *Vithu Rasa Mezhugu* (VRM) is one of the higher-order medicines which is prepared from *Rasam* (Mercury) and *Serankottai* (*Semecarpus anacardium*). The ingredients of VRM have been scientifically proven for their anti-oxidant, analgesic, anti-inflammatory, and anti-arthritic effects. This studyaims to review the pharmacological activities of Serankottai (Semecarpus anacardium) related to arthritis. From this review, the Siddha formulation *Vithu Rasa Mezhugu* can be used in the treatment of rheumatoid arthritis.

Keywords: Rheumatoid arthritis, *Semecarpus anacardium*, *Vithu Rasa Mezhugu,* anti-arthritic activity, *Vali azhal Keel vaayu*

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disease that occurs more frequently in females than males. Nowadays incidence of arthritis is gradually increasing due to the sedentary lifestyle, environmental factors, etc. Rheumatoid arthritis (RA) is a chronic systemic autoimmune inflammatory disease of joints of unknown cause, affecting mainly the peripheral small joints initially, associated with varied constitutional symptoms and presence of Rheumatoid factor and Anti CCP antibodies [1]. One study stated that the prevalence of RA in India is quite similar to that reported in developed countries. The prevalence is higher than that reported in China, Indonesia, the Philippines, and rural Africa[2]. The treatment modality of RA on the modern side is non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid medications, disease-modifying anti-rheumatic drugs (DMARDs) and Surgery is not the standard of care in the treatment of RA. Surgical management is usually reserved for those with severe joint damage to improve the quality of life of those affected. Because of the long-term usage of these medications leads to side effects like metabolic diseases and gastrointestinal complications.

To reduce the complications of synthetic drugs, there is an urgent need to establish potent drugs from Natural sources. In Siddha, higher-order medicines like *parpam, chenduram, and mezhugu are used to treat RA, mainly prepared from* Semecarpus anacardium and Mercury. *Vithu Rasa Mezhugu* (VRM)[3] is one of the higher-order medicines which is prepared from *Rasam* (Mercury) and *Serankottai* (*Semecarpus anacardium*).Rheumatoid arthritis is termed as *Vali azhal Keel vaayu* in Siddha. VRM is indicated for *Vaayu* (arthritis), *Soolai Noi* (painful condition), *Vatha noi* (musculo skeletal diseases), *Veekam* (oedema), *Kattigal* (tumor), Araiyappu (adenitis), *Thoal vatham* (peri arthritis shoulder), *Kuthikal vatham* (calcaneal spur), *Asthi kudaichal* (pain in bony joints), *Anda vatham* (hydrocele), *Karalai kattina soolai* (pain due to restriction of joints). Ingredients of VRM, which are *Semecarpus anacardium* seed and mercury, have been scientifically proven for theiranti-oxidant, analgesic, anti-inflammatory, and anti-arthritic effects. From this review study, the Siddha formulation *Vithu Rasa Mezhugu* can be used in the treatment of rheumatoid arthritis.

MATERIALS AND METHODS

Semecarpus anacardium
The drug consists of dried mature fruit devoid of the basal fleshy peduncle of Semerad Linn. Fam Anacardiaceae. A medium-sized to large tree, found in semi-evergreen and moist deciduous forests throughout India [4].

Other names [5]
Bhallataka, Arushkara, Agnimukha, Agnika. Bhalli, Viravriksha, Shophakrit, Bhallata.
Eng: Marking nut tree, Oriental cashew,
Hindi: Bhilawa, Bhela,
Beng: Bhela, Bhelatuki.
Gujarati: Bhilamu,
Kanada: Bhallataka, Goddugeru, Karigeri. Bhallika,
Malayalam: Chera, Cheru, Alakkucheru,
Tamil: *Tatamkottai, Scramkotati, Senkottai, Erimugi, Sherankottai.*
Telungu: Nallajidi, Nallajidiginga, Bhalatami Jidi, Bhallataki.,
Urdu: Baladur, Bhilavan.
Parts Used: Fruit, gum, oil

Action and uses [5]
Seeds – Alterative, Caustic [6]
The fruits are astringent, nervine, escharotic, emollient, digestive, carminative, appetizer, anthelmintic, purgative, liver tonic, respiratory stimulant, expectorant, alterant, Aphrodisiac, anti-arthritic, depurative, vermifuge, stimulant,

urinary astringent, antiseptic, anti-inflammatory, cardiotonic, uterine stimulant, sudorific, febrifuge, rejuvenating and tonic. They are useful in beriberi, cancer, sciatica, rheumatism, palsy, and epilepsy. Nervous debility, neurotic cardiac disorders, neuritis, cough, asthma, dyspepsia, constipation, flatulence, colic, hemorrhoids, helminthiasis especially hookworms, liver disorders, splenopathy, leprosy, leucoderma, scaly skin eruptions, inflammations, fever, diabetes, dysmenorrhoea, amenorrhoea, syphilis, scrofula, tumors, ulcers, and general debility. The gum exuding from the bark is useful in venereal diseases, scrofula, and leprosy. Oil is a powerful antiseptic and cholagogue. It is used in scaly skin eruptions like psoriasis and leucoderma.

Chemical Constituents [5]
Major Constituents in *S.anacardium*:
Anacardoside, jeediflavanone, sitosterol [4].
Others
Tetrahydro amentoflavone, tetrahydro robusta flavone, semecarpus flavanone, gallu flavanone semecarpetin[4].
Oil and seeds
Bhilawanol and anacardoside
Fruits
Nicotinic acid, riboflavin, thiamine, and the essential amino acids - arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.
Nuts
Bhilawanol, biflavan-tetrahydrorobusta flavone and tetrahydro amentoflavone, biflavanoids A,B and C, nallaflavone.
Nutshell
Semecarpus biflavanone B. biflavonoid-jeediflavanone, galluflavanone, semecarpu flavanone, anacardic acid, aromatic amines, bhilawanol (1-pentadeca-A-enyl-2,3- dihydroxybenzene) and 1-pentadeca-A dienyl-2,3-dihydroxybenzene.
Leaves
Amentoflavone.
Kernel oil
Linoleic, myristic, oleic, palmitic, and stearic acids.
Plant
Anacardic acid, cardol, catechol, anacardol, fixed oil, semecarpol, bhilawanol.

Pharmacological Activities
Anti-arthritic activity
Prakash, Dhirendra, *et al.,* studied the effect of *Semecarpus anacardium* at different dose levels (50, 100, 200, 400, and 800 µg/ml) that provided significant protection against denaturation of proteins and hypnotic saline-induced RBC membrane damage [7]. Saraf MN *et al.,* studied the chloroform extract of the *Semecarpus anacardium* nut significantly reduced acute carrageenan-induced paw edema in rats and was active against the secondary lesions of adjuvant-induced arthritis. Delayed hypersensitivity induced in mice by sheep red blood cells as an antigen was potentiated by the extract [8]. Vijayalakshmi, T. M. *et al.* studied the potency of a milk extract of *Semecarpus anacardium* (*Serankottai Nei*), a Siddha medicine from *Semecarpus anacardium* nut. Milk extract of *Semecarpus anacardium* (*Serankottai Nei*) was administered at different dose levels of 50, 100, 150, 200, and 250 mg/kg body weight in olive oil orally (volume 0.5 ml) after 14 days from the day of adjuvant injection. After administration of the milk extract, the lysosomal enzyme activity and protein-bound carbohydrate component levels were significantly reverted to normal levels. The data obtained indicated that the *Semecarpus anacardium* is effective at the dose level of 150 mg/kg body weight in adjuvant-induced arthritis in rats [9]. Ramprasath VR *et al.,* studied the effect of *Semecarpus anacardium Linn.* nut milk extract (SA) on the metabolism of bone turnover has been studied by analyzing various markers of bone turnover and by histological and radiological analysis of the joints in adjuvant arthritis in rats. *Semecarpus anacardium* remark ably reverted the alterations in the bone turnover observed in arthritic animals by modulating the levels of calcium, phosphorus, and the activities of the names of the enzyme'startrate-resistant acid phosphatase, acid phosphatase, and alkaline phosphatase. The test drug increased the bone weights that were found to be decreased

during arthritis. The protective effect of SA was also observed by the decrease in the levels and expression of tumor necrosis factor-alpha (TNF-alpha) as well as the histopathological and radiological observations. Based on these observations it can be concluded that SA possesses strong anti-arthritic properties by regulating bone turnover [10]. Ramprasath VR *et al.*, The effect of milk extract of *Semecarpus anacardium* Linn. nut milk extract (SA) was studied to gain some vision into this intriguing disease concerning collagen metabolism. Decreased levels of collagen and glycosaminoglycans (GAGS) components (chondroitin sulphate, heparan sulphate, hyaluronic acid) and an increase in the levels of connective tissue degrading lysosomal glycohydrolases such as acid phosphatase, beta-glucuronidase, beta-N-acetyl glucosaminidase and cathepsin-D observed in arthritic animals were reverted to near-normal levels with treatment of SA. The drug effectively regulated the urinary markers of collagen metabolism. Electron microscopic studies likewise revealed the protective effect of SA. Hence, it can be recommended that SA is very effectively regulated the collagen metabolism that deranges during the arthritic condition [11].

Anti-oxidant activity and immunomodulatory activity

Semecarpus anacardium has been reported in various studies for its antioxidant activity. Ramprasath VR, Shanthi P et.al., The alterations in the humoral and cell-mediated immunity were significantly reverted to near-normal levels on treatment with*Semecarpus anacardium* [12]. One of the results obtained depict the potency of the *Semecarpus anacardium* anti-oxidant activity by depleting lipid peroxide levels in the spleen and thymus and thus its role in enhancing immune function [13]. Ramprasath VR, *et al.*, reported the effect of milk extract of *Semecarpus anacardium Linn.* nuts (SA) on adjuvant-induced arthritis were studied to gain some insight into this intriguing disease about neutrophil functions. The decreased phagocytic function of neutrophils found in adjuvant arthritis was significantly increased by the administration of the drug *Semecarpus anacardium*. Increased levels of reactive oxygen species (superoxide radical, hydroxyl radical, H_2O_2 and myeloperoxidase), lysosomal enzymes (acid phosphatase and cathepsin D), and increased neutrophilaccumulation in the joints observed in adjuvant arthritic animals were reverted to near-normal levels by treatment with SA. The results of this study indicate that SA can be considered to be a good therapeutic agent for inflammation and arthritis [14]. Singh D et.al, evaluated the Immunomodulatory activity of *Semecarpus anacardium* extract. In this study, SA extract inhibited the spontaneous and LPS-induced production of proinflammatory cytokines IL-1beta and IL-12p40. The extract similarly suppressed LPS-activated nitric oxide production in mouse macrophage cell lines. Results exhibited that *Semecarpus anacardium* extract can inhibit proinflammatory cytokine production and demonstrate its mechanism of action[15].

Verma *et al.*, investigated the antioxidant activity of the aqueous extract of nuts of medicinal plant SA in AKR mouse liver during the development of lymphoma. Administration of the aqueous extract of SA to lymphoma transplanted mice leads to an increase in the activities of antioxidant enzymes, whereas LDH activity is brought down significantly indicating a decrease in carcinogenesis [16] Ramprasath, V.R *et al.*, reported the effects of milk extract of *Semecarpus anacardium* Linn. nut (SA) was studied on adjuvant-induced arthritis rats. A significant increase in the levels of lipid peroxides, ROS (superoxide radical, hydroxyl radical, H_2O_2 and myeloperoxidase), and RNS (nitrate+nitrite) observed in adjuvant arthritic animals were found to be significantly decreased on the administration of the drug at 150 mg/kg body weight/day. Treatment with SA regained the altered antioxidant defense components to near-normal levels. Thus, these shreds of evidence suggest that the free radical-mediated damage during arthritis could have been controlled by *Semecarpus anacardium* by its free radical quenching and anti-oxidative potential [17]. Haseena Banu et.al, Studied the Antioxidant potential of *Semecarpus anacardium* evaluated in Type 2 diabetic rats. SA treatment also significant ($p < .05$) increased the levels of antioxidant enzymes while decreasing the levels of lipid peroxidation [18] One of the studies stated that *Semecarpus anacardium* can be used as manure for the cultivation of anti-oxidant herbs (*kayakarpam* in Siddha medicine). And the results revealed that there was a significantly increased antioxidant capacity in the *kayakarpa* herb Centella asiatica by the traditional cultivation method which was proven by different methods of in-vitro anti-oxidant assays [19].

Anti-inflammatory

Ramprasath VR *et.al.* reported that *Semecarpus anacardium* significantly decreased the carrageenan-induced paw edema and cotton pellet granuloma. Standard drug Indomethacin likewise decreased the acute and chronic phases of inflammation. And also, SA decreased the adjuvant-induced (arthritis) paw edema after the treatment, in both developing and developed adjuvant arthritis [20]. Ethanolic extract of *Semecarpus anacardium* fruit revealed a dose-dependent anti-inflammatory activity in the carrageenan-induced rat paw edema model of inflammation [21]. The drug *Semecarpus anacardium* significantly reduced the elevation in the paw edema, TNF-alpha, nitric oxide, and myeloperoxidase levels when compared with adjuvant-induced arthritic animals, which shows the anti-inflammatory activity of the drug. SA showed strong anti-inflammatory effects in both xylene-induced ear edema and formalin-induced inflammation[22]. Salvem *et al*. investigated that ethyl acetate extract of *Semecarpus anacardium* led to the isolation of a major active principle, tetrahydroamentoflavone (THA), a biflavonoid. The in vitro cyclooxygenase (COX-1)- catalyzed prostaglandin biosynthesis assay of THA gave an IC50 value of 29.5 μM (COX-1) and 40.5% inhibition at 100 g/ mL (COX-2).

The in vivo carrageenan-induced paw edema assay resulted in the dose-dependent anti-inflammatory effect of THA and the activity was comparable to that of ibuprofen [23]. Bhitre *et al*. prepared the methanolic, ethanolic, chloroform, ethyl acetate, and petroleum ether extracts of fruits of *Semecarpus anacardium*. They testedthem to study the anti-inflammatory activity using the technique of carrageenan-induced paw edema in albino rats. The extract exhibited significantanti-inflammatory activity comparable to the reference standard aspirin [24]. Satyavati *et al*. reported the anti-inflammatory activity of *Semecarpus anacardium* for both immunological and non-immunological origins [25]. Premlatha *et al*. reported immunomodulatory potency, antioxidative, membrane stabilizing, tumors marker regulative, glucose level restoring, and mineral regulation properties of *Semecarpus anacardium* nut extract in hepatocellular carcinoma and found to detoxify a potent hepatocarcinogen aflatoxin B1 and cause its metabolites to excreted in the urine [26].

Analgesic activity

In the analgesic test, the extract elicited a potential activity on both acetic acid-induced writhing response as well as hot plate test showing its central and peripheral mediated action [22].

CONCLUSION

According to the literature review, *Serankottai (Semecarpus anacardium)* has been used by sage siddhars in ancient times to treat the various health ailments especially arthritis. And it also has been scientifically proven for its pharmacological activities such as Anti-oxidant, Anti-inflammatory, Analgesic, and Anti-arthritic activity. According to this review, the versatile Siddha formulation *Vithu Rasa Mezhugu* is a potent anti-arthritic drug and it can be used in the treatment of Rheumatoid arthritis.

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RESEARCH ARTICLE

Comparative Study of Dynamic Response of Monolithic and Rocking Columns under Earthquake Accelerations using FEA

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ABSTRACT

Another name for the rocking column is the kinematic base isolator, and both of these names refer to a kind of seismic isolation system. These two names refer to the same component in different ways. It is a column made of concrete that is of very good quality and, depending on the use, may either be free-standing or centrally post-tensioned in the centre. An interrupted look may be seen on the sides of the column as it curves around it. The ABAQUS software was used in this investigation to carry out a comparative examination of the dynamic responses of rocking columns and monolithic columns. This analysis was carried out using the ABAQUS software. The primary objective of this study is to understand and determine the performance of a monolithic RCC column as well as an available rocking RCC column, and then analyse the performance based on the stress and strain characteristics exhibited by the columns when they are subjected to longitudinal acceleration. This research was carried out in order to answer the question, "What happens to the stress and strain characteristics of RCC columns when they are subjected to horizontal acceleration?" Additionally, an investigation of the effects of horizontal acceleration on the columns will be carried out as part of this research. Following the completion of the investigation, it was discovered that the rocking column retained its structural integrity despite the presence of potential face-edge crushing failures. This was the conclusion reached after the study was carried out. Following the completion of the investigation, this was found to be the case.

Keywords: ABAQUS Software, Base Isolation, Earthquake, Finite Element Analysis, Rocking Column

INTRODUCTION

Structures, such as residential buildings, structures housing essential services, historical sites, and industrial structures, need to be planned with a great deal of care in order to provide adequate protection against earthquakes. Examples of these structures include historical sites and industrial structures. This is because, during the course of the last several decades, a number of earthquakes that were responsible for a significant amount of damage have happened in different parts of the world at different times. Because of this, there has been an increase in the number of people who have lost their lives as a result of buildings collapsing and significant damage being caused to the structural integrity of the structures. In recent years, there has been a growth in popularity of a method for the design of structures that is known as seismic response control. This strategy is also seeing an increasing amount of use in the field of civil engineering. The method provides performance-based design criteria, which are needed in many of today's seismic design standards and are offered as an advantage by the method. The technology fulfils the requirements for elastic performance even during significant earthquakes, making it economically feasible in a variety of applications. This is very necessary in light of the fact that earthquake design guidelines have gotten more sophisticated in recent years. The process of seismic isolation, which has the goal of isolating the superstructure from the movement of the earth, makes use of a bearing that is constructed expressly for isolation purposes. The goal of seismic isolation is to separate the superstructure from the movement of the earth.

It is controlled by increasing the basic period to a higher value, which results in a decrease in the pressures that are drawn by the structure but comes at the expense of larger isolator displacements. This is the method that is used to regulate it. Increasing the time period is one way to accomplish this goal. The realisation of the intended reaction, on the other hand, helps to reduce the relative displacement of the superstructure, which is the primary cause of damage to the superstructure. This helps to keep the superstructure in the best possible condition. The upshot of this is that the superstructure will experience less damage as a result. A kind of seismic isolation device known as the rocking column is also known as the kinematic base isolator. Both of these names refer to the same thing. These two names are both used to refer to the same object. It is a column composed of high-grade concrete that may be free-standing or centrally post-tensioned and has curving sides that, by their very nature, are discontinuous. The column may be free-standing or it may be centrally post-tensioned. With the aid of the ABAQUS software, a comparative analysis of the dynamic responses of monolithic columns and rocking columns is carried out in the current investigation. The primary purpose of this investigation is to perform an analysis on a monolithic RCC column as well as a free-standing rocking RCC column at the same time that both of these columns are being subjected to cyclic horizontal accelerations.

When this procedure is completed, the findings will be analysed and contrasted according to the characteristics of the stress and strain. ABAQUS is a piece of software that is capable of doing finite element analysis, which is also often referred to as FEA. The modeling and assessment of the many components that comprise structural and mechanical systems needs this particular kind of study to be carried out. When it comes to using data on horizontal acceleration and comparing it to the time period in question, the scenario that includes earthquake loading is going to run into an issue. This problem will arise when attempting to apply the data. When dealing with such data, it is necessary to carry out an analysis that is of a character that is both quasi-static and dynamic. ABAQUS offers a helpful environment for carrying out this kind of analysis in a variety of applications in civil engineering, such as monitoring the health of structures. These applications include monitoring the health of structures. The following is one of these applications:

Elements in ABAQUS Software
The ABAQUS programme includes a wide variety of modules, each of which is described in more depth in the list that is shown below. The various components that come together to form an Abaqus/CAE model are referred to as the model's "parts" as a collective noun. After the various components have been designed in the part module, they are transferred to the assembly module so that the final product may be put together using those components. In

addition to material calibrations, the property module can be used to precisely define materials, beam section statuses, sections, fibreglass layups, skin reinforcements, inertia on a component, springs, and dashpots between two points or between a point and ground. All of these can be done independently or in conjunction with one another. When designing the assembly, you have the option of beginning from scratch or using the Assembly module to make any necessary modifications. There is usually at least one essential assembly included in a model. This assembly is made up of several incarnations of the model's component parts in their various forms.

Users are granted the ability to design analysis stages via the use of the step module, in addition to providing output requests, adaptive meshing, and analysis control. In addition, the step module is compatible with a wide variety of input types. The connectivity module is being used to define and manage the thermal and mechanical interactions between both regions of a prototype, the interface region and coupling methods, analysis restrictions between regions of a concept car, connector sections, and connector section commitments to design connectors, and inertia (point mass, rotary rigidity, and heat capacitance) on regions of the model. Additionally, the connectivity module is being used to define and manage the analysis restrictions between regions of a prototype. The interface area and coupling techniques, connector sections, and connector section assignments to model connectors are some of the other elements of the Interaction module. Other elements such as the interface area and coupling methods are included in the interaction module. Additionally, the connector sections and the connector section assignments to model connections are also a part of this module. The connecting parts are the locations of each of these features and functions. It is possible to design and manage loads with the help of the load module, in addition to boundary conditions, specified fields, and load scenarios. All of these elements may be accessed via the module. The Mesh module offers a set of tools that, when paired with one another, make it possible to build meshes for components and assemblies that have been designed using Abaqus / CAE.

These meshes may then be used in simulations. The resulting meshes are afterwards suitable for use in simulations. In addition, the Mesh module provides methods that, if supplied, may check an already existing mesh. These methods are only available if the mesh is provided. Your model's topology or shape may be optimised with the help of the optimization module if you provide it with a list of goals to achieve and a list of limits to adhere to. This will allow your model to be optimised in the best possible way. Providing the module with the lists is how this objective is satisfied. It is possible to construct and manage analytic activities by using the Job module, and it is also possible to see a rudimentary plot of the findings obtained from such activities. The use of the Job module is what makes any of this workable at all. In addition to that, it is used in the creation and administration of adaptation studies, as well as in the co-execution of various projects. With the assistance of the module for visualisation, you will be able to display both the results of the analysis as well as your model. It is possible to use sketches, which are two-dimensional profiles of the part, as a help in the construction of the geometry that defines an Abaqus/CAE native part. Sketches may be found in the Sketches folder. The geometry may be constructed using sketches in certain cases.

METHODOLOGY

With the assistance of the ABAQUS computer programmer, it is possible to model either a monolithic RCC column or a free-standing RCC rocking column. This modelling is carried out with the assistance of the modules that are a part of the software that we are making use of at the moment. In order to make things easier for you, the steps that need to be followed in order to model both of the columns have been broken down and compiled into the following list.

Monolithic Column in parts
In order to replicate a monolithic column, you will need to generate three individual components by making use of the component module. The first kind of structure to be discussed is a column, which is held up by blocks situated at both of its ends (as a single unit). The stirrup is the second component, and the diameter of this component must meet the requirements. The rebar is the third component, and it has to be bent at both ends and have the correct

length. Figure 1 shows the components that were developed for the monolithic column. Table 1 has a listing of the various components along with their respective measurements.

Rocking Column in parts
In order for the part module to be able to carry out a simulation of a rocking column, it is necessary to produce four separate components in their own right. The column itself, the support block, the rebar, and the stirrup are the components that make up this structure. It is necessary to construct the column and the support block independently from one another in order to bring about the desired effect of the swaying column. Figure 2, which can be seen over here, illustrates the different parts that went into the manufacturing of the rocking column. These parts can be found here. The dimensions of the Monolithic Column and the Rocking Column are practically identical to one another; the main differences come in the specifics of the column itself, including the rebars and the stirrups. Due to the fact that the column has a diameter of 106.25 mm, which is often known as the kern of the column, the top and bottom sides of the column are required to remain in a plane (flat) state at all times. The smooth curve that is supplied is tangential to the surface of the tube, and it makes contact with the surface of the cylinder at a height that is 6.12 millimetres from the base; the measurements of all of the parameters are given in millimetres. Figure 3 illustrates this curve for your perusal. When the lengths of the hooks are not taken into account, the height of the rebar is calculated to be 2.82 metres.

Monolithic Column in property
The single monolithic column will have two portions created for it by the property module; one section will be constructed of concrete, while the other section will be built of steel. These various components stand in for the components of the column that are made of different materials. Before these sections can be created, a concrete material with a grade of M40 and a specific substrate with a grade of Fe500 must first be constructed. Only then can these sections be created. After that, these resources are delivered to the many parts and components of the whole that need them to do their jobs.

Rocking Column in property
The rocking column in the property module, which is constructed in a way that is quite distinct to the one described in the preceding example, is made up of two components that are together described as concrete and steel. Before these sections can be created, a concrete material with a quality of M40 and a steel material with a grade of Fe500 must first be constructed. Only then can these sections be created. After that, these resources are delivered to the many parts and components of the whole that need them to do their jobs.

Monolithic Column in assembly
The assembly module starts off with the production of the necessary quantity of rebar and stirrup instances, which is the first thing that happens after that. Following that, the component will proceed to the next stage. After that, during the second phase of the process known as assembly, each of the recently manufactured components that were initially derived from the part module is ultimately included in the final product. The placement of each component is first determined, and then, after taking into account the size of the structure and the amount of space that exists between each component, the location of each component is then secured so that the structure may be constructed. Figure 4 is a diagram that illustrates the process of putting together the monolithic column by utilising all of the individual elements that it consists of.

Rocking Column in assembly
It is necessary to install support blocks, rebar, and stirrups in the right locations before beginning construction on a swaying column. The process of assembling all of the components and determining the final locations of those components requires the use of the many tools that are at one's disposal, since this cannot be done manually. The rebars and stirrups are only positioned inside the column in the event that it rattles; the blocks that are positioned above and below it do not have any constraints placed on their mobility.

Process
The creation of the seismic loading step is the responsibility of the module that is simply referred to as the step. In the part of the paper labelled "Dynamic Analysis," the field output request for stress and strain with respect to time is described for both the monolithic column and the rocking column.

Monolithic Column interaction
When working with monolithic columns, the implementation of restrictions is accomplished via the use of an interaction module. After having been placed within the column, the stirrups and the rebar are next inserted into the column itself to begin the process. Another kind of constraint that may be used is known as a "stiff tie constraint," and it is possible to apply it to the column as a whole by using a reference point in order to do this. It is possible to take advantage of this specific limitation.

Rocking Column interaction
When playing a rocking column, the interaction between the column and the restrict is created at both ends by selecting the bottom face of a column as the master surface and the upper portion of the bottom assistance frame as that of the slave surface, and by selecting the top face of the column as that of the slave surface and the bottom surface of the top endorse block as that of the master surface. In other words, the interaction between the column and the restrict is created by selecting the bottom face of the column as the master surface and the upper portion of the bottom assistance block as the slave surface. To put it another way, the interaction between the column and the block is produced by designating the lower face of the column as the master surface and the upper face of the bottom support block as the slave surface. To put it another way, the interaction is produced by designating the lower face of a column as the master surface and the upper face of the bottom end block as the slave surface. In other words, the lower face of the column is the master surface, and the upper face of the bottom support block is the slave surface. As can be seen in Figure 5, connectors are currently being implanted between the support blocks and the column in such a way that it is possible to get the gyroscopic parameters relative to the movement of the bottom block in response to earthquake accelerations. This is being done in such a way that it is possible to get the rotational parameters relative to the movement of the bottom block in response to earthquake accelerations.

Load and mesh
At this precise instant, a gravitational force is being applied to the whole of the structure in both of the previously described sets of hypothetical circumstances. A pressure load equal to one thousand kilobits is distributed evenly throughout the whole of the uppermost surface of the support block for both columns. This burden is situated on the surface that is the highest in elevation. On the underside of the bottom support block, a load that simulates the effects of an earthquake is applied. An earthquake loading that consists of two sequential cycles of horizontal accelerations versus time has been used in order to produce earthquake conditions while also reducing the amount of time that is necessary for the study. This was done in order to minimise the amount of time that was needed for the investigation. These accelerations were calculated using the data collected during the Vrancea earthquake, which took place on March 4, 1977, and registered a 7.2 on the Richter scale in terms of its magnitude. The epicentre of the earthquake was located in the Vrancea region. The epicentre of the earthquake was discovered to be in the nation of Romania. Both of the columns' loads, as well as their boundary conditions, are shown in Figure 6, which may be seen here. This is where the figure may be viewed.

The mesh module is the component that unifies all of the individual parts that have been produced and assembled into a unified whole. The mesh size of the individual pieces is anticipated to be 0.075 metres, which is the same for both the monolithic and the rocking column designs. The rocking column, on the other hand, has hex-shaped support blocks and tet-shaped components for the rest of its elements, and the monolithic column has tet-shaped components for all of its parts. From the perspective of the element form, the monolithic column is preferable to the rocking column. It is possible to see rocking columns and monolithic columns coming together to build a new column in Figure 7.

Analysis

Finding the earlier approach of modelling and analysis that resulted in the required successful findings was not an easy task; rather, it required more than 20 unsuccessful efforts and around 1700 hours of labour on analysis. It was necessary to wait for approximately sixty to seventy hours in order to examine the results, and this was followed by the decision to either carry out the necessary rectifications or wait until the necessary rectifications had been carried out before running the analysis again. After waiting for approximately sixty to seventy hours, it was essential to examine the results. Utilizing three particles that were positioned alternately at the bottom of the column, in the centre of the column, and at the top of the column allowed for the generation of graphical results for the monolithic column. Thank you for your attention. Please check Figure 4 for the orientations. The bottom particle is located at the junction of the column and the bottom support block, with its front side turned toward the observer when the column is viewed in such a way that both the X-axis and the Y-axis are pointing in positive directions. This occurs when the column is viewed in such a way that both the X-axis and the Y-axis are pointing in positive directions. When this occurs, it means that both the X-axis and the Y-axis are pointing in the same direction, which is the positive direction. One should search for the centre particle inside the principal component of the column, at a point that is located squarely in the middle of the structure.

In addition, keeping the same view orientation suggests that the top particle may be located at the intersection of the column and the top support block facing away from the observer. This can be determined by keeping the same view orientation. This is observable provided that the view is preserved. As a consequence of this, it has been moved to the right-hand side of the column. The graphical findings for the rocking column were produced for three particles that were positioned in the same manner that was reported for the monolithic column. Further citation is required. It was agreed that these three particles would be used for both the monolithic column and the rocking column so that we could conduct our analysis and evaluation of the data in a manner that was both fair and consistent. The presentation of distinct and consistent contrasts between the two distinct types of columns was what made this feasible.

RESULTS

All of the charts on the left side are for the Homogeneous Column, which is also known as (a), and all of the graphs on the right side are for the Rock Column, which is also known as (b). The findings are presented in a graphical format down below (b). Figure 8 demonstrates that the strain-time curve for the bottom particle in case (a) has significant variations, whereas the strain-time curves for the top and bottom particles in case (b) have the same patterns. These results can be seen in comparison to the strain-time curve for the top particle in case (b) (b). The stress-time curve for the bottom particle exhibits high variations in (a) of Fig. 9, yet the same changes are seen for both the top and bottom particles in the picture in (b), showing that the same thing is happening in both cases (b). If we have a look at Figure 10, we are able to observe that the pressure curve for the bottom particle in instance (a) is of the unstable multiple hysteresis loop type, but the stress-strain curve for the bottom particle in instance (b) is of the steady half saturation magnetization type (b). Figure 11 shows that the strain curves again for centre particles are extremely thin and elongated hysteresis loops with very tiny values for both the stress and the strain. This is true for both (a) and (b) of the figures. Despite the fact that these curves cannot be seen with the naked eye at this size, they could be discernible to someone who looks very carefully and pays close enough attention to the details. The top particle for (a) in Figure 12 has a stress-strain curve that is known as an unstable multiple hysteresis loop, but the top nucleus for (b) has a steady curve that looks like the inverted stress-strain curve for a mild steel rod. Both of these curves may be found in Figure 12. Both of these varieties of curve are shown within the same figural representation. By using the stress-strain graph for the mild steel rod in its inverted form, it is possible to compare each of these curves to one another (b).

CONCLUSION

The following is a list of some of the inferences that may be made based on the facts and observations that were covered in the sections that came before this one

- The bottom component of (a), which is shown in Figure 8, is shown to be subjected to significant variations in strain over the course of time. This is made abundantly evident by the figure. The passage of time may be responsible for these distinct differences in appearance. As a direct result of this, there are indications of column deformation at its base, which, in the case of monolithic columns, is a symptom of failure at the base. (a) It was seen that the strain has been steadily increasing in response to the passage of time at both the top and the bottom. This is the situation in each of these areas. More evidence that probable failure symptoms are present near the margins of the rocking column is provided by this.

- Based on Fig. 9, it is crystal clear that the bottom segment of (a) experiences significant fluctuations in stress as a function of time, with some segments of the curve falling into the tensile stress zone. This is the case because some of the segments of the curve fall into the tensile stress zone. This conclusion might be reached as a result of the fact that the bottom portion of segment (a) is shown. This denotes the kind of failure that takes place at the base, which, depending on the evidence, may be determined to be cracking or shearing. This is an indication of the type of failure that takes place at the base. This describes the kind of failure that occurs at the foundation of the structure. In addition, it has been seen that the compressive stress in region (b) is steadily increasing with respect to time at both the top and the bottom of the region. This was the conclusion that was drawn from the investigation. The steady worsening of compression that has been taking place over the course of time is one sign that crushing-related failure may have occurred. We now have more evidence to support the findings that were formed in the preceding point as a direct consequence of this.

- When looking at Figures 10, 11, and 12, it is simple to observe that a monolithic column undergoes cyclic loading of a thin, elongated, and numerous looping characters all the way up its height. This is because the loading pattern increases in height from bottom to top. This is the result because the column is made of a single piece of stone. As a direct result of this, the column is displaying unusually high, unstable, and brisk fluctuations in its stress levels in proportion to the passage of time. This alludes to the larger chance of a reduced degree of durability, fractures both inside and externally, and the eventual collapse of the building in the long run. Despite this, the rocking column is subjected to cyclic loading that is of a wide and half-looped character all the way up the height of the column. This loading occurs throughout the whole rocking column. This loading happens throughout the whole of the column's length. As a consequence of this, displaying regular and minimum stress variations with regard to time in the column, which is indicative of maintained durability and structural integrity as well as a decreased probability of both internal and surface fractures. [Citation needed] On the other hand, there are indications that the column is being crushed as a result of the severe stresses that have developed along its face boundaries. The events that came before caused these tensions to arise as a direct result of those events. In the future, this will be a part of the scope of the study, along with an investigation of rocking columns post-tensioned along the vertical centroid axis. This has been shown to increase the capability of the structure to re-center itself, so it will be combined with the previous part of the study. The provision of high-strength steel plates with a specified curvature at the column faces may make dealing with and resolving this problem easier. This is going to be an aspect of the work that will be carried out at some point in the not-too-distant future.

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Table 1. Dimensions of elements of Monolithic Column

	Support Blocks	Column	Stirrups	Rebar
Length	1 m	0.425 m (Diameter)	8 mm ϕ	16 mm ϕ
Width	1 m		0.389 m (Diameter)	7 nos.
Height	0.5 m	2.9 m	250 mm c/c spacing	4.32 m

Figure 1. parts of monolithic column

Figure 2. parts of rocking column
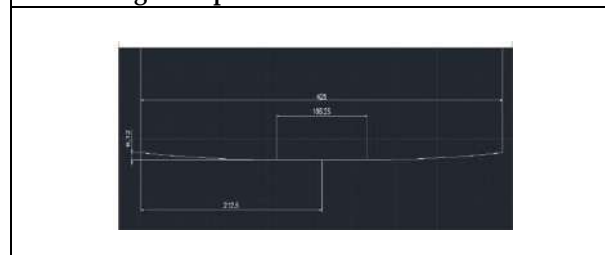
Figure 3. details of the curvature at the bottom & top face of the rocking column
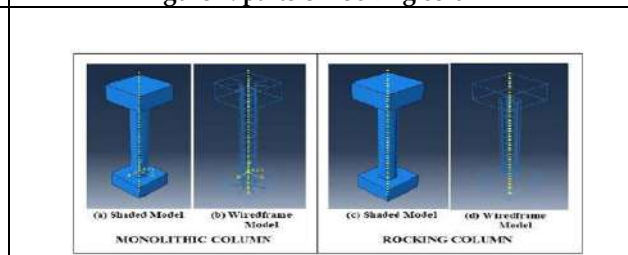
Figure 4. Assembly of monolithic and rocking column
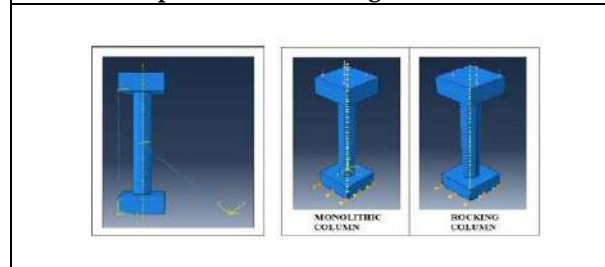
Figure 5. & 6. assembly of Rocking Column showing connectors load and boundary condition for monolithic and rocking column
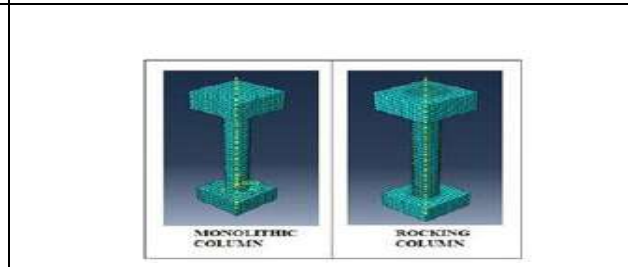
Figure 7. meshing of monolithic and rocking column
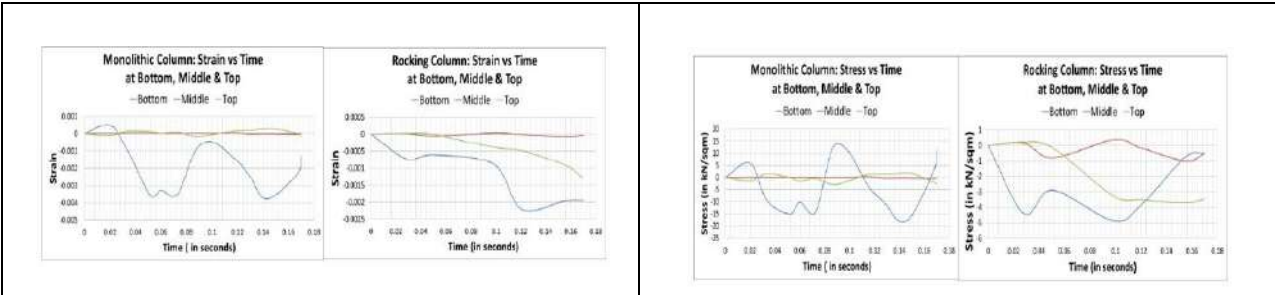
Figure 8. Strain (vs) Time curves at Bottom, Middle and Top for (a) and (b)

Figure 9. Stress vs Time curves at Bottom, Middle and Top for (a) and (b)
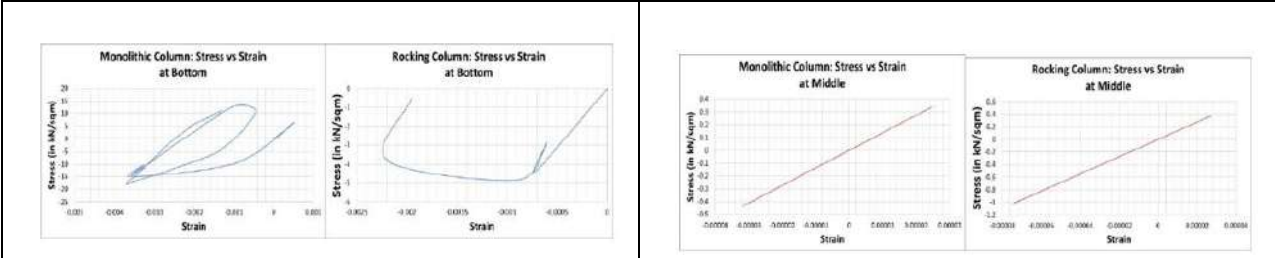
Figure 10. Stress vs Strain curve at Bottom particle for (a) and (b)

Figure 11. Stress vs Strain curve at Middle particle for (a) and (b)
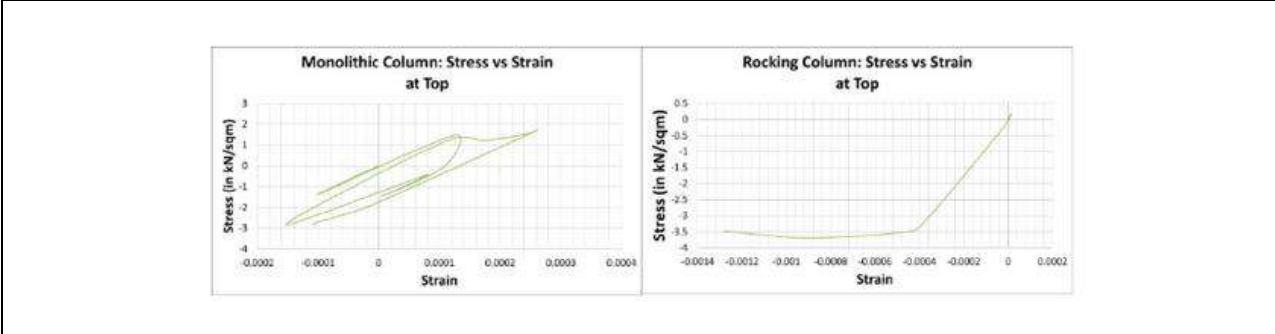
Figure 12. Stress (vs) Strain curve at Top particle for (a) and (b)

RESEARCH ARTICLE

Impact of Organic Granules on Yield Attributes and Yield of Maize

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ABSTRACT

The field experiment was conducted in farmer's field during the *kharif* season (June-October, 2021) in Neively Vadapathy village, Orathanadu Taluk, Thanjavur District of Tamil Nadu for to study the "Impact of organic granules on yield attributes, and yield of maize**"**. The experiment was laid out in Randomized Block Design (RBD) with replicated thrice with eight treatments. The eight treatments *viz.***,** T_1 - Control, T_2 - 100% Recommended Dose Fertilizer, T_3 - 100% RDF + seaweed granules @ 20 kg ha^{-1}, T_4 - 100% RDF + humic acid granules @ 20 kg ha^{-1}, T_5 - 100% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1}, T_6 - 75% RDF+ seaweed granules @ 20 kg ha^{-1}, T_7 - 75% RDF + humic acid granules @ 20 kg ha^{-1} and T_8 - 75% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1}. Among the different treatments, application of 100% RDF + Seaweed granules @ 10 kg ha^{-1} + Humic acid granules @ 10 kg ha^{-1} (T_5) recorded the higher yield attributes and yield of maize *viz.*, cob length (21.95 cm), cob diameter (5.12 cm), number of rows cob^{-1} (13.70), number grains row^{-1} (30.28), number of grains cob^{-1} (416.34), grain yield (6594 kg ha^{-1}) and stover yield (10550 kg ha^{-1}). The lower yield attributes and yield of maize were observed under control (T_1)

Keywords: maize, seaweed, humic acid, yield and nutrient uptake

INTRODUCTION

Maize is a wonder crop, because it can be used at any stage of crop growth. Early stage as succulent green fodder, very early cob stage as baby corn, little later stage as green cob and at fully matured stage as maize grain. Because of this ability it is also called as "Contingent crop"**.** Maize crop has multiple uses like it is used as food, feed and raw materials for commercial product preparation (Khan *et al*., 2017**).** Maize is an exhaustive crop and required high amount of nitrogenous fertilizer compared to other cereal crops. The conjunctive use of organic manure and chemical fertilizers can augment the nutrient use efficiency and also enhance the productivity of quality protein maize. Hence the concept of integrated nutrient management is gaining momentum in view of its beneficial effect on physio-chemical soil characteristics, beneficial microbial load and sustainable crop productivity. Use of organic manure to meet the nutrient requirements of crop would be an inevitable practice in the year to come for sustainable agriculture. Granulated organic manures will absorb the moisture slowly and it results in slow release of nutrients thus results in increased nutrient efficiency (Suresh Kumar and Baradhan, 2018). Seaweed extract increases the root respirations, root formation and quality of yields and improves their physical appearance. Seaweed also improves the level of soil nutrients like N, P and K and other minerals necessary for plant growth. The seaweed bio stimulants were found to withstand soil moisture stress and helped to reduce the yield loss to a significant extent. Seaweeds are an important part of the aquatic and coastal ecosystems and have commercial importance in improving agricultural productivity (Ali *et al*., 2021). Humic acid is useful in soil and crop management techniques, leading to improved productivity. It is believed that humic acid elements implies growth promotion and improve crop yield by its capability of supplying N and P to the plant when applied it in combination with inorganic fertilizers.

MATERIALS AND METHODS

The field experiment was conducted in the farmer's field located in Neively Vadapathy village, Orathanadu Taluk, Thanjavur District of Tamil Nadu during June – October 2021 for "Impact of organic granules on yield attributes, and yield of maize". The experimental field was geographically located at 10.44° N latitude and 79.14° E longitude at an altitude of +36 meters above mean sea level. The weather of Neively Vadapathi village is the moderately hot weather condition. The weekly mean maximum temperature ranged from $32.3^{\circ}C$ to $36.9^{\circ}C$ with a mean of $34.2^{\circ}C$ and the weekly minimum mean temperature ranged from $20.4^{\circ}C$ to $26.4^{\circ}C$ with a mean of $23.2^{\circ}C$. The relative humidity ranged from 40 to 78 percent with a mean of 61.3 per cent. The total rainfall received during the cropping period is 76.6 mm. The texture of the experimental field soil was sandy clay loam with neutral pH and low, high and high in available nitrogen, phosphorus and potassium respectively. The hybrid maize Syngenta NK 6240 was chosen for the study. The experiment was laid out in Randomized Block Design (RBD) with three replications and eight treatments. The treatment schedule were as follows : T_1 - Control, T_2 - 100% Recommended Dose Fertilizer (RDF), T_3 - 100% RDF + seaweed granules @ 20 kg ha^{-1}, T_4 - 100% RDF + humic acid granules @ 20 kg ha^{-1}, T_5 - 100% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1}, T_6 - 75% RDF+ seaweed granules @ 20 kg ha^{-1}, T_7 - 75% RDF + humic acid granules @ 20 kg ha^{-1} and T_8 - 75% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1}. The seeds were dibbled at the rate of 20 kg ha^{-1} with the spacing of 60 × 25 cm. Application of granular fertilizers *viz*., seaweed extract and humic acid granules were supplied as Sagarika z++ granules and Huminol – G granules, respectively. As per the treatment schedule, Seaweed granules are applied with mixture of 50 kg sand at 10, 30 DAS. Humic acid granules are applied with mixture of 50 kg sand at basally. One hoeing and weeding was given on 20 DAS. Observations on yield attributes were taken on periodical intervals during the cropping period.

RESULTS AND DISCUSSION

Yield attributes
The results of the field study on maize crop revealed that the all yield attributes were significantly influenced by the application of NPK along with organic granules. Among the various treatments imposed in this study, application of 100% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1} (T_5) recorded the maximum yield

parameters *viz.*, cob length (21.95 cm), cob diameter (5.12 cm), number of rows cob^{-1} (13.70), number of grains row^{-1} (30.28) and number of grains cob^{-1} (416.34). Cob length and diameter increased due to sufficient supply of NPK to the crop. Because, NPK being an essential constituent of plant tissue is involved in cell division, cell elongation. Application of NPK facilitates production of more photosynthates leading to increased cob length and diameter in maize. These are similar with findings of Adhikary *et al*. (2021). Number of rows cob^{-1} were increased due to the humic acid increase availability of nutrients in the soil and their availability to the plant and encourage the metabolic processes in the formation of proteins and starches and increase their accumulation in grain. These results are in agreement with Taj AL-Deen *et al.* (2017). The number of grains row^{-1} increased might be due to the Presence of micro-elements and plant growth regulators, especially cytokinins in seaweed extracts improve the better grain filling and increase the size of the cobs. These results are in line with Layek *et al.* (2016). The increase in number of grains cob^{-1} related to seaweed extract amended treatment increase in the number of grains per plant which was brought about by enhanced cob length and consequent greater grain setting. These results are in agreement with Mondal *et al.* (2015).

Grain and Stover yield

The results of the field study on maize crop revealed that the grain yield was significantly influenced by the application of recommended NPK along with organic granules. Among the different treatments, application of 100% RDF + Seaweed granules @ 10 kg ha^{-1} + Humic acid granules @ 10 kg ha^{-1} (T$_5$) recorded the maximum grain (6594 kg ha^{-1}) and stover yield (10550 kg ha^{-1}). Increase in yield of maize may be due to the presence of seaweed extract as well as the minerals element present in the seaweed extract, increased the photosynthate or delay the senescence of the leaves, this would have enhanced the supply of photosynthate available for grain filling, thus resulting in bolder grain and enhancing the number of grains cob^{-1}, number of rows cob^{-1}, number of grains row^{-1} and consequently higher grain yield. The results are in agreement with findings of Singh *et al*. (2016). The increase in stover yield might be due to Seaweed extracts probably encourage flowering by initiating robust plant growth. Stover yield increases in seaweed-treated plants are thought to be associated with the hormonal substances present in the extracts, especially cytokinins. This was in conformity with the findings of Sanodiya *et al*. (2022). This increase in stover yield might be due rapid penetration of humic acid in the plant cells, direct effect on chlorophyll content, acceleration of respiration, activation of growth enzymes, and indirectly through improved biological, physical and chemical conditions of the soil. This was in conformity with the findings of Wulandari *et al*. (2019).

CONCLUSION

Application of organic granules with inorganic fertilizer recorded significantly maximum values of yield attributes, and yield of maize. Based on the results of present study, it can be concluded that application 100% RDF + seaweed granules @ 10 kg ha^{-1} + humic acid granules @ 10 kg ha^{-1} (T$_5$) increase the grain yield and stover yield of maize.

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Table 1: Effect of Organic granules on yield attributes and yield of maize

Treatments	Cob length (cm)	Cob diameter (cm)	Number of rows cob^{-1}	Number of grains row^{-1}	Number of grains cob^{-1}	Grain yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
T$_1$ – Control	12.42	3.59	9.12	17.95	165.11	2240	5270
T$_2$ - 100% Recommended Doses of Fertilizer	19.61	4.66	12.91	28.47	368.43	5962	9600
T$_3$ - 100% RDF + Seaweed granules @ 20 kg ha^{-1}	20.04	4.73	13.05	28.88	377.12	6120	9780
T$_4$ - 100% RDF + Humic acid granules @ 20 kg ha^{-1}	19.98	4.70	12.98	28.65	373.22	6080	9758
T$_5$ - 100% RDF + Seaweed granules @ 10 kg ha^{-1} + Humic acid granules @ 10 kg ha^{-1}	21.95	5.12	13.70	30.28	416.34	6594	10550
T$_6$ - 75% RDF+ Seaweed granules @ 20 kg ha^{-1}	17.20	4.26	12.24	26.74	328.65	5280	8690
T$_7$ - 75% RDF + Humic acid granules @ 20 kg ha^{-1}	17.58	4.21	12.11	26.25	319.45	5112	8468
T$_8$ - 75% RDF + Seaweed granules @ 10 kg ha^{-1} + Humic acid granules @ 10 kg ha^{-1}	17.78	4.28	12.28	26.96	332.58	5518	8912
SEm±	0.59	0.12	0.20	0.45	9.79	141	214
CD (*p*=0.05)	1.79	0.36	0.60	1.36	29.10	428	654

RESEARCH ARTICLE

Plant Species Preferred for Sleeping during Day Hours by Mysore Slender Loris *Loris lydekkerianus lydekkerianus* in Keelaveliyur, Tamil Nadu, India.

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ABSTRACT

Primates spend much of their lives at sleeping site and thus are prone to predation while sleeping. Hence, selecting an appropriate sleeping site is very crucial for primates as it has important fitness consequences. However, factors determining the selection are poorly studied. In the present study, we examined the plant species preferred to sleep during day hours by Mysore Slender *Loris lydekkerianus* from January 2017 to December 2021 in Keelaveliyur, Tamil Nadu, India. Once a plant species found with loris sleeping, details like species of plant, height of the plant species, height at which loris was found sleeping, and phenology of plant species were recorded. Loris was found utilizing 14 species of plant species for sleeping during the day hours. A significant positive correction was found between height of the tree selected for sleeping and height preferred by loris for sleeping. Among the 14 plant species, greater number of loris was found sleeping on *Prosopis juliflora* followed by *Azadirachta indica*, *Commiphora cuadata*, *Zizuphus jijuba*, and *Albizia amara*.

Keywords: Mysore slender loris, sleeping plant, *Loris lydekkerianus*.

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INTRODUCTION

In primates, selection of sleeping sites may be crucial for individual survival. Predator avoidance [1] and proximity to food resources [2] are the most widely accepted explanation for the section of sleeping site. However, primates spend most of the time at sleeping sites, predator avoidance has been suggested to be the prime factor determining the selection of sleeping sites [3]. The slender *Loris lydekkerianus*, with two recognized subspecies (Malabar slender *Loris lydekkerianus malabaricus,* distributed in the wet evergreen forests of the Western Ghats and Mysore slender *Loris lydekkerianus lydekkerianus,* distributed in drier regions of southern India), is one of the two nocturnal primates found in India. Unlike macaques and langurs, lorises are poorly studied in India as they are small in size and nocturnal in habit. However, Mysore slender loris received relatively more attention in southern India during the past two decades. In the present study, we examined the plant species preferred to sleep during day hours by Mysore slender *Loris lydekkerianus* from January 2017 to December 2021 in Keelaveliyur, Tamil Nadu, India.

Study area
The present study was carried out in and around Keelaveliyur, a small village situated between 10^0 44' 39''- 10^0 44' 17'' N and 78^0 28' 44''-78^0 28' 54 E in Thogaimalai Block in Karur District of Tamil Nadu, India. Temperature varied from 28° C in the month of January to 42° C in the month of May. The variation of temperature exhibits a hot and dry weather with low degree of humidity throughout the year. The average annual rainfall varied from 356.1mm in North East monsoon to 270.3 mm in South West monsoon. As per the census 2020, the human population is 2340 which includes 1181 male and female 1159, Agriculture is the main occupation of the people of these village and paddy, *Sorghum bicolor*, **sunflower** *Helianthus annuus and* redgram *Cajanus cajan* are the main crops cultivated. *Prosophis juliflora*, *Tamarindus indica, Cummiphora caudate, Azadiracta indica* and *Tectona grandis* are the common tree species found in the village. The village and its surroundings have sizable population of loris on trees found along roadsides, backyards and bordering the cultivated lands.

METHODS

Search of loris was carried out in the early morning (0400 to 0800 hrs) and late evening hours (1700 to 2000 hrs) from January 2017 to December 2021 in and around Keelveliyur, Tamil Nadu, India. All the potential plant species available in the study area were searched for the presence of loris. Once a plant species was found with loris sleeping during day hours, the same plant species was examined for the same loris in the subsequent two days. If the loris was found sleeping during day hours in the same place in the same plant species, it is considered at sleeping-plant for the loris. If the loris was not found utilizing the plant species for continuous three days, it was not included for the present study. Plant was identified up to species level. Other details namely height of the plant, phenology of the plant, height at which the loris was found sleeping, and number of loris found sleeping on the plant were recorded. Observations was carried out using headlamps (Petzel headlamps) covered with red filters as *lorises* are not disturbed by a red light compared to white light [4]. Sex of the individual was identified by the genital organs: male with dark fur around its scrotum, female with elongated clitoris in general, and with prominent nipples in primipara. Age of the individual was categorized based on the size and fur colour.

RESULTS

During the present study, loris used a total of 14 species of plants to sleep during the day hours (Table 1). Of the 14 species of plants, greater number of loris was found sleeping on *Prosopis juliflora* followed by *Azadirachta indica, Commiphora cuadata, Zizuphus jijuba,* and *Albizia amara* (Figure 1). The height of the plant species preferred by loris for sleeping during day hours varied from 2.13 meters to 19.21 meters (Table 1). However, greater number plant species preferred by loris fall within 2-8 meters (Figure 2). The height at which loris sleeps varied from 0.91m to 15.25 m (Table 1). However, greater number of *lorises* preferred to sleep at two to six meter height (Figure 3). Number of loris found sleeping on a same tree varied from two to five. However, solitary loris was found sleeping in greater

numbers (Figure 4). It was followed by two to three *lorises* (mother and infant(s). However, four subadult males and five subadult males were also found sleeping closely at the same height of the same plant species. A significant positive correction was found between height of the tree selected for sleeping and height at which loris found sleeping.

DISCUSSION

Lorises spend only about 7 % of their time on social activities and sleeping together is one such a social activity [5]. They further reported the large sleeping groups of 2–6 individuals (a female with her offspring and an adult male). They also reported other types of sleeping groups (mother and infant, adult male and adult female, and siblings). In the present study also, mother with infants were largely found sleeping together. Slender loris to be the archetype of a solitary primate species, with most of the intraspecific social interactions occurring in biological contexts like reproduction and parental investment [6]. The present study also corroborated his view as loris was found sleeping solitarily in greater number rather than in groups. Number of loris found sleeping on a same tree varied from two to five similar to [5]. Other association existing beyond biological contexts among loris in social sleeping can be revealed only by further long-term studies on identified individuals [4]. In the present study also four subadult males and five subadult males were found sleeping closely at the same height of the same plant species on two occasions. Hence, a detailed long term study would through light on this issue.

Predator avoidance [1] and proximity to food resources [2] are the most widely accepted explanation for the section of sleeping site. In the present study greater number of lorises preferred to sleep at two to six meter height where canopy is thick and branches are closely arranged. Greater canopy cover and architecture of plant species (branching geometry) are potential factors that affect the detectability of loris and thus preferring the sleeping height at greater canopy level would be a protection strategy exhibited by loris. It minimizes the risk of being detected by predators and at the same time favor primates' detection of predators to increase their chances of escaping [7]. Loris showed a significant positive correction between height of the tree selected for sleeping and height at which loris found sleeping in the present study. It may be due to the fact that canopy occurs at the upper region of plants and thus loris increases its height according to the canopy height. *Lorises* preferred to sleep at two to six meter height in the present study and the mean height was 4.58 m. However, the mean height of sleeping trees was 8.4 m [8]. The differences may be attributed to the differences in the average height of the trees available in both the habitats.

CONCLUSIONS

Loris was found sleeping solitarily in greater numbers rather than in groups. It preferred to sleep where canopy is thick and branches are closely arranged. Preferring the sleeping height at greater canopy level exhibited by loris would be a protection strategy that minimizes the risk of being detected by predators.

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Table 1. Details of plants species preferred by the Mysore slender loris to sleep during the day hours

Plant species	Sample size	Sleeping-plant height (in meter)				Loris sleeping height (in meter)			
		Min	Max	Mean	Stand. dev	Min	Max	Mean	Stand. dev
Alangium salvifolium	2	7.62	8.54	8.08	0.65	5.18	7.01	6.09	1.29
Albizia amara	14	3.66	12.2	6.09	2.42	2.44	6.71	4.11	1.30
Azadirachta indica	29	4.57	15.24	8.05	2.53	3.66	9.76	5.37	1.53
Cereus diffusus	3	2.13	6.1	4.26	2.00	0.91	1.83	1.42	0.46
Cocus nusifera	4	9.15	9.15	9.15	0	7.62	7.62	7.62	0
Commiphora cuadata	24	3.66	9.15	5.08	1.44	1.22	4.88	3.42	1.05
Delonix eleta	1	9.15	9.15	9.15	0	6.1	6.1	6.1	0
Holoplelea integrifolia	9	6.1	19.21	11.48	4.11	4.57	15.24	7.72	3.14
Moringa oleifera	3	7.62	7.62	7.62	0	4.57	5.18	4.77	0.35
Prosopis juliflora	33	3.66	11.59	5.55	1.54	1.22	5.18	3.71	0.87
Tamarindus indica	3	10.98	15.24	13.31	2.15	6.71	10.67	8.64	1.98
Vachellia seyal	1	9.15	9.15	9.15	0	6.4	6.4	6.4	0
Wrightia tinctoria	7	3.35	4.88	4.09	0.65	2.13	3.05	2.52	0.38
Zizuphus jijuba	19	3.66	10.67	6.93	2.01	2.13	8.54	4.79	1.67
Over all	152	2.13	19.21	6.81	2.84	0.91	15.24	4.58	2.00
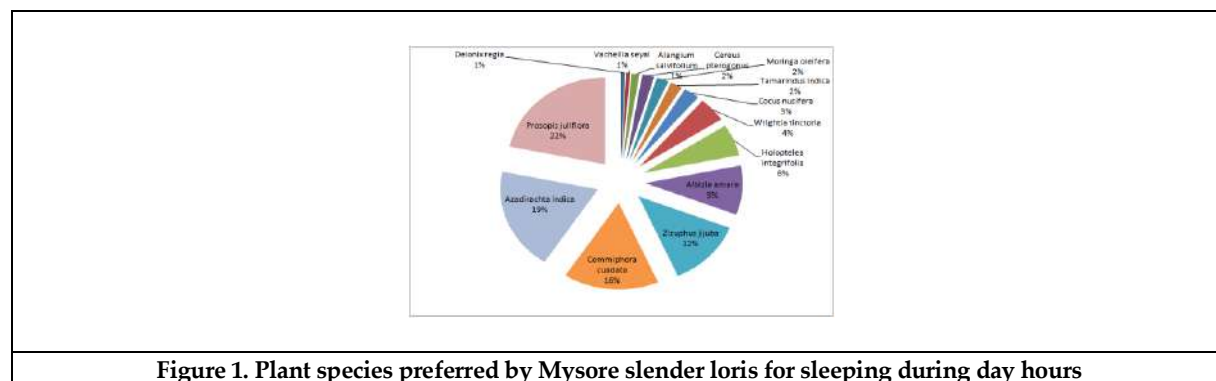
Figure 1. Plant species preferred by Mysore slender loris for sleeping during day hours

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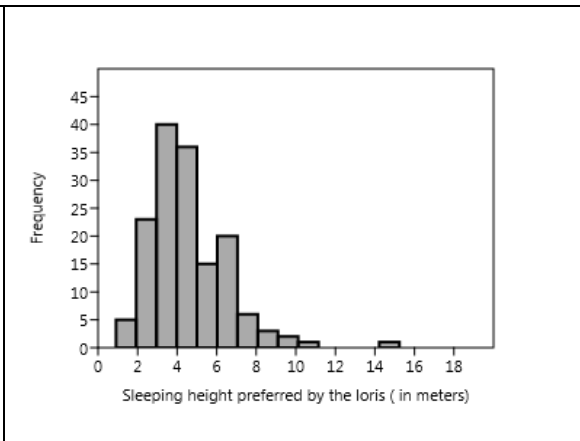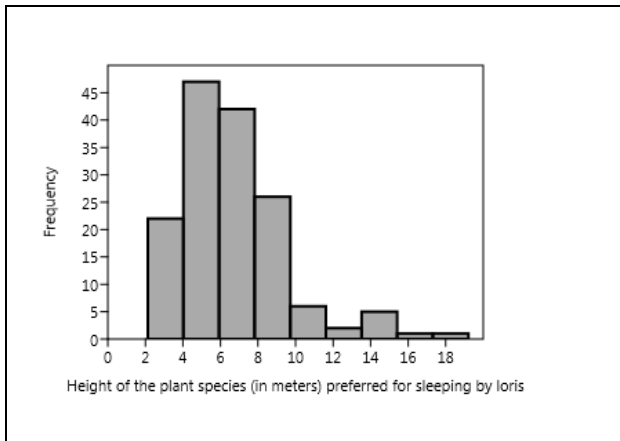
Figure 2. Histogram showing the height of the plant species preferred by Mysore slender loris

Figure 3. Histogram showing the sleeping height of Mysore slender loris
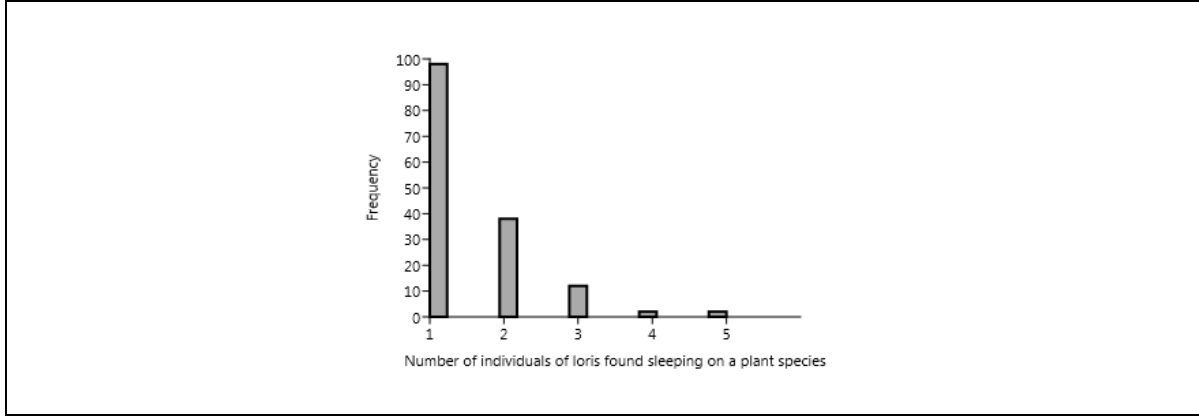
Figure 4. Number individuals of loris found sleeping on plant species

RESEARCH ARTICLE

Optimization of Lycopene Phytosomes for its Enhanced Therapeutic Applications

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ABSTRACT

The potential to prevent diseases by complementary and alternative medicine; these so-called "community-based lifestyle interventions" has influenced towards rising interest of consumers own healthcare and their attitude towards the use of dietary supplements. Phytopharmaceuticals stand out as recent promising candidates for the treatment of chronic diseases with fewer side effects and lower phytochemical costs. Lycopene is a linear, unsaturated hydrocarbon carotenoid, the major red pigment in fruits like tomato; with highest content of all fruits and least bioavailability. Although promising data from epidemiological, as well as cell culture and animal, studies suggest that consumption of lycopene containing foods reduce cancer or cardiovascular disease risk, To improve therapeutic utilities; Phytosome - little cell like structures is a novel form of herbal formulations which contains the bioactive phytoconstiuents of herb extract with phospholipids to produce lipid compatible molecular complexes. In present study Three-level factorial design quadratic model was employed using Design Expert to investigate the combined effect of three independent variables, Phosphotidylcholine (PC) % (1and 3), Tomato extract containing Lycopene % (1 and 3), and method of preparation (solvent evaporation, co-solvency, and salting out), on three dependent variables, Showing better entrapment efficiency 81.57, 82.34 and 83.22 %, partition coefficient 0.761, 0.782 and 0.812, and drug release 82.39, 91.37 and 91.87% by solvent evaporation method respectively compared to co-solvency and least by salting out method. The

improved bioavailability and therapeutic efficiency of lycopene is formulated in the form of Nutraceuticals and Cosmeceutical dosage forms.

Keywords: Lycopene, Phosphotidylcholine, Phytosomes, factorial design, Design expert.

INTRODUCTION

Phytopharmaceuticals stand out as recent promising candidates for the treatment of chronic diseases. Fewer side effects and lower phytochemical costs open new avenues for the treatment of various diseases. Lycopene is a linear, unsaturated hydrocarbon carotenoid, the major red pigment in fruits. Tomatoes are reach in lycopene content and it is a class of carotenoids which are chemically characterized by a large polyene chain containing 35-40 carbon atoms; some carotenoid polyene chains are terminated by two 6-carbon rings. Carotenoids possess antioxidant properties which may retard aging and many degenerative diseases. As an essential nutrient, lycopene is required in the diet [1]. Recently, lycopene has also been studied in relation to its potential health effects. The antioxidant properties of lycopene are thought to be primarily responsible for its beneficial properties. The recent studies influence people's attitude towards the use of dietary supplements, there is also a rising interest of consumers in their own healthcare. In the last decade, an increasing amount of scientific information has been published about the potential to prevent diseases by complementary and alternative medicine. These so-called "community-based lifestyle interventions". Lycopene is one of the active ingredients obtained from natural source [2]. Lycopene; a highly lipophilic molecule has wide range of pharmacological activities. Nevertheless its limited aqueous solubility and extensive pre-systemic metabolism confine its bioavailability. Many obstacles stand against medicinal use of herbal derived drugs particularly that containing polyene chain containing 35-40 carbon atoms in their chemical structure owing to their poor oral bioavailability. One of the methods to respond to latter challenges is the application of phytosomal technology. Although promising data from epidemiological, as well as cell culture and animal, studies suggest that lycopene and the consumption of lycopene containing foods may affect cancer or cardiovascular disease risk, more clinical trial data is needed to support this hypothesis [3]. Phytosome little cell like structures is a novel form of herbal formulations which contains the bioactive phytoconstituents of herb extract complexed with phospholipids to produce lipid compatible molecular complexes. This phytosome technology is a break through model for marked enhancement of bioavailability, significantly greater clinical benefit, assured delivery to the tissues, and without compromising nutrient safety. Phytosomes provide better pharmacokinetic and pharmacodynamic behaviour than conventional botanical extracts. This technique utilized complex formation between phospholipid molecules and herbal extracts or its constituents producing a lipid compatible molecular complex soluble in both water and lipid environment [4]. The effectiveness of any herbal product is dependent upon delivering an effective level of the active compounds. The phytosome technology meets this challenge by markedly enhancing the bioavailability of phytomedicines [5].

MATERIALS AND METHODS

Fresh tomatoes were obtained from local market at Mangalore, natural or synthetic phospholipid, such as phosphatidylcholine, were obtained from media, aprotic solvent, such as dioxane or acetone, n-hexane, ethanol were obtained by Merck chemicals.

Preparation of Lycopene Phytosomes:
The lycopene phytosomes were prepared by Solvent Evaporation, Co-solvency and Salting Out method as perJain S *et al., 2019*[6].

Formulation of Phytosomes: Experimental design
Data fitting to the model and ANOVA

For the factorial model twelve experimental runs Table No. 1 were conducted and the responses for twelve formulations were computed. Range of responses Y_1 for the independent variables % of Soya Phosphotidylcholine was 1% (minimum) and 3% (maximum), % of Lycopene Extract was 1% (minimum) and 3% (maximum) and Method of Formulation with dependent variables % Entrapment efficiency (EE), Partition Coefficient (PC) and % Drug release (CDR). All the ratios were considered for three method of formulation like Solvent Evaporation, Co-Solvency and Salting Out methods. Entrapment efficiency, Determination of solubility by partition coefficient method was done as per Jain S *et al.,* 2019. An *in-vitro* drug release study of the Lycopene Phytosomes was performed as per Ravi *et al.,* 2015[7].Table 1 and Table 2.

RESULTS AND DISCUSSION

Response surface analysis:
A response surface model factorial design with three independent variables was used to study the effect on dependent variables. The dependent variables (% EE, PC & %CDR) obtained at various levels of the three independent variables (A, B & C) were subjected to multiple regression to yield polynomial equation. The response values subjected for this analysis are;
1. Percentage Entrapment Efficiency
2. Partition Coefficient
3. Percentage Drug Release

These responses were chosen for the analysis of the following relationship:
1. To study the effect of percentage of polymer: drug ratio on Entrapment efficiency.
2. To study the effect of percentage of polymer on Partition coefficient.
3. To study the effect of polymer: drug ratio on Drug release.

ANOVA for selected factorial model
Response 1: Percentage Entrapment Efficiency (%EE) (Table 3)
Fit Statistics
The **Predicted R²** of 0.7791 is close to the **Adjusted R²** of 0.9510 as one might normally expect; i.e. the difference is less than 0.2. The R^2 value for selected factorial was 0.9911

Final Equation in Terms of Coded Factors for %EE
Y_1 **(%EE) = +55.17 – 1.00 A+0.667 B+27.08 C [1] -5.17 C [2] +0.8333 AB + 0.7500AC [1]+1.00 AC[2] – 0.4167 BC[1] – 1.17 BC[2]**
Mathematical relationship in the form of polynomial equations for the measured responses obtained with the statistical package Design Expert version 12.0. The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the factors are coded as +1 and the low levels are coded as -1. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients. (Table 3).

To study the effect of percentage of polymer: drug ratio on Entrapment efficiency (Figure 1)
The relationship between the variables was elucidated using response surface (Figure 1). At lower level of A & B the Y_1 (Percentage of Phosphotidylcholine) increased in entrapment efficiency with decrease in the concentration of polymer. At higher level of A & B the Y_1 (Percentage Phosphotidylcholine) decreased in entrapment efficiency with increase in the concentration of polymer. At lower level of A & B the Y_1 (Percentage of Lycopene Extract) decreased in entrapment efficiency with increase in the concentration of extract. At higher level of A & B the Y_1 (Percentage Lycopene Extract) increased in entrapment efficiency with decrease in the concentration of extract.At lower level of A & B the Y_1 (Method of Preparation) decreased in entrapment efficiency with hierarchy in method of preparation like Solvent Evaporation method > Co-Solvency method > Salting out method. At higher level of A & B the Y_1 (Method of Preparation) increased in entrapment efficiency with hierarchy in method of preparation like Solvent Evaporation method > Co-Solvency method > Salting out method.

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Validation of Response Surface Methodology results:
Linearity correlation plots between the observed experimental values and the predicted values are shown in Figure No. 2. Linearity correlation of Predicted verses Actual values found to be good.

Response 2: Partition Coefficient (PC) (Table 3)
Fit Statistics
The **Predicted R²** of 0.9693 is in reasonable agreement with the **Adjusted R²** of 0.9953; i.e. the difference is less than 0.2. The R² value for selected factorial was 0.9991

Final Equation in Terms of Coded Factors for Y$_1$ PC
Y$_1$ (PC) = 0.3817-0.0017 A -0.0017 B + 0.4083 C [1] + 0.2467 C [2] + 0.0083 AB – 0.0033 AC [1] + 0.0067 AC [2] + 0.0067 BC [1] – 0.0083 BC [2].
The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the factors are coded as +1 and the low levels are coded as -1. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients.**(Table 3).**

To study the effect of percentage of polymer: drug ratio on Partition Coefficient
The relationship between the variables was elucidated using response surface (Figure 3). At lower level of A & B the Y$_1$ (Percentage of Phosphotidylcholine) increased in Partition Coefficient with decrease in the concentration of polymer. At higher level of A & B the Y$_1$ (Percentage Phosphotidylcholine) decreased in Partition Coefficient with increase in the concentration of polymer. At lower level of A & B the Y$_1$ (Percentage of Lycopene Extract) increased in Partition Coefficient with decrease in the concentration of extract. At higher level of A & B the Y$_1$ (Percentage Lycopene Extract) decreased in Partition Coefficient with increase in the concentration of polymer.At lower level of A & B the Y$_1$ (Method of Preparation) decreased in Partition Coefficient with hierarchy in method of preparation like Solvent Evaporation method > Salting Out method > Co-Solvency method. At higher level of A & B the Y$_1$ (Method of Preparation) increased in Partition Coefficient with hierarchy in method of preparation like Solvent Evaporation method > Salting Out method > Co-Solvency method.

Validation of Response Surface Methodology results:
Linearity correlation plots between the observed experimental values and the predicted values are shown in Figure 4. Linearity correlation of Predicted verses Actual values found to be good.

Response 3: Percentage Drug Release (%CDR)
Final Equation in Terms of Coded Factors for Y$_1$ %CDR.Y$_1$ (PC) = 0.3817-0.0017 A -0.0017 B + 0.4083 C [1] + 0.2467 C [2] + 0.0083 AB – 0.0033 AC [1] + 0.0067 AC [2] + 0.0067 BC [1] – 0.0083 BC [2].
The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the factors are coded as +1 and the low levels are coded as -1. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients.

To study the effect of percentage of polymer: drug ratio on % Drug Release
The relationship between the variables was elucidated using response surface (Figure 5). At lower level of A & B the Y$_1$ (Percentage of Phosphotidylcholine) increased in % Drug Release with decrease in the concentration of polymer. At higher level of A & B the Y$_1$ (Percentage Phosphotidylcholine) decreased in % Drug Release with increase in the concentration of polymer. At lower level of A & B the Y$_1$ (Percentage of Lycopene Extract) decreased in % Drug Release with increase in the concentration of extract. At higher level of A & B the Y$_1$ (Percentage Lycopene Extract) increased in % Drug Release with decrease in the concentration of polymer. At lower level of A & B the Y$_1$ (Method of Preparation) decreased in % Drug Release with hierarchy in method of preparation like Solvent Evaporation method > Co-Solvency method > Salting out method. At higher level of A & B the Y$_1$ (Method of Preparation)

increased in % Drug Release with hierarchy in method of preparation like Solvent Evaporation method > Co-Solvency method > Salting out method.

Validation of Response Surface Methodology results
Linearity correlation plots between the observed experimental values and the predicted values are shown in Figure 6.Linearity correlation of Predicted verses Actual values found to be good.

Reproducibility of results
Reproducibility of the results were carried out by using numerical optimization. The constraints for optimization selected for independent variable and dependent variable according to table No. 3.The optimization with the goal of maximizing entrapment efficiency with PC in range and targeting drug content to maximum Based upon the constraints explained in table no. 3. Four solutions with desirability near to 1 was suggested by the software explained in Table. 4. Solution No. 1 was selected for reproducibility of results.

Solutions given by the software based on constrains
4 Solutions found. Solutions for 12 combinations of categoric factor levels (Table 5). The experiments done based on solution 1, and the value was observed very near to predicted values according to table No 6& Figure 7 and the % errors was less than 2% which indicates reproducibility of results within the 95% confident interval. As per the results the predicted verses observed it is concluded to get reproducible results. The present study has been a satisfactory attempt to formulate phytosomal nano carriers for enhanced delivery of Lycopene using polymer Soybean phosphatidylcholine. From the reproducible results of the executed experiments, it can be concluded that: The lycopene phytosomes can be prepared by best with Solvent evaporation and less consistent by Co-solvency and Salting method. The entrapment efficiency was better seen in solvent evaporation method compared to co-solvency and salting out method. Solubility Partition coefficient studies: Revealed that the phytosomal nano carriers enhanced the solubility of the drug Lycopene in aqueous layer than organic layer; showing that complexes are more hydrophilic than lipophilic. *In-vitro* drug release studies of the Lycopene Phytosomes: All formulations released the drugs at varying concentration with less release in acidic pH (≤ 10%) with fare release throughout irrespective of variation in entrapment efficiency. Table No: 1 Shows the result.

ACKNWLEDGEMENT

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Table No. 1: Factor Design

Factorial Design		
Independent Variable	-1	+1
Soya Phosphotidylcholine (%)	1%	3%
Lycopene Extract	1%	3%

Table No. 2: Design matrix depicting the experimental runs

Run	Formulation code	Factor 1	Factor 2	Factor 3	Res 1	Res 2	Res 3
1	E1	3.0	1.0	Evaporation	81.57	0.761	82.39
2	E2	1.0	3.0	Evaporation	82.34	0.782	91.37
3	E3	1.0	1.0	Evaporation	83.22	0.812	91.79
4	E4	3.0	3.0	Evaporation	83.11	0.799	91.67
5	C1	1.0	3.0	Co-solvency	51.25	0.127	81.39
6	C2	3.0	1.0	Co-solvency	52.57	0.153	90.37
7	C3	1.0	1.0	Co-solvency	49.34	0.147	90.79
8	C4	3.0	3.0	Co-solvency	50.21	0.145	90.12
9	S1	3.0	1.0	Salting Out	25.24	0.213	71.39
10	S2	1.0	3.0	Salting Out	35.14	0.223	85.37
11	S3	1.0	1.0	Salting Out	37.5	0.230	83.79
12	S4	3.0	3.0	Salting Out	38.12	0.233	84.24

EE-Entrapment Efficiency, PC-Partition Coefficient & CDR-Cumulative Drug Release

Table No. 3: ANOVA summary of Responses Y_1(%EE) and (PC)

Source	STD Dev	R^2	Y_1		
			F value	P – value	
Model for (EE)	4.75	0.9911	24.71	0.0395	SIGNIFICANT
Model for (PC)	0.0208	0.9991	260.64	0.0038	SIGNIFICANT

P-values less than 0.0500 indicate model terms are significant. EE-Entrapment Efficiency, PC-Partition Coefficient

Table No 4: Constraints for Optimization

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
A: Phosphotidyl choline	is in range	1	3	1	1	3
B: Lycopene Extract	is in range	1	3	1	1	3
C: Method of Preparation	is in range	Evaporation	Salting out	1	1	3
%EE	maximize	80	83.22	1	1	3
PC	is in range	0.7	0.812	1	1	3
DR	is target = 85.55	85	91.79	1	1	3

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Table No. 5: Solutions for 12 combinations of categoric factor levels

No	Phosphotidyl choline	Lycopene Extract	Method of Preparation	%EE	PC	% CDR	Desirability	
1	3	1	Evaporation	82.532	0.771	86.597	0.809	Selected
2	1	3	Evaporation	82.532	0.792	86.597	0.809	
3	1	1	Evaporation	82.532	0.802	86.597	0.809	
4	3	3	Evaporation	82.532	0.790	86.597	0.809	

%EE- Entrapment Efficiency, PC-Partition Coefficient, CDR- Cumulative Drug Release.

Table No. 6. Point of Prediction values

Solution 1 of 4 Response	Predicted Mean	Predicted Median	Observed	StdDev	n	SE Pred	95% PI low	95% PI high
%EE	82.53	82.53	81.55	3.46	1	3.87	73.75	91.31
PC	0.771	0.77	0.67	0.02	1	0.02	0.66	0.87
%CDR	86.59	86.59	85.23	4.54	1	4.72	76.19	97.00
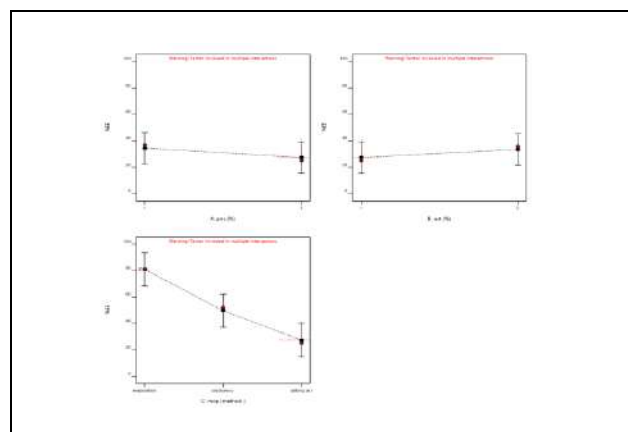
Fig. 1. Relationship between Independent variable on Dependent variables (Entrapment Efficiency)	**Fig. 2. Predicted v/s actual graph of optimized formulation for Entrapment Efficiency**
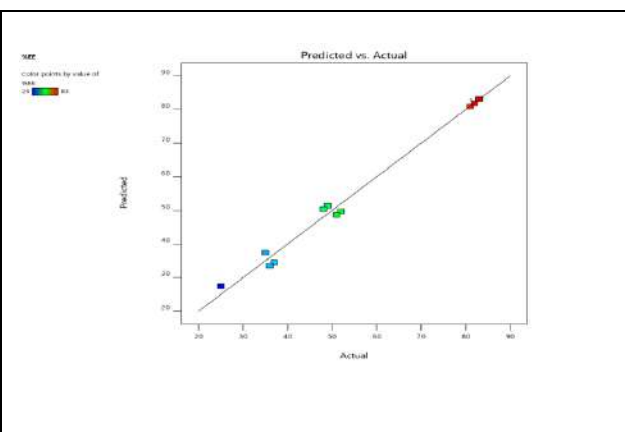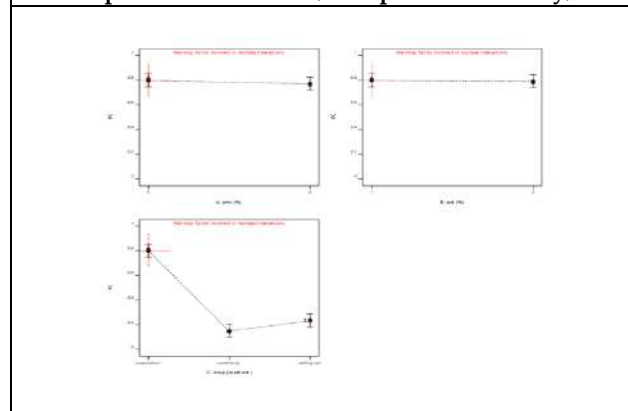
Fig. 3. Response surface plot of A & B on Partition Coefficient.	**Fig. 4: Predicted v/s actual graph of optimized formulation for Partition Coefficient.**
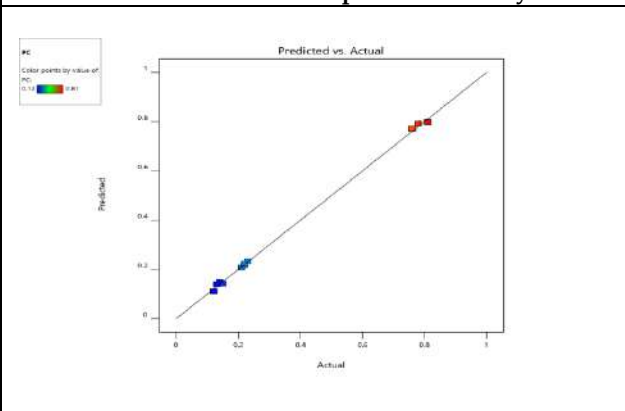
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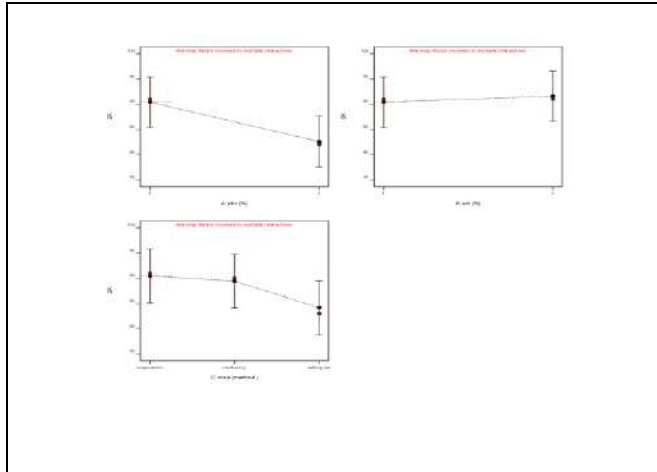
Fig. 5: Response surface plot of A & B on % Drug Release.	**Fig. 6: Predicted v/s actual graph of optimized formulation for Partition Coefficient.**
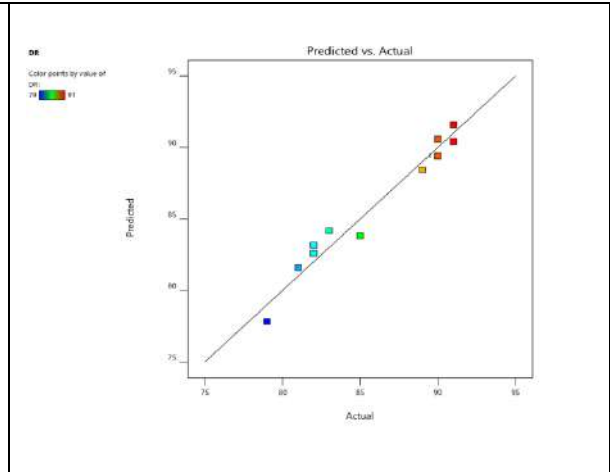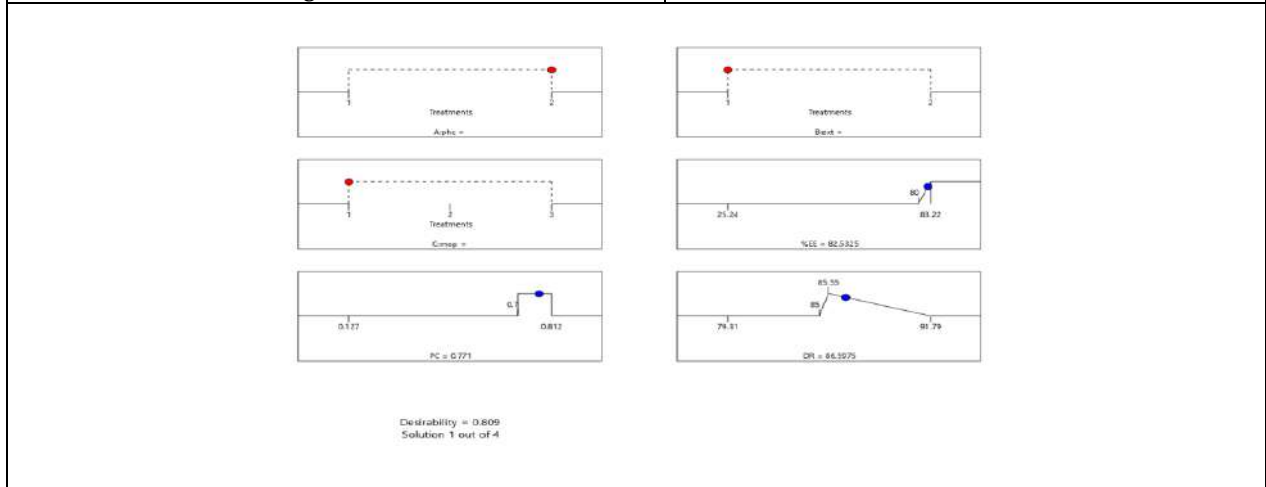
Fig. 7. Graphical representation of solution 1 on Dependent and Independent variable

RESEARCH ARTICLE

Analysis of A Markovian Retrial Queue with Orbital Search and Working Vacation under N-Control Pattern

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ABSTRACT

A Markovian retrial queue with orbital searchand working vacation under N-control pattern are investigated in this article. To describe the system, we employ a QBD analogy. The model's stability condition is deduced. The stationary probability distribution is gotten by utilizing the matrix-analytic technique. The conditional stochastic decomposition of the line length in the orbit is calculated. The performance measures and special cases are designed. The model's firmness is demonstrated numerically.

Keywords: Markovian Retrial Queue, Working Vacation, N-Control Pattern,Conditional Stochastic Decomposition, Orbit Search.

INTRODUCTION

Wallace [23] investigated the Quasi Birth – Death(QBD) process in Queueing Theory using a markov chain with a tridiagonal generator in 1969. Numerical techniques can be used to analyse congestion situations when it is impossible to achieve a explicit solution for queueing problems. The Matrix Geometric technique is ideal for this. Neuts [16] on 1981, Latouche and Ramaswami [9] on 1999 proposed the matrix geometric solution to the *QBD* process. Control policies are important for managing queue levels at different epochs. On 1963 Yardin and Naor [26] first propose the N - policy. The queueing system with attendant vacation is noteworthy, and can be refer in Tian and Zhang [22] (2006). Servi and Finn [21] created a modern vacation policy on 2002, termed as Working Vacation

(WV), where the attendant delivers a lesser rate of service than during the engaged period. Wu and Takagi [25] (2006) worked on M/G/1/MWV. Kalyanaraman and Pazhani Bala Murugan [7] (2008) have worked on the retrial queue with vacation, Pazhani Bala Murugan and Santhi [18](2013) have worked on WV. On (2007) Wen-yuan liu [24] analysed the stochastic decompositions in the M/M/1/WV queue. The M/M/1/WV queue and WV interruptions was analysed by Jihong Li and Naishwo Tian [10] on (2007). On (2008) Naishwo Tian [15] considered M/M/1/SWV queue. Analysis for the M/M/1/MWV queue and N-policy was studied by Zhang-Xu [28] on (2008). On (2015) Qingqing Ye [20] discussed The analysis of the M/M/1 Queue with two vacation policies.

Recently retrial queues have been studied widely and it was different from normal queues. Due to limited waiting space in the retrial queue the customers are forced to stay in the orbit. Whenever the approaching customers finds that the attendant is engaged they join the orbit and requests service from the orbit. On (1993) An M/M/1retrial queue with general retrial times was studied by Choi [2]. The retrial queue and WV was simultaneously considered by Do [4] on (2010). Retrial queues with attendants search of customers from orbit (orbital search) are widely used in telecommunication fields. On 2006 Chakravarthy and Krishnamoorthy *et al.* [3] investigated analysis of a multi-server retrial queue with orbit search. Pazhani Bala Murugan and Vijaykrishnaraj [19] studied an M^x /G/1 retrial queue with orbital search and exponentially distributed MWV on 2019. Juntong Li *et a*l.[6] investigated an M/M/1 retrial queue with WV orbit search and balking on 2019.We consider the M/M/1 retrial queue with orbital search and WV under N- control pattern. The following are the categories for this article. We present the model and find the infitesimal generator matrix in segment 2. The stability condition and Rate matrix(R) is computed in segment 3. In segment 4, we use a matrix-analytic technique to derive the stationary probability distribution. The line length's conditional stochastic decomposition is computed in segment 5. In part segment 6 we calculate performance measures. The special cases is presented in segment 7 and segment 8 has a firmness of the model. The conclusion is given in segment 9.

QBD PROCESS MODEL
We examine a markovian retrial queue with WV and orbital searchunder N-control pattern. With the parameter λ, the customer's inter-approach times are exponentially distributed. A Poisson process with rate α governs request retrials from the infinite-sized orbit. The attendant will take a WV when the system gets clear, which is exponentially distributed with parameterθ. The service is exponentially distributed with parameters μ at the time of the regular busy period. When comparing to the service offered throughout engaged period, the service provided at the time of the vacation is at a slower rate. WV service is exponentially distributed with parameters η ($\eta < \mu$). At the termination of the service, if the attendant identifies not less than N customers in the orbit, the attendant will terminates WV and return to engaged period. Otherwise, the attendant will start another vacation.After finishing the service the attendant searches for any customers in the orbit with probability p($0 \leq$ p $\leq$1), otherwise stays inactive with complementary probability q(=1-p). We presume that the search time is insignificant. Inter-approach times, inter-retrial periods, service periods, and vacation periods are all presumed to be independent of one another. Let the number of customers in the orbit at time t is indicated by Q(t) and H(t) represent attendant's condition at time t. The single attendant might exist in four different states at timet.

$$H(t) = \begin{cases} 0 - \text{attendant is on WV and is unoccupied} \\ 1 - \text{attendant is on WV and is engaged} \\ 2 - \text{attendant is on engaged period and is unoccupied} \\ 3 - \text{attendant is on engaged period and is engaged} \end{cases}$$

Evidently $\{(Q(t), H(t)): t \geq 0\}$ is a Markov process with state space
$\Omega = \{(m, h): m \geq 0, h = 0,1,2,3\}$.

The states infinitesimal generator can be described by employing *lexicographical sequence* as follows

$$\tilde{Q} = \begin{bmatrix} D_0 & F & & & & & & \\ E & D_1 & F & & & & & \\ & E & D_1 & F & & & & \\ & & E & D_1 & F & & & \\ & & & \vdots & \vdots & \vdots & & \\ & & & & E & D_1 & F & \\ & & & & & E & D & F \\ & & & & & & E & D & F \\ & & & & & & & \vdots & \vdots & \vdots \end{bmatrix}$$

Where

$$D_0 = \begin{bmatrix} -\lambda & \lambda & 0 & 0 \\ \eta & -\eta-\lambda & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \mu & 0 & 0 & -\mu-\lambda \end{bmatrix} \qquad F = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & \lambda & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \lambda \end{bmatrix}$$

$$D_1 = \begin{bmatrix} -\alpha-\lambda & \lambda & 0 & 0 \\ q\eta & -\eta-\lambda & 0 & 0 \\ 0 & 0 & -\alpha-\lambda & \lambda \\ 0 & 0 & q\mu & -\mu-\lambda \end{bmatrix} \qquad E = \begin{bmatrix} 0 & \alpha & 0 & 0 \\ 0 & p\eta & 0 & 0 \\ 0 & 0 & 0 & \alpha \\ 0 & 0 & 0 & p\mu \end{bmatrix}$$

$$D = \begin{bmatrix} -\alpha-\lambda-\theta & \lambda & \theta & 0 \\ q\eta & -\lambda-\eta-\theta & 0 & \theta \\ 0 & 0 & -\alpha-\lambda & \lambda \\ 0 & 0 & q\mu & -\mu-\lambda \end{bmatrix}$$

Due to the block structure of matrix $\tilde{Q}$, $\{(Q(t), H(t)): t \geq 0\}$ is called a QBD process.
Pr{that the attendant is engaged and does not offer a service to a customer while there is no customer in the orbit}= 0.

THE MODEL'S STABILITY CONDITION AND *R*

Theorem 1: The QBD process $\{(Q(t), H(t)): t \geq 0\}$ is $(+)^{ve}$ recurrent $\Leftrightarrow \mu(p\lambda + \alpha) > \lambda(\lambda + \alpha)$.
Proof: Consider

$$S_m = E+D+F = \begin{bmatrix} -\alpha-\lambda-\theta & \alpha+\lambda & \theta & 0 \\ q\eta & (p-1)\eta-\theta & 0 & \theta \\ 0 & 0 & -\alpha-\lambda & \alpha+\lambda \\ 0 & 0 & q\mu & (p-1)\mu \end{bmatrix}$$

"Theorem 7.3.1" in [9] offers requirement for $(+)^{ve}$ recurrence of the QBD process, because matrix S_m is reducible. After permutation of rows and columns and hencethe QBD is $(+)^{ve}$ recurrent $\Leftrightarrow$

$$\pi \begin{bmatrix} 0 & \alpha \\ 0 & p\mu \end{bmatrix} e > \pi \begin{bmatrix} 0 & 0 \\ 0 & \lambda \end{bmatrix} e$$

Here all the elements of the column vector e = 1 and π is the unique solution of the system

$$\pi \begin{bmatrix} -\alpha-\lambda & \alpha+\lambda \\ q\mu & (p-1)\mu \end{bmatrix} = 0, \pi e = 1.$$ The QBD process is $(+)^{ve}$ recurrent $\Leftrightarrow \mu(p\lambda + \alpha) > \lambda(\lambda + \alpha)$ after some algebraic manipulations.

Theorem 2 : If $\mu(p\lambda + \alpha) > \lambda(\lambda + \alpha)$, the matrix quadratic equation $R^2E + RD + F = 0$ has the minimal non-negative solution

$$R = \begin{bmatrix} 0 & 0 & 0 & 0 \\ r_1 & r_2 & r_3 & r_4 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & r_5 & r_6 \end{bmatrix}$$

where

$r_1 = \frac{q\eta r_2}{(\lambda+\alpha+\theta)} r_2 = \frac{t-\sqrt{t^2-4\lambda(p\eta\lambda+p\eta\theta+\alpha\eta)(\lambda+\alpha+\theta)}}{2(p\eta\lambda+p\eta\theta+\alpha\eta)}$ where $t = [(\lambda+\alpha+\theta)(\lambda+\theta+\eta) - q\eta\lambda]$

$r_3 = \frac{r_1\theta + r_4 q\mu}{(\lambda+\alpha)} r_4 = \frac{\alpha r_2 r_1\theta + r_1\theta\lambda + r_2\theta(\lambda+\alpha)}{-(\lambda+\alpha)[(r_2+r_6)p\mu + \alpha r_5 - \lambda - \mu] - \alpha r_2 q\mu - q\mu\lambda} r_5 = \frac{\lambda q\mu}{\mu\alpha + \lambda p\mu} r_6 = \frac{\lambda(\lambda+\alpha)}{\mu\alpha + \lambda p\mu}$

Proof: We can consider $R = \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix}$, from the matrices E, D, F where R_{11}, R_{12} and R_{22} are all

2x2 matrices. Substituting R into $R^2E + RD + F = 0$, we get

$$R_{11}^2 \begin{bmatrix} 0 & \alpha \\ 0 & p\eta \end{bmatrix} + R_{11} \begin{bmatrix} -\alpha-\lambda-\theta & \lambda \\ q\eta & -\lambda-\eta-\theta \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & \lambda \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$(R_{11}R_{12} + R_{12}R_{22}) \begin{bmatrix} 0 & \alpha \\ 0 & p\mu \end{bmatrix} + R_{11} \begin{bmatrix} \theta & 0 \\ 0 & \theta \end{bmatrix} + R_{12} \begin{bmatrix} -\alpha-\lambda & \lambda \\ q\mu & -\mu-\lambda \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$R_{22}^2 \begin{bmatrix} 0 & \alpha \\ 0 & p\mu \end{bmatrix} + R_{22} \begin{bmatrix} -\alpha-\lambda & \lambda \\ q\mu & -\mu-\lambda \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & \lambda \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

From the above set of equations with some computations, we get R_{11}, R_{22}, and R_{12} respectively as

$$R_{11} = \begin{bmatrix} 0 & 0 \\ r_1 & r_2 \end{bmatrix}, R_{22} = \begin{bmatrix} 0 & 0 \\ r_5 & r_6 \end{bmatrix} \text{and } R_{12} = \begin{bmatrix} 0 & 0 \\ r_3 & r_4 \end{bmatrix}.$$

THE MODEL'S STATIONARY PROBABILITY DISTRIBUTION
If $\mu(p\lambda+\alpha) > \lambda(\lambda+\alpha)$, assign(Q, H) be the stationary probability distribution of the process {(Q(t), H(t): t≥0)}. Represent,

$\pi_m = (\pi_{m,0}, \pi_{m,1}, \pi_{m,2}, \pi_{m,3}) m \geq 0;$

$\pi_{m,h} = P\{Q = m, H = h\} = \lim_{t\to\infty} P\{Q(t) = m, H(t) = h\}, (m,h) \in \Omega.$
It's worth noting that $\pi_{0,2} = 0$ from states we discussed previously.

Theorem 3: If $\mu(p\lambda+\alpha) > \lambda(\lambda+\alpha)$, the stationary probability distribution of (Q, H) is indicated by

$$\pi_{m,0} = \pi_{N-1,1} r_1 r_2^{m-N} \qquad\qquad m \geq N \qquad\qquad (1)$$

$$\pi_{m,1} = \pi_{N-1,1} r_2^{m+1-N} \qquad\qquad m \geq N \qquad\qquad (2)$$

$$\pi_{m,2} = \pi_{N-1,1}\left[r_3 r_2^{m-N} + \frac{r_4 r_5}{r_6 - r_2}\left(r_6^{m-N} - r_2^{m-N}\right)\right] + \pi_{N-1,3} r_5 r_6^{m-N} \qquad m \geq N \qquad (3)$$

$$\pi_{m,3} = \pi_{N-1,1}\frac{r_4}{r_6-r_2}\left(r_6^{m+1-N} - r_2^{m+1-N}\right) + \pi_{N-1,3} r_6^{m+1-N} \qquad m \geq N \qquad (4)$$

$$\pi_{m,0} = \frac{q\eta}{\lambda+\alpha}\pi_{0,1} + \frac{q\eta}{\lambda+\alpha}\left(\pi_{1,1}-\pi_{0,1}\right)\frac{1-q_1^m}{1-q_1} \qquad 2 \le m \le N-2 \qquad (5)$$

$$\pi_{m,1} = \pi_{0,1} + \left(\pi_{1,1}-\pi_{01}\right)\frac{1-q_1^m}{1-q_1} \qquad 2 \le m \le N-2 \qquad (6)$$

$$\pi_{m,2} = \frac{q\mu}{\lambda+\alpha}\pi_{0,3} + \frac{q\mu}{\lambda+\alpha}\left(\pi_{1,3}-\pi_{0,3}\right)\frac{1-q_2^m}{1-q_2} \qquad 2 \le m \le N-2 \qquad (7)$$

$$\pi_{m,3} = \pi_{0,3} + \left(\pi_{1,3}-\pi_{0,3}\right)\frac{1-q_2^m}{1-q_2} \qquad 2 \le m \le N-2 \qquad (8)$$

$$\pi_{N-1,0} = \frac{-\lambda q\eta}{[\lambda q\eta+(r_1\alpha+r_2 p\eta-\lambda-\eta)(\lambda+\alpha)]}\pi_{N-2,1} \qquad (9)$$

$$\pi_{N-1,1} = \frac{\lambda+\alpha}{q\eta}\pi_{N-1,0} \qquad (10)$$

$$\pi_{N-1,2} = \frac{\lambda q\mu}{\mu\alpha+\lambda p\mu}\pi_{N-2,3} + \frac{q\mu}{\mu\alpha+\lambda p\mu}(r_3\alpha+r_4 p\mu)\pi_{N-1,1} \qquad (11)$$

$$\pi_{N-1,3} = \frac{\lambda+\alpha}{q\mu}\pi_{N-1,2} \qquad (12)$$

where $\quad q_1 = \frac{\lambda(\lambda+\alpha)}{\alpha\eta+\lambda p\eta} \qquad$ and $\qquad q_2 = \frac{\lambda(\lambda+\alpha)}{\alpha\mu+\lambda p\mu}$

$$\pi_{1,1} = -K^{-1}\left[\frac{q\eta\lambda+\lambda(\lambda+\alpha)}{(\lambda+\alpha)} + \Delta - K\right]\pi_{0,1} \qquad (13)$$

$$\pi_{1,0} = \frac{q\eta}{\lambda+\alpha}\pi_{1,1} \qquad (14)$$

$$\pi_{0,0} = \frac{\lambda+\eta}{\lambda}\pi_{0,1} - \frac{\alpha}{\lambda}\pi_{1,0} - \frac{p\eta}{\lambda}\pi_{1,1} \qquad (15)$$

$$\pi_{0,3} = \frac{\lambda}{\mu}\pi_{0,0} - \frac{\eta}{\mu}\pi_{0,1} \qquad (16)$$

$$\pi_{1,2} = \frac{\lambda+\mu}{\alpha}\pi_{0,3}\,\frac{p\mu}{\alpha}\pi_{1,3} \qquad (17)$$

$$\pi_{1,3} = \frac{\lambda+\alpha}{q\mu}\pi_{1,2} \qquad (18)$$

where $\Delta = \frac{-[q\eta\lambda\alpha+\lambda(\lambda+\alpha)p\eta]}{[\lambda q\eta+(r_1\alpha+r_2 p\eta-\lambda-\eta)(\lambda+\alpha)]} - \lambda - \eta$ and

$$K = \left[\lambda\frac{1-q_1^{N-3}}{1-q_1} + \left(\Delta + \frac{\lambda q\eta}{\lambda+\alpha}\right)\frac{1-q_1^{N-2}}{1-q_1}\right]$$

The normalization condition can finally be used to determine $\pi_{0,1}$.

Proof: Using the technique from [16], we have
$$\pi_m = (\pi_{m,0},\pi_{m,1},\pi_{m,2},\pi_{m,3}) = \pi_{N-1}R^{m+1-N}$$

$$= (\pi_{N-1,0},\pi_{N-1,1},\pi_{N-1,2},\pi_{N-1,3})R^{m+1-N}, \quad m \ge N.$$

For $m \ge N$,

$$R^{m+1-N} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ r_1 r_2^{m-N} & r_2^{m+1-N} & r_3 r_2^{m-N} + \frac{r_4 r_5}{r_6-r_2}(r_6^{m-N} - r_2^{m-N}) & \frac{r_4}{r_6-r_2}(r_6^{m+1-N} - r_2^{m+1-N}) \\ 0 & 0 & 0 & 0 \\ 0 & 0 & r_5 r_6^{m-N} & r_6^{m+1-N} \end{bmatrix}$$

substituting R^{m+1-N} into the above equation, we get $(1-4)$.

However, $\pi_0, \pi_1, \ldots, \pi_{N-1}$ satisfies the equation $(\pi_0, \pi_1, \ldots, \pi_{N-1})B[R]=0$,

where

$$B[R] = \begin{bmatrix} D_0 & F & & & & \\ E & D_1 & F & & & \\ & E & D_1 & F & & \\ & & \vdots & \vdots & & \vdots \\ & & E & D_1 & & F \\ & & & E & & RE + D_1 \end{bmatrix}$$

and,

$$RE + D_1 = \begin{bmatrix} -(\lambda+\alpha) & \lambda & 0 & 0 \\ q\eta & r_1\alpha + r_2 p\eta - \lambda - \eta & 0 & r_3\alpha + r_4 p\mu \\ 0 & 0 & -(\lambda+\alpha) & \lambda \\ 0 & 0 & q\mu & r_5\alpha + r_6 p\mu - \lambda - \mu \end{bmatrix}$$

The following equations are computed from B[R]

$$-\lambda\pi_{0,0} + \eta\pi_{0,1} + \mu\pi_{0,3} = 0 \tag{19}$$

$$\lambda\pi_{0,0} - (\lambda+\eta)\pi_{0,1} + \alpha\pi_{1,0} + p\eta\pi_{1,1} = 0 \tag{20}$$

$$-(\lambda+\mu)\pi_{0,3} + \alpha\pi_{1,2} + p\mu\pi_{1,3} = 0 \tag{21}$$

$$-(\lambda+\alpha)\pi_{m,0} + q\eta\pi_{m,1} = 0 \quad 1 \le m \le N-2 \tag{22}$$

$$\lambda\pi_{m-1,1} + \lambda\pi_{m,0} - (\lambda+\eta)\pi_{m,1} + \alpha\pi_{m+1,0} + p\eta\pi_{m+1,1} = 0 \quad 1 \le m \le N-2 \tag{23}$$

$$-(\lambda+\alpha)\pi_{m,2} + q\mu\pi_{m,3} = 0 \quad 1 \le m \le N-2 \tag{24}$$

$$\lambda\pi_{m-1,3} + \lambda\pi_{m,2} - (\lambda+\mu)\pi_{m,3} + \alpha\pi_{m+1,2} + p\mu\pi_{m+1,3} = 0 \quad 1 \le m \le N-2 \tag{25}$$

$$-(\lambda+\alpha)\pi_{N-1,0} + q\eta\pi_{N-1,1} = 0 \tag{26}$$

$$\lambda\pi_{N-2,1} + \lambda\pi_{N-1,0} + (r_1\alpha + r_2 p\eta - \lambda - \eta)\pi_{N-1,1} = 0 \tag{27}$$

$$-(\lambda+\alpha)\pi_{N-1,2} + q\mu\pi_{N-1,3} = 0 \tag{28}$$

$$\lambda\pi_{N-2,3} + (r_3\alpha + r_4 p\mu)\pi_{N-1,1} + \lambda\pi_{N-1,2} + (r_5\alpha + r_6 p\mu - \lambda - \mu)\pi_{N-1,3} = 0 \tag{29}$$

From (19) to (29), we get (5) to (18), where $\sum_{h=0}^{3} \sum_{m=0}^{\infty} \pi_{m,h} = 1$, finally we can get $\pi_{0,1}$.

THE MODEL'S CONDITIONAL STOCHASTIC DECOMPOSITION

Lemma 1: $\mu(p\lambda + \alpha) > \lambda(\lambda + \alpha)$, let Q_0 be the conditional line length of an M/M/1 retrial queue with orbital search in the orbit where the attendant is engaged, then Q_0 has a PGF

$$G_{Q_0}(z) = \frac{1 - r_6}{1 - r_6 z}$$

Proof: Consider a Markovian retrial queue with orbit search. Two inter-valued random variables are used to explain the system at at time t. Let $Q^{\bullet}(t)$ be the number of customers in the orbit at time t,

$$H^{\bullet}(t) = \begin{cases} 0 \text{ - attendant is unoccupied} \\ 1 \text{ -attendant is engaged} \end{cases}$$

Then $\{(Q^{\bullet}(t), H^{\bullet}(t)): t \geq 0\}$ is a Markov process with state space $\{(m, h): m \geq 0, h = 0,1\}$. The infinitesimal generator can be expressed as

$$\widetilde{Q^{\bullet}} = \begin{bmatrix} D_0 & F & & \\ E & D & F & \\ & E & D & F \\ & \vdots & \vdots & \vdots \end{bmatrix}$$

where

$$D_0 = \begin{bmatrix} -\lambda & \lambda \\ \mu & -\mu - \lambda \end{bmatrix} F = \begin{bmatrix} 0 & 0 \\ 0 & \lambda \end{bmatrix} E = \begin{bmatrix} 0 & \alpha \\ 0 & p\mu \end{bmatrix} D = \begin{bmatrix} -\alpha - \lambda & \lambda \\ q\mu & -\mu - \lambda \end{bmatrix}$$

The QBD process $\{(Q^{\bullet}(t), H^{\bullet}(t)); t \geq 0\}$ is $(+)^{ve}$ recurrent $\mu(p\lambda + \alpha) > \lambda(\lambda + \alpha)$, Express

$$\pi_{m,h} = P\{Q^{\bullet} = m, H^{\bullet} = h\} = \lim_{t \to \infty} P\{Q^{\bullet}(t) = m, H^{\bullet}(t) = h\}$$

The stationary probability distribution is

$$\widetilde{\pi}_{m,0} = \widetilde{\pi}_{0,1} r_5 r_6^{m-1}, \qquad m \geq 1$$

$$\widetilde{\pi}_{m,1} = \widetilde{\pi}_{0,1} r_6^m, \qquad m \geq 0$$

$$\widetilde{\pi}_{0,0} = \left[1 + \frac{1 + r_5}{1 - r_6} \frac{\lambda}{\mu}\right]^{-1}$$

$$\widetilde{\pi}_{0,1} = \frac{\lambda}{\mu} \widetilde{\pi}_{0,0}$$

The normalization condition is used to determine the value of $\pi_{0,0}$.

$$G_{Q_0}(z) = \sum_{m=0}^{\infty} z^m P\{Q_0 = m\} = \frac{\sum_{m=0}^{\infty} \widetilde{\pi}_{0,1} r_6^m z^m}{\sum_{m=0}^{\infty} \widetilde{\pi}_{0,1} r_6^m} = \frac{1 - r_6}{1 - r_6 z}$$

Establishing Q^N = {Difference of Q and N such that the state of the attendant is either 1 or 3 and $Q \geq N$} and Q^N is the line length which depends on the condition that the attendant is engaged and there are atleast N customers in the orbit.

Let $P_b^{\bullet}$ denotes that Pr{the server is occupied given that atleast N customers present in the orbit}.

$$P_b^{\bullet} = P\{Q \geq N, H = 1 \text{ or } 3\} = \sum_{m=N}^{\infty} \pi_{m,1} + \sum_{m=N}^{\infty} \pi_{m,3}$$

$$= \sum_{m=N}^{\infty} \pi_{N-1,1} r_2^{m+1-N} + \sum_{m=N}^{\infty} \frac{r_4}{r_6 - r_2}(r_6^{m+1-N} - r_2^{m+1-N})\pi_{N-1,1} + \sum_{m=N}^{\infty} r_6^{m+1-N}\pi_{N-1,3}$$

$$= \frac{r_4 + r_2(1 - r_6)}{(1 - r_2)(1 - r_6)}\pi_{N-1,1} + \frac{r_6}{(1 - r_6)}\pi_{N-1,3}.$$

Theorem 4: If $\alpha(p\mu - \lambda) > \lambda(q\mu + \lambda)$, then we can disintegrate $Q^N = Q_o + Q_c$, where Q_o go along with a geometric distribution with specification $1 - r_6$. Subsidiary line length Q_c has a distribution

$$P\{Q_c = 0\} = \frac{1}{P_b^\bullet} \cdot \frac{(r_2 + r_4)\pi_{N-1,1} + r_6\pi_{N-1,3}}{1 - r_6}$$

$$P\{Q_c = m\} = \frac{\pi_{N-1,1}}{P_b^\bullet} \frac{r_2(r_2 + r_4 - r_6)}{1 - r_6} r_2^{m-1}, \qquad m \geq 1.$$

Proof: The PGF of Q^N is given below:

$$G_{Q^N}(z) = \sum_{m=0}^{\infty} z^m P\{Q^N = m\} = \frac{1}{p_b^\bullet}\left[\sum_{m=0}^{\infty} z^m \pi_{N+m,1} + \sum_{m=0}^{\infty} z^m \pi_{N+m,3}\right]$$

$$= \frac{1}{p_b^\bullet}\left[\pi_{N-1,1}\frac{r_2}{1 - r_2 z} + \pi_{N-1,1}\frac{r_4}{(1 - r_2 z)(1 - r_6 z)} + \pi_{N-1,3}\frac{r_6}{1 - r_6 z}\right]$$

$$= \frac{1}{p_b^\bullet}\left[\frac{1 - r_6}{1 - r_6 z}\right]\left[\pi_{N-1,1}\frac{r_2(1 - r_6 z)}{(1 - r_2 z)(1 - r_6)} + \pi_{N-1,1}\frac{r_4}{(1 - r_2 z)(1 - r_6)} + \pi_{N-1,3}\frac{r_6}{1 - r_6}\right]$$

$$= \frac{1}{p_b^\bullet}\left[\frac{1 - r_6}{1 - r_6 z}\right]\left[\frac{(r_2 + r_4)\pi_{N-1,1} + r_6\pi_{N-1,3}}{1 - r_6} + \pi_{N-1,1}\frac{r_2(r_2 + r_4 - r_6)z}{(1 - r_2 z)(1 - r_6)}\right]$$

$$= \left[\frac{1 - r_6}{1 - r_6 z}\right]\left[\frac{1}{p_b^\bullet}\frac{(r_2 + r_4)\pi_{N-1,1} + r_6\pi_{N-1,3}}{1 - r_6} + \pi_{N-1,1}\frac{1}{p_b^\bullet}\frac{r_2(r_2 + r_4 - r_6)z}{(1 - r_2 z)(1 - r_6)}\right]$$

$$= G_{Q_o}(z)G_{Q_c}(z)$$

THE MODEL'S PERFORMANCE MEASURES

By a known fact

$$\Pr\{\text{that the attendant is engaged}\} = P_b = \sum_{m=0}^{\infty} \pi_{m,1} + \sum_{m=0}^{\infty} \pi_{m,3}$$

$$= (N - 1)\left(\frac{\pi_{1,1}}{1 - q_1} - \frac{q_1\pi_{0,1}}{1 - q_1}\right) - \frac{\pi_{1,1} - \pi_{0,1}}{(1 - q_1)^2}\left(1 - q_1^{N-1}\right)$$

$$+ (N - 1)\left(\frac{\pi_{1,3}}{1 - q_2} - \frac{q_2\pi_{0,3}}{1 - q_2}\right) - \frac{\pi_{1,3} - \pi_{0,3}}{(1 - q_2)^2}\left(1 - q_2^{N-1}\right)$$

$$+ \frac{1 - r_6 + r_4}{(1 - r_2)(1 - r_6)}\pi_{N-1,1} + \frac{1}{1 - r_6}\pi_{N-1,3}$$

$$\Pr\{\text{that the attendant is unoccupied}\} = P_f = \sum_{m=0}^{\infty} \pi_{m,0} + \sum_{m=1}^{\infty} \pi_{m,2} = 1 - P_b$$

Assume that L denotes the number of customers in the orbit, subsequently

$$E[L] = \sum_{m=1}^{\infty} m(\pi_{m,0} + \pi_{m,1} + \pi_{m,2} + \pi_{m,3})$$

$$= \sum_{m=1}^{N-1} m(\pi_{m,0} + \pi_{m,2}) + \sum_{m=1}^{N-2} m(\pi_{m,1} + \pi_{m,3})$$

$$+ (N-1)\pi_{N-1,1} \frac{(1 + r_1 + r_3)(1 - r_6) + r_4(1 + r_5)}{(1 - r_2)(1 - r_6)}$$

$$+ (N-1)\pi_{N-1,3} \frac{1 + r_5}{1 - r_6} + \pi_{N-1,3} \frac{r_5 + r_6}{(1 - r_6)^2}$$

$$+ \pi_{N-1,1} \frac{(r_1 + r_2 + r_3)(1 - r_6)^2 + r_4 r_5(2 - r_2 - r_6) + r_4(1 - r_2 r_6)}{(1 - r_6)^2(1 - r_2)^2}$$

Let L_s be the number of customers in the system, subsequently

$$E[L_s] = \sum_{m=1}^{\infty} m(\pi_{m,0} + \pi_{m,2}) + \sum_{m=0}^{\infty} (m+1)(\pi_{m,1} + \pi_{m,3})$$

We have the following assumptions and results.

Let
W − orbit customer's waiting time

$E[W_s]$ − expected stopover time of orbit customer in the system

T − engaged period.

Then $E[W] = \frac{E[L]}{\lambda}$, $E[W_s] = \frac{E[L_s]}{\lambda}$, and $\pi_{0,0} = \frac{E[T_{0,0}]}{E[T] + 1/\lambda}$

Where $E[T_{0,0}]$- absolute time in the idle state throughout a regenerative cycle.

Also $E[T_{0,0}] = \frac{1}{\lambda}$, $E[T] = (\pi_{0,0}^{-1} - 1)\lambda^{-1}$.

SPECIAL CASES

(a) If p = 0 and q = 1 this model is remodeled as "An M/M/1 retrial queue with working vacation under N-policy".
(b) If $\alpha \to \infty$ this model isremodelled as "An M/M/1 queue with multiple working vacations under N-policy".
(c) If $\alpha \to \infty$, $\eta = 0$ this model is remodeled as"An M/M/1 queue with multiple vacation under N-policy".
(d) If $\alpha \to \infty$, $\eta = 0$, $\theta = 0$ this model be remodeled as "An M/M/1 queue under N-policy".

NUMERICAL RESULTS

By fixing the values of N = 2, μ = 6.8, θ = 2.1, η = 1.3,p = 0.6, q = 0.4, α = 1.2and extending the values of λ from 1.0 to 2.0 incremented with 0.2 and extending the values of αfrom1.2 to 3.2 insteps 1 of subject to the stability condition the values of E(L) are calculated and tabulated in Table 1 and the corresponding line graphs are drawn in the Figure 2 . From the graph it is inferred that as αrises E(L) rises as expected. By fixing the values of N = 2, μ = 8.6, θ = 1.4, η = 0.2,p = 0.3, q = 0.7,α = 2and extending the values of λ from 1.0 to 2.0 incremented with 0.2 and extending the values of ηfrom0.2 to 2.2 insteps 1 of subject to the stability condition the values of E(L) are calculated and tabulated in Table 2 and the corresponding line graphs are drawn in the Figure 3 . It is inferred from the graph that as ηrises E(L) rises as expected.By fixing the values of N = 2, μ = 6.8, θ = 1.8, η = 0.8,p = 0.7, q = 0.3and α = 0.4and extending the values of λ from 1.0 to 2.0 incremented with 0.2 and extending the values of αfrom0.4 to 1.2 insteps 0.4 of subject to the stability condition the values of P_b are calculated and tabulated in Table 3 and the corresponding line graphs are drawn in the Figure 4 . It is inferred from the graph that as αrises $P_b$rises as expected.By fixing the values of N = 2, μ = 4.8, θ = 1.2, η = 0.6,p = 0.7, q = 0.3and α = 0.3and extending the values of λ from 1.0 to 2.0 incremented with 0.2 and extending the values of αfrom0.3 to 0.9 insteps 0.3 of subject to the stability condition the values of P_f are calculated and tabulated in Table 4 and the corresponding line graphs are drawn in the Figure 5 . It is inferred from the graph that as αrises P_f falls as expected.

CONCLUSION

In this article, a markovian retrial queuewithWV and orbital searchunder N - control pattern is evaluated. We calculate stability condition and rate matrix of the model. We went on the stationary probability distribution by adopting the matrix-analytic methods. We also derive the conditional stochastic decomposition and performance measures. We perform some special cases. We illustrate some numerical examples under the stability condition

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Table 1: E(L) with turn over of λ

λ	α = 1.2	α= 2.2	α = 3.2
1.0	0.1584	0.1250	0.1090
1.2	0.2174	0.1731	0.1513
1.4	0.2848	0.2286	0.2003
1.6	0.3623	0.2925	0.2567
1.8	0.4516	0.3663	0.3218
2.0	0.5557	0.4518	0.3971

Table 2: E(L) with turn over of λ

λ	η= 0.2	η= 1.2	η= 2.2
1.0	0.2237	0.1688	0.1336
1.2	0.2907	0.2304	0.1889
1.4	0.3647	0.3005	0.2536
1.6	0.4474	0.3804	0.3289
1.8	0.5413	0.4721	0.4168
2.0	0.6493	0.5786	0.5200

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Table 3: Pb with turn over of λ

λ	α = 0.4	α= 0.8	α = 1.2
1.0	0.4063	0.4135	0.4174
1.2	0.4304	0.4387	0.4438
1.4	0.4516	0.4608	0.4667
1.6	0.4711	0.4808	0.4873
1.8	0.4893	0.4994	0.5064
2.0	0.5066	0.5169	0.5243

Table 4: Pf with turn over of λ

λ	α= 0.3	α= 0.6	α= 0.9
1.0	0.5419	0.5337	0.5287
1.2	0.5163	0.5070	0.5009
1.4	0.4924	0.4825	0.4756
1.6	0.4697	0.4594	0.4520
1.8	0.4477	0.4371	0.4293
2.0	0.4262	0.4155	0.4075
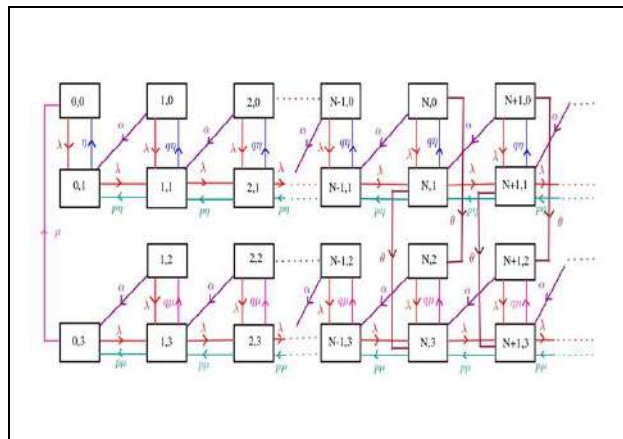
Figure 1: Transition between the states
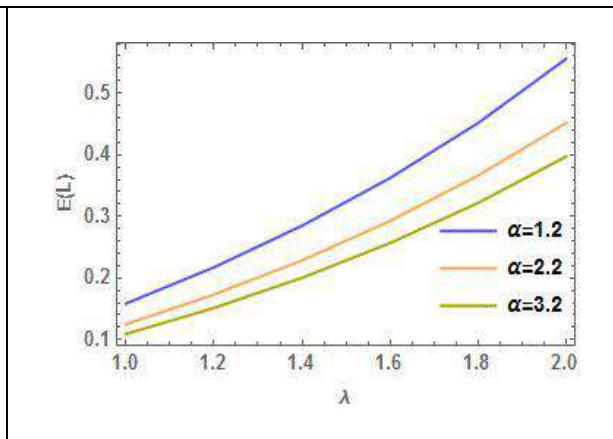
Figure 2: E(L) with turn over of λ
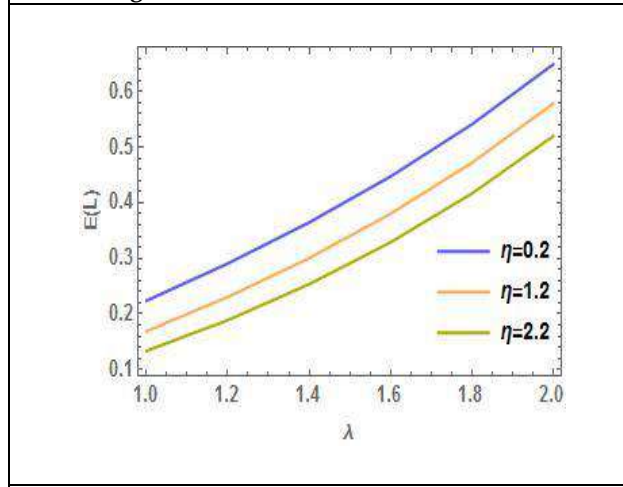
Figure 3: E(L) with turn over of λ
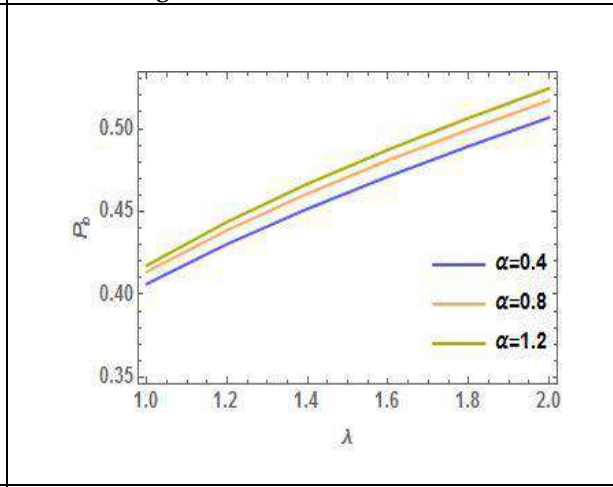
Figure 4: Pb with turn over of λ

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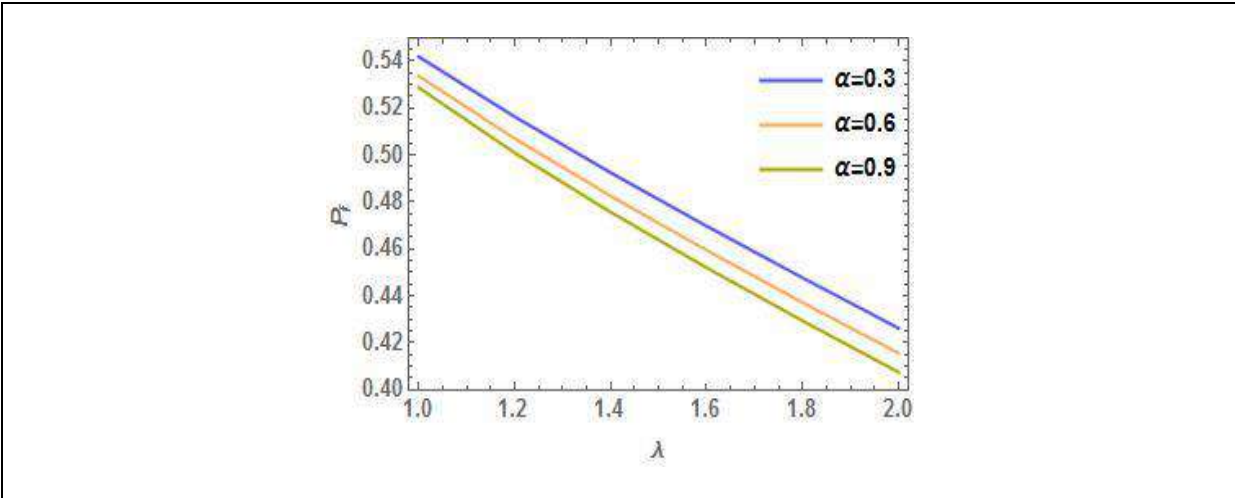
Figure 5: P$_f$ with turn over of λ

RESEARCH ARTICLE

Single Image Super Resolution of Noisy Images

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ABSTRACT

In this paper, a novel learning method for super-resolution of noisy images is proposed. Single image super-resolution is the technique of recovering missing high-resolution details from a single low resolution image (LR) to reconstruct its high resolution image (HR). Correspondences between LR and HR image blocks are learned, and are used in the test low-resolution image to recover the high-resolution version. This paper proposes a new method which jointly perform denoising and super-resolution using lifting based directionlet transform and bilateral filter. This method involves mapping between the low resolution image and the training set, pre-processing using bilateral filter is done here. The new super resolution method is found to be effective for all types of noises used.

Keywords: Directionlet, anisotropic, super resolution, noisy image, bilateral filter

INTRODUCTION

Digital image processing has several applications in surveillance, satellite imaging, forensic science, target identification, diagnostics, etc. These applications need High Resolution (HR) images. It is advantageous when images used in the above applications contain more detailed information. Super resolution techniques are used to convert low resolution images to high resolution images. The super resolved images not only give the user a pleasing appearance but also offer additional data that is important in many applications. The image acquisition environment condition, resolution of sensors, optical technology used are some of the factors that affect the quality of digital image and captured image will be a low resolution image(LR). For example getting high quality images in applications like satellite imaging is difficult since there are many factors like weather, height that cannot be controlled. High quality or HR images mainly depend on manufacturing technology of sensor that tries to increase the number of pixels per unit area by reducing the pixel size. But there is limitation to this pixel size reduction due to shot noise in the sensor itself and high precision optics sensors are too expensive to use for commercial applications. Therefore, some image processing techniques are needed to construct a HR image from one or more available noisy

low resolution (LR) images. LR images can be considered as under-sampled, noisy and blurred versions of the original scene. Super resolution problem is an inverse problem that refers to the process of reconstructing a HR image than what is afforded by the physical sensor through post processing, making use of one or more LR observations [3]. This technique includes up sampling the image, thereby increasing the maximum spatial frequency and removing degradations that arise during the image capture namely aliasing and blurring. Super resolution is proved to be effective in areas including medical imaging, satellite imaging, video applications, image enlarging in web pages and restoration of old historic photographs, tracking, and license plate recognition system, etc. Standard interpolation techniques consider LR image information. They only increase the number of pixels without adding the details and the resulting image is often blurry and contains artifacts. These techniques perform well in smoother regions of the images and tend to blur edges and other sharp details in the images. Here a new learning based single image super resolution method for noisy images is presented. An image is often corrupted by noise in its acquisition, recording and transmission. The performance of sensors is affected by a variety of factors, such as environmental conditions during image acquisition and by the quality of the sensing elements .

For instance, while acquiring images with a CCD camera, light levels and sensor temperatures are major factors affecting the amount of noise in the resulting image. Images are corrupted during transmission principally due to interference in the channel used for transmission. For example, an image transmitted using a wireless network might be corrupted as a result of lightening or other atmospheric disturbances. In many surveillance video applications, it is of interest to recognize a region of interest (ROI), which often occupies a small portion of a low-resolution, noisy video. These random distortions make it difficult to perform the required picture processing. With the exception of spatially periodic noise, noise is independent of spatial coordinates and is uncorrelated with respect to the image itself. That is, there is no correlation between pixel values and values of noise components. Image denoising methods are used to remove the additive noise while retaining as much as possible the important signal features. A new directionlet-based single image super resolution method on noisy images is presented here. In this method a training set or database is used which contains directionlet transform coefficients of high resolution images and their low resolution images. Here noisy input low resolution image is preprocessed by bilateral filter and is decomposed into different frequency bands using directionlet transform. Instead of using convolution based directionlet transform, lifting based method is used to implement directionlet transform. To implement the directionlet transform Directional variance is used. The directionlet coefficients are compared with the corresponding training set coefficients to select the most similar ones. The higher bands of high resolution images are learned from the training set. The low bands are obtained from the low resolution noisy image. The inverse directionlet transform of all these bands gives the super resolved image of the noisy image.

Related work

Many denoising and super resolution methods have been developed over the years. Multi resolution analysis has been proven to be an important tool for eliminating noise in signals. In the paper [4], authors introduced a hybrid interpolation and denoising scheme that leverages noise decreasing property inherent in the image pyramid, thereby minimizing noise amplification in conventional SLSR. In another paper[1], authors showed that high frequency content in the noisy image (which is ordinarily removed by denoising algorithms) can be effectively used to obtain the missing textural details in the HR domain. For this, authors obtained first obtain HR versions of both the noisy and the denoised images, using a patch-similarity based SR algorithm. In the article [2],authors proposed a novel example-based method for denoising and super-resolution of medical images. The main objective was to estimate a high-resolution image from a single noisy low-resolution image, with the help of a given database of high and low-resolution image patch pairs. In the paper[11] authors proposed a super-resolution method for noisy images based on sparse mixing estimators. Sparse mixing estimators were introduced to achieve a directional and sparse representation of noisy low resolution (LR) image. Then, the authors employed the median filter to define thresholds using the local characters of the sparse representation. After the noise is removed by shrinkage thresholds, the adaptive interpolations are adopted to achieve high resolution (HR) image. This paper is organized as follows. In Section 3, the concepts of Directional transform are presented. This section explains concepts of lattice based transform, lifting method and Directional variance to implement directionlet transform. In this section concepts of

bilateral filter and overview of noises are also given. Experimental results with noisy test images and the comparison with cubic spline interpolation method is presented in Section 4. Finally, conclusions are given in Section 5.

Overview
Directionlet transform

The Directionlet Transform (DT) is skewed anisotropic transform. It is an efficient tool compared with standard wavelet transform, for representing images, which contains multiple direction oriented and elongated edges. DT is anisotropic in which transforms are applied along random directions and number of transforms are not equal, that is, n1 in one direction and n2 in other direction, where n1 is not necessarily equal to n2. The iteration process is continued in the lower sub-band, as in the standard wavelet transform to obtain multi level transform. This Anisotropic transform is represented as AWT(n1,n2). When n1 = 2, n2 = 1, the AWT(2,1) produces eight bands AL, AH, HL, HH, VL, VH, DL and DH as in Figure 1. The next level decomposition is obtained by repeating the process in the sub band AL. As already stated the Directionlet Transform is obtained by applying transform in two random directions, not necessarily along horizontal and vertical directions. For this, the transform can be taken on two random digital lines which causes a problem called directional interaction. That is the concept of digital lines is not enough to provide a systematic rule for sub sampling. As already stated the directionlet transform is obtained by applying transform in two random directions, not necessarily along horizontal and vertical directions. For this, the transform can be taken on two random digital lines which causes a problem called directional interaction. That is the concept of digital lines is not enough to provide a systematic rule for sub sampling. To overcome the problem of directional interaction and the concept of integer lattices is proposed by Velisavljevic et al [8].

Lattice based Transform

A full rank integer lattice A can be represented as a collection of points obtained by taking linear combinations of two linearly independent digital lines. The lattice A can be represented by a generator matrix X1 given by;

$$X1 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \qquad\qquad (1)$$

According to lattice theory, it is shown that [5], integer lattice A can be partitioned into det(X1) cosets. Each coset is identified by shift vectors sk, where k = 0, 1, ..., det X1 − 1. Here shift vector determines how much the coset is shifted from origin. Each coset is considered as shifted version of lattice A. Intersection of each coset and digital line is called co-line. The lattice A with the corresponding generator matrix X1, partitions each digital line into co-lines. Lattice based transform is obtained by applying 1-D wavelet transform and sub sampling along co-lines with the first slope m1 for all cosets of the lattice. The process is repeated for the second slope m2. The sub pled corresponding lattice is clearly a sub lattice of the initial one containing a quarter of the samples[9].

Directional variance

For an image information locally varies in different directions. Directionlet transform is an efficient tool and it is obtained by applying transform along colines in selected pair of directions , for that appropriate directions for the image segment must be selected. Here the concept of directional variance is introduced to select the appropriate directions. The directional variance for a given image segment X1, along the lines with rational slope m, is defined as

$$\text{Divariance} = \sum_{i=1}^{n} X1 \qquad\qquad (2)$$

$$v = \sum_{i=1}^{n} \sum_{j=1}^{k} ((Xj - XL(r,i))2 \qquad\qquad (3)$$

where XL(r, i) is the mean of the digital line with slope m and Xj is the pixel in the same line. N is the total number of pixels in the segment X1, n is the total number of lines, and k is the number pixels in line.

Lifting scheme for directionlet transform

The lifting method can be used to represent Directionlet transform [7].

The lifting steps are :

1. Split step : Split the pixels of lattice A located along the transform direction d1, x(n) into two disjoint subsets: the odd and even polyphase samples $x_o(n)$ and $x_e(n)$.

Here $x_e(n) = x(2n)$ and $x_o(n) = x(2n + 1)$.

2. Prediction step: The wavelet coefficients or detail signal d[n] is generated as error in predicting $x_o(n)$ from xe(n) using prediction operator P, by keeping even samples changeless. The difference between the prediction value of $x_o(n)$ and the real value of $x_o(n)$ is defined as the high-frequency component or detail signal

$$d(n) = x_o(n) - P(x_e(n)) \qquad (4)$$

3. Update step: This detail coefficients are used to update even samples xe(n), to obtain the approximate signal which creates the low-frequency component. $x_e(n)$ and d(n) are combined to obtain scaling coefficients c(n) which is a coarse approximation to the original signal x(n). This is done by applying an update operator U to the wavelet coefficients d(n) and adding the result to $x_e(n)$:

$$c(n) = x_e(n) + U(d(n)) \qquad (5)$$

By performing this process along co-lines in all cosets in both directions, the lifting directionlet decomposition is obtained.

Bilateral filter

Bilateral filter is introduced by Tomasi and Manduchi in 1998. The bilateral filter concept is also referred as the SUSAN filter and in as the neighborhood filter. Unlike other traditional filters, the bilateral filter eliminates noise while preserving the edge information. The performance of the bilateral filter depends upon the parameters of the filter. Properties of bilateral filter;

1. It is simple to implement it. in an image segment each pixel is replaced by a weighted average of its neighbors.
2. Filtering process depends only on two parameters that indicate the size and contrast of the features to preserve.
3. Since it is an non-iterative method which makes the parameters easy to set since their effect is not cumulative over several iterations. The bilateral filter takes a weighted sum of pixels in a local neighborhood; the weights depend on both the spatial distance and the intensity distance. In this way, edges are preserved well while noise is averaged out. The bilateral filter is a nonlinear filter that does spatial averaging without smoothing edges; it has shown to be an effective image denoising technique [10], [6].

Noise Overview

Gaussian noise

Because of its mathematical traceability in both the spatial and frequency domains, Gaussian noise models are used frequently in practice. In fact, this traceability is so convenient that it often results in Gaussian models being used in situations where they are marginally applicable at best. The probability density distribution of a Gaussian random variable z, is given by

$$P(z) = 1/\sqrt{2\pi\sigma}\ e^{-z - \mu 2/2\sigma^2}$$

where z represents gray level, μ is the mean or average value of z, and σ is its standard deviation. The standard deviation squared, σ^2 is called the variance of z.

Salt and Pepper Noise(Impulse noise)
The PDF of impulse noise is given by equation P(z) = Pa; for z = a

    = Pb; for z = b

    = 0; otherwise   (7)

If b>a, gray level b will appear as a light dot in the image and level a will appear like a dark dot. Impulse noise will resemble salt and pepper granules randomly distributed over the image. For this reason bipolar noise is also called Salt and Pepper noise.

Speckle Noise
 It is a form of multiplicative noise in which the intensity values of the pixels in the image are multiplied by random values.

Single image super resolution of noisy images using Bilateral filter and lifting based directionlet transform
Since super resolution involves mapping between input image patches and training set patches, the noisy input image is preprocessed by bilateral filter before the process of super resolution. The directionlet transform based super resolution is applied on filtered low resolution input image. It's block diagram is shown in Figure 2. Directionlet transform is applied on input noisy image patches and the high frequency bands HL, HH, VL, VH, DL, DH are learned from the training set. The low frequency bands AL and AH is obtained from LR input image. The inverse directionlet transform gives the almost noise free high resolution image.

IMPLEMENTATION AND DISCUSSIONS

The experiments were done with images with Gaussian noise, Speckle noise and Salt and Pepper noises of different values of standard deviation.

Single image super resolution on images with Gaussian noise
Table 1 shows the SNR values obtained for super resolving different low resolution images with Gaussian noise of standard deviation $\sigma=0.1, 0.2, 0.3$ .From the table it is clear that as noise increases the quality of super resolved image decreases. For example, the SNR values decreases for Butterfly from 23.92dB to 21.031dB as noise in low resolution image increases from $\sigma=0.1$ to 0.3. Figure3 shows the results obtained with Gaussian noise of standard deviations $\sigma=0.3$ respectively. The results were compared with cubic spline interpolated noisy low resolution images. In the cubic spline interpolated image, the low resolution image itself acts as the input to the interpolation process. So it can't remove the blur or noise. But in the super resolution method the missing high frequency bands are learned from the training set which are entirely free of noise. The low frequencies were obtained from the directionlet transform of interpolated version of low resolution image. Thus the noise present in the low resolution image is almost removed by the averaging process of low pass filters in low frequency bands.

Single image super resolution on images with Speckle noise
Table2 shows the SNR values obtained for super resolving different low resolution images with Speckle noise of standard deviation $\sigma=0.1, 0.2, 0.3$. Here also it is clear that as noise increases the quality of super resolved image decreases. For example, the SNR values decreases for Butterfly from 24.59dB to 23.46dB as noise in low resolution image increases from $\sigma=0.1$ to 0.3. Figures 4(a) show low resolution images with Speckle noise $\sigma=0.2$. Super resolved images in Figures 4(c) are better than the cubic spline interpolated images in Figures 4(b) show super resolved images. It is clear that super resolved image is better than cubic spline interpolated images.

Single image super resolution on images with Salt and Pepper noise

Table 3 shows the SNR values obtained for super resolving different low resolution images with Salt and Pepper noise of standard deviation σ=0.1, 0.2, 0.3. The SNR values decreases for Butterfly from 24.39dB to 22.92dB as noise in low resolution image increases from σ=0.1 to 0.3.

CONCLUSION

Here single image super resolution with directionlet method is applied on noisy images. The low resolution noisy images are filtered using bilateral filter before undergoing super resolution process. Experiments are conducted on different images with different types of noises like Gaussian, Speckle, Salt and Pepper with different variance. Results are compared with cubic spline interpolated noisy low resolution images.

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Table 1: SNR values for different low resolution images with Gaussian noise

Images	Method	SNR in dB	
		σ=0.1	σ=0.2
Butterfly	Cubic spline	19.75	18
	Directionlet	23.92	22.54
Barbara	Cubic spline	15.59	14.26
	Directionlet	19.40	17.95

Table 2: SNR values for different low resolution images with speckle noise

Images	Method	SNR in dB	
		σ=0.1	σ=0.2
Butterfly	Cubic spline	20.60	20.12

	Directionlet	24.59	24.05
Barbara	Cubic spline	14.70	14.37
	Directionlet	20.31	19.75

Table 3: SNR values for different low resolution images with Salt and Pepper noise

Images	Method	SNR in dB	
		$\sigma=0.1$	$\sigma=0.2$
Butterfly	Cubic spline	20.402	19.76
	Directionlet	24.39	23.66
Barbara	Cubic spline	14.65	14,30
	Directionlet	20.03	19.51
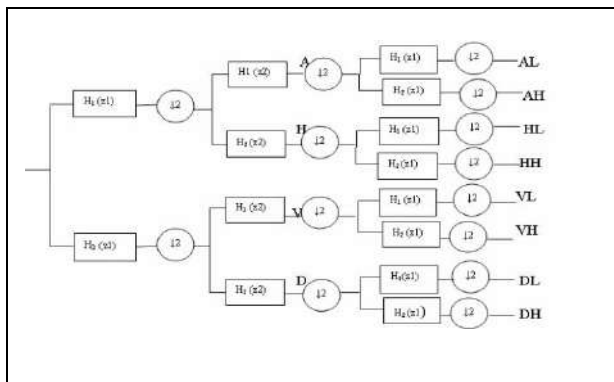
Figure 1: Filtering scheme for the AWT (2,1)
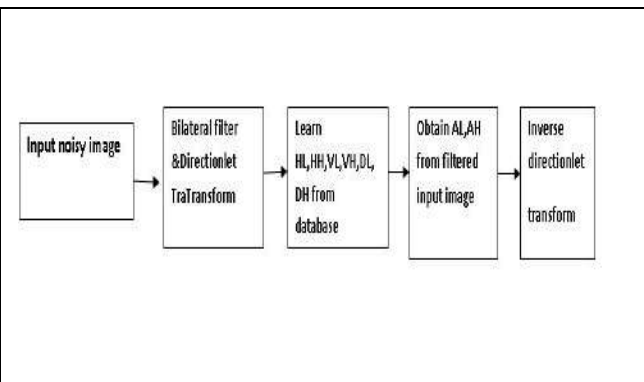
Figure 2: Block diagram of noisy image super resolution using directionlet transform with Bilateral filter for preprocessing

Figure 3: (a) Low resolution image with Gaussian noise (σ=0.2) (b)Cubic spline interpolated image(c) Super resolved images

Figure 4: (a)Low resolution image with Speckle noise(σ=0.2) (b)Cubic spline interpolated image(c)Super resolved image

Figure 5: (a)Low resolution image with Salt and Pepper noise(σ=0.3)(b)Cubic spline interpolated image(c)Super resolved image

RESEARCH ARTICLE

Technical Efficiency of System of Rice Intensification (SRI) and Traditional Method of Paddy Cultivation in Nagapattinam District of Tamil Nadu

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ABSTRACT

Rice is life for millions of people in the world where more than 90% of rice is grown and consumed. For about 65% of the people living in India, Rice is staple food for them. It is the part of every meal, and it is grown on a majority of a rural farms. Nagapattinam district was selected purposively, as it ranked second among the districts of Tamil Nadu in area under paddy (14.64%).The total numbers of respondents were fixed as 120, in consideration of time and other resource limitations. The objectives of the study is to examine the technical efficiency of inputs used pattern in SRI and traditional method of paddy cultivation. The mean technical efficiency SRI and traditional method was estimated at 91% and 86% indicating that output can be raised by 9% and 14% through following inefficient crop management practices without actually increasing the level of application of inputs. The frequency distribution of sample farmers according to different technical efficiency rating of SRI and traditional method of paddy cultivation it is inferred that higher percentage of farmers were falling in more than 90 range of technical efficiency in both method of production of paddy. The study has revealed that among the selected variables, only five factors viz., age, primary education, secondary education, collegiate, paddy transplanter was found significantly influenced on technical efficiency in SRI method.

Keywords: Paddy Cultivation, Traditional Method, SRI Paddy, Input Saving, Technical Efficiency.

INTRODUCTION

Rice is life for millions of people in the world where more than 90% of rice is grown and consumed (Syed Sadaqath, 2016). Rice is one of the most important food crops of India contributing to 43% of total food grains productions in the country. The rice harvesting area in India is the world's largest. Rice is one of the prominent cereal crops in India and it is grown in many regions across in India. For about 65% of the people living in India, Rice is staple food for them. It is the part of every meal, and it is grown on a majority of a rural farms (Meenasulochani *et al.*, 2018).The major rice growing states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadu, Orissa, Bihar & Chhattisgarh, which together contribute about 72% of total area and76% of the total production in the country. Rice is the predominant crop accounting nearly 65% of total irrigated area in Tamil Nadu. Among the production constrains, availability of irrigation water is a major one, since rice is a predominant crop in Tamil Nadu consumes 70% of the water available for agriculture (Pandiyan *et al.*, 2014). In Asia,17 million ha of irrigated rice area may experience "physical water scarcity" and 22 million ha may have "economic water scarcity" by 2025 (Sita Devi and Ponnarasi, 2009). The traditional paddy cultivation was oldest method of rice cultivation. The traditional paddy cultivation practices also had undergone changes due to changing times where, the cumbersome practices were replaced. SRI paddy was introduced in Madagascar for the benefit for all the farmers (Sandhya Shenoy, 2013).

Under this scenario, the system of rice intensification (SRI) may an appropriate practice to produce more food with less inputs. SRI is actually an amalgamation of refined and intensive management practices for rice production at farmer's fields (Barah, 2009). The main component of SRI includes careful transplanting of single young seedlings at wider spacing, water management that keeps the soil moist but not continuously flooded, yearly and frequent mechanical /manual weeding before canopy closure and ensuring adequate nutrients supplies. SRI was tried as an alternative practice to traditional rice cultivation to solve the water crisis and to improve paddy yields in India (Nirmala *et al.*, 2015). The SRI method is based on four components – quick and healthy plant establishment, improved soil condition, weed control and water management. It has several benefits over traditional/conventional method of rice cultivation. The yield of rice is higher in the SRI method over the traditional method but this method is not popular among the cultivators (Vishal Dagar*et al.,* 2015).Technical efficiency was referred as the ability of the firm to produce the maximum possible output from a given set of inputs and technology. Technical efficiency is defined as a given from(at given time period) as the ratio of its mean production (conditional on its levels of factor inputs and firm effect) to the corresponding mean production if the firm utilized its levels of input most efficiently. The objectives of the study is to examine the technical efficiency of inputs used pattern in SRI and traditional method of paddy cultivation in different irrigation systems of Tamil Nadu.

METHODOLOGY

Nagapattinam district was selected purposively, as it ranked second among the districts of Tamil Nadu in area under paddy (14.64 percent). Nagapattinam district consists of eleven blocks viz., Nagapattinam, Thirumarugal, Kilvelur, Keelaiyur, Vedaranyam, Thalainayur, Mayiladuthurai, Kuthalam, Sirkali, Kollidam, and Sembanarkoil. The selection of blocks was done keeping in the mind that farmers of the blocks were growing rice crop using SRI method.   The total numbers of respondents were fixed as 120, in consideration of time and other resource limitations. A list of paddy cultivating farmers in the selected four villages were prepared and they were arranged in the descending order, based on the area under rice cultivation in SRI and traditional method of paddy production. The ultimate sample farms were selected randomly from the list. In each village 15 farmers each were selected from both methods of paddy cultivation.

Measurement of Technical Efficiency Using Stochastic Frontier Production Function Analysis
Analytical tools used in the study were descriptive statistics, stochastic frontier production function and to bit model. The technical efficiency was referred as the ability of the firm to produce the maximum possible output from a given set of inputs and technology. Frontier production function is the maximum feasible or potential output that can be

produced by a production unit such as farm, given level of inputs and technology. Stochastic frontier production was used to analyse the technical efficiency and determinants of efficiency. The stochastic frontier production function for estimating farm level technical efficiency is specified as:

$$Y_i = f(X_i \beta) + \epsilon_i \qquad ....(1)$$

Where i is the nth observations, Yi is output, Xi denotes the actual input vector of production function and β is the vector of parameters of production function and ε is the error term that is composed of two elements, that is

$$\epsilon_i = V_i - U_i \qquad ....(2)$$

Where Vi is the symmetric disturbances assumed to be identical, independently and normally distributed as N (0, σ_{vi}^2) given the stochastic structure of the frontier. The second component Ui is a one-sided error term that is independent of Vi and is normally distributed as (0, σ_{ui}^2), allowing the actual production to short fall below the frontier but without attributing all short falls in output from the frontier as inefficiency. The farm- specific technical efficiency is defined in terms of observed output (Yi) to the corresponding frontier output (Y $*_i$) using the available technology derived which is defined as follows:

$$TE_i = \frac{Y_i}{Y_i} = \frac{E(^{Y_i}/_{u_i X_i})}{E(^{Y_i}/_{u_i=0, X_i})}$$

$$= E[exp^{(-U_i)}/_{\epsilon_i}] \qquad .... \ (3)$$

In measuring the technical efficiency this study assumed that yield of paddy production (Kg) is dependent on farm size (ha), quantity of seeds (Kg), chemical fertilizers (Kg), organic fertilizers (t), plant protection chemicals (Lit), labor (man day), irrigation (no.) and machinery usage (hr). The stochastic frontier model was specified as,

$$\ln(Y) = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + (V_i - U_i) \ ...(4)$$

Where,
Y= paddy yield per season per hectare (Kg)
X_1= farm size (ha)
X_2 = quantity of seed per hectare (kg)
X_3 = quantity of chemical fertilizers per hectare (kg)
X_4 = quantity of organic fertilizers per hectare (tones)
X_5 =quantity of plant protection chemicals (litre)
X_6 =labour per hectare (man day)
X_7 =irrigation per hectare (numbers)
X_8 =machineries usage per hectare (hours)
β_0 = constant
β_0 - β_8 = Coefficient of independent variable X_1-X_8
V_i = random error team which is assumed to be independent and normally distributed as N $(0, \delta^2)$
U_i = Technical inefficiency which is assumed to be independent and a truncated normal distribution at zero with mean μ_i and variance δ_u^2 , N (μ_i, δ_u^2)

Estimation of equation (4) was accomplished by Maximum Likelihood Estimation (MLE) available in Frontier 4.1 and has been used extensively by various authors in estimating technical efficiency among crop farmers. Production and socio-economic factors affecting production was analyzed to know the determinants affecting production. To bit

model regression had employed since the efficiency score had range from 0-1. Socio economic variables were regressed with estimated efficiency score to know the variables affecting technical efficiency of paddy production through to bit model. The to bit model was used in this study to examine the factors that could cause inefficiency in paddy production. Hence, efficiency was regressed with socio economic variables such as age (yrs), experience (yrs), house hold size (no.), education (binary variable) and other independent variables such as method of sowing, usage of dapog nursery, transplanter and harvester as binary variables. Thus, specified tobit model is,

$$TE = \sigma_0 + \sigma_1 AGE + \sigma_2 EXP + \sigma_3 HHSIZE + \sigma_4 PRIMARY + \sigma_5 SECONDARY + \sigma_6 COLLEGIATE + \sigma_7 SOWING + \sigma_8 DAPOG + \sigma_9 TRANSPLANTER + \sigma_{10} HARVESTER$$

TE	=	Technical efficiency
AGE	=	Age of the farmers (yrs)
EXP	=	Experience in paddy production (yrs)
PRIMARY	=	Primary level education (1 if yes, 0 otherwise)
SECONDARY	=	Secondary level education (1 if yes, 0 otherwise)
COLLEGIATE	=	College level education (1 if yes, 0 otherwise)
SOWING	=	Method of sowing (1 if direct sowing, 0 otherwise)
DAPOG	=	Dapog nursery (1 if yes, 0 otherwise)
TRANSPLANTER	=	Paddy transplanter (1 if yes, 0 otherwise)
HARVESTER	=	Paddy harvester (1 if yes, 0 otherwise)
a_0	=	constant
a_1 - a_{10}	=	coefficient of independent variables
ϵ_i	=	Error team

RESULT AND DISCUSSION

Descriptive Statistics of Variables
Summary of the descriptive statistics of variables were showed in Table 1 that the estimated average output per farmer was higher in SRI (22694.58 kg/ha) compared with traditional method of paddy cultivation (14510.31 kg/ha). The variables such as seed, plant protection chemicals, labour requirement and number of irrigations were lower in SRI method of paddy cultivation when compared to traditional method. Machinery usage was higher in SRI method to save the cost incurred on human labours also due to the non-availability of human labours. The usage of organic fertilizers was higher in SRI method than traditional method due to decreasing rate of usage of chemical fertilizers.

Frequency Distribution of farmers according to Technical Efficiency
Table 2shows that 61.67% of farmers were falling under the range of technical efficiency of more than 90 in SRI and 46.66% of farmers falling in traditional method. In between 80-90 range of technical efficiency, 11.66 % and 23.34 % of farmers were falling in SRI and in traditional method, respectively. Like that 10 percent of farmers in each method were falling under the range of 70-80. It is inferred that higher percentage of farmers were falling in more than 90 range of technical efficiency in both method of production of paddy.

MLE estimators of stochastic frontier function for SRI and traditional method of paddy cultivation
Table 3 shows that among the eight independent variables included in the model in SRI method, farm size, seed, organic fertilizer, plant protection chemicals, irrigation and machinery usage were found to influence the production of paddy positively and significantly. In traditional method, farm size, chemical fertilizers and labour were influenced only positively and significantly, and the number of irrigations was negatively significant. The variance parameters for γ and δ^2 were 0.99 and 0.11 in SRI and 0.91 and 0.20 in traditional method of paddy production. The sigma squared indicated that the goodness fit and correctness of the distribution form assumed for the composite

error team while the gamma indicated that the systematic influence was un-explained by the production. The mean technical efficiency SRI and traditional method was estimated at 91% and 86% indicating that output can be raised by 9% and 14% through following inefficient crop management practices without actually increasing the level of application of inputs.

Tobit Model for Technical Inefficiency

Tobit model has postulated that the factors that could cause inefficiency in paddy production were dependent on the socio–economic factors that influence on efficiency of both SRI and traditional method. Table 4 shows that among the selected variables, only five factors viz., age, primary education, secondary education, collegiate and paddy transplanter was found significantly influenced on technical efficiency in SRI method. In traditional method, dapog nursery and method of sowing were negatively significant which indicates that not aware of technical system of farming.

CONCLUSIONS

The usage of organic fertilizers was higher in SRI method than traditional method due to decreasing rate of usage of chemical fertilizers in the descriptive statistics of variables. The technical inefficiency levels in both the methods of paddy production (9.00% in SRI method and 14.00% in traditional method) indicated that there is a scope to enhance the productivity levels in both the methods without using additional resources. The study has revealed that among the selected variables, only five factors viz., age, primary education, secondary education, collegiate, paddy transplanter was found significantly influenced on technical efficiency in SRI method. In traditional method, dapog nursery and method of sowing were negatively significant which indicates that not aware of technical system of farming. Therefore, there is a greater responsibility on the part of the extension department to provide timely suggestions and to conduct extension programmes regarding recommended practices of production in SRI paddy cultivation. The extension support system should work towards awareness building in terms of improving economic and technical efficiency of inputs.

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Table 1: Descriptive Statistics of Variables

Sl.No.	Variables	SRI Method				Traditional Method			
		Mean	Standard deviation	Maximum	Minimum	Mean	Standard deviation	Maximum	Minimum
1	Yield	22694.58	12504.92	65100	2712.5	14510.31	8474.29	44640	1159
2	Farm size	4.18	2.30	12	1.5	4.18	2.29	12	0.5
3	Seed	117.70	64.74	320	12.5	246.64	138.21	720	29.5
4	Chemical fertilizer	1050.46	572.71	2955	125.6	1407.08	814.38	4200	1.54
5	Organic fertilizer	30.86	17.55	90	2.75	10.30	5.74	30	1.25
6	Plant protection chemical	9.01	7.74	58	0.5	14.64	7.94	42	1.25
7	Labour	106.61	108.33	564	23.5	196.49	109.10	570	20.5
8	Irrigation	31.37	17.28	90	3.75	57.56	32.92	180	5.5
9	Machinery usage	60.65	33.42	174	7.25	15.30	8.50	38	2.3
10	Age	43.63	12.05	68	24	43.1	11.80	68	24
11	Experience	6.41	4.06	18	3	7.41	3.07	15	1
12	House hold size	6.96	2.01	12	3	6.53	2.06	12	3

Table 2: Frequency Distribution of Technical Efficiency

SI. No.	Technical Efficiency	SRI Method	Traditional Method
1	Up to 60	3 (5.00)	5 (8.33)
2	60 – 70	7 (11.66)	7 (11.66)
3	70 – 80	6 (10.01)	6 (10.01)
4	80 – 90	7 (11.66)	14 (23.34)
5	More than 90	37 (61.67)	28 (46.66)
	Total	**60 (100.00)**	**60 (100.00)**
	Mean Technical Efficiency	**91**	**86**

(Figures in parentheses indicates percentage to total)

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Table 3 - MLE Estimators of Stochastic Frontier Function for SRI and Traditional Method of Paddy Cultivation

Sl. No.	Variables	Parameters	SRI Method			Traditional Method		
			Coefficient	Standard error	T value	Coefficient	Standard error	T value
A	**Frontier production function**							
1.	Constant	β_0	7.2619***	0.9609	7.5574	5.7041***	0.8339	6.7909
2.	Farm size (ha)	β_1	0.5712***	0.2576	2.2198	0.4298*	0.2510	1.7123
3.	Seed (kg)	β_2	0.2001*	0.1602	1.249	0.1140NS	0.6693	0.1703
4.	Chemical Fertilizer (kg)	β_3	-0.0168NS	0.2039	0.0828	0.5500***	0.1123	4.8974
5.	Organic fertilizer (tones)	β_4	0.0225**	0.0115	1.956	0.3448NS	0.8474	0.4069
6.	Plant protection chemicals (litre)	β_5	0.0891***	0.0237	3.7594	-0.0118NS	0.1099	-0.1078
7.	Labour (man days)	β_6	-0.1633NS	0.7230	-0.2258	0.2309***	0.0657	3.5106
8.	Irrigation (numbers)	β_7	0.0239*	0.0140	1.7107	-0.3163**	0.1654	-1.913
9.	Machinery usage (hours)	β_8	0.3312**	0.1562	2.120	0.09312NS	0.4410	0.2302
B.	**Diagnosis statistics**							
11.	**Sigma- square**	σ^2	0.1154	0.3402		0.2022	0.0441	
12.	Gamma	Γ	0.9999	0.6830		0.9199	0.2171	
13.	Log – likelihood		0.2445			0.3998		
14.	LR		52.2938			59.3347		
15.	Mean technical efficiency		0.91			0.86		
16.	Mean technical inefficiency		0.09			0.14		
17.	Number of Observation		60			60		

(***significant at 1%, **significant at 5% and*significant at 10%, NS - Non significant)

Table 4: Result of Tobit Model for Technical Inefficiency SRI and Traditional Method of Paddy

Sl. No.	Variables	SRI Method				Traditional Method			
		Coefficient	Standard error	Z –value	P-value	Coefficient	Standard error	Z –value	P-value
1	Constant	1.0195	0.1398	7.292	<0.0001***	0.7673	0.1021	7.514	<0.0001 ***
2	Age	−0.0033	0.0018	−1.786	0.0741*	-0.0035	0.00257	1.368	-0.1714
3	Experience	0.0115	0.0068	1.679	0.0931	0.0034	0.0087	0.3913	0.6956
4	House hold numbers	−0.0023	0.0057	−0.4181	0.6759	-0.0016	0.00673	−0.2411	-0.8095
5	Primary education	−0.0597	0.0353	−1.689	0.0913*	-0.0275	0.0381	0.7223	-0.4701
6	Secondary education	0.0940	0.0298	−3.153	0.0016***	0.0290	0.03970	−0.7328	0.4637
7	Collegiate	0.0571	0.02993	−1.909	0.0563*	0.00389	0.0543	0.0715	0.9430
8	Method of sowing	0.0789	0.0615	1.283	0.1996	−0.00496	0.0308	−1.610	0.08721 *

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9	Dapog nursery	0.0420	0.0624	0.6734	0.5007	-0.1061	0.0379	−2.797	0.0052***
10	Paddy transplanter	0.0871	0.0487	1.787	0.0740*	-0.0502	0.0422	1.190	-0.2340
11	Paddy harvester	0.0521	0.0349	1.494	0.1351	0.00892	0.0378	0.2356	0.8137
12	Log –likelihood	45.22176				39.74129			

(Note: ***,** and * indicates significant at 1%,5% and 10% respectively)

RESEARCH ARTICLE

Weather Prediction using Linear Regression in Machine Learning

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ABSTRACT

Weather prediction is a process that involves analyzing various factors that could affect the future state of affairs. Before any undertaking, it is very crucial to know the weather conditions. It is possible by predicting some weather factors including humidity, temperature, sea level pressure and wind speed etc. It could help us avoid experiencing certain weather conditions that could cause delays. Due to the significant changes in Earth's climate due to human activities, various scientific and non-scientific debates have been held regarding the effects of these changes on the planet's inhabitants. Simulations that predict the future conditions of Earth have been presented as helpful tools for policymakers.

Keywords: Weather prediction, planet's inhabitants, Earth's climate.

INTRODUCTION

Weather prediction anticipates weather conditions of various regions. They play a vital role in today's world as it affects all aspects of our lives. Weather forecasts are done using computer models to analyze and predict the weather conditions of a given location. They rely on various atmospheric factors such as cloud cover and barometric pressure to predict the future. It is very important that we make accurate predictions when it comes to weather forecasts. Scientists are working on developing new algorithms that can improve the accuracy rate of their predictions. There is a huge development in machine learning models and artificial neural networks to examine weather prediction and occurrence.

Dataset
The daily weather dataset starting from "21-12-2013" to "31-07-2017" has been collected from Kaggle.com. Various weather aspects are chosen for this machine learning model. A small glimpse of the data is as follow:

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Implementation
1) Data Collection: Collection of data set, which contains complete weather details for a certain period.
2) Data wrangling: In this step, we perform data cleaning which is basically removing of unwanted and miscellaneous data rows and also by including zero wherever the data is null.
3) Data Traversing: Allocating index to every row to make the traversing easier.
4) Prediction and Result: Here we use the updated final data to apply the machine learning model and get the predictions for the dataset on which the created model is applied.

Literature Review
Data analysis is a vital component of machine learning, as it plays a huge role in the development of the algorithm. In order to get the most out of their data, data scientists often spend a lot of time preparing it, which can be divided into various phases such as data cleansing, data aggregation, and data exploration. Aside from being used in machine learning, data analysis also serves as a prelude to the creation of new models. It can also help prepare the data for the model's development. To begin working on machine learning algorithm, a feature selection process needs to be performed. This step can improve the accuracy of the learning process and reduce the time spent on it. The availability of weather data is huge. Large number of satellites collect data on a daily basis on various weather-related factors such as temperature, wind, and cloud patterns. Underground Weather Companies state that they have access to over 250,000 weather stations. With the help of AI and Machine Learning, it will be able to provide real-time weather forecasts.

Proposed Model
It uses historical weather data to predict the conditions of different regions. It takes into account various factors such as wind speed, humidity, temperature, and visibility. The data undergoes pre-processing stage at first and then the values are replaced with the most probable result or the most recent data entry. After the data pre-processing is finished, the remaining parts of the project are divided into two parts, namely the test set and the training set. To find and contrast the results produced by the model, a test set is used. The training phase consists of two stages, which are testing and training sets. To teach a machine learning model, these steps are followed. The kth set is the test set that is used to evaluate the model's correctness. It helps us reduce the condition of over fitting as well.

Linear Regression
Linear regression is a machine learning algorithm that predicts the value of a dependent variable relative to its independent counterpart. It considers relationship between two independent variables. It is a type of statistical procedure that models the relationship between a pair of explanatory variables and a scalar response. It can be used to find a predictive function. The linear equation has a scale factor that assigns one value to each input column. The addition of a coefficient gives the line more freedom.

Using simple linear regression to find predictive function
```
X.filter(['AvgTemperatureFahrenheit', 'AvgDewFahreinheit', 'AvgHumidityP',  'AvgSeaLevelI', 'AvgVisibilityM', 'AvgWindSpeedMPH'], axis=1)
for i in range(x_f.columns.size):
pt.subplot(3, 2, i+1)
pt.scatter(days, x_f[x_f.columns.values[i][:100]], color='g')
pt.scatter(days[day_index], x_f[x_f.columns.values[i]]  [day_index], color='r')
pt.title(x_f.columns.values[i])
pt.show()
```

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RESULT

The aim of this model is to predict using Linear Regression. This model predicts weather conditions such as average temperature in Fahrenheit, average dew point in Fahrenheit, average humidity in percent, average sea level pressure, average visibility in miles, average speed of wind. Here the figures represent all the weather conditions. An Average temperature is simply an arithmetical average. Evaporation occurs in large quantity whenever the Earth's surface rises resulting in increase of overall precipitation. Number of days as well as predicted Average Temperature in terms of Fahrenheit is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification. The dew point temperature is a commonly used parameter in industrial humidity measurement. It is commonly used to determine the relative humidity of air drying and plastics in order to measure their dryness. Number of days as well as predicted Average dew point in terms of Fahrenheit is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification. Humidity measures the concentration of water vapor in the air that is invisible to the human eye. Number of days as well as predicted Average humidity in terms of percentage is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification. Atmospheric pressure is a measure of the force exerted by an atmospheric column on a body of water. Number of days as well as predicted Average Sea level pressure is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification. A fog is a type of invisible layer that appears near the surface of the atmosphere due to the suspension of water droplets. It is caused by the accumulation of pollutants such as aerosols. Number of days as well as predicted Average visibility in terms of miles is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification. The movements of air in the atmosphere are caused by the temperature difference between high and low pressure. As a result, the wind speed is affected by the distance that air has travelled. Number of days as well as predicted Average wind speed in terms of Miles Per Hour (MPH) is displayed. Dark green represents the plotting of data on the graph and red dot displays the predicted value for the input data based on specification.

CONCLUSION

In this paper, with the use of machine learning technique we have trained a machine learning model for weather prediction. This model is quick and genuine then the traditional models. For prediction, the data set consisted of three years daily weather data starting from 21-12-2013 to 31-07-2017. With the help of past data, we have performed predictions. The accuracy of the model was measured using the coefficient correlation method. Machine learning techniques are more advantageous than traditional models for creating intelligent models. In the future, we'll use weather data collected by low-cost sensors to predict future conditions. By combining the data collected by different sensors, we'll be able to create more robust models with better predictions.

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Table 1: Data set

Date	Temperature (In Fahrenheit)	Dew point (In Fahrenheit)	Humidity(In Percentage)	Sea Level Pressure
21-12-2013	60	49	75	29.68
21-12-2013	48	36	68	30.13
21-12-2013	45	27	52	30.49
21-12-2013	46	28	56	30.45
21-12-2013	50	40	71	30.33
21-12-2013	48	36	63	30.40
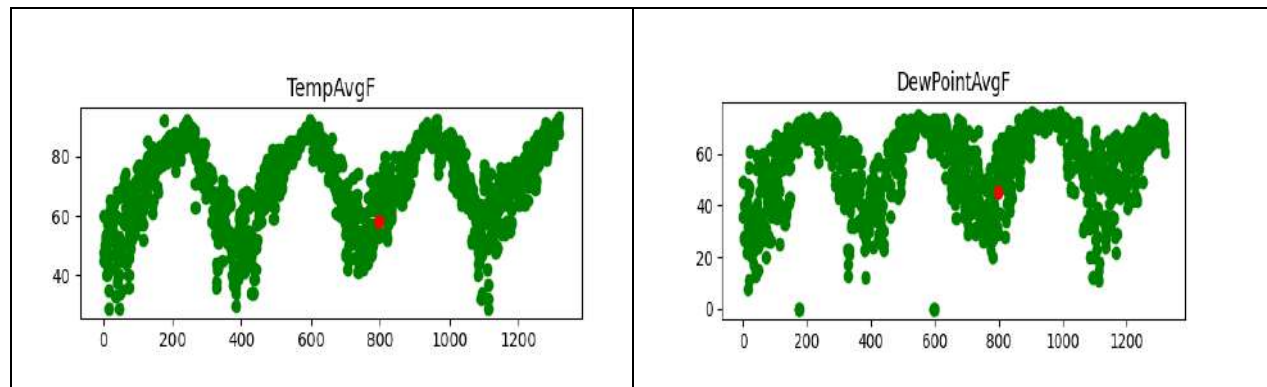
Fig. 1: Average Temperature in terms of Fahrenheit

Fig. 2: Average Dew Point in terms of Fahrenheit
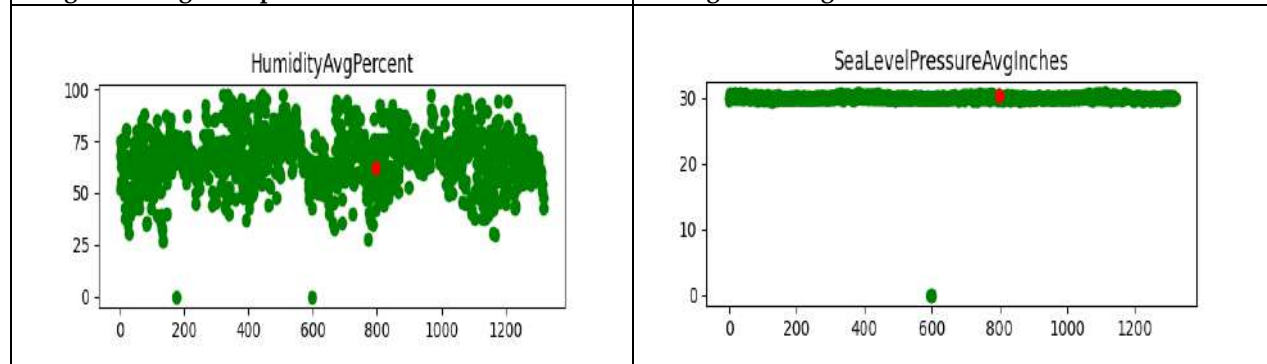
Fig. 3: Average Humidity in terms of Percentage

Fig. 4: Average Sea Level Pressure in terms of Inches
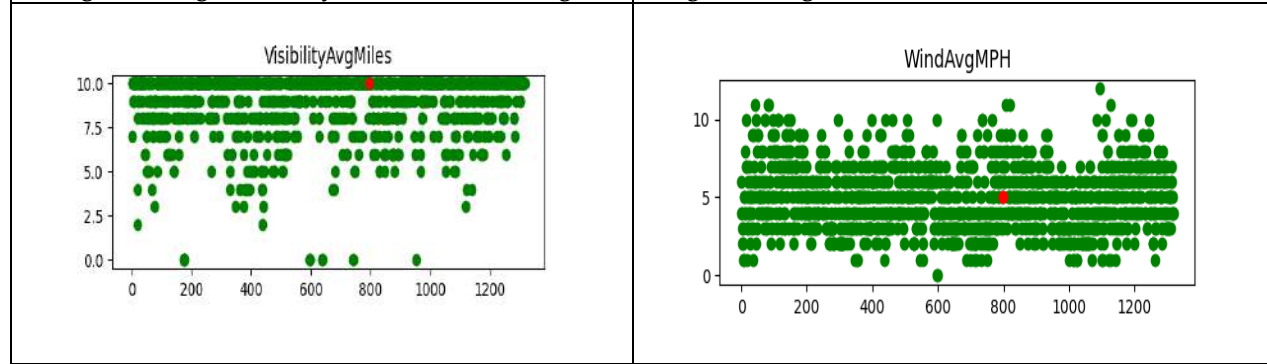
Fig. 5: Average Visibility in terms of Miles

Fig. 6: Average Wind in terms of Speed

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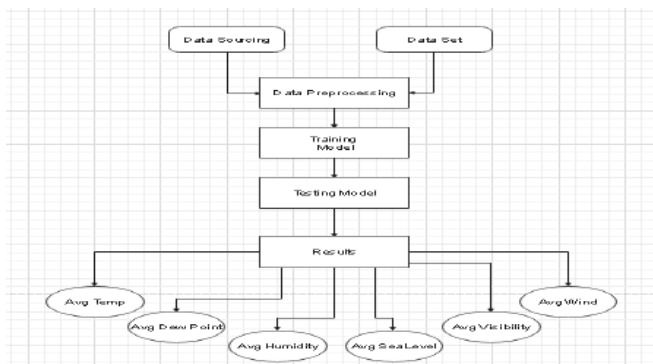
Fig. 7. Flow Chart of Linear Regression Model

RESEARCH ARTICLE

Framework for Energy-Aware and Robust Security Mechanism Based on Malicious Behaviour of an Adversary Node in IoT

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ABSTRACT

With the increased dependency of Internet-of-Things (IoT) over various upcoming applications, there is a higher degree of risk in secure communication among a massive number of IoT devices. Irrespective of the various existing security solution, it is seen that they are either attack-specific or environment-specific solutions, and hence their applicability will be required to be more extended. Apart from this, energy being the prime contributor for every node performance is one prime concern which usually degrades while performing a sophisticated existing encryption-based operation. Therefore, the proposed system introduces a novel non-encryption-based security solution where energy is considered a prime indicator of identifying an attack of various forms in the IoT environment. Adopting analytical modelling, the proposed system is simulated and benchmarked to find that it offers significant resistance towards application and routing specific attacks in IoT with exhibits of better energy retention and satisfactory data delivery performance.

Keywords: Internet of Things, Security, Network Performance, Data Transmission, Attacks.

INTRODUCTION

There has been a tremendous rise in the connected embedded devices in the present era where these devices are used for multiple purposes, resulting in the generation of a massive stream of data [1]. This demand for massive connectivity of different types of machines is termed as Internet-of-Things (IoT) designed to be used over various business processes, home automation, transportation, medical sector, etc. [2]. Although there has been an extensive rise in the IoT system's adoption, the technology still lacks significant architecture to ensure full-proof connectivity. Owing to the usage of heterogeneous devices with numerous communication protocols, monitoring the IoT device's security is still an open challenge [3]. The usage of IoT devices frequently encounters security threats in multiple ways, posing various degrees of security breaches. At present, there have been various threats and attacks being reported in the IoT environment, where it is not feasible to identify any specific attack to be highly vulnerable [4][5]. It is because different forms of attacks have different intentions and strategies for launching an attack. This leads to the evolution of various security solutions in the present time [6]-[10]. It is observed that there has been surfacing of various techniques where encryption is the prominent technique to offer secure communication in the IoT environment. However, such implication of the encryption approach is questionable as IoT is usually characterized by nodes with low processing capability and limited availability of resources.

It is found that energy is one of the prominent indicators that can be utilized to identify the threat and can also be used to optimize network performance. Any security solution towards IoT must be energy efficient as well as it should perfectly meet the security demands while it performs the data propagation process. Hence, the proposed system has introduced a novel framework that mainly uses energy as the prime indicator to understand the IoT nodes' malicious behavior, which has never been studied before. The proposed system uses an analytical model to implement this concept, incorporate secure data communication, and optimize network performance in the IoT environment. The paper's organization is as follows: Section 2 discusses the existing security approaches in IoT while briefing the addressed research problem is carried out in Section 3. The solution towards identified problems is briefed in Section 4, followed by an illustration of the proposed algorithm design. The analysis of the proposed simulation study's obtained outcome is carried out in Section 6 while Section 7 summarizes the proposed work's contribution as a conclusion.

REVIEW OF LITERATURE

Incorporating a higher security grade has always been the primary concern among the existing researchers regarding safeguarding communication within an IoT environment. Recent studies have emphasized certain new and unique attacks where the greedy approach has been used for exploring elite cube to investigate the encryption used for authentication (He *et al*. [11]). The algebraic degree associated with the encryption system that uses a non-linear shift register has been investigated to find that they offer better convergence capability for a given search space, significantly when larger. However, such an approach is limited for search and is also time-consuming, leading to a lack of offering end-to-end security. In this regard, the incorporation of quantum walks is proven to improve the resistivity capability towards lethal threats over an IoT (El-Latif *et al*. [12]). This approach can generate a pseudo-random number for facilitating encryption by building better secured permuted blocks and is most effective if all the data arriving from nodes are of similar types. It should be noted that applications over the practical environment of an IoT are heterogeneous, and they are most vulnerable to their privacy factors. This problem was addressed by using a symmetric key with the aid of a Logistic Map. It is used to address both security issues over heterogeneous devices and energy consumption problems to resist device capture attacks and key reset attacks (Luo *et al*. [13]). These approaches have a one-directional emphasis on data security and not much over the storage of encrypted data. The existing system solves this problem using a standard RC4 encryption mechanism and uses Huffman compression for energy-efficient secure storage modelling (Zhang *et al*. [14]). Better efficiency towards secure data storage, as well as authentication, can be carried out using Blockchain. The frequently reported attack, e.g., selected attack on plaintext leading to leakage of the secret key, is discussed to be mitigated with a blockchain security system (Niu *et al*. [15]).

The adoption of Blockchain was also witnessed to show improved security when combined with compressed sensing (Mangia *et al*. [16][17]). Blockchain has been used for securing the information extracted by compressed sensing in IoT and is meant for resisting man-in-middle attack. A study towards an automated validation approach using the key establishment process is another frequently used approach towards ensuring effective scalability in IoT security. Different forms of the analytical scheme have been implemented to thwart specific attacks (Khan *et al*. [18]). IoT involves various multi-parties, and hence the risk of intrusion is also quite high. It was noted that the usage of symmetric encryption keys offers significant security among the devices (Al-Asli *et al*. [19]). Adopting a re-encryption scheme offers resistivity towards various attacks over different machines connected in an IoT. However, multi-parties usage is not always with a certificate, but there is a greater demand to use a certificateless scheme. Further improvement in the authentication process over multi-parties has been carried out extensive offer security using a certificateless scheme (Zhang *et al*. [20]). This scheme's advantage is that it supports faster and parallel authentication for verifying ciphertext in 5G networks, which is meant exclusively for an IoT. However, this verification is carried out only once and could be less effective when exposed to a dynamic attack environment. Existing research approaches offer solutions to this problem using a physical unclonable function integrated with identity-based encryption (Zhao *et al*. [21]). This approach uses residues of the quadratic form to perform encryption twice over the IoT environment. A study towards a certificateless scheme has been carried out to offer security for energy-constrained devices (Karati *et al*. [22]).

By adopting certificate less signcryption, the security model is found to be supportive of maximum-security standards in IoT. The existing system has also been noted to support optimization towards securing low-powered devices connected in IoT. Advanced Encryption Standard has exhibited better security optimization over hardware level in IoT (Bui *et al*. [23]), where the resistance towards power analysis attack has been carried out. Study using a similar approach for resisting collision attack associated with a power factor (Niu *et al*. [24]) and eavesdropping attack (Tsai *et al*. [25][26]). Adopting Advanced Encryption Standard and counterfeited keys could offer more resistance from threats against the secret keys (Yu and Kose [27]). Such an approach is proven to be resistive against power analysis attack without any significant overhead. A study towards the optimized performance of ciphering is also investigated for the development of futuristic security demands. It has been found that there is a discrete relationship between the size of the block over the optimization of energy while performing encryption (Mohd and Hayajneh [28]). Such studies focus more on design-level improvement and its possible influence on different parameters, e.g., overhead, throughout, rounds, block size, etc.

Existing approaches have also considered a case study where the summarization of the multimedia contents has been integrated with the encryption of digital signals (Muhammad *et al*. [29]). Usage of the probabilistic method, an encryption method, and a chaotic map can be used for robust encryption structure. Such methods are also non-sensitive to various noise. However, this work does not emphasize much on securing the entire communication channel. It was also found that randomizing the ciphering process could lead to better channel security (Choi [30]). Such an approach is applicable over securing the physical layer where the mathematical modelling has been carried out to show its robustness against channel estimation attack. There are various literature archives to showcase the adoption of unique and different approaches to ensure secure communication among the devices present in IoT. The studies mentioned above are mainly found to adopt an analytical approach while their capacity is limited to resist certain attacks and address a specific set of problems. The next section discusses the research problem that has been concluded to address current work.

Research Problem

There are various set of problems that have been identified to be addressed in proposed studies as following viz. i) existing approaches are designed for resisting specific set of attack only and hence their capability towards full-fledged security coverage is still questionable, ii) adoption of sophisticated attack mitigation strategy mainly used encryption which is higher iterative as well as uses higher resources. Therefore, the balance between the security demands and communication demand is still not met, iii) the studies carried out towards energy optimization and resource optimization do not discuss an explicit model. Due to this, the existing approaches cannot be extended

when incorporating the dynamicity of communication in an IoT environment. The presence of an explicit model is required to offer more scalability when the model is exposed to large scale topology in IoT. iv) studies towards optimization are found to introduce new parameters and attributes apart from conventional attributes in IoT; hence chances are more for storage overhead and resource depletion. Therefore, to develop a useful, optimized version of the security system, there is a need to use all the parameters, directly and indirectly, available from the network and devices by any means. To build a potential resistance system, it is necessary to develop an identification module that can trace an appropriate malicious behavior using run-time parameters, e.g., the amount of energy used, routing direction, node density, power depletion processing time, etc. Hence, the research problem of the proposed system is, "It is challenging to identify parameters that are readily available and can exploit the malicious behavior in order to resist them for any form of participation in given IoT environment." The next section briefs about the proposed solution.

RESEARCH METHODOLOGY

Our prior work has introduced a framework that uses analytical modelling to prevent the malicious node from participating in data forwarding and regular node [31]. This work's idea was based entirely on identifying an adversary node's malicious behavior considering the IoT environment. However, the model has to carry out the execution of algorithms over the various scenarios. The possibility of drainage of resources could re-surface. Hence, there is a need for a module that could offer significant support for resource availability that can offer more optimized performance. This part of the work is an extension of the prior work where the exceptional contribution of the proposed study is to evolve up with secure modelling that can offer a good balance between network lifetime and data communication performance in an IoT environment. Fig.1 highlights the block diagram of the proposed system, which shows that the proposed system formulates its operation using various operation components to ensure secure communication within the IoT. The IoT environmental parameters include IoT devices and gateway nodes. The proposed system also selects Auxiliary nodes from the IoT devices. The proposed system uses group-based communication using heterogeneous groups of IoT devices where one auxiliary node collects data from one group and forwards to the gateway node. The proposed system also implements a standard application attack and routing attack as a core adversarial model to testify its resistivity performance's effectiveness towards threats. Irrespective of the absence of any apriori information about the adversary, the proposed system implements a standard first-order radio energy model [32] where there is a definitive energy allocation for all the data transmission operation among the IoT nodes. This causes a uniform reference model for observing energy patterns where the regular node is perfectly anticipated to exhibit uniform power dissipation while the malicious node will offer a higher degree of energy fluctuation. The complete proposed logic is considered to be executing within the gateway nodes. Using a communication model, the proposed system facilitates detecting malicious behavior and preventing them by not allowing such nodes' participation in IoT's routing process. The next section briefs about the algorithm design.

Algorithm Implementation
This section discusses a set of algorithms designed to achieve the objective of assessing the security performance in IoT devices. It should be noted that the proposed study introduces a framework that is capable of assessing the degree of vulnerability associated with different dynamics of attack in IoT. The algorithm's complete discussion is carried out vividly concerning the strategies involved in its design process and elaboration of the proposed algorithm's execution steps.

The strategy of Algorithm Formulation
The proposed algorithm construction's core strategy is to ensure that it should offer enough optimization in the complete process of securing the communication channel. The prime justification behind adopting this strategy is that the proposed model is developed to resist the attack considering no prior intelligence about an adversary. Hence, any operation leading to identifying such a dynamic attack is anticipated to exploit various information and

resources to trace the vulnerable activity. Hence, the proposed strategy's baseline is to develop an algorithm that can resist the adversary so that there is no significant drainage of resources. Following this direction of the research planning, these are the essential strategy formulation viz. i) the proposed system considers the complete communication setup of an IoT with both nodes and gateway in order to investigate the malicious behavior, ii) the environment has been set up considering nodes residing over multiple domains assuming deploying of local communication protocol in order to map the heterogeneous communication scenario, iii) the proposed model also has an assignment of specific resources in order to investigate the utilization of the demanded resources, iv) the proposed model is also subjected to multiple test environment of an adversary in order to investigate the impact of different adversarial tactics towards the communication performance in an IoT.

Execution of Algorithm

The proposed algorithm's complete implementation targets two prominent goals, i.e., i) to offer computational efficient modelling and ii) to offer a significant secure communication system in a distributed IoT system. The primary goal is achieved by not adopting a conventional encryption approach while incorporating a security system that ensures a higher algorithm progression and highly reduced iterative operation. The secondary goal is achieved by the proposed model, which connects energy behavior with malicious behavior in IoT. The proposed algorithm's complete basis is that a regular node and malicious node has a discrete way of exhibiting energy dissipation, which has not been studied earlier. The system hypothesized that when an attacker compromises a node, the behavior associated with data transmission is autonomously independent of any criteria imposed by the local communication protocol. Therefore, more chances of such compromised nodes exhibit significant energy behavior when they are captivated by the adversary. The proposed algorithm aims to extract this unseen malicious behavior and exploit the energy consumption pattern to identify malicious threats with the communication environment. The complete algorithm is formulated by assuming that all the IoT nodes are wireless. The communication of such resource-constrained IoT devices is exposed to higher vulnerability ranges due to vulnerable wireless environments. The proposed system uses two sequential algorithms where the first algorithm orients towards deployment of all the essential actors (normal IoT nodes, attackers, gateway nodes, auxiliary node) of simulation, and the second algorithm is to develop a security strategy exploiting energy dissipation behavior to protect complete communication in IoT. This section further elaborates both the algorithms as follows.

Algorithm for Preliminary Communication

This algorithm is responsible for setting up the simulation's initial configuration to establish the initial phase of communication among the IoT nodes and the gateway node. This is an essential phase of configuration where the node deployment is carried out. The algorithm takes the input of n (IoT devices) and gn (gateway node), which yields an outcome of the communication vector between them after processing. The steps of the algorithm are as follows:

Algorithm for Preliminary Communication
Input: n (IoT devices), g_n (gateway node)
Output: communication establishment between n and g_n.
Start
1. init n, g_n
2. For i =1: n
3. n=r(n)
4. d_{area}→(n, g_n)
5. End
6. n→g_n
End

A simulation model is developed, which takes the input of the number of the IoT nodes deployed over a specific simulation area darea. It also assigns a single gateway node within the simulation area. The proposed algorithm

considers all the nodes n (Line-2), which establishes its communication with the gateway node gn within the defined area of simulation darea (Line-4). All the nodes are randomly deployed using function r(x) so that they are all deployed with the simulation area and within the communication range of the gateway node. Finally, a communication vector is established between all the IoT nodes and the gateway nodes. The attacker nodes are deployed within this same region, and there is no information associated with neither the identity of an attacker nor the position of an attacker. The study considers that the attacker node will not initiate an attack and extend its resources to study the communication behavior of the IoT nodes. Since the gateway node cannot be compromised, they have a higher degree of resource availability; hence, the attacker node generally targets the normal IoT devices. Usually, the IoT devices are wireless, and it establishes its connection with the gateway node following existing protocols of TLS and DTLS. However, they are never secured enough, and chances of getting themselves compromise are more [33]. Therefore, this algorithm contributes towards establishing a specific communication vector between the IoT devices and the gateway node so that the consecutive algorithm of secure communication can be carried out over this communication vector.

Algorithm for Secured Message Transmission

This algorithm is responsible for ensuring secured message transmission. The prime strategy applied for this algorithm's development is that malicious nodes always target the node with low resource count as any form of IoT devices working on a lower count of resources will have degradation in its communication performance. Therefore, this algorithm's core agenda will be to offer better retention of the resource while the IoT nodes carry out data aggregation with the gateway node. Apart from this, this algorithm also offers dynamic fine-tuning of the resources to automate the complete process of secure communication in the IoT environment. The algorithm uses this concept to mitigate any possibility of malicious node inclined to attack the vulnerable nodes with depleted resources. The steps of this algorithm are as follows:

Algorithm for Secured Message Transmission
Input: E_o (initial energy), pl (packet length), p (probability)
Output: Successful message transmission
Start
1. init E_o, pl, p
2. For i=1: n
3. [v nl]=$\arg_{min}$ (|v-card(n*p)|)
4. formulate group with G_{id}.
5. End
6. compute n_{elite}
7. For j=1: TG
8. 　TG=$f_1(A_{ix})$
9. 　n(A_{ix1})=$f_2(A_{ix1}, A_{ix2}, pl)$
10. End
End

Before implementing this algorithm, the proposed system undertakes certain more parameters, e.g., probability of an IoT device to be an auxiliary node p, preliminary resource allocated to it Eo, and the proportion of adversary pa. This part of the study's novelty is that all the IoT nodes are not permitted to forward the data to the gateway node, and there are chances of more overhead and challenges from various attackers of unknown type. Moreover, the emphasis is given to the security of the data and retain maximum energy as possible. The complete assessment is carried out, considering 4 different combinations. The installed IoT devices on uniform location and installed IoT devices on moving locations will be the assessment scenario towards two forms of adversaries, i.e., i) application-specific attack and ii) routing specific attack. By considering this taxonomy of attack, most of the attacks are covered up, as shown in fig.2. The proposed secure communication's complete operations are as follows: The preliminary algorithm offers disclosure of regular IoT nodes n and gateway node gn. To formulate an organized communication,

the proposed system constructs multiple groups where each group will have one auxiliary node AN and multiple IoT devices. The study assumes that auxiliary nodes are the attacker's prominent target as it possesses fused information from other IoT devices. Hence, the complete algorithm is mainly towards securing AN when establishing communication with the gateway node gn. For all the deployed random nodes (Line-2), the algorithm initially extracts the information about the number of AN and coverage of deployed region v (Line-3), followed by selecting this group's minimal value. This formulation of minimum value will always restrict the simulation to generate a surplus number of groups, which will further sophisticate the routing process where the variable nl represents a unique group number (Line-4). Therefore, the minimum value selection helps maintain the optimal number of groups for a given scenario based on the distance among all the IoT nodes and gateway nodes. This process generates a matrix with elements representing selected members (all IoT nodes, including AN) in the group. This information is highly sensitive from route establishment and hence would be of prime interest to an attacker.

This challenge is addressed by further encoding it. In this encoding process, the algorithm extracts the real-value of the number of groups in the form of nl2. Although nl2 will eventually lead to harmonic values as higher possibilities, the advantage of keeping the square form is the size of the data increases, which will eventually consume a more significant number of energies for the attacker to decode them. Hence, the attacker will need double of their energy in order to perform the decoding operation. Finally, the algorithm formulates a group and tags each group with its identifier Gid connected with the encoded matrix. Once this is set up, the AN is now ready to forward a data packet to gateway node gn. However, it adopts two discrete mechanisms to circumvent i) application-specific attack and ii) routing specific attack. The following are the mechanism.

The process to mitigate application-specific attack
This kind of attack is highly application-specific, and we can term it as an active attack. In this case, the adversary has already compromised a specific victim node (node with less resource). Therefore, the proposed algorithm focuses on protecting other neighboring nodes of the victim node from further intrusion. This process of securing the neighboring nodes is carried out by using a statistical mechanism. It is seen that a compromised node exhibits a specific abnormal pattern of resource utilization while formulating further attack strategy or for launching an attack. The easiest way is to find the rate of resources found to be significant fluctuation over every data aggregation cycle. All the IoT devices have a predefined allocation of static resources; hence, it is usual to know its resource dissipation rate. A common node will always have a uniform pattern of resource dissipation. In this neighborhood monitoring process, the algorithm checks if the fluctuation of energy is quite higher. When it is found higher, the energy of a node will mean that it is currently processing data by violating existing incoming stream of data and its local protocol. When the same stream of data is allocated to all the IoT nodes in a group, it is anticipated to have approximately uniform dissipation of resources. If certain nodes are found to offer higher fluctuation, it will only mean either a curious node or rogue node, or attacker of a certain kind. Although there is also a possibility of a slight fluctuation of regular nodes resources, this fluctuation will not be for a long time. This is the unique criteria developed in the proposed system to identify an active attack's presence without having any definitive information about the attack strategy. The proposed system makes use of threshold energy to compare with the energy that is fluctuated. If the fluctuation is found more, any communication routes linking to such nodes are aborted. The entire process of the implementation mentioned above is carried out by constructing an explicit function $f_1(x)$ where the input argument is all the communicating IoT devices (Line-8).

The process of routing a specific attack
In this form of attack, it is essential to select a secure and stabilized communication link. The proposed system defines a stabilized link as the communication channel between two communication nodes with sufficient residual energy. For this reason, the proposed system implements a standard first-order radio energy model, which has an inclusion of calculating transmittance and receiving energy [32]. If one of the communicating node's energy is less, it is termed a weak link, and no communication is initiated. In this process, the possibility of attack could happen while routing between i) normal IoT node and AN and ii) AN to gateway node. In both the cases, chances of AN to get

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compromised is quite high; therefore, the proposed system evaluates a threshold of upgrading the AN, which is as follows

$$Th_{AN} = p.\alpha \qquad\qquad (1)$$

In the above expression, AN's threshold is upgraded based on the probability of AN, i.e., p, which is configured by the user, and variable α represents $(1-p.mod(p^{-1}))^{-1}$. In the next process, the proposed system looks for an unstabilized node where the overall energy is close to 0. In such a case, the algorithm declares such node as a dead node while otherwise, it applies a similar first-order radio energy model [32]to re-compute its E_{tx} and E_{rx}. The algorithm then shortens all the nodes with reduced Etx and selects all the nodes that have reduced Etx in to confirm route with less energy dissipation. This process's justification is that there are less chances of an attacker to expend more resources toward the stabilized path where chances of intrusion are less. The proposed system further uses the Dijkstra algorithm to explore the shortest path between two communicating nodes. This information is further used for upgrading all the AN. Another novelty of this algorithm is that if the E_{tx} value is less than E_{Th} (threshold energy), then the algorithm performs re-selection of the path with low E_{tx}. However, if E_{tx} is found more than E_{TH}, the proposed algorithm computes the path with reduced energy, and the shortlisted path is used for forwarding the data to the gateway node. The process mentioned above is implemented in second explicit function $f_2(x)$, which uses data packet length pl, and two communication nodes A_{ix1} and A_{ix2} (Line-9). This completes the secure transmission of data among the IoT devices and gateway node.

Fig. 3 highlights the complete flow of the proposed algorithm, where it can be seen that the proposed system's initial process is all about forming up an IoT environment where normal nodes and a single gateway node are present. The proposed system offers a strategy to select an Auxiliary Node (AN), an explicit operation carried out by the user, and this selection is assumed to be private information. For cost-effectiveness, the proposed system will only consider a low number of normal auxiliary nodes randomly to select as AN. Therefore, the next process will be to safeguard all the communication that leads to and from this AN as they will carry all the aggregated information about the member IoT nodes, and this aggregated information will be forwarded to the gateway node. Once formulated, all the groups are given an identifier followed by encoding private information about the identity of the member IoT devices among the group. As this encoded information is stored within the gateway, there are less chances of this information to be compromised, and attackers will need to perform all the efforts to explore the possibilities of vulnerable IoT nodes based on their residual energy.

For this purpose, information about transmittance energy is monitored, and the degree of its fluctuation is also monitored. If the degree of energy fluctuation is found to be more than this threshold limit, the system considers these nodes to be either curious or compromised nodes. They are, therefore, isolated from the network. Applying the standard energy model [32], this fluctuation is easy to monitor as a regular node will never violate this resource allocation model. In contrast, the malicious node will be forced to violate this model and display a higher degree of energy fluctuation. The prime intention of the malicious node will be only to launch the attack, and in order to do so, they will demand more energy while acting as normal nodes. They will perform the normal operation, which causes energy fluctuation.

RESULT ANALYSIS

The proposed system's complete logic is scripted in MATLAB, considering 100 IoT nodes in a defined IoT environment of 1000x1000 m2 simulation area. The study considers probability where 0.05 is assigned as the probability of AN out of total node while 0.5J of energy is initialized among all IoT nodes. Transmission of 2000 bits of the data packet is considered along with the presence of 0.2% of attacker presence within the IoT environment. For assessment, the study is compared with two existing approaches with similar motive, i.e., Haseeb *et al*. [34] shown as Existing1 while Haseeb *et al*. [35] shown as Existing2 in graphical outcomes. The approach of Existing1 has

used a heuristic analysis-based method for detection and prevention of malicious links, while the approach of Existing 2 has used secret sharing for a similar purpose.

Fig.4 and Fig.5 show that the proposed system offers better retention of IoT device energy in the presence of both routing attack and application attack in both the scenario of static and mobile IoT devices compared to the existing system. The prime reason behind this is – Existing1 uses a learning scheme to understand the vulnerability of networks, and while doing so, enough energy is consumed while the Existing2 approach uses XOR operation for its secret sharing encryption scheme, which also leads to a certain amount of energy. On the other hand, the proposed system performs its identification of links based on energy patterns that do not require extensive calculation, leading to lower resource utilization. This method also contributes to better throughput, as seen in Fig. 6. As a result, the proposed system offers better resistivity against both the kinds of attacks irrespective of uniform or mobile nodes.

Fig.7 shows that the proposed system offers much better stability when it comes to energy fluctuation than the existing system. Energy fluctuation is strongly related to the security behavior where a compromised node will certainly possess higher energy fluctuation than a regular node. To ascertain this fact, the proposed system uses a first-order radio energy model, which has a uniform allocation of transmittance energy of 50nj/bits for every regular node [32]. Hence, using this reference energy model, the power fluctuates very often to a higher degree when a malicious node is present in the network. Fig. 7 also exhibits that the proposed system could offer cost-effective data transmission irrespective of any nature of the adversary's malicious strategy, which is not present in either of the existing approaches meant to restrict only known kinds of attacks. Therefore, the proposed model offers a capability to offer better-optimized performance towards communication security over the IoT environment.

CONCLUSION

This paper has introduced a novel framework where solutions towards resisting attacks of unknown kinds are introduced. The prime logic behind this is that irrespective of the attacker's form, there is a hidden pattern of energy dissipation, which acts as a possible indicator to identify the threat. Using a standard energy model, where there is a uniform allocation of resources, it is anticipated that all IoT nodes will have a certain degree of uniform patterns of energy dissipation as allocated resources are always fixed. If an IoT device exhibits abnormal energy dissipation behavior, it will eventually mean that they are a malicious node or compromised regular node. Using thresholding, identifying such nodes' presence is carried out and isolated from the network. The significant contribution of the proposed system are as follows i) The proposed system does not use any form of encryption, and hence there is no hassle of key management over a massive number of IoT nodes, ii) The proposed system uses auxiliary node to carry out the forwarding of the data where the encoding is carried out further to safeguard their identity unlike any IoT topology studied till date. This makes communication lightweight and organized, but it also becomes easy to monitor the threat. It is because auxiliary nodes are the prime target of the attack as they carry all aggregated information. As they are less in number, offering protection to auxiliary nodes is highly feasible and effective using a group-based communication system. iii) Unlike any existing system, the proposed system uses energy as identification of intrusion and is also used to optimize network performance

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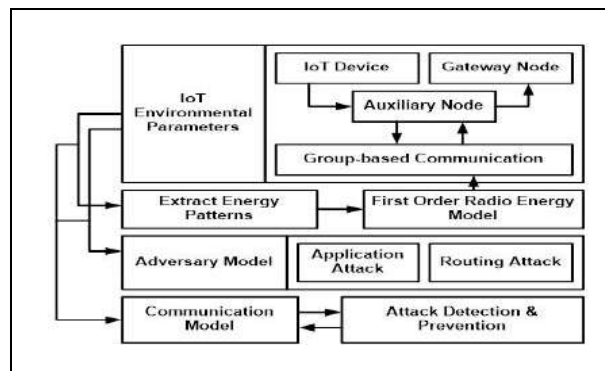
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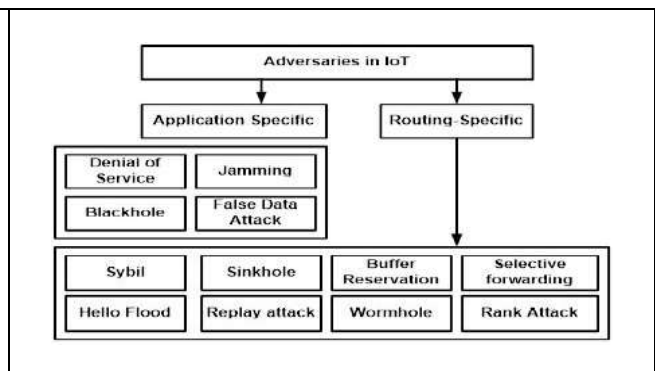
Fig.2 Major Taxonomy of Attacks in IoT
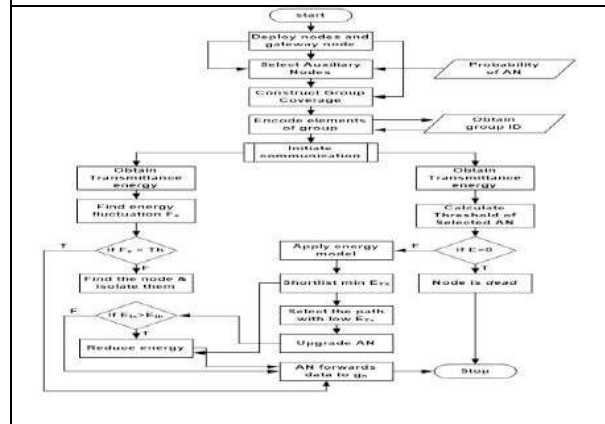
Fig.3.Complete Process Flow of Proposed Algorithm
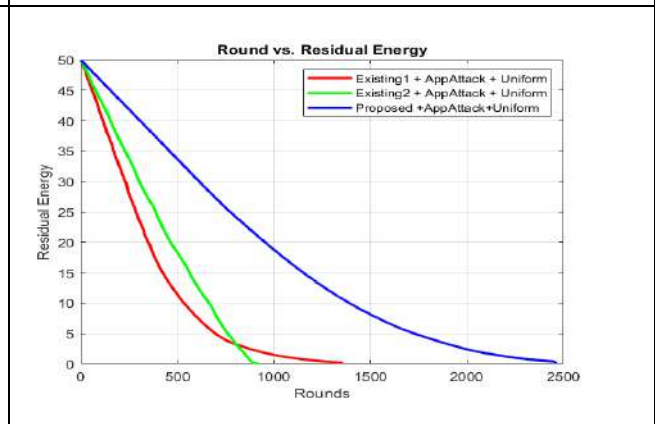
Fig.4 Comparative Analysis of Residual Energy

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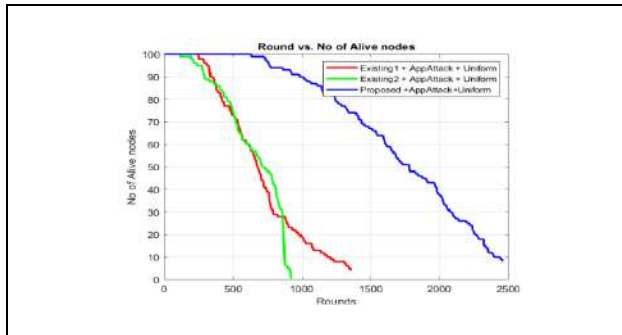
Fig.5 Comparative Analysis of Alive Node	**Fig.6 Comparative Analysis of Throughput**
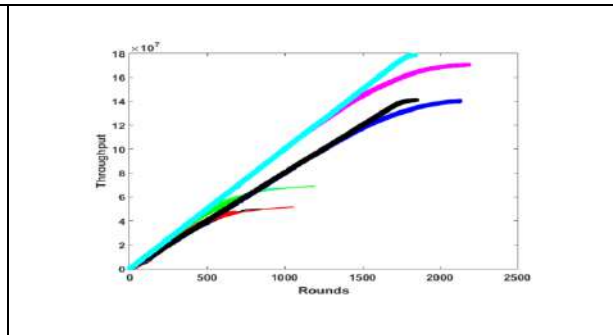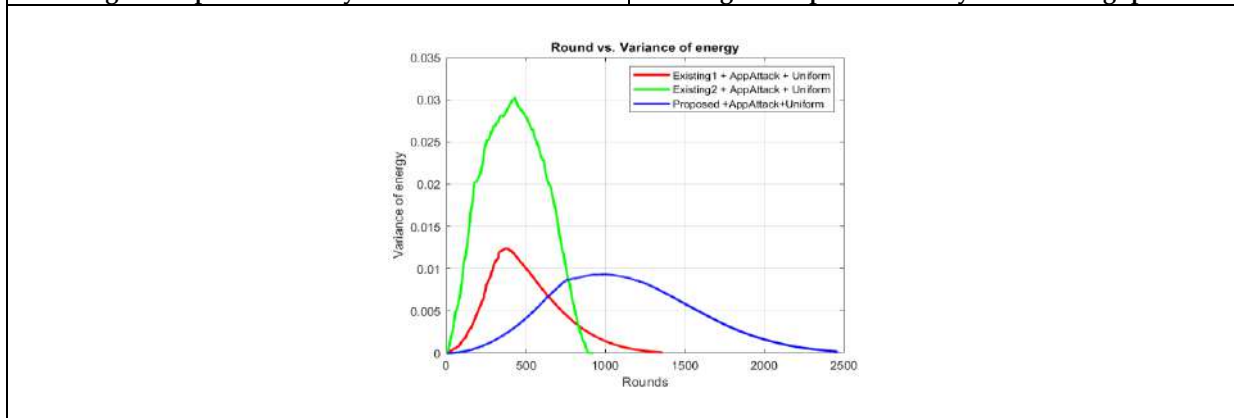
Fig.7 Comparative Analysis of Energy Fluctuation

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RESEARCH ARTICLE

Crop Recommendation System using Random Forest Approach

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ABSTRACT

There are plenty of Machine Learning applications which can be adopted in various fields. The purpose of practicing the method of Machine learning algorithm Random Forest in farming is to assist farmers, to estimate crop yield and considering the particular weather conditions help them by recommending suitable crops for that field to gain the best and high accurate results or production.

Keywords: Agriculture, Random Forest, Yield Prediction, Crop Recommendation.

INTRODUCTION

From ancient times, India is known for its agriculture and farming. Agriculture is regarded as the core of the Indian economy [8]. But due to various problems, farmers struggle to keep up with the evolving needs of the earth as well as those of businesses, consumers, etc. The majority of India's agricultural products have been severely impacted by climate change in terms of performance over the past 20 years. Crop production will be heavily affected by so many variables including climatic, geographic, biological, factors in politics and the economy [11]. For farmers, growing numerous crops can be challenging, especially if they lack knowledge of market trends and commercial tactics [11]. Prior to harvest, crop output predictions would aid farmers and policymakers in deciding on the best course of action for marketing and storage. Determining crop productivity is a productive agricultural challenge. Every farmer seeks to anticipate the yield and determine whether it will satisfy their goals. In the past, yield prediction calculations were based on an examination of a farmer's prior knowledge of a particular crop. Between the years 2004 and 2005, as studied from the Wikipedia, India's farmer suicide rate was ranged from 1.4 and 1.8 per 100,000 people [4]. Farmer suicides increased from 5650 in 2014 to over 8000 in 2015[4]. The purpose of this research is to identify the best crop prediction model that can support given in selecting the right crop to harvest based on local climatic factors and soil nutrient levels. This project will assist farmers in understanding the productivity of their crop prior to planting it on

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an agricultural area, assisting them in making the right choices. This effort will let the farmers determine the yield of their crop before it is planted in the field and also enabling them to make rational choices. By creating a working model of an interactive prediction technique, it attempts to find a solution.

LITERATURE REVIEW

The author S Bharath has used "Decision tree classifier" algorithm for prediction and got the accuracy result 99.87% [2]. The selected algorithm model for this system is Random Forest Classifier machine learning algorithm. Considering the importance of crop predictions, various proposals to improve crop prediction accuracy have been made in the past [2]. It is possible to produce a tool for farmers that will help to solve numerous issues facing the industry. Farmers can use this tool to execute single or numerous tests by entering information about their crops, the time of year, and their location. As soon as one enters the input, the user can select a method and obtain the results. The outputs represent the crop's yield rate [2]. The datasets have been changed into a format that is supported and includes the outcome of the data from the previous year [2]. By using basic engineering calculations, the study checks the soil's fertility and the nutrients available to plants. The yields are precise and enable improving soil characteristics. Compared to traditional approaches, this yields superior results. However, the framework is inconsistent and sometimes wasteful. The author M Kalimuthu has used Naïve Bayes and has got the result with accuracy of 97% [2]. Likewise many of the authors namely, Payal Gulati and Suman Kumar, V Geetha, Shilpa Mangesh P and Chaitanya Chandvidkar have used Random Forest Classifier for the working model and got the accuracy result of nearly 99.87% [2]. Before deciding on a strategy and continuing to work with it, a number of algorithms were evaluated, and their error rates and accuracy were looked at for each.

METHODOLOGY

Any machine learning system needs data to function properly. Once the dataset has been created, it must be trained and tested accordingly by following the chosen algorithm model. We choose to target on several Indian States when putting the strategy into action. It was required to collect data at the district or state level because local climate varies. For the system to work, historical information on the local climate and crop was required. These statistics can be obtained from many official websites such as www.data.gov.in, www.imd.gov.in [12]. The climatic elements that have the greatest effect on the crop includes humidity, temperature, rainfall and the frequency of rainy days. In order to better understand these climatic characteristics, data was obtained on a regular basis. This working model has made use of the sample data collection that needs to be trained and then tested. Based on the data and six parameters, crop production is predicted [5]. These six factors are state, crop, area, season, soil type and production [5]. As an outcome, using these data, we can build a machine learning model, train it, and then predict production based on the soil type and locality [5]. Once dataset is trained based on the selected algorithm they must be now tested. Two datasets are required when building a machine learning model: one for training and the other for testing. With the help of the Random Forest Regressor, we fitted the data to several decision trees. Finally, we must fit the model during training. We must test the model after it has been trained. We'll use the prediction method for it.
The selected algorithm model for this project is Random Forest Regressor machine learning algorithm.

- One of the best and popular Machine learning techniques is random forests.
- They are highly effective because they often have good predictive accuracy, little over fitting, and are simple to interpret.
- This evaluation is enhanced by the efficiency with which each variable's influence on the tree decisions may be determined.
- In other words, it is simple to calculate the percentage of the decision that each variable generates.

This particular project consists of following as working modules;

Login in as user

- In the login page user need to enter the username and password.
- Username and password should be verified
- Once it verified user can upload dataset, yield prediction, weather forecast,

Uploading

➢ First of all the user needs to browse the dataset.
➢ After that need to upload that data set.
➢ Once it uploaded the user can see the preview page of the dataset.
➢ After that user need to train and test to the data set.

Yield Prediction

➢ By entering the State name, Crop, Area, Soil type, Production and Yield will be predicted.

Crop Recommendation:

➢ Here crop will be predicted according to the location and Soil Type.

Weather Forecast:

➢ Here Weather forecast can be done and can see whether the fertilizer can be used or not.

This particular working module will 1st recommend the crop that is suitable for that field based on the inputs provided soil type, state and area in acres. Below diagram (1) shows the pictorial representation. After the suitable crop has been recommended then it will predict the yield for various crops as shown in the below diagram (2).

RESULTS AND DISCUSSION

Crop Yield Prediction Table (1), Algorithms Accuracy Table (2). We may conclude from the above drawn Table [2] that the Random Forest Algorithm provides the highest level of accuracy for our dataset.

CONCLUSION AND FUTURE ENHANCEMENT

This study uses two predictor variables, Gini and Entropy, to examine well-known algorithms, namely K-Nearest Neighbor (KNN), Decision Tree, and Random Forest Classifier [2]. Results indicate that of the three, Random Forest does have the highest accuracy [2]. The machine learning approach called random forest seems to be adaptable and user-friendly. It frequently produces excellent results even without hyper-parameter changing. It is also one of the most frequently applied algorithms because of its versatility and efficiency. Both classification and regression tasks can be accomplished with it. To provide a forecast that is more specific and predictable, several decision trees are created through random forest, and they are then combined. For most existing machine learning systems, the primary benefit of random forest is that it can be used to resolve regression and classification issues. To determine the crop that will grow the most effectively on a given plot of land, a comparison of numerous and distinct supervised machine learning models is conducted. Finally, we found that the Random Forest Classifier provided the highest level of accuracy for the crop forecast dataset. The intention of the ongoing effort is to regularly update the datasets in order to give precise predictions, as well as to provide the sequence of crops that should be cultivated depending on the soil and weather conditions. The entirely automated options give in the upcoming study will produce the same outcome. The current study demonstrated that the methods of data mining can be used effectively to estimate agricultural production based on atmospheric input variables [10]. The developed application is user-friendly, and overall forecast accuracy is greater than 75% the study's chosen states and crops show higher accuracy

of forecast. By giving that location's climate data, since user-friendly anyone can apply a website created for estimating agricultural yield for their preferred crop.

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Table 1: Crop Yield Prediction

References and Years	Algorithm used	Accuracy
S Bharath et.al(2020) [2]	Decision Tree Classifier	99.87%
Payal Gulati And Suman Kumar (2020) [2]	Random Forest Classifier	98.9%
Archana Guptaet.al (2020) [2]	Decision Tree Classifier	91.03%
V.Geethaet.al (2020) [2]	Random Forest Classifier	95%
M Kalimuthu et.al(2022) [2]	Naive Bayes	97%
Shilpa Mangesh P et.al(2021) [2]	Random Forest Classifier	95%
Chaitanya Chandvidkar	Random Forest Classifier	96%

Meghana   and Veena S Badiger

Table 2: Algorithms Accuracy

Sl. No	Algorithm	Accuracy generates
1	K Nearest Neighbor's (KNN)	90%
2	K-Nearest Neighbors Classifier	97.04%
3	Multivariate linear Regression	60%
4	Support Vector Machine (SVM)	75%
5	Artificial Neural Networks (ANN)	86%
6	Decision Tree Classifier Entropy Criterion [2]	97.95%
7	Decision Tree Classifier Gini Criterion [2]	98.86%
8	Random Forest Classifier Entropy Criterion [2]	99.32%
9	Random Forest Classifier Gini Criterion [2]	99.32%

Fig.1 :Soil occupied area	Fig.2: The yield for various crops

RESEARCH ARTICLE
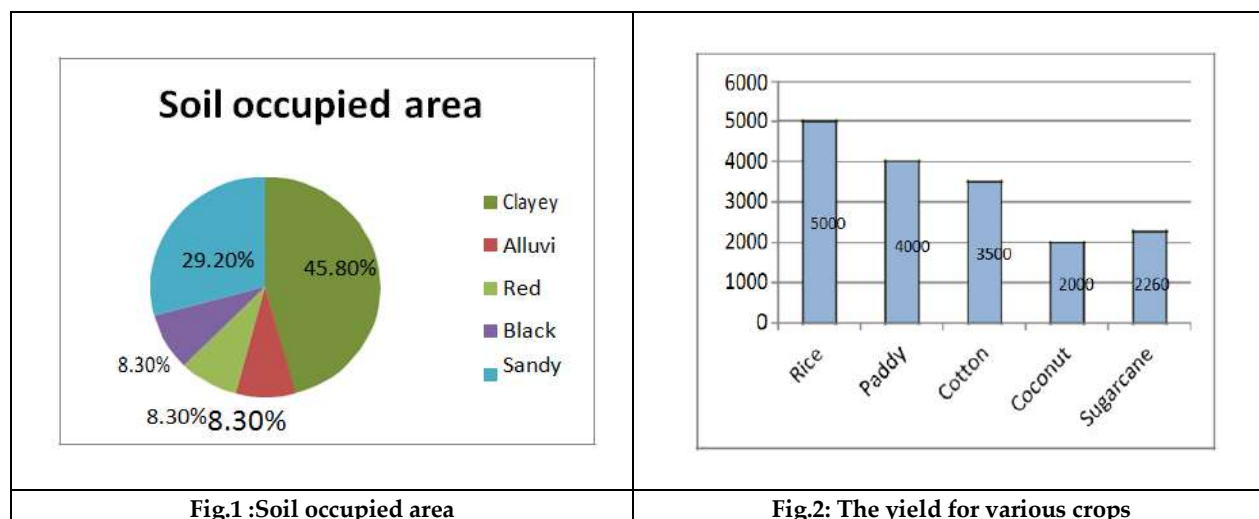
An Analysis of Activity Recognition Technology and Monitoring for the Elderly people

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ABSTRACT

By regularly tracking and identifying physical activity, we can control and minimize the risk of various medical conditions including obesity, cardiovascular disease, and diabetes. Deep Learning and Machine Learning aid in the identification of relevant data in order to recognize desired actions. The feature selection method facilitates the extraction of pertinent data in particular so that the type of activity can be appropriately generated. This study aims to offer a thorough introduction to people new to sensor-based human activity detection and how sensors can help in healthcare solutions to improve continuous monitoring. It is essential to first understand the needs of elderly persons in terms of care and assistance. We conclude that most of the researchers suggested sensors are well-suited for Human activity recognition research in the health sciences.

Keywords: Human activity Identification, worn-in Sensors, Features, Classification, Healthcare, Elderly care and support.

INTRODUCTION

Ageing populations are rising in several nations throughout the world. By 2050, more than 25% of the world's population, according to the World Health Organization, will be over the age of 60. (WHO)[23].In 2016, Malaysian statistics revealed that 6% of the 31.7 million populations were old, with projections that by 2030, the senior population will account for 15% of the overall population [15]. From 1950 to 2050, the average age of people in various areas such as Africa, the Eastern Mediterranean, Europe, the Western Pacific, the Americas, Southeast Asia, and other parts of the world all indicates a significant growth in numbers. Around the world, the population of adults 60 and older is expanding more quickly. According to the 2017 World Population Report, from 2010 to 2015, life expectancy was 71 years; by 2045–2050, it will be 77 years. (United Nations).

Elderly Centered Activity Recognition

Low birth rates in the recent decade, along with longer life expectancy, have shifted the age distribution of a population dramatically in favour of the elderly. Because the majority of older people nowadays live alone, their families must keep a close watch on their everyday activities. It is not always feasible to be with elders at all times due to a busy schedule. As a result, families prefer remote monitoring. They can follow the activity of older persons using technology and be alerted if they engage in unusual behavior, such as falling-down. This form of monitoring allows seniors to stay safe while just needing little assistance. Protect the quality of life of old persons who wish to live alone and without the help of others. [8]. Monitoring and supervising elderly single people in their homes is important in this setting. Computer-based autonomous systems might provide a workable solution to this issue. The needs of the ageing global population are a big concern. Elderly individuals have needs in the areas of healthcare, ageing in place, security, and social well-being. Continuous monitoring is made possible by activity identification, which also helps prevent risky circumstances like falls. Gheorghe Sebestyen [21] explain the prospects for implementing a supervision system capable of monitoring a person's behaviour in his or her house without invading privacy are examined in this study. The fundamental aim is to collect data from numerous sensors installed around the building and in the house and on mobile devices, and deduce the most likely sequence of the tasks carried out by the monitored individual A Secret for the activity chain, the Markov chain approach is used.

Activity Recognition

One of the most essential and challenging issues in computer vision is identifying human activities. One of the most promising assistive technologies for assisting seniors in their everyday lives is one that uses sensors. It has a lot of potential for human-centered applications. A sequence of basic activities (e.g., walking, standing, and sitting) done by a human is defined as an activity in HAR systems. The general system for HAR are follows as

1. Application => Surveillance and Healthcare system
2. Human Activity recognition system => single person activity and Abnormal activity
3. Core technology => Feature extraction

Section II discusses the background study, Section III elaborates the technology enabling activity recognition, Section IV highlights the uses and potential of HAR, and Section V concludes with a discussion and conclusion.

Background Study

The goal of HAR is to detect a person's bodily activity using accelerometer and/or gyroscope information. As a result, it's a system that collects data on user behavior in order to prevent dangerous situations and forecast future events. J.R. Villar *et al.* [2] examine the optimum adaption of the specified approach for assessing an individual's present activity. The findings are likely to be incorporated into a particular gadget for detecting early strokes. According to Prasad *et. al*. [3], Numerous hospitals and clinics have delayed in-person outpatient clinic visits where patients with head and neck disorders receive essential long-term therapy because to the coronavirus epidemic. The majority of practises have been convinced to use telemedicine out of necessity in order to ensure that their patients receive continuity of treatment. Telemedicine is now more widely used as a result of the outbreak. According to Z. Zhou *et al.,*[4] With the help of the cloud, each smart device can download data using RF or low-power backscatter connections. thanks to a revolutionary human activity identification system according to the algorithm (IBCN). The research' findings indicate that a variety of aleatoric and epistemic causes of uncertainty, including noise and unreliability, might affect the data gathered by wearable IoT sensors. Additionally, Comparing IBCN to more conventional designs like Cognitive radio (CR) learning, deep learning-based sensor activity recognition (DL-SAR), and Cloud-assisted Agent-based Smart home Environment, the accuracy of classifying patient health data has increased dramatically. B. Nguyen, Y. Coelho, T. Bastos *et al.*[5] author emphasis that Remote monitoring and telemedicine are both feasible with HAR. allowing physicians to observe an infected patient's behaviour without having to be physically there. An customised block diagram for COVID-19 patients can be constructed in circumstances like this epidemic. Heart rate variability, body temperature, and other data can be used in block classifications to assist diagnose the patient. As a result, a telemedicine and remote monitoring application would be created, reducing the requirement for in-person contact.

Technology supporting Activity Recognition

Wearable technology, video technology, ambient technology, smart phone-based ubiquitous technology, and robots are among the four ways to activity identification. 1. Daily activities, 2. Raw data preprocessing, 3. Feature selection and 4. Classification method is all included in wearable sensor-based HAR. Wearable-based techniques to fall detection are particularly beneficial for older persons who live independently in their own homes. Sensor devices are typically worn on the waist or chest because, as compared to other places, this allows for more easier fall detection.[7]. Despite being easy to use and capable of producing excellent results, computer vision-based techniques have a number of shortcomings. Privacy is the main issue. Due of the low cost and progress in sensor technology, the majority of activity recogntion research has switched to a sensor-based approach [21].

Human Activity Identification Using Detectors

As the significance of day-to-day living grew, researchers turned their attention away from activity detection from images and movies and toward employing wearable and ambient sensors to track human activities. Nowadays, everyone needs a smart phone in their lives, allowing for ubiquitous healthcare service for anybody. Sensor-based HAR involves tracking a person's activities using a network of sensors and linked devices. To detect physical activity, we are currently employing Smartphone sensors. Accelerometer, gyroscope, barometer, and other sensors are now in use. Smartphone's, which come with a variety of sensors, have recently is being investigated as alternate platforms for human activity identification. The One of the most promising approaches for assisting senior citizens in their daily life is human activity recognition (HAR) using sensors, according to Wang, *et al.*'s[16] analysis. In Figure.1 the illustration of sensor –based activity recognition are shown in flow chart manner.

Accelerometer

Accelerometers are electromechanical devices that measure the rate at which an object's velocity changes. Measures rate of change of velocity along three orthogonal axes of Smartphone.

Applications of Accelerometers

1. Fall detection
2. Medical applications
3. Wearables and fitness trackers

Godwin Ogbuabor [10] elaborates that this the objective of this study is to examine how gyroscope and accelerometer sensors work together to automatically detect, analyse, and recognise human behaviour using ANN. The experiment's results, which were based on a publicly available dataset, reveal that each of the sensors can be used to recognize human activity independently. The results of the experiment using the publicly accessible dataset show that each of the sensors may be utilized for human activity recognition independently.

Gyroscope

An instrument that can gauge and monitor an object's orientation and angular velocity is a gyroscope sensor. Gyroscope sensors may also be referred to as angular rate sensors or angular velocity sensors. When it is difficult for a human to discern an object's orientation, these sensors are utilised. The change in an object's rotational angle per unit of time, expressed in degrees per second, is known as angular velocity. Measures angular velocity around three orthogonal axes of Smartphone.

Applications of Gyroscope

1. Computing Pointing Devices.
2. Racing car industry (engine act like a gyroscope).
3. Wheels on motorbikes (make bike easier to balance).

The HAR procedure is lengthy and involves five steps

1) Data collection from datasets

2).Collecting the data from the sensors data
3).Feature selection
4). Training and testing the data

In Figure 2, classification models in HAR are graphically depicted. The process begins with training data, which is then fed into a machine learning algorithm, which subsequently determines whether the patient is standing, sitting, walking, or lying.

Importance of a Wearable Sensor Network in Health Care

Several wearable sensor networks are now being developed for health and wellness objectives. Wearable solutions for healthcare have grown in priority in recent decades as a result of the advancement and availability of various equipment and technical solutions, as well as their cost reduction and ease of use in daily use and satisfied performance. In Figure 3 the Sensor data will be used to offer clinicians with a patient's total and objective clinical condition, allowing medicine to be tailored to each person and therapy modifications to be made in response to changes in symptoms. Wearable-based techniques to fall detection are particularly beneficial for older persons who live independently in their own homes. When compared to other locations, sensor devices are frequently worn around the waist or on the chest since this allows for easier fall detection. The multi-sensor system also monitors the user's heart and respiration rate, as well as their general health. Table 1 presents a full explanation of the sensor modalities used in human activity detection systems, as well as their benefits and drawbacks. M Pastorino [9] according to the author this wearable solution was employed for objective evaluation of Parkinson's symptoms.The findings show that Worn-in sensors may be used to objectively evaluate motor variation, and physicians can utilise these tools to adapt and personalise treatment.

According to Abdulhamit Subasi *et al.* [11], The recommended algorithm could produce more accurate predictions for smartphone-based human activity recognition, which is essential for the development of precise and efficient healthcare monitoring systems as well as the environment of smart cities. The Adaboost ensemble classifier in HAR, when paired with k-Nearest Neighbors, neural networks, Nave Bayesian networks, and decision trees, yields good performance, as demonstrated in the current study. Adaboost ensemble classifiers outperformed the other examined data mining methods, analysed, according to the study's results. The Wearable Sensor Network for Health Care is depicted in Figure 4. Asif Iqbal [13] elaborates that the physical activity is defined as bodily movement caused by skeletal muscle contractions that result in an increase in energy expenditure over resting levels. Human physical activities have a significant impact on a person's mental and physical wellbeing. Physical fitness can be harmed by a lack of physical activity. Physical inactivity, along with poor diet, smoking, and alcohol consumption, has been shown in recent research to be a substantial cause of early mortality. With the use of physical activity tracking technologies, this difficulty may be considerably addressed. To this aim, the information gathered from them can be used to utilize to identify activities. As a result of such surveillance, the health risks associated with physical inactivity can be considerably decreased. This approach can also be applied to other aspects of healthcare, such as tracking the progress of a patient. Table 2 summarizes the datasets utilized, technique, and themes mentioned in the Healthcare-Related Human Activity Recognition Research Papers.

Datasets

A dataset called WISDM (Wireless Sensor Data Mining) was released in 2019. This collection is composed of processed sensor data from a smart watch and smart phone's accelerometer and gyroscope. The collection includes 7352 participants and 6 activities lasting for 180 seconds Each participant was wearing a smart watch on his wrist and carrying a smart phone in his pocket. Customized apps running on smart phones and smart watches were in charge of data collection. Sensor data collected from accelerometers and gyroscopes on both smart phones and smart watches reveals a total of four sensors.

HAR Applications in Healthcare

• Identification of ICU Patients' Early Mobility Activity
• Identification of DMD Patients' Gait Characteristics (Duchenne muscular dystrophy)

Opportunities of HAR for Healthcare

Prevention and intervention of chronic illness
In chronic illness, it is important to track the patient's long-term habits. This can be accomplished with the aid of biometrics, mobility screening, ECG, and other vital indicators, such as continuous glucose monitoring.

Healthy aging
Population aging is becoming more common in most countries as fertility declines and life expectancy increases. We think that diagnosing and monitoring gait and movement patterns is crucial to healthy ageing.

DISCUSSION

COVID-19
HAR can be used in telemedicine and as a remote monitoring device. The SARS-COV-2 virus is now causing a global epidemic of COVID19. This virus is a fast-spreading virus that originated in China and has spread over the globe. Many governments have imposed travel restrictions and imposed self-isolation to stay apart from other people regrettably, vital employees, such as Clinicians must enter the hospital and engage with infected patients. This is especially concerning because protective medical equipment, such as masks, gloves, and goggles, is in short supply. HAR applications can be an effective tool for reducing spread. HAR allows physicians to observe patients remotely and use telemedicine. It keep track of an infected patient's activities.[5] One of the synthesis's main advantages is the broader approach taken when estimating the care and support needs of elderly people living at home with chronic conditions. Understanding the physical, social, and psychological issues that older persons face, as well as the larger context in which they live and interact, is critical to developing successful solutions and promoting the adoption of these solutions. [20]. Wearable sensor-based physiological monitoring of senior citizens having the capacity to significantly enhance their lifestyle of quality and avert undesirable health-related occurrences. Monitoring daily activity patterns may help elderly adults who want to keep track of their health state. The system for care for elderly persons has a big challenge with the detection of human activity. People are interested in creating systems for long-term monitoring of human beings utilising wearable monitoring devices as a result of advancements in sensor technology.

Future Direction

Selecting the appropriate sensor modality for a given task
The primary issues with employing house cameras for HAR are a heavy computational load and privacy invasion. Wearable sensor-based HAR is a potential approach since it is less expensive, more adaptable, and more useful for daily usage. A research challenge to address is how to design, implement, and optimize a HAR system to meet the demands of senior citizens who want to live as freely and comfortably as possible.

Issues with wrist-mounted sensors
A subtle and more practical option for daily use is a wrist-worn watch-like device with integrated sensors. Additionally, since most tasks involve wrist motions, the wrist is an ideal site to produce high precision . While the wrist-worn sensors face a number of challenges, including high within-class variance in sensor signals (especially acceleration) and recognition accuracy reductions from activities like tooth brushing and eating (feeding), wiping, and ironing that are easily misclassified. This makes it more challenging to use wrist-worn sensors for activity tracking. One approach is to add additional sensors to produce more accurate data. It is necessary to create intelligent expert systems that the government may employ to monitor and identify senior people's actions. Nowadays, with the help of these machines learning tools, medical decision support systems have emerged. The novel machine learning techniques will be proposed for HAR system to reach maximum accuracy.

CONCLUSION

Continuous unobtrusive monitoring and precise activity detection ensures the elderly protection in emergencies and recognizes changes in their bodies. The goal of this study was to see how the   sensors used to help older people. Current studies on geriatric care activities, sensors, and recognition techniques were examined. We have discussed in detail the technology used in sensor based and importance. In conclusion, this analysis gave an overview of the areas in which older individuals with chronic diseases who live at home require care and assistance. Finally, we want to explore in future how to improve and protect the senior population's standard of living who wish to live freely and without the use of mechanical devices.

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Table 1: Sensor Modalities in HAR Systems

Sensor Modality	Description	Examples	Advantage	Disadvantage
Wearable[17]	Mining the useful data from wearable sensors to recognize human activities.	Accelerometer, gyroscope, heart rate, etc., built in a smartphone, band, watch.	Small size, low-cost, flexibly worn on body, capture motion-related data	Since they are unable to give contextual information, they face the problem of arbitrary data generated by actions. (skin disease)
Ambient	Using sensors that are generally fixed in the environment to infer human actions	Surveillance camera	Camera can give precise and direct information	Privacy issues, expensive, working in a constrained space

Table 2: Healthcare-Related Human Activity Recognition Research Papers using wearable sensor

Studies	Dataset	Methodology	Concepts Discussed
[2]	Smartphone	Genetic Algorithm	Problem of stroke early diagnosing
[4]	wearable IoT sensor	Bayesian network, deep learning	For the long-term, personalized monitoring of a person's actions, a novel IoT framework is offered.
[7]	Wearable sensors	SVM RBS and DT	SVM was the modeling approach that performed best in terms of specificity and provided the lowest false alarms.
[6]	Wearable sensors	Machine learning	To detect human activities (elderly people and patients in a hospital environment.)
[14]	Wearable sensors	IOT and AI	Gait study of Duchene muscular dystrophy (DMD) patients and early mobility detection of human activities for intensive care unit (ICU) patients
[18]	Wearable sensors	Machine learning techniques	Systematic review of studies on recognizing bathroom activities in older adults using wearable sensors.
[19]	GPS(Smartphone)	Deviation Detection Algorithm	Monitoring care in outdoor navigation by mining the elder's previous movement trajectories and identifying any outliers.

Figure 1. Illustration of Sensor–Based activity recognition

Figure 2 . Classification Models in HAR
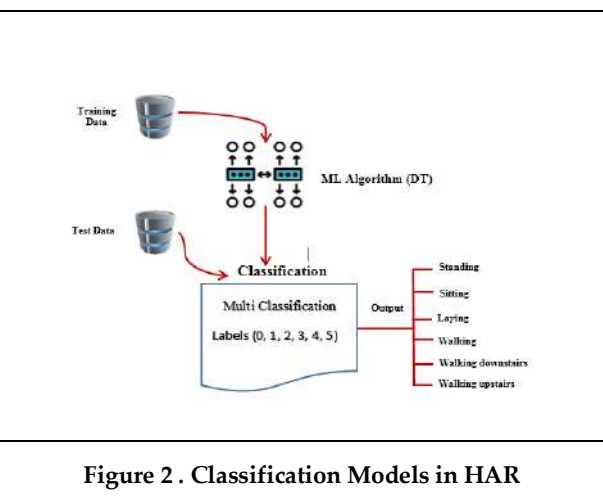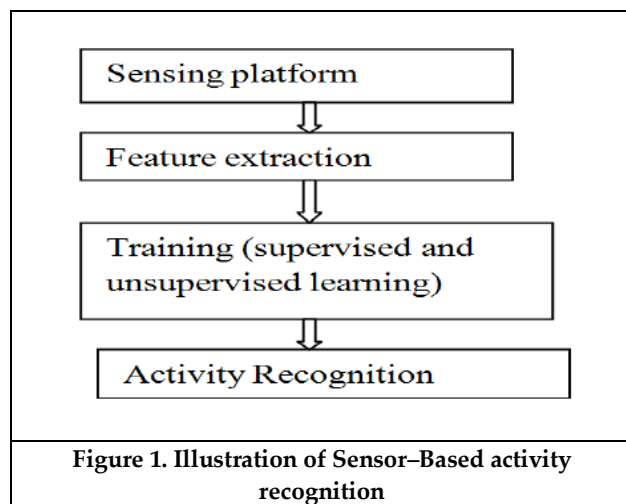
Janaki and Geethalakshmi
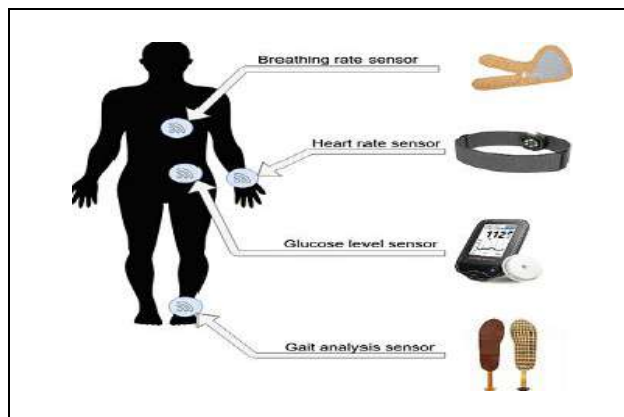
Figure 3: Types of Sensor Data	**Figure 4: Wearable Sensor Network for Health Care**
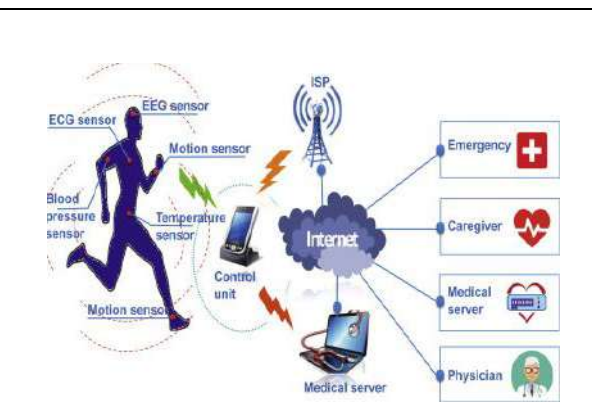
RESEARCH ARTICLE

A Survey of Mythril, A Smart Contract Security Analysis Tool for EVM Bytecode

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ABSTRACT

The transactional records of crypto currencies in a decentralized data structure are popularly known a block chain. It is made popular and widespread by the two most popular crypto currencies, Bitcoin and Ethereum. Ethereum has evolved to the notion of smart contracts, which are full-blown programs that are run on block chains. Over the past few years, Ethereum's smart contract system has seen steady adoption, supporting millions of contracts, controlling millions of dollars' worth of crypto assets. The large-scale adoption and utility of Non-Fungible Tokens (NFT) in the art and music space has given a much-needed boon to the smart contracts. All NFT implementations are carried out using smart contracts and because they involve huge financial and intellectual worth, their security becomes paramount. The paper investigates the security of running smart contracts based on Ethereum in an open distributed network. We introduce Mythril, a smart contract vulnerability assessment tool, its usage, scope and bindings with official vulnerabilities documents for smart contracts.

Keywords: Blockchain, smart-contracts, Ethereum, EVM, Mythril.

INTRODUCTION

Ethereum is a groundbreaking technology in block chain landscape because it facilitates smart contracts or DApps (Decentralized Applications) [1]. DApps are essentially tiny sized programmed logics that automate and orchestrate financial transactions on the block chain. As the money involved in such smart contracts range in the order of hundreds of millions of dollars, it inevitably becomes a target for hackers. At the same time need for security in such smart contracts is also rising [2]. There are multitude of new security problems in Ethereum, that an exploiter can manipulate in smart contract execution to gain profit. These bugs suggest a certain subtle gap in the distributed semantics of the underlying platform. The threat analysis study on the Ethereum network suggests that among

nineteen thousand and three hundred and sixty six subsisting Ethereum contracts, eight thousand eight hundred and thirty three of them as vulnerable, that includes the Decentralized Autonomous Organizations (DAO) bug which led to a 60 million US dollar loss in June 2016. Many tools to analyze the security of smart contracts are present in the blockchain ecosystem [3] [4]. In this paper, we are focusing on Mythril, one such smart contract security tool for Ethereum Virtual Machine (EVM) [5] bytecode. We discuss installation, usage and kind of vulnerabilities it can handle.

Contributions. This paper makes the following contributions.

- We document several classes of security bugs in Ethereum smart contracts which are resolvable by Mythril.
- We introduce Mythril, an execution tool which analyses the Ethereum smart contracts to detect bugs.
- We map the Mythril vulnerabilities detection table with Smart Contract Weakness Classification (SWC) and Common Weakness Enumeration (CWE) repositories.

Smart contract security

Need of Security in Smart Contracts

The discussion over security of smart contracts is beefing up day by day. In order to understand this growing need, it is imperative to understand the scale of Ethereum network. The Fig. 1 shows the scale at which the Ethereum Cumulative Address growth is happening. Currently, it stands at just over 200 million addresses. This clearly shows how much adoption and traction Ethereum is attracting by the day. Another important and interesting metric of observation is the total verified contracts per day. Fig.2. shows how many unique contracts are being generated every day since the inception of Ethereum block chain. The trend clearly shows that it is hovering in the range of 300-600. This number is directly associated to the applications, NFTs and other contracts beings deployed on Ethereum, each of which is a spot of interest and observation for smart-contract vulnerability. Most of the smart contracts in Ethereum block chain are Ethereum Request for Comments (ERC) viz ERC-20 tokens, ERC-721 or ERC-1155 tokens. A survey on these tokens on etherscan.io revels that the stakes are huge in these tokens. The numbers are staggering, lucrative and worth exploration. Table 1 shows top 10 ERC-20 tokens and their market capitalizations with top 3 tokens harboring in excess of 167 billion US dollars. Another important observation is the number of such tokens. A total of 591,356 Token Contracts were found and each one of them is using smart-contract in their implementation.

The Table II shows the top 10 ERC-721 tokens based on the number of transactions per day. Top 3 ERC-721 tokens generate in excess of 50000 transactions. A total of 120,999 ERC-721 Token Contracts were found which is a splendid number in a so-called bear market. The Table III shows the top 10 ERC-1155 tokens based on the number of transactions per day. Top 3 ERC-1155 tokens generate around 16000 transactions. A total of 16,918 ERC-1155 Token Contracts were found which is a very good number.

With just a small amount of research one can conclude that there are many well documented concerns with smart contracts. Solidity is the market leader in terms of choice of programming language to write smart contract. There are proven vulnerabilities in solidity that can be exploited and hence security check requirement mounts up. There is an incident where a gambling contract contained in excess of 10 million dollars was ditched out of funds due to exploits. A recent reentrancy bug robbed a Decentralized Autonomous Organization (DAO) [6]of $150 million US Dollars (USD). All this discussion proves that a poorly written code in Solidity can result in humongous losses. So, developers need a platform or framework or tool to assist them in analyzing these vulnerabilities [7] [8].

[1] https://etherscan.io/chart/address
[2] https://etherscan.io/chart/verified-contracts
[3] https://etherscan.io/tokens
[4] https://etherscan.io/tokens-nft
[5] https://etherscan.io/tokens-nft1155

Further motivation on the scale of adoption can be gauged by the fact that the Ethereum blockchain smart contract employability is spread across vast domains. The smart contracts have many use cases in real-life. The following are some of the use cases:

• Smart Contracts in Finance Sector: The operational instructions of a financial product or a service can be coded seamlessly into a smart contract thereby facilitating interest disbursements, claims settlements and automated financial transactions. The DeFi (Decentralized Finance) space caters to a hugge market of financial ecosystem void of a bank. Thefore, DeFi applications could become more flexible and cost-effective than traditional ones.

• Smart Contracts in Prediction Markets: Prediction market is bound to grow exponentially owing to the data growth at a very high rate. In the field of graphics and gaming , the trust on third parties is minimal, at the same time witnessing a good percentage involved in betting and gambling. Ethereum based smart contracts can increase the trust level in gaming and betting domains as it also supports the payment options in the form of Ethereum based crypto currency. Also, the reward distribution can be made more accurate, fast and reliable if done on Ethereum blockchain.

• Maintaining Digital Identity: PKI (Public Key Infrastructure) has been responsible for ensuring the identity and trust management in the traditional systems. Various issues related to digital identity have been reported which are addressed and resolved by Ethereum smart contracts along with a second layer solutions which are fast and cost effective.

• Supply Chain Management: This domain has witnessed the issues related to transparency and tracking. Smart contracts based on Ethereum have simplified and increased the effectiveness of the complete supply chain management system due to its inherent nature of automatic verification.

• Health Care Sector: Health care is the most sensitive of all the sectors. Ensuring honest and transparent data keeping is much required in the medical sector. The deployment of smart contracts for preserving the confidentiality and sacredness of public health data can very effectively rule out the possibility of tempering and can reduce the broker role in such sensitive domain of health care sector.

Although smart contracts promise security, confidentiality and integrity of data stored on their respective blockchains, still they are prone to certain vulnerabilities. However, smart contracts [9], [10], [11] are prone to attacks owing to a few security loopholes present in them. These vulnerabilities [12] are due to several reasons such as blockchain implementational features, coding issues, etc. Often it is seen that the attackers exploit these gaps as huge number of cryptocurrencies are stored as balance. Several security analysis tools are developed to address these gaps [13]. Our survey focuses only on the analyzing mechanisms linked to the Ethereum blockchain smart contract.

Mythril
The need for automated tools in security analysis for smart-contract is on the rise because of large scale adoption of Ethereum and explosive NFT marketplace [14]. A ready to use tool for like VULTRON can make life easier for threat analysis team in blockchain development area [15]. Mythril is an excellent tool for analyzing smart contracts built for EVM bytecode. It can detect security vulnerabilities in Ethereum, Hedera, Vechain, Tron, Quorom, Roostock and basically every or any EVM compatible blockchains. Mythril is exclusively based on symbolic execution engine. It thoroughly goes through all probable states within a contract with the help of function(s) call. In this way Mythril is able to detect the vulnerabilities but not the exploits. Before jumping into the realm of exploits caused due to the vulnerabilities . It is important to state the difference between a vulnerability and an exploit. Vulnerabilities are codes with some insecurity and unacceptable exception handling. On the other hand, an exploit is the process of abusing that vulnerability, which could lead to loss of funds for the contract holder and payouts for the attacker or the exploiter. It may be stated that an exploit may not always happen when a vulnerability subsists. Mythril analysis uses the bytecode of the smart contract to decompile it back into EVM opcode instructions. It then explores all probable program states over 'n' transactions. Mythril uses LASER, a symbolic virtual machine (SVM) to create an environment, where it executes opcode and reveal vulnerabilities. LASER computes all probable program states. Mythril uses a number of analysis modules to determine if the vulnerability subsists. If a compromised or vulnerable state subsists. Mythril uses Z3, an automated theorem prover, to prove or disprove the extendibility of the state. Z3 is delivered by Microsoft Research under MIT license. All the issues about symbolic execution engines, detecting

vulnerabilities are well documented. A review of types of attacks is also done. There are other tools also that automatically detect and exploit contracts. Karl is one such tool that utilizes Mythril to get insights of new contracts on the blockchain.

Mythril installation / Usage

The first step to using Mythril for vulnerability assessment is to install in properly on the machine. Installation of Mythril is relatively easy and is classified as a 3-step process:

a. Environment preparation by installing Homebrew, python and python3.
b. Install Mythril using following commands

```
>brew update
>brew upgrade
>brew tap
ethereum/Ethereum

>brew install leveldb
>brew install solidity
>pip install mythril
```

c. Checking Mythril for proper running
>myth -x smartcontract.sol

If it shows analysis results and displays the message that the analysis result is complete and some issues or no issues are found then the installation is done correctly. Mythril can detect 16 types of vulnerabilities and each vulnerability could potentially cause huge losses to contracts. Though each vulnerability is unique and holds its own importance, Mythril rates them with severity ratings to indicate the level of danger. In the following paragraph we are discussing the probable vulnerabilities types Mythril detects and their quick explanations.

a. Integer Underflow and Integer Overflow: An integer overflow/underflow occurs at the moment of arithmetic operation outstretches its maximum or minimum size of datatype. E.g., $uint8 = 2^8$. Overflow can result in incorrect if statement results.
b. Exception State: It occurs when the Flow control outstretches uncompromisingly failing Assert () statement.
c. External call to user supplied address: It occurs when a smart-contract calls an external contract which the callee of the contract supplies, giving a probable reentrancy bug.
d. External call to a fixed address: This vulnerability occurs when a contract calls an external contract which a contract has hardcoded, again causing a probable reentrancy bug.
e. Delegate call to proxy user supplied address: This scenario occurs when a contract uses an address for example [address].delegatecall() where external contract could change the local repository or ditch the contract of its balance.
f. A Dependence on one or more predictable environment variables: If the numbers supervised by miners are a not a good source of haphazardness, then the miners can control the yield, thereby making the variable a potential vulnerable spot.
g. Use of the tx.origin command: It is a deprecated function in Solidity and this might lead to not expected consequences.
h. Unprotected withdrawal of Ether: If the Function(s) are not protected with appropriate coding then the attacker might withdraw ether from the contract.
i. Denial of Service with failed call: It occurs at the moment of external call fails by accident or by intent, a Denial-of-Service condition can result in the contract as a contract which is waiting for a call to return.
j. State change after external call: In this case a contract might call back into the calling contract even before its first invocation is executed. This could result in unforeseeable results.
k. An Unprotected self-destruct function: This is a vulnerable function and any attacker can call the function that contains a self-destruct contract's context.

l. Unchecked call return value: It happens when the Return values of a message call are checked to see if an exception was thrown despite which the function call is executed.

m. Use of call code: It is also one of the deprecated functions that might lead to bad consequences.

n. Jump to arbitrary Instructions: A software developer might use an assembly command mstore or the assign operator which a party might redirect to a function data type variable to any other programmable line of Solidity.

o. Jump to arbitrary line: A coder might incorporate an assembly instruction mstore or the assign operator, for which the exploiter might direct a function type variable to the programmable line of Solidity.

p. Write to arbitrary repository slot: This scenario subsists when the contract might write into arbitrary repository place, that could host the contract holder's address; an attacker then could rename the contract.

The repository of all the above discussed vulnerabilities is tabularized in Table IV along with their SWC-Codes, SWC Names, CWE- Codes and CWE Names for quick reference and guide.

CONCLUSION

In the presented paper, discussion about the scope of smart contracts in current business ecosystem is done. Though a very promising technology, it is not free of vulnerabilities, attacks, hacks or exploits. The paper explores the magnanimity of inclusion of the smart contract in day-to-day life. The paper discusses various smart contract types in Ethereum block chain network ecosystem viz. ERC-20, ERC-721 and ERC-1155 and market capitalizations associated with them. As smart contracts are written in Solidity primarily or any other programming language, there is need to check the code for any loose ends known as vulnerabilities. There needs to be a thorough check before any smart contract is deployed in the real block chain. Many tools are available to do so, and one such promising tool is Mythril, which is explored in this paper, we have concisely discussed its abilities in terms of finding multiple vulnerabilities in the contract. The mapping of vulnerabilities Mythril catches is mapped to the SWC registry and CWE repository for enhanced referential usage.

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Table 1. Top erc-20 token ranked according to market capitalization as on 25-08-2022 [3]

Rank	ERC-20 Token	Market Cap
1	Tether USD	$67,480,318,188.00
2	USD Coin	$52,270,490,835.00
3	BNB	$48,228,347,307.00
4	BUSD	$19,191,288,144.00
5	HEX	$9,024,753,133.00
6	SHIBA INU	$7,842,306,323.00
7	stETH	$7,114,517,173.00
8	MATIC	$6,630,385,934.00
9	Dai Stablecoin	$6,484,273,420.00
10	Wrapped BTC	$5,352,497,809.00

Table 2. Top erc-721 token ranked according to transaction volume as on 25-08-2022 [4]

Rank	ERC-721 Token	Transfers in 1 Day
1	Ethereum Name Service (ENS)	26,851
2	Pudgy Dickbutts	15,896
3	Pudgy Penguin Girls	10,403
4	MyRedPanda NFT Collection	10,001
5	MY LAST NFT	9,389
6	Pudgy Doodles	9,094
7	Guardian	8,087
8	EZU	7,394
9	3D Penguin Castle	6,964
10	BOBS	6,685

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Table 3: Top erc-1155 token ranked according to market capitalization as on 25-08-2022 [5]

Rank	ERC-1155 Token	Transfers in 1 Day
1	OpenSea Shared Storefront (OPENSTORE)	12,242
2	Sandbox's ASSETs	2,978
3	10KTF Stockroom ()	1,418
4	Fractalz Waystone	1,256
5	0x62cf887b0084ea2adbce95f15dd6e8547ab53f50	1,087
6	Town Star ()	982
7	0xa642375cc15249a81da9c435fb4edd8a9343ce7f	792
8	parallel (LL)	753
9	0x9d861963dcb40f53c12637afd7aa2c303747f202	731
10	RTFKT-MNLTH Original	731

Table 4: Mythril vulnerabilities and their swc-codes and cwe-codes.

S.No.	Mythril Vulnerability	SWC-Code	SWC Name	CWE-Code	CWE Name
1.	Integer overflow and underflow	SWC-101	Integer overflow and underflow	CWE-682	Incorrect Calculation
2.	Exception State	SWC-110	Assert Violation	CWE-670	Always incorrect control flow implementation
3.	External call to user supplied address	SWC-107	Reentrancy	CWE-841	Unacceptable enforcement of behavioral workflow
4.	External call to fixed address	SWC-107	Reentrancy	CWE-841	Unacceptable enforcement of behavioral workflow
5.	Delegate call to proxy user supplied address	SWC-112	Delegate call to untrusted callee	CWE-829	Inclusion of functionality from untrusted control sphere
6.	Dependence on predictable environment variable	SWC-120	Weak sources of randomness from chain attributes	CWE-330	Use of insufficiently random values
7.	Use of tx.origin	SWC-111	Use of deprecated Solidity function	CWE-477	Use of obsolete functions
8.	Unprotected Ether Withdrawal	SWC-105	Unprotected Ether withdrawal	CWE-284	Unacceptable access control
9.	DoS with failed call	SWC-113	DoS with failed call	CWE-703	Unacceptable check or handling of exceptional conditions
10.	State change after external call	SWC-107	Reentrancy	CWE-841	Unacceptable enforcement of behavioral workflow
11.	Unprotected self-destruct	SWC-106	Unprotected self-destruct	CWE-284	Unacceptable access control
12.	Unchecked call return value	SWC-104	Unchecked call return value	CWE-252	Unchecked return value
13.	Use of call code	SWC-111	Unchecked call return value	CWE-477	Use of obsolete functions
14.	Jump to arbitrary instruction	SWC-127	Arbitrary jump with function type variable	CWE-695	Use of low-level functionality
15.	Jump to arbitrary line	SWC-127	Arbitrary jump with function type variable	CWE-695	Use of low-level functionality

16.	Write to arbitrary repository slot	SWC-124	Write to arbitrary repository location	CWE-123	Write What Where condition
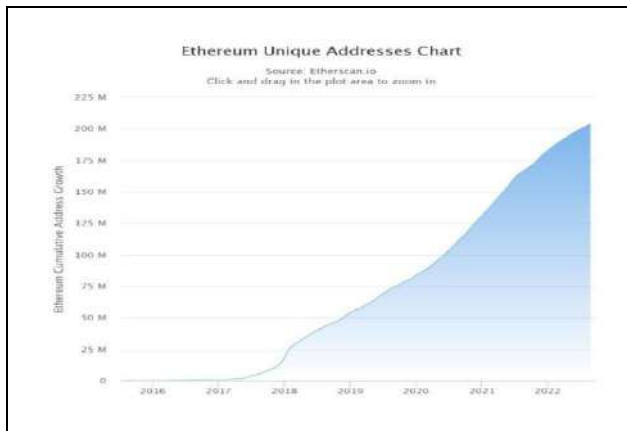
Fig. 1. Ethereum Cumulative Address Growth as of August 2022[1]
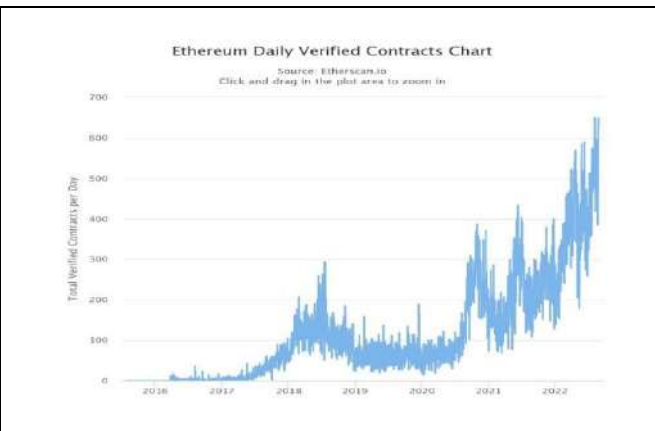
Fig. 2. Total verified contracts per day as of August 2022[2]

RESEARCH ARTICLE

A Comparative Study of Artificial Intelligence Methods for Weather Forecasting

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ABSTRACT

Big data is refers to quantity of data to be stored and different data used for decision-making. Weather forecasting is the method of forecasting future weather conditions. Weather forecasting is the application of science and technology to predict the conditions of the atmosphere for a given location and time. Weather forecasting is performed by collecting the qualitative data about the current state of atmosphere. Classification is the method of classifying the data points that are recognized and distinguished. Classification groups the related data into diverse classes. Different classification techniques are introduced by the existing researchers for weather foresting with marine data. However, the forecasting accuracy and forecasting time performance was not increased through weather forecasting methods. In order to, address these issues, weather forecasting intended by discussed in machine learning and deep learning methods.

Keywords: Big data, decision-making, classification, qualitative data, weather foresting, marine data.

INTRODUCTION

Weather plays a significant part of human daily life. Day-to-day activities are things people do on a regular or daily basis in human plan. Process of predicting atmosphere is particular location in weather forecasting. It's used to predict weather conditions depending on parameters such as temperature, wind, humidity, and rainfall. In the future time, prediction of weather is concerned with weather forecasting. Weather forecasting is producing the critical information about future weather. The weather prediction is carried out for climate monitoring, drought

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detection, industry, and pollution dispersal. This road map of article is including as follows: Reviews the weather forecasting techniques are Section 2. Section 3 describes the existing weather forecasting techniques. Section 4 explains the simulation settings with a possible comparison between them. Section 5 discusses the limitation of existing weather forecasting techniques. Section 6 concludes the paper.

LITERATURE SURVEY

A new weather forecasting model of lightweight data-driven was performed in [1] to discovering the temporal modeling of long short-term memory (LSTM). Different layers are using deep model through the surface weather parameters over the period for weather forecasting. However, forecasting time was not minimized. Deep learning architecture termed Spatiotemporal Convolutional Sequence to Sequence Network (STConvS2S) was intended in [2] to learning the spatial and temporal data dependency with convolutional layers. But, the computational cost was not decreased. SPRINT algorithm was introduced in [3] to decision tree. The weather result was predicted with higher accuracy. SPRINT algorithm was effective and accurate in forecasting weather conditions. But, forecasting accuracy was not improved by the SPRINT algorithm. To improve the prediction accuracy by using Tanimoto Correlation-based Combinatorial MAP Expected Clustering and Linear Program Boosting Classification (TCCMECLPBC) Technique was introduced in [4]. However, the forecasting time was not minimized by the TCCMECLPBC technique. A data distribution model was designed in [5] with cloud computing for Big Data analytics. HR_Alloc Algorithm was designed for data placement in Big Data applications. But, the error rate was not reduced through the data distribution model. A multi-step forecasting method was introduced in [6] with hourly $PM_{2.5}$ concentration. To improve the extreme learning machine (ELM) by using ensemble prediction of $PM_{2.5}$. Modified Ada Boost RT and Gradient Boosting were employed. However, the forecasting time was not reduced by the multi-step forecasting method. A short-term WPF model depending on numerical weather prediction (NWP) analysis was performed in [7] to enhance the accuracy and to improve the time scale. While the forecasting accuracy, time complexity was not minimized by the WPF model. A hybrid mechanism was introduced in [8] to MLP and VAE with firefly optimization. A hybrid mechanism was performed with VAE and MLP to extract features for classification. But, the feature extraction accuracy was not increased by the hybrid mechanism. The numerical Weather Prediction method was introduced in [9] with the artificial intelligence method. To identify the wind turbine hub height position by using convolutional neural network algorithm and downscaling model. But, forecasting time was minimized, the space complexity was not reduced. A new IoT based smart machine learning model was designed in [10] to forecast the weather by finding the necessary trends in big weather datasets. But, the computational complexity was not reduced. To achieve the correlation between meteorological features and power generation by deep learning network (DLN) was –performed in [11]. A multilayer neural convolutional architecture and gradient descent was determined to reduce the error. Though the error rate was reduced, the space complexity was reduced by DLN. A predictable planning framework was designed in [12] to improve the renewable energy penetration (REP) rate and to reduce the cost by emission. However, forecasting accuracy was not reduced by a predictable planning framework.

Weather Forecasting With Big Marine Data
A developing technology of weather forecasting is forecast the weather condition at an exact location at a period. Weather forecasting is a sensitive research field with a group of real-time problems such as inaccurate prediction, lack of handling large inadequate technology advancement, and data volumes. Its plays an important role in resource planning in that instant natural phenomena like heat waves, droughts, and hurricanes. To produce the weather forecast uses computer algorithms based on current weather conditions by a large system of nonlinear mathematical equations.

Weather forecast prediction and analysis using sprint algorithm
SPRINT algorithm was performed by using a decision tree with data in tree structure. SPRINT algorithm was salient features with improvable measurement in cloud technology used for managing large data. The decision tree was the tree structure with its extension. SPRINT algorithm stated data in the tree structure. Data were structured based on

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relationships. The sample data was divided into many subsets and child nodes of every subset. Tree structure was created with classification rules. Two phases in decision tree algorithm likes tree construction and tree pruning stages. On the tree structure, leaf and child nodes are formed by a classification algorithm. The tree pruning phase was accountable for unwanted branch cutting. SPRINT algorithm has two data structures attribute table and histogram. Three parts are employed in property sheet such as index of data records, attribute value, class identification. Attributes were partitioned with node expansion and linked to the corresponding child nodes. The histogram was linked to the nodes for identifying the attribute node distribution type. The sample type and its distribution were explained with the sample distribution type. On the SPRINT algorithm, the pruning was carried out with minimum description length opinions.

TC-CMECLPBC Technique of remote sensed big data for weather forecasting
Tanimoto Correlation-based Combinatorial MAP Expected Clustering and Linear Program Boosting Classification (TC-CMECLPBC) Technique is performed to enhance the prediction accuracy with minimum time consumption. The data and features are gathered from weather database. The relevant features were chosen by identifying the comparison between features. Tanimoto Correlation Coefficient was obtained to classify the similarity with features designed for choosing the relevant features with better feature selection accuracy. After that, the relevant features are choosing and MAP expected clustering process was performed to group the weather data for cluster formation. The amount of cluster and cluster centroids was developed. With clustering process, to comprise the two steps likes expectation (E) and maximization (M) to employ the maximum probability of grouping the data into the cluster. The clustering result was sent to linear program boosting classifier and enhances the prediction performance. During the classification, the weak classifier results were combined to form the strong classifier. Finally improve the prediction accuracy with minimum time and less false positive rate than conventional methods by using TC-CMECLPBC technique.

Data Processing Model to Perform Big Data Analytics in Hybrid Infrastructures
Data distribution model was implementing with cloud computing and volunteer computing environments in a hybrid manner for Big Data analytics. To require the evaluation is carried out with efficient deployment of Big Data in hybrid infrastructures. HR_Alloc Algorithm was introduced to form the data placement in big data applications. The designed scheme is employed for resource share in hybrid infrastructures. HR_ Alloc Algorithm reduced the network latency and data movement during decision-making through a data-driven mechanism for resource allocation between hybrid infrastructures. The data distribution model reduced the hardware and computing complexity. The feasibility of hybrid infrastructure was improved without losing performance. The monetary cost and communication cost were reduced in the best-case scenario because of load balancing.

A combined model for short-term wind power forecasting based on the analysis of numerical weather prediction data
A short-term wind power forecasting (WPF) combined model was introduced depending on NWP analysis to improve the accuracy and time scale. Factors were employed from NWP multivariate data consistent with the criterion of mRMR algorithm. Different characteristics are removed and weather patterns are partitioned into several types. CNN and LSTM were employed to short-term WPF under different weather types. The proposed models were joined by Induced Ordered Weighted Average (IOWA) operator. The actual data was gathered from wind farm to verify the conclusions. A forecast wind power using different weather circumstances in designed method.

Hourly PM2.5 concentration multi-step forecasting method based on extreme learning machine, boosting algorithm, and error correction model
A new multi-step forecasting method was designed for hourly PM2.5 concentration. AdaBoost. RT and Gradient Boosting were obtained into develop the extreme learning machine (ELM) for ensemble prediction of PM2.5. Multiple-input multiple-output (MIMO) was employed for performing weather prediction. By using error correction model (ECM), the predicting error was employed to achieve the hourly PM2.5 multi-step forecasting results. The forecasting method attained a good multi-step forecasting effect of PM2.5. The forecasting policy or boosting

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algorithm is a small influence of forecasting effect. ECM increased the PM2.5 forecasting accuracy. When forecasting steps increase, then the improvement effect of ECM was more important. The forecasting framework was effective and the forecasting accuracy was improved.

Deep learning-based effective fine-grained weather forecasting model
A lightweight data-driven weather forecasting model was introduced by temporal modeling of LSTM and TCN. SR, SVR, and RF were used in machine learning. Autoregressive Integrated Moving Average (ARIMA), Vector Auto Regression (VAR), and Vector Error Correction Model (VECM) were employed for forecasting. Arbitrage of Forecasting Expert (AFE) was used for the dynamic ensemble method. Weather information was collected through time-series data. LSTM and TCN models were a specialized form of neural network for weather prediction. The deep model comprised different layers with surface weather parameters over the period for weather forecasting.

STConvS2S for Weather Forecasting
A deep learning architecture termed Spatiotemporal Convolutional Sequence to Sequence Network (STConvS2S) was introduced to learning both spatial and temporal data dependencies with aid of convolutional layers. The designed method employed the convolutional networks to predicting sequences using historical data. STConvS2S violates the temporal order in the learning process. STConvS2S was employed to make the length of input and output sequences equal. The air temperature and rainfall data from South America gathered the spatiotemporal context and matched the results for forecasting tasks.

PERFORMANCE ANALYSIS
The experimental analysis of proposed different weather forecasting techniques, several marine data points are considered as input. The experiment is carried out using the Atlantic hurricane database with 49,105 instances for cyclone forecasting in the Atlantic Ocean. The databases include 22 attributes. Experimental evaluation of seven methods namely SPRINT algorithm, TC-CMECLPBC Technique, data distribution model, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model, and STConvS2Sare implemented using Java. The experimental results of proposed methods is established with different performance metrics likes,

- Forecasting accuracy
- Forecasting time and
- Error rate

Forecasting Accuracy
Forecasting accuracy (FA) is ratio of number of marine data points which are correctly forecasted to total number of marine data points. It is measured in percentage (%) and calculated as,

$$FA(\%) = \frac{Number\ of\ marine\ data\ points\ that\ are\ correctly\ forecasted}{N} * 100 \qquad ...(1)$$

From (1), forecasting accuracy is obtained. 'N' is number of marine data points.

In table 1, the forecasting accuracy using different data packets varied from 100 to 1000. When improve the number of data packets, than the forecasting accuracy gets improved or decreases correspondingly. While measure, the amount of data packets are400, forecasting accuracy of SPRINT algorithm, TC-CMECLPBC Technique, data distribution model, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model, and STConvS2S is 88%,93%,76%,77%,67%, 85%, and 75% respectively. In fig 1, below the graphical representation of forecasting accuracy is illustrated. In fig 1,illustrate the forecasting accuracy measure Vs several data packets varied from 100-1000. From the figure, the forecasting accuracy of the TC-CMECLPBC Technique is comparatively higher than other existing techniques. In order to find the similarity between the features are selecting the relevant features with higher feature selection accuracy by using Tanimoto correlation coefficients. MAP expected clustering process was performed to group the weather data for cluster formation. In this way, the forecasting accuracy gets improved.

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As a result, TC-CMECLPBC Technique increases the forecasting accuracy by 7%, 18%, 15%, 28%,   7%,   and   25% when compared to the SPRINT algorithm, data distribution model, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model and STConvS2S respectively.

Forecasting Time

Forecasting time is sum of time consumed to perform weather forecasting of marine data. It is the product of several marine data and time consumed to forecast one marine data. Forecasting time is measured in milliseconds and measured as,

$$FT = N * Time\ consumed\ to\ forecast\ one\ marine\ data \qquad ... (2)$$

From (2), the forecasting time 'FT' is calculated. 'N' denotes the number of marine data points.

In table 2,the forecasting time used to many data packets varied from 100 to 1000. When number of data packets gets increased, the forecasting time gets increased or decreased correspondingly. Let us consider, the number of data packets are 200, the forecasting time of SPRINT algorithm, TC-CMECLPBC Technique, data distribution model, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model and STConvS2S is 38ms,28ms,29ms, 42ms,15ms, 20ms, and 24ms. In Fig 2, explains the forecasting time measure versus amount of data packets varied from 100-1000. From the figure, the forecasting time of the multi-step forecasting method is comparatively lesser than other existing techniques. This is because of applying the multiple-input multiple-output (MIMO) for performing weather prediction. The weather forecasting method attained a better multi-step forecasting effect of PM2.5. The forecasting policy attained a small influence on the forecasting effect. In this way forecasting time gets reduced. Consequently, the multi-step forecasting method reduces the forecasting time by 54%, 48%, 41%,58%, 25%, and 33% when compared to the SPRINT algorithm, TC-CMECLPBC Technique, data distribution model, WPF model, and lightweight data-driven weather forecasting model and STConvS2S respectively.

Error Rate

ER is ratio of number of marine data points that are wrongly forecasted to total number of marine data points. ER is determined in percentage (%) and calculated as,

$$ER(\%) = \frac{Number\ of\ marine\ data\ points\ that\ are\ incorrectly\ \ forecasted}{N} * 100 \qquad ... (3)$$

From (3), error rate 'ER' is computed. 'N' is the number of marine data points.

In Table 3 describes the error rate using number of data packets varied from 100 to 1000. When the number of data packets gets increased, the error rate gets increases or decreases respectively. Let us consider, the number of data packets is 700, the error rate of the SPRINT algorithm, TC-CMECLPBC Technique, data distribution model, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model, and STConvS2S is 22%, 8%, 7%, 12%, 20%,11%, and 27% respectively. In Fig3, illustrates the error rate measure versus number of data packets varied from 100-1000. In figure, error rate of the data distribution model is comparatively lesser than other weather forecasting methods. This is due to the application of HR_Alloc algorithm for data placement in big data implementation. HR_Alloc algorithm reduced the network latency and data movement in decision-making for resource allocation between the hybrid infrastructures. Consequently, the data distribution model reduces the error rate by 70%, 25%, 55%, 70%, 58%, and 82% when compared to the SPRINT algorithm, TC-CMECLPBC Technique, WPF model, multi-step forecasting method, lightweight data-driven weather forecasting model and STConvS2S respectively.

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DISCUSSION OF LIMITATIONS ON WEATHER FORECASTING TECHNIQUES

STConvS2S was designed for learning spatial and temporal data by convolutional layers. The designed method collected the spatiotemporal context and performed a forecasting process. STConvS2S used convolutional networks to predict sequences with historical data. SPRINT algorithm was designed with the decision tree objectives. SPRINT mechanism built the tree and leaf node forms tree structure with data consistent with the specifications. SPRINT algorithm was accurate for predicting weather conditions. SPRINT algorithm increased the sensitivity, specificity, and accuracy. The forecasting accuracy was not improved by the SPRINT algorithm. TCCMECLPBC Technique was introduced to improve prediction accuracy with lesser time consumption. Tanimoto Correlation Coefficient identified the similarity between features using relevant feature selection with better feature selection accuracy. MAP expected clustering process grouped the weather data for cluster formation. The forecasting time was not minimized by the TCCMECLPBC technique. Data distribution model was introduced in cloud computing and volunteer computing environments for big data analytics. The data distribution model performed efficient resource allocation in the hybrid infrastructures. The designed model reduced the computational cost and communication costs. However, the error rate was not minimized by the data distribution model. A short-term WPF combined model was introduced to numerical weather prediction (NWP) analysis are enhancing accuracy and minimize time consumption. The designed model forecasted wind power under different weather circumstances. WPF combined model improved the robustness and reliability. Multi-step forecasting method of hourly $PM_{2.5}$ concentration was introduced with Modified AdaBoost. RT and Gradient Boosting. ECM increased $PM_{2.5}$ forecasting accuracy. But, the forecasting time was not reduced by the multi-step forecasting method. A lightweight data-driven weather forecasting model was introduced by discovering the temporal modeling approach for LSTM and TCN. But, the forecasting time was not minimized by the designed model.

Future Work
In future, to achieve the efficient weather forecasting by using deep learning and machine learning methods with better accuracy and minimum time consumption.

CONCLUSION

In this study of various weather forecasting techniques are performed. In this issues, failed to improve the forecasting accuracy by using WPF combined model. In addition, the forecasting time was not reduced using STConvS2S. The forecasting accuracy was not enhanced by SPRINT algorithm. The wide experiment on conventional techniques estimates the result of different weather forecasting techniques and discusses its issues. The result analysis of in this research work is carried out using machine learning and ensemble learning techniques for efficient weather forecasting with higher accuracy and lesser time consumption.

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Table 1: Tabulation of Forecasting Accuracy

Number of data points	Forecasting Accuracy (%)						
	SPRINT algorithm	TC-CMECLP BC Technique	Data distribution model	WPF model	Multi-step forecasting method	The lightweight data-driven weather forecasting model	STConvS2S
100	85	91	75	81	71	88	78
200	82	92	77	78	73	90	80
300	86	94	79	75	69	87	82
400	88	93	76	77	67	85	75
500	90	95	78	79	70	82	72
600	87	94	80	80	72	86	70
700	85	92	82	82	74	89	68
800	88	93	84	85	77	91	71
900	90	94	81	87	75	88	73
1000	87	92	79	89	78	86	75

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Table 2: Tabulation of Forecasting Time (ms)

Number of data points	Forecasting Time (ms)						
	SPRINT algorithm	TC-CMECLPBC Technique	Data distribution model	WPF model	Multi-step forecasting method	The lightweight data-driven weather forecasting model	STConv S2S
100	35	21	27	40	12	18	22
200	38	28	29	42	15	20	24
300	40	36	31	44	17	22	26
400	43	44	33	47	19	25	29
500	46	45	35	49	21	28	31
600	48	44	37	51	22	30	33
700	50	46	39	54	25	33	35
800	52	47	41	58	27	36	38
900	55	50	43	60	29	38	40
1000	58	56	47	62	30	40	44

Table 3: Tabulation of Error Rate

Number of data points	Forecasting Time (ms)						
	SPRINT algorithm	TC-CMECLPBC Technique	Data distribution model	WPF model	Multi-step forecasting method	The lightweight data-driven weather forecasting model	STConv S2S
100	15	9	6	13	20	11	25
200	12	8	4	10	18	13	27
300	14	6	5	9	15	15	28
400	16	7	6	12	12	12	32
500	19	5	4	10	16	10	34
600	20	6	5	9	18	8	29
700	22	8	7	12	20	11	27
800	19	7	5	14	17	14	25
900	17	6	4	15	19	16	28
1000	20	8	6	13	22	18	30

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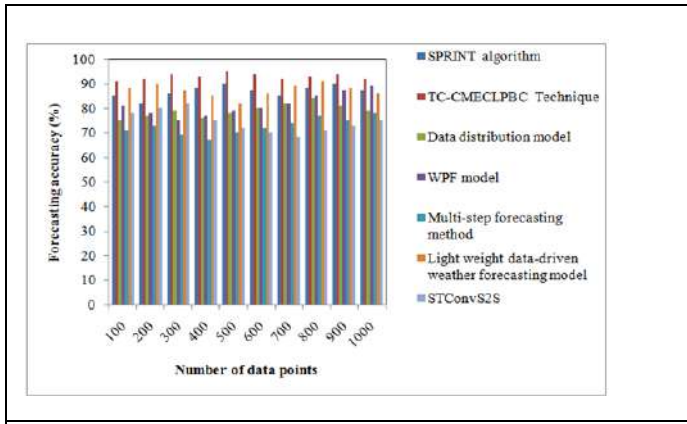
Fig .1: Measurement of forecasting accuracy
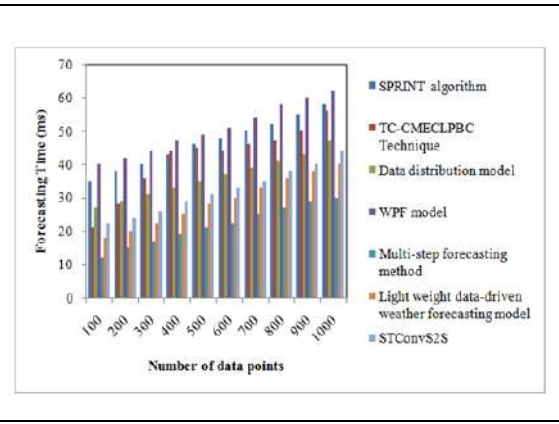
Fig.2: Measurement of forecasting Time
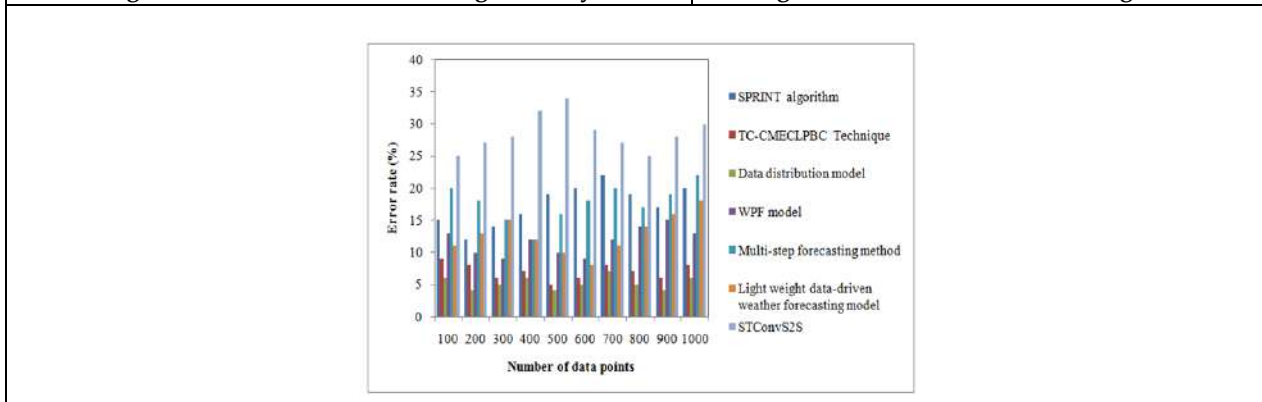
Fig.3: Measurement of Error Rate

RESEARCH ARTICLE

Expert Systems Applications

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ABSTRACT

The current outcome of AI is the expert system. An expert system resolves issues which are generally resolved by human expertise. An expert system depicts with awareness of certain expert for resolving issues or providing suggestions. An expert system is an awareness-based system which utilizes awareness about its implementation field and utilizes a reasoning methods for resolving issues. The aim of this topic is to discuss use of expert system in agriculture and some case studies related to expert systems like DENDRAL and MYCIN. DENDRAL was a convenient tool for chemical researchers. MYCIN was and expert system used to detect blood disorders.

Keywords: DENDRAL, AI is the expert system, MYCIN, chemical researchers.

INTRODUCTION

The contemporary outcomes of AI are expert systems. They resolve issues which are typically figured out by human experts. A computer program that characterizes and concludes with awareness of certain phenomenon content with an idea to resolve issues or giving suggestions is called an expert system. It is an awareness-based system which utilizes awareness regarding its implementation area and utilizes a hypothesizing (cause) method for resolving issues which would require human subsistence of knowledge. It is a software which tries to recreate the accomplishment of some human experts, most widely in a particular issue area. It utilizes human awareness for resolving issues which widely need human intelligence and utilizes few nonalgorithmic expertise and expresses that expertise awareness in the form of data or procedures among computer that can be called when required to resolve issues. They are set of plans which influence encrypted awareness for resolving issues in a specified field which need human expertise. The expert systems are the computer applications established to resolve complicated issues at a pecific field, at exceptional human intelligence and expertise's level. It is a computer program which can perform at the level of a human expert in a restricted issue field. Rule-based systems are the most favored expert systems. A large number are put up and tried in areas like business and engineering, medicine and geology, power systems and

mining. To establish procedure-based systems, expert system shells are becoming favored. Their benefit is system architect can concentrate on the awareness itself preferably than researching programming language.

Expert system in agriculture:

The expert system utilizes procedure-based system and the human expert's awareness is represented in the structure of IF-THEN procedures and certainties that are utilized for resolving issues by responding to quizzes typed at a keyboard connected to a computer. Example, to control a pest, the spray requirement, preference of a component for spraying, amalgamating, applying etc. The prior situation to evolve the expert systems are in the 1990s are a97s were generally written on a mainframe computer in the programming language on the basis of LISP. Some examples of these expert systems are MACSYMA evolved at the Massachusetts Institute of Technology (MIT) to help individuals to resolve complicated mathematical issues. Agricultural expert system assists farmhands for doing a single point conclusion. It is utilized for planning a watering system for their farm utilization. The other tasks of agricultural expert system are:

- To forecast the utmost incidents like electrical storm and ice.
- To choose the most applicable variation of crop

Expert System Shell

An expert system having awareness separated has the ability examined as an expert system shell. Consequently, every user should add awareness in the description of procedures and issue applicable data for issue resolving. In the expert system evolution group, there are five coworkers: the domain expert, the knowledge engineer, the programmer, the project manager and end-user. The expert system's victory relies upon the way co-workers perform co-operatively. The domain expert is a well-versed as well as proficient person able to resolve issues in a specific field. This member has the incomparable knowledge in a given field. The proficiency can be supplied in the expert system. Thus, the expert can transmit with his or her awareness, be prepared to take part in the expert system evolution and perpetrate a remarkable duration to the activity. The significant performer in the expert system evolution group is the domain expert. The knowledge engineer plans, sets up and examine an expert system. He has to choose a proper work for the expert system. He should have a discussion with domain expert to track down the way a specific issue is resolved. By interacting with expert, the knowledge engineer generates the analysis procedures which the expert utilizes for handling factors and regulations and plans the way to depict them in expert system. Then the knowledge engineer selects certain evolution software or an expert system shell or considers programming languages for encoding the awareness. The knowledge engineer takes the responsibility to test, revise and integrate the expert system at the computer terminal. Therefore, the knowledge engineer is dedicated to the project from the beginning phase to the ending supply of the expert system, when project is concluded, he or she might be required to maintain the system.

The programmer is answerable to particular programming, explaining the domain the computer will be able to analyze. The programmer should have ability in symbolic programming in AI languages like LISP, PROLOG and OPSS as well as some skills in varying categories of expert system shells approaches. Additionally, the programmer needs to be aware of traditional programming languages like C, Pascal, FORTRAN and Basic. Suppose and expert system shell is utilized, the knowledge engineer will be able to encode awareness into the expert system and therefore requirement of programmer will be terminated. But, in case a shell is not able to be utilized, a programmer should build the awareness and data characterization layout (database and knowledge base), control layout (inference engine) and dialogue layout (user interface). The developer has to examine expert system. The superior of expert system establishment team is the project manager. The project manager ensures whether all resources and critical points are met, converse with expertise, engineer of knowledge, developer and user.The user utilizes the expert system when it is established. The user can be an analytical chemist who can determine the soil's formation of molecules from mars, a junior doctor who can diagnose a contagious blood defect, an investigation geologist to find a recent raw material sediment, a grid worker requiring suggestion in a crisis. Every expert system user has various requirements the system should satisfy. The ultimate conformation of the system relies upon satisfaction of the user.

The user should be self-assured in the work of expert system. Thus, expert system user interface design is essential for prosperity of the project.

DENDRAL

The standard example of appearing technique is the DENDRAL program. DENDRAL was elaborated at Stanford University for investigating chemicals. NASA supported the project as the remotely-controlled spaceship had to be initiated to Mars and a program was on demand for finding out the structure of molecules of Martial soil, on the basis of mass spectral information that the mass spectrometer provided. Erstwhile Scholar of Herbert Simon, Edward Feigenbaum, a computer scientist Bruce Buchanan and a noble reward achiever in genetics Joshua made up a group for resolving this demanding issue. The usual procedure to resolve such issues depends upon a create -and - examine technique: every feasible molecular structure stable with the mass spectrograph are reproduced initially, then the mass spectrum is forecasted for every structure and examined contrary to real spectrum. But this procedure was unsuccessful as millions of feasible structures were able to be reproduced- the issue became uncontrollable for molecules of decent size as well. There was no research-based algorithm to map the mass spectrum to its structure of molecule to add to complexity of issues. But analytical chemists, like Lederberg, was able to resolve this issue by utilizing their expertise. They could decrease the number of feasible structures considering They could decrease the number of feasible structures scrutinizing familiar structures of peaks in the spectrum, and therefore issue a few likely resolutions for more investigation. Thus, Feigenbaum's work put together with the experience of Lederberg into a computer program and made it work at a level of human expertise. Those programs were then known as expert systems. Feigenbaum had to acquire chemistry and spectral analysis basic concepts to analyze and adopt Lederberg's awareness and function with his words. But it became evident that Feigenbaum utilized regulations of chemistry and his own information, or thumb regulations, on the basis of his skills. Feigenbaum recognized vital issues in the project, that he called 'awareness acquiring barrier'- way to take out awareness through human experts so that it can be used in computers. Lederberg had to study computing basics as well to understand his awareness. Fegenbaum, Buchanan and Lederberg established DENDRAL by performing in a group. DENDRAL was the first successful knowledgebased system.

IMPORTANCE OF DENDRAL

- DENDRAL decided an utmost 'paradigm shift' in AI: a reposition from widespread purposeful, awareness particular field, awareness-scattered, inadequate procedures to -comprehensive skills.
- The assignment's goal was to establish a computer program to accomplish an expert human chemist's potential level. The DENDRAL team demonstrated that computers can be identical to an expertise in restricted, described, issue areas utilizing information in the formation of high-standard particular regulation through human experts. - thumb regulations obtained
- DENDRAL project developed the basic intention of the recent expert system approaches- knowledge engineering, which incorporated skill to capture, analyze and express in regulations the practical knowledge of an expert.
- DENDRAL demonstrated as convenient investigative tool for chemical researchers and was promoted in USA productively.

MYCIN

MYCIN was a procedure-based expertise system for the detection of contagious blood defects. It also provided a doctor with therapeutic guidance in a suitable, comprehensible manner.

Characteristics of MYCIN

- MYCIN was able to work at a level equal to human experts in the area and considerably one step ahead than junior doctors.

- MYCIN's awareness comprised of around 450 self-determining IF-THEN regulations obtained through human awareness in a restricted field through considerable interrogation of expertise.
- MYCIN project created the first expert system shell known as EMYCIN. EMYCIN facilitated establishment of a variation of detected approaches. System programmers had to include recent skills in regulations form to get a current practice.

PROSPECTOR

It is an expert system for raw material investigation established by the Stanford Research Institute (Duda et al., 1979). The assignment continued since 1974 till 1983. Nine experts added their awareness and skills. PROSPECTOR utilized an integrated structure that comprised regulations and a semantic network for depicting their awareness. PROSPECTOR had more than thousand regulations to depict thorough domain knowledge and it had advanced support package comprising an awareness acquiring system. PROSPECTOR works in the following manner: The user, a survey geologist, needs to insert the features of a surmised sediments: the geographical surroundings, structures, types of minerals and rocks. The program notes the similarities and dissimilarities between the features with ore models sediments and, if required, questions the user for getting more details. Then, PROSPECTOR judges the surmised mineral sediment and finally concludes it. It can also describe the course of actions it utilized to reach conclusion. Significant choices are produced in the aspect of unpredictability, with awareness that is insufficient or fuzzy in investigation geology. PROSPECTOR included Bayes' regulations of proof to spread uncertainties through the system for dealing with such awareness. PROSPECTOR worked at expert geologist level and demonstrated itself in practice.

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RESEARCH ARTICLE

Parkinson's Disease Detection using Machine Learning Algorithms

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ABSTRACT

Parkinson's Disease (PD) patients' vocal changes could be identified early on, allowing for management before physically incapacitating symptoms appear. Both static and dynamic communication is highlighted in this piece, which are pertinent to the detection of PD are looked at. The amount of pronunciation changes as well as the development of essential frequency bend are considerably different between HC & PD patients, according to contrast between articulation transition features. We suggest using the direction LSTM model to capture time-series dynamic aspects identifying disease result of this study. The active speech capabilities are determined established totally on processing strength content within the transition from voiceless to voiced segments (onset), and voiceless segments (offset). Below the 2 assessment techniques of move and separating 1 man or woman. Result of this investigation, there may be a new indication of PD.

Keywords: python programming, Jupyter notebook, accuracy, machine learning algorithm.

INTRODUCTION

PD is the highest maximum common nervous sickness. Globally greater than ten million humans' disorder in man or woman. Although the ailment is, first-class lifestyles main wholesome opposite numbers. The humiliation in a fine of means of problems means of humans wearing everyday retaining for a while, etc. Most important signs include an uncontrollable tremble or shaking of difficulties sitting and standing, loss of balance out, strength of the muscles. PD has been a broad investigation for numerous centuries, even though in many instances the root cause of the condition is still unknown. However, a clear correlation between PD and dopamine levels in the brain was discovered in 1961. In the basal cyst's region of the brain, where death of nerve cell and a lack of their rejuvenation effect in a reduction in dopamine level, PD is frequently diagnosed. Dopaminergic therapies are therefore used to treat the condition and slow the disease's progression. However, full recovery is never certain.

Objective

The suggested technique significantly performs conventional machine learning using static PD detection accuracy.

Problem Statement

This experiment compares the precision of algorithms to ascertain which one is most effective at forecasting Parkinson's disease. Additionally, we'll categorize the amount of Parkinson's disease patients and determine their stage of the illness.

Justification

Machine learning for numerous purposes, including evaluation to reach our objectives. Even though the use of various techniques still required the highest degree of precision. Consequently, many levels and types of numerous evaluation techniques are employed to assess these algorithms. This will enable medical professionals and researchers to understand the condition better and find a solution to figure out the most accurate ways to forecast Parkinson's disease. This project's primary contributions include extracting categorized accuracy relevant for predicting contrasting several algorithms and determining the optimum performance-based method. This essay has seven sections. Section I covers the introduction, Section II the discussion of machine learning, Section III the discussion of the literature review, Section III the discussion of methodology, and Section IV the discussion of machine learning algorithms is discussed. In Section V, Result analysis is covered in Section VI, and Conclusion and Future Aims are covered in Section VII.

Algorithms

Machine learning is typically used when people train the computer so that the work can be completed much more quickly. Types of machine learning are as follows.

Supervised Learning

When we teach or train the computer using labeled data, this is supervised learning. With "labeled" data, supervised learning works with or learns. This implies that some evidence the proper response. The following are examples of algorithms for expecting Parkinson's disease detection is applied various algorithms Naïve Bayes, K Nearest Neighbor, SVM and XG Boost

Unsupervised Learning

Unsupervised learning is divided into two types-Clustering, Dimensionality Reduction.

Reinforcement Learning

With the help of actions and their outcomes, a computer learns how to operate in each environment using reinforcement learning, a feedback-based learning method. The machine receives praise for each positive activity, and the agent receives criticism or punishment for each negative action.

Review of Literature

Various researchers have periodically attempted several notable attempts to predict Parkinson's disease in test volunteers. This section contains an examination of the appropriate literature for the work. Max A. *et al.* [2]proposed a unique method for dividing the accomplices PD by identifying difficulty in speaking(dysphonia) using algorithms. PPE, a new and reliable measure that functions well in a, was introduced. Information's of their research work included One hundred nineteen vowel phonations and came from 31 individuals, 23 of whom had Parkinson's disease. The subject's range in age from forty-six to 85, and 6 phonations for everyone were recorded. Following feature filtering, 10 measures were chosen, and all feasible feature patterns were looked for in such combination, it was discovered that 4 generated the best categorization results. Their suggested model has a 91.4% accuracy rate. The best categorization outcomes, according to their research, come from combination of conventional ratios unconventional techniques. Resul Das[6] analyzed the effectiveness of various categorization approaches to diagnose PD extremely successfully. For PD identification, many classifiers rely on Sass-based software. Regression, neural

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network, decision trees, and D.Mneural were the various classifiers used. The results 84.3% for the decision tree, and 88.6%, including 84.3%. The best performance was recorded 92.9%. The employed dataset was divided for trained and tested which performed on hyper parameter adjustment for each classifier.

Among patients with PD and presumed normal subjects. They employed a genetic algorithm (GA) to minimize the feature vector's dimension, generate optimum features, and classify data using k nearest neighbors (k-NN). 197 speech samples from 31 participants were used in their study's the dataset for Parkinson dataset taken from UCI repository. A model for classifying PD proposed by B.E. Sakar *et.al* [7-10] in another key work. Data used in their survey was gathered from 40 patients, 20 patients are having symptoms and another 20 patients has normal healthy life. Each participant had to recorded around 26 speech samples for testing. In which included sustained vowels, syllables, brief sentences, and numerals. They employed SVM and k-NN for classification, with cross-validation approaches called. [11-14]various techniques are optimized dataset used. The software for sound analysis Praat to extract features. The values 1, 3, 5, and 7 use k in the k-NN classifier, with different kernels were employed in the SVM. For KNN and SVM, the results 82.50% and 85%, respectively. Data extracting methods were used by R. GeethaRamani *et.al* [1] to categorize PD participants. The 197 examples that make up the dataset for their investigation were utilized to extract 22 characteristics. They performed various techniques for classification. David Gil A. *et.al* [3]used the UCI repository for obtaining dataset. The multilayer perceptron network was built on an ANN and had two layers. Artificial Neural Networks results 91.79% also 93.33% .MLP achieved with of 92.31%. Ipsita Bhattacharya *et.al* [4] used the more effective SVM classification for PD data. To predict the disease and healthy persons man or woman. Pre-processing used was Maori hen -a tool. The arbitrary separation was done repeatedly. The different kernels values with RBF kernel and poly kernel. They got 60.8696% 65.2174% and SVM. To perform the classification, K.Uma Rani *et.al* [5] experimented on the neural networks with multiple layers results 90.12% and 87.5% for the test and training. The suggested system's primary objective was tooncereview the papers, was Parkinson's disease prediction system using the inputs as shown. Security concerns the online damages to data from viruses [15-19].

METHODOLOGY

Major objective of this experiment was to assess how well Parkinson's disease may be detected through changes in emotional expression during speaking. Particularly, simulate changes that occur during activity, such as reading a book.24 of the most pertinent elements from 194 entries in patience were picked. The 10-fold cross validation, machine learning classifiers are utilized. The results from using the seven classifiers were compared after their training. The classifiers DT, SVM, KNN, NB, RF, Logistic Regression, and XGBoost were employed.

Data Collection
The samples are collected web site UCI [14] dataset, the data are extracted to perform the testing and training. Training samples are 80% and Testing samples are 20%.

Attribute Selection
The characteristics of a dataset are called attributes. For Parkinson's disease, numerous attributes are used, including vocal fundamental frequency, age, gender, and tone components. Predicted output is also provided. The dataset's attributes are described table

Preprocessing
To work with categorical variables, we should split each categorical column into dummy columns with 1s and 0s. One of the important actions finished to get accurate results.

Data Balancing

We may make sure that both output classes are balanced to proceed to the next stage by using data balancing. The numerals "0" and "1" represent those who are expected to have Parkinson's disease and people who do not.You may see the graph below

Histogram of attributes

The histogram makes it simple to understand each attribute of data. The best feature of this type of graphic is to construct data which is predicted output.

Algorithms
Logistic Regression

To forecast the variable supported by another variable, the logistic regression technique is used. The variable quantity is the element you want to foresee and is the one you use to estimate the opposing variable. Such a kind of using one independent best able to quantity, study calculates equation.

Decision Tree

DT corresponds to a supervised methodology to categorization. Decision could take from performing testing of samples. The results demonstrate on the data samples to get classified data.

K Nearest Neighbor

Every elemental has one nearest neighbor algorithms to predict output values using input values. One of the highest algorithms that is frequently used. It classifies the info purpose on however its neighbor is classed. KNN classifies the new knowledge points supported the similarity live of the sooner hold on knowledge points.

Random Forest

Regression problems to distinguish the samples from testing data. The classification done on the categorized data from the total set of samples.

SVM

This is best classification algorithm categorize data straight line divide the grouped features near the decision line. Among all applied classification techniques this performs the best results.

Naïve Bayes

Naive Thomas Bayes algorithm uses the probability model to predict the level of instances carried for classification. The vectors are used to apply the predict data.

XGBoost

XGBoost is an algorithm used to distributed gradient based categorized data using machine learning techniques. The regression and classification done on data. XGBoost used to predict more accurate categorization.

RESULT ANALYSIS

Jupyter Notebook

The simulation tool is a Jupyter notebook, which is convenient for Python programming tasks. Figures, equations, links, and many richer text components are included in Jupyter notebooks in addition to code.

Truthfulness computation

The numerical value of TP, FP, TN, FN defines as:

Accuracy = (FN+TP) / (TP+FP+TN+FN)

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True Positive, Parkinson
- True Negative, No. Parkinson disease Parkinson
- False Positive, no Parkinson
- False Negative, Parkinson Parkinson

RESULT

The results are demonstrated using testing and training of dataset by using the machine learning approach. The findings are SVM gives highest efficiency is noticed, compared to six different approaches applied research paper. The highest accuracy 97% using SVM.

CONCLUSION AND FUTURE SCOPE

Data analysis is allowed for quickly and automatically identify patterns and relationships across various classifications. More people are employing these techniques frequently in EEG analysis, making it easier to employ this low-cost clinical test to identify or gather data on a variety of neurological illnesses. Despite the small number of publications discovered, research employing resting state tests to categorize PD prevails, highlighting a dearth of studies utilizing motor activation tests as well as studies centered on the development of the disease. The information offered by the papers is rather heterogeneous, and clinical factors like the usage of medication during the recordings and the stage of the disease are not present. In comparison to the ones often found in the ML literature, the size of the datasets taken into consideration in the studies is, overall, quite modest. The chosen articles did, however, perform well in the categorization task, with values above 90% in some experiments. The models under consideration in these publications revealed that both the architecture and the features comprised of the manner were crucial for a successful prediction of the classification.

Contrarily, the EEG cleaning process, which varied greatly between trials, did not affect the outcomes, and could therefore be discarded. The construction of a quick and effective autonomous. The benefit of a prediction model would indeed be skipping this cleaning phase, which is often done manually. Finally, Noteworthy that ML techniques have significantly advanced recently, adding more sophisticated models this assessment and the results reached here should be viewed as a first step in the evaluation of performed by cubic centimeter techniques and graph within the study of PD. Future research can concentrate on various methods for anticipating Parkinson's disease utilizing various datasets. In this study, we categorize patients using binary criteria (1- diseased patients, 0- non-diseased patients). The classification of patients and the distinct stages of Parkinson's disease will be done in the future using various types of features. In the future, it may even be possible to forecast diseases by providing an intuitive mobile app. Deep-learning methods, in conjunction with these feature selection method combinations. Other characteristic selection techniques might also be investigated.

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Table.1: Dataset Attributes

Sno	Attribute	Description	Type
1	name	Subject Name and recording number	ASCII
2	MDVP: Fo(Hz)	AVF	Numeric
3	MDVP:Fhi(Hz)	MVF	Numeric
4	MDVP:Flo(Hz)	MVF	Numeric
5	MDVP:Jitter(%), MDVP:Jitter(Abs), MDVP:RAP,MDVP:PPQ, Jitter:DDP	SIV	Numeric
6	MDVP:Shimmer, MDVP:Shimmer(dB),	Numerous actions of variation in amplitude.	Numeric

	Shimmer:APQ3,Shimmer:APQ5,MDVP:APQ,Shimmer: DDA		
7	NHR, HNR	voice's noise tonal component ratio.	Numeric
8	status	1: paralysis agitans0: healthy	Numeric
9	RPDE, D2	dynamical complexity measure	Numeric
10	DFA	Signal fractal scaling exponent	Numeric
11	Spread1, Spread2,ppe	fundamental frequency variation	Numeric

Table.2 Comparison of all algorithms

Algorithm	Accuracy
Logistic Regression	84%
Decision Tree	82%
K-NN	94%
RF	92%
SVM	97%
NB	64%
XGBoost	92%
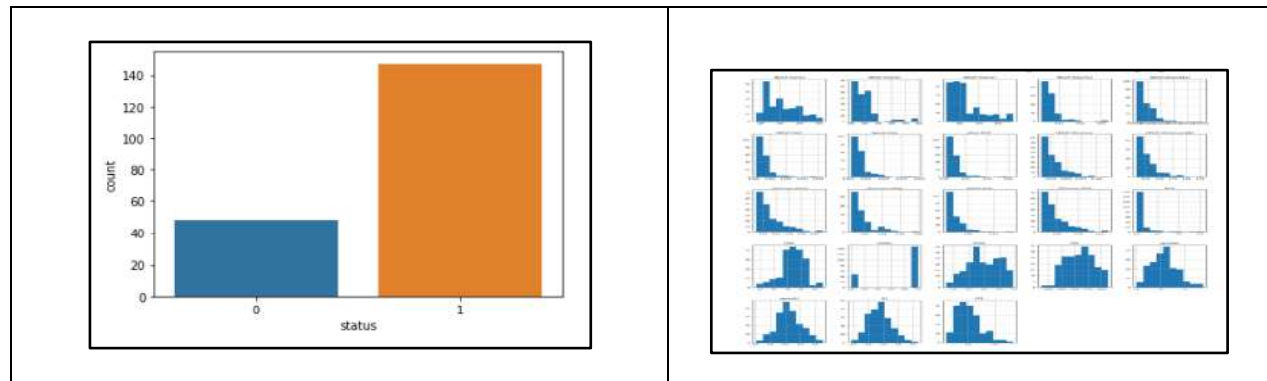
Fig.1. Dataset samples count and status.

Fig.2. Histogram of data samples
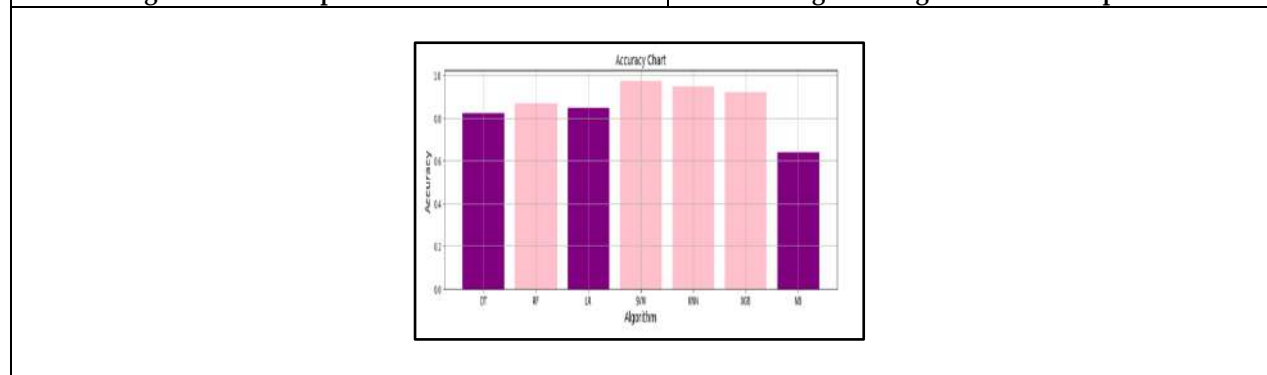
Fig.3. Accuracy chart based on all algorithms.

RESEARCH ARTICLE

Self-Driving Car Simulation using Neural Network

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ABSTRACT

The progression of Computer Vision nowadays has grown up past creative mind. As of late, numerous specialists also, tech organizations are contending to foster self-driving vehicle utilizing either conventional or profound learning approach. This paper is regarding the simulation of Self-Driving Car. Here, the beneficiary gets to know about the applied physics on Car, Working of Sensors, briefing about the collisions and mainly focusing on the Neural networks as well as the genetic algorithm. The sensors work based on the ray-casting it used because to detect the edge of the road or to detect how far the other vehicle is. The car actually perceives the environment an act accordingly. This is actually based on the segment intersection formula will be explained further. The collision detection is also working based on the segment intersection formula. Use of the collision detection is to avoid the car colliding with the edge of the road or with the other vehicle. And most importantly we deal with the neural network which is inspired by the Human biological neural networks in out brain. We will be able to optimize the brain by trial and error. Working will be explained further in the paper. We will also parallelize this step and generate the hundreds of cars to simulate at a time. By the way this can't be used using the real-world hardware devices until your very rich. So, Simulation is way better to know how actually we interact with the car. Most of the car companies use these techniques to build their car to turn in to fully Autonomous Driving. And also, this paper helps in learning basic genetic algorithm.

Keywords: Computer, self-driving, formula, techniques, Neural networks

INTRODUCTION

This paper is regarding the simulation of Self-Driving Car. Here, the beneficiary gets to know about the applied physics on Car, Working of Sensors, briefing about the collisions and mainly focusing on the Neural networks as well as the genetic algorithm. The sensors work based on the ray-casting it used because to detect the edge of the road or to detect how far the other vehicle is. The car actually perceives the environment an act accordingly. This is actually based on the segment intersection formula will be explained further. The collision detection is also working based on the segment intersection formula. Use of the collision detection is to avoid the car colliding with the edge of the road or with the other vehicle. And most importantly it deals with the neural network which is inspired by the Human biological neural networks in out brain. We will be able to optimize the brain by trial and error. We will also parallelize this step and generate the hundreds of cars to simulate at a time. By the way this can't be used using the real-world hardware devices because it is so expensive and not affordable. So, Simulation is way better to know how actually we interact with the car. Most of the car companies use these techniques to build their car to turn in to fully Autonomous Driving. Purpose of this is to avoid collision and congestion on road. It also helps in avoid the traffic. In, Future the Autonomous Driving Car connects with every car in the particular radius so that traffic will be totally eradicated and it saves the human time lot more than expected. are fundamentally utilized for object discovery and acknowledgment. The paper's fundamental body is coordinated as follows: Section I is the preparation of certain foundations and the presentation of our proposed techniques, Section II and Section III contain the systems that will be utilized in the examination, Section IV presents the exploratory aftereffects of the techniques, and Section V sums up the finish of our proposed techniques and potential thoughts for the following improvement.

Literature Survey

Autonomous vehicles are programmed vehicles that operates by themselves. Autonomous vehicles are developed based on mechanical improvement in the field of automobiles that gives both safety and security highlights for drivers. Fundamental type of this car is path location and item identification [2]. Various renowned independent vehicles have features like they take control when they notice miss mindedness laziness of drivers. According to investigate by ASIRT (Relationship for Safe overall road travel) on ordinary 3,700 people lose their lives reliably in the city. An additional 20-50 million experience non-deadly injuries, oftentimes achieving long stretch inadequacies(WHO, 2021) [3]. This for the most part occurs because of human missteps. To keep away from such missteps Autonomous vehicles come to the ground. According to Gringer Bonnie's conversation on "History of the Independent Vehicle" In titlemax.com the principal self-driving model that was proposed by Broad Engines in 1939 that was coordinated by radio-controlled electromagnetic fields created with enraptured metal spikes embedded in the road. In 1958 GM's arrangement was followed through on business level and vehicle's front was embedded by circles that were used as sensors. In 1969 John McCarthy put forth his perspectives on autonomous vehicle where he proposed an idea of way acknowledgment using camera. (Gringer, 2021.) Prof. B. Wang, V. Frémont and S. A. Rodríguez tells in his paper on ' Variety based Street revelation and its evaluation' tells that Self-driving vehicles works on picture dealing with techniques in view of feature extraction. Each dealing with is done on each edge of the video [1]. Machines doesn't acknowledge video as a flood of events it acknowledges it as a surge of edges got at each base snapshot of time. And all taking care of is done using those edges. For a camera each image is a 2d cross part of shaded pixels [6]. Likewise, it's our inclination that how we can interpret those concealed pixels and turn the edges according to our need. (Wang, 2014) There are numerous ways of managing complete way acknowledgment. We will analyse all we have seen or progressed and subsequently propose our own. First technique that C. Mom and M. Xie, told in their assessment paper is perceiving the ways by thresholding the given picture and processing left or right in light of white pixels. In this method each packaging is curved and not entirely settled in what heading is the whiter pixels. As worth of white in colours is 255 and of dull is zero. Hence, values off all pixels is resolved area unfortunate behaviour pattern and checked for the greatest number of critical worth. The side having the most critical worth means there are more white pixels and vehicle turns that way. This technique is only implementable in a controlled environment where we have a way made with white papers or stuff like that, it can't manage roads since we want to change potential gains of cutoff for every environment and it's unreasonable on

business creation level [5]. There can be updates in this method by executing various steps after it or by using this technique (Mama, 2010) Before vigilant edge area to additionally foster edges, another procedure proposed by Ammar N. Abbas, Muhammad Asad Irshad is by applying man-made intelligence estimations that distinguishes the abilities of unrefined housings to make dataset of picture and coordinating point and train data using that dataset. In view of arranged model, the advantages of directing are expected by differentiating each image and the way [7]. This methodology can do assumption for a way that is presently followed and ready and can't run on new locales. We truly need to put in every single road to plan model that we need to use in our everyday daily schedule since it can expect the directing point according to picture data. Moreover, it makes it slower as the need might arise to balance organizations of groups with train a model. What's more, besides, it takes in a lot of data to get ready so its lack of limit as well. Along these lines, this system is in no way, shape or form material according to our perspective. (Abbas, 2021)

METHODOLOGY

Car Physics
Initially the speed of the car is kept zero and the acceleration is also minimal. Based on the user pressing the key the speed and acceleration of the car varies. And to note that the maximum speed of the car is fixed. The car cannot accelerate beyond the maximum speed. Even Friction is also said to be fixed. To make is much real looking we are adding up the friction. Backward movement of the car speed is kept constant. Because in real world too, the backward or reverse movement of the car is less than the forward direction speed. We will also move the car in left and right direction and also, we can able to move the car reverse-left and reverse right. For the movement of the left and right direction of the car we use the math based on the unit circle. Here, we set the angle to be fixed. So, that the user can rotate the steering angle to turn the car left and right. The structure of the unit circle is depicted below. With the help of the unit circle, we will be able to steer the vehicle this acts as the coordinate system for the vehicle. Based on the trigonometry ratios i.e., $\sin(\theta)$ and $\cos(\theta)$ we can actually steer the vehicle. To note that x-axis is coordinated with $\sin(\theta)$ and y-axis is coordinated with the $\cos(\theta)$. Fig 1. Unit circle representation. Fig 2. Implementing T-ratios.

Sensors
We must also implement the sensors just because to sense the border of the road as well the distance between the user vehicle and other vehicle. It is important because we must teach the car how to drive itself. In that case the sensors are very helpful to fetch the data. The Sensors work the same as the hardware component work. With the help of Ray-Casting the sensors are implemented. Sensors are built in the car and also it takes attributes such as Ray-Count, Ray-length, Ray-Spread, Ray-Angle. And also, we built the stroke method i.e., that helps the ray to shade to particular portion, if the user sees the shade, then we can actually say some obstacle is present. It can the border of the road or the other vehicle. Fig 3. Stroke look between red car and white car.fig.4. Implementing Sensors.

Segment intersection
Segment intersection is the method used to implement the sensors in the cars as well as to detect the collision with the side of the road or to the other vehicle as well. The x-coordinate and y-coordinate is going to be found using linear interpolation (lerp). The linear interpolation just gets two values let us say let it be 'A' and 'B' and the third one is said to be the percentage(t), it just determines how far we are from the point 'A' or from point 'B'. And it finally returns A+(B-A) *t. When t=0, (B-A) cancels out only 'A' value is found. When t=1, 'A' and '-A' cancels out each other only 'B' value is found. So, we can conclude by using the formula as when t=0, the point is at 'A'; But when t=1, the point is at 'B'. Interpolation is the technique used as the pivot element which between the two points. Here, we have the condition like the 't' varies from '0' to '1'. So, we can find the different 'x' and 'y' coordinate values with the help of the lerp function. We actually like to return two things, firstly it's the 'x' and 'y' value of the point, secondly to return the value of 't' as an offset value because when the sensors of the car are reading the values, we can get to know how far the other vehicle is present. Fig.5. Segment Intersection.

Collision Detection

We can implement the collision detection by checking for segment intersections between all edges of the car and the road borders. It will work for the different orientations of the car as well as with the different shapes as well. Initially we much get to know the coordinates that are present at the edges of the car. We can actually create a polygon having certain points. Fig 6. Defining the radius of the car Initially we don't do the fine tuning where as we determine the car as the actual rectangle. So, it being determined as the polygon later. The horizontal is said to be the width of the car and vertical is said to be the height of the car. This is represented is 2-Dimensional. Radius is said to be the distance between the centre of the car and the edge of the car. Fig 7. Defining the angle and other attributes With the help of angle 'A', Like the angle can be calculated by knowing the height and width value of the car by using Pythagoras theorem like we just need to find the hypotenuse. So, we fix the points with the help of the angle to all the four edges of the car. Initially no car is said to be damaged. Then we will assess damage when hit with road borders. Here we declare the line among the borders is said to the polygon. Here, we will check the intersection between the two parameters i.e., polygon 1(car) and the polygon 2(line- road borders) with the help of the segment intersection is linear interpolation method. The value of the road borders is being updated by the sensors.

Proposed work

Neural Networks

Neural Networks are the fundamental to solving all kinds of problems. Neural Networks are inspired by the biological neural networks from our brain. Fig. 9. Biological Neuron. Neuron is the fundamental unit of the brain and the nervous system. Dendrite (synapse) (1) these branch like structure receive the signals when simulated enough the neuron will fire a signal through its axon (4). A single neuron does something really simple and intelligence only come when they work as a team. Our brain has 86billion neurons and also, we have quite many in our spinal cord and in sensory organs like eye, ears, etc., These sensors send signals to some neurons that pass it to the brain there the processing happens like the chain reaction where some neurons fire but some don't. Eventually signals arriving to motor neurons that pass through the spinal cord and make some muscles contract in very specific ways. Let's try to study a case, there are two persons. Let them be Person 1 and person 2. Person 1 shouts "hey" and throws the ball Fig.8. Neural network layers in Self-Driving Car. towards person 2. Person 2 sensors inside the ear pickup compression waves from the air and sends the signals to the brain which figures out the direction based on different intensities. Signals then travels to the neck muscles tell them to contract and turn the head in that direction. The eye catches the glimpse of event happening and new signals travel to the brain. Fig. 10. Neural Net. Peripheral vision is blurry but good enough information exists to detect some object is approaching and new signals travel to facial muscles to contract and protect the eyes to protect. At the same time the brain begins a kind of defence protocol by sending signals throughout the body. Time passes and the vision becomes clear. Brain does pattern-matching and recognizes the object is the ball. Contextual and historical information will play an important role in what happens next. The brain concludes there is no threat and uses knowledge about the physics it learned during its lifetime where it is headed. It then senses new signals to the muscles to contract in slightly different ways to catch the object instead of blocking it and the rest is history. One time where the brain did a good thing and not much happens afterwards.

But some time there is possibility that the person 2 might lose hold the ball that can hurt him/her. So, the brain learns that it did something wrong and configures itself so the same thing doesn't happen again. Our car's neural network will do something like that. The neurons on the first layers will be connected to the sensors they will send signals forward a few times and the last layer is connected to the car controls. In this neural network we have three different level. Input, one hidden and output layer. We should simply break the layers into two levels i.e., each level comprises of floor and roof. We can name the two levels as level 0 and level 1. The roof of level 0 is the floor of the level 1. We can store the quantity of data sources and number of results in the exhibit. And furthermore, we can add predisposition, each result neuron has the inclination; a worth above which it will fire. In this way, we can likewise characterize the predisposition to exhibit itself [9]. We really going to associate each information layer neuron to each result layer neuron, that is not the situation in our natural minds [9]. Be that as it may, these associations will

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have loads so the heaviness of zero methods the essentially exactly the same thing. For each input node we have the number of connections to the output node. The bias Fig.11. Visualizing Neural Network. values must be set to the real value to be functional. Thus, we will randomize the qualities. For each information yield pair we will set the load to irregular worth that has the reach from [-1,1]. To really imagine the brain organization, we have recognized the qualities with the different variety i.e., positive are in yellow and negatives are in blue. The predispositions will be in a similar reach too. Yet, you might ask why negative worth? Furthermore, here's an ideal justification for it. How about we expect that the vehicle sees something with the front sensor so it ought to go to stay away from crash yet what direction? Negative loads associated with these sensors on the right could send the message that don't to the right so the excess choice is to turn left. The two loads and predispositions can be between the reach [-1.1]. Now the inputs layers values are fetched with the help of car sensors and we need to compute the outputs using these weights and biases that we defined. For now, we have randomized but in the smart brain they certainly have the fixed value so it can function in optimized manner. We compute the output values using the feed-forward algorithm.

It takes the inputs as the value from the input layer and also the different levels inputs too. And also, we are going to calculate the sum between the value of the inputs and the weights. Initially the sum=0, later the sum will actually add the product between the input-layer-input and the weight between the input-layer-input. We finally need to check is the sum is greater than the bias of the output neuron and if so, we are going to set the output neuron to 1 i.e., we are essentially turning it on. Otherwise, the output neuron is going to be set to zero. In the simple network w*s+b=0 is the line equation (w-weight, s-sensor input, b-bias) is the very simple function. Weight controls the slope and bias controls the y-intercept. We have the individual function for each output these neurons will fire if the value of the function is above zero and with weights and biases between the range [-1,1] we can implement any situation. Now if we have two sensors then it's the plane in 3-dimensional space and the equation is given as follows, $w_0s_0+w_1s_1+b=0$ (for each output). When we add more sensors, we have higher dimensions that are harder to visualize. Scientists don't use the binary values instead they allow to fire all the time just at different amounts. Only the output layer must be binary to get the output as yes or no. We actually set the null value for the offset if the sensors didn't fetch any value. If the sensors actually fetch some data, then we actually subtract it with '1', and then we assign it to the offset as the value. We are doing this because our neurons must receive the low values if the object is far away and the high values close to '1' if the object is nearer. Fig. 13. Projection of the same car.

Forward Propagation

Forward Propagation is to calculate the output value using the equation that we have above and we also use the activation function in the output. In this case we use sigmoid activation function we use binary values that is transforming the input to [-1,1] interval. So, that we can find which class its belonging to, here class refers to Fig. 12. Sigmoid Function Graph. the output i.e., accelerate, brake, turn left or turn right by making the values greater than 0 to 1 and less than 0 to -1.

Optimizing the Neural Network

Firstly, we will continue to do trial and error but we will parallelize this so we have many cars going at once we don't waste much time. There is a more efficient way of doing this is using genetic algorithm that does mutation [6]. Testing the movement of the car one by one these randomly generated networks and expecting some miracle is not very convenient. So, we actually parallelize the cars that is create the projection of the original car that it behaves uniquely in parallel universe [7]. We actually have the option to save and discard the brain (neural network) it all the user wish. Once the car starts to move forward, and the projected cars will also work along the user need to click on save so that it can remember the path, then again if any obstacles occur then again user need to click on save. Similarly, the user needs to train the neural network [8]. Then the car remembers the path and move accordingly. The best brain is stored in the local storage so that even when the browser is closed it can remember the data for the next time. Training the neural network becomes faster when we train those in parallel. So, we are using the projection to make things speed up. This can be fully automated so that the computer tries again and again and always keeps the best. But the thing is what actually the good network able to do? We are actually using only the y-coordinate of the car [8]. But we can use other function as well these are called fitness function. For example, we can

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actually measure the travel distance instead doing that may result in cars that go backwards as an easy way to avoid obstacles or just go around in circles forever that is going infinitely far but also going nowhere at the same time. So, we need to be careful when choosing the fitness function [8]. Here, we decided the road to be narrow so we are sticking with 'y' as our fitness function. But in case there is turning ahead then it wouldn't work anymore. Fig. 14. Blue car making its own decision. To keep the cars closer to each other or to think the same ways how the best brain thinks so that we must keep the mutation value very low so that we can actually get the optimized result and also very quickly we can overtake the car without crashing it with wall or with another vehicle [8].Genetic Algorithms is a kind of investigation study, that utilizes the possibility that getting over the loads of two great brain organizations, would bring about a superior brain organization. The explanation that genetic calculations are so viable is on the grounds that there is no immediate enhancement calculation, taking into account the likelihood to have very shifted results. Furthermore, they frequently concoct extremely intriguing arrangements that frequently give important knowledge into the issue. A Set of arbitrary cars are being created. A few tests are performed on the main vehicle. The vehicle gets a score in view of the tests. Rehashing this multiple times to make a populace. Choosing the top 10% of the populace which is accessible for the crossover. Each time a crossover happens there is little possibility of mutation: That is an irregular worth that is in neither of the parent's weight i.e., the first vehicle. This interaction gradually improves the vehicle's exhibition, as the vehicles gradually adjust to the environment.

CONCLUSION

This is a stage for Autonomous vehicles. With the assistance of this brain organizations and hereditary calculation ideas, for example, hybrid and change, vehicles can explore all alone by consistently getting the sensor information from another vehicle pushing forward. The vehicle courses itself with the direction of brain network present. Hence, numerous sorts of deviations might happen. The accomplishment of way arranging process for a self-driving vehicle is to drive the vehicle without crashing even in undefined circumstances. The way arranging is one of the fundamental parts of independent frameworks. Exactly when the robotized vehicle truly starts to move towards the organized course it could find dark preventions from the ongoing region to the appointed region, accordingly the mechanical vehicle ought to avoid the hindrances and follow an optimal course to show up at the foreordained position. The potential uses of this vehicle are to use such autonomous vehicle on expressways or significant traffic roads. Such free vehicles can moreover be used when a driver goes to the new locales. It is an unrivalled course structure for free vehicles.

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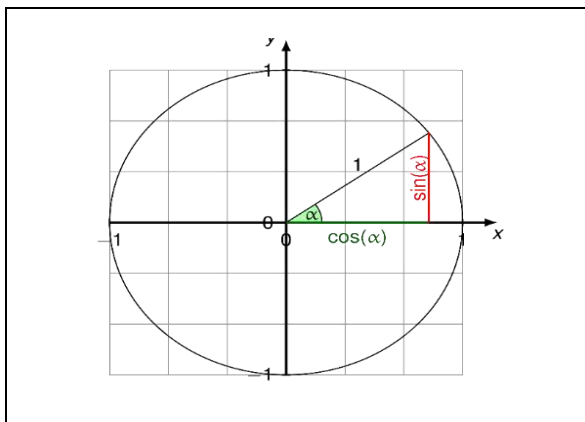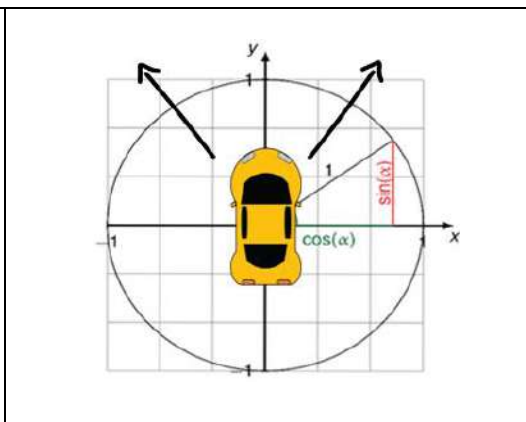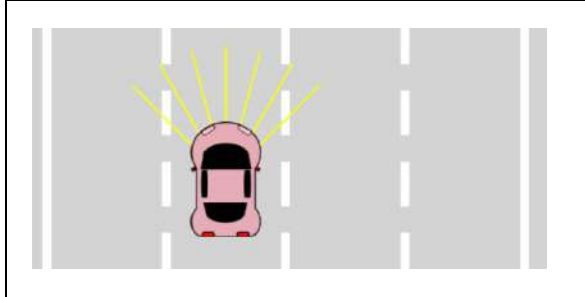
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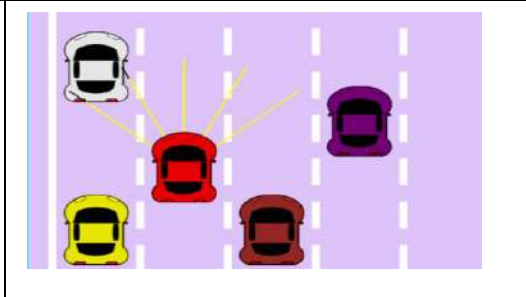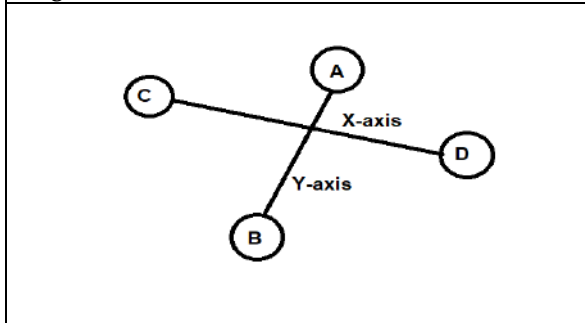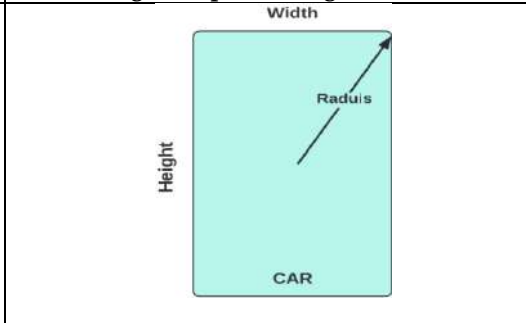
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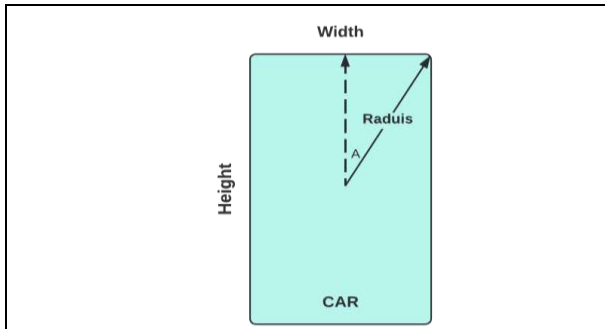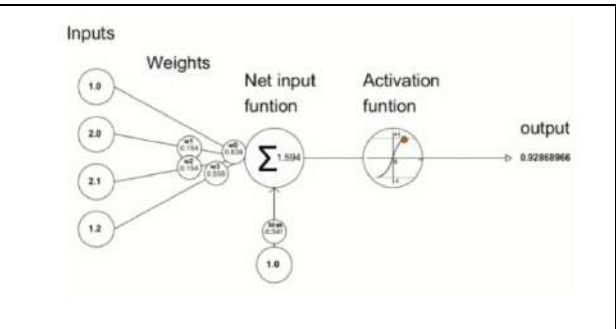
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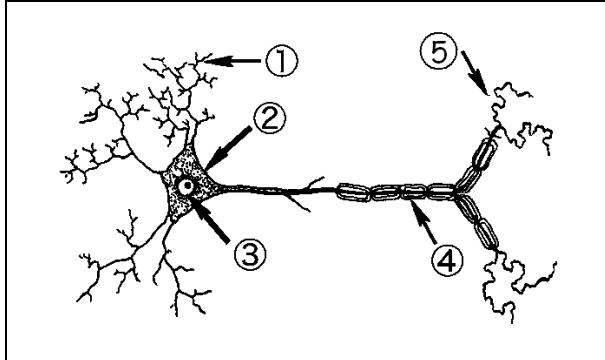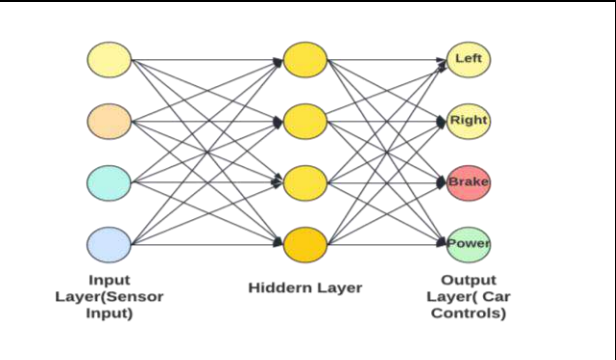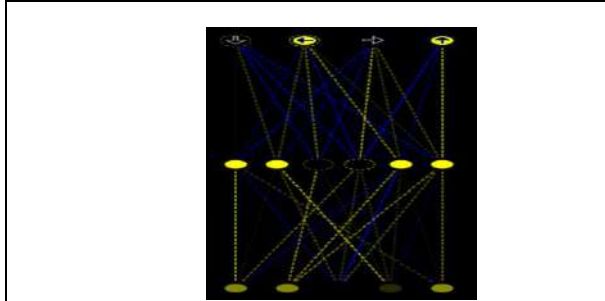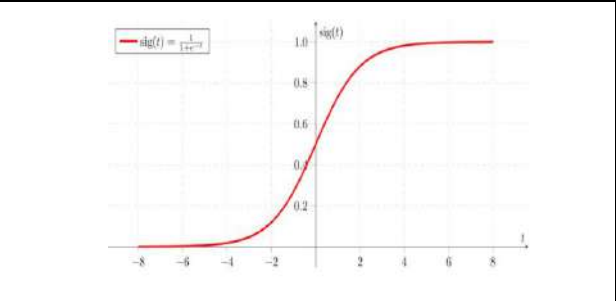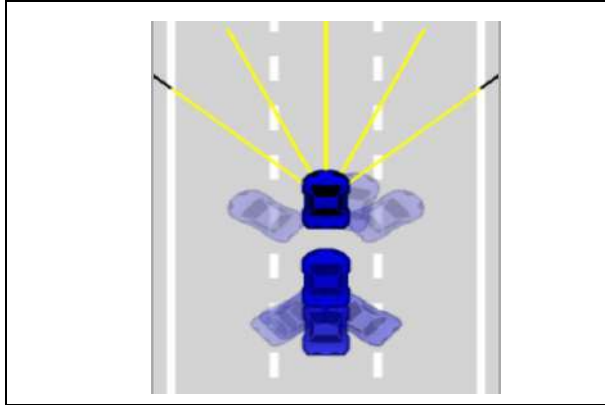
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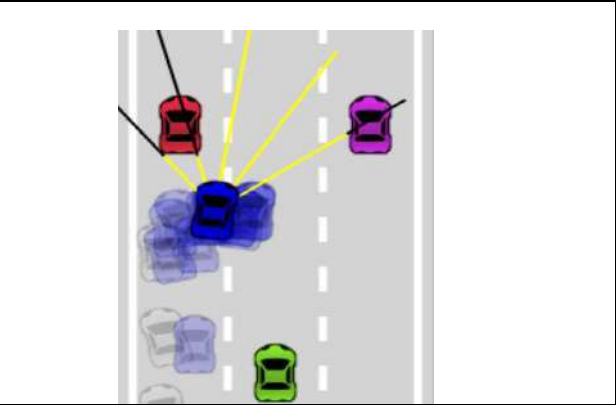
Laneline Edge Detection using Machine Learning

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ABSTRACT

Auto industry is the fastest growing industry in the world. Lanes present on roads represents various road rules for automobile vehicles. Recognition of these lines present on the road is challenging for a computer vision. The current study process the images of roads from Bosch R&D dataset and identifies the lane lines present in each image by edge detection process. To identify the lane line edges present on the images a marker based watershed algorithm is used. The features are extracted using Gray level co-occurrence matrix (GLCM) algorithm for the edge identified segmented output images and found different features from resultant images. The Random forest classifier succeeds with 94% accuracy, Hoeffding tree with 89% accuracy and JRip classifier obtain 98% accuracy, which is considered as best when evaluated with other two classifiers. The results will be applicable for automobile with an auto piolet engine.

Keywords: Road lane line, morphology , edge detection, marker-based watershed, machine learning, random forest, JRip classifier.

INTRODUCTION

From few decades the automotive and automobile industries is working hard to avoid risk in driving/riding and to increase the robustness in the system. Lane line identification on roads provides the major comfortness for rider or driver while driving, that too on long road highways. To enhance the current technology, we can able to change cruse mechanism technology engines into autopilot or auto-drivemode engines which drives smoother and more accurate. Due to this the engine performance will also boosts and also maintains good health of the engine. For all these phenomena accurately, identification of lane lines present on the roads is considered as a motive for this work. Images are segmented for image analysis and understanding the image activities. Image techniques can be classified based on edges, region, histogram, markov random filed and other hybrid techniques of segmentation. Each of the methods have advantages as well as complexity when compared with others. [1]Watershed segmentation is

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morphological based process where it can be mixed up with segmentation based upon edges, which yields a hybrid technique. From the survey, Watershed segmentation is based on region segmentation with mathematical morphology used. Watershed algorithm provides efficient results in identifying or notifying the edges in the input images hence the process of algorithm is marginally tweaked and used in identifying the lane lines edge segmentation. Since the Watershed algorithm is sensitive to image noise [2], it may causes problem of over segmentation. The input color images will be converted to a grayscale images. Later local maxima and grayscale image morphology is found and those values are fed as input for watershed algorithm for lane line edge detection.. This paper uses the marker based watershed transform. Six different features like energy, contrast, correlation, Angular second moment, homogeneity, and dissimilarity are picked using GLCM algorithm. The extracted features further classified using Random Forest, Hoeffding tree, JRip classifier algorithm. The Random forest algorithm achieves 94% accuracy whereas JRip classifier obtains an accuracy of 98% which is higher than Random forest algorithm. The whole process is carried on BOSCH dataset for roadways R&D, which are RGB images and comparison done with canny algorithm using BSD 500 dataset.

Related work

Watershed segmentation initially developed by Digabel and Lantuejoul and later improvised by Beucher and Lantuejoul [3,4]. Watershed transform deals with immersion and toboggan (flooding) approach. To overcome the disadvantage of original watershed transform a marker controlled watershed transform for low level segmentation is used [5] which is better in image segmentation [6]. The lane line detection method had modules for capturing video of lane marking, extraction of feature, lane detection, lane tracking and departure of lane warning system [7,8]. Marzougui *et.al* proposed a reliable real time vision based lane marking detection and tracking. Which gets adjust to numerous environment conditions and obtained average correction rate is 93.82% [9]. Muhammad Shafique *et. al.,* proposed an efficient identification of road lane line with object tracker using Heuristic combined with canny edge algorithm and found lane lines and targets efficiently on the lane [10]. Lane marking Regression Network considered assured detection of area and inference of field for producing more accurate lane markings in an encoder decoder framework also introduced the graph diffusion technique to cumulate the appropriate information for improved detecting hard areas [11]. Abhishek Goyal *et. al.,* used Sobel operator to segment lanes on path by using Sobel operator and obtained accuracy of 92% [12] P.Lu *et.al* presented a graph embedded solution which consists of a learning constructed low level algorithm for extracting features and a graph annotated lane data.[13]. Youcheng Zhang *et. al.,* had proposed a process with AI based system. RiLLD networks and Ripple-GAN networks gave edge segmentation results multi-target semantic segmentation and Wasserstein generative adversarial networks obtained results with accuracy of 96.77%[14].Ganlu Deng *et. al.,* had worked on dual line lane edges detection process using constraint condition Hough transform. The whole process estimates curve roads and straight lane lines[16]. A morphological watershed transform used to recognize lane lines and obtained a structural similarity index measure (SSIM) of 99.89% [17]. Alireza Kheyrollahi *et. al* proposed road marking recognition in real time which detects multiple feature like speed, slow limits marking, road direction marking and parking lane lines painted on roads. They used ANN algorithm and obtained accuracy of 92% [18]. Q. Zou *et. al* has proposed the detection of lane using numerous frames consisting scenes of continuous driving, and proposed an hybrid architecture model combining the convolutional and recurrent neural network. Information of individual frame were evaluated using a convolutional framework and features from numerous continuous frames are fed into the RNN framework for feature learning and prediction of lane line [19].Lane line segmentation process initiated using swarm intelligent particle optimization technique and obtained an efficient result [20]. [22-24] discuss works related to road line detection.

Proposed method

The proposed study involves five steps toper form and to identify the lane line edges from input color images.

Setp.1

The first and initial step is to initiate in collecting a RGB image from the BOSCH R&D dataset. Preprocessing of images is not required as the selected images are blur free and hence no need of filtering the images. The images selected for the experimental process are single, double and road with three line from the dataset.

Step.2

The input images were directly consider to process without resizing. The input RGB image converted to grayscale format image. To identify the closest and nearest distance between the pixel values distance transform applied by extracting component of binary. By considering the image distance transform, the local maxima will be estimated per pixel. After transformation, marker based watershed controlled segmentation is applied for segmentation, which is a unique idea in detecting the road lane line edges. The f represents the input image and T is a topographical distance between points p and q can be found by using (1), applied

$$T_f(p,q) = \inf_\gamma \int_\gamma \| \nabla f(\gamma(s)) \| \, ds \qquad (1)$$

Various types of mages can be inputted for detecting edges using watershed algorithm, which treated as marker, gray scale and morphology-based techniques. The technique employed in this study is based on marker control to identify lane line edges on the road. The distance transform and marker values are computed and the sevalues are given as input to segmentation algorithm. After applying watershed marker controlled segmentation algorithm the results are given in Fig 2 a, Fig 2 b, and Fig 2 cfor various lane line edge detection.

Step.3

Noise filtering and reconstruction of image is done by marker region extraction in bringing the lane pixels location. The reconstructed binary image after marking is applied for segmentation. The improvement in watershed algorithm is based on the markers technique which is a group of points in an image. Selecting a point is a significant factor in segmentation decision. Image threshold to be set to differentiate the foreground and background intensity also to recognize the marker.

Step.4

Feature extraction of image is an significant step in recognition an image edge. The image edge features are used to classify the edge point or non-edge points of an image. The features of image are used to judge and classify the image. In this study, GLCM algorithm used to extract the features[21]. GLCM works with co-occurrence that exists between neighbor gray level pixels. Extracting GLCM features using a square matrix based on ROI(Region of Interest) dimension. Image textural features are extracted from the segmented images using GLCM algorithm. Various image textural features extracted are listed below

Contrast
Measures image spatial frequency such as intensity of pixel and also determines image local variations. Contrast of an image obtained using (2),

Contrast = $\sum i=0 \sum j=0 \ |i - j| 2(i, j)$ $\qquad$ (2)

Homogeneity
Referred to as inverse different movement, it measures homogeneity of image with values larger for difference in smaller gray tone. to calculates the distribution tightness in the pixel elements output diagonally in resultant output image. This feature measured using (3),

$$Homogeneity = \sum_{i,j=0}^{N-1} \frac{P(i,j)}{R} \qquad (3)$$

Energy
Measures the degree of pixel pair repetitions. The energy value is large with highly correlated pixels. The disorder in image texture is measured using the given equ. (4),

$$Energy = \sum_{i,j=0} \{P(i,j)\}^2 \qquad (4)$$

ASM (Angular second moment)

It is known as angular second moment and is the estimates the strength of the pixels homogeneity in an image and can be measured using (5),

$$ASM = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} \{P(i,j)\}^k \qquad (5)$$

Dissimilarity

Defines the distance between pair of image pixels. Image gray level mean difference in distribution is measured using formula (6),

$$Dissimilarity = \sum_{i,j=0} |i-j| \{P(i,j)\} \qquad (6)$$

Correlation

The correlation feature of an image is an dependency on levels of gray pixels on pixels of neighbor over the entire image. It varies from -1 or 1 for negative correlation of image and for a constant image the value is infinity. Correlation feature is defined by using (7),

$$correlation = \sum_{i,j=0}^{N-1} P(i,j)[(i-\mu i)(j-\mu j) \Big/ \sqrt{(\sigma i^2)(\sigma j^2)} \qquad (7)$$

Step.5

Classification is the final step of whole process. Hoeffding tree, JRip and random forest classifiers algorithm are used to clarify with the help of features extracted from GLCM algorithm. Random forest an Jrip classifier algorithm are supervised machine learning algorithm and Hoeffding tree is a decision tree for classification of stream data. Confusion matrix of window 3x3 is produced by the classifiers. The accuracy performance and the classifiers performance is evaluated using confusion matrix. False-negative (FN), True negative(TN), False positive (FP) and True positive (TP), are estimated by the given confusion matrix. In the evaluation process JRip classifier achieves 98%, Random forest achieves 94% and Hoeffding tree achieves 89% of accuracy from the textural features extracted by GLCM. The accuracy calculated using (8).

$$Accuracy = (TP + TN)/(TP + TN + FP + FN) \qquad (8)$$

RESULTS

The current approach is performed on Bosch5-megapixel full-resolution files, which are downscaled versions of the Bosch image dataset. Each dataset has roughly about 100 images of different versions. Dataset provides blur free RGB images in png format, which are treated as experimental inputs. Which involves three category of images such as, one-lane, two-lane and three-lane road images. The whole experimental process is tested with watershed algorithm for five images in each section.Figure3 to Figure 6demonstratesvariousroad lane lines detection and output are marked in color for visual interpretation. The whole process in identification of lane line edge detection is an important work in computer vision. Table 1represents the Hoeffding tree, JRip algorithm and Random forest accuracy results of the classifiers. Comparatively JRip classifier results with 98%, which is best than Random forest and Hoeffding tree classifier accuracy. The resultant comparison with canny edge and watershed edge detection

represented in Table 2. The visuals of edge detection using Canny are not appropriate when it is compared with watershed edge algorithm.   Table 3 represents the comparison with conventional canny edge detection technique and proposed system for BSD-500 dataset.

CONCLUSION

As automobile industry is widening its area of research due lack of smartness in the existing devices. Also, mechanical moment is tough to handle by an individual for a extended time. There are multiple ways to make these things smarter among them. Lane line edge segmentation and identification is one of the hot topic for research. In this approach, identification of lane line edges is performed by using marker-based watershed algorithm with newer approach on lane line edges. Bosch R&D roadways dataset are fed as input to this process. Input images are not pre-processed and resized but images inputted is converted to grayscale images. Estimated the distance transform and morphological values and fed to marked-based watershed algorithm and obtains the output. GLCM algorithms extracts the six different features per image and the same features are loaded into JRip, Random forest and Hoeffding tree classifier algorithm. The JRip classifier makes a top-notch classification accuracy of 98%, which is best compared to Random forest classifier algorithm with accuracy of 94%. The resultant outputs can be applied to convert cruse mechanism engines into auto-pilot mode engines. The proposed system is also validated and compared for BSD-500. The visual resultants are far better than canny edge detection. Blur images with low contrast or dark images were failed to recognize the edges of lane lines that exist on the road which is treated as disadvantage. The same process is carry forward for video processing as future scope.

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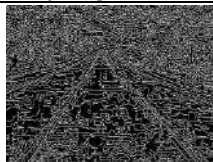
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Table.1: Comparison of results

Sl No.	Classifier	Accuracy
1	Hoeffding tree	89%
2	Random forest	94%
3	JRip	98%

Table.2: Result comparison of edge detection using canny and watershed with Bosch roadway dataset

Input Images	Canny edge detection	Watershed edge detection
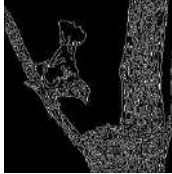
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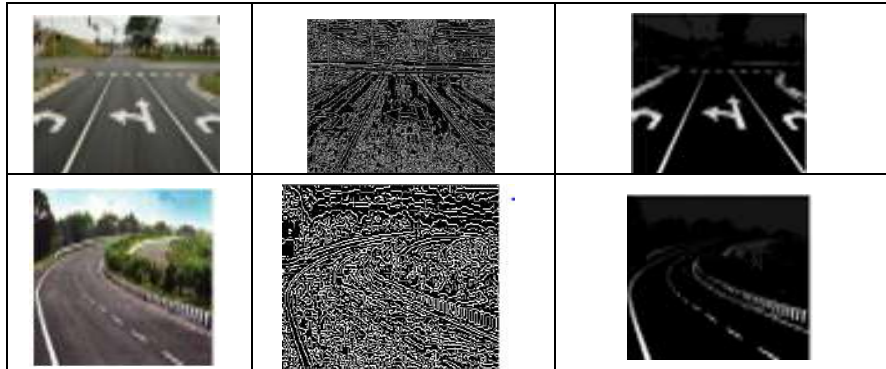
Table.3: Result comparison of edge detection using canny and watershed with BSD-500 images

Image number	Canny edge	Watershed
118035		
181018		
163014		
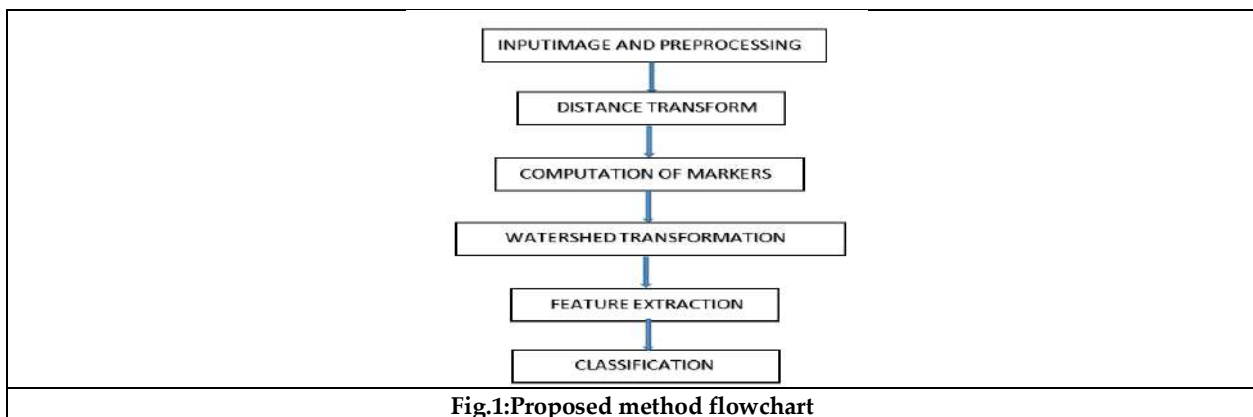
Fig.1:Proposed method flowchart

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| **Fig 2a : Road with One line** | **Fig 2b: Road with two line** | **Fig 2c:Road with three line** |

Fig.3: Segmented Colored Single-Lane Line | **Fig.4: Segmented Colored Three Lane Line**

Fig.5:Segmented Colored Cross Two Lane Line | **Fig.6: Identification of Feature Lane Lines**

RESEARCH ARTICLE
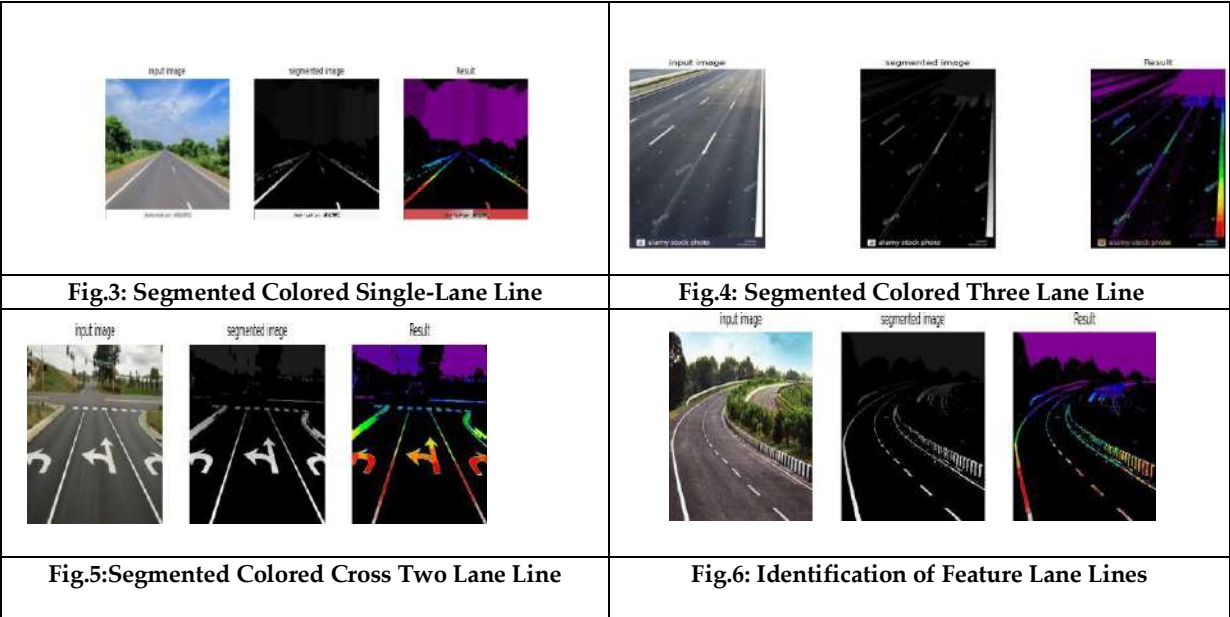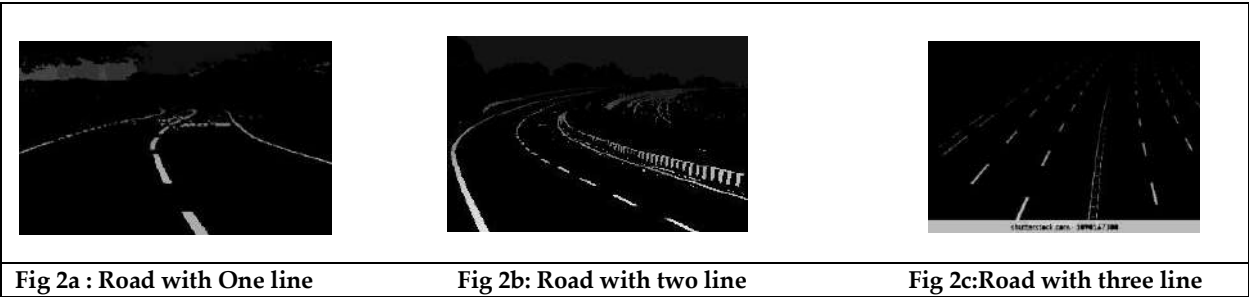
Comparative Analysis of Fuzzy Logic based Requirements Prioritization Approaches

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ABSTRACT

Requirement Engineering (RE) is the progression of defining, recording and sustaining the requirements. In RE, the most significant activity is about prioritizing the requirements collected from multiple stakeholders. Due to financial, logistical, and other limitations, it is essential to prioritize because all requirements cannot be fulfilled in a single release. This paper lists all of the work that has been done in requirements prioritisation (RP) using only fuzzy logic. This work focuses on different aspect of earlier approaches of RP and brings about the positive and negative sides of each approach considering multiple criteria for evaluation. The discoveries of this study can be useful to investigators who are working on RP approaches using Fuzzy Logic.

Keywords: Requirements Prioritization, Fuzzy Logic, Uncertainty, Techniques, Challenges

INTRODUCTION

Requirement Engineering (RE) is among the most crucial phases in the Software Development Life Cycle (SDLC), which has many phases. The procedure for collecting, recording, and maintaining stakeholder requirements lies at the heart of RE. [1]. One essential concept of RE is Requirements Prioritization (RP). A decision-makingis the process of ranking requirements that serves to rank various requirements submitted by various stakeholders. It emphasises which requirements will be supplied, implemented, and followed up on during the original release cycle, as well as which requirements will do so over subsequent releases[2].A high-quality system can advance through the iterative process of RP, which combines crucial and complex decision-making processes, under a variety of restrictions [3]. In literature we can find plethora of approaches towards RP, but the truth is that during the initial phases of the SDLC, stakeholders' understanding of the priority of requirements may be hazy, confusing, or imprecise. As a result, applications of RP approaches that do not account for uncertainty are of limited benefit in situations involving little

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knowledge[4]. There will be not much issue when we have single stakeholder but RP becomes challenging when multiple stakeholders will be involved in decision making. For massive projects with thousands of requirements and hundreds of stakeholders, a systematic, analytical, and quantitative strategy is required to resolve their disputes and give management the proper recommendations for how to satisfy all the issues of the many stakeholders involved[5]. Mathematical Fuzzy Logic (FL) is a significant area of study. Research in this field focuses difficult issues and many-valued logics using linearly ordered truth theories, which continues to draw an increasing number of researchers. Prof. Lotfi A. Zadeh known as father of FL first introduced FL in the year 1965. Fuzzy logic can be used to cope with data produced from computational perception and cognition that is ambiguous, imprecise, hazy, partially true, or without clear limitations. The utilisation of hazy human judgments in computational problems is made possible by fuzzy logic. Additionally, it provides a useful method for resolving disputes over a variety of criteria and for improving choice evaluation [6]. The primary goal of this endeavour is to systematically collect the work done in past on RP using Fuzzy logic technique and to evaluate each work from multiple factors. The paper is structured as follows: Section 2 discusses about earlier work done on RP using FL, Section 3 gives Research methodology, Section 4 describes about evaluation of earlier work, Section 5 illustrates the observations and directions for future research and Section 6 gives the conclusion.

LITERATURE REVIEW

A AFHCV approach that offers a way to add requirements to the current data set at runtime or adjust the requirements' order of precedence [7]. Collectively all the requirements are prioritized using AFHCV which uses re-prioritization procedure. The study's findings demonstrate that AFHCV is efficient at adding additional needs at runtime and also produces results for prioritising that are closer to the final priority than FHCV. In [8] authors present a Fuzzy based MoSCoW method for the prioritization of the software requirements. Their proposed method consists of five steps i.e., (i) Sort the requirements into functional and non-functional categories (ii) outline triangular fuzzy numbers (TFN) for the Must have, Should have, Could have, and Will not have types of requirements (iii) gather the fuzzy valuation of stake holders, (iv) utilise the triangular fuzzy numbers' graded mean integration representation, (iv) calculate the ranking standards of the requirements. A novel approach to requirement prioritization based on ranking fuzzy numbers that expresses the rank of an attribute in a requirement by its predicted value [9]. By selecting values at random from the reliability distributions of these numbers, the ranking includes approximating these anticipated values. Their method can combine several attributes and measurements to give a comprehensive perspective of the quality needs. Authors in [10], propose an approach which works in the following steps i) Sort the requirements for usability and their conflictsii) Usability professionals characterise the input fuzzy values iii) Explain the rules for using simple logic operators to connect the inputs to the output iv) Give a range for each factor (attribute)further sub factor (i.e. Low, medium, and high). They also list two benefits. First, fuzzy inference has the ability to calculate accurate values from imprecise data. By detaching dependable variables, fuzzy inference manages systemic relationships between variables. A scheme for requirement prioritization.

The method is a two-step procedure in which stakeholders' requirements are gathered in accordance with their order of importance [11]. After that, the group of experts is split into two independent teams during the first phase. Only one team is designated with prerequisites (exclusive of the stakeholders from whom these requirements originated). Second team is provided with stakeholder's descriptions only (exclusive of the requirements that they submitted). This step generates an independent ranked list of stakeholders and a ranked list of requirements. In order to iteratively rank the requirements, authors present a hierarchical prioritisation and classification technique that involves a variety of stakeholders and a mechanical fuzzy logic-based system at various phases [12]. The iterative method ensures that the actors are all able to evaluate the requirements at various points, and it also produces more realistic results. They carry out requirement elicitation in the first phase and rank stakeholders at the stakeholder level; the result of this phase is a stakeholder profile. In the second phase, experts employ requirements categorization criteria to rank stakeholders in the second stage. Later on, they look at fuzzy logic-based demand prioritizing, specifically using the fuzzy C-means method. Authors in [13], have worked on fuzzy decision matrix to solve ranking difficulties. Their analysis of the outcomes proved promising capabilities. Twelve criteria and four user

requirements were identified for the planning and execution of the planned technique. The paired evaluations of the criteria and requirements over linguistic scales were founded taking into account the fuzzy numbers. A formal framework for requirements prioritization that is centred on fuzzily defined goals [14]. The framework enables the depiction of ambiguous software goals, ambiguous desirable scenarios, and ambiguous stakeholder requirements. Additionally, their work offers measurable descriptions of the same Each circumstance is specified by goals that had an important value, and the desired situation is then followed. A feature and amount of aspiration make up a goal. The framework creates a prioritised list of needs based on goals' positions. Researches suggest a hybrid strategy based on the Logarithmic Fuzzy Trapezoidal Approach (LFTA) and Artificial Neural Network (ANN), which delivers a positive degree of membership function and an exclusive normalised ideal importance weight vector [15].

They have considered best college selection example for students. Their research shows that the pair-wise assessment matrix's lowest triangular components have exactly the same weighting. In the PRFGORE approach for eliciting goal-oriented requirements, offer a method for prioritizing needs utilising a fuzzy based approach by merging:i) α-level weighted F-preference relation (ii) Paired evaluations of functional and non-functional needs using extent fuzzy AHP (iii) ranked list of requirements are obtained using binary sort tree technique [16]. Authors have worked on easy to device ranking technique for multi-criteria multi-person decision-making in a fuzzy setting. Due of the ambiguous and uncertain stakeholder requirements, they used the Fuzzy analytical hierarchy process [5].Weights for stakeholders are determined using eigen values. In order to identify the comparison matrices, Fuzzy AHP is used; as a result, an integrated matrix that represents the prospects of all stakeholders is obtained. By taking the fuzziness of the data into account using Fuzzy logic, provide a strategy that enhances the current approaches for release planning [17].They represent the ambiguity surrounding the detection of structural dependency limitations among requirements using Fuzzy logic. Authors have illustrated their method using an example with 25 requirements. Researchers propose in what way notions of soft computing can effectively be useful for provision of decision-making in software release planning [18]. They have addressed the vagueness in giving effort estimates, in framing capacity bounds, and in integrating dissimilar purposes associated to cost, profit and quality of the release plans. They have demonstrated a case study with 30 requirements and 3 stakeholders. In [19] authors provide a ground-breaking method for release planning to address the SaaS apps' "next release" development challenge.

Their technique uses a ranking strategy called the Hierarchical Fuzzy Inference System (HFIS) to rate each distinct attribute. A feature's priority among other features indicates its importance. Next, ranks are generally adjusted to reflect dependencies and limitations. They order and rank the features using a greedy method, taking into account both what they deem necessary and what effort is accessible. With the aim of maximising, authors have worked on four objectives for uncertainty-wise requirements ranking i) the rank of requirements, ii) requirements dependencies, iii) implementation cost of requirements 4) cost overrun potential. Together, they evaluated the NSGA-II multi-objective exploration approach employing Random Search (RS), while taking the RALIC dataset and 19 synthetic issues into consideration. Results reveal that when it comes to presenting the needs prioritising problem, NSGA-II performs noticeably better than RS [20]. The authors provide a method to assist decision-makers with the challenging issue of release planning [21]. They provide statistical probability for the timing of thorough releases and the potential business advantage using probabilistic methods. Their approach was created to work in an agile environment. The authors note that their approach is simple and in line with current agile development standards. They also provide a case study to illustrate how the technique could be used. Authors in [22]suggest a system that rates software requirements collectively based on ambiguous ratings provided by many stakeholders. In order to get at a final requirement ranking that more fairly, impartially, and objectively represents the aggregated calculations of all stakeholders, comparisons in stakeholders' ratings are used. The authors' approach is predicated on qualitative stakeholder evaluations that are articulated and organised as fuzzy linguistic 2-tuples.

RESEARCH METHODOLOGY

This work follows a research protocol as shown in Fig 1, and the protocol includes the following steps, i) Search strategy ii) Designing the evaluation criteria iii) Evaluation of the past work on Requirements prioritization using Fuzzy Logic.

Search Criteria
This study's goal is to assess previous research on RP that just uses fuzzy logic. Following sources were accessed to retrieve the previous work, Google scholar, Springer, IEEE Xplore, ACM Digital Library and Scopus. Fig 2 shows the year wise number of publications. The Table 1 shows the search strings that were applied to retrieve the past work. The percentage of study selection is shown in Fig 3.

Evaluation Criteria
This section describes various criteria that will be using to evaluate earlier work on RP. The following are the criteria: amount, interdependence, and volatility of needs, as well as non-functional requirements in RP, prioritization criteria, and stakeholder participation.

Number of Requirements (NR)
During RP, the quantity or magnitude of the needs is crucial. Analysis must be done to determine whether a given RP strategy is effective for large sets of requirements (consisting of hundreds or thousands of requirements), even though it may perform well for small sets of requirements. This work, assumes three sets of requirements: small ($NR < 15$), medium ($20 <= NR > 50$) and huge ($NR >= 50$), as mentioned by [23]. This work will investigate NR criteria to the studies selected in Fig 3. During the assessment Unknown (UK) will be used if earlier study does not specify NR.

Requirements Dependencies (RD)
RP is a complex process involving various criteria one of them is RD. The values of requirements are impacted by the intricate interdependencies that exist between software projects [24]. Since the priority of needs is a key factor in increment planning, an RP that ignores RD is essentially worthless because it is impossible, or at the very least extremely difficult, to schedule requirements based solely on priority [25].

Volatility of Requirements (VR)
SDLC is a process which is dynamic in nature, which causes customer requirements to change though development is in progression. Market variations, business requirements, legislation fluctuations, user changes, or requirements that become apparent during the SDLC are the causes of changing requirements [26]. The above stated reasons make RP really challenging because even though initially we might have got a ranked list of requirements no matter which RP approach we use, predicting which requirements will change (either added or removed) in future is an aspect to be considered during RP.

Non-Functional Requirements (NFR)
NFRs are concerned with performance, scalability, maintainability, reliability, security and other quality attributes. These attributes put certain constraints on the system under development also critic operation of a system. The NFRs should be equally given importance as Functional Requirements (FR) because failure of one of the NFRs may mean the entire system is of no use. Prioritizing NFRs and FRs types of requirements at the same time or disjointedly may not be the optimal solution [27], since they are not at the same abstraction level. It is also obviously a bad decision since the effects of both types of requirements are interrelated [26]. Requirements engineering community lacks a broad understanding of NFRs prioritization techniques and the challenges which need to be overcome [28].

Prioritization Criteria (PC)
There are 84 PCs [29] in literature which are used as basis to prioritize the requirements, some of them are importance, Quality, Business Value, Cost, Benefits and others. Out of which the most used criteria are importance and second most used criteria in cost. Important issue is how to decide which criteria to use and who will decide this. We believe that domain also plays important role in which the software is going to be developed. For example, consider importance, cost and value are the criteria used to prioritize requirements of a retail domain. Is it guarantee that the aforementioned criteria must be used to a health care domain or some other criteria which is dependent of health care domain? This is the area to be investigated.

Stakeholder Participation (SP)
SP is really important during RP, as each stakeholder has different perception on the requirements. To satisfy all stakeholder requests and maximize product profit, choosing the appropriate specifications is a difficult undertaking [30]. Project's success heavily depends on the impact value of each stakeholder and the requirements posed by them[31]. In literature there are hardly few studies viz, VIRP, EVOLVE, RUPA and others, which give importance to SP in their work and most of the previous works do not take in to account SP.

Evaluations of Earlier Studies
In Table 2 shows earlier work done on RP using FL approaches and the alternate name used for each study for simplicity purpose. Table 3 shows the evaluation of each approaches considering all the criteria mentioned in section II. If any approach does not consider a particular criterion then Not Considered (NC) or Considered(C) is specified.
- 37.5% of previous studies does not consider prioritization criteria during RP.
- Future research work on RP that uses fuzzy logic, has to consider all the 6 criteria (NR, RD, VR, NFR, PC, SP) as mentioned in section 2. Researchers have to come up with some novel approaches which undertakes the impact of all 6 criteria during RP.
- It is observed some of the studies have not applied RP under real world setting and have only shown the result as proof of concept. Hence future work has to consider RP on some real-world setting.
- Some of the Fuzzy approaches used could be improved using some optimization techniques for example work can be done to improve the accuracy, to lessen time to prioritize, and other aspects.
- The number of fuzzy rules increases proportionally as the input variables, hence future work should look in this direction, which will also focus on NR criteria.

Observations And Future Directions For Research
The Fig 4 shows the number of studies considering the evaluation criterion.
- Out of 16 studies selected, we can see that only two approaches have worked on large number of requirements i.e. NR and majority of themare on small number of requirements only. Hence future research has to work in this direction.
- Only 5 studies take RD into account.
- It is observed from VR, majority of the studies (93.7%) does not consider volatility aspect during RP which is an important aspect specially in agile environment.
- Regarding NFR, only 18.7% of earlier studies have worked on NFR criteria.

CONCLUSION

Our work explicitly concentrates on Requirements Prioritization using Fuzzy approach, for this sake search criteria was formulated to select previous studies and a total of 16 studies were selected. To evaluate each study, 6 evaluation criteria (Number of requirements, Requirements dependence, Volatility of requirements, Prioritization criteria, Stakeholder participation, Non-functional requirements) are been described. The selected studies were investigated to see the impact to each of the 6 criteria and the observations are been depicted.

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Table 1: Keywords used to select studies

Sl.No	Search Strings involving Boolean operators
I.	"Requirements Prioritization" AND ("Fuzzy Logic" OR "Uncertainty" OR "Vague")
II.	"Software Release Planning" AND ("Fuzzy Logic" OR "Uncertainty" OR "Vague")
III.	"Release Planning" AND ("Fuzzy Logic" OR "Uncertainty" OR "Vague")

Table 2:　Study name and its alternate naming used

Study name	Alternate name used
Requirement Prioritization using Adaptive Fuzzy Hierarchical Cumulative Voting	S1
Fuzzy_MoSCoW: A fuzzy based MoSCoW method for the prioritization of software requirements	S2
Software requirement prioritization using fuzzy multi-attribute decision making	S3
Fuzzy Approach to Prioritize Usability Requirements Conflicts: An Experimental Evaluation	S4
Value Based Fuzzy Requirement Prioritization and Its Evaluation Framework	S5
Value based intelligent requirement prioritization (Virp): Expert driven fuzzy logic-based prioritization technique	S6
An Adaptive Fuzzy Decision Matrix Model for Software Requirements Prioritization	S7
A Fuzzy Approach to Requirements Prioritization	S8
A Hybrid Approach for Requirements Prioritization Using Logarithmic Fuzzy Trapezoidal Approach (LFTA) and Artificial Neural Network (ANN)	S9
Applying fuzzy preference relation for requirements prioritization in goal-oriented requirements elicitation process	S10
Fuzzy Structural Dependency Constraints in Software Release Planning	S11
Release planning under fuzzy effort constraints	S12
Cognitive and Hierarchical Fuzzy Inference System for Generating Next Release Planning in SaaS Applications	S13
Search-Based Uncertainty-Wise Requirements Prioritization	S14
Handling Uncertainty in Agile Requirement Prioritization and Scheduling Using Statistical Simulation	S15
Using Fuzzy Linguistic 2-Tuples to Collectively Prioritize Software Requirements based on Stakeholders	S16

Table 3: Comparative Analysis using evaluation criteria

Study	NR	RD	VR	NFR	PC	SP	Limitations	Benefits
S1	UK	Dependency is taken as one of the components to reprioritize	Address addition of new requirements	NC	NC	C	Does not consider what if existing requirements are removed	• considers re-prioritization aspect • Dynamic calculation of priorities is addressed
S2	Small	NC	NC	C	C	C	Size of requirements set is small	• Address non-functional requirements prioritization

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S3	UK	NC	NC	NC	C	NC	Does not specify clearly what criteria is used for decision making	• multiple attribute decision-making problem • easy to implement and
S4	Small	NC	NC	C	NC	C	Does not specify which FR is connected with usability requirement	• handles conflict among usability attributes
S5	UK	NC	NC	NC	NC	C	Not evaluated, only a proposal	• considers stakeholders prioritization
S6	Medium	NC	NC	NC	C	C	Expert participation is needed to prioritize	• best performing technique compared to traditional ones
S7	Small	NC	NC	NC	C	C	Experts involvement needed to initiate and conduct prioritization	• scalable prioritization model involved
S8	Small	NC	NC	NC	C	NC	Need to be applied for real world setting	• Handling uncertainty in SDLC
S9	Small	NC	NC	NC	C	C	Complexity can be improved using genetic algorithms	• Not specified
S10	Small	NC	NC	C	NC	C	Binary search tree is used, which take long searching time	• Considered interrelationship between functional and non-functional requirements
S11	Medium	C	NC	NC	NC	NC	No stakeholder involved	• Handles uncertainty during release planning
S12	Medium	C	NC	NC	C	C	Only considers time, benefit, and quality	• Handles uncertainty during release planning
S13	Large	NC	NC	NC	C	C	lack of learning capabilities [32]	• Shows promising results compared to the binary linear programming approach
S14	Large	C	NC	NC	C	C	Prioritization problem is complex	• Considers large number of requirements
S15	Small	C	NC	NC	NC	C	Small number of user stories considered	• Suits well for iterative and incremental development methods

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S16	Small	NC	NC	NC	C	C	Requires stakeholders to put in more time and effort to examine a big number of needs.	• Ranking replicates the opinions of all stakeholders as a whole.
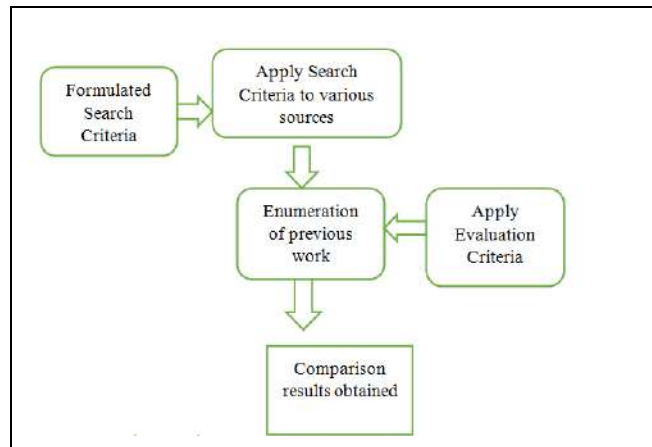
Fig. 1 Research Protocol
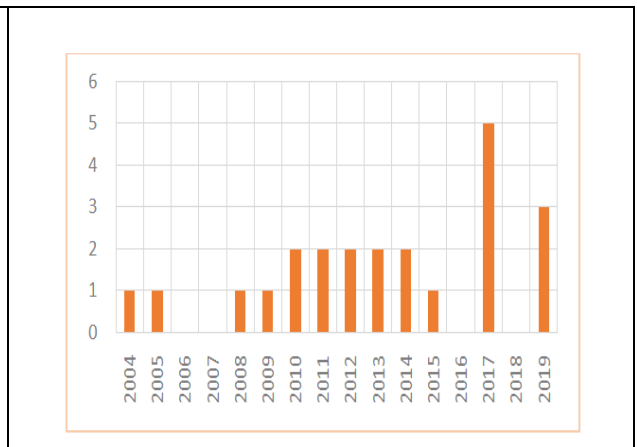
Fig. 2 Year wise Number of Publications
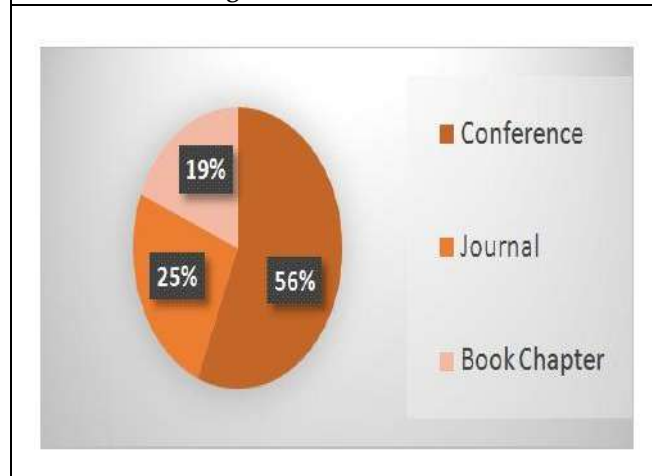
Fig. 3 Percentage of study selection
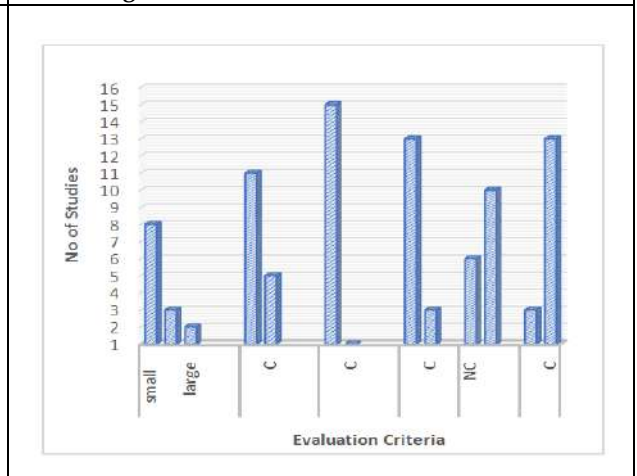
Fig.4 Number of Studies employing particular criterion

RESEARCH ARTICLE

Land use Land Cover Change Detection using Remote Sensing and Geographical Information – A Case Study of Aizawl District of Mizoram, India

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ABSTRACT

It's important to accurately record LU/LC variations in order to comprehend the connections and relations between natural and human activities. An effective technique that can deliver accurate data and information on LU/LC changes is the integration of Remote Sensing (RS) and Geographic Information System (GIS). Generally, supervised classification, unsupervised classification, visual interpretation, GEE (Google Earth Engine), and NDVI have all been used in national and international research on LU/LC change analysis using remote sensing and GIS (Normalize Difference Vegetation Index). One of the most often used methods in use nowadays is visual interpretation. Additionally, it is established that the main causes of changes (conversion of one class into another class) in the pattern of LULC are natural, human, and socioeconomic variables. It is crucial to monitor LULC variations on time so that appropriate control measures can be put in place to protect the environment and natural resources. According to NRSC standards, the study area was divided into fifteen groups. There has been an increase in the built-up area, forest, and wasteland, according to a comparison of LULC between the years of 2012 and 2016 determined from toposheet and satellite imagery interpretation.

Keywords: Land use / Land cover, Change, Remote sensing, Geographic information system, Visual Interpretation method.

INTRODUCTION

The understanding of LULC is crucial for management and planning tasks. Evaluating the LULC change is crucial to comprehending the current situation of the land. LULC shift has now taken a prominent place in the current approaches to manage a region's natural resources. It is highly challenging to map the changes in the LULC pattern over vast, inaccessible areas using existing techniques. The best methods to track changes in LULC have been determined to be remote sensing methods and GIS techniques (Meyer 1995; Pelorosso *et al.,* 2009). Important factors that influence ecological conditions and functions include land use/land cover dynamics. The biogeochemical cycle has changed significantly over the past 40 years due to land use cover change dynamics, which has also affected soil quality, biodiversity, human needs-supporting capacity of biological systems, surface atmospheric energy exchanges, carbon and water cycling, soil quality, and soil quality at all scales (Amare Sewnet 2016). In the present strategies and policies for managing and monitoring natural resources, land use and land cover dynamics play a key role. Currently, the globe is witnessing the significance of changes in land use and/or cover in global environmental adjustments that may have negative repercussions (Iqbal and Khan, 2014). Changes in land use and land cover indicate environmental changes brought on by anthropogenic or natural causes (Rawat and Kumar, 2015). This offers a crucial component in assessing, monitoring, and protecting Earth's resources, which is necessary for an area's sustainable development and economic growth (Rawat *et al*., 2013a). Over the past few decades, remote sensing data have been extensively employed to create detailed LULC maps (Manakos& Braun, 2014; Millington & Alexander, 2000; Thenkabail, 2015).

Existing LULC maps can be updated and elaborated using a variety of methods. To elaborate LULC mapping, visual interpretation, frequently computer-aided, has been used extensively (Afrasinei *et al*., 2017; Asner, Keller, Pereira, &Zweede, 2002; Gurgel, Farias, & Oliveira, 2017; Sunar, 1998).With the use of visual interpretation, map makers can incorporate a variety of classification criteria, including the interpreter's familiarity with the study region and factors like texture, shape, pattern, size, and closeness between items (Lu *et al*., 2004; NRSC/ISRO, 2010). Visual interpretation is still popular despite being time-consuming and requiring skilled analysts because it frequently produces more accurate results than spectral-based digital approaches (Mas & Ramirez, 1996; Palacio Prieto& González, 1994; Ruelland, Tribotte, Puech, &Dieulin, 2011; Sader, Stone, & Joyce, 1990; Van Den Broek, Smith, &Toet, 2004). For a better understanding of interactions and linkages between human activities and natural occurrences, change analysis of surface features of the Earth is crucial. This knowledge is required for better resource management and decision-making (Lu *et al*., 2004; Seif and Mokarram, 2012).Applying multi-temporal Remote Sensing data to quantitatively examine the historical consequences of an event is known as "change detection," which aids in identifying changes related to land cover and land use attributes with reference to multi-temporal datasets (Ahmad, 2012; Seif and Mokarram, 2012; Zoran, 2006). In this study, an examination is conducted in the Mizorami district of Aizawl to look for changes in the land usage and land cover.

Study area
One of Mizoram's eleven districts, Aizawl is located in the northern section of the state. It is located between 92° 37' 03.27" and 93° 11' 45.69" E Longitudes and 24° 25' 16.04" and 23° 18' 17.78" N Latitudes (SRSC, 2006). Champhai district and Manipur state border it on the east, Mamit district and Kolasib district border it on the west, Cachar district of Assam state borders it on the north, and Serchhip district borders it on the south. Aizawl district's geographic area, which is 3576 Sq.km in total, makes up 16.96% of the state's overall geographic area. The survey of India topo-sheet numbers 83D/15, 83D/16, 84A/9, 84A/10, 84A/11, 84A/13, 84A/14, 84A/15, 84E/1, 84E/2, and 83H/3 include the Aizawl district. The state has the following types of forests, according to Champion and Seth's (1968) classification: (a) tropical wet evergreen forests (up to 900 m); (b) tropical semi-evergreen forests (900-1500 m); and (c) montane sub-tropical pine forests (1500-2158 m). Mizoram has a tropical monsoon climate. The entire year doesn't get too hot or too cold. The south-west monsoon has a direct impact on the Aizawl district. As a result, the region experiences an adequate quantity of rainfall, which contributes to the humid tropical climate that is defined by a long, wet summer and a short winter (SRSC, 2004). The Aizawl district is located in a high-rainfall area with great

potential for horticulture, agriculture, and forestry (Bote and Pillai, 2010). Aizawl district has a total area of 3576 square kilometres and is divided into two sub districts: Aizawl, and Sakawrdai. Aizawl district has a population of 4,04,054 people, 2,01,072 of whom are men and 2,02,982 of whom are women, according to the 2011 Census. 94.75% of this population was made up of scheduled tribes. This population is the largest in the district and makes up about 37.03 percent of the state's total population. 113 people per square kilometre live there, compared to 52 in Mizoram. Aizawl district has a 98.50% literacy rate, compared to 91.58% for the entire state (Directorate of Census Operations, 2011). More than two thirds of the people in the Aizawl district reside in cities. A total of 22.58 and 77.42% of the population was rural, respectively.

DATA AND METHODOLOGY

Data used
Satellite data and auxiliary data were the two types of data employed in this study. The Indian Remote Sensing Satellite (IRS-1D) LISS III, which delivers data in four spectral bands (0.5-0.75 micrometre) with a spatial resolution of 23.8m, was used to collect satellite data for two years, from 2012 to 2016. For reference and the gathering of secondary data, numerous State Departments' archived records, reports, and maps were employed. a study of India Additionally, toposheets were used to create base maps and gather physiographic data. Various field information like areas of both current jhum and abandoned jhum, plantations etc. were collected on the ground. Local information are also collected for incorporation in generating the research.

Methods
Standard methods of remote sensing technology for interpretation and geographic information system for generation of maps were used as per National Remote Sensing Centre norms (NRSC, 2006a&b). To make land use features more visible, image processing and enhancement were done. The different land use / land cover classifications from the satellite data were classified and delineated using visual interpretation and on-screen digitising processes. Then, employing visual interpretation keys like colour, tone, texture, pattern, size, and shape, different land use/land cover classes were determined, including built up, agricultural land, forest, wasteland, shifting cultivation, water bodies, etc.

Classification
The classification system provided in the Manual of National Land Use Land cover (NRC-LULC50K) by National Remote Sensing Centre, Hyderabad was referred to and representative classes of land use land cover that existed for Aizawl district was selected out. The main objective of selecting out these classes from the predefined list of classes was to group together a set of observational units on the basis of their common attributes. Thus a total of 15 land use/land cover classes were selected out from the standard list provided in the LULC-50K manual. The classification of land use land cover for Aizawl district was done using the following feature codes:-

RESULT AND DISCUSSION

The study showed that shifting agriculture areas in the Aizawl district saw a significant decline in area coverage, whereas, the area of Forest, Built up, and Wasteland classes were increased. Agriculture and Water bodies more or less remains the same. Shifting cultivation area shrank from12.05% to9.18% of the total area while Built up areas increases from 1.80% to 2.29%. Forest areas increases from 83.60% to 85.29%.Wasteland areas increases from 0.82% to 1.48%.The Agriculture areas more or less remains from 1.21% to 1.23 % and the water body also remains 0.53% to 0.53%. The following tables shows the change matrix of different class of LULC

CONCLUSION

From the result we can conclude that the Built up area changes a little bit which is due to increase in population, Agriculture areas more or less remain the same, Forest area increases which is due to the conservation, afforestation and plantation carried out by the government and NGO's. Wasteland changes due to successive construction of roadways etc. Water bodies more or less remains the same. Shifting cultivation decreases which is due to the introduction of permanent cultivation by the government. The overall trend shows that due to the decrease in shifting cultivation area, forest area tends to increase. A little bit increase or decrease in other classes do not have much effect in LULC change pattern.

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Table 1 : LULC code with description.

LU_CODE	DESCRIPTION
1	Built Up – Urban
4	Built Up - Rural
10	Agricultural Land – Kharif Crop
16	Agricultural Land- Agricultural Plantation
18	Forest-Evergreen / Semi Evergreen-Dense/Closed
19	Forest-Evergreen / Semi Evergreen-Open
22	Forest-Forest Plantation
23	Forest-Scrub Forest
27	Forest - Tree Clad Area-Bamboo
34	Wastelands-Scrub land-Dense/Closed
35	Wastelands-Scrub land-Open
44	Waterbodies-River
47	Waterbodies-Lakes/Ponds
52	Shifting cultivation - Current
53	Shifting cultivation - Abandoned

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Table 2 : LULC statistic of Aizawl district.

DESCRIPTION	LULC 2012 (Area in sq km)	LULC 2016 (Area in sq km)	LULC 2012 (Area in %)	LULC 2016 (Area in %)
Built up - Urban	37.84	47.28	1.06	1.32
Built up - Rural	26.63	34.59	0.74	0.97
Agriculture - cropland	10.61	13.63	0.30	0.38
Agriculture - plantation	32.57	30.37	0.91	0.85
Forest Evergreen/Semi-Evergreen-Dense/Closed	479.27	566.87	13.40	15.85
Forest Evergreen/Semi-Evergreen-Open	598.27	659.22	16.73	18.43
Forest - Forest Plantation	18.22	19.35	0.51	0.54
Forest - Scrub Forest	647.52	617.78	18.11	17.28
Forest - Tree clad area (Bamboo)	1246.23	1186.66	34.85	33.18
Wasteland-Scrubland-Dense/Closed	13.29	24.80	0.37	0.69
Wasteland-Scrubland-Open	15.87	28.28	0.44	0.79
Shifting Cultivation-Current	171.00	122.46	4.78	3.42
Shifting Cultivation - Abandoned	259.86	205.80	7.27	5.76
Waterbodies-River	18.73	18.73	0.52	0.52
Waterbodies-Lakes/Ponds	0.09	0.19	0.00	0.01
Grand Total	3576.00	3576.00	100.00	100.00

Table 3 : Change matrix of LULC 2012 to 2016.

						LULC 2016										
DESCRIPTION	1	10	16	18	19	22	23	27	34	35	4	44	47	52	53	Grand Total
Built up - Urban	37.84															37.84
Agriculture - cropland		10.07					0.42	0.12								10.61
Agriculture - plantation	4.83		27.73													32.57
Forest Evergreen/Semi-Evergreen-Dense/Closed				470.16	2.70						0.61			4.58	1.21	479.27
Forest Evergreen/Semi-Evergreen-Open				96.71	476.08	1.13	3.45				0.80			15.56	4.53	598.27
Forest - Forest Plantation						18.22										18.22
Forest - Scrub Forest	3.85	2.21	1.08		180.43		375.23	2.00	4.33	0.18	5.07			31.78	41.34	647.52
Forest - Tree clad area (Bamboo)	0.75	0.22	0.27				123.19	1028.11	1.88	0.03	1.48		0.11	53.23	36.95	1246.23
Wasteland-Scrubland-Dense/Closed							2.86	0.17	5.02	5.24						13.29
Wasteland-Scrubland-Open							1.70	2.13	1.02	11.02						15.87
Built up - Rural											26.63					26.63
Waterbodies-River												18.73				18.73
Waterbodies-Lakes/Ponds													0.09			0.09
Shifting Cultivation-Current		0.31	0.42				19.09	25.06	2.89	8.42				0.15	114.66	171.00
Shifting Cultivation - Abandoned		0.81	0.86				92.25	128.76	9.54	3.39				17.14	7.10	259.86
	47.28	13.63	30.37	566.87	659.22	19.35	617.78	1186.66	24.80	28.28	34.59	18.73	0.19	122.46	205.80	3576.00

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CHANGE MATRIX TABLE FOR AGRICULTURE -PLANTATION CLASS LULC(2012) TO LULC(2016)

CHANGE TO

LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Agriculture - plantation	32.57	Agriculture - plantation	27.73
		Built up - Urban	4.83
		Total	32.57

CHANGE FROM

LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Agriculture - plantation	30.37	Agriculture - plantation	27.73
		Forest - Scrub Forest	1.08
		Forest - Tree clad area (Bamboo)	0.27
		Shifting Cultivation-Current	0.42
		Shifting Cultivation - Abandoned	0.86
		Total	30.37

CHANGE MATRIX TABLE FOR AGRICULTURE -CROPLAND CLASS LULC(2012) TO LULC(2016)

CHANGE TO

LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Agriculture - cropland	10.61	Agriculture - cropland	10.07
		Forest - Tree clad area (Bamboo)	0.42
		Wasteland-Scrubland-Dense/Closed	0.12
		Total	10.61

CHANGE FROM

LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Agriculture - cropland	13.63	Agriculture - cropland	10.07
		Forest - Scrub Forest	2.21
		Forest - Tree clad area (Bamboo)	0.22
		Shifting Cultivation-Current	0.31
		Shifting Cultivation - Abandoned	0.81
		Total	13.63

CHANGE MATRIX TABLE FOR EVERGREEN/SEMI-EVERGREEN-DENSE/CLOSED CLASS LULC(2012) TO LULC(2016)

CHANGE TO

LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Forest Evergreen/Semi-Evergreen-Dense/Closed	479.27	Forest Evergreen/Semi-Evergreen-Dense/Closed	470.16
		Forest Evergreen/Semi-Evergreen-Open	2.70
		Built up - Rural	0.61
		Shifting Cultivation-Current	4.58
		Shifting Cultivation - Abandoned	1.21
		Total	479.27

CHANGE FROM

LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Forest Evergreen/Semi-Evergreen-Dense/Closed	566.87	Forest Evergreen/Semi-Evergreen-Dense/Closed	470.16
		Forest Evergreen/Semi-Evergreen-Open	96.71
		Total	566.87

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CHANGE MATRIX TABLE FOR BUILT UP-URBAN CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Built up - Urban	37.84	Built up - Urban	37.84
		Total	37.52
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Built up - Urban	47.28	Built up - Urban	37.84
		Agriculture - plantation	4.83
		Forest - Scrub Forest	3.85
		Forest - Tree clad area (Bamboo)	0.75
		Total	47.28

CHANGE MATRIX TABLE FOR BUILT UP-RURAL CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Built up - Rural	26.63	Built up - Rural	26.63
		Total	
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Built up - Rural	34.59	Built up - Rural	26.63
		Forest Evergreen/Semi-Evergreen-Dense/Closed	0.61
		Forest Evergreen/Semi-Evergreen-Open	0.80
		Forest - Scrub Forest	5.07
		Forest - Tree clad area (Bamboo)	1.48
		Total	34.59

CHANGE MATRIX TABLE FOR EVERGREEN/SEMI-EVERGREEN-OPEN CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Forest Evergreen/Semi-Evergreen-Open	598.27	Forest Evergreen/Semi-Evergreen-Open	476.08
		Forest Evergreen/Semi-Evergreen-Dense/Closed	96.71
		Forest - Forest Plantation	1.13
		Forest - Scrub Forest	3.46
		Built up - Rural	0.80
		Shifting Cultivation-Current	15.56
		Shifting Cultivation - Abandoned	4.53
		Total	598.27
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Forest Evergreen/Semi-Evergreen-Open	659.22	Forest Evergreen/Semi-Evergreen-Open	476.08
		Forest Evergreen/Semi-Evergreen-Dense/Closed	2.70
		Forest - Scrub Forest	180.43
		Total	659.22

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CHANGE MATRIX TABLE FOR FOREST PLANTATION CLASS (LULC(2012) TO LULC(2016)				
CHANGE TO				
LULC(2012)	AREA (In Sq.Km)	LULC(2016)		AREA (In Sq.Km)
Forest - Forest Plantation	18.22	Forest - Forest Plantation		18.22
		Total		18.22
CHANGE FROM				
LULC(2016)	AREA (In Sq.Km)	LULC(2012)		AREA (In Sq.Km)
Forest - Forest Plantation	19.35	Forest - Forest Plantation		18.22
		Forest Evergreen/Semi-Evergreen-Open		1.13
		Total		19.35

CHANGE MATRIX TABLE FOR FOREST-FOREST-SCRUB CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Forest - Scrub Forest	647.52	Forest - Scrub Forest	375.23
		Built up - Urban	3.85
		Agriculture - cropland	2.21
		Agriculture - plantation	1.08
		Forest Evergreen/Semi-Evergreen-Open	180.43
		Forest - Tree clad area (Bamboo)	2.00
		Wasteland-Scrubland-Dense/Closed	4.33
		Wasteland-Scrubland-Open	0.18
		Built up - Rural	5.07
		Shifting Cultivation-Current	31.78
		Shifting Cultivation - Abandoned	41.34
		Total	647.52
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Forest - Scrub Forest	617.78	Forest - Scrub Forest	375.23
		Forest Evergreen/Semi-Evergreen-Open	3.46
		Forest - Tree clad area (Bamboo)	123.19
		Wasteland-Scrubland-Dense/Closed	2.86
		Wasteland-Scrubland-Open	1.70
		Shifting Cultivation-Current	19.09
		Shifting Cultivation - Abandoned	92.25
		Total	617.78

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CHANGE MATRIX TABLE FOR WASTELAND-SCRUBLAND-DENSE/CLOSED CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Wasteland-Scrubland-Dense/Closed	13.29	Wasteland-Scrubland-Dense/Closed	5.02
		Forest - Scrub Forest	2.86
		Forest - Tree clad area (Bamboo)	0.17
		Wasteland-Scrubland-Open	5.24
		Total	13.29
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Wasteland-Scrubland-Dense/Closed	24.80	Wasteland-Scrubland-Dense/Closed	5.02
		Agriculture - cropland	0.12
		Forest - Scrub Forest	4.33
		Forest - Tree clad area (Bamboo)	1.88
		Wasteland-Scrubland-Open	1.02
		Shifting Cultivation-Current	2.89
		Shifting Cultivation - Abandoned	9.54
		Total	24.80

CHANGE MATRIX TABLE FOR WASTELAND-SCRUBLAND-OPEN CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Wasteland-Scrubland-Open	15.87	Wasteland-Scrubland-Open	11.02
		Forest - Scrub Forest	1.70
		Forest - Tree clad area (Bamboo)	2.13
		Wasteland-Scrubland-Open	1.02
		Total	15.87
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Wasteland-Scrubland-Open	28.28	Wasteland-Scrubland-Open	11.02
		Forest - Scrub Forest	0.18
		Forest - Tree clad area (Bamboo)	0.03
		Wasteland-Scrubland-Dense/Closed	5.24
		Shifting Cultivation-Current	8.42
		Shifting Cultivation - Abandoned	3.39
		Total	28.28

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CHANGE MATRIX TABLE FOR FOREST-TREE CLAD AREA(BAMBOO) CLASS LULC(2012) TO LULC(2016)

CHANGE TO

LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Forest - Tree clad area (Bamboo)	1246.23	Forest - Tree clad area (Bamboo)	1028.11
		Built up - Urban	0.75
		Agriculture - cropland	0.22
		Agriculture - plantation	0.27
		Forest - Scrub Forest	123.19
		Wasteland-Scrubland-Dense/Closed	1.88
		Wasteland-Scrubland-Open	0.03
		Built up - Rural	1.48
		Waterbodies-Lakes/Ponds	0.11
		Shifting Cultivation-Current	53.23
		Shifting Cultivation - Abandoned	36.95
		Total	1246.23

CHANGE FROM

LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Forest - Tree clad area (Bamboo)	1186.66	Forest - Tree clad area (Bamboo)	1028.11
		Agriculture - cropland	0.42
		Forest - Scrub Forest	2.00
		Wasteland-Scrubland-Dense/Closed	0.17
		Wasteland-Scrubland-Open	2.13
		Shifting Cultivation-Current	25.06
		Shifting Cultivation - Abandoned	128.76
		Total	1186.66

CHANGE MATRIX TABLE FOR SHIFTING CULTIVATION-CURRENT CLASS LULC(2012) TO LULC(2016)

CHANGE TO

LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Shifting Cultivation-Current	171.00	Shifting Cultivation-Current	0.15
		Agriculture - cropland	0.31
		Agriculture - plantation	0.42
		Forest - Scrub Forest	19.09
		Forest - Tree clad area (Bamboo)	25.06
		Wasteland-Scrubland-Dense/Closed	2.89
		Wasteland-Scrubland-Open	8.42
		Shifting Cultivation - Abandoned	114.66
		Total	171.00

CHANGE FROM

LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Shifting Cultivation-Current	122.46	Shifting Cultivation-Current	0.15
		Forest Evergreen/Semi-Evergreen-Dense/Closed	4.58
		Forest Evergreen/Semi-Evergreen-Open	15.56
		Forest - Scrub Forest	31.78
		Forest - Tree clad area (Bamboo)	53.23
		Shifting Cultivation - Abandoned	17.14
		Total	122.46

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CHANGE MATRIX TABLE FOR SHIFTING CULTIVATION-ABANDONED CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Shifting Cultivation - Abandoned	259.86	Shifting Cultivation - Abandoned	7.10
		Agriculture - cropland	0.81
		Agriculture - plantation	0.86
		Forest - Scrub Forest	92.25
		Forest - Tree clad area (Bamboo)	128.76
		Wasteland-Scrubland-Dense/Closed	9.54
		Wasteland-Scrubland-Open	3.39
		Shifting Cultivation-Current	17.14
		Total	
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Shifting Cultivation - Abandoned	205.80	Shifting Cultivation - Abandoned	7.10
		Forest Evergreen/Semi-Evergreen-Dense/Closed	1.21
		Forest Evergreen/Semi-Evergreen-Open	4.53
		Forest - Scrub Forest	41.34
		Forest - Tree clad area (Bamboo)	36.95
		Shifting Cultivation-Current	114.66
		Total	205.80

CHANGE MATRIX TABLE FOR WATERBODIES-RIVER CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Waterbodies-River	18.73	Waterbodies-River	18.73
		Total	
CHANGE FROM			
LULC(2016)	AREA	LULC(2012)	AREA (In Sq.Km)
Waterbodies-River	18.73	Waterbodies-River	18.73
		Total	

CHANGE MATRIX TABLE FOR WATERBODIE S-LAKES/PONDS CLASS LULC(2012) TO LULC(2016)			
CHANGE TO			
LULC(2012)	AREA (In Sq.Km)	LULC(2016)	AREA (In Sq.Km)
Waterbodies-Lakes/Ponds	0.09	Waterbodies-Lakes/Ponds	0.09
		Total	
CHANGE FROM			
LULC(2016)	AREA (In Sq.Km)	LULC(2012)	AREA (In Sq.Km)
Waterbodies-Lakes/Ponds	0.19	Waterbodies-Lakes/Ponds	0.09
		Forest - Tree clad area (Bamboo)	0.11
		Total	0.19
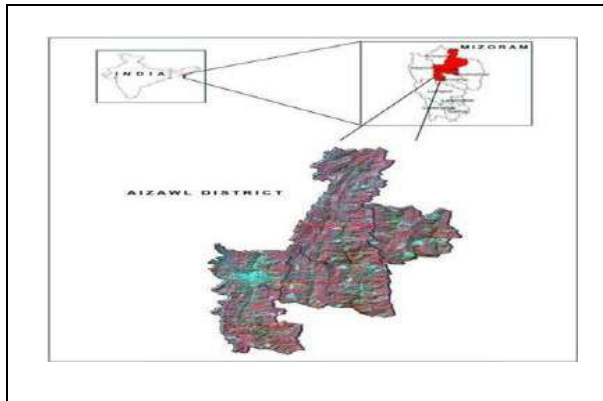
Figure 1 : Location map of the study area.
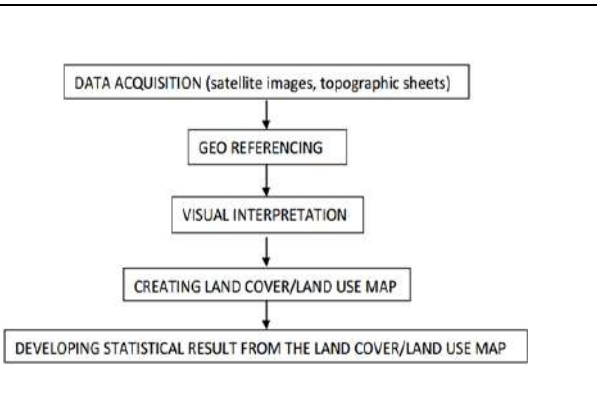
Figure 2 : Flowchart of Methodology
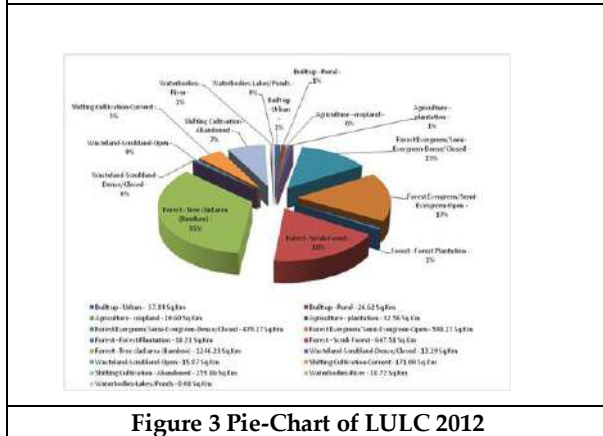
Figure 3 Pie-Chart of LULC 2012
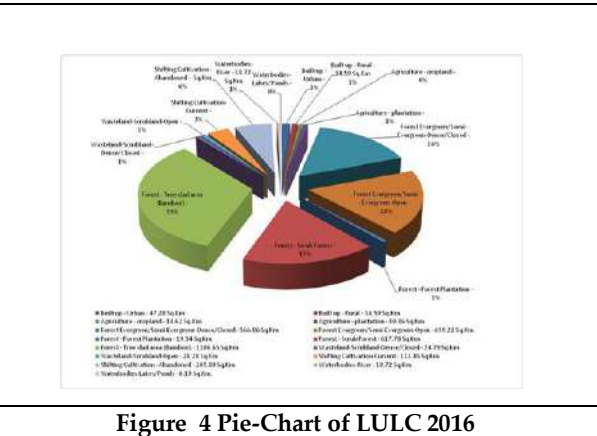
Figure 4 Pie-Chart of LULC 2016
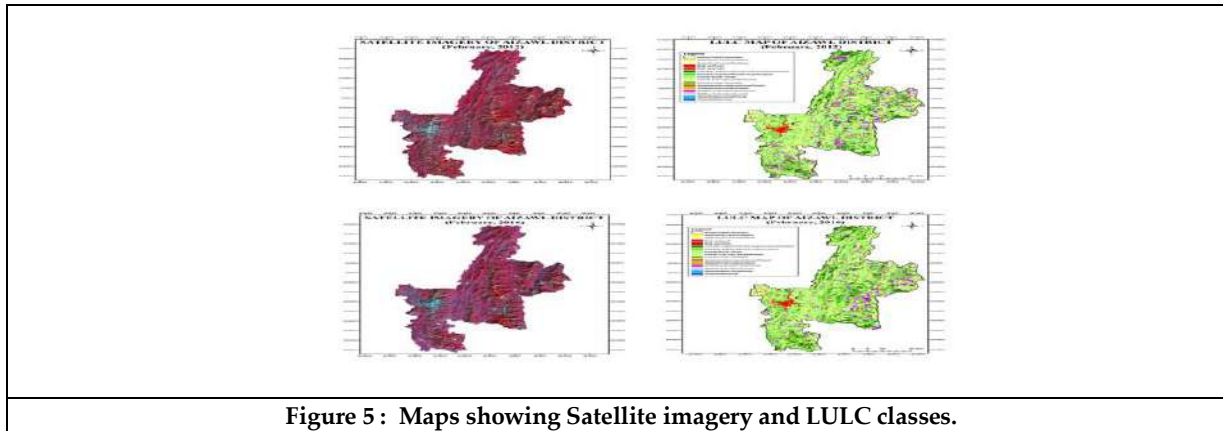
Figure 5 : Maps showing Satellite imagery and LULC classes.

Watermarking Images using Singular Valued Decomposition in DCT and DWT

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ABSTRACT

In this article we have attempted evaluation of two algorithms known as DWT and DCT in the field of digital image processing and particularly in the domain of watermarking. Hence in this projected approach, depending upon the implanting stage and mining stage are proposed, embedding the message image inside the original image in the low frequency domain in the case of DWT, because DWT gives optimal results in the LL Sub band, using middle frequency domain in the case of DCT. For watermarking singular value decomposition (SVD) method is used.

Keywords: DCT, DWT, SVD, Watermarking, Wavelength Transformation

INTRODUCTION

Watermarking is one of the popular technique in Digital Image Processing and is widely used in images to hide some information (message) behind the original image which can be used to send the image over the network in a secure manner so that other person who is sitting at the other end of the network can receive that information without any difficulty and he/she don't have worry about the breach of the information which has been sent over the network. Information may originate from source point in different formats. This paper compares between different two algorithms used for water- marking images that is DCT, DWT to see which among the two is the best algorithm which should be used to watermark images.

Literature review
Table.1 .Analysis on Subjective Answers.

METHODOLOGY

After comparing both model answers and the student's answer, we observe the evaluation is done almost similar. In our experiment, the students get 68% of marks for the answers which are evaluated by this system. In human evaluation, they get 65% of marks. By comparing both the results we can say that the proposed system is more accurate. Singular Valued Decomposition. Its, one of the popular handy tool which is used in Digital Image Processing for image compression. Previously, singular value decomposition was done on square matrices and later it was extended to rectangular matrices. The SVD of a rectangular matrix and A is a decomposition of the form

$$A = U \, W \, V^{-1}$$

SVD can be understood by taking a small example in which there is the occurrence of words 'Computer' and 'Laptop' in two documents named as D1 and D2, which is shown below U m x n - This matrix is called the Left Singular Vectors ("m" Documents x "r" Concepts (means categories, text documents can be of sports category document or it can be a political category document). W Singular Matrix of (r x r) diagonal matrix. r is the rank of the matrix A. W:Represents the strength of each concept. This matrix is called the Right Singular Vectors (n x r) ("n" is the no of terms and "r" is the concepts). Among these three matrices U and V are orthogonal matrices and w is the diagonal matrix. Table. 2: Representing the occurrence of words 'Laptop' and 'Computer' in documents 'D1' and 'D2'

Orthogonal Matrix
A matrix 'A' is said to be an orthogonal matrix if AAT= ATA=I (Identity Matrix).

Diagonal Matrix
A matrix is said to be diagonal matrix when it has non- zero value along its diagonal and rest matrix is filled with zeroes. Process of Watermarking Images Using SVD in Discrete Cosine Transform and Discrete Wavelength Transform
Step 1: Retrieving original image
Step 2: Resizing Images into 200 X 300
Step 3: DWT transform on low level filter
Step 4: Separating the channels into Red, Green and Blue (RGB)
Step 5: Applying SVD on all the three channels matrices obtained
Step 6: Doing manipulations in the diagonal elements of the diagonal matrix obtained after SVD
Step 7: Performing idwt on the concatenated image to get the watermarked image

RESULTS AND DISCUSSION
Figure 2 to 6

CONCLUSION

We have attempted to embed the message image into original image by separating the three channels i.e. red, green and blue (RGB components of the image) and taking the advantage of singular valued decomposition method to break these channels further into three matrices , out of which we have taken only the diagonal matrix for manipulations through which watermarking is actually taking place, because of its unique property that it has element only on its diagonal rest other cells have zero values. In future we would like to encrypt this embedded image by using an encryption algorithm, particularly Huffman Encoding for images algorithm so that whenever the image is communicated over the network nobody can see what is the message that is sent to the receiver and only the receiver will have the right/permission to decrypt that particular message. This encryption process will also generate a key matrix which will be used at the decryption process to decrypt the message. A static key will be used to

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enhance the security furthermore which only the sender and receiver will know which will be used both at the encryption and decryption process.

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Table.1 Analysis on Subjective Answers.

Author	Approaches	Contributions
Khalid K. Jabber&Munthir B. Tribe	Used both DCT & DWT for invisibility.	Mainly focused for the invisibility of the embedded watermark image under Discrete Cosine Transformation and DWT.
Tan Xiamei, Mei Jiansheng, LiSukang	Used both DCT & DWT	Proposed algorithm for watermarking using DCT and DWT.
Kalra, G. S., Talwar, R.,& Sadawarti	Arnold And Chaos basedTransform.	Finding better approach on DCT and DWT.
Authors Mandeep SinghSaini1,Venkata Kranthi,Gursharanjeet SinghKalra.	Watermarking using DCT,DWT, and DCT+DWT.	Comparison of DCT versus DWT and concluded that DWT is better than DCT and even hybrid model will be more accurate for watermarking process.
Sonja grgic et.al	Comparison between DCT and DWT	Comparison of DWT & Discrete Cosine Transformation using new features of wavelength transformation.

Table. 2: Rectangular Matrix

U – Right Singular Matrix	V – Left Singular Matrix	W – Diagonal Singular Matrix
U: M X M & orthogonal	U: N X N & orthogonal	U: M X N & orthogonal

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Figure 1. Computer and Laptop documents
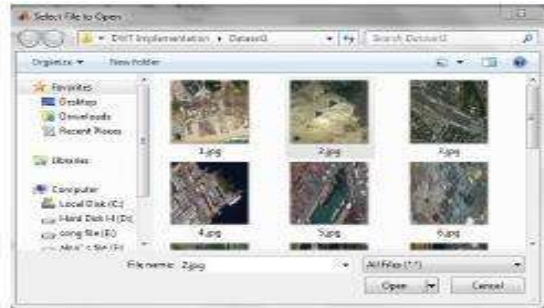
Figure 2. Selected Image
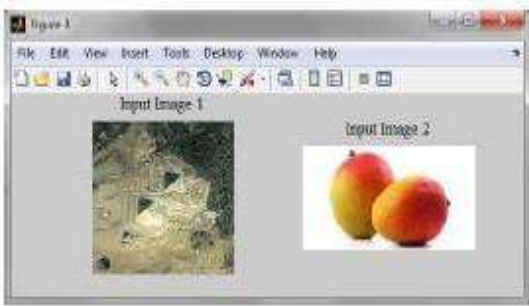
Figure 3. Input Image

Figure 4. Selected Input Image
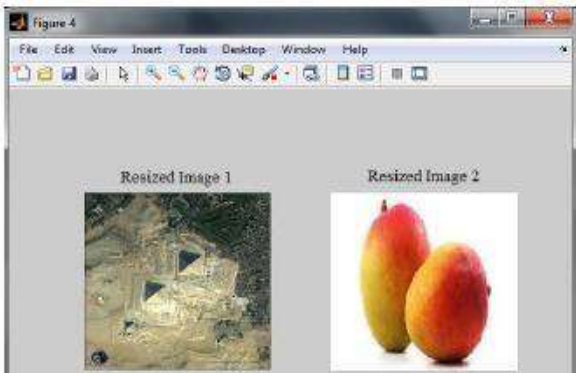
Figure 5. Resized Image

Figure 6. Watermarked Image

RESEARCH ARTICLE

An M/G/1 Queue Offering A Variety of Services and K+1th Phase Excursions

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ABSTRACT

We take a look at an M/G/1 queuing machine for important and optionally available excursion. The arrival follows Poisson process. In this version the server offers 3 kinds of carrier. The first types (kind 1, kind 2) of carrier are important. After final touch of kinds of important carrier,the consumer select an optionally available carrier with opportunity$Þ$ $(0 < Þ < 1)$ or go away the machine with opportunity $(1 - Þ)$. In addition after final touch of kinds of important carrier or optionally available carrier, if there aren't any consumers with inside the machine, the server takes - Klevels of important excursion. After final touch of important excursion, if there aren't any consumer with inside the queue the server might also additionally both wait idle for consumer with opportunityθ_0 or might also additionally take $K + 1$th section of optionally available excursion with opportunityθ_1. Both the carrier and excursion duration follows preferred distribution. Now that version the supplementary variable approach implemented through gain the opportunity producing feature on wide variety of consumer with inside the line. Some general exhibition measures are inferred. A specific case is examined. Mathematical investigate is in like manner introduced.

Keywords: M/G/1 line, Voluntary carrier, Voluntary vacation, Supplementary variable, PGF, Exponential Distribution, Performance measures.

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INTRODUCTION

In the M/G/1 queueing framework, every idea of excursion was concentrated about Keilson and Servi [5]. The exemplary M/G/1 line with different excursion strategies have been concentrated by Doshi [3]. The server do 1st fundamental support of every showing up client and subsequent to finishing the fundamental help, discretionary assistance will be given to some client, the people who request a second discretionary assistance such a model was first concentrated by Madan [8]. Different attempts likely referred right here are Medhi [11], Al-jararah[1], Wang[13]. Choudhry [2], Kalyanaraman [4,6], Madhu Jain and Binay Kumar [9], Manoharan [7,10] concentrated on the queueing model with second discretionary excursion. Sathiya and Ayyappan [12] examined a non-markovian queueing framework with two kinds of administrations and general excursion appropriation. Here this version we remember M/G/1 line along varieties of important carriers, one non-compulsory carrier and varieties of excursion. The relaxation of the paper is prepared as follows. The numerical depiction and assessment of this adaptation is given in stage 2. In phase 3, we derive a few running traits of the version analysed in phase 2. Section four offers with a few specific fashions and phase five affords a few numerical consequences associated with the version analysed on this paper. A definitive stage offers an end.

The Mathematical Model and Analysis

In a solitary server queueing framework, the client appearance follows a poisson way with state dependent parameter λ. The ready room is of unending potential and provider field is FIFO. The server gives the three kinds of administrations called two sorts of fundamental help and another is discretionary assistance. The carrier time follows general appropriation and whose distribution functions $ß_i(\varkappa), (i = 1,2,3), (LST)ß_i^*(\varsigma) = E(e^{-\varsigma ß_i})$, first, second and third moments b_{i1}, b_{i2} and b_{i3} respectively. As quickly as the two sorts of ES is completed, with probability Þ,the patron may also decide the elective carrier or with possibility$(1 - Þ)$, he may also prefer to depart the system. After final touch of sorts of ES or OS, if there aren't any clients with inside the system, the server takes K stages of critical holiday. The critical holiday follows general distribution with distribution feature$\mathcal{V}_i(\varkappa)$ whose *LST*is $\mathcal{V}_i^*(\varsigma)$. After final touch of critical holiday, if there aren't any patron with inside the queue, if the server may also both wait idle for patron with possibilityθ_0 or may take some other one holiday, we name this segment as$K+1$th segment, which follows general distribution with distribution feature $\mathcal{V}_{K+1}(\varkappa)$ whose LST is $\mathcal{V}_{K+1}^*(\varsigma)$ with possibilityθ_1.i.eif there are patron with inside the line, the server begins administration for the client in the top of the line, in any other case the server waits best for brand new arrival or take simplest sing lesegment holiday. The arriving patron input right into a queue of endless potential, if the carrierisn'ton the spot because of server is occupied or go to holiday.

Let altered get-away length is$\mathcal{V} = \begin{cases} \sum_{i=1}^{K} \mathcal{V}_i \\ \sum_{i=1}^{K+1} \mathcal{V}_i \ with \ probability \ \theta_1 \end{cases}$

Assume that $ß_i(0) = 0, ß_i(\infty) = 1, (i = 1 \ to \ 3), \mathcal{V}_i(0) = 0, \mathcal{V}_i(\infty) = 1, i = 1,2,.,K+1.$ the elapsed two sorts of important help time (discretionary assistance time) of the purchaser with carrier time f is meant through $ß_i(\mathfrak{t}), i = 1,2,3$.Elapsed excursion time f is meant through of $\mathcal{V}_i(f), i = 1,2,...,K$ and elapsed excursion time of elective section is $\mathcal{V}_{K+1}(f)$.

Let $\mathfrak{Y}(f)$ be the conditions of the server at time f and is described as

$$\mathfrak{Y}(f) = \begin{cases} 0, \ if \ the \ server \ is \ idle \\ 1, if \ the \ server \ is \ occupied \ providing \ kind \ 1 \ ES \\ 2, if \ the \ server \ is \ occupied \ providing \ kind \ 2 \ ES \\ 3, if \ the \ server \ is \ occupied \ providing \ the \ SOS \\ 4, if \ the \ server \ is \ on \ 1^{st} \ normal \ excursion \\ 5, if \ the \ server \ is \ on \ 2^{nd} \ discretionary \ get-away \end{cases}$$

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Let the rv's$\aleph(\mathfrak{t})$ is defined as,

$$\aleph(\mathfrak{t}) = \begin{cases} 0, \text{if } \mathfrak{Y}(\mathfrak{t}) = 0 \\ \beta_i(\mathfrak{t}), \text{if} \mathfrak{Y}(\mathfrak{t}) = 1 \text{ to } 3, i = 1 \text{ to } 3 \\ \mathcal{V}_i(\mathfrak{t}), \text{if} \mathfrak{Y}(\mathfrak{t}) = 4 \\ \mathcal{V}_{k+1}(\mathfrak{t}), \text{if} \mathfrak{Y}(\mathfrak{t}) = 5 \end{cases}$$

and Let the rv's$N(\mathfrak{t})$is the quantity of clients in the line at $\mathfrak{t}$, we characterize the limiting probabilities as follows

$Q(\mathfrak{t}) = \mathcal{P}r\{N(\mathfrak{t}) = 0, \aleph(\mathfrak{t}) = 0\}$

$\mathbb{P}_{i,\mathfrak{N}}(\varkappa)d\varkappa = \mathcal{P}r\{N(\mathfrak{t}) = \mathfrak{N}, \aleph(\mathfrak{t}) = \beta_i(\mathfrak{t}), \varkappa < \beta_i(\mathfrak{t}) \le \varkappa + d\varkappa\}, \mathfrak{N} \ge 0, \varkappa > 0, i = 1,2,3$

$Q_{i,\mathfrak{N}}(\varkappa)d\varkappa = \mathcal{P}r\{N(\mathfrak{t}) = \mathfrak{N}, \aleph(\mathfrak{t}) = \mathcal{V}_i(\mathfrak{t}), \varkappa < \mathcal{V}_i(\mathfrak{t}) \le \varkappa + d\varkappa\}, \mathfrak{N} \ge 0, \varkappa > 0, i = 1,..,K$

$R_{K+1,\mathfrak{N}}(\varkappa)d\varkappa = \mathcal{P}r\{N(\mathfrak{t}) = \mathfrak{N}, \aleph(\mathfrak{t}) = \mathcal{V}_{K+1}, \varkappa < \mathcal{V}_{k+1}(\mathfrak{t}) \le \varkappa + d\varkappa\}, \mathfrak{N} \ge 0, \varkappa > 0$

Where $\{N(\mathfrak{t}), \mathfrak{Y}(\mathfrak{t}), \mathfrak{t} \ge 0\}$ is a bivariate markov process with state space. In steady state, the equivalent probabilities

are $Q \quad = \lim_{\mathfrak{t}\to\infty} Q(\mathfrak{t}),$

$\mathbb{P}_{1,\mathfrak{N}}(\varkappa) \quad = \lim_{\mathfrak{t}\to\infty} \mathbb{P}_{1,\mathfrak{N}}(\mathfrak{t}, \varkappa),$

$\mathbb{P}_{2,\mathfrak{N}}(\varkappa) \quad = \lim_{\mathfrak{t}\to\infty} \mathbb{P}_{2,\mathfrak{N}}(\mathfrak{t}, \varkappa),$

$\mathbb{P}_{3,\mathfrak{N}}(\varkappa) \quad = \lim_{\mathfrak{t}\to\infty} \mathbb{P}_{3,\mathfrak{N}}(\mathfrak{t}, \varkappa),$

$Q_{i,\mathfrak{N}}(\varkappa) \quad = \lim_{\mathfrak{t}\to\infty} Q_{i,\mathfrak{N}}(\mathfrak{t}, \varkappa)$ and

$R_{K+1,\mathfrak{N}}(\varkappa) = \lim_{\mathfrak{t}\to\infty} R_{K+1,\mathfrak{N}}(\mathfrak{t}, \varkappa).$

Let $\mu_i(\varkappa), i = 1$ to 3 be the conditional probability of a finalization of the two types of ES and OS in the course of the time period$(\varkappa, \varkappa + d\varkappa]$ given that the elapsed carrier times of three kinds of administration is$\varkappa$, so that$\mu_i(\varkappa) = \frac{d\beta_i(\varkappa)}{1-\beta_i(\varkappa)}$.

The similar quantity for $\mathcal{V}_i(\varkappa), i = 1,2,....,K, K+1$ is $\mathcal{V}_i(\varkappa) = \frac{d\mathcal{V}_i(\varkappa)}{1-\mathcal{V}_i(\varkappa)}, i = 1,2,...,K+1.$

The version is administered by the specified differential difference Eqns:

For $\varkappa > 0$

$$\frac{d}{d\varkappa}\mathbb{P}_{1,0}(\varkappa) + (\lambda + \mu_1(\varkappa))\mathbb{P}_{1,0}(\varkappa) = 0 \tag{1}$$

$$\frac{d}{d\varkappa}\mathbb{P}_{1,\mathfrak{N}}(\varkappa) + (\lambda + \mu_1(\varkappa))\mathbb{P}_{1,\mathfrak{N}}(\varkappa) = \lambda\mathbb{P}_{1,\mathfrak{N}-1}(\varkappa) \tag{2}$$

$$\frac{d}{d\varkappa}\mathbb{P}_{2,0}(\varkappa) + (\lambda + \mu_2(\varkappa))\mathbb{P}_{2,0}(\varkappa) = 0 \tag{3}$$

$$\frac{d}{d\varkappa}\mathbb{P}_{2,\mathfrak{N}}(\varkappa) + (\lambda + \mu_2(\varkappa))\mathbb{P}_{2,\mathfrak{N}}(\varkappa) = \lambda\mathbb{P}_{2,\mathfrak{N}-1}(\varkappa) \tag{4}$$

$$\frac{d}{d\varkappa}\mathbb{P}_{3,0}(\varkappa) + (\lambda + \mu_3(\varkappa))\mathbb{P}_{3,0}(\varkappa) = 0 \tag{5}$$

$$\frac{d}{d\varkappa}\mathbb{P}_{3,\mathfrak{N}}(\varkappa) + (\lambda + \mu_3(\varkappa))\mathbb{P}_{3,\mathfrak{N}}(\varkappa) = \lambda\mathbb{P}_{3,\mathfrak{N}-1}(\varkappa) \tag{6}$$

$$\frac{d}{d\varkappa}Q_{i,0}(\varkappa) + (\lambda + \eta_i(\varkappa))Q_{i,0}(\varkappa) = 0 \tag{7}$$

$$\frac{d}{d\varkappa}Q_{i,\mathfrak{N}}(\varkappa) + (\lambda + \eta_i(\varkappa))Q_{i,\mathfrak{N}}(\varkappa) = \lambda Q_{i,\mathfrak{N}-1}(\varkappa), i = 1,2,....,K, \tag{8}$$

$$\frac{d}{d\varkappa}R_{k+1,0}(\varkappa) + (\lambda + \gamma_{k+1}(\varkappa))R_{K+1,0}(\varkappa) = 0 \tag{9}$$

$$\frac{d}{d\varkappa}R_{k+1,\mathfrak{R}}(\varkappa) + \big(\lambda + \gamma_{k+1}(\varkappa)\big)R_{K+1,\mathfrak{R}}(\varkappa) = \lambda\, R_{K+1,\mathfrak{R}-1}(\varkappa), \tag{10}$$

$$\lambda Q = \Theta_0 \int_0^\infty \eta_K(\varkappa) Q_{K,0}(\varkappa)d\varkappa + \int_0^\infty \gamma_{K+1}(\varkappa)R_{K+1,0}(\varkappa)d\varkappa \tag{11}$$

The boundary conditions at $\varkappa = 0$ are

$$\mathbb{P}_{1,0}(0) = \text{Þ}_1 \lambda Q + \text{Þ}_1 \Theta_0 \int_0^\infty \eta_K(\varkappa) Q_{K,1}(\varkappa)d\varkappa + \text{Þ}_1 \int_0^\infty \gamma_{K+1}(\varkappa)R_{K+1,1}(\varkappa)d\varkappa$$

$$+\text{Þ}_1(1-\text{Þ}) \int_0^\infty \mathbb{P}_{1,1}(\varkappa)\mu_1(\varkappa)d\varkappa + \text{Þ}_1(1-\text{Þ}) \int_0^\infty \mathbb{P}_{2,1}(\varkappa)\mu_2(\varkappa)dx + \text{Þ}_1 \int_0^\infty \mathbb{P}_{3,1}(\varkappa)\mu_3(\varkappa)d\varkappa \tag{12}$$

$$\mathbb{P}_{1,\mathfrak{R}}(0) = \text{Þ}_1 \Theta_0 \int_0^\infty \eta_K(\varkappa) Q_{K,\mathfrak{R}+1}(\varkappa)d\varkappa + \text{Þ}_1 \int_0^\infty \gamma_{K+1}(\varkappa)R_{K+1,\mathfrak{R}+1}(\varkappa)d\varkappa$$

$$+ \text{Þ}_1(1-\text{Þ}) \int_0^\infty \mathbb{P}_{1,\mathfrak{R}+1}(\varkappa)\mu_1(\varkappa)d\varkappa + \text{Þ}_1(1-\text{Þ}) \int_0^\infty \mathbb{P}_{2,\mathfrak{R}+1}(\varkappa)\mu_2(\varkappa)d\varkappa + \text{Þ}_1 \int_0^\infty \mathbb{P}_{3,\mathfrak{R}+1}(\varkappa)\mu_3(\varkappa)d\varkappa \tag{13}$$

$$\mathbb{P}_{2,0}(0) = \text{Þ}_2 \lambda Q + \text{Þ}_2 \Theta_0 \int_0^\infty \eta_K(\varkappa) Q_{K,1}(\varkappa)d\varkappa + \text{Þ}_2 \int_0^\infty \gamma_{K+1}(\varkappa)R_{K+1,1}(\varkappa)d\varkappa + \text{Þ}_2(1-\text{Þ}) \int_0^\infty \mathbb{P}_{1,1}(\varkappa)\mu_1(\varkappa)d\varkappa + \text{Þ}_2(1-\text{Þ})$$

$$\int_0^\infty \mathbb{P}_{2,1}(\varkappa)\mu_2(\varkappa)d\varkappa + \text{Þ}_2 \int_0^\infty \mathbb{P}_{3,1}(\varkappa)\mu_3(\varkappa)d\varkappa \tag{14}$$

$$\mathbb{P}_{2,\mathfrak{R}}(0) = \text{Þ}_2 \Theta_0 \int_0^\infty \eta_K(\varkappa) Q_{K,\mathfrak{R}+1}(\varkappa)d\varkappa + \text{Þ}_2 \int_0^\infty \gamma_{K+1}(\varkappa)R_{K+1,\mathfrak{R}+1}(\varkappa)d\varkappa + \text{Þ}_2(1-\text{Þ}) \int_0^\infty \mathbb{P}_{1,\mathfrak{R}+1}(\varkappa)\mu_1(\varkappa)d\varkappa + \text{Þ}_2(1-\text{Þ})$$

$$\int_0^\infty \mathbb{P}_{2,\mathfrak{R}+1}(\varkappa)\mu_2(\varkappa)d\varkappa + \text{Þ}_2 \int_0^\infty \mathbb{P}_{3,\mathfrak{R}+1}(\varkappa)\mu_3(\varkappa)d\varkappa \tag{15}$$

$$\mathbb{P}_{3,\mathfrak{R}}(0) \quad = \text{Þ} \int_0^\infty \mathbb{P}_{1,\mathfrak{R}}(\varkappa)\mu_2(\varkappa)d\varkappa + \text{Þ} \int_0^\infty \mathbb{P}_{2,\mathfrak{R}}(\varkappa)\mu_2(\varkappa)d\varkappa \tag{16}$$

$$Q_{1,0}(0) \quad = (1-\text{Þ}) \int_0^\infty \mathbb{P}_{1,0}(\varkappa)\mu_1(\varkappa)d\varkappa + (1-\text{Þ}) \int_0^\infty \mathbb{P}_{2,0}(\varkappa)\mu_2(\varkappa)d\varkappa + \int_0^\infty \mathbb{P}_{3,0}(\varkappa)\mu_3(\varkappa)d\varkappa \tag{17}$$

$$Q_{1,\mathfrak{R}}(0) \quad = 0, \mathfrak{R} \geq 1 \tag{18}$$

$$Q_{i,\mathfrak{R}}(0) \quad = \int_0^\infty Q_{i-1,\mathfrak{R}}(\varkappa)\eta_{i-1}(\varkappa)d\varkappa, \;\; i = 1,2,\dots,\text{K} \tag{19}$$

$$R_{K+1,\mathfrak{R}}(0) = \Theta_1 \int_0^\infty Q_{K,\mathfrak{R}}(\varkappa)\eta_K(\varkappa)d\varkappa, \;\; \mathfrak{R} = 0,1,2, \tag{20}$$

The normalizing condition is

$$Q + \mathbb{P}_1(1) + \mathbb{P}_2(1) + \mathbb{P}_3(1) + \sum_{i=1}^{K} Q_i(1) + R_{K+1}(1) = 1 \tag{21}$$

From Eqn (1), we have

$$\mathbb{P}_{1,0}(\varkappa) \quad = \mathbb{P}_{1,0}(0)\big(1 - ß_1(\varkappa)\big)e^{-\lambda\varkappa} \tag{22}$$

Similarly from Eqn (3), (5), (7) and (9), we get

$$\mathbb{P}_{2,0}(\varkappa) \quad = \mathbb{P}_{2,0}(0)\big(1 - ß_2(\varkappa)\big)e^{-\lambda\varkappa} \tag{23}$$

$$\mathbb{P}_{3,0}(\varkappa) \quad = \mathbb{P}_{3,0}(0)\big(1 - ß_3(\varkappa)\big)e^{-\lambda\varkappa} \tag{24}$$

$$Q_{K,0}(\varkappa) \quad = Q_{K,0}(0)\big(1 - \mathcal{V}_K(\varkappa)\big)e^{-\lambda\varkappa} \tag{25}$$

$$R_{K+1,0}(\varkappa) = R_{K+1,0}(0)\big(1 - \mathcal{V}_{K+1}(\varkappa)\big)e^{-\lambda\varkappa} \tag{26}$$

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Multiply Eqn(2) by $z^{\Re}$, take$\sum_{\Re=1}^{\infty}$ and sum the Eqn(1), then

$$\mathbb{P}_1(\varkappa,z) = \mathbb{P}_1(0,z)\big(1-\text{\ss}_1(\varkappa)\big)e^{-\text{T}\varkappa} \tag{27}$$

Similarly from Eqn(4), (6), (8) and (10), we get

$$\mathbb{P}_2(\varkappa,z) = \mathbb{P}_2(0,z)\big(1-\text{\ss}_2(\varkappa)\big)e^{-\text{T}\varkappa} \tag{28}$$

$$\mathbb{P}_3(\varkappa,z) = \mathbb{P}_3(0,z)\big(1-\text{\ss}_3(\varkappa)\big)e^{-\text{T}\varkappa} \tag{29}$$

$$Q_K(\varkappa,z) = Q_K(0,z)\big(1-\mathcal{V}_K(\varkappa)\big)e^{-\text{T}\varkappa} \tag{30}$$

$$R_{K+1}(\varkappa,z) = R_{K+1}(0,z)\big(1-\mathcal{V}_{K+1}(\varkappa)\big)e^{-\text{T}\varkappa} \tag{31}$$

Where $\text{T} = \lambda(1-z)$

Multiply Eqn(13) by $z^{\Re}$, take $\sum_{\Re=1}^{\infty}$ and sum the Eqn (12)and multiply by z, we obtain

$$z\,\mathbb{P}_1(0,z) = z\lambda\,\text{Þ}_1 Q + \text{Þ}_1\theta_0\left[\int_0^{\infty} Q_K(\varkappa,z)\eta_K(\varkappa)d\varkappa - \int_0^{\infty} Q_{K,0}(\varkappa)\eta_K(\varkappa)d\varkappa\right]$$
$$+ \text{Þ}_1\left[\int_0^{\infty} R_{K+1}(\varkappa,z)\gamma_{K+1}(\varkappa)d\varkappa - \int_0^{\infty} R_{K+1,o}(\varkappa)\gamma_{K+1}(\varkappa)d\varkappa\right] + \text{Þ}_1(1-\text{Þ})\left[\int_0^{\infty} \mathbb{P}_1(\varkappa,z)\mu_1(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{1,0}(\varkappa)\mu_1(\varkappa)d\varkappa\right]$$
$$+ \text{Þ}_1(1-\text{Þ})\left[\int_0^{\infty} \mathbb{P}_2(\varkappa,z)\mu_2(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{2,0}(\varkappa)\mu_2(\varkappa)d\varkappa\right] + \text{Þ}_1\left[\int_0^{\infty} \mathbb{P}_3(\varkappa,z)\mu_3(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{3,0}(\varkappa)\mu_3(\varkappa)d\varkappa\right] \tag{32}$$

Multiply Eqn (15) by $z^{\Re}$, take $\sum_{\Re=1}^{\infty}$ and sum the Eqn (14) and multiply by z, we obtain

$$z\,\mathbb{P}_2(0,z) = z\lambda\,\text{Þ}_2 Q + \text{Þ}_2\theta_0\left[\int_0^{\infty} Q_K(\varkappa,z)\eta_K(\varkappa)d\varkappa - \int_0^{\infty} Q_{K,0}(\varkappa)\eta_K(\varkappa)d\varkappa\right]$$
$$+\text{Þ}_2\left[\int_0^{\infty} R_{K+1}(\varkappa,z)\gamma_{K+1}(\varkappa)d\varkappa - \int_0^{\infty} R_{K+1,o}(\varkappa)\gamma_{K+1}(\varkappa)d\varkappa\right] + \text{Þ}_2(1-\text{Þ})\left[\int_0^{\infty} \mathbb{P}_1(\varkappa,z)\mu_1(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{1,0}(\varkappa)\mu_1(\varkappa)d\varkappa\right]$$
$$+ \text{Þ}_2(1-\text{Þ})\left[\int_0^{\infty} \mathbb{P}_2(\varkappa,z)\mu_2(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{2,0}(\varkappa)\mu_2(\varkappa)d\varkappa\right] + \text{Þ}_2\left[\int_0^{\infty} \mathbb{P}_3(\varkappa,z)\mu_3(\varkappa)d\varkappa - \int_0^{\infty} \mathbb{P}_{3,0}(\varkappa)\mu_3(\varkappa)d\varkappa\right] \tag{33}$$

From Eqn (22), we have

$$\int_0^{\infty} \mathbb{P}_{1,0}(\varkappa)\mu_1(\varkappa)d\varkappa = \mathbb{P}_{1,0}(0)\text{\ss}_1^*(\lambda) \tag{34}$$

Similarly from Eqn(23), (24), (25) and (26) we have

$$\int_0^{\infty} \mathbb{P}_{2,0}(\varkappa)\mu_2(\varkappa)d\varkappa = \mathbb{P}_{2,0}(0)\text{\ss}_2^*(\lambda) \tag{35}$$

$$\int_0^{\infty} \mathbb{P}_{3,0}(\varkappa)\mu_3(\varkappa)d\varkappa = \mathbb{P}_{3,0}(0)\text{\ss}_3^*(\lambda) \tag{36}$$

$$\int_0^{\infty} Q_{i,0}(\varkappa)\eta_i(\varkappa)d\varkappa = Q_{i,0}(0)\mathcal{V}_i^*(\lambda), \tag{37}$$

$$\int_0^{\infty} R_{K+1.o}(\varkappa)\gamma_{K+1}(\varkappa)d\varkappa = R_{K+1.o}(0)\mathcal{V}_{K+1}^*(\lambda) \tag{38}$$

From Eqn (26), we have

$$\int_0^{\infty} \mathbb{P}_1(\varkappa,z)\mu_1(\varkappa)d\varkappa = \mathbb{P}_1(0,z)\text{\ss}_1^*(\text{T}) \tag{39}$$

Similarly from Eqn (29), (28), (30) and (31), we have

$$\int_0^\infty \mathbb{P}_2(\varkappa,z)\mu_2(\varkappa)d\varkappa = \mathbb{P}_2(0,z)\text{ß}_2^*(\mathbb{T}) \tag{40}$$

$$\int_0^\infty \mathbb{P}_3(\varkappa,z)\mu_3(\varkappa)d\varkappa = \mathbb{P}_3(0,z)\text{ß}_3^*(\mathbb{T}) \tag{41}$$

$$\int_0^\infty \mathbb{Q}_i(\varkappa,z)\eta_i(\varkappa)d\varkappa = \mathbb{Q}_i(0,z)\mathcal{V}_i^*(\mathbb{T}), i = 1,2,\ldots,\text{K} \tag{42}$$

$$\int_0^\infty \mathbb{R}_{K+1}(\varkappa,z)\gamma_{K+1}(\varkappa)d\varkappa = \mathbb{R}_{K+1}(0,z)\mathcal{V}_{K+1}^*(\mathbb{T}) \tag{43}$$

From Eqn(32)and (33), we get

$$[z - \text{Þ}_1(1-\text{Þ})\text{ß}_1^*(\mathbb{T})]\mathbb{P}_1(0,z) = [(z-1)\lambda\,\text{Þ}_1 Q$$
$$+ \text{Þ}_1[(1-\text{Þ})\mathbb{P}_2(0,z)\text{ß}_2^*(\mathbb{T}) + \mathbb{P}_3(0,z)\text{ß}_3^*(\mathbb{T})] + \text{Þ}_1[\theta_0 \mathbb{Q}_i(0,z)\mathcal{V}_i^*(\mathbb{T}) + \mathbb{R}_{K+1}(0,z)\mathcal{V}_{K+1}^*(\mathbb{T})] - \text{Þ}_1 \mathbb{Q}_1(0,z)] \tag{44}$$

$$[z - \text{Þ}_2(1-\text{Þ})\text{ß}_2^*(\mathbb{T})]\mathbb{P}_2(0,z) = [(z-1)\lambda\,\text{Þ}_2 Q$$
$$+ \text{Þ}_2[(1-\text{Þ})\mathbb{P}_1(0,z)\text{ß}_1^*(\mathbb{T}) + \mathbb{P}_3(0,z)\text{ß}_3^*(\mathbb{T})] + \text{Þ}_2[\theta_0 \mathbb{Q}_i(0,z)\mathcal{V}_i^*(\mathbb{T}) + \mathbb{R}_{K+1}(0,z)\mathcal{V}_{K+1}^*(\mathbb{T})] - \text{Þ}_2 \mathbb{Q}_1(0,z)] \tag{45}$$

$$\mathbb{P}_3(0,z) = \text{Þ}[\mathbb{P}_1(0,z)\text{ß}_1^*(\mathbb{T}) + \mathbb{P}_2(0,z)\text{ß}_2^*(\mathbb{T})] \tag{46}$$

Using the Eqn(36) in (35)and(36), we get

$$[z - \text{Þ}_1(1 - \text{Þ} + \text{Þß}_3^*(\mathbb{T}))\text{ß}_1^*(\mathbb{T})]\mathbb{P}_1(0,z) = [(z-1)\lambda\,\text{Þ}_1 Q + [\text{Þ}_1 \mathbb{P}_2(0,z)\text{ß}_2^*(\mathbb{T})(1-\text{Þ}+\text{Þß}_3^*(\mathbb{T}))]$$
$$+ \text{Þ}_1[\theta_0 \mathbb{Q}_i(0,z)\mathcal{V}_i^*(\mathbb{T}) + \mathbb{R}_{K+1}(0,z)\mathcal{V}_{K+1}^*(\mathbb{T})] - \text{Þ}_1 \mathbb{Q}_1(0,z)] \tag{47}$$

$$[z - \text{Þ}_2(1 - \text{Þ} + \text{Þß}_3^*(\mathbb{T}))\text{ß}_2^*(\mathbb{T})]\mathbb{P}_2(0,z) = [(z-1)\lambda\,\text{Þ}_2 Q + [\text{Þ}_2 \mathbb{P}_1(0,z)\text{ß}_1^*(\mathbb{T})(1-\text{Þ}+\text{Þß}_3^*(\mathbb{T}))]$$
$$+ \text{Þ}_2[\theta_0 \mathbb{Q}_i(0,z)\mathcal{V}_i^*(\mathbb{T}) + \mathbb{R}_{K+1}(0,z)\mathcal{V}_{K+1}^*(\mathbb{T})] - \text{Þ}_2 \mathbb{Q}_1(0,z)] \tag{48}$$

Multiply the Eqn(18) by $z^\Re$, take $\sum_{\Re=1}^\infty$ and sum the Eqn(17), we obtain

$$\mathbb{Q}_1(0,z) = [\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda)) \tag{49}$$

By taking $z = 1$ in Eqn (49), we get

$$\mathbb{Q}_1(0,1) = [\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda)) \tag{50}$$

Multiply Eqn(19) by $z^\Re$, summing from $\Re = 0$ to ∞,we get

$$\mathbb{Q}_i(0,z) = [\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\prod_{l=1}^{i-1}\mathcal{V}_l^*(\mathbb{T}), i = 2,3,\ldots,\text{K} \tag{51}$$

By taking $z = 1$ in Eqn (51), we get

$$\mathbb{Q}_i(0,1) = [\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda)), i = 1,2,\ldots,\text{K} \tag{52}$$

By taking $n = 0$ in Eqn (19), we get

$$\mathbb{Q}_{i,0}(0) = [\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\prod_{l=1}^{i-1}\mathcal{V}_l^*(\lambda) \tag{53}$$

In a similar way from Eqn(20), we get

$$\mathbb{R}_{K+1}(0,z) = \theta_1[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\prod_{l=1}^{\text{K}}\mathcal{V}_l^*(\mathbb{T}) \tag{54}$$

By taking $z = 1$ in Eqn (54), we get

$$\mathbb{R}_{K+1}(0,1) = \theta_1[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda)) \tag{55}$$

By taking $\Re = 0$ in Eqn (20),we get

$$\mathbb{R}_{K+1,0}(0) = \theta_1[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\prod_{l=1}^{\text{K}}\mathcal{V}_l^*(\lambda) \tag{56}$$

From Eqn(11), we get

$$\lambda Q = \left[\theta_0 + \sum_{j=1}^N \theta_j\,\mathcal{V}_{K+1}^*(\lambda)\right]\prod_{l=1}^{\text{K}}\mathcal{V}_l^*(\lambda)\,[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda)) \tag{57}$$

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From Eqn(44), (45) and (46), we get

$$\mathbb{P}_1(0,z) = \frac{[\mathbb{P}_{1,0}(0)\text{\ss}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{\ss}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))}{z - [\text{Þ}_1\text{ß}_1^*(\text{Ţ}) + \text{Þ}_2\text{ß}_2^*(\text{Ţ})](1 - \text{Þ} + \text{Þß}_3^*(\text{Ţ}))} \, \text{Þ}_1 \left[(z-1)A_1 + \Theta_0 \prod_{l=1}^{K} \mathcal{V}_l^*(\text{Ţ}) + A_2 - 1 \right] \tag{58}$$

$$\mathbb{P}_2(0,z) = \frac{[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))}{z - [\text{Þ}_1\text{ß}_1^*(\text{Ţ}) + \text{Þ}_2\text{ß}_2^*(\text{Ţ})](1 - \text{Þ} + \text{Þß}_3^*(\text{Ţ}))} \, \text{Þ}_2 \left[(z-1)A_1 + \Theta_0 \prod_{l=1}^{K} \mathcal{V}_l^*(\text{Ţ}) + A_2 - 1 \right] \tag{59}$$

$$\mathbb{P}_3(0,z) = \frac{[\mathbb{P}_{1,0}(0)\text{ß}_1^*(\lambda) + \mathbb{P}_{2,0}(0)\text{ß}_2^*(\lambda)](\text{Þ}_1\text{ß}_1^*(\text{Ţ}) + \text{Þ}_2\text{ß}_2^*(\text{Ţ}))(1 - \text{Þ} + \text{Þß}_3^*(\lambda))}{z - [\text{Þ}_1\text{ß}_1^*(\text{Ţ}) + \text{Þ}_2\text{ß}_2^*(\text{Ţ})](1 - \text{Þ} + \text{Þß}_3^*(\text{Ţ}))} \, \text{Þ}_3 \Big[(z-1)A_1$$
$$+ \; \Theta_0 \prod_{l=1}^{K} \mathcal{V}_l^*(\text{Ţ}) + A_2 - 1 \Big] \tag{60}$$

Where $A_1 = (\Theta_o + \Theta_1 \mathcal{V}_{K+1}^*(\lambda))\mathcal{V}_l^*(\lambda)$ and
$A_2 = (\Theta_1 \mathcal{V}_{K+1}^*(\text{Ţ}))\mathcal{V}_l^*(\text{Ţ})$ Now

$$\mathbb{P}_1(z) = \int_0^\infty \mathbb{P}_1(\varkappa, z)d\varkappa = \mathbb{P}_1(0,z)\frac{[1 - \text{ß}_1^*(\text{Ţ})]}{\text{Ţ}}$$

$$\mathbb{P}_2(z) = \int_0^\infty \mathbb{P}_2(\varkappa, z)dx = \mathbb{P}_2(0,z)\frac{[1 - \text{ß}_2^*(\text{Ţ})]}{\text{Ţ}}$$

$$\mathbb{P}_3(z) = \int_0^\infty \mathbb{P}_3(\varkappa, z)d\varkappa = \mathbb{P}_3(0,z)\frac{[1 - \text{ß}_3^*(\text{Ţ})]}{\text{Ţ}} \tag{61}$$

$$Q_i(z) = \int_0^\infty Q_i(\varkappa, z)dx = Q_i(0,z)\frac{[1 - \mathcal{V}_i^*(\text{Ţ})]}{\text{Ţ}}$$

$$R_{K+1}(z) = \int_0^\infty R_{K+1}(\varkappa, z)d\varkappa = R_{K+1}(0,z)\frac{[1 - \mathcal{V}_{K+1}^*(\text{Ţ})]}{\text{Ţ}}$$

the $\mathbb{P}_{1,0}(0)$ we utilize the normalizing condition

$$Q + \mathbb{P}_1(1) + \mathbb{P}_2(1) + \mathbb{P}_3(1) + \sum_{i=1}^{K} Q_i(1) + R_{K+1}(1) = 1$$

We get

$$\mathbb{P}_{1,0}(0) = \frac{\text{Þ}_1 \lambda (1 + \lambda(\text{Þ}_1 \text{ß}_1^{*'}(0) + \text{Þ}_2 \text{ß}_2^{*'}(0) + \text{Þß}_3^{*'}(0)))}{[\text{Þ}_1\text{ß}_1^*(\lambda) + \text{Þ}_2\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\hat{C}_1} \tag{62}$$

$$\mathbb{P}_{2,0}(0) = \frac{\text{Þ}_2 \lambda (1 + \lambda(\text{Þ}_1 \text{ß}_1^{*'}(0) + \text{Þ}_2 \text{ß}_2^{*'}(0) + \text{Þß}_3^{*'}(0)))}{[\text{Þ}_1\text{ß}_1^*(\lambda) + \text{Þ}_2\text{ß}_2^*(\lambda)](1 - \text{Þ} + \text{Þß}_3^*(\lambda))\hat{C}_1} \tag{63}$$

Where, $\hat{C}_1 = \left[1 + \lambda((\text{Þ}_1 - 1)\text{ß}_1^{*'}(0) + (\text{Þ}_2 - 1)\text{ß}_2^{*'}(0)\right](A_1 + \lambda E(\mathcal{V}))$ And substituting Eqn(60), (61) in (55), we get

$$Q = \frac{A_1(1 + \lambda(\text{Þ}_1 \text{ß}_1^{*'}(0) + \text{Þ}_2 \text{ß}_2^{*'}(0) + \text{Þß}_3^{*'}(0)))}{\hat{C}_1} \tag{64}$$

Conditions in (61) along with (49), (51), (54), (58) to (60) gives the PGF of range of clients with inside the line while server is occupied the assistance is inactive and he is at the k+1thdurations of get-away separately.

Performance Measures
Let L_q stand for the mean queue size respectively, then

$$L_q = \frac{d}{dz}\mathfrak{P}(z)\Big|_{z=1} \left[\frac{\text{Þ}_1\text{ß}_1^*(\lambda) + \text{Þ}_2\text{ß}_2^*(\lambda)]\mathbb{P}_{1,0}(0)(1 - \text{Þ} + \text{Þß}_3^*(\lambda))}{\text{Þ}_1} \right] \tag{65}$$

Where,
$\mathfrak{P}(z) = \frac{\mathcal{N}(z)}{\mathcal{D}(z)}, \mathcal{N}(z) = ab\lambda + cx\lambda + A_1 xy$ and

$\mathcal{D}(z) = xy\lambda$,

$a = [(z-1)A_1 + \Theta_0 \prod_{l=1}^{k} \mathcal{V}_l^*(\text{T}) + A_2 - 1]$,

$b = (1 - (\text{Þ}_1 \text{ß}_1^*(\text{T}) + \text{Þ}_2 \text{ß}_2^*(\text{T}))(1 - \text{Þ} + \text{Þß}_3^*(\text{T}))$

$$c = (1 - \mathcal{V}_1^*(\text{T})..\mathcal{V}_k^*(\text{T}) + \Theta_1(1 - \mathcal{V}_{k+1}^*(\text{T}))\prod_{l=1}^{k} \mathcal{V}_l^*(\text{T})$$

$x = z - (\text{Þ}_1 \text{ß}_1^*(\text{T}) + \text{Þ}_2 \text{ß}_2^*(\text{T}))(1 - \text{Þ} + \text{Þß}_3^*(\text{T}))$, $y = \lambda - \lambda z$

Using the L' Hospital rule

$$L_q = \frac{2(\mathcal{D}''(z)\mathcal{N}'''(z) - \mathcal{N}''(z)\mathcal{D}'''(z))}{6(\mathcal{D}''(z))^2}\left[\frac{[\text{Þ}_1 \text{ß}_1^*(\lambda) + \text{Þ}_2 \text{ß}_2^*(\lambda)]\text{P}_{1,0}(0)(1 - \text{Þ} + \text{Þß}_3^*(\lambda))}{\text{Þ}_1}\right]$$

$\mathcal{D}''(z) = -2\lambda^2\left[1 + \lambda[\text{Þ}_1 \text{ß}_1^{*'}(0) + \text{Þ}_2 \text{ß}_2^{*'}(0) + \text{Þß}_3^{*'}(0)]\right], \mathcal{N}''(z) = -2\lambda[A_1 + \lambda E(\mathcal{V})]$

$\mathcal{D}'''(z) = 3\lambda^4[\text{Þ}_1 \text{ß}_1^{*''}(0) + \text{Þ}_2 \text{ß}_2^{*''}(0) + 2\text{ÞÞ}_1 \text{ß}_1^{*'}(0)\text{ß}_3^{*'}(0) + 2\text{ÞÞ}_2 \text{ß}_2^{*'}(0)\text{ß}_3^{*'}(0) + +\text{Þß}_3^{*''}(0)]$ and
$\mathcal{N}'''(z) = -3\lambda^3 E(\mathcal{V}^2)$ Where,

$E(\mathcal{V}) = \sum_{i=1}^{K} \mathcal{V}_i^{*'}(0) + \Theta_1 \mathcal{V}_{K+1}^*(0)$.

Then use of the Little's formula, we get L_q, the mean waiting time with inside the queue as $\mathcal{W}_q = \frac{L_q}{\lambda}$ respectively.

Particular cases

Case 1: Now we take the service time and exponential time distribution ED,

$\text{ß}_1^{*'}(0) = \frac{-1}{\mu_1}$,

$\text{ß}_1^{*''}(0) = \frac{2}{\mu_1^2}$,

$\text{ß}_2^{*'}(0) = \frac{-1}{\mu_2}$,

$\text{ß}_2^{*''}(0) = \frac{2}{\mu_2^2}$,

$\text{ß}_3^{*'}(0) = \frac{-1}{\mu_3}$,

$\text{ß}_3^{*''}(0) = \frac{2}{\mu_3^2}$

$\mathcal{V}_i^{*'}(0) = \frac{-1}{\gamma_i}$,

$\mathcal{V}_i^{*''}(0) = \frac{2}{\gamma_i^2}$, and

$\mathcal{V}_{K+1}^{*'}(0) = \frac{-1}{\gamma_{K+1}}$,

$\mathcal{V}_{k+1}^{*''}(0) = \frac{2}{\gamma_{K+1}^2}$,

$Q = \frac{O_1(\mu_1\mu_2\mu_3 - \lambda(\text{Þ}_1\mu_2\mu_3 + \text{Þ}_2\mu_1\mu_3 + \text{Þ}\mu_1\mu_2))}{O_2(\mu_1\mu_2\mu_3)}$, $\mathcal{W}_q = \frac{L_q}{\lambda}$ and

$$L_q = \lambda^2\left[\frac{O_3\left(\mu_1\mu_2\mu_3 - \lambda(\text{Þ}_1\mu_2\mu_3 + \text{Þ}_2\mu_1\mu_3 + \text{Þ}\mu_1\mu_2)\right)(\mu_1\mu_2\mu_3) + 2O_2}{[\text{Þ}_1\mu_2^2\mu_3^2 + +\text{Þ}_2\mu_1^2\mu_3^2 + \text{Þ}\mu_1^2\mu_2^2 + \text{ÞÞ}_1\mu_1\mu_2^2\mu_3 + \text{ÞÞ}_{12}\mu_1^2\mu_2\mu_3]}{2O_2[\mu_1\mu_2\mu_3 - \lambda(\text{Þ}_1\mu_2\mu_3 + \text{Þ}_2\mu_1\mu_3 + \text{Þ}\mu_1\mu_2)]\mu_1\mu_2\mu_3}\right]$$

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$$W_q = \lambda \left[\frac{O_3(\mu_1\mu_2\mu_3 - \lambda(\text{Þ}_1\mu_2\mu_3 + \text{Þ}_2\mu_1\mu_3 + \text{Þ}\mu_1\mu_2))(\mu_1\mu_2\mu_3) + 2O_2}{\dfrac{[\text{Þ}_1\mu_2^2\mu_3^2 + +\text{Þ}_2\mu_1^2\mu_3^2 + \text{Þ}\mu_1^2\mu_2^2 + \text{Þ}\text{Þ}_1\mu_1\mu_2^2\mu_3 + \text{Þ}\text{Þ}_{12}\mu_1^2\mu_2\mu_3]}{2O_2[\mu_1\mu_2\mu_3 - \lambda(\text{Þ}_1\mu_2\mu_3 + \text{Þ}_2\mu_1\mu_3 + \text{Þ}\mu_1\mu_2)]\mu_1\mu_2\mu_3}} \right]$$

Case 2: Now we take, the probability Þ=0, queue without optional service.

$$Q = \frac{A_1(1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0) + \text{Þ}_2\text{ß}_2^{*'}(0))}{C_1'}$$

$$L_q = \frac{\lambda^2\left[E(V)^2[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0) + \text{Þ}_2\text{ß}_2^{*'}(0)] + [A_1 + \lambda E(V)][\text{Þ}_1\text{ß}_1^{*''}(0) + \text{Þ}_2\text{ß}_2^{*''}(0)]\right]}{2C_1'[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0) + \text{Þ}_2\text{ß}_2^{*'}(0)]}$$

$$W_q = \frac{\lambda\left[E(V)^2[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0) + \text{Þ}_2\text{ß}_2^{*'}(0)] + [A_1 + \lambda E(V)][\text{Þ}_1\text{ß}_1^{*''}(0) + \text{Þ}_2\text{ß}_2^{*''}(0)]\right]}{2C_1'[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0) + \text{Þ}_2\text{ß}_2^{*'}(0)]}$$

Where,

$$C_1' = \left[1 + \lambda((\text{Þ}_1 - 1)\text{ß}_1^{*'}(0) + (\text{Þ}_2 - 1)\text{ß}_2^{*'}(0)\right](A_1 + \lambda E(\mathcal{V}))$$

Case 3: Now we take, the probability $\text{Þ} = P_1 = 0$, queue without optional service.

$$Q = \frac{A_1(1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0))}{C_1'},$$

$$L_q = \frac{\lambda^2\left[E(V)^2(1 + \lambda\left(\text{Þ}_1\text{ß}_1^{*'}(0)\right) + [A_1 + \lambda E(V)]\text{Þ}_1\text{ß}_1^{*''}(0)\right]}{2C_1'[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0)]}$$

$$W_q = \frac{\lambda\left[E(V)^2(1 + \lambda\left(\text{Þ}_1\text{ß}_1^{*'}(0)\right) + [A_1 + \lambda E(V)]\text{Þ}_1\text{ß}_1^{*''}(0)\right]}{2C_1'[1 + \lambda(\text{Þ}_1\text{ß}_1^{*'}(0)]}$$

Where,

$$C_1' = \left[1 - \lambda\text{ß}_2^{*'}(0)\right](A_1 + \lambda E(\mathcal{V}))$$

Mathematical outcomes

In this part, we present a mathematical outcome to represent. Accepting specific qualities to the boundaries of the framework as $\lambda = 1.0$ to $1.18, \text{Þ} = 0.9, \mu_1 = 3, \mu_2 = 2.5, \mu_3 = 2, \text{K} = 5, \eta_1$ to $\eta_5 = 1.2$ to $2.0, \gamma_1$ to $\gamma_6 = 0.2$ to 1.2 and $\theta_1 = 0.7565$. We find the values of Q, L_q and W_q and are organized in table 1. We see from the table that once λ builds, there's a Q decline and regular growth in each L_q and W_q that's expected.

CONCLUSION

The examination an M/G/1 line with two sorts of fundamental assistance and K+1th phase of discretionary excursion has been considered. For this model get the PGF for the quantity of client inside the framework and additionally to gain the ready time of a patron within side the queue. A wide mathematical work should be done to notice the concept of the operating qualities.

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RESEARCH ARTICLE

Dynamic Shortest Path Finding and Evaluation of Various Pathfinding Algorithms

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ABSTRACT

Pathfinding is the quest for an ideal way from a beginning area to an objective area in a habitat. According to intelligent retrieval, trailblazing calculations are normally planned considering a sort of chart hunt. These calculations are relevant for a huge variety of uses, for example, PC games, mechanical technology, organizations, and route frameworks. The presentation of these calculations is impacted by a few factors, for example, the issue size, scope of the path, the count and appropriation of barriers, information designs and pragmatics. When latest trailblazing calculations are offered in the writing, their presentations are regularly researched experimentally. Appropriate exploratory plan and examination is urgent to give a useful and genuine assessment. At this point of the exploration, we overview plenty of papers and characterize them as per the system, trial plan and scientific strategies. We recognize a few shortcomings here that are all around regularly saw as in revealed approaches. We initially tracked down the entanglements in pathfinding research and afterward give arrangements by making model issues. Our exploration shows that false impacts, control conditions and testing predisposition information can give deluding results and our contextual analyses give answers to keep away from these traps.

Keywords: WayPoints, Way-Finding, Heuristics, Dijkstra's

INTRODUCTION

This offer the arrangement of rules for the specialist to plan the exploration and to observationally examine the outcomes from the information gathered. In trailblazing when another calculation or information is offered it is tried on a group of various guides. Consequently, the principle focal point of this postulation is to concentrate on the different viewpoints of guides, produced in pathfinding tests, similar to the way length, the thickness of obstructions, map size, etc. as the exhibition of recently fabricated calculation is tried for the mentioned guides

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subsequently it is a significant part for pathfinding tests. We examined more exploration papers identified with pathfinding and saw that almost 65% of papers try not to give sufficient data to help their case and almost half of these papers have just either arbitrary framework guides or game guides to test their calculation[1]. As it were 20% of the papers direct strong trials and give exact examination of their results. While evaluating these papers we tracked down certain shortcomings in the test arrangement dependent on the plan of the examinations, approach and logical procedures utilized by specialists. Our proposal shows that it is truly essential to keep away from these traps, furthermore plan the analyses exactly strongly to test the calculation for all conceivable results to do a definite investigation of the calculations' presentation. In view of our discoveries, we sorted the guides into four kinds to think about various obstruction conveyances of obstructions and furthermore show how various properties of guides can be controlled to get more solid outcomes.

An Overview of Pathfinding
Pathfinding alludes on registering a perfect course in a given guide in the middle of the determined beginning along with objective hubs. This is a significant exploration theme in the space of Artificial Insight with fields of implementations such as Global Positioning Systems, Real-Time Strategy Games [1], Mechanical technology, coordination while executed in static or dynamic or true situations. Ongoing advancements in trailblazing lead to better, precise and quicker techniques and still enthralls the specialist's consideration for additional upgrades and growing new strategies as more complicated issues emerge or being created in Artificial Intelligence. A lot of examination tasks are made ready in trailblazing for creating new calculations that are quick and give an ideal way afterward the distribution of the Dijkstra's algorithm. The greater part of the examination work is approved utilizing exploratory information. In this manner, the examination should give solid and precise data as tests are extremely unpredictable [8].

Problem Definition of Pathfinding
Pathfinding is firmly identified with most brief way issue, in this manner the meaning of pathfinding is identifying the ideal way from a starting node to objective node in the given a graph, where ideal alludes to the briefest way, minimal expense way, quickest way or some other given standards. Pathfinding can by and large be isolated into two classes: SAPF, that is Single Agent Pathfinding, for creating a way for one specialist what's more MAPF, that is Multi-Agent Pathfinding, for creating the way for multiple specialists. In this research, we just involve the single-specialist pathfinding issue in a dynamic climate, which implies the guide doesn't vary as the specialist moves. Pathfinding has advantages in various habitats and it is highly difficult to think about all the advantages regions, thus in this research, just computer entertainment applications are utilized and in 2D conditions [3].

Representations of the Map
Pathfinding is utilized in a wide assortment of regions and typically carried out on various maps that are produced to test pathfinding calculations. The broadly well-known guides are executed utilizing a grid-based chart, set of hubs and edges, and portrayals in the calculation. Normally, a network is overlaying over a guide and afterward the diagram is utilized to track down the ideal way. This has its own benefits and hindrances. Frameworks are viewed as straightforward and simple to carry out what's more are usually utilized by analysts. Different portrayals are Navigation Mesh, and Waypoints.

Tile Grids
The synthesis of the matrix incorporates vertices or focuses that are associated by boundary. Essentially, lattices consistently partition the guide world into more modest gatherings of ordinary shapes called "tiles". Here every tile is outlined in the color blue and filled in with white here the number of rows is height divided by the scale and columns will be the width divided by the scale, scale is set to the size of the screen ratio are not famous among game designers also specialists yet a few strategies put forward to lessen the hunt exertion and time utilization.

Way-Finding Mesh

A way-finding mesh is a linking graph in which the pathway of a source to destination is decided by the chosen algorithm in the given obstructions/maze/walls that is either brought by the randomized feature of the algorithms present or the user can add the mazes if a particular point is not supposed to be visited, in other case user adds weights to make sure that the algorithm is made to visit that particular point.

Waypoints

A waypoint can be characterized as a node present in a path where the node can be stamped physically or consequently registered. The reason for waypoints is to limit the way portrayal as the briefest way can be registered prior within any two focuses. Accordingly, few advancement procedures are created to register the way utilizing waypoints. The principal benefit of waypoints may be static as the guide doesn't vary, so the briefest ways between two waypoints can be pre-processed; what's more put away, decreasing an opportunity to compute the last way after execution.

Algorithms

For observing a way between two hubs in a given chart an inquiry calculation is needed. Numerous inquiry calculations have been created for chart-based trailblazing. Pathfinding calculation for the most part tracks down the way by extending hubs and adjoining hubs as per some given measures. Pathfinding calculations can be comprehensively isolated into two classifications
-Informed Pathfinding Algorithms.
-Uninformed Pathfinding Algorithm.

Informed Search

As the title recommends, informed defines having earlier data about the issue space prior to looking through it. Informed pursuit alludes to the utilization of information about the search space like issue map, assessed costs, a gauge of objective area. Subsequently, the calculation uses this data while looking through a way and it makes pathfinding quick, ideal and decreases memory use in hub extension. Various algorithm that fall under this classification are A*, Greedy Search, and some more. These calculations utilize diverse heuristic capacities or uniform expense capacity to use the data of the hunt issue.

Heuristics function

Heuristic is an operation which is highly made use in Informed Search in which the the highest encouraging way is tracked down [5]. Present status of specialist is chosen as the feedback and provides the assessment of how nearer the specialist is from the objective. The heuristic strategy, nonetheless, may not generally offer the best arrangement, yet it ensured to track down a decent arrangement in sensible durations. Heuristic function appraises how nearer a circumstance is present from the objective[5]. Generally addressed with h(n), it also computes the expense of an ideal way within the set of circumstances. It is definitely worth it to implement with the idea of Heuristic Function. permissibility of heuristic function is mentioned as

$h(n) <= h^*(n)$

Here h(n) being the heuristic expense with h*(n) being the assessed expense. Consequently, heuristic expense ought to be not exactly or equivalent to the assessed cost.

Uninformed Search

Uninformed pathfinding alludes to tracking down the way with no information on the objective in the pursuit space with just data about start hub and adjoining hubs, otherwise called blind inquiry. In this manner, the calculation indiscriminately looks through the space by investigating contiguous hubs to the current hub. Expansiveness first hunt, profundity first search, Dijkstra are a few calculations that fall under this class[6]. Uninformed inquiry is slow

and devours loads of memory in putting away hubs as it looks through the entire space until the objective hub is found. The uninformed pathfinding is otherwise called an undirected pursuit approach, which basically doesn't invest any energy in arranging. It just investigates the hubs that are associated with the current hub and afterward investigate their neighbor hubs etc. Until it observes the hub set apart as an objective hub [6].

Planning of Path

The Planning of Path is a non-derivable quadratic-time tiresome issue with the errand of observing a constant way interfacing a framework along with an underlying to a last objective arrangement. The problem is the increase in addition with the degrees of change of the structure [2]. Here, we follow the procedure for following (best way) will be collected subject to a rule and states. Example, in view of the briefest way linking end centers as a choice around the other hand the base opportunity to go except any effects. Occasionally, prerequisites along with destinations are mixed. Example, attempting to restrict power usage not changing the development time to outperform little cutoff regard. Then again, close by way organizing is most regularly acted in dark or dynamic conditions. Neighborhood way orchestrating is actioned if the robot is in action or either taking data from neighborhood sensors. For present circumstances, source creates one more way in feedback to the movements inside the habitat. Barrier, if present, may be held (right if its location and bearing comparable with an acknowledged constant course layout is changeless on time), or active (if the location, heading, or both change similarly with the decent direction edge). Productive path planning algorithm must fulfill four measures. To begin with, the movement arranging strategy should be able to continually track down the ideal way in practical static conditions. Second, it should be expandable to dynamic conditions. Third, it must stay viable with and upgrade the picked self-referring to approach. Fourth, it must limit the intricacy, information stockpiling, and calculation time. In this paper, we present an outline of the most of the time utilized way of arranging calculations furthermore examine which calculation is the most appropriate for a static/dynamic climate.

Planning of Path Algorithms

This topic initially starts by showcasing Dijkstra calculation, whereas it is ordinarily applied in real-world scenarios. For instance, Google Maps or any coordinating structures. For get the better of Dijkstra's figuring-power doing stun searches, varieties of A* are proposed as the ultra-modern calculations for the use of inside invariable conditions.

Be that as it may, A* is utilized for briefest way assessment dependent on the data in regards to the deterrents present in the climate, and the most limited way assessment for the realized static climate is a two-level issue, which includes a choice of attainable hub sets and most brief way assessment dependent on the acquired practical hub sets. Both of the previously mentioned measures are not accessible in a unique climate, which makes the algorithm wasteful and unfeasible in powerful conditions. We picked these algorithms since they address the primary algorithms utilized inside contemporary continuous way arranging arrangements. Novel examination expands on these algorithms to track down extra execution and effectiveness The rundown of covered algorithms is, accordingly, not comprehensive, however gives inclusion of a few normal algorithms utilized with regards to way getting ready for independent vehicles and automated frameworks.

The Dijkstra's Algorithm

Dijkstra computation performs by managing auxiliary issues, calculating the most short way beginning with the source vertex amidst the nearest vertex directing towards the source. This discovers the accompanying nearest point with staying aware of the latest vertex in essentially significant least lines; it reserves just the center so just a solitary most restricted way can be established. It discovers the briefest way within a non-cyclic domain along with it can learn the most restricted way via early phase to each point. We track down various variations of Improved Dijkstra's calculation this relies upon unequivocal implementation that we discover everywhere. Each upgraded version of Dijkstra's calculation will be remarkable, returning the assortment of usage of instance and implementation one and the same. Varieties about further fostered Dijkstra's calculation will be analyzed in the topic. Standard Dijkstra's calculation depends on an anxious framework for orchestrating. It is used to find the briefest way in a graph. It is stressed over the briefest course of action without formal thought in regards with reasonableness among game plan. Changed Dijkstra's calculation intends to discover reinforcement blueprints within conditions as-far-as the price of

delivering possible most restricted ways are tremendous. This adjusted calculation familiarizes another part with the customary calculation as probabilities that describe what is going on with a potential open door along each edge of the graph. This strategy assists with conquering computational weaknesses in the testimonial algorithm, subsidizing its utilization in original implementation. One further developed Dijkstra model saves every hub along similar separation from the source hub as moderate hubs, and afterward looks again from every one of the middle hubs until navigating effectively through to the objective hub, see Figure 1. Through cycle, all conceivable most limited ways are found and may then be assessed. A multi-facet word reference gives a complete information design to the Dijkstra algorithm for an inward climate tool that facilitates direction that is not dependable. The way data in the information structure assists with deciding the level of rotational point the robot needs to execute at every hub or intersection.

The proposed algorithm creates the briefest way as far as length while likewise giving the most safe way as far as the least important absolute point of turns in degrees, which is infeasible to figure inside the conventional Dijkstra algorithm. It is a solid method at way arranging. The subject is additionally memory weighty while the subject needs to figure every one of the potential results to decide the briefest way, and it can't deal with rejecting verges. Its calculation intricacy is $O(n^2)$ along 'n' substance the quantity pertaining to hubs within the organization. Because of its restrictions, many further developed variations emerged dependent on the implementation[8]. As we talked about before for a memory downside, another memory plot was presented, there was additionally an answer for map with a colossal expense factor. Individually we sum up Dijkstra calculation be the most appropriate cause to fixed climate in turn potentially worldwide way arranging as a large portion of the information required are pre-characterized for calculation of briefest way[8]; notwithstanding, certain implementations are done through Dijkstra calculation for active conditions. For the present circumstance, the environment is fairly known or absolutely dark, and consequently the center point information concerning the barrier is handled on impulse ; It is known as neighborhood orchestrating, also the Dijkstra calculation is run for appraisal of the briefest way computation.

A* Algorithm

A* algorithmic discovery is highly used and largely known variety for the best-first appeal. This uses a heuristic limit h(n), with a cost that displays in the middle of the mapping point n from the beginning state g(n). It solidifies components of UCS and greedy best-first request, which deals with the problem actually[8]. A* discovery calculation notices the one of the most restricted way via pursuit space when it is using the heuristic limit. This capturing event calculation develops less pursuit tree and gives ideal result speedier. A* The calculation resembles UCS apart from this it uses g(n)+h(n) over g(n).

In A* search calculation, we use search heuristic similarly as the cost to show up at the center point. Subsequently, we can merge the two costs as follows, and this absolute is called a wellbeing number[8].

f(n)=g(n)+h(n)
f(n)= Estimated cost of the least expensive arrangement.
g(n)= Cost to arrive at hub n from the start state.
h(n)= Cost to reach from hub n to objective hub.
At every point in the pursuit space, only their respective hubs are extended which have the most reduced worth of f(n), also algorithm ends while the objective hub is discovered[8].
Ideal A* search calculation is ideal assuming that it obeys under two conditions:
Acceptable the principal state needs for optimality is that h(n) ought to be an allowable heuristic for A* tree calculation. A permissible heuristic is hopeful in nature.
Consistency required condition is compatible for just A* Diagram search.
In the event that the heuristic capacity is acceptable, then, at that point, A* tree calculation will forever track down the most minimal expense way.

Time Complexity

The time intricacy of A* calculation relies upon heuristic capacity, and the quantity of hubs extended is outstanding to the profundity of arrangement d. So the time intricacy is O (b^d), where b is the expanding factor [8].

Space Complexity: The space intricacy of A* search calculation is O (b^d).

It is easier and less computationally-weighty than numerous other way arranging algorithms, with its effectiveness fitting procedure on compelled and inserted frameworks. A* calculation is the heuristic calculation were it utilizes analytical data in order to track down the ideal way The A* calculation needs to look for hubs in the guide and set proper heuristic capacities for direction. An algorithm is administered by two elements for productivity assets utilized for execution as-far-as errand and response pulse or calculation time taken for execution about assignment. Surely ,it has tradeoff among pace and precision meanwhile the A* computation is utilized. We could diminish the measure of intricacy about method in return being more prominent remembrance, or consume less memory as a trade-off for all the more sluggish executions. In the two cases, we see it as the briefest way. One clear implementation of the A* estimation is to discover the briefest way to a void area inside a jam-pressed stopping region. In the dynamic A* estimation, way looking is secluded into relatively few cycles, the ideal response for every collaboration is found, and a short time later the overall ideal game plan is obtained, which is the most concise way to the unfilled spot. Another improvement is done on this computation, with the chipped away at moderate A* estimation utilize the ideal time as an estimation document, and establishing a variable, a weighted total worn close by the heuristic:

$$F_w(n) = (1 − w) *g(n) + w*h(n) \quad (2)$$

Here, w is a loaded coefficient.

The loaded coefficient is depicted concerning every application and, generally speaking, it very well may be utilized to address straight reach (e.g., Euclidean distance). Chipped away at various leveled out A* is broadcasted to have also developed feasibility anlong with accuracy. One more combination of the calculation is utilized in valet leaving at which the interior character machine(machines that all center basically around their nearby climate and don't ponder standard setting) has a course of advancement that relies on the rate, equipment, coordinating point, and different restrictions of the machine dynamics. This calculation is known as the Composite A*calculation. The Composite A* computation assessment further cultivates the usual A* calculation when finished on a non-holonomic robot (e.g., independent machines). This assessment utilizes the dynamics of an inside character vehicle to expect the improvement of the machine relying on the pace, stuff, as well as the controlling point, and various restrictions of the machine will add price for as far as possible. A further developed sort of Half-breed A* knew about a relative application with the assistance of a perceptible quality outline way facilitator. A perceptible quality outline was undeniably one of the essential diagram-based pursuit calculations utilized in a way of coordinating in state of the art mechanics. This strategy ensures observing the most confined way from the beginning to the final position. The beginning, final and obstruction locations are managed into as information to the Composite A* assessment where A* is run on the possible results of the recognizable quality graph, which then, at that point, gives the best interval. This is known as the Lead Composite A* assessment.

CONCLUSION

Most limited way issues are one of the fundamental issues inside Computer Science and explicitly Operations Exploration and Programming sub-fields separately. In this paper, we assessed chosen briefest way calculations like Dijkstra, A*-search, Bellman-Ford, Floyd algorithm development calculation. Taking everything into account, the utilization of Dijkstra's calculation and A* calculation in the most limited way is fundamental will give a similar result right away when being utilized on the town or local scale maps. In any case, for an enormous scope map, A* will give the arrangement quicker than Dijkstra. A* filter the region just toward objective due to the heuristic worth that included in the computation, while Dijkstra look by extending out similarly toward each path and normally

winds up investigating a lot bigger region before the target is found coming about making it slower than A*. This can be demonstrated by the circle count of Dijkstra and A*, the more focused (hubs) the higher the distinction between the circle count nor the time.

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Algorithm	Dynamic Constant	Static Constant
Dijkstra's		X
Multi-layer Dictionary	X	X
Improved Dijkstra's		X

Figure.1: Pathfinding Example Map	**Figure.2: Different types of tile grids**
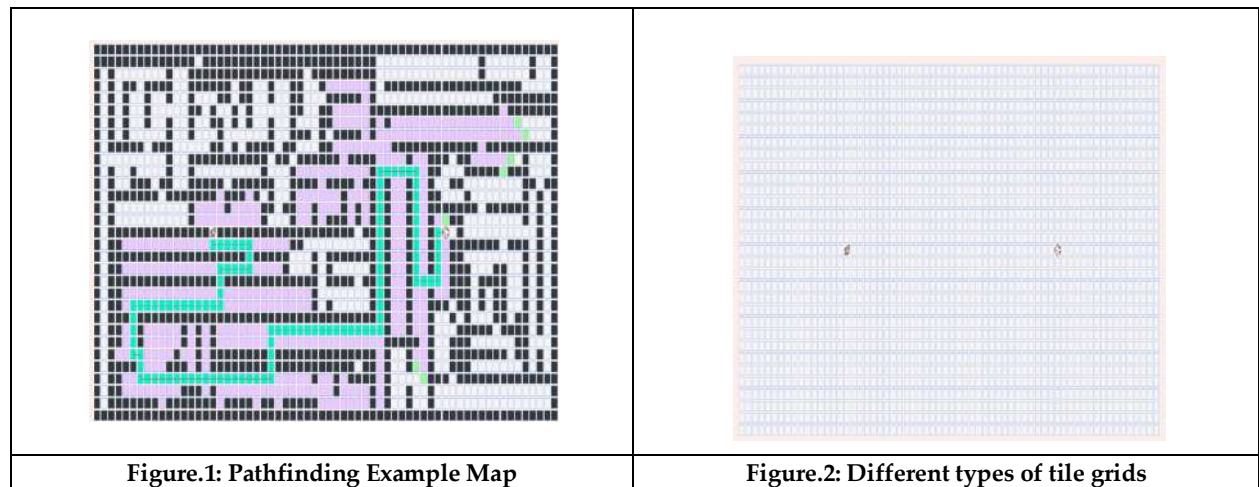
Balaji and Alli
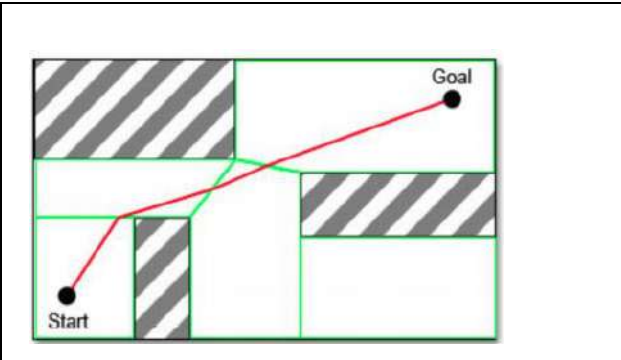
| Figure.3: Navigation mesh | Figure.4: Waypoint |

| Figure.5: Flowchart of the superior Dijkstra calculation utilized in way arranging | Figure.6: Visualization using Dijkstra's Calculation |
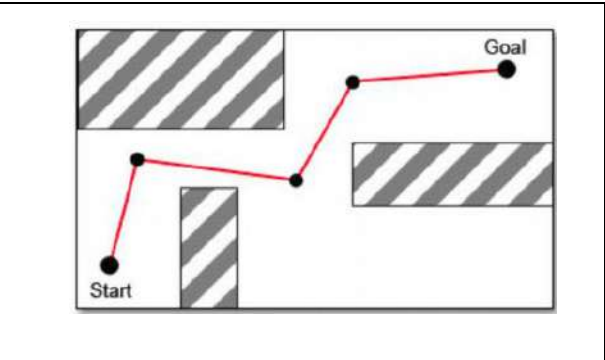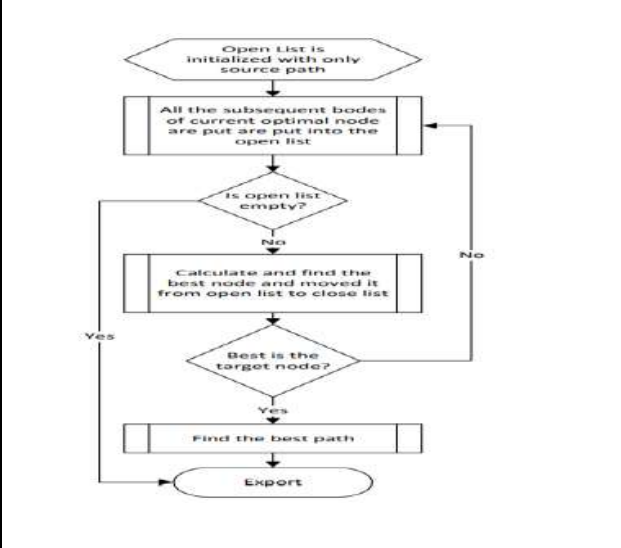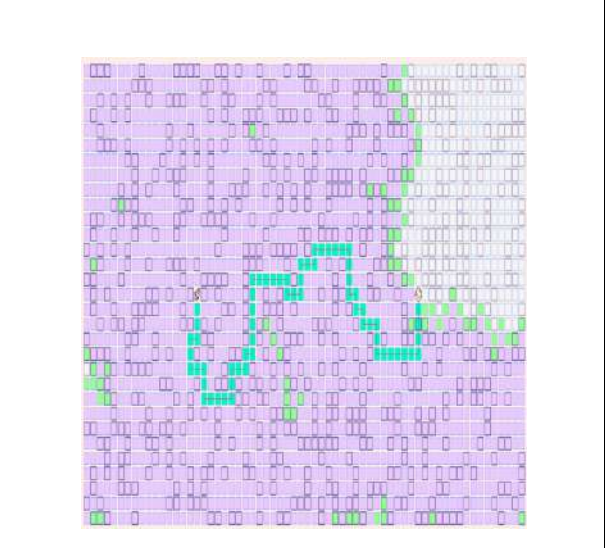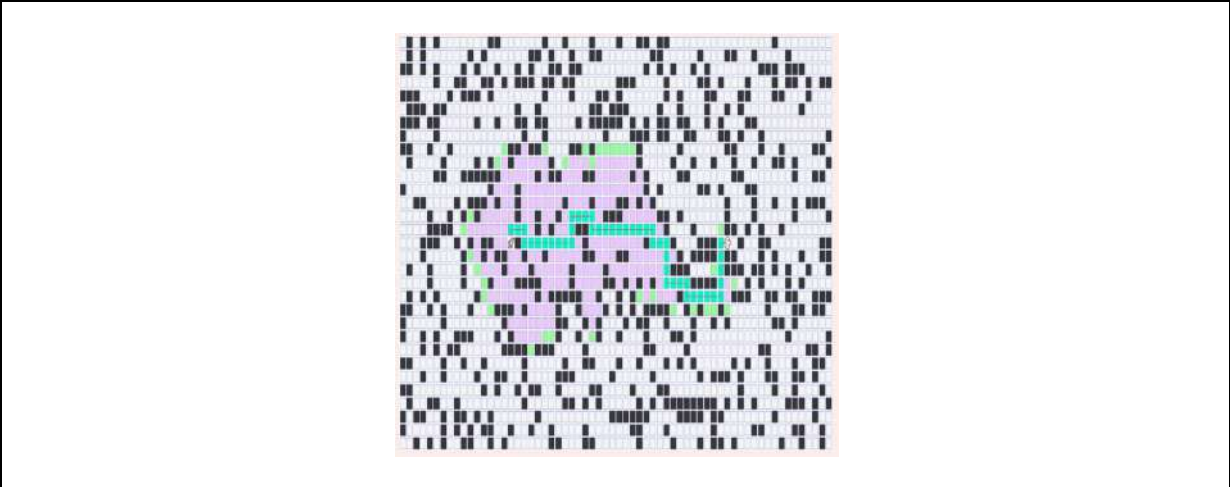
Figure.7: Visualization using A* Calculation

RESEARCH ARTICLE

Environmental Impact of Plastic Polymers and Mycoremediation by the Enzymatic Action

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ABSTRACT

Plastics have carved out a significant niche for themselves as its growing significantly it is estimated that it has produced 3.3 million tons plastic in India each year for which China is the leading country with 59.08 million tons. Plastic wastes have a great impact on humans and wildlife as well as on marine animals. Micro plastics are commonly found in marine and coastal environment which is the leading concern. To degrade the plastic polymers, fungi involved are *Aspergillus fumigatus, Aspergillus niger, Penicillium citrinum, Curvular senegalensis, Chaetomium globosum* etc. These microorganisms' secret different enzymes that have capacity to degrade thermoplastics and thermosets like polyethylene, polypropylene, polyurethane, polystyrene, polyvinyl chloride. Degradation of these plastics are done with 4 pathways, they are Bio-deterioration, Bio-fragmentation, Assimilation and Mineralization.

Keywords: Micro Plastics, Fungi, Degradation, Plastic Wastes, Enzymes.

INTRODUCTION

Environmental impact of plastic polymers and mycoremediation by the enzymatic action
Plastics have created a huge corner for themselves with a prominent growth. From 20th century, plastics like polystyrene (PS) have been highly utilized in the industries for various purposes like construction, packaging and in machines (Yang Y *et al.,* 2015, Lintsen *et al.,* 2017). It is visualized particularly the plastic materials have achieved a great success and fame in order of its utilization in day-to-day life. Its existence has been very common everywhere due to its versatile nature. They feature various properties like they are inexpensive, long-lasting, thin, corrosion free and mostly they also exhibit thermal and electrical insulating qualities. (Andrady *et al.,* 2009). Plastic usage has been increased so quickly that its manufacturing will be enlarged to 1800 million tons roughly which would result in a

huge burden for the environment with roughly 12,000 million metric tons plastic wastes by the year of 2050 (Gallo et al., 2018, Geyer *et al.,* 2017; https://www.nature.com/articles/s41467-018-04565-2.pdf). The reason for this is that we throw away more than half of the plastic products after a single use (https://www.nature.com/articles/s41467-018-04565-2.pdf). Their disposal has become a universal problem due to their endurability in the nature (Biron, 2013). Plastic pollution has scattered over the ocean in the world through which the marine animals because of this human health has led a path to danger (Eriksen *et al.,* 2014; Quero *et al.,* 2017). In landfills, plastic-related contaminants degrade the appearance of the landscape, soil contamination, discharge of dangerous chemicals and CO_2 emissions (Mudgal, 2011; de Souza Machado *et al.,* 2018). In the creation of plastic trash, polyethylene (PE) is essential because it is widely brought in use. These are commonly found in the agricultural sectors (Fleck-Arnold JE, 2000). It has also affected the life of animals and birds. Its consumption leads to death by blocking their gut (Roman et al., 2019a; Pierce *et al.,* 2004). Micro plastics are most commonly found in the surroundings.

It is plastic detritus with the size less than 5mm. Every year near about 8 million tons of micro plastics are discharged towards ocean (Jambeck *et al.,* 2015; Phuong *et al.,* 2016; Li *et al.,* 2016; Auta *et al.,* 2017; Carbery *et al.,* 2018). This has increased the pollution in ocean. There are two sources of pollution from micro plastics which involves primary sources such as fibers, plastic pettles, nurdles, beads etc. (Gregory, 1996). Another source is secondary micro plastics which are derived by degradation of macro plastics (shown in fig.1) under weathering process (Browne *et al.,* 2007). Micro plastics can be very dangerous for the marine organisms. This contaminates their environment and food (Santana *et al.,* 2017; Bakir *et al.,* 2012). Most prevalent kinds of micro plastics include PE, PP, PS, PVC, PA, and PET found in maritime habitats (Andrady, 2017; Hidalgo-Ruz *et al.,* 2012). The fraction of crystalline areas in polymers that are aligned with each other is referred to as the fraction of crystalline samples. The fraction of crystalline samples affects the mechanical characteristics of plastic polymers. High strength and fatigue resistance are two properties of semi-crystallinity polymers. Amorphous polymers, in general, are soft and flexible, with low strength and fatigue resistance. Glassy domains and rubbery domains are also part of the amorphous reigns of polymers.

A polymer converts it from glassy to rubbery (Tg) in the appearance as soon as after temperature ruse above the glass transition temperature. Micro plastic dispersion in the water column is determined by their density. PE and PP floats because their densities are lower than water. Because PVC, PS, PET, and PA are denser than water, they sink. Micro plastics, on the other hand, have qualities such as crystallinity and density that are easily changed through the weathering/aging process. The characteristics of micro plastics have changed as a result of these modifications. Despite the fact that plastics can be recycled to turn down the growing polymer wastes in the surrounding, the research on mycoremediation of plastic is continued. The reason behind is the problem experienced executing this process like the investment in the recycling could be higher than the production of new plastics every so often. To degrade the plastic waste materials, it cannot be recommended to relie on recycling because it cannot degrade petroleum-based plastics and can lasts for hundreds of years (Yrikou J *et al.,* 2007).

Production of plastic wastes till 2021
The world is battling with plastic pollution. Since 1950, the production of plastics has been estimated in excess of 8 billion tons. Of which more than half goes into landfills and only 9% is recycled. The plastics that are in the landfills mostly arrive to halt in the ocean. The amount of plastic entering the ocean annually is between 4.8 and 12.7 million metric tons which is a big problem for humans as well as other living organisms in the ocean because they tend to consume as their food and get harmed through that. There are many developed countries that produce more plastic wastes individually. In spite of having a well-managed waste stream, however pillage gets into seas and rivers. There are different countries that produce largest quantity of plastic wastes. Studies on plastic pollution till 2021 suggests the top 10 countries that produce plastic wastes in largest quantity (Hannah Ritchie *et al.,* 2018). The production of plastics in the 11 countries as mentioned in table 1 (https://ourworldindata.org/plastic pollution # total-plastic-waste-by-country) states that largest manufacturer of trash producer is China in the entire world. India is still not counted in top 10 countries which generate highest plastic trash. The estimation of plastic trash generated across the India as per central pollution control board (CPCB) for year 2019-20 is represented in fig 2. The study of last five years (2016-20) on the generation of plastic wastes per capita has been outlined and it is estimated that the generation

of plastic wastes per capita has doubled in the last 5 years. In fig.3 the generation of plastic wastes gram per year is graphically represented which states the prior five years growth in plastic wastes production and it is seen that over the years the plastic wastes generation has increased only.

Impact of micro plastics on Wildlife
Plastics has influence wildlife the most. The biggest problems when it comes to micro plastics are that it is very small in size with the diameter lesser to 4.75 millimeters in which the major discussion is about ingestion. There are many organisms that ingest the micro plastics as shown in fig.4 which may happen due to various mechanisms like consumption by filter-feeders, by engulfing or uptake of the micro plastic ingested organisms (Galloway et al., 2017). Micro plastics consumption by the organisms is rarely dangerous; it rarely causes death to them. Lethal concentration levels are determined when common goby is exposed pyrene and polyethylene, Daphnia magna neonates are exposed to polyethylene, Asian green mussels are exposed polyvinylchloride (PVC).(Oliveira *et al.,* 2013, Rist *et al.,* 2016, Ogonowski *et. ,al* 2016). According to research such evidences has been found that ingestion of micro plastics affects prey consumption which leads to power decrement, obstruct in the expansion and effect prolificacy. The consumption of micro plastics by the organisms stuck in their gut and digestive system which reduces their hunger due to this their nutrient uptake is hindered and impacts their health.

The impacts of reduced consumption as per evidences are
1. Life of Asian green mussels reduce due to slower metabolic rate (Rist *et al.,* 2016)
2. Survival and reproducibility rate in copepods are lessen (Cole *et al.,* 2015)
3. Growth and development in Daphnia and Langoustine are lessen (Ogonowski et al., 2016, Welden *et al.,* 2016)
4. Capacity to store energy in lugworms and shore crab are lessen (Watts *et al.,* 2015, Wright *et al.,* 2013)

There are also such organisms which do not make any difference even after ingesting micro plastics. There are many organisms like oyster larvae, Pacific oysters, urchin larvae, European flat oysters which are suspension feeders. Some detritivorous like amphiposa and isopods and there is no impact of micro plastics on vertebrates (Galloway et al., 2017). All-inclusively the existence of micro plastics in guts of any organisms may affect biologically.

Impact of micro plastics on Human health
There are a very few evidences found that micro plastics impact human life. Micro particles and nano-particles are very small particles for the humans that can however be ingested and this has been a great concern for human health. However, it can be ingested by humans as there are various ways that include the followings It can be ingested orally by water intake, by consuming aquatic products as they consume micro plastics. It also affects human health via skin by using cosmetics or while breathing as particles are also found in the air (Revel *et al.,* 2018). It is not too far away for the micro plastics to appear in food-chain due to its small size. This is possible when a species consumes an organism that has micro plastics in their guts or tissues and are at lower-level organisms from food chain (Galloway *et al.,* 2015).

There is a possible factor that can limit the uptake of micro plastics in humans. Fish consumed by humans have micro plastics in their guts and digestive system. However, avoiding that particular part may limit the dietary uptake (Galloway *et al*, 2015). Also, different plastics fibres have been spotted in food items like beer, honey and table salt but due to this there has been no health risk so far. (Liebezeit *et al*, 2014, Liebezeit *et al*, 2013, Yang *et al*, 2014). Demand on the utilization of types plastics are seen and stated in the percentage. It has been observed that the plastics that are demanded highly across India but the year 2019 were polyethylene (PE) holding 33%. Then with 32% of polypropylene (PP) was brought in the use and other plastics such as PVC, PET, Styrenics and with 21%, 10%, 2% respectively (Ian Tiseo 2021). The demand on the utilization of types plastics is seen and stated in the percentage in fig.5. It has been observed that the plastics that are demanded highly across India but the year 2019 were polyethylene (PE) holding 33%. Then with 32% of polypropylene (PP) was brought in the use and other plastics such as PVC, PET, Styrene's and with 21%, 10%, 2% respectively (Ian Tiseo 2021). Nevertheless, plastics are classified according to their characteristics and importance. It includes thermoplastics (such as such as Polyethylene (PE), Polypropylene (PP), Polyamides (PA), Polyethylene terephthalate (PET), Polycarbonate (PC), Polystyrene

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(PS)Polyvinyl chloride (PVC), High density polyethylene (HDPE)) and thermosets (such as Silicon, Polyurethane (PUR), Epoxy, Acrylics, Phenolic resins) https://plasticseurope.org/wp-content/uploads/2021/09/Plastics the facts WEB) (Ojeda *et al,.* 2013). Thermoplastics feature ductile character that means it can be heated up and molded, cooled and re-used many times whereas thermosets does not exhibit any of these characters. It cannot be recycled. However, thermoplastics are environmental friendly (https://plasticseurope.org/wp-content/uploads/2021/09/Plastics the facts WEB).

Biodegradable plastics

The studies on biodegradable plastics have been done deeply in recent years and have been utilized in the manufacture of a variety of items, such as compost bags, garbage bags, agriculture compost films and poly bags. The environmental-friendly plastics disposed in the environment can be decomposed with the involvement of microorganisms. The plastics that get decomposed by the microorganisms produce products like CO_2 and H_2O after decomposition (Tharanathan 2003). There are two types of environmental-friendly polymers that are involved in the mulch film. The polymers are polylactic acid (PLA) or polyhydroxyalkanoate (PHA). PLA is obtained from 100% renewable resources such as starch and corn (Drumright *et al.,* 2000). Microorganism's converts starch into lactic acid by the process of fermentation which then linked into long chains to form polymer (Gupta *et al.,* 2007). PHA has been spotted to be green because these biodegradable plastics are produced from renewable resources by lipids bacteria fermentation or sugar (Kaihara *et al.,* 2005; Posada *et al.,* 2011). Both microbes and plants can manufacture PHA polymer but the main source of this polymer is microbes (Keshavarz and Roy, 2010). Biodegradable plastics are susceptible to fungi, bacteria and more microorganisms while the process of decomposition because they utilize it as their food. These plastics are manufactured from plant-based products or oils. When the molecular weight of polyethylene chain is less than 500 then it can be biodegradable. At the same time there are most of the other polymers whose molecular weight is less than 500. Polyester shows susceptibility to biodegradation but these are rarely used in packaging. Even so, it is not necessary that the use of polyester will resolve the problem of disposing wastes. These days there are different environmental-friendly plastics used in the markets which are in the based on starch, soy, bacteria, lignin, cellulose and plastics with natural fibre reinforcing (Mohanty *et. al* 2002).

Biodegradation of Plastics

It has been observed that the plastics do not degrade naturally into the environment but there is nothing surprising in this (Yamada-Onodera *et. al* 2001, Zheng *et. al* 2005, Marqués-Calvo *et., al* 2006, Bonhomme *et., al* 2003). The main cause of this is their durability and firmness (Yamada-Onodera *et. al* 2001, Zheng *et., al* 2005). The breakdown of plastics is caused by four main processes which includes: Thermo oxidative degradation, photo degradation, hydrolytic degradation and biodegradation by microorganisms (Raquez *et. al* 2011). When we look for the plastics to degrade naturally it generally starts with photo degradation in which the polymers have the tendency that in the presence of UV radiation, it reacts slowly with oxygen in the atmosphere from the sun which leads to thermo oxidative degradation in which the oxidation is initiated by heat. The oxygen atom incorporates into the polymer (Raquez *et., al* 2011, Andrady *et., al* 2011) due to which plastics become fragile and breaks down into small pieces until the molecular weight of polymer chains reaches the range at which it is metabolized by the microorganisms (Zheng *et., al* 2005, Andrady *et., al* 2011). Deterioration of plastics by microorganisms involves a biotic oxidation products having low molecular weight. The research on degradation of plastics by microbes began during 1980s. It was initiated for different types of plastics like polyhydroxybutyrate (PHB), polylactic acid (PLA), polystyrene (PS), polyesters, polyethylene (PE), polycaprolactone (PCL), polyurethane (PUR), nylon and polyvinyl alcohol (PVA) (Shimao *et al.,* 2001).

Biochemical deterioration pathways of plastic degradation

Bio-deterioration   Bio-fragmentation   Assimilation   Mineralization

Mechanism of microbial degradation of plastics

Microbes shows a vital role in the breakdown of plastics by breaking down the compounds into simpler form by the process of biochemical transformation. The physical properties of plastics confirm the microbial action of plastic degradation. The physical properties that can be observed in the polymers are reduction in the molecular weight, drop in the density, durability and conversion in the exterior properties seen in fig.9 (Ho *et al.,* 2018). It has been studied that the main aim in the biodegradation of plastic is the conversion of unmanageable waste which are seen to be toxic into non-toxic compounds with low molecular weight. Consequently, plastic degradation involves various biochemical deterioration pathways are described below in fig.7 (Gu, 2003, Pathak, 2017).

Bio-deterioration

This step involves the microbial responsibility in which they are responsible for the physical and chemical deterioration. This mechanism shows external degradation which alters the physical, chemical and mechanical properties of plastics (Anjana *et al.,* 2020). Throughout biodegradation the conversion noticed in the polymers are increased by exposing it to the temperature, light and the chemicals in the surroundings. Bio-deterioration is the initial step in which the microbes migrate and attaches to surface of the polymers in the focus to reduce the longevity and resistivity of the plastic substances. Studies on nature of plastics states it to be hydrophobic in nature so to assist the attachment of surface dwelling microbes on plastics hydrophilic functional groups is required to introduce (Nauendorf *et al.,* 2016). Moreover, it has been seen that the plastics like polyethylene which has high surface hydrophobicity, the development of biofilm is important because it enhances bacteria's interaction with polymeric surfaces (Schwibbert *et al.,* 2019). *Pseudomonas* which is a biofilm forming bacteria degrades low-density polyethylene by strongly attaching to the surface in comparison with other bacteria (Tribedi *et al.,* 2015). Conversely, the fungal cells can grow on any type of surfaces and it has been seen that they adhere to the surface of polymeric plastics with the help of hyphae (Sánchez, 2020). The adherence and fungi growing on polymeric surface develops into swelling in the polymer and reduces their mechanical properties. When the microbes adhere to the plastic surface, they start multiplying by the use of carbon source obtained from polymers. Additionally, it has been noticed that the existence of additives like plasticizers increases the adherence and microbial growth (Ru *et al.,* 2020). Moreover, it has also been observed that the exopolysaccharides have significant role in the adherence and bio-deterioration of the plastic polymers (Anjana et al., 2020).

Bio-fragmentation

Refers to the microorganism secreting ecto-enzymes or free radicals that catalyzes the polymeric plastics into oligomers, dimers or monomers. In this stage the plastic polymers which are bio-deteriorated are cleaved into tiny pieces by the process of free radicals and extracellular enzymes obtained by microorgainsms. There are two reactions involved in the process of bio-fragmentation. One is the polymer's molecular mass decreasing and low-weight molecules being oxidised molecules. These two are necessary reactions as it help in the enzymatic action of microbes that often attacks the compounds with low-molecular mass (Restrepo-Flórez *et al.,* 2014). The hydrolytic cleavage of polymers is catalyzed by these enzymes as the bonds within the plastics are peptide, glycosidic and ester bonds are put to attack on carbonyl carbon by hydrolytic nucleophile. There are two modes in which these hydrophilic attacks take place, they are exo-attack and endo-attack resulting in various products and sometimes it results into monomers or oligomers like terephthalic acid and ethylene glycol which help the microbes to incorporate into the cells. But before microbial assimilation, the endo-attack must go through degradation (Pathak, 2017).

Assimilation

The molecules that has smaller molecular weight are generated at the time of bio fragmentation is transported into microbial cytoplasm during assimilation step. Although plastic molecules assimilation has not been completely investigated across different microbial membranes, it is believed that, like the assimilation of hydrocarbons, the process needs There are active and passive ways of transportation (Shahnawaz *et al.,* 2019) At higher concentrations, Pseudomonas sp. DG17 has been shown to take up octadecane, a broken down product of plastic polymer, via facilitated passive transport mechanisms, but at low density, it is digested by energy-dependent active transportation. Furthermore, numerous monooxygenases which are membrane bound have been discovered that in

alkene-assimilating bacteria they are ubiquitous for the beginning of oxidation of alkenes (Durairaj *et al.,* 2016).Several membrane transport mechanisms that promote the passage of these chemicals into the cytoplasm for next process. The inward transfer of terephthalic acid gives a result of polyethylene terephthalate (PET), has been found in the Comamonas species (Hosaka *et al.,* 2013). It is observed that porins also carry polyethylene glycol, it is seen as the product that breakdown plastics for bioconversion in the cytoplasm (Duret *et al.,* 2010). When *Rhodococcus rhodochrous* ingested polyethylene oligomeric intermediates, several transporters, particularly from the ATP binding cassette family of proteins and across different microbial membranes were found to be enhanced (Gravouil *et al.,* 2017). Some transits like a newly found transport protein with NADH dehydrogenase activity have also been hypothesised to have a double function in midway trafficking and oxidation.

Mineralization

Following their effective delivery into cells, these plastic derivatives undergo enzymatic processes in a sequence which culminates in their entire degradation into oxidised substances like CH_4, N_2, H_2O and CH_4. (2018 (Ho et al.). Isotopic tracing and CO_2 quantification leakage with Strum's approach usage have viewed that polymeric polymers have calcified fully (Yang et al., 2020). On the other hand, the intermediates might be transported by a number of chemical pathways. Polyethylene breakdown, for example, is thought to proceed by acetic acid production, that can subsequently moves in the Krebs cycle by the creation of acetyl-CoA or be diverted to approach the development of lipids (Wilkes and Aristilde, 2017). Similarly, the enzyme esterase in *Pseudomonas* sp. AKS2 produces succinate from the breakdown of polyethersulfones (Tribedi and Sil, 2014). According to understood styrene bioremediation, the monomeric unit of the refractory polystyrene, styrene is largely react to phenyl acetate. For complete metabolism, the phenyl acetyl coenzyme A is subsequently absorbed into the Kreb's cycle (Ho et al., 2018). According to research on I. sakaiensis 1,2-dihydroxy-3,5-cyclohexadiene-1,4-dicarboxylate dehydrogenase (DCDDH) and TPA 1,2-dioxygenase (TPADO) metabolise internalised terephthalic acid which produces an end molecule like protocatechuic acid (PCA). PCA undergoes a variety of proteolytic reactions, including dehydrogenase and PCA 3,4 dioxygenase, to produce 2-pyrone-4,6-dicarboxylic acid, that is then funneled via the Kreb's cycle as oxaloacetate and pyruvate before being mineralized to H_2O and CO_2. (Yoshida et al. 2016). In both aerobic and anaerobic mineralization processes, enzymes like lipases, esterases, cutinases, lactases and peroxidases are involved (Alshehrei, 2017).

Proteolytic degradation of plastics

Enzymes are biocatalysts that take part in a process, work on a specific substance, and speed up the transformation of that substance into a useful product. The thought of microorganisms decomposing plastic contaminant that contaminates our surroundings has spurred interest in the underlying process by which bacteria are able to digest such a tough material. The bulk of degradation happens along the aid of enzymes present in microbial cells (extracellular/intracellular), that induce polymer chain disruption by absorption inside the cell which releases products such as CH_4, H_2O, N_2, and CO_2 (Amobonye *et al.,* 2021). Algae has been shown to have a variety of enzymes that induce breakdown in a variety of polymeric polymers; *actinomycetes,* bacteria, and fungi are included in table 4. (Urbanek *et al.,* 2020). All enzymes that are known to breakdown polymeric polymers are classified as "Hydrolases." In the presence of water, this class of enzymes catalyses the chemical bonds breakage in its substance (Tokiwa *et al.,* 1976). Esterase, Cutinase, Lipase and PETase are some of the most frequent enzymes linked to the breakdown of polymer, in accordance with early study about it (Tokiwa *et al.,* 1977). Each of the enzymes work in the same way on the plastic polymer, commencing hydrolytic breaking of C-chains that is long and then absorbs the tiny subunits into the microbial cells for next proteolytic breakdown and metabolic product liberate (Tokiwa *et al.,* 1977). These enzymes extraction and their modifications to improve their proteolytic activity that has been one of the primary study topics to cooperate along the plastic pollution that grows in the surroundings. Numerous kinds of plastics, involving PET, PE, PU, PLA and PBS are viewed to breakdown slowly when these enzymes are present (Mukai *et al.,* 1993).

CONCLUSION AND SUGGESTIONS

This review analyzes the pollution caused in the marine and land by plastic wastes which are the major concern these a days. Plastic wastes causing impact on humans as well as animals and birds are reviewed here. This review majorly focuses on the fungi that can degrade the plastic polymers by secreting different enzymes. And also some of the bacterial strains that can help in degradation of plastics are also observed. Microplastics are seen to be the vital discussion as it ruins humans, animals and birds by unknown ingestion. Animals and birds intake it unknowingly which blocks their and leads to death. Types of plastics and the microorganisms degrading particular polymer by secreting different enzymes. In order to degrade these plastic polymers, different stages are followed like bio-deterioration, bio-fragmentation, assimilation and mineralization. Furthermore, microplastics undergo aging processes which leads them to degradation. And after degradation it exhibit properties like change in color, size, external morphology, reduction in size, change in crystallinity and growth of bio-film. The ingestion of plastic wastes by marine animals may affects their food chain and its contamination impacts their life cycle.

SUGGESTIONS RECOMMENDED ARE AS FOLLOWS

1. In order to reduce the plastic wastes, the use of plastics must be reduced by replacing plastic bags with environmental friendly materials like jute bags, cloth bags etc., plastic bottles should be avoided instead copper bottles would provide health benefits with no harm.
2. Production of plastic material must be reduced and must only be used for the necessary items.
3. Microorganisms such as fungi and bacteria which secrets an ezymes that are capable to degrade the plastic polymers. To bring this processes in every area government should recommend by producing in large scale and make use of this research to vanish the plastic pollution.
4. The impact of microplastics on human life is still not studied well.
5. To reduce the microplastic wastes, a long term production of microbes should be followed.

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Table.1: Lists of the countries that produces largest quantity of plastic wastes every year (https://ourworldindata.org/plastic-pollution#total-plastic-waste-by-country)

Countries	Tons of plastic wastes produced each year
China	59.08 million tons
United States	37.83 million tons
Germany	14.48 million tons
Brazil	11.85 million tons
Japan	7.99 million tons
Pakistan	6.41 million tons
Nigeria	5.96 million tons
Russia	5.84 million tons
Turkey	5.6 billion tons
Egypt	5.46 million tons
India	3.3 million tons

Table.2: The involvement of microbes and enzymes in the breakdown of plastics Microorganisms that contribute in the plastic degradation

Microorganisms	Plastic type	Degrading enzyme	Reference
Fungi			
A.fumigatus	PS	Esterase	(Pathirana *et., al* 1984a)
Penicillium citrinum	PS	Urease, Esterase and Protease	(Pathirana *et., al* 1984a)
Curvularia senegalensis	PS	Esterase	Crabbe *et., al* 1994)
Mucor circinilloides and *Aspergillus flavus*	PE	NA	(Pramila *et., al* 2011)
Chaetomium globosum	PE	NA	(Sowmya *et., al* 2014)
Aspergillus niger and *Aspergillus japonicas*	PE	NA	(Raaman *et., al* 2012, Annamalai *et., al* 2011)
Cochliobolus sp.	PVC	Diethyl phosphonate, enzenedicarboxylic acid	(Sumathi *et al.,* 2016)
Mucor spp.	PS	Pyridine, Benzene	(Chaudhary and Vijayakumar, 2019)
Phanerochaete chrysosporium	PP	Octane	Jeyakumar *et al.,* 2013)
Bacteria			
Comamonas acidovorans	PUR	PUR esterase	(Oda *et al.,* 1998), (Morton *et al.,* 1994)
Pseudoxanthomonas sp. Strain NyZ600	PC	NA	(Yue *et al.,* 2021)
Ideonella sakaiensis 201-F6	PET	PETase, MHETase	(Janatunaim *et al.,* 2020)
Pseudomonas aestusnigri	PET	MHETase	(Bollinger *et al.,* 2020)

Note: PS: polyester, PE: polythene/polyethylene, PUR: polyurethane, PC: polycarbonate, PET: polyethylene terephthalate.

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Table.3: The enzymes secreted by microorganisms for the degradation of plastics

Enzymes	References
Cutinase	(Tokiwa *et al.,* 1977)
Lipase	(Tokiwa *et al.,* 1977)
PETase	(Tokiwa *et al.,* 1977)
Esterase	(Tokiwa *et al.,* 1977)
MHETase	(Janatunaim *et al.,* 2020)
Urease	(Pathirana *et., al* 1984a)
Protease	(Pathirana *et., al* 1984a)
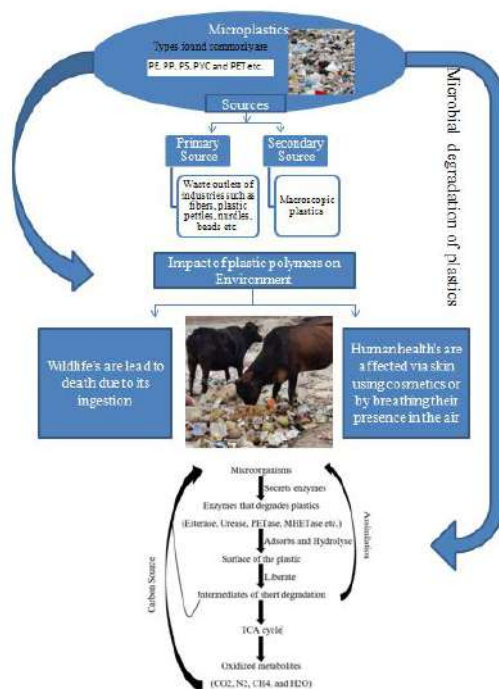
Graphical Abstract
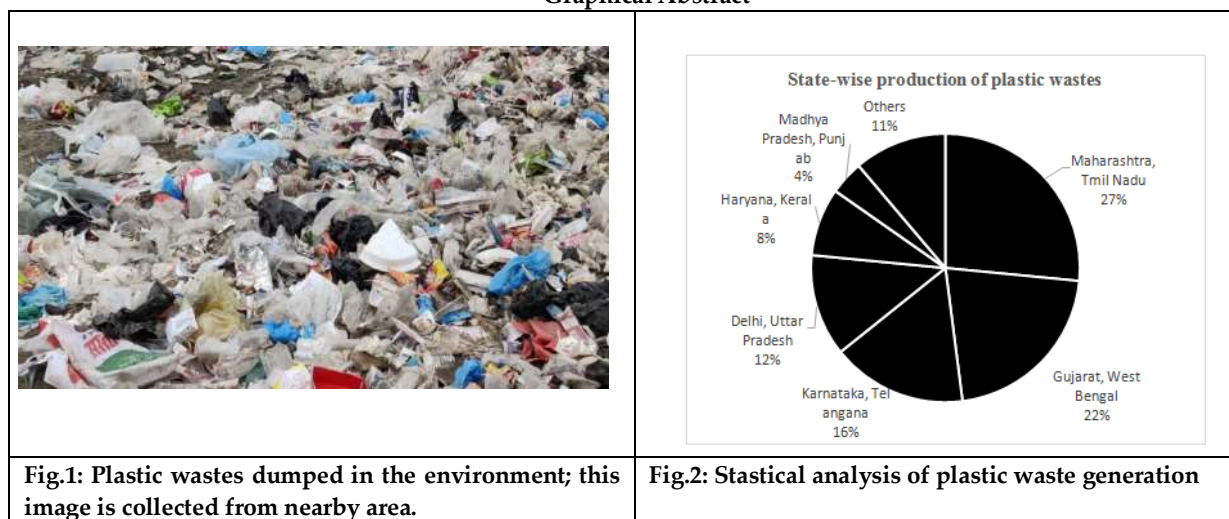
Fig.1: Plastic wastes dumped in the environment; this image is collected from nearby area.	**Fig.2: Stastical analysis of plastic waste generation**

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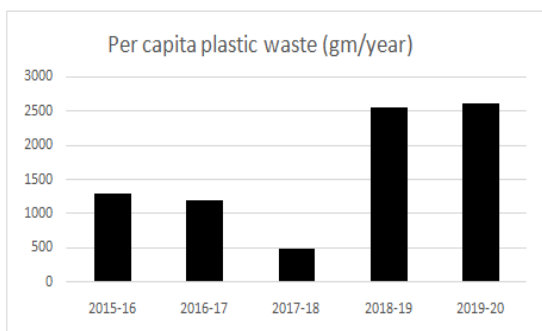
Fig.3: Representation of plastic wastes that are produced in the last five years in grams

Fig.4: Image collected from the nearby place showing numbers of animals ingesting food thrown along the dumped plastics which may also cause them to ingest plastics. The ingestion of plastics leads them to death.
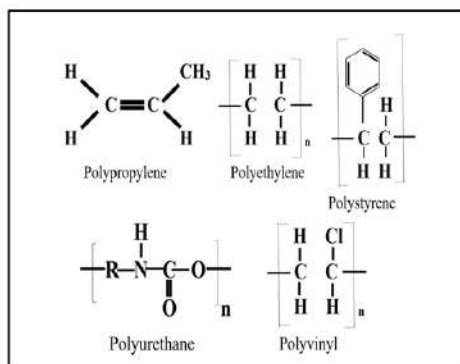
Fig.5: Structure of types of polymer
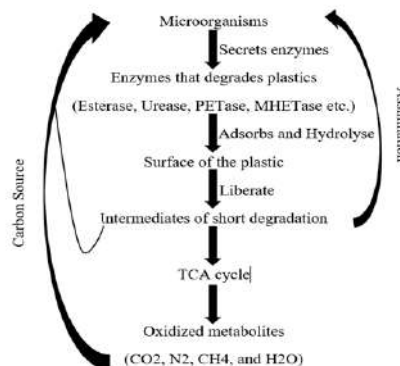
Fig.6: Mechanism of microbial degradation of plastics in aerobic environment (Mohanan *et al*, 2020).

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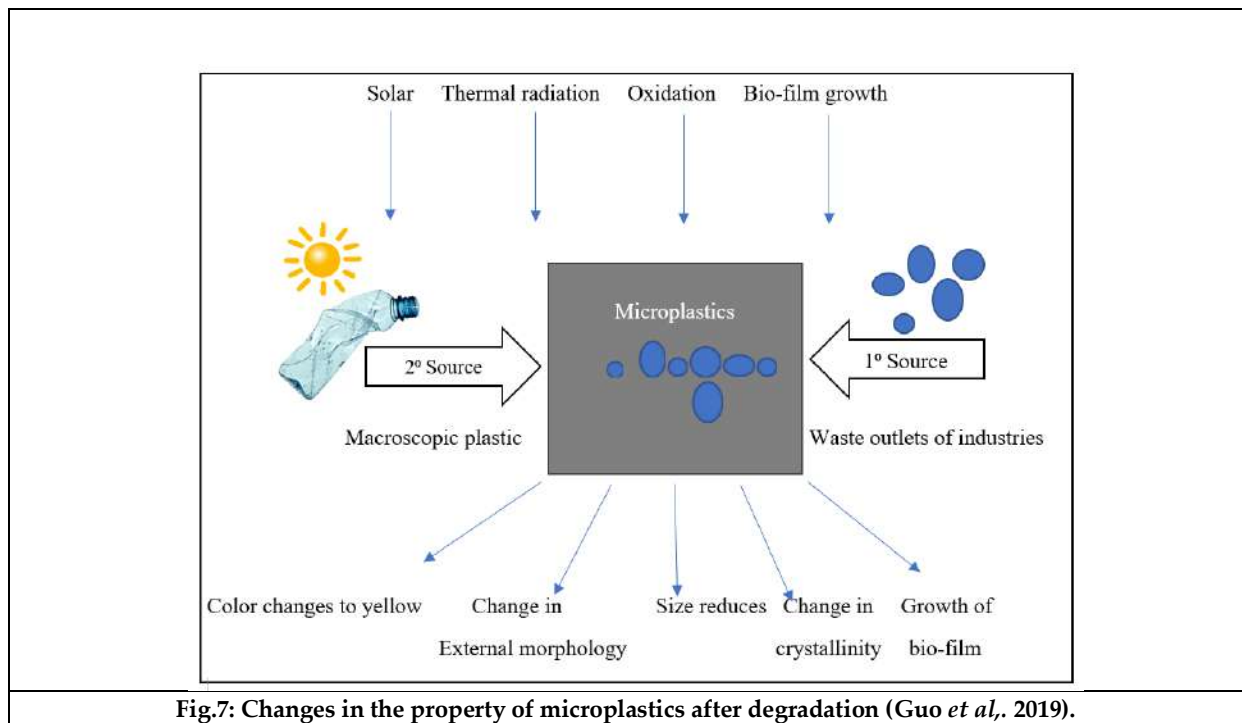
Fig.7: Changes in the property of microplastics after degradation (Guo *et al,*. 2019).

RESEARCH ARTICLE

Analysis of Descriptive Answer Evaluation Process using NLP Techniques

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ABSTRACT

For the University Examination evolution system, the process of evaluating subject answer is very important, however it consumes more resources and time. If teachers are evaluating there will be lot of differences exists in the quality of the evaluation, because the judgment differ from each other. It is based on their mind set, knowledge, emotion, and their approach etc. The traditional evaluation system consumes more time and it is very lengthy process. On the other hand, in online evaluation method, it will verify the answers by comparing it with predefined answer keys. These answer keys are stored on the server. With the help of assessment tools, the evaluation system is automated. This technique is very beneficial in terms of reducing usage of resources.

Keywords: Text Mining, Machine Learning, The Automatic Assessment Tools, Lexical Analysis, Semantic Analysis, n-gram, Natural Language Processing, Pre-processing, Active Learning.

INTRODUCTION

Universities conduct examinations every academic year. The examinations may be competitive, institutional as well as non-institutional. The present examination system is descriptive. Teachers evaluates the answer scripts manually. Huge number of students writes examinations. Since different teachers award different marks for the same question answers the process becomes error prone. There will be lot of differences in the evaluation. For the same script different teachers award different marks. This is because the score not only based on the answer it also based on handwriting, way of presentation as well as the perception of the Teachers. The teachers bored doing the same task repeatedly. Our proposed system will relieve them from such difficulties. The proposed system is more accurate.

The traditional system is boring because it involves repetitive manual tasks such as reading the scripts and awarding marks. In the Anna University around 20,000 students applied for revaluation. Because they were confident that they would score good marks. In the revaluation 90% of the applicant were passed. This situation proves that there will be lot of differences from examiners to examiners in the valuation. This is one of the drawbacks of manual evaluation system [8]. So, to overcome these problems and drawback of manual evaluation system digital answer script evaluation system is introduced. Using computers, the process is automated. In case of Online Examination students must attend Multiple Choice Questions. In recent years it was seen that government Examinations and the semi-government Examinations are done through online [IBPS, SSC, RRB] [14]. But this system cannot be used to evaluate description type questions [3]. The University question pattern is different, like 2 marks questions, 5 marks questions, 10 marks questions, 15 marks questions etc. There will be number sections in the question paper. The corresponding marks also different for each section. It is a challenge that the automated system should manage all these differences in the question pattern. Approaches such as Text to Text, Graph to Graph etc. are used to find out a good automated system [2]. There are different techniques and approaches are used to evaluate answer in online system. These methods are discussed in this section.

The APTeSa

This was designed to automate the evaluation of subjective answer [7]. It provides a smart approach for evaluating answers. It can be work in a semi-automated or fully automated mode. The semi-automated mode enables the teachers to revalue the answer scripts as well as to update results. The semi-automated mode produces better results than the fully automated mode. It will evaluate the descriptive answer by comparing the keywords and phrases along with the answer key which is stored.

The Latent Semantic Analysis (LSA)

It was introduced by Laundauer, Foltz and Laham in 1998 [1]. This uses mathematical methods. It measures the semantic resemblance in the texts. It can extract the hidden meaning using decomposition technique. It is also called as bag-of words method. This method extracts certain words if the user gives the input text. After extraction is over it will create a matrix. It will store the frequency of occurrence each word in the text in that matrix. The element in that matrix is transformed to its logs and then it will calculate the entropy.

The Auto Tutor

The tutoring research groups from the University of Memphis designed this tool [1]. It is complete automatic tool. It helps to students to learn subjects such as computer hardware, operating system as well as internet. It provides question as well as answers to the students and receives the answers from the standard input.

The Apex

This is web-based application it will rate learner's answers by referring the answer keys stored in the system [1]. The students can choose the topic and questions and they can answer the questions, the answers will then be compared with the stored answers. LSA is used to measure the semantic similarity.

The Intelligent Essay Assessor (IEA)

Landauer designed this application. This is used to evaluate essay type of questions. It will provide essays for a given topic and this can be used for evaluation. Then that essay is compared with references essays and a feedback is provided. LSA is used to measure the semantic similarity in the essays.

The SELSA (Synthetically Enhanced LSA)

This method consider word and the context by considering it with its adjacent words. It considers word as a unit of knowledge representation. It solves the problem encounter in LSA by considering only words.

The Bilingual Evaluation Understudy (BLEU Algorithm)

This method is introduced by Papineni *et al* [1]. This is uses n-gram co-occurrence scoring method. The ideal of this method is measuring the closeness of translation as well the translation of reference by the use of numeric metric. Here n indicates sequences of words that can be applied to compare two different texts. The machine translates the input sentences. Among the machine translation and reference translation n-gram matching will be counted.

The ERB (Evaluating Responses with BLEU)

Introduced by Perez, Alfonseca and Rodziguez in 2004. This uses an algorithm which is related to BLEU also uses a set of NLP technology. The central idea of this algorithm is similar to that of BLEU. The students answer and the reference answer are more alike and hence the score is high.

ATENEA

This was developed by Perez et al. [1]. This method is related to BLEU algorithm. It can evaluate answers in English as well as Spanish. It can evaluate the answers at the same time it enables the students to personalize the user interface as per their need. It enables the students to select a question for that question they have choice to answer in any of the language, English and Spanish are preferable. During question answering the answers will be compared with the stored answer. It uses Natural Language Processing Techniques such as Stemming, Word Sense Disambiguation etc.

The Natural Language Processing (NLP) Techniques

It includes different techniques which are linguistically fascinated. The test will be parsed syntactically by using the knowledge of formal grammar and lexicon. The resultant text will be interpreted semantically and it can also be applied to extract information about the meaning [1]. The NLP may parse all the part of the sentence or some parts or paragraph. It also comprises of Technology such as Word Stemming, Synonym Normalization, Part of Speech, as well as Role Determination and so on.

The C-rater

This is designed by the Education Testing Service (ETS). The input answer is pre-processed to correct spelling as well as grammar mistakes. Next it will be subject to POS (Part of Speech) tagged for removing ambiguity. The Feature Extraction technique is used extract relations among the predicates from the given answer. The NLP tools are used to process the model answer. Then the matching algorithm is applied on the resultant answer. The Gold map is a rule oriented Pattern Matching Algorithm. This algorithm offers a score, and this is the feedback to the candidates.

The Auto Mark

This model was developed by Mitchell et al [1]. It is used to access the Subjective Answers. It permits the candidate for setting reference making schemes [1]. It provides freedom to the candidates for making schemes [13]. It will correct spelling mistakes automatically when it is pre-processing the answers, that relives students to worry about spelling mistakes. Then the Sentence Analyser is used to identify the phrases as well as relationship among them. Then the Pattern Matching Module used to identify the similarity among the reference and the candidates answer. Finally, it offers a score to the candidates for their answer.

The Text Mining

The Text Mining extracts essential features from different sources of unstructured form of text. It is not easy to deal with un-structured form of text. The aim of Text Mining is to extract vital information from the text.

The GLSA over LSA

This method will represent the text and the words in the text in a two dimensional matrix. The Singular Value Decomposition (SVD) an algebraic method is used identify the relationship among the words and the text. The existing relationship can also be updated in order to represent its significance very accurate [1]. In the matrix row indicates word and column indicates sentences, paragraph and other sub divisions. The LSA will not consider word

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sequence in a text [2]. The LSA will fail to extract the semantic effect of association in the text. The GLSA will solve this problem by considering n-gram as atomic unit of text. The n-gram consists of sequence of n words in the given document.

The QAL (Question Answer Language) and Indus Maker

This method compares the answer text structure with the predefined structure. The structure is created the structure editor. The teachers state their required structure using a special language. This language was known as QAL [7]. It was extended as language called Question Answer Markup Language (QAML)[6].

LITERATURE REVIEW

Proposed method

The proposed System has 5 phases namely Student answer, pre-processor, tf-idf, cosine similarity, and grading of answer, and the system flow in fig.1

Student Answer

Here we store all the collected answers that are answered by each student for the given question.

Preprocessor

It is a normalization of the text that includes removing unwanted words, stemming, etc.
- Pre-processing refers to the transformations applied to our data before feeding it to the algorithm.
- Data Preprocessing is a technique that is used to convert the raw data into a clean data set. In other words, whenever the data is gathered from different sources it is collected in raw format which is not feasible for the analysis.

Need of Data Preprocessing

For achieving better results from the applied model in Machine Learning projects the format of the data must be in a proper manner. Some specified Machine Learning model needs information in a specified format, for example, Random Forest algorithm does not support null values; therefore, to execute random forest algorithm null values must be managed from the original raw data set. Another aspect is that the data set should be formatted in such a way that more than one Machine Learning and Deep Learning algorithm are executed in one data set, and the best out of them is chosen.

TF-IDF

Tf-idf stands for the term frequency-inverse document frequency, and the tf-idf is often used in information retrieval and text mining.TF-idf can be successfully used for stop-word filtering in various subject fields including text summarization and classification.

TF-IDF

stands for "Term Frequency — Inverse Data Frequency".

Term Frequency (tf)

Gives us the frequency of the word in each document in the corpus. It is the ratio of the number of times the word appears in a document compared to the total number of words in that document. It increases as the number of occurrences of that word within the document increases. Each document has its tf.

$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{i,j}}$$

Inverse Data Frequency (idf)

Used to calculate the weight of rare words across all documents in the corpus. The words that occur rarely in the corpus have a high IDF score. It is given by the equation below.

$$idf(w) = \log \frac{N}{dft}$$

Combining these two we come up with the TF-IDF score (w) for a word in a document in the corpus. It is the product of tf and idf:

$$w_{i,j} = tf_{i,j} \times \log \left(\frac{N}{df_j} \right)$$

tf_{ij} = number of occurrences of i in j
Df_{ij} = number of documents containing i
N = total no of documents

Cosine similarity

Cosine similarity is a metric used to measure how similar the documents are irrespective of their size. Mathematically, it measures the cosine of the angle between two vectors projected in a multi-dimensional space. The cosine similarity is advantageous because even if the two similar documents are far apart by the Euclidean distance (due to the size of the document), chances are they may still be oriented closer together. The smaller the angle, the higher the cosine similarity.

Knowledge-Based

In the knowledge-based system it contains the standard answer and the marks that assign for each question.

Grading of Answer

After completing all the above processes, the grade is given according to the content of the students and marks will be assigned as per the grade of answer. Answer Evaluation comparison table. The table shows the marks obtained by students for each question from both computer and human assessor. After comparing both model answers and the student's answer, we observe the evaluation is done almost similar. In our experiment, the students get 68% of marks for the answers which are evaluated by this system. In human evaluation, they get 65% of marks. By comparing both the results we can say that the proposed system is more accurate.

RESULTS AND DISCUSSION

To Analyse the performance of this proposed model, the system assign marks will be compared with the human assign marks for the same answers of each student. For that, we use NLP techniques for the experiment process. Here we have taken the subjective type of questions for the experiment process. Hence these answers are verified in detail, by checking the spellings and grammar of the sentence in student answer. We have taken 10 questions for analysis; each question carries 2 marks, and 3 model answers are prepared for each question. These 10 questions are given to each student. The total number of students is 5. Once the answers are submitted by students then it is evaluated by both system and the human assessor by comparing student answers with the 3 model answers.

CONCLUSION

In this study we have examined different techniques used for evaluating subjective answers. These approaches compare the candidates answers with standard descriptive answers. It verifies the candidates answer by matching it with the stored answers. The evaluation is performed automatically. It saves time and resources to a great extent. It relives the examiners all the difficulties which are encountered in the traditional valuation system. The semantic

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similarity-oriented approaches produce accurate results. The similarity measure techniques provide required similarities between the answers. Hence the Universities and other Educational Institutions can adopt these systems for evaluation purpose.

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Table.1 Analysis on Subjective Answers.

Authors	Approaches	Contributions
Ms.Paden Rinchen [1]	1]LSA	It is a commonly used technique for automatic determination of document similarity. It way it evaluates answers is almost like a human expert evaluator.
	2]BLUE	The purpose of BLUE is measuring the candidate translation as well as reference translations sets using a numeric value. It Highly dependent on reference answer.
	3]SELSA	It overcomes the short comings of LSA.
Amarjeet Kaur, M.Sasikumar [2]	Comparison based approaches are undertaken techniques like Text-Text, Graph-Graph, Text-C are used for determining a best solution for the automatic descriptive answer.	The text-Cmap method provides mean sore difference. This method is efficient than Text-Text, Graph-Graph method.

Pooja Kudi, Amith Kumar Manekar, Kavita Daware, and Tejawini Dhatrak[3]	Machine learning approach using text mining.	This approach extracts all the information or data from the unstructured form. It is mainly used to extract valuable information from the given document.	
Somik, Goswami, Avik, Ranjan Pal[4]	The measure of lexical and semantic similarities was presented	This approach finds the similarity among the students and the teachers answers.	
Mrunall M, Parag, Pagnis, Pawar and Prakash [5]	The evaluation system is improved by using contextual synonym as well as feedback driven model	This approach regulates the errors frequently as well as enhances the results after every training.	
Asmitha Dhokrat, Gite Hanumat R, C. Namrata Mahender[6]	Interference process method.	In this approach python with NLKT tool kit were used to match the answers.	
Kiran, Dharma, Lakshmi [7]	It is a Python Tool and uses semi-automated mode as well as fully automated mode to evaluate subjective answers.	This approach using a smart as well as systematic method for evaluation.	
Sachin, Piyush, Vaibhav. Anmol Bhandar.[8]	Evaluation with Machine Learning and Natural Language processing (NLP).	It an approach using Machine learning technology that will give the satisfactory Results due to the holistic evaluation.	
Gite, C.Namrata, Asmitha Dhokrat, [9]	This is online subjective approach to assess answers	This approach is particularly concentrate on the interested part of the answer to confirm the answer is correct or not.	
Mousami Saha, Mainak Chakraborty, Tamasree Biswas[10]	A Novel Approach for descriptive Answer Script Evaluation using Intelligent Tutoring System using AI.	This technique checks on the answers with appropriate spelling and grammar under restriction. It works on respected answer given and distinguishes them weather correct, error or elaboration. This approach can support a wide variety of answers	
Sheebha Parveen[11]	Proposed model for online subjective Examination System.	The main objective of the system offers a solution to the automatic evaluation method for subjective answers.	
Paulo, Escudeiro,and Augusto. [12]	D-Confidence	It weights the classifier confidence by the inverse of the distance among the class at hand and the previously known classes.	

Table. 2 Answer Evaluation comparison table.

Students	Answers	Computer Analysis	Human Analysis
Student 1	Answer 1	1	1
	Answer 2	1	1
	Answer 3	1	1
	Answer 4	2	2
	Answer 5	1	1
	Answer 6	1	1
	Answer 7	2	2
	Answer 8	2	1
	Answer 9	2	2
	Answer 10	0	0
	Total	14	12
Student 2	Answer 1	1	1

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	Answer 2	1	1
	Answer 3	1	1
	Answer 4	2	2
	Answer 5	2	1
	Answer 6	2	1
	Answer 7	1	1
	Answer 8	1	1
	Answer 9	2	2
	Answer 10	2	1
	Total	15	12
Student 3	Answer 1	1	1
	Answer 2	1	1
	Answer 3	0	1
	Answer 4	2	2
	Answer 5	1	0
	Answer 6	1	1
	Answer 7	1	1
	Answer 8	1	1
	Answer 9	1	1
	Answer 10	1	1
	Total	11	10
Student 4	Answer 1	1	1
	Answer 2	1	1
	Answer 3	2	12
	Answer 4	1	1
	Answer 5	1	2
	Answer 6	1	1
	Answer 7	1	2
	Answer 8	1	1
	Answer 9	1	1
	Answer 10	2	1
	Total	12	13
Student 5	Answer 1	1	1
	Answer 2	2	1
	Answer 3	1	1
	Answer 4	2	2
	Answer 5	1	1
	Answer 6	1	1
	Answer 7	2	1
	Answer 8	1	2
	Answer 9	2	1
	Answer 10	2	2
	Total	16	13

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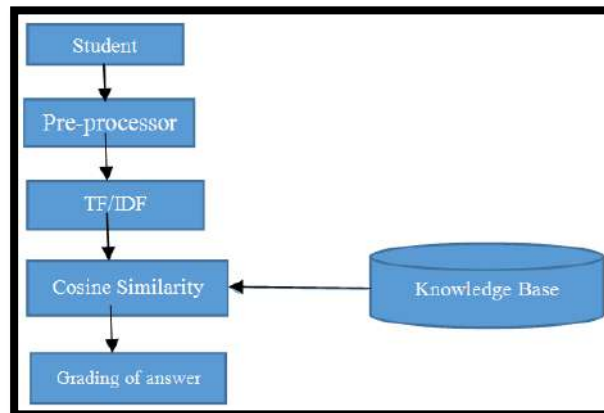
Fig. 1. Analysis on Subjective Answers

RESEARCH ARTICLE

Divergence Issues in English-Urdu Machine Translation

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ABSTRACT

In this emerging era, MT is one of the topnotch Research area. It has many bulging issues which needs keen consideration. Among all these issues, Translation Divergence is one of the most important phenomenon which plays a very important role for the development of Machine Translation. Divergence is a mapping scheme of a language pair and differs according to its grammar structure. More clearly we can say that if the grammar of either language is different then it is sure that divergence will take place. In this paper, we are presenting the divergence issue of English-Urdu language pair.

Keywords:

INTRODUCTION

Translation divergence is a complex issue in the field of Machine Translation. Divergence can be defined as a difference between two language pair that arises due to their different grammatical structure. Whenever we translate a source language to target language and the corresponding translated output differs from the original sentence then it means divergence has occurred. This varying translated output effects the quality of Machine Translation. For example in English, we have a word "Sorry", the same word in Urdu is written as "معافی چاہتی ہوں (*Maffi chahti hun*)". Thus we can see that the word 'sorry' has three corresponding words in Urdu which show divergence problems. This is a common example of divergence issue. Such variation creates problem to machine for translation. Sometimes similar divergence patterns are seen for related target languages. For example, in this paper, we are discussing divergence issues for Urdu. The divergence that occurs in English-Hindi and English-Urdu pair is somewhat same. But it is not necessary that every time we get the same divergence pattern.

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For example

English- Iqbaal goes to school.   (SVO)

Hindi-   इकबाल विद्यालय जाता है | (SOV)

Urdu- اقبال مدرسہ جاتا ہے *(iqbaal madarsah jata hai)* (SOV)

In the above example of English-Urdu and English-Hindi language pair, we have same divergence issue.

For example

English: Find it.

Hindi: खोजो |

Urdu: اسے حاصل کرو - *(ise haasil kro)*

In this paper, we have presented Dorr's based divergence issues and some other issues which comes under English-Urdu language pair. Urdu is weakly inflected language. It also supports multiple generative morphological schemes. In most of the cases English-Urdu contradict each other. Both languages have different script and writing system, as well as different word ordering in sentence level. That's why English-Urdu language pair is a good source to define translation divergence which arises in Machine Translation. Translation Divergence is a part of our ongoing project Evaluation of English to Urdu Machine Translation Systems. In this paper, we have dealt with these issues. The rest of the paper is organized as: Section 2 gives the literature review. Section 3 gives the Script and Writing system of both languages. Section 4 describes Dorr's Classification of divergence. Section 5 describes Syntactic Divergence. Section 6 describes Lexical Semantic Divergence. Section 7 describes Other Issues. Section 8 finally provides Conclusion and Future Work.

LITERATURE REVIEW

The first researcher to analyse the divergence pattern in the natural language was B.J.Dorr [1]. She introduced translation divergence issues in 1993. She gave us the systematic solution of divergence between a language pair. Dorr classified his divergence pattern into two types, which are Syntactic Divergence and Lexical- Semantic Divergence. For Indian languages, Sinha and Thakur [2] studied the divergence patterns in Machine Translation between Hindi and English. In this paper, authors discussed the translation pattern between Hindi and English by constructing different types of patterns with a view to identifying the potential topics of Translation Divergence. Gupta and Chatterjee [3] in 2003 proposed study of divergence for Example-Based English-Hindi Machine Translation. Here authors described the divergence pattern by recognizing six different divergence categories and provided scheme for its identification. Sinha and Thakur [4] proposed the work for Translation Divergence in English-Hindi MT. In this work, authors characterized the Dorr's based seven classes of translation divergence for both English to Hindi and Hindi to English Machine Translation. Mishra et al [5] in 2009 proposed a work for Divergence patterns between English and Sanskrit Machine Translation. In this work, authors performed a novel method that uses rules and ANN technique to detect and implement the adaptation rules for the divergence in English to Sanskrit Machine Translation. Shukla and Balyan [6] in 2011 proposed a work for Pattern identification for English to Hindi, Urdu and Punjabi Translation. In this paper, authors describe the different identification patterns that were generated for different languages. Bhattacharyya et al [7] in 2011 studied for Divergence patterns between

English and Bangla

Machine Translation perspective. In this study, authors described the identification criteria for different pattern of divergence which arises in English and Bangla translation. Shukla and Sinha [8] in 2011 proposed a work for Divergence patterns for Urdu to English and English to Urdu translation. Main goal of this study is to identify the various divergence patterns on the basis of morphology, complex predicate verb structure and reduplicacy. A broad category of divergence is based on Dorr's classification. Balyan et al [9] proposed a work for Resolving IT table approach translation ambiguities in Angla Urdu. This approach is used for English to Urdu translation which is different from the approach that has been used in Angla Punjabi, Angla Bangla and Angla Malayalam. This approach is simple and easy to implement with its own limitation.

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Script and Writing System

Urdu is an Indo Aryan language widely spoken in Pakistan, the northern parts of India. Urdu Script is based on Perso-Arabic alphabet which is written right to left whereas English Script is based on Latin or Roman alphabet which is written in left to right.

Dorr's Classification of Language Divergence

Bonnie Dorr [1] in 1993 has classified translation divergence into two groups: 1.Syntactic Divergence 2.Lexical-Semantic Divergence. Syntactic Divergence is constituted with syntactic information of both source and target languages whereas Lexical Semantic Divergence is constituted with properties and features that are lexically determined.

Syntactic Divergence is further divided into

1. Constituent-order Divergence 2. Adjunction Divergence 3. Preposition-stranding Divergence 4. Movement Divergence 5. Null-subject Divergence 6. Dative Divergence 7. Pleonastic Divergence.

Lexical-semantic Divergence is further divided into

1. Thematic Divergence 2. Promotional Divergence 3. Demotional Divergence 4. Structural Divergence 5. Conflational / Inflational Divergence 6. Categorial Divergence 7. Lexical Divergence.

SYNTACTIC DIVERGENCE
Constituent-order Divergence

Constituent divergence occurs when there is a variation of word order from source to target language.
-In English language word order is in the form of SVO while Urdu language has SOV.
-Similarly in English we have S-V-Adv while in Urdu we have S-Adv-V.

For Example

Students go to school ⟶
طالب علم مدرسہ کو جاتے ہیں
(*taalibe ilm madarsah ko jate hain*)
(SVO)   (SOV)

Iqbaal walks slowly ⟶
اقبال آہستہ آہستہ چلتا ہے
(*Iqbaal aahistah aahistah chalta hai*)
(S-V-Adv)   (S-Adv-V)

Adjunction Divergence

Adjunction divergence is related to the difference in the position of modifiers (adjuncts) in a sentence.
-The language can differ by changing the position of modifiers.

For Example

The students who go to school are given more knowledge.
جو طالب علم مدرسہ جاتے ہیں انہیں اخلاقی علم دی جاتی ہے - ⟶
(*jo taalibe ilm madarsah jate hain unhen akhlaaqi taalim di jati hai*)

-The Relative clause in Urdu can be placed anywhere in a sentence either at the initial position, in the middle or at the initial position, in the middle or at the end of a sentence. But in English such case is not possible because the grammar structure of English does not allow us to do so.

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Preposition-stranding Divergence

English is a prepositional language while Urdu is postpositional language.

-There are certain cases in English where head noun can move from one canonical position to some other position, leaving the preposition stranded in its original position, but Urdu has no such counterpart.

For Example

Government is working for country   ⟶
حکومت ملک کے لیے کام کر رہی ہے
(hukumat mulk ke liye kam kar rahi hai)

Movement Divergence

Natural Languages show displacement property that causes translation divergences between source and target languages.

For Example

Sayma knows Tahira ⟶   سا یما طاہرا کو جانتی ہے)*Sayma taahira ko janti hai)*

*Sayma Tahira knows ⟶ طاہرا کو سیما جانتی ہے
(taahira ko sayma janti hai)

From the above example, we find that subject and object NP can be mobilized in Urdu but in English such movement leads to grammatical problems.

Null-subject Divergence

In this type of divergence pattern, the language difference depends on the subject NP. Subject NP is must in English while in Urdu we can drop it.

For Example

I accept it   ⟶   قبول ہے   *(qabool hai)*
I am admitting ⟶ تقسیم کر رہی ہوں
(Taqseem kar rahi hu)

The above example shows that the subject NP "I" is present in English while it is absent in Urdu.

Dative Divergence

Dative case (case markers) is not present in English whereas in Urdu, the subject NP is marked by dative case.

For Example

Every person has the right to education.
ہر شخص کو تعلیم کا حق ہے ⟶
(har shakhs ko taaleem ka haq hai)

Pleonastic Divergence:

This kind of divergence is due to the presence of pleonastic Subject NP in one language and absence of the same in another language. English has pleonastic Subject, which means that the subject position is filled by dummy NP which does not have any semantic content.

For Example

It is hailing.   اولین پڈ رہے ہیں
(aulein pad rahe hain)

-In English, 'it' occurs in the subject NP position without any semantic content of its own whereas in Urdu counterpart of this sentence is formed by a subject with semantic content.

-English sentence contains a dummy NP subject and a verb phrase. Thus the verb "Hailing" in English is translated to " اولین گرنا " (*aulein girna*)" in Urdu. We did not use "fall" verb for "گرنا" (*girna*)" in English but we use " اولین گرنا " (*aulein girna*)" for the word "hailing" where "fall" is a verb and "hail" is a noun. Thus in Urdu, اولین(*aulein*) can potentially take the position of the noun and گرنا (*girna*) takes the position of the verb.

LEXICAL - SEMANTIC DIVERGENCE

Thematic Divergence
This divergence occurs when the difference is observed in the argument structure of the verb.
-In one language, the subject NP is in the form of Dative case while in another language subject NP is in the form of Nominative case.

For Example
Students like to read article.

طالب علم کو مضمون پڑھنا پسند ہے ➡
(taalib ilm ko mazmoon padhna pasand hai)

Or ➡   تالب علم مضمون پڑھنا پسند کرتے ہیں   *(taalib ilm mazmoon padhna pasand karte hain)*

Promotional Divergence
Promotional divergence occurs when the position of a syntactic constituent in the source language changes to a higher up position in the target language.
-In this divergence, an adverbial element in one language is identified by a verbal element in another language.

For Example
Sayma is dancing happily.

سایما خوشی سے ناچ رہی ہے ➡
(Sayma khushi se (ke sath) naach rahi hai)

In English, some of the adverbial expressions are mapped onto corresponding verbal constituents whereas in Urdu, adverbial expressions are usually mapped to propositional phrase.

Demotional Divergence
Demotional divergence occurs when the position of syntactic constituent in the source language change to the lower syntactic position in the target language.

For Example
See you in the evening. ➡   شام مے ملینگے   *(sham me milenge)*

Structural Divergence
Structural divergence occurs when NP argument in the source language is identified by PP adjunct NP of target language.

For Example
Lion entered the cage. ➡

شیر پنجڑے مے داخل ہوا   *(sher pinjade me dakhil hua)*
In English, the verb 'enter' takes an NP argument 'the cage' whereas in Urdu, verb [enter]=>[(daakhil hua) **داخل ہوا**]takes a preposition phrase [پنجڑے میں (*pinjde mein*)]

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Conflational / Inflational Divergence

Conflational divergence arises when two or more words in the source language are mapped by single word in the target language. Inflational is just reverse of conflational divergence where single word of source language is mapped to more than two words in the target language.

Thank You. ⟶ شکریا
                    (Shukriya)

Another example that can be considered for Inflational divergence:

Please sit. ⟶ برائے مہربانی بیٹھئے
                    (baraaye meharbaani baithiye)

Translate it ⟶ اسکا ترذمہ کرو
                    (iska tarzumah karo)

Sorry ⟶ معافی چاہتا ہوں
              (maafi chahta hun)

Categorial Divergence

Categorial divergence arises due to the mismatch between part of speech of the source and target language.

For Example

Don't talk to me. ⟶   مجھسے گفتگو مت کرو   *(mujse guftagu mat kro)*

In English, talk is a verb but when it is converted in Urdu it becomes noun [(*guftagu*) گفتگو].

Lexical Divergence

Lexical divergence occurs when there is no one to one mapping of lexical item from source to target language.
-Conflational and Inflational divergence along with some other type of divergence overlap with the lexical divergence.

For Example

Please to meet you. ⟶
                    آپسے ملکر بہت خوشی ہوئی
                    (Aapse milkar bahut khushi hui)

OTHER ISSUES

Gender Specific Problem

In English, three genders exist- Masculine, Feminine and Neuter whereas only two genders- Masculine and Feminine exists in Urdu. When a word represents gender in English and the same word represents different gender in Urdu it leads to gender type divergence. In this paper, we describe some gender based divergence words. When we match an Urdu word with respective English word on the basis of gender, it is observed that most of the English words come under the category of neuter gender. In this reference, certain words are mentioned in the following table.1.

Word Ambiguities

The words having different meanings are known as ambiguous words. List of some ambiguous words are mentioned in following table.2.

Replicative / Reduplicate Words

Urdu is almost similar to Hindi language. Urdu has more replicative words (e.g. کرتے- کرتے *karte-karte* , ہنستے – ہنستے *hanste-hanste*) and reduplicate words (e.g. کھانا – وانا *khana-vana* , پانی وانی *paani-vaani*) like Hindi. These replicate and

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reduplicate words are used to emphasis the effect of original words. English does not have replicate/reduplicate words. Therefore it is very difficult to find an exact match of Urdu word in English.

For Example:

Can you take lunch?

➡ کیا آپ دوپہر کا کھانا – وانا لینگے؟ (*Kya aap dopahar ka khana-vaana lenge*?)

Honorific and Non-honorific verbal form

In Urdu honorific features are expressed due to the presence of plural pronoun and plural verbal inflection while in English no honorific features exists. For example – in Urdu, " میرے پتہ مسزد جاتے ہیں (*mere pita maszid jaate hain*)" – express as plural inflection form, while in English, "my father goes to maszid" no plural inflection exists.

Urdu also expresses non honorific features . For example " میرا بھائی مسزد گیا ہے (*mera bhai maszid gaya hai*)" is expressed as singular inflectional form while in English "my brother goes to maszid" also has singular inflectional form. It means when both languages expresses same features then no divergence problem will be there but if both the languages like the above example shows different features then divergence problem arises.

CONCLUSION AND FUTURE WORK

In this paper, we have analysed the problems which occur in the English to Urdu Machine Translation. We have thoroughly studied Dorr's classification in respect to English-Urdu MT. We have shown all the divergence pattern for English-Urdu language with example. We can get a good machine translation after resolving these divergence issues. This work is a part of our ongoing project. Here we have demonstrated only the particular aspect of translation divergence due to the limited time and space. In future, we will focus on the remaining aspects of divergence which comes under the English- Urdu language pair. So that we can make a good machine translator which improves the quality of the MT output.

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Table.1: Gender Related Issues

English Word	English Gender	Urdu Word	Urdu Gender
Season	Neuter	آب و ہوا(*aabohava*)	Feminine
Sacrifice	Neuter	قربانی (*qurbaani*)	Feminine
Life	Neuter	زندگی (*zindagi*)	Feminine
Stable	Neuter	اصطبل (*astabal*)	Masculine
Revolution	Neuter	انقلاب (*inqlaab*)	Masculine

Table.2(a): Word Ambiguities in Urdu

Urdu	Transliteration	Gloss
عام/ آ م	*AAm*	Ordinary/Mango
جعلی/ جالی	*Jaali*	Fake/Net
صورت/سورت	*Surat*	Condition/Face
شیر/شعر	*Sher*	Verse/Lion

Table .2(b): Word Ambiguities in English

English	Gloss	Transliteration
Saw	دیکھا/آرہ	*Aarah/Dekha*
Kind	رحم/قسم	*Raham/Qism*
Bank	کنارہ/بینک	*Kinara/Bank*
Stable	مضبوط/اصطبل	*Mazboot/Astabal*

RESEARCH ARTICLE

The Future of Computer Assisted Education

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ABSTRACT

The purpose of this research was to explore how computer-assisted learning has impacted this generation and the impact it will have on our future generations to come. This paper shows the level of difference in the learning process of students and the achievement associated with it. Computer-assisted learning helps provide education with various multimedia platforms containing required information for easy and user-friendly learning of students. It stimulates innovative ideas to be induced into learning methodology. For over a decade we have been using various tools to enhance learning using computer-based platforms such as smart classes, videos, and online courses with better resources. This has proven effective in the lives and academic success of the students when compared to traditional learning methodology. This method is most suitable for young kids than the older generation. Computer-based learning has become a fun way of learning and this method could be the future, almost replacing the conventional learning system. This form of learning had come to the rescue during the pandemic. With kids learning a lot from the internet, it has become a trend to learn this way and grasp things online without which learning cannot go any faster. In this digital world where new technologies are being introduced every few months, it's high time to incorporate this innovation into enhanced learning for students and kids. The level of convenience and flexibility are the key points in this research. It also describes the success of the proposed methodology which can be a revolution in education.

Keywords: Computer Assisted Education, Virtual Learning, Online Classes, E-Learning, Recorded Sessions

INTRODUCTION

Education has been included as an essential role in one's life. It determines academic progress and achievement in knowledge. While some see it to gain a certificate for intellectual strength while others just see it merely as a rule in life, something which has to be completed to be successful. It's the method to develop skills and habits, attain moral values, and enhance one's character. So, it not only prepares an individual for his career but also makes an impact on his personal growth as well which is an important aspect when it comes to living in society. It provides individuals with various opportunities to grow and also prove themselves. A well-educated person is given respect and treated with respect than a dropout or illiterate. Education is the backbone of society. Education assists us in prospering by paving way for us and providing the right direction to move forward in life. While an educated person with his ideas and knowledge has the power to change the world while an uneducated man can do nothing but be a destruction to society. Not everyone is capable enough to receive an education. One of the major problems is because of financial issues, family concerns especially in the case of girl children, or interest of the children, etc. Despite all these, Government is taking initiative in compensating a little financially by giving scholarships and encouraging children so that they can have an interest and develop a desire for education without the need to worry about financial issues.

What is computer-assisted education?
Computer-assisted education should be seen as the primary function for developing, and projecting skills and ideas for the great growth of students by scientifically using microcomputers and computers, digital products, software applications, and multimedia systems. Other terms like computer-assisted instruction, computer assistance (or assistance) instruction (CAI), computer-managed instruction (CMI), and computer-based learning (CBL) are also used alternatively. It may also refer to the acquisition of education through electronic devices and products. Teaching materials are commonly stored on physical devices such as DVDs, especially for children, mobile phones, servers, and alternative web-based resources. Now there is no need to rely entirely on schools or books for knowledge and education. There are hardly any areas where technology is not used. The online system of education can act as a good medium for the transformation of the Indian Education System [5]. The professional level of this type of education is also attractive, flexible, and dynamic, allowing students to carry out studies more comfortably by bringing out and displaying their learning and listening skills. With the help of electronic devices, students can freely perceive all kinds of knowledge from all disciplines with one click and in their own time.

Computer Assisted education is also used in the medical and clinical fields to deepen the understanding through visualization of the human body. This will gradually lead to improving the diagnostic pattern and make health care faster and more efficient. In any case, computer-assisted learning provides a faster or slower route at their own pace, for people of different abilities and different levels of aptitudes, while also maintaining the trainer's progressive record. The feedback from the computer-based learning system is also an instant response, allowing students to personally review the available curriculum content as needed, privately, and without feeling embarrassed by mistakes. So, it is non-judgmental which is a great relief and improves the self-confidence of learners and gives hope to the prospective ones.One of the goals of the Science and Technology course is to train individuals who are capable and can respond to the rapidly evolving, changing world of science and utilize the latest technological discoveries in all areas. With the rapid development of information and communication technology, the use of computers in the process of learning has become unavoidable. It motivates students and encourages them to actively participate in the learning process. It helps learners develop problem-solving skills, and creativity, and provides identity and self-confidence too. It provides drawings, graphics, animations, music, and lots of material that allow students to move at their own pace and in line with their differences. This helps control many factors that affect learning that traditional teaching methods cannot control. In most schools and institutions, virtual learning replaces face-to-face classroom learning. Only because of computers, today we can have access to smart classes, video classes, online offline videos, web classrooms, and many more. Computer-based education is an easy way to learn and capture content. With this, we can create appealing and engaging presentations that explain the topic.

The teaching style and environment of education have changed over the years. From gaining knowledge seating under a banyan tree to learning from electronic gadgets/ sources such as computers, mobile, and the internet, education has undergone a revolution in the method of teaching. Earlier the only source of information was a library and published articles [4]. But in this digital era, everything you need to know is available on the internet in a digital form. Technology not only enhances the student's learning process; it also helps teachers get their work done quickly and efficiently. Teachers are using the latest technology to work on digital products like power point presentations, simulations, and streaming videos, which were never possible before due to a lack of technological innovation. Companies have taken the initiative to sell products to help teachers and students and have been in the market for a while. Nowadays you can buy software for just about anything. With the help of computers, it has increased human potential in every field possible. In computer-assisted education, multimedia plays an important role in helping kids grasp the concept discussed. It has reached a level where the field of learning can create and design programs and courses which is easier and user-friendly for students to adapt to, especially during this generation where everything is digital and computerized and plays a major role in students' lives. Technology has provided a platform for accessible and sound learning to join everyone together to help understand the concepts better. Computers play the role of a proctor in the E-Learning platform, thus allowing students to show their capabilities in mastering a subject.

In today's modern world, computer-assisted education is a fortune for the students of this generation where everything is just a click away. The availability of relevant sources and speed is an important aspect of learning. When learning with the help of multimedia, the learning capacity, or the percentage of understanding the concepts better is relatively high than just reading plain text. With the introduction of online courses being offered by various universities, students need not rely completely on schools for gaining education, the internet is a stream of information to gain knowledge. This approach to learning has its applications in the various disciplines available for study. The multimedia and visualizations to interpret the content enhance the learning and better understanding of in-depth concepts thus making the particular field efficient in its operations. Interactive videos recorded tutorial sessions, presentations, etc help gain and maintain the interest of students in learning. Computer-assisted learning has only helped achieve educational goals but also the training process of employment and internships for students. E-Learnings are replacing the conventional classroom environment via extensive utilization of digital devices such as smart classes, online videos, applications dedicated to learning, etc. E-learning makes it possible to share ideas with many people around the world who are limited to classroom education. Teachers can record the contents of the syllabus and students can study, take up assignments, and exams in online mode. Thus, it saves time for both the students and teachers. Therefore, through this learning method, students can learn as many concepts as they like until they are completely familiar with the concepts. With the flexibility of e-learning it can be done anywhere, anytime and any number of times. Some students are fast learners due to their high grasping power and some are relatively slow. An internet connection is required to access this video content and online tutorials. In this way, virtual learning has revolutionized the educational system massively and has created a desire in the students to be independent to gain knowledge of their interests.

Virtual Education or computer-assisted education is the interaction of the user with electronic devices, digital instruments, and applications which are all combined and accessed via the internet. With this method of teaching, we can see that it helps to detect and measure students' ability to learn and their listening skills. Students will not have any interference or distractions that make learning more effective.There are numerous ways computer-assisted education takes place like Smart classes, Online Courses, Gamified learning, recorded videos, PowerPoint Presentations, Social networking, and dedicated learning apps like byju and unacademy. We have innumerable benefits from computer-assisted education. Knowledge attainment is simplified and interactive, high motivation for the student to learn, the training process is simplified, and facilitates the making of rich content with help of text, audio, and videos in an appealing way. Students can track, choose language and break complex problems into small pieces by viewing their daily learning progress and planning accordingly While there are great advantages to this, we need to look at some disadvantages a little expensive for students sometimes depending on their financial status, isolation, and reduced social interaction which can be a challenge for them, development of creative content is still under progress and also teachers need to be trained. In a time where competition intensifies among people, world

boundaries are reducing and people are having very fierce competition, it is important to keep their knowledge updated. Such opportunities are provided by various websites like- Coursera, Udemy, Internshala, Khan Academy, edX, etc. Whatever may be the evolution in technology, it is ultimately the teacher who is bestowed with the responsibility to ensure whether computer-aided education is appropriate and has adjusted in their lessons or is not depending on the content and the way it is projected. The use of computer-assisted education might be a boundless way to leverage new technologies and effectively improve the language learning experience for students as well for as long as the profound advantages and disadvantages are being fairly measured. Computers bind learning by bridging the gaps that traditional teaching methods couldn`t fulfill. This is a very favorable method of education and seems to work effectively when compared to the conventional method of learning. It provides for an educational environment platform in which a learning environment is created by the respective teachers to identify student skills and abilities, conduct teaching accordingly, practice, repeat, and personalization of activities according to the student's abilities. Some of the brand new and recent applications like Google Meet, Zoom, and Microsoft teams have paved way for the successful accomplishments in computer-assisted education. They have raised the bar for the education sector in its progress and success. They assist teachers and make learning interactive, feasible, and attractive.

LITERATURE REVIEW

E-learning is a way of learning with the help of the internet it is an online form of learning. Online learning was introduced in the year 1960 by Donald Bitzer who was working as a laboratory assistant at the University of Illinois. Donald was the creator of the first e-learning system called PLATO, a computer-based training program for students at the University of Illinois. The main purpose of this system of education was just to deliver information to students. Later on, this technique was not only used by educational institutions but also by companies to train their employee and expand their knowledge and skill set. It is now a fact that almost 80% of educational institutions have incorporated e-learning into their organization for the benefit of the students. Researchers have overseen several experiments to find out the benefits of using computers in education and their effectiveness with reading skills, literature, and training processes especially in Turkey and China in the year 2020[1]. Computer-assisted learning has inspired student involvement in higher education. Such training needs special hardware, software, and some processing capabilities on the computer or its device. Research of extended technology acceptance model and theory of planned behavior model was proposed to analyze university students' adoption of mobile learning platforms for accessing course materials, searching the web for information related to their disciplines, sharing knowledge, and submitting assignments during the COVID-19 pandemic [9]. A study by Muhammad Adnan has proposed predictive models trained on several ML and DL algorithms for predicting students' performance based on demographic variables. This study revealed that techniques such as feature engineering momentously improve the performance of predictive models. During the course module timeline, the performance of students was predicted at the very beginning when only demographic variables were available. Overall, the results of the RF predictive model demonstrated effectiveness in the earliest possible prediction of the performance of at-risk students[10]. A study done in Turkey by Salih Usun states that there is no noticeable difference in the significance of virtual learning among males and females which is also an important point to be noted as we can see that online learning can equally improve the intelligence of both genders [3]. It also states that students tend to learn faster when compared to conventional learning systems which is a positive impact.

SCOPE OF STUDY

This research was carried out to check the growing usage rate of the internet and electronic devices in terms of education and the impact it has on academic performance. Also, to get an insight into the various means, tools, and applications available in support of virtual education. This is a broad concept that emphasizes human-computer interaction, the internet and web and mobile applications, and also multimedia. All these together provide effective e-learning which directly indicates the success of students in their academics. Currently, there are enough tools that play an important role in virtual learning which includes smart classes, recorded tutorial videos, websites, etc. This

study proposes that all these put together in one system of education can be a game changer. Days are not too far where kids learn on their own and don't require the assistance of a teacher to help them in their academics. Kids have evolved to be smart enough while they are too young and almost 90% of the kids have access to the internet which is why this approach has given a major success in the scores of their academics. The capacity to inculcate whatever they learn has changed over the past with a positive impact. This form of education is not going to be a benefit in the cities alone but also in the rural areas as well if the network facility is uninterrupted. The only disadvantage would be the internet facility but within a few years, this won't be a problem anymore. With cloud computing, all the necessary information will be available on the internet and can be accessed by anyone, anywhere, and at any time through web-based tools and applications which gives flexibility in learning at convenience [2]. This liberty will have a drastic change in an individual's approach to learning. Cloud-based storage relies on remote database storage. In recent years, many companies such as IBM, Microsoft, and Amazon have provided cloud services. The companies that provide cloud services allow users to store files and information on remote servers. Through the gateway of the internet, students will be able to access the remote server. Cloud-based e-learning is the latest technology in previous years and is being used globally. It is a flexible and convenient way to teach and share knowledge all around the world. E-learning using the cloud has several advantages. They are low cost, immediate software updates, and high performance. Due to these pros, it is beneficial to both students as well as teachers. The e-learning cloud is a migration of cloud technologies that will be significantly improved in the future, including all the software and hardware computing resources needed for e-learning.

METHODOLOGY

An analysis has been done on the various ways computer-assisted learning has been implemented and also in the fields it is being incorporated in. It is being used on such a vast scale that virtual learning has now become the trend to gain knowledge in all aspects. E-learning has been there in the market for a while with many sites and applications such as Byjus, Unacademy, etc. Earlier in the 1970's Computer-assisted instruction was used for hearing-impaired or deaf students. The curriculum for these students was primarily concerned with elementary mathematics and language arts. In recent times computer-aided learning came to the rescue and had become popularly used during the time of COVID in the years 2020 and 2021. Similarly, there are resources related to the age group of students from which they can perceive knowledge. For example, Flintoclass – which is play-based learning, has been implemented for nursery and pre-school kids. This program has a lot of lessons and activities for kids aged from 1.5 to 6 years and this is pre-school education at your doorstep. This is a fun way to keep the kids engaged and bring them to track in learning. Here multimedia is a crucial part where every representation of the learning must be engaging for kids to have a fun learning experience. It includes daily recorded sessions, assessment, development progress, parent resources, and communication tools. They also provide a counselor for support and guidance based on each child's unique needs. For the next age group, students can learn using the Byjus app where subjects are covered from classes 1 to 10. They have also introduced coaching for LKG and UKG as well in the year 2020. Also, for classes 11 and 12 in the commerce stream. They provide study materials and coaching for board exams as well.

Eager learners learn through video lessons, worksheets and interactive quizzes are available to evaluate their performance and check the knowledge they have gained and their level of understanding. Even social media platforms have been contributing to the field of education where teachers and other students post their understanding of a particular topic in their way which can be helpful to other students to learn different methods of solution to a particular problem and better understanding of concepts in the syllabus. Next is higher education, where people have been learning from online courses where students can gain knowledge from people working in top companies and teaching in top universities from overseas as well. Online learning portals and apps are available such as Udemy and Coursera. These learning sites provide recorded videos by professionals and graded quizzes and assessments to gain a certificate for the completion of a course. This certificate is helpful as it is evidence of gaining knowledge same as we get a certificate from our institution when we pass a grade. A study says that children have been learning a lot from these and there is a positive impact on their advancement in education. Students can

perceive the information in their own time at their own pace and also the feedback will be available almost instantly regarding the progress in their learning. The grasping power of kids nowadays has grown exponentially compared to people born in the previous decade. Taken a dataset of students ranging from 5 to 25 years of age and taken into consideration all the factors such as gender, age, educational level, institution type, financial condition, internet type, network type, and device. With the help of machine learning and using the random forest algorithm the adaptability level of online learning in the kids was predicted. Random forest is a supervised learning algorithm in machine learning that is used for Classification and Regression problems as well. It builds many decision trees based on different samples. Later their majority vote is taken for classification and the average is considered in case of regression. The importance of each feature on a decision tree is then calculated as:

$$fi_i = \frac{\Sigma_{j:node\ j\ splits\ on\ feature\ i}\ ni_j}{\Sigma_{k\in all\ nodes}\ ni_k}$$

- fi sub(i)= the importance of feature i
- ni sub(j)= the importance of node j

These can then be normalized to a value between 0 and 1 by dividing by the sum of all feature importance values:

$$normfi_i = \frac{fi_i}{\Sigma_{j\in all\ features}\ fi_j}$$

The final step which is feature importance, in the Random Forest level, is its average over all the trees. The sum of the feature's importance value on each tree is calculated and divided by the total number of trees:

$$RFfi_i = \frac{\Sigma_{j\in all\ trees}\ normfi_{ij}}{T}$$

- RFfi sub(i)= the importance of feature i calculated from all trees in the Random Forest model
- normfi sub(ij)= the normalized feature importance for i in tree j
- T = total number of trees

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

TP – True Positive
TN – True Negative
FP – False Positive
FN – False Negative

Data Preprocessing
First and foremost, is the preprocessing step performed on the dataset. It is a technique where the collected data is cleaned, reduced, and transformed to suit the requirements of this research and provide insights. This dataset involved only categorical features and data was split into 70% and 30% for training and testing.

Exploratory Data Analysis
Next, an exploratory data analysis was performed to get a statistical analysis of the dataset being used on the training data with the help of describe () function to summarize the major characteristics. The data is transformed into quantitative data using Ordinal Encoder () to perform analysis efficiently. Then Random Forest Classifier () function is used to classify whether e-learning has a major impact and is suitable for age groups 5 to 14 and 15 to 25. Keeping the above features in mind, a prediction was made as to how the students adapt to the new technologies

and their level of understanding. By using a random forest classifier, it was easy to classify the data and analyze the understanding level of students through online mode.

RESULTS

With this approach, we can see that there is less interaction of the teachers in the lives of the students while educating themselves on their own and this is most suited for the new generation of students. The main purpose of this study was to investigate the impact of the students in the education of computer-based learning on their achievements and problem-solving skills. Sure, they are excelling in their lives with this method of learning by which we can predict that there may not be any need for institutions teaching kids anymore while only doubts and other concerns are investigated and also the certificate of completion of education is given to the students. Technology advancements are propelling that there might be a system introduced where homeschooling can be done, and students can get their education completion certificate as well via computer-assisted learning. On implementing a random forest algorithm on the available data with an accuracy of 0.92%, analysis shows the important factors contributing to the success of online education among others. The top 5 are financial conditions followed by age, gender, network type, and institution type. This research also found that males perform better in academics than the female gender from online learning. This comes in contradiction to the results mentioned by Salih Usun in his paper that both genders perform equally well in academics [3].

It is also noted that mobile is the device that is highly being used for this purpose. It's right as it's handy, portable, and easy to use. While self-learning is on the rise, this can help the students to progress quicker on a larger scale. This proves that the new generation of kids has a high potential to adapt to the various technologies available and promote distance learning while maintaining their grades high. But this can have an impact on the health of the students such as eyesight and back pain from the strain of sitting in one place to learn. This can be eliminated with a hybrid learning structure where students can learn from online sources as well as educational tools and technologies such as VR devices, etc to make the learning process more fun. Content writers and multimedia experts are going to be in high demand for the presentation of the information in a productive way. Teachers too won't lose their jobs as they can contribute to the content via recorded videos or tutorials. Cheating during assessments is one of the major disadvantages of this system. With many software and applications being developed, we need to ensure that malpractice is reduced with remote monitoring or proctored assessment is being taken place. The main challenge is to see how the cost of these specialized courses can be reasonably maintained in the future by using computer technology efficiently and appropriately. Our goal is to increase the possible courses offered by the teaching faculties which may be a little hectic. Learning with the help of simulations and virtualization is the trend now where every detail in each field can be simulated and studied for a better understanding. So here virtual reality and augmented reality also has a role to make this method of education a fun learning journey than just a stressful one that we are going through.

Some of the limitations would be:
- Research is valid only for urban people as rural areas are somehow still deprived of the technologies available today [1].
- This research is based on the collected information.
- Computer-assisted education requires high and efficient technology.

CONCLUSION

The entire world has shifted to become a digital world with the advancements in technologies where everything is being operated and controlled via computer and their applications. The education sector has also taken advantage of this advancement and implemented it in the system of learning which has become a powerful tool in learning. The use of computer-assisted learning provides opportunities to students in the cities preferably citing the current

situation of the network facilities. The comfort and flexibility in learning can boost productivity in students. There will be more advanced software that can be more interactive. However, the challenge for scholars is not only to integrate computer-based education into the curriculum but also to assess its impact on actual learning. It's easy to witness the rise of online courses that provide a platform for students and those who want to learn it to study at home and earn a degree. Therefore, it can be clearly emphasized that there is success in computer-based education.

The disadvantage of this method is also to be considered which is the less social interaction among students, students also tend to spoil their eyesight if being exposed to staring at the computers for a long time and can also lead to other health issues which is a serious concern as we study to earn a happy and healthy livelihood. The results show that the analysis done on the students who are currently aged 15 to 25 have a moderate adaptability level to online learning and is not suitable for this generation while kids of age 6 to 14 have a high level of adaptability to e-learning and their academic scores are high as they engage themselves with the various technologies available more often, so they accustom themselves to that mode of learning which is suitable for the new generation. Therefore, online learning is best suited for a new generation of kids. This research concludes that technology is taking huge steps in building a better and more effective future in the field of education. Computer-assisted learning has already been implemented in certain institutions since the pandemic and has proven to be effective and increase the capacity of learning of the students. Initially, it is a little difficult to implement, but later this can be done with ease.

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Table 1: Mini Analysis of the dataset.

Features	Count	Uniq	Top	Freq
Gender	1205	2	Boy	663
Age	1205	6	21-25	374
Educational level	1205	3	School	530
Institution type	1205	2	Non-government	823

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Financial Condition	1205	3	Mild	878
Internet Type	1205	2	Mobile data	695
Network Type	1205	3	4G	775
Device	1205	3	Mobile	1013

Table 2: Results after applying Random Forest Classifier.

Measure	Precision	Recall	F1- Score	Support
0.0	0.91	1.00	0.95	214
1.0	0.93	0.92	0.92	207
2.0	0.93	0.85	0.89	198
Accuracy			0.92	619
Macro Avg	0.92	0.92	0.92	619
Weighted Avg	0.92	0.92	0.92	619
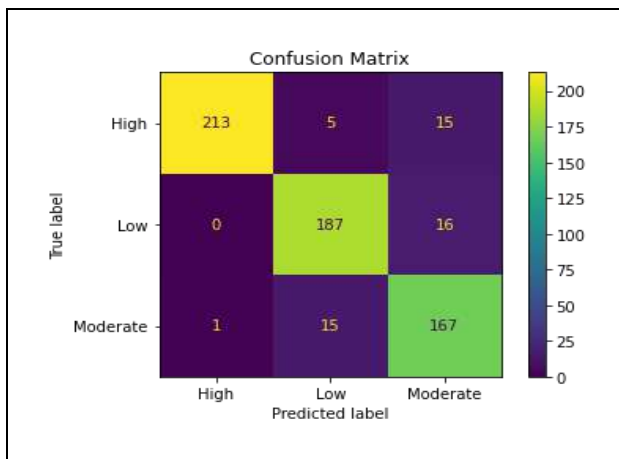
Fig .1: Confusion Matrix for the test data.	Fig. 2: ROC Curve
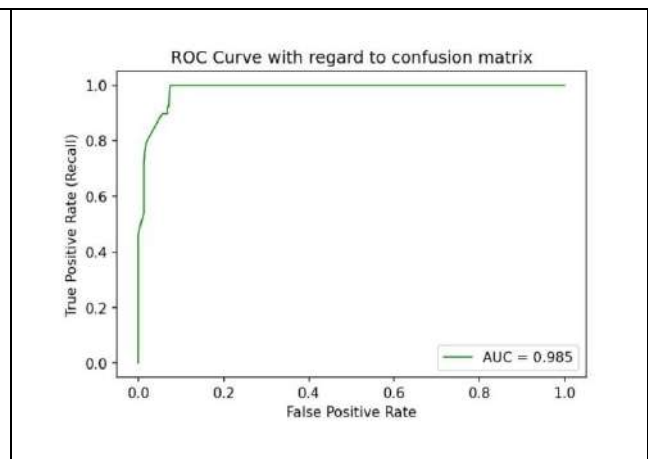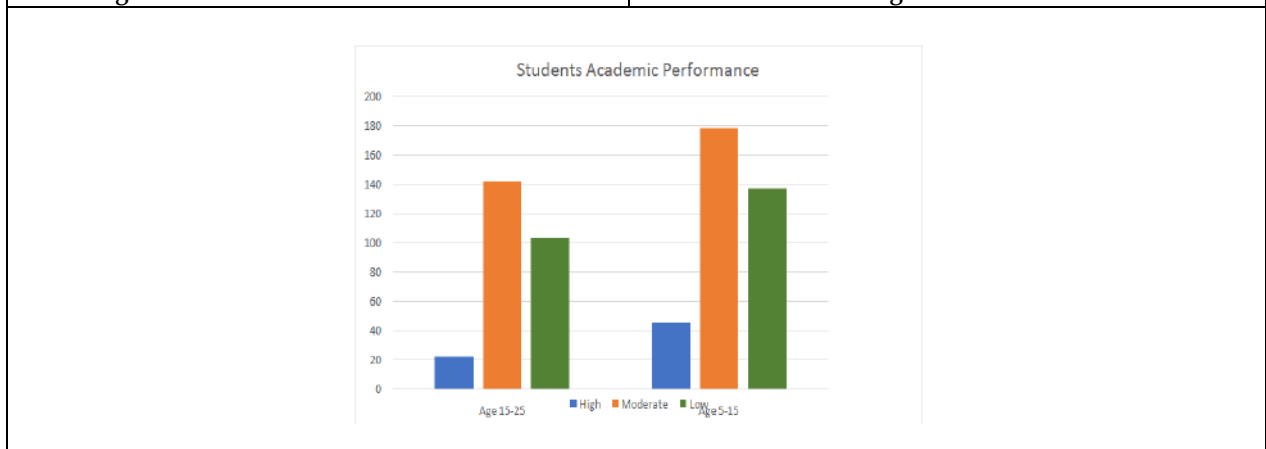
Fig. 3: Student Academic Performance

RESEARCH ARTICLE

Development and Standardisation of Polyherbal Formulation for the Treatment of Autoimmune

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ABSTRACT

Polygonum glabrum, *Canthium dicoccum*, and *Ochna obtusata*, plant components, were studied using thin layer chromatography and phytochemical screening. Petroleum ether extract, ethyl acetate extract, alcohol extract, and aqueous extracts were used as different solvent systems with changing polarities in the phytochemical screening determination and thin layer chromatographic analysis. phytochemical evaluation. The findings of this study showed that *Polygonum glabrum, Canthium dicoccum*, and *Ochna obtusata* are excellent sources of natural antioxidants. In a preliminary phytochemical investigation, it was discovered that bioactive compounds such saponins, phyto-sterols, and phenolic are present in reasonably high concentrations using Petroleum Ether Extract, Ethyl Acetate Extract, Alcoholic Extract, and Aqueous Extracts. The total phenol content and flavonoid content ethanol extracts are relatively more than other extracts with respect to the standard concentration of Gallic acid and rutin. In selected plants ethanol extract showed significant anti-oxidant activity of on dose dependent manner. Ascorbic acid is used as a standard to establish the IC_{50} values in all experiments. The current study demonstrates that the four plants that were chosen have good bioactive compounds, making them viable sources of pharmaceuticals and natural antioxidants. based on a literature study and early experimental findings Four conventional methods PHF1 and PHF2 were shown to have significant flavonoid concentrations and anti-oxidant activity in vitro when they were tested in several polyherbal formulations of various

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fractions. PHF2 is one of the two formulations with the higher flavonoid concentration, making it suitable for further investigation for pharmacological activities.

Keywords: *Canthium dicoccum, Ochna obtusata* Rheumatoid arthritis, *Polygonum glabrum*

INTRODUCTION

The majority of the food and medicine used in modern society are the result of traditional aboriginal knowledge of plants [1]. Herbs have been used for food and as a primary tool for maintaining health and assisting in the recovery of disease throughout history [2]. Approximately 80% of the world's population use plant-based medicines [3], and about one third of the world's countries rely on herbal medicines. In the world, arthritis is the primary cause of adult disability and affects one billion people daily. According to the WHO, arthritis (from the Greek arthro- joint and itis-inflammation) affects 1% of the world's population. Depending on the kind of arthritis, many reasons exist. They are similar in that they tend to affect the joints, muscles, ligaments, cartilage, and tendons, and many have the potential to affect other internal body areas. Some of the leading causes include injury leading to osteoarthritis, metabolic abnormalities such as gout and pseudo gout, hereditary factors, direct and indirect effects of infections, and autoimmune disorders such as rheumatoid arthritis and systemic lupus erythematosus. Where one bone moves on another bone is called a joint. The two bones are held together by ligaments, which operate as elastic bands to hold the bones in place as the muscles contract or relax to move the joint. The two bones' surface is covered in cartilage to prevent movement. The cartilage covering makes it possible for the joint to move easily and painlessly [8]. The joint is surrounded by a capsule. The synovial fluid is present in both the joint cavity and the joint space. The cartilage in the joint and the synovial fluid are nourished. The synovium (synovial membrane), which borders the joint cavity, produces the synovial fluid [9]. All forms of arthritis cause chronic sickness that needs ongoing care [10]. Joint discomfort is the primary complaint of arthritis sufferers. Pain is frequently continuous and may be limited to the injured joint. The inflammation around the joint, disease-related damage to the joint, daily wear and tear of the joint, muscle strains brought on by jarring motions against stiff, painful joints, and other factors all contribute to arthritis pain.

The diarthrodial joint is affected by rheumatoid arthritis (RA), a systemic inflammatory condition. It is a chronic, systemic autoimmune illness that primarily affects the synovial membranes and articular tissues and involves several joints (Fig.: 1). Usually, the smaller joints in the hands and feet are afflicted first, then the bigger joints. Periodic flare-ups are common in RA patients and can result in permanent joint damage. Injurious effects on organs like the heart and lungs are examples of systemic impacts. [12] In the US, 1.3 million persons have RA, and women are 2 to 3 times as likely than males to have it. Although the exact origin of RA is still unknown, genes seem to be involved in the progression of the condition. The inflammatory process may be sustained by hormonal or environmental causes [13-14]. Within a year of being diagnosed with RA, 80% of patients have synovitis (inflammation of the soft synovial joint tissue), cartilage loss, and bone erosions. 17 Up to one-third of persons diagnosed with rheumatoid arthritis are unable to work within two years of the disease's inception, which results in a considerable loss in job output. 18 Blood markers that distinguish RA from other auto immune connective tissue disorders are used in traditional techniques of diagnosing RA. Research into the creation of novel blood markers suggests promise in the development of additional blood tests to assist in diagnosing RA earlier, before symptoms appear; those diagnosed earlier could then begin receiving drug therapies intended to stop or slow down the effects of the debilitating disease [19].

AIM AND OBJECTIVE
The present study aimed to investigate the anti-arthritic effect of a polyherbal formulation containing aerial parts of *Polygonum glabrum*, *Canthiumdi ccocum,* and *Ochna obtustata* using experimental models of Rheumatoid arthritis. In the light of the above facts, the main objective of the present study has been directed

- To prepare the extract of the selected plants using various solvents and subjected to phytochemical analysis.
- To select potent bioactive extract using *in-vitro* antioxidant assay
- To select increased therapeutic effective proportion of selected bioactive extract (poly herbal extract) by *in-vitro* anti arthritic methods.
- To evaluate the poly herbal extract for the management of rheumatoid arthritis using *in-vivo* models.
- To promote the effective polyherbal extract to an oral dosage form and evaluation for their product performance.
- To evaluate the developed formulation for anti-arthritic activity using *in-vivo* model.

REVIEW OF LITERATURE
- **Singh *et al.,* (1987)**[41]. studied the anti inflammatory activity of the aqueous and ethanol extracts of stems of *Polygonum glabrum* in various test models viz acute carrageenan-induced paw edema, granuloma pouch test, formaldehyde arthritis test and adjuvant-induced polyarthritis test. The study reported that both the aqueous and ethanol extracts were effective in parenteral route than oral route.
- **Muddtahir*et al.,* (1987)** [42] performed anthelmintic activity of leaves of *P. glabrum* against *Hymenolepis nana var amiable* of the mouse at bit of 200-600 mg·kg−1 and antimolluscidal development of the watery and harsh concentrate of leaves of *P. glabrum* against *Biomphalaria glabrata* and *Lymnaea truncatula* Reflect. Unpleasant concentrate demonstrated 100% and 40% mortality against *B. glabrata* and *L. truncatula*, separately.
- **Ali AM (2003)**[43] announced the antimalarial action of ethanol concentrate of the leaves of *P. glabrum* against *Plasmodium falciparum* with a noteworthy impact with IC50 6.6 µg.mL−1.
- **Nizar*et al.,* (2007)**[44] evaluated the anti depressant activity of the aqueous extract of leaves of *Polygonum glabrum* in different models like behavioural despair test, tail suspension test and L-dopa induced hyperactivity and aggressive behavior test. The antidepressant activity of the plant was found to be mediated through monoamines like dopamine, nor-epinephrine systems.
- **Santhan *et al.,* (2013)**[63] investigated the anti-diabetic and nephroprotective activity of the ethanolic extract of the whole plant of *Canthium dicoccum* (family: Rubiaceae) on alloxan induced diabetic albino rats. Alloxan induced diabetic rat model and oral glucose tolerance test (OGTT) model was used for evaluation of antidiabetic activity. The biochemical parameters were analysed. All rats in the diabetic groups had FBG levels well within the diabetic range (>150 mg dL-1) at the initial stage of the experiment but after 21 days of treatment with extracts or glibenclamide the FBG significantly dropped in dose-dependent manner.
- **Bhaargavi vuyyuri *et al.,* (2013)**[64] studied anti inflammatory activity of the ethanolic extract of the whole plant of *Canthium dicoccum* in various animal experimental models. The plant extract at doses 250mg/kg and 500mg/kg significantly inhibited inflammation at P<0.05 in all the experimental models. Test dose at 500mg/kg, offered more protection against inflammation when compared to standard in carrageenan paw oedema model. In the formalin induced model aprogressive inhibition of inflammation from the 4th day was observed with both the study compound and the standard Indomethacin.

PLAN OF WORK
- Selection of different four plant species used in the treatment of folklore medicine in Tirupathi area based on literature survey
- Collection and authentification of areal parts of plant material
- Drying of plant material using shade drying and blending the plant material into coarse powder.
- Selection of suitable different solvents for extraction potential phytochemicals based on literature survey.
- Preparation of extract using different solvents, preliminary Photochemical screening for individual plant extract and evolution of physicochemical values for individual plant
- Quantitative phytochemical estimation(TPC,TFC) of individual extract of different solvent
- Evaluation of In Vitro anti oxidant activity of different extract of individual plants.
- Preparation of poly herbal powder mixing in equal quantities (wt) and Preparation of Polyhedral extraction using selected solvent, Determination of extractive values and Quantitative phytochemical Estimation of plant extracts (TPC And TFC).
- Choosing the Ethonalic extract as potential extract based on above experimental results.

- *In vitro* anti oxidant activity of potential Ethanol extract.
- Preparation of Polyherbal formulation of ethanol extract with varying proportions in a sequence.
- Evaluation of In -vitro Anti rheumatoid activity different formulations.
- Evaluation of In- vivo Anti rheumatoid activity different formulations.
- Formulation of poly herbal capsule using the potential composition of Ethanol extract.
- Evaluation of Polyherbal capsule In vivo Anti rheumatoid activity

Preliminary Phytochemical, Qualitative and Quantitative Phytochemical Investgation
Preparation of the Plant Extracts
Polygonum glabrum, Canthium dicoccum, and *Ochna obtusata* aerial portions were gathered and dried. The material was then combined to create a fine powder, and ethanol was extracted using a Soxhlet apparatus and water by maceration for 6 hours at 50°C. The rotary evaporator (Rotavapor® R-210, BUCHI Corporation) entirely evaporated the solvent 27].

Preliminary phytochemical investigation selected plants
All the Extraction is Subjected to Various Preliminary Phytochemical Evaluation with the Standard Test Procedure [29-32] and the results showed in table no.5 to 8 in this same way the Preliminary Phytochemical Evaluation concucted for polyherbal extract of different solvents and results showed in table [13].

TLC profile of selected plants [33-39].
Little Layer Standard methods were utilized for the chromatography of extracts, which is primarily used to identify the types of phytoconstituents present. TLC profiles created for an extract from a certain solvent system and other characteristics might be used as a fingerprint in a qualitative comparison of different herbal medications. A growing trend in assessment is using this technique since it is straightforward and reproducible. The retention factor (Rf), which was determined for several samples and is shown in the table 9, is a way of expressing how the active chemical moved.

$$R_f = \frac{\text{Distance travelled by solute}}{\text{Distance travelled by solvent front of TLC}}$$

Extractive Values [40-43]
The yields from the blended and extracted extracts of the four chosen plants (petroleum ether, ethyl acetate, ethanol, and water) are listed in the table. 5 to 8 . Therefore, ethanol is appropriate for extraction and is employed in subsequent research. similar to how yields for polyherbal powders are recorded.

Determination of total phenol
Comparing the total phenol concentration with gallic acid as the reference point using the Folin-Ciocalteu reagent. [44]. The results were displayed in a table for the chosen plants' separate extracts. 10 and for outcomes from polyherbal extract.

Determination of total flavonoid content
Total flavonoid content by Total flavonoid content was determined by aluminium chloride method compare with the Rutin as standard [45] .

RESULTS AND DISCUSSION

With regard to chemical tsets and chromatographic methods, the results of a phytochemical examination showed the existence of saponins, tannins, flavonoids alkaloids, carbohydrates, and phenolic substances. The *Polygonum glabrum*, *Canthium dicoccum*, and *Ochna obtusata* herbal powder blend provides a number of essential primary and secondary

metabolites for the pharmaceutical industry. The current work is helpful for making multi-herbal medicines, but more research is needed to identify the specific bioactive chemicals that are present in the combination and their functions. Ethanol is a better solvent from an extractive standpoint, generating a greater yield and having a fair level of total phenol and total flavonoid content.

In vitro Anti-Oxidant Activity of Selected Plants

DPPH Radical Scavenging Assay: According to Chang et al., the DPPH assay was used to assess the radical scavenging activity of various extracts (2001). [46-47] At 517 nm, the reduction in DPPH solution absorption following the addition of an antioxidant was observed. As a reference, ascorbic acid (10 mg/ml DMSO) was employed. Results for each plant extract were displayed in a table. [15–18] and a table showing the anti-oxidant effectiveness of ethanolic fractionated formulations F1–F5 [24]. The following formulas were used to compute the % inhibitory activity: $[A_0 - A_1/ A_0] \times 100$ = DPPH Scavenging activity (%). A_0 represents the absorbance of the control reaction, and A_1 represents the absorbance when an extract sample is present.

Hydrogen Peroxide Scavenging Assay

According to a procedure described by Long et al. in 1999 [48–50], this activity was assessed by measuring the absorbance at 230 nm in comparison to a blank solution made out of phosphate buffer without hydrogen peroxide. Each sample was processed, analyzed, and averaged three times. The equations below were used to calculate the antioxidant activity, and the results for each plant extract are shown in the table[19-22]. A_c is the absorbance of the control reaction, and A_s is the absorbance in the presence of the sample. Scavenged $[H_2O_2 = [A_c - A_s/ A_c] \times 100\ A_c$. Activity of nitric oxide to scavenge free radicals . Nitric oxide scavenging activity can be estimated by the use of Griess IIIosvoy reaction (Garrat, 1964) after the incubation period; 0.5 ml of Griess reagent (1% sulfanilamide, 2% H_3PO_4 and 0.1% N-(1-naphthyl) ethylenediamine dihydrochloride) was added..

Results of *In-vitro* antioxidant activity of selected four plants
Evaluation of polyherbal's *In-vitro* anti-arthritis of ethanolic extract.
Bovine serum-based protein denaturation inhibition technique [46-48]

Experimental technique Using 1N HCl, the pH of all the aforementioned solutions was brought to 6.3. The samples were incubated for 20 minutes at 37 °C, after which the temperature was raised for 3 minutes to maintain the samples at 57 °C. The aforementioned solutions received 2.5 ml of phosphate buffer after chilling. At 416 nm, a UV-Visible spectrophotometer was used to detect the absorbance. Formula: Percentage inhibition = [100-(optical density of test solution - optical density of product control) (optical density of test control)] 100; used to determine the percentage inhibition of protein denaturation. Utilizing egg albumin as a tool to prevent protein denaturation[39-41]. The standard solution was made using 0.2 ml of fresh hen's egg albumin, 2.8 ml of pH-6.4 phosphate buffered saline, and 2 ml of different concentrations of diclofenac sodium solution (i.e., 10, 50, 100, 200, 400, 800, and 1000 g/ml). Building the test solution: A total of 2.8 ml of phosphate buffered saline (pH 6.4), 0.2 ml of fresh hen's egg albumin, and 2 ml of various concentrations (i.e., 10, 50, 100, 200, 400, 800, and 1000 g/ml) were used to create the test solutions, which totaled 5 ml. The test control solution was created by mixing 0.2 mL of fresh hen's egg albumin with 2.8 mL of phosphate buffered saline (pH 6.4) and 2 mL of distilled water. Experimental protocol: All of the aforementioned solutions were heated for five minutes at 70°C after 15 minutes of incubation at 37 2°C in an incubator. Their absorbance was measured at 660 nm after cooling, using a vehicle as a reference. The following equation was used to determine the % inhibition of protein denaturation: The formula for percentage inhibition is [100-(optical density of test solution - optical density of product control)]/(optical density of test control)/(optical density of test control)/100. 0.2 mL of fresh hen's egg albumin was combined with 2.8 mL of phosphate buffered saline (pH 6.4), 2 mL of distilled water, and 0.2 mL of fresh hen's egg albumin to make the test control solution. Experimental technique After 15 minutes of incubation at 37 2°C in an incubator, all of the aforementioned solutions were heated for five minutes at 70°C. After cooling, their absorbance was assessed at 660 nm using a vehicle as a standard. The percentage inhibition of protein denaturation was calculated using the formula below: [100-(optical density of test solution - optical density of product control)] / (optical density of test control)/(optical density of test control)/100 is the formula for percentage inhibition. The test mixtures were all centrifuged at a speed of 3,000 rpm

after 30 minutes of incubation at 37 °C. The supernatant liquid was drained out, and a UV spectrophotometer set at 560 nm assessed the amount of hemoglobin present. The following formula was used to determine the fraction of the human red blood cell membrane that was stabilized or protected from hypotonicity-induced hemolysis: Percentage protection is equal to 100 minus [(optical density control/optical density sample) / 100]. Scavenging percentage is equal to 100 times [control absorbance minus test sample absorbance].

RESULTS

The ethanolic extracts of *P. glabrum, C. dicoccum,* and *O. obtusata* are combined into five formulations, each with a different portion, and their in vitro anti-arthritis activity is assessed at concentrations ranging from 10 g/ml to 800 g/ml using the *in vitro* inhibition of protein denaturation method using bovine serum, the in vitro inhibition of protein denaturation method using egg albumin, and According to the results above, the F2 and F4 formulations have much more potential and have anti-arthritic effectiveness than other polyherbal formulations with varied concentrations. Further investigation is required to use the two formulations in the treatment of rheumatoid arthritis.hence this two formulations are evaluated by *in vivo* methods two see its potentiality.

Evaluation of *In- vivo* Rheumatoid Arthritic Activity of Polyherbal Formulations
In the previous studies, we have investigated for the above plants with in vitro anti-rheumatoid activity of same formulations. In this study, we attempted in vivo evaluation studies for anti-RA.

Formulation and evaluation capsules containing polyherbal ethanolic extract of selected indian traditional plants used for anti- rheumatoid activity preparation of polyherbal granules:
By using the wet granulation process, polyherbal granules were created. The poly herbal extract was thoroughly combined with lactose monohydrate, added the necessary amount of starch to create a smooth mass, and then run through a # 12 filter to create granules. Granules that had been prepared were gently dried in an oven at around 60 degrees. To get granules of the same size, dried granules were run through a # 16/44 filter. Divide the penalties. Granules and 15% of the fines were combined, and the necessary amounts of talc and magnesium stearate were added to the remaining excipients. Additionally, granules with Croscarmellose Sodium (CCS) as a super disintegrant were created. After adding lactose to the extract, CCS were added separately in varying amounts (3%, 4%, and 5% with regard to average weight), and granulations were done in a way similar to that described before. quantities for formulation trails [73-76].

Formulation of Polyherbal Capsules
Using a hand-operated capsule filling machine, prepared granules were packed into firm gelatin capsules (size 2) such that each capsule contained 300 mg of granules. For formulation trials, polyherbal capsules without CCS were labeled as F1 while capsules with 3%, 4%, and 5% of CCS were labeled as F2, F3, and F4, respectively.

Evaluation of Polyherbal Capsules:
The above-formulated capsules are assessed based on pharmacopeial criteria and a number of different factors, including estimated drug content, weight uniformity, and disintegration time.

In-vitro **dissolution study of capsules**: **Formulation of Polyherbal capsules**: Using a manually operated capsule filling machine, prepared granules were placed into firm gelatin capsules (size 3), each containing 300 mg of granules. For formulation trials, polyherbal capsules without CCS were labeled as F1 while capsules with 3%, 4%, and 5% of CCS were labeled as F2, F3, and F4, respectively. Evaluation of the *in vivo* rheumatoid arthritic activity of a formula capsule with various portions Selected potent Indian herbs were used to create polyherbal ethanol from them. Chemicals and drugs [48–50] Turpentine oil (Uni-Chem, Germany), Diclofenac sodium (Sigma-Aldrich, USA), Ethanol (Sigma-Aldrich, USA), complete Freund's adjuvant (Sigma-Aldrich, USA), and formaldehyde (VWR, International Ltd, England). Swiss Albino rats of either sex, weighing between 200 and 300 g, were employed as test

subjects. The rats were kept in normal housing with a 12 hour cycle of light and darkness, relative humidity of 55%, and temperatures between 23 and 25°C. They were given a conventional pellet diet and unlimited access to water. The experiment was planned and carried out in accordance with CPSCEA's ethical committee's standards and was given their blessing (1987/PO/Re/S/17/CPCSEA). Adjuvant for Freund's complete Rats with Induced Arthritis.
Following are the divisions made into seven groups of six male Wistar rats apiece.
Group I: Standard management
Group II: Management of arthritis
F1 Capsule, Group III
F4 capsules, Group IV
Diclofenac sodium (10 mg/kg) is in Group VII. The intensity of the inflammation is indicated by an increase in the amount of erythema and edema in the tissues. At the appropriate frequent intervals, the change in body weight and paw edema were observed. Every value is displayed as mean S.E.M. One-way analysis of variance (ANOVA) and Dunnett's test were used in the statistical study. In comparison to the control group, p0.05 and P0.001 were deemed statistically significant and highly significant, respectively.

SUMMARY AND CONCLUSSION

Results from a phytochemical analysis using chromatographic methods and chemical testing showed the presence of saponins, tannins, flavonoids, alkaloids, carbohydrates, and phenolic compounds. The Polygonum glabrum, Canthium dicoccum, and Ochna obtusata herbal powder blend provides a number of essential primary and secondary metabolites for the pharmaceutical industry. As a consequence, the poly herbal formulation F2, which contains Polygonum glabrum, Canthium dicoccum, and Ochna obtusataand in the ratios of 2, 1, and 1, has superior antioxidative properties and a higher flavonoid content. Therefore, further research to determine the precise pharmacological actions can be employed with this polyherbal formulation of ethanolic extract. According to in vitro anti-arthritis research, various concentrations of herbal formulations exhibit anti-arthritic action, with F2 and F4 having much higher potential. . The two formulations need to be studied further before they can be used to treat rheumatoid arthritis. In the current experimental study, the groups that received the herbal formulation had noticeably higher levels of hemoglobin (Hb) and red blood cells (RBC), while WBC and platelets had levels that were noticeably lower than those of the arthritic control group but similar to those of the normal control group. ESR serves as a crucial hematological marker for both the diagnosis and prognosis of inflammatory and viral illnesses. Its fractions significantly lowered ESR count in arthritic rats as compared to the usual medication and herbal therapy, demonstrating its importance in arthritic conditions. Key serologic marker rheumatoid factor (RF) is an autoantibody that targets the Fc region of immunoglobulin G. and creates immunological complexes that aid in the development of RA. When arthritic rats were given a precise dosage of polyherbal extract, the amount of RF in their blood was dramatically reduced, revealing the preventive effect against RA. Based on these hematological results, it can be hypothesized that B. calliobotrys shifts the abnormalities in blood parameters back toward normal by inhibiting the inflammatory response, which may be caused by its blocking action on pro-inflammatory cytokines and the COX enzyme as well as by suppressing the immune response, as suggested by previous studies. The composition of the capsules having The polyherbal capsule formulation F4 had favorable physical characteristics in terms of disintegration, hardness, and dissolving rate, according to the results. After a comparison of several formulations with various excipients came to the conclusion that Croscaramellose To treat rheumatoid arthritis, salt 15 mg (5%) is more suited and therapeutically more advantageous. The polyherbal extract formulations dramatically (p 0.001) decreased joint and paw swelling and significantly improved body weight, hematological profile, and parameters in complete Freund's adjuvant-induced arthritis models. It is possible to draw the conclusion that the ethanolic extract of two separate formulations has the potential to be anti-arthritic, confirming its long-standing usage in the treatment of rheumatoid arthritis.

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Table.1 Preliminary phytochemicals screening of Polygonum glabrum

Sl. No	Test	PEE	EAE	ALE	AE
1	CARBOHYDRATES	-	+	+	+
2	GLYCOSIDES	+	+	+	+
3	SAPONINS	++	+	++	+
4	ALKALOIDS	++	+	+	++
5	PROTEINS AND AMINO ACIDS	++	++	+	+
6	PHYTOSTEROLS AND TRITERPENOIDS	++	+	++	+
7	PHENOLIC COMPOUNDS & TANNINS	++	+	+++	++

Table 2   Preliminary phytochemicals of *Canthium dicoccum*

Sl. No	Test	PEE	EAE	ALE	AE
1	CARBOHYDRATES:	+	+	+	++
2	GLYCOSIDES	++	+	+	+
3	SAPONINS	++	+	+++	++
4	ALKALOIDS	++	+	++	-
5	PROTEINS AND AMINO ACIDS	+	+	+	+
6	PHYTOSTEROLS AND TRITERPENOIDS	+	+	++	+
7	PHENOLIC COMPOUNDS AND TANNINS	+	+	++	+

Table . 3 Preliminary phytochemicals *Ochnao btusata*

Sl. No	Test	PEE	EAE	ALE	AE
1	CARBOHYDRATES:	+	+	-	+
2	GLYCOSIDES	++	+	+	+
3	SAPONINS	+	+	++	+
4	ALKALOIDS	+	+	++	-
5	PROTEINS AND AMINO ACIDS	+	+	+	+
6	PHYTOSTEROLS AND TRITERPENOIDS	+	+	+	++
7	PHENOLICs, TANNINS	+	+	+	+

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Solvent	Method of extraction	Physical Nature	Color	Yield (% w/w)
Petroleum ether	Continuous Hot Percolation	Semi solid	Brownish	3.78
Ethyl acetate		Semisolid	Dark brown	5.78
Ethanol		Solid	Brownish	8.56
Aqueous	Maceration	Solid	Dark brown	5.76

Table. 4. Extractive values of *Canthium dicoccum* Petroleum Ether Extract, Ethyl Acetate Extract, and Aqueous Extract

Solvent	Method ofextraction	Physical Nature	Color	Yield(% w/w)
Petroleum ether	Continuous Hot Percolation	Semi solid	Brownish	3.58
Ethyl acetate		Semisolid	Dark brown	3.78
Ethanol		Solid	Brownish	8.56
Aqueous	Maceration	Solid	Dark brown	5.76

Table . 5 Extractive values of *Ochnao btusata* Petroleum Ether Extract, Ethyl Acetate Extract, and Aqueous Extract

Solvent	Method of extraction	Physical Nature	Color
Petroleum ether	Continuous Hot Percolation	Semi solid	brownish
Ethyl acetate	Continuous Hot Percolation	Semisolid	Dark brown
Ethanol	Continuous Hot Percolation	Solid	Brownish
Aqueous	Maceration	Solid	Dark brown

Table. 6 Rf values of TLC with respect to Different extracts of Selected mixed Herbal extract using different solvent systems

S.no	Extract	SOLVENT I		SOLVENT II		SOLVENT III		SOLVENT IV		SOLVENT V	
		No of spots	Rf Values	No of spots	Rf values	No of spots	Rf values	No of spots	Rf values	No of spots	Rf Values
1	Hexane	3	0.20 0.36 0.52	1	0.90	1	0.90	2	0.07 0.81	3	0.09 0.81 0.94
2	Chloroform	2	0.14 0.40	3	0.10 0.82 0.90	2	0.05 0.90	2	0.09 0.78	2	0.18 0.94
3	Ethyl acetate	2	0.16	2	0.82 0.90	1	0.85	2	0.07 0.81	2	0.03 0.94
4	Ethanol	2	0.44	1	0.82	2	0.05 0.90	2	0.03 0.81	2	0.09 0.80
5	Methanol	1	0.10	1	0.92	4	0.05 0.25 0.80 0.90	2	0.10 0.81	2	0.09 0.81

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Table 7 Estimation of Total phenol content of *Polygonum glabrum, Canthium dicoccum, Ochnao btusata,* in extracts Petroleum ether, Ethyl acetate, Ethanol, Aqueous.

S.No	solvent	*Polygonum glabrum*	*Canthiumdicoccum*	*Ochnao btusata*
1	Petroleum ether	13.16±0.554	8.06±0.098	4.13±0.042
2	Ethyl acetate	13.16±0.554	2.46±0.098	1.73±0.111
3	Ethanol	14.33±0.042	15.5±0.068	15.16±0.061
4	Aqueous	1.5±0.068	1.5±0.229	1.53±0.240

Table. 8 Estimation of total flavonoids content of *Polygonum glabrum,Canthiumdicoccum, Ochnao btusata,* in extracts Petroleum ether, Ethyl acetate, Ethanol, Aqueous

S.No	Solvent	*Polygonzum glabrum*	*Canthium dicoccum*	*Ochnao btusata*
1	Petroleumether	0.116	0.266	0.15
2	Ethyl acetate	0.566	0.291	0.241
3	Ethanol	1.1	1.525	1.316
4	Aqueous	1.4	1.44	1.033

Table. 9 Percentage of Herbal powder mixture using different extracts

S.No	Formulations	Total phenolic content of Ethanolic extract	Total flavanoid content of Ethanolic extract
1	F1	9.13±0.554	0.166
2	F2	16.26±0.554	2.453
3	F3	10.33±0.042	1.232
4	F4	12.52±0.068	1.652
5	F5	8.96±0.554	0.812

Results of *In-vitro* antioxidant activity of selected four plants

Table.10 Antioxidant activity of Canthiumdicoccum using DPPH- scavenging model

Concentration (µg/ml)	Ascorbic acid	% Antioxidant activity Canthiumdicoccum			
		PEE	EE	ALE	AE
10	9	9.4	10.8	10.2	8.4
20	22.4	19.5	22.6	21.4	19.6
40	40.2	40.8	43.6	42.2	39.8
60	59.6	59.4	61.2	58.8	56.2
80	79.4	78.6	81.4	79.2	76.9
100	97.8	96.1	98.2	96.9	97.8

Table.11 Antioxidant activity of Ochnao btusata *using DPPH- scavenging model*

Concentration (µg/ml)	Ascorbic acid	% Antioxidant activity Ochnao btusata			
		PEE	EE	ALE	AE
10	9	9.2	10.6	9.8	9.4
20	22.1	23.5	23.6	22.6	19.6
40	42.2	41.8	43.8	41.2	39.8
60	58.6	58.8	61.6	61.2	58.8
80	77.4	79.2	81.8	76.2	78.6
100	94.8	93.8	99.6	98.4	98.2

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Table 12. Inhibition of protein denaturation method using bovine serum

Conc µg/ml	Standard solution	F1	F2	F3	F4	F5
10	51.92±0.4	37.12±0.4	44.82±0.24	34.22±0.12	39.36±0.34	32.29±0.2
50	57.81±0.5	43.24±0.6	51.91±0.3	42.91±0.24	46.18±0.4	41.92±0.4
100	63.14±0.9	49.42±0.6	54.64±0.6	45.82±0.19	69.26±0.8	43.19±0.9
200	79.12±1.5	57.12±2.5	71.24±1.3	53.64±0.9	61.92±1.4	52.28±1.5
400	85.46±0.8	65.46±0.4	78.36±0.6	67.74±0.25	64.82±0.6	61.42±0.5
800	92.16±0.9	74.24±0.2	84.29±0.9	72.92±0.16	76.19±0.8	68.26±0.3
1000	94.28±1.0	81.26±0.5	89.16±0.6	79.29±0.24	82.28±0.28	78.18±1.5

% Inhibition of Protein Denaturation using bovine serum

Table.13. Inhibition of protein denaturation method using egg albumin

Conc./ml	Stad. solution	F1	F2	F3	F4	F5
10	52.32±0.8	46.12±0.25	49.42±0.24	42.12±0.5	46.89±0.5	43.42±0.46
50	58.24±0.6	48.24±0.62	53.91±0.3	44.24±0.2	49.12±0.12	45.36±0.42
100	65.04±1.2	51.42±0.24	57.64±0.6	48.42±0.4	52.22±0.4	48.32±0.15
200	73.24±1.4	56.12±2.5	69.24±1.3	51.12±1.5	58.25±2.15	52.22±0.4
400	76.08±1.18	63.46±0.4	74.36±0.6	59.46±1.4	64.14±0.41	62.36±0.6
800	79.16±1.5	72.24±0.2	76.29±0.9	68.24±1.2	73.43±0.12	69.34±0.25
1000	86.14±1.2	79.26±0.5	83.16±0.6	74.26±0.5	81.12±0.15	72.84±0.6

% Inhibition of Protein Denaturation using egg albumin

Table 14. HRBC membrane stabilization method

Conc. µg/ml	Standard solution	F1	F2	F3	F4	F5
10	56.92±0.4	41.56±0.46	44.56±1.2	39.56±0.4	39.96±0.14	38.56±0.2
50	62.81±0.5	49.21±0.42	51.21±1.5	45.21±0.6	50.21±1.3	43.21±0.6
100	89.14±0.9	82.13±1.3	84.13±0.9	82.13±0.25	81.13±1.6	81.13±0.4
200	91.59±1.5	85.14±0.2	89.14±1.4	78.14±1.2	84.14±1.2	72.14±1.2
400	94.26±0.8	89.46±1.4	92.46±0.4	84.46±0.6	86.46±0.9	81.46±1.6
800	96.59±0.9	90.49±1.2	94.49±0.5	89.49±1.3	92.49±0.5	89.49±1.3
1000	98.98±1.0	92.98±0.25	96.98±0.26	93.98±0.4	93.98±0.6	91.98±1.6

% HRBC membrane stabilization

Table 15. Results for Acute Non immunological Formaldehyde-Induced Arthritis in Rats.

S.No	Group	Treatment	Days			
			1	5	10	15
1	GROUP I	Normal control	4.3 ± 0.1a	4.5 ± 0.2a	4.4 ± 0.1a	4.6 ± 0.1a
2	GROUP II	Arthritic control	7.6 ± 0.0	16.6 ± 0.0	22.5 ± 0.0	25.7 ± 0.0
3	GROUP III	Polyherbal formulation1 (400 mg/kg)	5.8 ± 0.0a	7.3 ± 0.0a	6.5 ± 0.0a	5.35± 0.0a
4	GROUP IV	Polyherbal formulation 1 (800 mg/kg)	5.8 ± 0.0a	7.5 ± 0.0a	6.7 ± 0.0a	5.5± 0.0a

Effect of Paw Edema

5	GROUP V	Polyherbal formulation2 (400 mg/kg)	5.7 ± 0.0a	6.9 ± 0.0a	5.9 ± 0.0a	4.8 ± 0.0a
6	GROUP VI	Polyherbal formulation2 (800 mg/kg)	5.9 ± 0.0a	7.1 ± 0.0a	6.2 ± 0.0a	4.9 ± 0.0a
7	GROUP VII	Diclofenac sodium (10 mg/kg).	6.1 ± 0.0a	7.4 ± 0.0a	6.5 ± 0.0a	5.9 ± 0.0a

Table. 16. Results for Complete Freund's adjuvant Induced Arthritis in Rats

S.no	Group	Treatment	Hematological parameters in arthritic rats					
			Hb (g/dl)	Rbcs $10^6/\mu l$	Wbcs $10^3/\mu l$	Platelets $10^3/\mu l$	Esr mm/1st hr	Rf iu/ml
1	GROUP I	Normal control	14.2 ± 0.2a	7.4 ± 0.2a	5.2 ± 0.1a	311 ± 3.2a	3.0 ± 0.5a	14 ± 0.0a
2	GROUP II	Arthritic control	9.3 ± 0.1	4.9 ± 0.0	9.4 ± 0.2	1225 ± 105.3	20.3 ± 0.8	48.3 ± 2.0
3	GROUP III	Polyherbal formulation1 (400 mg/kg)	12.6 ± 0.1a	6.7 ± 0.1a	7.7 ± 0.2a	454.3 ± 18.7a	13.3 ± 0.8a	26.0 ± 1.1a
4	GROUP IV	Polyherbal formulation 1 (800 mg/kg)	12.8 ± 0.1a	6.9 ± 0.1a	7.9 ± 0.2a	456.3 ± 18.7a	15.3 ± 0.8a	28.0 ± 1.1a
5	GROUP V	Polyherbal formulation2 (400 mg/kg)	15.3 ± 0.1a	7.1 ± 0.0a	6.6 ± 0.2a	408.3 ± 4.1a	9.8 ± 0.8a	21.3 ± 1.7a
6	GROUP VI	Polyherbal formulation2 (800 mg/kg)	15.5 ± 0.1a	7.3 ± 0.0a	6.8 ± 0.2a	410.3 ± 4.1a	9.9 ± 0.8a	23.2 ± 1.7a
7	GROUP VII	Diclofenac sodium (10 mg/kg).	12.8 ± 0.1a	6.9 ± 0.1a	7.9 ± 0.2a	734.3 ± 4.6a	12.5 ± 1.2a	25.5 ± 2.3a

Table.17. Formulae Polyherbal Capsule Preparation

S.NO	NAME OF THE INGREDIENT	QUANTITY			
		F_1	F_2	F_3	F_4
1	HERBAL EXTRACT	25	25	25	25
2	Lactose mono hydrate	227	218	215	212
3	Starch Paste	30	30	30	30
4	Croscaramellose sodium	-	9	12	15
5	Talc	9	9	9	9
6	Magnesium stearate	9	9	9	9
	Total	300	300	300	300

Table 18. Evaluations of Polyherbal Granules

Evaluation Parameters					
	Angle of Repose (°)	Carrs Index (%)	Drug Content (%)	Disintegration Time(Min)	Weight variation
F_1	30.25±0.06	16.43±0.03	88.70±0.1	17.03±0.1	295.8±0.12
F_2	21.12±0.02	12.30±0.01	88.65±0.5	12.21±0.1	294.6±0.09
F_3	23.01±0.05	15.67±0.02	88.41±0.3	11.21±0.4	295.2±0.12
F_4	20.02±0.03	12.01±0.01	89.08±0.3	9.23±0.4	294±0.06

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Table 19. % Cumulative Drug Release

S.NO	Time (Hours)	% Cumulative Drug Release			
		F_1	F_2	F_3	F_4
1	0	0	0	0	0
2	0.25	3.60	7.01	9.32	11.23
3	0.5	10.81	15.23	18.21	21.25
4	1	12.32	33.25	28.90	48.20
5	1.5	15.81	52.12	50.10	60.29
6	2	15.89	55.15	62.32	67.25
7	3	16.01	60.90	69.21	75.20
8	4	17.28	73.21	80.09	80.21
9	6	18.29	81.18	85.22	85.29
10	8	31.86	85.21	87.39	94.25
11	12	52.86	85.90	88.88	98.99

Table. 20 Cage Observations

S. No.	Parameters	Observations(2000 mg/kg)
1	Condition of fur	Normal
2	Skin	Normal
3	Subcutaneous swelling	Nil
4	Eyes dullness	Nil
5	Eyes opacities	Nil
6	Color and consistency of faeces	Normal
7	Condition of teeth	Normal
8	Breathing abnormalities	Nil

Table. 21 Mean Body Weight and Percentage Body Weight Gain

Group	Dose (mg/kg body wt)	Body weight		% body wt gain	Body weight	% body wt gain	% body wt gain
		Day 1	Day 7	Day 1-7	Day 14	Day7-14	Day 1-14
Control	-	22.47	23.69	5.43%	25.62	8.14%	14.02%
I	2000	22.85	24.44	6.96%	26.25	7.40%	14.87%

Table. 22 Mortality Record

Group	Dose(mg/kg body wt)	Mortality	
		Male	Female
I	2000	0/3	0/3

Table 22.Results for Complete Freund's adjuvant Induced Arthritis in Rats for selected capsules formulations (F4)

		Effect of Paw Edema				
S.No	Group	Treatment	DAYS			
			1	5	10	15
1	Group I	Normal control	4.3 ± 0.1a	4.5 ± 0.2a	4.4 ± 0.1a	4.6 ± 0.1a
2	Group II	Arthritic control	7.6 ± 0.0	16.6 ± 0.0	22.5 ± 0.0	25.7 ± 0.0
3	Group III	F4(PGEE,CDEE,OBEE AND ANEE (2:1:1:1))	5.45 ± 0.0a	6.93 ± 0.0a	6.2 ± 0.0a	4.85± 0.0a
4	Group IV	F4(PGEE,CDEE,OBEE AND ANEE	5.62 ± 0.0a	6.85 ± 0.0a	6.3 ± 0.0a	4.23± 0.0a

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		(1:1:2:1))				
5	Group V	Diclofenac sodium (10 mg/kg).	6.1 ± 0.0a	7.4 ± 0.0a	6.5 ± 0.0a	5.9 ± 0.0a

Values are expressed as mean ± S.E.M; n=3; One-way ANOVA followed by Dunnett's test used and $p < 0.05$ was considered as significant when compared with arthritic control group where b = $p < 0.01$, a = $p < 0.001$

Table. 23 Results for hematological parameters in arthritic rats

S. No	Group	Treatment	hematological parameters in arthritic rats					
			Hb (g/dL)	RBCs 10^6/μL	WBCs 10^3/μL	Platelets 10^3/μL	ESR mm/1st hr	RF IU/mL
1	Group I	Normal control	14.2±0.2a	7.4±0.2a	5.2± .1a	311±3.2a	3.0±0.5a	14 ± 0.0a
2	Group II	Arthritic control	9.3 ± 0.1	4.9± 0.0	9.4± 0.2	1225±105.3	20.3±0.8	48.3± 2.0
3	Group III	F4	10.6±0.1a	5.7±0.1a	7.7±0.2a	454.3±18.7a	13.3±0.8a	26.0±1.1a
4	Group IV	F4	12.8±0.1a	6.9±0.1a	7.9±0.2a	456.3±18.7a	15.3±0.8a	28.0±1.1a
5	Group V	Diclofenac sodium (10 mg/kg)	12.8±0.1a	6.9±0.1a	7.9±0.2a	734.3± 4.6a	12.5±1.2a	25.5±2.3a

Encrypting Images using Huffman Encoding Algorithm in DCT and DWT

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ABSTRACT

As there is rapid growth of multimedia and the rate at which it is getting transmitted over the network, therefore there is an utmost need to secure the information which is being sent over the network so that no one else other than the intended party should be able to retrieve that data. In this paper we are performing encryption on the images which has been watermarked by the help of svd function, both in the case of DCT and DWT. Also the time taken for the image to get encrypted is noted with the help of tic & toc function of MATLAB.

Keywords: Huffman Encoding, DCT , DWT, svd.

INTRODUCTION

Cryptography is a technique to provide message confidentiality. It's a Greek word which means Secret Writing. It involves the process of encryption and decryption. Cryptography is implemented with the help of Cryptosystem. A Cryptosystem consists of 5 keywords, E is an Encryption algorithm, D is the Decryption algorithm, M is the set of plaintexts, K is the set of keys and C is the se of Cipher text.

Literature Review

Authors [1] Ambika Oad, Himanshu Yadav, Anurag Jain had studied many important encryption techniques with the other encryption algorithms used in encrypting the image which has been transferred over network, and they concluded that every algorithms has its own advantages and disadvantages, it depends on the techniques which have been applied on the images. They also concluded that image encryption provides a way to hide the important stuff so that no intruder can access those information which is open in the network when it is being sent. Authors [2] Rajinder Kaur, Er.Kanwalprit Singh, based on their study drawn the conclusion that in order to protect the various multimedia we need to use Chaos- Based Algorithm. Compressed and more complex algorithms should be used to

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secure the system even further advance level or more modified level of various algorithms can be used to make the system more secure and impenetrable. Authors [3] studied various Image Encryption Methods like Position Permutation Based Algorithm Value Transformation Based Algorithm Position-substitution Based Algorithm, and concluded that there were many problems related to the encryption and decryption algorithms which previously existed. Many of them were based on Scrambling Algorithms pixels gets changed .the encryption scheme could encrypt the image but couldn't change the histogram of the image. As a result of which security performances were very poor. Also there didn't exist even a single algorithm which could explain the changing of pixel position and gray level changing effect. Authors [4] Jyoti A. Patil, Dipali M. Lohar, Prachi M. Badgujar, Dipmala V. Patil studied the different image compression techniques and found out that lossless image compression techniques are far more effective then lossy compression techniques which were being used. But, lossy Compression provides a higher compression ratio over the lossless compression. And also, by using Huffman Encoding images is getting compressed by 40 percent as compared to other encryption techniques.

METHODOLOGY

Encryption process for DCT and DWT
Step 1: Storing the values of rows, columns, and channel of the watermarked invariables (m, n, & ch)
Step 2: Calling first sub process to generate a matrix having keys equal to the size of the resized image (200 X 300)
Step 3: Storing the value returned from the first sub process in a variable named as key.
Step 4: Calling second sub process to start the encryption process.
Step 5: Passing the parameters such as the input image, key matrix and a static key.
Step 6: Grouping the values of key matrix in a column format to create another matrix named as Akey.
Step 7: Performing the encryption process with the help of bitxor function to get encrypted matrix for each channel(R G B) and placing a static key at any one place in any of the three channel matrix.
Step 8: Displaying the encrypted image.

Process begins with storing the watermarked image size in variables m, n & ch where, m denotes no. of columns n denotes no of rows ch denotes no. of channels. Passing the values of variable m & n to Sub_1 function. Each bit of the pixel is considered that is all the 8 bits, since we are taking 'unit8' as the data format, and for all 8 bits one equivalent key is being generated. By doing this we will have a matrix having 60000 keys. (i.e matrix having 200 x 300 = 60,000 keys). The matrix then generated is stored in variable names as "key". Then we are calling the 2nd sub - process where the actual encryption is taking place, this sub - process is getting the parameters (i).Input Image (ii) Key Matrix (iii) Static Key Then grouping the values of key matrix (200 values = no. of rows) in a column format to create another matrix named as A key which will have the same dimension (200 x 300=60000). Taking the advantage of XOR truth table.

RESULT

Figure.1.Selecting Images from D1 and D2. Figure 2. Input Image1 (Original) and Image2 (Message). Figure 3. Encrypted Image formed and then saving it with the name 'Data'. Figure 4. Saved Encrypted image in the folder named as 'Secret'.

CONCLUSION

In this paper we have attempted to encrypt the watermarked image by using Huffman encoding algorithm for images. A matrix was generated in 1st sub- process which was having the key values equal to the number of values of the size of the resized image(i.e 60,000 keys).Then the same matrix along with a static key was used further to secure the image further in encryption process in which encrypted matrices were being created for each channel i.e red, green and blue by performing bitxor function of the key matrix with all the three channels one by one and at the

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last a static key was put in one of the channel matrix to further enhance the security , since only the sender knows where (position/location) he/she had put that key and can be given to receiver so that he/she can easily decrypt that image. In future we would like to encrypt the watermarked image by using various other encryption algorithms like RSA algorithm, DES, Triple DES, Blowfish, Two fish, AES algorithm. Also an attempt can be done to use combinations of the above said algorithms (two algorithms at a time) to make the encryption process even stronger. Other enhancement which can be done is that , instead of using a static key a function can be used which will generate a number on a random basis each and every time the image is getting encrypted, which will indeed increase the security of the image which is been encrypted.

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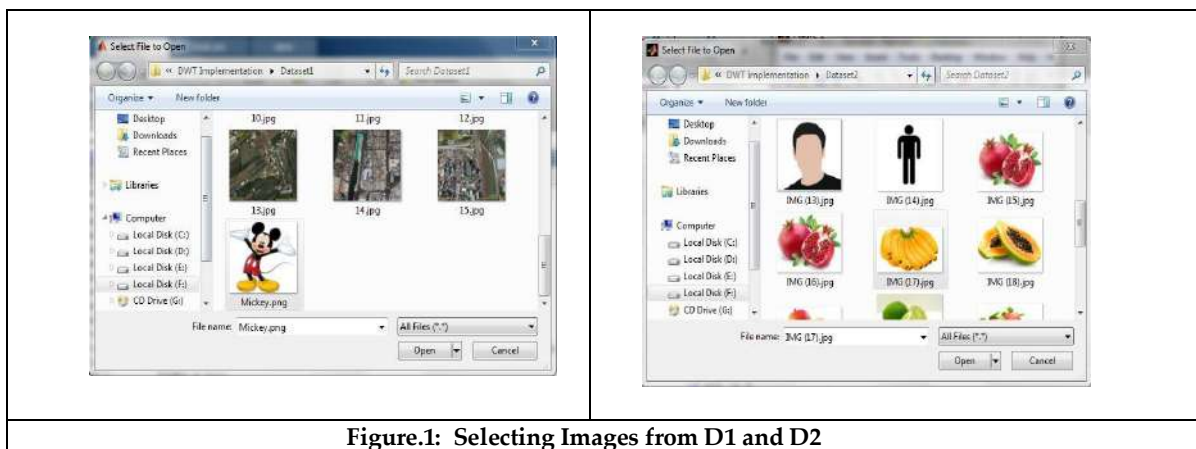
Figure.1: Selecting Images from D1 and D2

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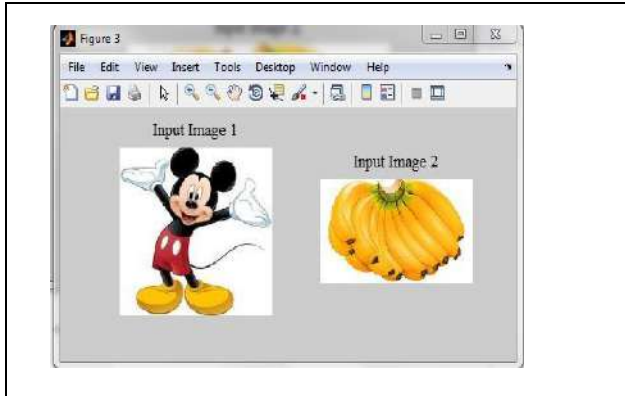
Figure.2: Input Image1 (Original) and Image2 (Message).	Figure.3: Encrypted Image formed and then saving it with the name 'Data'
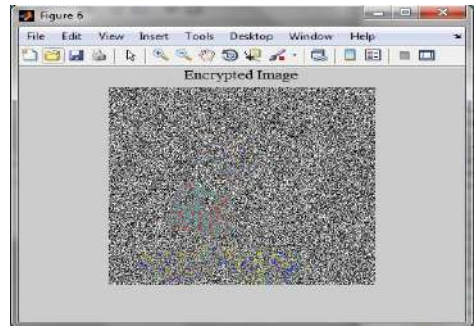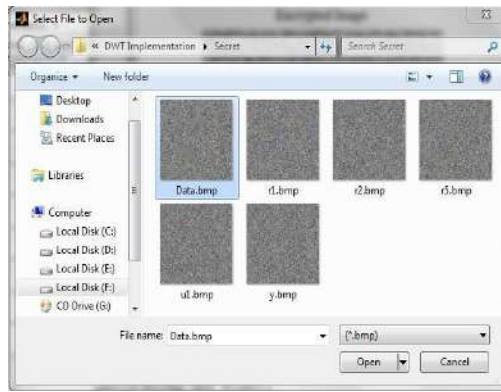
Figure.4: Saved Encrypted image in the folder named as 'Secret'.

MIC-αIg and MIC-Igα Closed Sets in Micro Ideal Topological Spaces

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ABSTRACT

In this Study Paper, we introduce the concept of MICR-α-I gene -C (X) (closed sets) and MICR-I-gene-α-C(X) in MITS and discussed classification of characters and Structures of MICR- α-I-gene-C(X) in MITS.

Keywords: MICR-Igene-C(X)(Closed Sets),MICR-I$\overline{gene}$-C(X), MICR- α-I-gene – C(X),MICR-I-gene-α-C(X), MICR-b-I-C(X).

INTRODUCTION

The Idea of ITS (Ideal Topological Space) was introduced by Kuratowski [1] in 1933 and Vaidyanathswamy [3] in 1944. In 1988 Hamlett and Jankovic [2] introduced generalization in some of the most important buildings in ITS. In 2019 S.Chandrasekar [4] introduced Microtopology. S.Ganesan [5] has introduced a new concept of Micro topological space through small systems, MIC-I-gene-C (X) was introduced by S.Selvaraj Ganesan [7] .In 2018 S. Chandrasekar, G.Swathi [6] proposed a route to MIC-α-O (X).S. Maragathavalli and D.Vododine [8] initiated by α-gene-C (X) in ITS .P.Maheshwaran [9] introduced the gene- α-C(X) in relation to Ideal. In this paper Proposed Method MICR-I$\overline{gene}$-C(X), MICR- α-I-gene – C(X), MICR-I-gene-α-C(X) and MICR-b-I-C(X) at MITS and some of its structures are being investigated.

PRELIMINARIES
Explication 2.1
Start U as a set of horizontal instruments called the Universe and R as the equivalent relationship with U, which is called the relation of ignorance.

This couple (U,R)is said to be the space of enterprise. Enable X⊆U.

i) The minimum X relative to R is the set of all the details, which is set for the object divided by X relative to R and denoted by $L_R(X)$.That is,

$L_R(X) = \bigcup_{x \in U} \{R(x): R(x) \subseteq X\}$ where R(x) represents the equivalent class determined by X.

ii) The maximum X value relative to R is $U_R(X) = \bigcup_{x \in U} \{R(x): R(x) \cap X \neq \phi\}$.

iii) The boundary area of X with respect to R is a set of all objects which is intermediate or

non-X with respect to R and is defined as $B_R(X)$.That is, $B_R(X) = U_R(X) - L_R(X)$. and their complement is called micro closed sets.

Explication 2.2

(U, $\tau_R(X)$)is a Nano topological space then $\mu_R(X) = \{N \cup (N' \cap \mu) : N, N' \in \tau_R(X)\}$and called it Micro topology of $\tau_R(X)$ by μ where $\mu \notin \tau_R(X)$.

Explication 2.3

Micro topology $\mu_R(X)$ satisfies the following theories

(i)U, $\varphi \in \mu_R(X)$

(ii) A combination of any of the elements The group is $\mu_R(X)$ in $\mu_R(X)$

(iii) The intersection of parcels of any finite subdivision of $\mu_R(X)$ in $\mu_R(X)$. Also $\mu_R(X)$is called the micro topology in relation to X in U. Triplets (U, $\tau_R(X), \mu_R(X)$) are called micro topological spaces and the bases of $\mu_R(X)$ are called micro open sets and their complements are called micro closed Sets.

Explication 2.4

A subset Ʊ(ie A) of an MITS (Ŭ,NA,MICR,ID) is reveal to be

i). MICR-Clr*(MICR-Int(Ʊ))

ii). MICR-Int(MICR-Clr*(Ʊ))

iii) MICR-Clr(MICR-Int*(MICR-Clr(Ʊ))

iv) MICR-clr(Ʊ) ⊂ Ŭ if MICR-clr(Ŭ)-Ŭ∈ I whenever Ʊ ⊂Ŭ and Ŭ is MIC-α-O(X) in (Ŭ,NA,MICR).

Explication 2.5

Enable (Ŭ, NA, MICR, ID) be a MITS. A subset Ʊ of X is reveal to be MICR-I$\widehat{gene}$-C(X) if Ʊ* ⊆ Ŭ whensoever Ʊ ⊆Ŭ and Ŭ is MICR-Se-O(X).

Explication 2.6

A subset Ʊ MITS (Ŭ,NA,MICR,ID) is impart to be MICR-b-I-C(X) if MICR-clr*(MICR-Int(Ʊ)) ∪ MICR-Int(MICR-clr*(Ʊ)) ⊆ Ʊ.

Explication 2.7

Enable (Ŭ,NA,MICR,ID) be a MITS. A subset Ʊ of X is reveal to be MICR-Igene-C(X) iff MICR-clr(Ŭ)-Ŭ∈ I whensoever Ʊ ⊆Ŭ and Ŭ is MICR-O(X).

Illustration:2.8

Enable Ŭ=$\{o_1, p_1, q_1, r_1\}$ with Ŭ / R=$\{\{o_1, p_1\}, \{q_1\}, \{r\}\}$,$X_1$ =$\{o_1, p_1\}$, μ=$\{q_1\}$ and

MTS=$\{\emptyset, Ŭ, \{q_1\}, \{o_1, p_1\}, \{o_1, p_1, q_1\}\}$,ID=$\{\emptyset, o_1\}$. MICR--I-gene-

C(X)=$\{\emptyset, Ŭ, \{r_1\}, \{o_1, r_1\}, \{p_1, r_1\}, \{q_1, r_1\}, \{o_1, p_1, r_1\}, \{o_1, q_2, r_3\}, \{p_1, q_2, r_3\}, \}$.

3.MICR- α-I-gene –Closed Set

Explication 3.1

Enable (Ŭ, NA, MICR, ID) be a MTS and I be an ideal on Ŭ. A subset Ʊ of Ŭ is said to be MICR- α-I-gene-C(X) if Ʊ* ⊆ Ŭ whensoever's Ʊ ⊆Ụ(ie U) and Ụ is MICR- α-O(X).

Illustration 3.2

Enable $Ŭ=\{p_1, q_1, r_1\}$ with $Ŭ/R=\{\{p_1, r_1\},\{q_1\}\}, X_1 =\{q_1, r_1\}$, $\mu=\{r_1\}$ and MTS=$\{\emptyset, Ŭ,\{r_1\}$, $\{q_1, r_1\},\{p_1, r_1\},\{q_1\}\}$,ID=$\{\emptyset,\{p_1\}\}$ and MICR-α-I-gene-C(X)=$\{\emptyset, Ŭ,\{p_1\},\{q_1\},\{q_1, r_1\}$, $\{p_1, r_1\},\{p_1, q_1\}\}$.

Proposition 3.3

If ($Ŭ$,NA,MICR,ID) is any ID-space and $Ʊ ⊆ Ŭ$,then the ensuing are equivalent.

(i)$Ʊ$ is MICR-α -I-gene-C(X).

(ii)MICR –clr*($Ʊ$) whensoever $Ʊ ⊆ Ų$ and $Ų$ is MICR-α-O(X) in $Ŭ$.

(iii)For all $Ŭ ∈ MIC$- clr*($Ʊ$),MICR-αclr($\{Ŭ\}$) ∩ $Ʊ ≠ \emptyset$.

(iv)MICR-clr*($Ʊ$) - $Ʊ$ contains no non-empty MICR-α-C(X).

(v)MICR-$Ʊ^*$- $Ʊ$ contains no non-empty MICR-α-C(X).

Proof

(i) $\Rightarrow$ (ii) : If $Ʊ$ is MICR-α -I-gene-C(X),then MICR-$Ʊ^* ⊆ Ų$ and $Ų$ is MICR-α-O(X) in $Ŭ$ and so MICR-clr*($Ʊ$)= $Ʊ ∪$ MICR- $Ʊ^* ⊆ Ų$ whensoever $Ʊ ⊆ Ų$ and $Ų$ is MICR-α-O(X) in $Ŭ$. This proves (ii).

(ii) $\Rightarrow$ (iii) : Suppose $Ŭ ∈$ MICR- clr*($Ʊ$).If MICR-αclr($\{Ŭ\}$) ∩ $Ʊ = \emptyset$,then $Ʊ ⊆ Ų$-MICR-αclr($\{Ŭ\}$). By (ii).

(iii) $\Rightarrow$ (iv) : Suppose E ⊆ MIC-clr*($Ʊ$) – $Ʊ$, E is MICR-α-C(X) and $Ŭ∈$ E. Since E⊆$Ŭ$ - $Ʊ$ and E is MICR-α-C(X) , then $Ʊ ⊆Ŭ$ –E and so MICR- α-clr($\{Ŭ\}$) ∩ $Ʊ = \emptyset$.Since $Ŭ ∈ MICR$- clr*($Ʊ$)by (iii),MICR- α-clr($\{Ŭ\}$) ∩ $Ʊ ≠ \emptyset$.Therefore, MICR-clr*($Ʊ$)- $Ʊ$ contains no nonempty MICR-α-C(X).

(iv) $\Rightarrow$ (v) : Since MICR-clr*($Ʊ$)- $Ʊ$ = ($Ʊ ∪ Ʊ^*$) – $Ʊ$ = (($Ʊ ∪ Ʊ^*$) ∩ $Ʊ^C$= ($Ʊ ∩ Ʊ^C$) ∪ ($Ʊ^* ∩ Ʊ^C$)=$Ʊ^* ∩ Ʊ^C$ =$Ʊ^*$- $Ʊ$.Therefore, $Ʊ^*$- $Ʊ$ contains no nonempty MICR-α-C(X).

(v) $\Rightarrow$ (vi) : Enable $Ʊ ⊆ Ų$ where $Ų$ is MICR-α-O(X).Therefore $Ŭ$ -$Ų⊆Ŭ$ - $Ʊ$ and so MICR-$Ʊ^* ∩ (Ŭ$-$Ų=Ŭ – Ʊ$.Therefore MICR- $Ʊ^* ∩ (Ŭ$-$Ų) ⊆ Ʊ^*$- $Ʊ$. Since $Ʊ^*$ is always C(X), MICR-$Ʊ^* ∩ (Ŭ$ -$Ų)$ is a MICR-α-C(X) contained in $Ʊ^*$- $Ʊ$.Therefore, MICR- $Ʊ^* ∩ (Ŭ$-$Ų)= \emptyset$ and so $Ʊ^* ⊆ Ų$.Therefore, $Ʊ$ is MICR-α -I-gene-C(X).

Proposition 3.4

Each MICR-∗-C(X) is MICR-α-I-gene-C(X) yet not conversely.

Proof:

Enable $Ʊ$ be a MICR-∗-C(X), then $Ʊ^* ⊆ Ʊ$.Let $Ʊ ⊆Ų$, and $Ų$ is MICR-α-O(X).This implies $Ʊ^* ⊆Ų$. So $Ʊ$ is MICR-α -I-gene-C(X).

Illustration:3.5

Enable $Ŭ=\{e_1, f_1, g_1, h_1\}$ with $Ŭ/R=\{\{e_1, h_1\},\{f_1\},\{g_1\}\}, X_1 =\{f_1, g_1\}$, $\mu=\{h_1\}$ and MTS= $\{\emptyset, Ŭ,\{h_1\},\{f_1, g_1\},\{f_1, g_1, h_1\}$,ID=$\{\emptyset,\{f_1\},\{g_1\},\{h_1\}\}$. It is clear that $Ș=\{e_1, f_1\}$is MICR-α-I-gene-C(X).

Remark: 3.6

Each MICR-Pr-I-C(X) need not be an MICR- α-I-gene-C(X).

Illustration: 3.7

Enable $Ŭ=\{i_1, j_1, k_1, l_1\}$with $\frac{Ŭ}{R}=\{\{j_1, k_1\},\{i_1\},\{l_1\}\}$, $X_1=\{i_1, k_1\}, \mu=\{j_1\}$ and MTS=$\{\emptyset, Ŭ$, $\{i_1\},\{j_1\},\{i_1, j_1\},\{j_1, k_1\},\{i_1, j_1, k_1\}\}$,ID=$\{\emptyset,\{l_1\}\}$.$Ș=\{k_1\}\}$ is MICR-Pr-I-C(X).

Remark: 3.8

MICR**-** α-I-gene-C(X) and MICR-Se-I-C(X) are independent to each other, as seen from the ensuing illustrations.

Illustration: 3.9

Enable Ŭ ={5,6,7,8}with Ŭ / R={{5,8},{6},{7}}, X_1={6,7},μ={8} and MTS={∅,Ŭ,{8},{6,7,8}}, ID={∅,{6}, {7,8}}.Ş={8}} is MICR-Se-I-C(X).

Illustration: 3.10

Enable Ŭ={5,6,7,8}with $\frac{Ŭ}{R}$={{5,8},{6},{7}}, X_1={6,7},μ={8} and MTS={∅,Ŭ,{8},{6,7,8}},ID={∅,{6}, {7,8}}.Ş={5,7,8} is MICR-α-I-gene-C(X).

Proposition: 3.11

Each MICR-b-I-C(X) is MICR-Igene-C(X) yet not conversely.

Proof:

Enable ℧ be a MICR-b-I-C(X) then MICR-clr*(MICR-Int (℧))∪ MICR-Int(MICR-clr*(℧)) ⊆ ℧.Let MICR-℧*⊂Ų ,when so ever ℧ ⊂ Ų and Ų is MICR-O(X).So ℧ is MICR-Igene-C(X).

Illustration: 3.12

Enable   Ŭ={n_1,o_1,p_1,q_1}with $\frac{Ŭ}{R}$={{n_1,q_1},{o_1},{p_1}}, X_1={o_1,p_1},μ={q_1}   and   MTS={∅,Ŭ,{q_1},{o_1,p_1},{o_1,p_1,q_1}}, ID={∅,{o_1},{p_1,q_1}}.Ş={o_1,p_1,q_1} is MICR-Igene-C(X).

Proposition: 3.13

Each MICR-α-I-gene-C(X) is an MICR-Igene-C(X) yet not conversely.

Proof:

Enable ℧ ⊆ Ų and Ų is MICR-O(X).Clearly each O(X) is α-MICR-O(X).Since ℧ is MICR-α-I-gene-C(X), ℧*⊆ Ų,which implies that ℧ is a MICR-Igene-C(X).

Illustration: 3.14

Enable Ŭ={7,8,9,10} with $\frac{Ŭ}{R}$={{8,9},{7},{10}}, X_1={7,9},μ={8} and MTS = {∅,Ŭ,{7}, {8},{7,8},{8,9}, {7,8,9}}, ID = {∅,{l}} . Ş={8,10} is MICR- α-I-gene-C(X).

Proposition: 3.15

Each MICR-I$\widehat{gene}$ (ie I$\hat{g}$)-C(X) is an MICR-α-I-gene-C(X) yet not conversely.

Proof:

Enable ℧ ⊆ Ų and Ų is MICR- α-O(X).Clearly each α-O(X) is MICR-Se-O(X).Since ℧ is MICR-I$\widehat{gene}$-C(X), ℧*⊆ Ų,which implies that ℧ is a MICR-α-I-gene-C(X).

Remark: 3.16

If ℧ ∩ ℧ (℧ (ie) B) are MICR-α-I-gene-C(X), then ℧ ∪ ℧ is also an MICR-α-I-gene-C(X).

Proof:

Enable ℧ *and* ℧ ⊆Ų where Ų is MICR- α-O(X) in Ŭ. Then ℧ ⊆ Ų and ℧ ⊆Ų . Since ℧ *and* ℧ are MICR-α-I-gene-C(X) , then ℧*⊆ Ų and ℧ * ⊆Ų and so ℧*∪ ℧* ⊆Ų. Hence ℧ ∪ ℧ is a MICR-α-I-gene-C(X).

Remark: 3.17

The intersection of MICR-α-I-gene-C(X) need not be an MICR-α-I-gene-C(X) as shown from the following example.

Illustration: 3.18

Enable $Ŭ=\{m_1, n_1, o_1, p_1\}$ with $\frac{Ŭ}{R}=\{\{m_1, p_1\}, \{o_1\}, \{n_1\}\}$, $X_1=\{n_1, o_1\}, \mu=\{p_1\}$ and MTS=$\{\emptyset, Ŭ, \{p_1\}, \{n_1, o_1\}, \{n_1, o_1, p_1\}\}$, ID=$\{\emptyset, \{n_1\}, \{o_1, p_1\}\}$. If $Ʊ =\{o_1, p_1\}$, $Ʊ =\{m_1, n_1, p_1\}$,then $Ʊ$ and $Ʊ$ are MICR-α-I-gene-C(X) but their intersection $Ʊ \cap Ʊ$ =$\{p_1\}$ is not a MICR-α-I-gene-C(X).

Proposition:3.19

Enable($Ŭ$,NA,MICR,ID) be an MITS and $Ʊ$ be an MICR-α-I-gene-C(X).Then the following are equivalent.
(1) $Ʊ$ is a MICR-$*$-closed set
(2) MICR-clr*($Ʊ$) - $Ʊ$ is a MICR-α-C(X)
(3) MICR- $Ʊ*$- $Ʊ$ is a MICR-α-C(X).

Proof:

(1)$\Rightarrow$(2): If $Ʊ$ is MICR-$*$C(X),then MICR-$Ʊ*\subseteq Ʊ$ and so MICR-clr*($Ʊ$)- $Ʊ$=($Ʊ \cup Ʊ*$)- $Ʊ= \emptyset$. So MICR- clr*($Ʊ$)- $Ʊ$ is MICR-α-C(X). (2)$\Rightarrow$(3):Since MICR-clr*($Ʊ$)- $Ʊ$=MICR- $Ʊ*$- $Ʊ$ and so MICR- $Ʊ*$- $Ʊ$ is MICR-α-C(X). (3)$\Rightarrow$(1): If MICR- $Ʊ*$- $Ʊ$ is a MICR-α-C(X),then by Proposition 3.3,MICR- $Ʊ*$- $Ʊ= \emptyset$ and so $Ʊ$ is MICR-$*$C(X).

Proposition: 3.20

Enable ($Ŭ$,NA,MICR,ID)be an MIDTS . If $Ʊ$ and $Ʊ$ are subsets of $Ŭ$ such that $Ʊ \subseteq Ʊ \subseteq$ MICR-clr*($Ʊ$) and $Ʊ$ is MICR-α-I-gene-C(X), then $Ʊ$ is MICR-α-I-gene-C(X).

Proof:

Since $Ʊ$ is MICR-α-I-gene- C(X) then by proposition 3.3(iv)MICR-clr*($Ʊ$) - $Ʊ$ contains no nonempty MICR-α-C(X).Since MICR-clr*($Ʊ$) - $Ʊ \subseteq$ MICR-clr*($Ʊ$) - $Ʊ$ and so MICR-clr*($Ʊ$) – $Ʊ$ contains no nonempty MICR-α-C(X). Hence $Ʊ$ is MICR-α-I-gene- C(X).

Proposition: 3.21

Enable ($Ŭ$,NA,MICR,ID) be an MIDTS and $Ʊ \subseteq Ŭ$.If $Ʊ$ is MICR-α-I-gene-O(X) and MICR-Int*($Ʊ$)$\subseteq Ʊ \subseteq Ʊ$ then $Ʊ$ is MICR-α-I-gene-O(X).

Proof:

Since $Ʊ$ is MICR-α-I-gene-O(X) then $Ŭ$ - $Ʊ$ is MICR-α-I-gene- C(X).By Proposition 3.3(iv),MICR-clr*($Ʊ$)contains no nonempty MICR-α-C(X).Since MICR-Int*($Ʊ$) $\subseteq$ MICR-Int*($Ʊ$), $Ʊ \subseteq$ $Ŭ$-MICR-clr*($Ŭ$-$Ʊ$) $\subseteq Ŭ$-MICR-clr*($Ŭ$ -$Ʊ$) which implies that MICR-clr*($Ŭ$ –$Ʊ$) $\subseteq$ MICR-clr*($Ŭ$-$Ʊ$) and so MICR-clr*($Ŭ$ –$Ʊ$) - ($Ŭ$ –$Ʊ$) $\subseteq$MICR-clr*($Ŭ$-$Ʊ$)-($Ŭ$-$Ʊ$) . Hence $Ʊ$ is MICR-α-I-gene -O (X).

Proposition:3.22

Enable ($Ŭ$,NA,MICR,ID)be an MIDTS .Then each subset of $Ŭ$ is MICR-α-I-gene-C(X) iff each MICR-α-C(X) is MICR-α-C(X) is MICR- $*$ -C(X).

Proof:

Suppose each subset of $Ŭ$ is MICR-α-I-gene-C(X). If $Ų \subseteq Ŭ$ is MICR-α-O(X),then $Ų$ is MICR-α-I-gene -C(X) and so $Ų*$ $\subseteq Ų$. So $Ų$ is MICR- $*$ -C(X).Conversely , Suppose that $Ʊ* \subseteq Ų \subseteq Ŭ$ and so $Ʊ$ is MICR-α-I-gene-C(X).
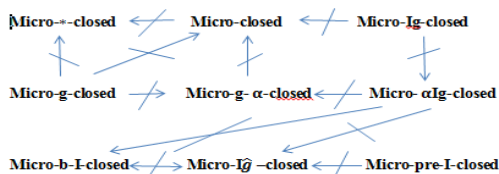
MICRO-Igene-α-closed sets(briefly MICR-Igα-C(X))

Explication 4.1

Enable (Ŭ,NA,MICR,ID) be a MTS and I be an ideal on Ŭ. A subset Ʊ of Ŭ is reveal to be MICR-Igene-α-C(X) iff MICR- αclr(Ʊ) -Ụ ∈ I whensoever Ʊ ⊂Ụ (Ụ is (ie) U) and Ụ is MICR- α-O(X).

Remark: 4.2

MICR- Igene-C(X) Need not be an MICR-Igene-α-C(X).

Illustration: 4.3

Enable   Ŭ={$\varrho_1,\varrho_2,\varrho_3,\varrho_4$}   with $\frac{Ŭ}{R}$={{ϱ_1,ϱ_2},{ϱ_4},{ϱ_3}}, X_1={ϱ_1}, μ={ϱ_3}   and   MTS={∅,Ŭ, {ϱ_3},{ϱ_1,ϱ_2},{$\varrho_1,\varrho_2,\varrho_3$}}, ID={∅,{$\varrho_1$},{$\varrho_2$}{$\varrho_1,\varrho_2$}}.Ṣ={$\varrho_1,\varrho_2$} is MICR-I-gene-C(X) yet Ṣ is not a MICR-Igene-α-C(X).

Proposition: 4.4

A set Ʊ is MICR-Igene- α-C(X) in (Ŭ,NA,MICR) iff ʍ ⊂ MICR-αclr(Ʊ) - Ʊ and ʍ is α-C(X) in Ŭ implies ʍ ∈ ID.

Proof:

Enable Ʊ be MICR-Igene-α-C(X).Suppose that ʍ ⊂ MICR-αclr(Ʊ) – Ʊ. If ʍ is α-C(X) then ʍ ⊂ Ŭ - ʍ .Since ʍ is MICR- Igene-α-C(X).Then MICR-αclr(Ʊ) – (Ŭ -ʍ) ∈ ID. But ʍ ⊂ MICR-αclr(Ʊ)- (Ŭ -ʍ) and hence ʍ ∈ ID.Conversely ,Assume that ʍ ⊂ MICR-αclr(Ʊ) – Ʊ and ʍ is α-C(X) in Ŭ implies that ʍ ∈ ID.Suppose Ʊ ⊂ Ụ and Ụ is MICR- α-C(X).Then MICR-αclr(Ʊ) –Ụ = MICR-αclr(Ʊ) ∩ (Ŭ-Ụ) ⊂ MICR-αclr(Ʊ) –Ʊ.But MICR-αclr(Ʊ) –Ụ∈ ID.Hence Ʊ is MICR-Igene-α-C(X).

Proposition: 4.5

If Ʊ and Ʊ are MICR-Igene-α-C(X) of (Ŭ,NA,MICR),then their union Ʊ ∪ Ʊ is also MICR-Igene-α-C(X).

Proof:

Enable Ʊ and Ʊ be MICR-Igene-α-C(X) in (Ŭ,NA,MICR). If Ʊ ∪ Ʊ ⊂ Ụ and Ụ is MICR- α-O(X),then Ʊ ⊂ Ụ and Ʊ ⊂ Ụ.Since Ʊ and Ʊare MICR-Igene-α-C(X). Then MICR-αclr(Ʊ) – Ụ ∈ ID and MICR- αclr(Ʊ) – Ụ ∈ ID and so MICR- αclr(Ʊ ∪ Ʊ) – Ụ = (MICR- αclr(Ʊ) – Ụ) ∪ (MICR- αclr(Ʊ) – Ụ) ∈ ID. ie) Ʊ ∪ Ʊ is also MICR-Igene-α-C(X).

Illustration: 4.6

Enable   Ŭ={$ṣ_1,ṣ_2,ṣ_3,ṣ_4$}   with $\frac{Ŭ}{R}$={{$ṣ_1,ṣ_2$},{$ṣ_4$},{$ṣ_3$}}, X_1={$ṣ_1$}, μ={$ṣ_3$}   and   MTS={∅,Ŭ, {$ṣ_3$},{$ṣ_1,ṣ_2$},{$ṣ_1,ṣ_2,ṣ_3$}}, ID={∅,{$ṣ_1$},{$ṣ_2$}{$ṣ_1,ṣ_2$}}.Ʊ={$ṣ_1,ṣ_4$}, Ʊ ={$ṣ_2,ṣ_4$} are MICR-I-gene -α-C(X).Hence Ʊ ∪ Ʊ ={$ṣ_1,ṣ_2,ṣ_4$} is also a MICR-Igene-α-C(X).

Proposition: 4.7

If Ʊ and Ʊ are MICR-Igene-α-C(X) of (Ŭ,NA,MICR),then their intersection Ʊ ∩ Ʊ is also MICR-Igene-α-C(X).

Proof:

Enable Ʊ and Ʊ be MICR-Igene-α-C(X) in (Ŭ,NA,MICR).Then MICR-αclr(Ʊ) – Ụ ∈ ID whenever Ʊ ⊂ Ụ and Ụ is MICR-α-O(X) and MICR- αclr(Ʊ) – Ụ ∈ ID whenever Ʊ ⊂ Ụ and Ụ is MICR-α-O(X) and hence MICR- αclr(Ʊ ∩ Ʊ) – Ụ = (MICR- αclr(Ʊ) – Ụ) ∩(MICR- αclr(Ʊ) – Ụ) ∈ ID. whensoever Ʊ ∩ Ʊ ⊂ Ụ,Ụ is MICR-α-O(X) and ie) Ʊ ∩ Ʊ is also MICR-Igene-α-C(X).

Illustration: 4.8

Enable Ŭ={7,8,9,10}with $\frac{Ŭ}{R}$={{8,9},{7},{10}}, X_1={7,9},μ={8} and MTS={∅,Ŭ,{7},{8},{7,8},{8,9},{7,8,9}},ID={∅,{l}}. Ʊ={9,10} ,Ʊ.={7,8,9} are MICR-I-gene- α-C(X).So Ʊ ∩ Ʊ.={9} is also MICR-I-gene- α-C(X).

Proposition: 4.9

If Ʊ is MICR-Igene-α-C(X) and Ʊ $\subset$ Ʊ $\subset$ MICR- αclr(Ʊ) in (Ŭ,NA,MICR),then Ʊ is MICR-Igene-α-C(X) in (Ŭ,NA,MICR).

Proof:

Enable Ʊ is MICR-Igene-α-C(X) and Ʊ $\subset$ Ʊ $\subset$ MICR- αclr(Ʊ)in (Ŭ,NA,MICR).Suppose Ʊ $\subset$ Ų and Ų is MICR-α-O(X).Then Ʊ $\subset$ Ų. Since Ʊ is MICR-Igene-α-C(X),then we have MICR- αclr(Ʊ) – Ų $\in$ ID. Now Ʊ $\subset$ MICR- αclr(Ʊ). This implies that (MICR- αclr(Ʊ)–Ų)$\subset$(MICR- αclr(Ʊ) – Ų) $\in$ ID. Hence Ʊ is MICR-Igene-α-C(X) in (Ŭ,NA,MICR).

Proposition: 4.10

Enable Ʊ be a MICR-Igene-α-C(X) and ᴍ be a C(X) in (Ŭ,NA,MICR),then Ʊ $\cap$ ᴍ is an MICR-Igene-α-C(X) in (Ŭ,NA,MICR).

Proof:

Enable Ʊ be a MICR-Igene-α-C(X).Then (MICR- αclr(Ʊ) – Ų) $\in$ ID, whenever MICR- αclr(Ʊ) – Ų $\in$ ID. Enable ᴍ be a C(X) in (Ŭ,NA,MICR).Since Each C(X) is MICR-Igene-α-C(X). Hence ᴍ is MICR-Igene-α-C(X).By preposition 4.7, intersection of any two MICR-Igene-α-C(X) is also MICR-Igene-α-C(X).Thus Ʊ $\cap$ ᴍ is a MICR-Igene-α-C(X) in(Ŭ,NA,MICR).

Proposition:4.11

Enable MICR-α-Int(Ʊ) $\subset$Ʊ $\subset$ Ʊ and Ʊ be a MICR-Igene-α-O(X) in (Ŭ,NA,MICR).Then Ŭ - Ʊ $\subset$Ŭ-Ʊ $\subset$ MICR-clr(Ŭ - Ʊ) and Ŭ - Ʊ is MICR-Igene-α-C(X).By preposition 4.9,Ŭ-Ʊ is MICR-Igene-α-C(X) and So Ʊ is MICR-Igene-α-O(X).
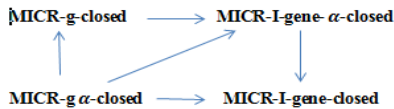
CONCLUSION

Here's a look at some of the Micro topological spaces, Let's consider a new MICR-α-C(X) in MTS and discuss its properties and uses. This paper was presented with MICR- α-I-gene-C (X), MICR-I-gene-α-C(X) in MITS and investigated some of the key frameworks in the MITS. A variety of interesting problems identified in the analysis. Future research will be considered regarding MTS applications.

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RESEARCH ARTICLE

Future Study of Antibiotics use in Multi-Specialty Hospitals in Narasaraopet, Guntur District, Andhra Pradesh

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ABSTRACT

Prescription use research is essential to clinical practice because it serves as the foundation for changes to local and federal drug dispensing regulations. Such research's ultimate purpose is to encourage sensible drug usage. Additionally, it is essential in India's emerging economy because 72% of all health care costs are carried by patients, and it aids in the development of methods to use health resources as effectively as possible. The WHO ATC / DDD (Anatomical Therapeutic Chemical / Defined Daily Dose) protocol is the gold standard for medication use. The WHO Collaborating Centre for Medicine Statistics and Methodology defines the defined daily dose (DDD) for each drug and method of administration as the daily assumed average maintenance dosage for an adult. As a result, the DDD is a global unit used for global or regional comparisons. The optimal benefit of medication therapy in patient care must be considered, and rational drug usage is a crucial component to be examined. The main causes of subpar health care in India include a variety of factors including illiteracy, poverty, use of multiple health care systems, drug advertising and promotion, prescription drug sales, competition in the medical and pharmaceutical industries, and a lack of readily accessible drug information. In developing nations, self-medication, layman medical advice, or pharmacist recommendations pertaining to the treatment of various disorders are common. Study Approach The several multi-specialty hospitals in Narasaraopet,

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Guntur, and Andhrapradesh served as the sites for this study. 1425 (48.1%) of the 2963 patients in our research were men, and 1538 (51.9%). All of these patients are treated in the following departments: general medicine, pediatrics, pulmonology, gynecology, and orthopedics. In this study, a total of 1923 antibiotics are prescribed, with the majority of those 939 (48.8) prescribed in general medicine and fewer than 80 (4.1) in gynecology. Amoxicillin is the most often prescribed medicine in this study, at 150 (7.8%), and the most frequently prescribed drug in the category of penicillin, at 377. (19.6) Conclusion: The study offers details on a prospective investigation on the use of antibiotics in multispecialty hospitals. It has assisted in identifying drug prescribing patterns that are irrational in a number of departments, including general medicine, pediatrics, pulmonology, gynecology, and orthopedics.

Keywords: Penicillin's, Patient care ,Irrational Drug Therapy , Health Care

INTRODUCTION

A continuous, approved, and systemic method of quality improvement is a drug use (DU) study. The marketing, distribution, prescription, and use of drugs in a society with a focus on the ensuing medical, social, and economic repercussions is referred to as drug utilization by the World Health Organization (WHO) in 1977 [1]. The purpose of these research is to examine drug use and prescription trends in light of the most recent recommendations or best practices for the management of particular diseases. Studies on drug use in the population (DU) assess drug usage in terms of age, sex, and socioeconomic class. The prescribers receive feedback from them on drug usage statistics. The evaluation of drug use is crucial for clinical, academic, and financial reasons. Periodic evaluations of prescribing patterns are necessary to improve treatment effectiveness, reduce side effects, and give prescribers feedback. There are an increasing number of pharmaceutical items accessible on the global market, and both medicine use and spending have increased. Regarding drugs, inappropriate drug prescription is frequent in clinical practice, with a key contributing factor being ignorance about unethical drug advertising. Although logical drug usage is a fairly common practice, occasionally specific situations may lead to irrational behavior. Because healthcare and medication funding in developing nations is constrained, rational drug prescribing is crucial to making the best use of the resources available [2]. The bulk of the population's healthcare needs are met by essential pharmaceuticals, which are those that are always accessible in sufficient quantities, in the wrong dose forms, and at a cost that both people and the community can pay. This drug use study's main goal is to encourage patients to utilize medications in accordance with WHO recommendations while minimizing side effects and drug interactions to improve patient outcomes. Additionally, polypharmacy is more typical before, during, and after surgery.

By analyzing the potential risks associated with their indiscriminate use. The substantial physiological changes that occur in a woman's body during pregnancy present a challenge to doctors when treating illness states and choosing the right drugs to address them [3]. While using drugs while pregnant may put the fetus at risk for teratogenic effects, it would be impractical and potentially harmful to abstain from all drugs in the early stages of pregnancy. When administering medications during pregnancy, careful evaluation of the benefit to the mother and the danger to the fetus is necessary. Drug abuse is a major issue across the world, and pregnant women should be given special attention. For instance, multivitamins in big doses for patients with no nutritional issues or antibiotics for patients with no sign of bacterial disease are occasionally recommended [7]. Particularly during the first and early part of the second trimester, drugs may be transferred from the mother to the fetus at risk. When organogenesis occurs in the fifth week following conception, the fetus grows quite fast. This period increases vulnerability to outside influences, including negative consequences that might not be immediately noticeable after delivery. Studies on medication use are now being developed to determine illness prevalence, drug costs, the appropriateness of prescriptions, and compliance with evidence-based recommendations [8]. It is crucial to evaluate the pattern of medication use during pregnancy to see how existing prescribing procedures might be improved [9]. In developing nations, self-medication,

layman medical advice, or pharmacist recommendations pertaining to the treatment of various disorders are common.

PRESCRIBING INDICATORS
By "patients get medicines suited to the clinical needs, in dosages that made their own specific requirements for an acceptable amount of time, at the least cost to them and their community," the World Health Organization (WHO) defined rational drug use [10]. In order to assess the services offered to the community in relation to pharmaceuticals, WHO established medication usage indicators, including prescription indicators [11]. Prescription indicators make it possible to identify the therapeutic measures taken in similar institutions, allowing for a comparison of their parameters in the future. They also allow for the assessment of the population's medication needs and the identification of the drugs that are used the most frequently in a specific location. The investigator is also able to determine the population's service quality and prescription profile thanks to these indications.

MATERIALS AND METHODS

Research plan In the Guntur region of Andhra Pradesh, India, many multispecialty hospitals participated in the study. All patients who underwent procedures in these hospitals were registered. Clinical information was gathered.

AIM AND OBJECTIVES OF THE STUDY
Prospective analysis of the use of antibiotics in different multi-specialty hospitals.
To learn more about the multispecialty hospitals that were chosen for the prescription's demographic parameters.
To look into and evaluate how often antibiotics are used in different multispecialty hospitals.
Investigate the harmful consequences of antibiotics.
To research and compare antibiotic prices.
To investigate the logic in a few chosen multispecialty hospitals inclusion standards.
Patients between the ages of 0 and 70.
In several departments, all outpatients.
Patients are spread across numerous departments.

Exclusion criteria:
Intensive care unit patients who do not want to participate in the research who are older than 71 but not included
Statistics: SPSS software was used to analyze the data.

RESULTS AND DISCUSSION

A total number of 2963 peoples were involved in the study. Out of 1425 were males and 1538 were females. The gender distribution of patients enrolled for the study was presented in Table -1, Figure -**1.** In this Prospective Study conducting Five Different Department in Various Multi Speciality Hospitals Such as General Medicine, Pediatrics, Pulmonology, Gynecology, Orthopedics, Based on various Departments study was Presented Table-2 and Figure-2. Based on Age group total prescriptions -2963, Males were 1425 Females were 1538 shown in table -3 figure -3. Based on Dosage forms: Total 11494 Number of dosages forms used in this Five department Departments shown in Table-4and figure- 4. Based on Department wise Total 11494 Number of dosages forms used in this Five department Departments shown in Table- 5 and figure- 5. The Total number of Prescriptions 2963 Based on category of Dosage forms is 11494 is shown in Table-6 Figure-6. Total Number Of Antibiotics Based Department wise shown in Table-7 Figure-7. Total Number Of Antibiotics Based on category wise shown in Table-8 Figure-8. Total Number Of Antibiotics Based on Classification wise shown in Table-9 Figure-9. Table-10 Analysis of Prescriptions according to W.H.O Prescribing indicators.

CONCLUSION

Information is provided regarding a prospective study examining the use of antibiotics in multispecialty hospitals. It has aided in the identification of unreasonable medication prescription trends in a number of specialties, including general medicine, pediatrics, pulmonology, gynecology, and orthopedics. Therefore, the clinical pharmacist must be seen as a crucial component. As part of clinical audit, they should be involved in the collecting and display of prescribing data as well as in counseling patients and caregivers. The proper administration of medications, which is much more crucial in other sectors, requires pharmaceutical care. The WHO core indicators assisted in improving prescribing practices, identifying serious issues related to patients' or caregivers' understanding of doctors' directions, and even reducing the financial load.

ACKNOWLEDGMENT

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Table 1: Gender Distribution

Gender	Number of Patients	Percentage
Male	1425	48.1
Female	1538	51.9
Total	2963	100

Table 2: Based on Department

Name of the Department	Number Of Patients	Percentage
General Medicine	1648	55.6
Pediatric	478	16.1
Pulmonology	335	11.3
Gynecology	352	11.9
Orthopedics	150	5.1

Table 3: Age Distribution

Age group	Males	Percentage	Female	Percentage
0-20	140	9.8	322	22.0
21-40	420	29.5	697	45.3
41-60	515	36.1	380	24.7
61-70	350	24.6	139	9.0
Total	1425	100	1538	100

Table 4: Based on Dosage forms

Based on Dosage forms	Number Of Dosage forms	Percentage
Drops	449	3.9
Syrups	2142	18.6
Injections	829	7.2
Tablets	4616	40.1
Capsules	3114	27.1
Powders	130	1.1
Creams	113	0.9
Nebulizers	64	0.5
Nasal sprays	37	0.3

Table 5: Based on Department

Name of The Department	Drops	Syrups	Injections	Tablets	Capsules	Powders	Creams	Nebulizers	Nasal sprays	Total
General Medicine	2	607	123	3166	2359	Nil	26	24	1	6308
Pediatrics	437	1135	130	120	5	7	37	Nil	Nil	1871
Pulmonology	10	120	146	530	210	28	Nil	40	36	1120
Gynecology	Ni	310	190	470	290	50	Nil	Nil	Nil	1210
Orthopedics	Nil	70	240	330	250	45	50	Nil	Nil	985
Total	11494									

Table 6: Based on category of Dosage forms

Category of Dosage forms	General Medicine	Pediatrics	Pulmonology	Gynecology	Orthopedics
Antibiotics	939	394	330	80	180
Antihistamines	448	421			
Antipyretics	479	368		47	70
Multivitamins	922	143	240	218	80
Bronchodilators	236	248	163	21	
Alpha Agonist		67			
Anti emetic's	80	21		130	
Antiseptics		19			35
Antifungal		11			
Antacids		28		60	80
Anti Helimintics		6		33	
Antiepileptics		2			45

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NSAIDS	325	52	45		
Calcium Suplements		40	135	135	
Iron Suplements				185	25
Hormone and Related Drugs				176	
Laxatives	50				
Anti Hypertensives	360		35		40
Anticoagulants					40
Urinary Alkalizers					
Antidiabetics	746		44		40
Corticosteroids				20	
Expectorants					12
H2 Blockers	63		36		
Anti thyroid	44				
Vaccines				70	
Anticholinergics					35
Antioxidants				60	33
Diuretics					15
Angitension Drugs			26		35
Antidepressants	44				30
Anti arrhythmics					40
Analgesics	436		19		
PPI'S	484			45	
Anti Tussives	322				
Anti hyper lipediaemics	82				
Anti vertigo	108				
Anti consultants	119				
Antidiarreheal	21		47		

Table 7: Number of Antibiotics

Name of the Department	Number of Antibiotics	Percentage
General Medicine	939	48.8
Pediatrics	394	20.5
Pulmonology	330	17.2
Gynecology	80	4.1
Orthopedics	180	9.5
Total	1923	100

Table 8: Based on Antibiotics

Name of The Antibiotics	Number of Antibiotics	Percentage
Ceftrioxone+Sulbactum	56	2.9
Piperacillin+Tazobactum	60	3.1
Aminoglycoside Antibiotics	72	3.7
Linezolid	59	3.0

Ampicillin+Sulbactum	62	3.2
Cefuroxime	74	3.8
Ceftrioxone	79	4.1
Amoxicillin	150	7.8
Azithromycin	130	6.7
Amoxicillin+Potassium Clavulanate	105	5.4
Amikacin	99	5.1
Cefixime	95	4.9
Ciprofloxacin	110	5.7
Norfloxacin	66	3.4
Ofloxacin	50	2.6
Gentamicin	70	3.6
Metronidazole	92	4.7
Doxycycline	116	6.0
Meropenem	65	3.3
Kenamycin	45	2.3
Moxifloxacin	78	4.0
Isoniazid + Ethambutol	52	2.7
Isoniazid + Rifampicin	66	3.4
Streptomycin	72	3.7

Table 9: Number of Antibiotics Based on Classification

Classification	Drugs	Number of Drugs	Total number of drugs	Percentage
Penicillin	Ampicillin	62	377	19.6
	Amoxicillin	255		
	Piperacillin	60		
Cephalosporin's	Ceftrioxone	79	248	12.9
	Cefuroxime	74		
	Cefixime	95		
Beta-lactamase Inhibitors	Sulbactum	118	179	9.3
	Tazobactum	60		
Carbapenems	Meropenem	65	65	3.3
Aminoglycosides	Gentamicin	70	286	14.8
	Amikacin	99		
	Streptomycin	72		
	Kenamycin	45		
Macrolides	Azithromycin	130	130	6.7
Linezolid	Linezolid	59	59	3.0
Tetracycline	Doxicyclin	116	116	6.0
2nd generation	Ciprofloxacin	110	226	11.7
	Norfloxacin	66		
	Ofloxacin	50		
4 th generation	Moxifloxacin	78	78	4.0
Bactericidal Metabolic biproducts	Metronidazole	92	92	1.6
Bactericidal (inhibits RNA	Rifampacin	66	66	3.4

transcription by inhibiting RNA polymerase				
Mycolic acid synthase	Isoniazid +Ethambutal	52	52	2.7

Table 10 Analysis of Prescriptions according to W.H.O Prescribing indicators

Parameters	Observed Value
Total Number of Precipitations Analyzed	2963
Total Number Drugs Prescribed	11494
Total Number of Drugs Prescribed From Essential Drugs list	5920
Average number of Drugs per encounter	3.8
Total Number of Antibiotics Prescribed	1923
Percentage of encounters with an Antibiotics Prescribed	16.7
Percentage of encounters with Oral Antibiotics Prescribed	13.0
Percentage of Drugs Prescribed from essential Drugs list	51.5
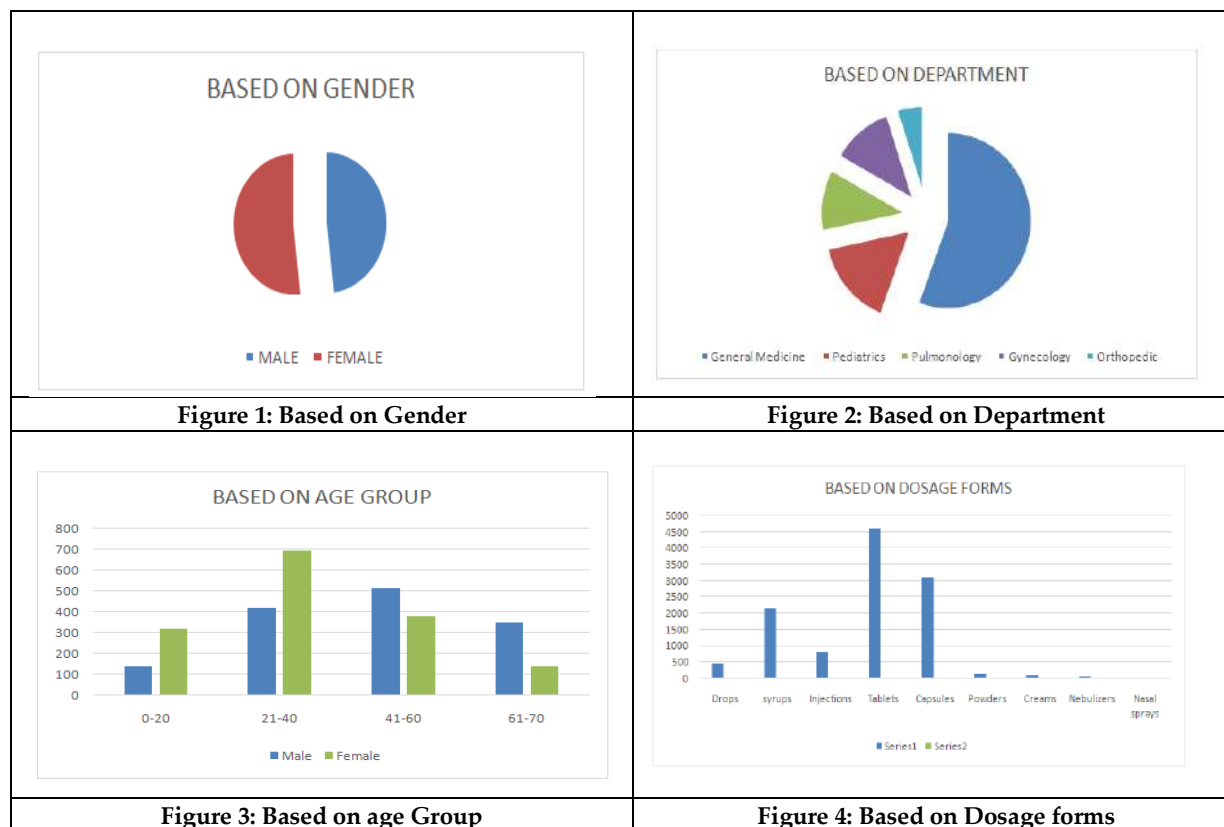
Figure 1: Based on Gender

Figure 2: Based on Department

Figure 3: Based on age Group

Figure 4: Based on Dosage forms

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Figure-5:Based on Department wise

Figure 6:Based on category of Dosage forms

Figure 7: Number Of Antibiotics Based Department

Figure 8: Based on Antibiotics category

Figure 9: Number Of Antibiotics Based on Classification wise

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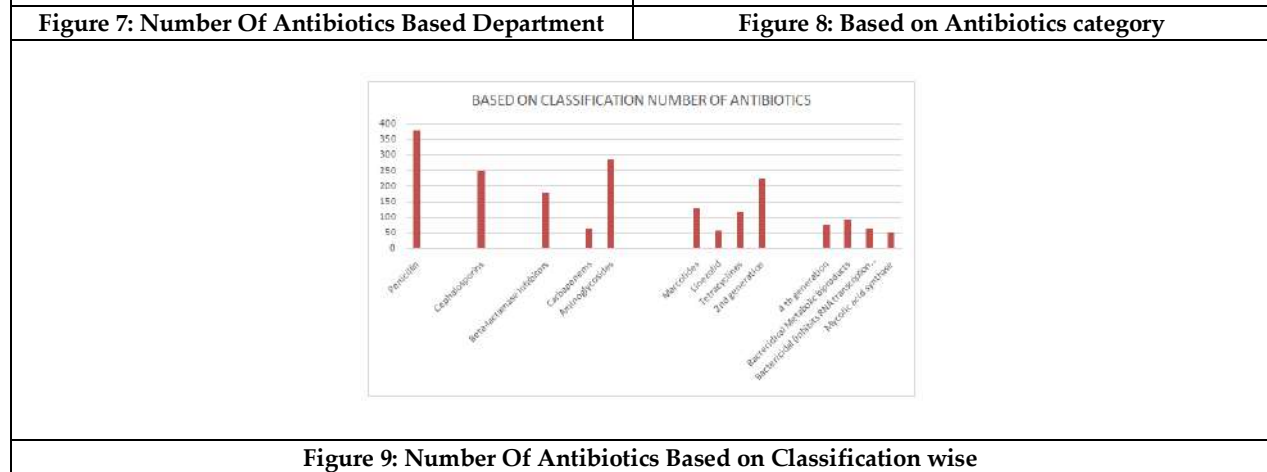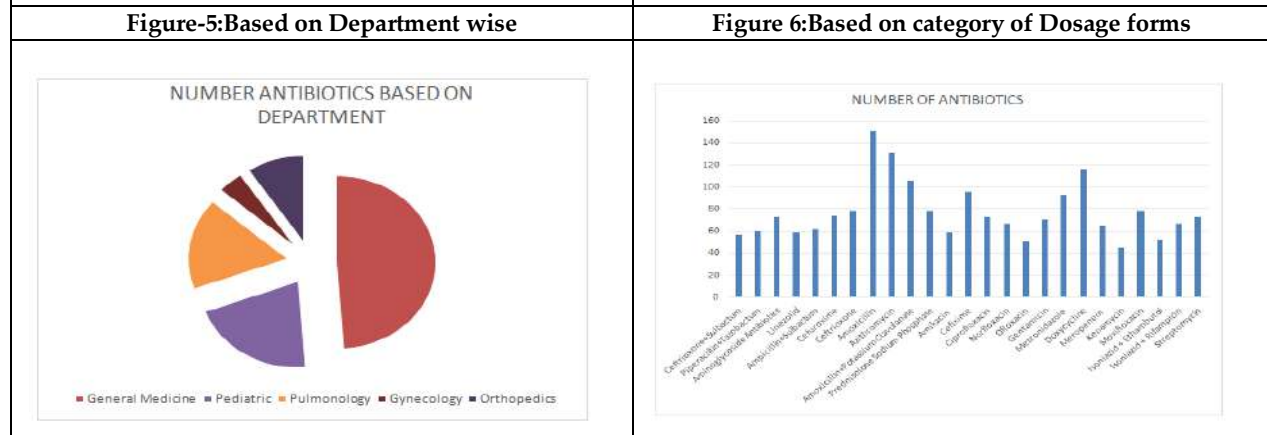
An Ethnobotanical Study of Medicinal Plants used by the Villagers of Karaikal, Puducherry, South India.

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ABSTRACT

The present study is the first attempt towards quantitative valuation of ethnobotany of Karaikal, Puducherry, South India. For this purpose, 12 villages were surveyed from November 2020 to March 2021. In total 55 medicinal plants from 27 families were ascertained for the treatment of 15 ailment categories. Medicinal plants belonging to Fabaceae were predominantly used over other families. Herbs constituted the majority with 41.8% among the life forms used. Of the total plant parts used, Leaves recorded the highest (65%) followed by Roots (8%). Paste (27.69 %) and Decoction (24.62%) were commonly used by the villagers. The highest Relative Importance was recorded for *Boerhavia diffusa*(2.00) followed by *Acalypha indica* (1.80) and the highest Species Use Value was also recorded for *Boerhavia diffusa* (0.82) followed by *Mimosa pudica* (0.75). Among the families the highest Family Use Value was recorded for Poaceae (0.8). The highest Fidelity level was recorded for *Desmostachya bipinnata*(71.79%) followed by *Ricinus communis* (64.1%). A total of 17 plants were used for treatment of Gastrointestinal ailments that accounted for 30% of the total plants used by the villagers. Nevertheless, dependance on medicinal plant among the villagers is declining which is leading to annihilation of traditional knowledge of plant-based treatment of diseases. Thus, proper documentation and quantification is crucial for preservation of associated knowledge of medicinal plants which is facing extinction due to modern medicines.

Keywords: Ailments, Karaikal, Medicinal plants, Relative importance, Traditional knowledge, Use value.

INTRODUCTION

Plant resources are vital in maintaining and supporting all forms of life and are at the forefront of benefitting mankind by supplying essential commodities for its subsistence [1]. Despite being the chief food provider, plants also thrive as potent supplier of beneficial drugs to mankind. The earliest record of disease treatment using medicinal plants comes from Mesopotamia around 2600BC [2]. Similarly, in ancient India, 2500 to 500 BC, Vedas and other scriptures also mentioned therapeutic properties of medicinal plants [3]. Indian subcontinent harbors a wide range of habitat supporting a rich floristic diversity which accounts for 8% of the total documented world plant species [4]. This immense floristic wealth provides the required raw material for classical and folk health care traditions of India [5]. However, growing demand of medicinal plants coupled with unsustainable and destructive harvesting technique has led to a number of medicinal plant species being categorized as either threatened or endangered [6] in the Indian Subcontinent. According to red listed plants of India, there are 124 endangered plant species, 109 vulnerable, 80 indeterminate, 45 possibly extinct, 12 presumed extinct and 1 extinct plant species [7]. Therefore, effective actions addressing multiple causes of biodiversity loss through involvement of indigenous communities and stakeholders, can bring about biodiversity conservation and sustainable use [8].Traditional medicines are still prevalent around the world with 80% of the people relying on practices involving plant extracts [6].

In India, other than Ayurveda, Siddha, Unani and Swa-rigpa, a vast majority of people depends on zonal and community specific indigenous healthcare practices [5]. These practices generally involve ailments which can be treated locally without hospitalization, using plant extracts in the form of pastes, decoctions, powder, infusion etc. from plants available in their vicinity. Studies pertaining to ethnobotany has been carried out among the tribal and rural populations throughout the country [9] indicating the immense medicinal knowledge existing among the natives. Karaikal is a small coastal enclave with an area of 157 km^2 at the Eastern coast of Bay of Bengal with tidal swamps and plateau vegetation representing dry and deciduous vegetation and scrubland supporting a significant number of floral wealth with rare and endemic plant species [10]. The vast majority of people in Karaikal district depends on modern medicines for the treatment of diseases however, some of the families living in the rural area still uses easily available plants for the treatment of common diseases. The prevalence of medicinal plants usage among the younger generation is decreasing and the associated knowledge in the formulation is also declining. Further, the knowledge associated with medicinal plants are passed on to the next generation orally which leads to extinction of the traditional knowledge [11]. Thus, the current investigation is the first attempt towards quantitative estimation and documentation of the medicinal plants of Karaikal used in the treatment of various ailments. The data obtained were subjected to analysis to determine the Family use value (FUV), Fidelity Level (FL%), Plant part value (PPV), Relative Importance (RI), Species use value (SUV), and Use Value (UV)of the medicinal plant species and encourage the conservation of associated knowledge adhered to the medicinal plants in use.

MATERIALS AND METHODS

Study site
Survey and documentation were carried out at 12 villages in the district of Karaikal (10º49'N to 11º01'N latitude and 79º43'E to 79º52'E longitude)from November 2020 to March 2021 (Figure 1).

Data collection
Collection of data was done by visiting the villages from November 2020 to March 2021. Ethnobotanical information was collected by interviewing 39 informants (40 to 70 years) through semi-structured and structure questionaries [12].The plant specimens were collected in the presence of the informant in the flowering and fruiting condition. Where fruits and flowers were not present, the twigs with leaves were collected for identification. Field identification was done on spot for certain species and those species which could not be identified in the field were identified consulting the E-flora of Karaikal [10] and Flora of the Presidency of Madras [13,14,15]. The collected specimens were

tagged properly with accession numbers and herbarium prepared were deposited in the Department of Plant Sciences, Avvaiyar Government college for Women, Karaikal.

DATA ANALYSIS
The data obtained were analysed using Excel and Past 4.10.

Plant Part Value (PPV)
Plant part value is the percentage of plant part utilized. The PPV is calculated as follows [16]:$\sum$RU (plant parts)$/\sum$RU x 100. Where ΣRU (plant part) = sum of the cited plant parts and ΣRU = total number of cited uses for a given plant.

Relative Importance (RI)
Relative importance value (RI) was calculated as [17]
RI = PP+AC.

Where PP = $\dfrac{number\ of\ phamacological\ properties\ of\ a\ species}{maximum\ number\ of\ properties\ attributed\ to\ most\ resourceful\ species}$

AC = $\dfrac{number\ of\ ailment\ categories\ treated\ by\ a\ given\ species}{maximum\ number\ of\ ailment\ categories\ treated\ by\ the\ most\ resourceful\ species}$

Species Use value (SUV)
The Species use value was also calculated as [18]: UV = $\sum$U$/n$. Where $\sum$U = is the total number of use reports per species. n = represents the total number of informants interviewed for a given plant.

Family Use Value (FUV)
FUV was calculated as [19]: FUV = $\sum$UV$s/$(ns). Where ΣUVs = sum of the use values for all species belonging to a particular, ns = total number of species in the same family.

Fidelity Level % (FL)
It was calculated using the following equation [20]:FL(%) = Np/N x100.Where Np = number of informants who mentioned the plant species for a particular medicinal treatment. N= total number of informants who cited the plant species for various kinds of medicinal treatment.

RESULT AND DISCUSSION

Survey of 12 villages from Karaikal revealed 55 medicinal plants used for the treatment of 15 ailment categories (Table1) indicating the prevalence of traditional knowledge among the villagers. Similar results have been reported by various authors from different parts of South India[21]. The traditional knowledge practices among the villagers is inherited from their ancestor which is passed to the next generation orally. Some of the regularly used plants are either grown in homestead primarily for consumption or as ornamental plants, among which some are used for their medicinal properties[22]. Among the medicinal plants collected, 17 were grown in the kitchen garden or as ornamental plants and 38 were collected from the wild. The preference of wild plants was more among villagers as it is believed that material power of naturally growing plants was more compared to cultivated plants. These medicinal plants were distributed into 27 families. Fabaceae was the most dominant family represented by seven species followed by *Apocynaceae* (5 species), *Malvaceae, Lamiaceae, Solanaceae, Euphorbiaceae* (4 species), *Amaranthaceae, Acanthaceae* (3 species) and the rest represented by one or two species each (Fig. 2).Plants belonging to Fabaceae were predominantly used due to their abundance in the study site. The optimal climatic and environmental factor is a key player in determining the dominance of a particular family in a given region[23], [24]. Apart from being easily

available, Fabaceae contains flavonoids, alkaloids, coumarins and other metabolites [25], which helps in the treatment of various ailments and body system[26]. The abundance of Fabaceae is reflected by the repeated use of leaves of *Erythrina variegata* (Kalyana murungai) with rice as Dosa batter to treat chest mucus and phlegm. Among the 55 medicinal plants used, 41.8% were Herbs, 20% were Shrubs and Climbers, 10% were Tree and 7.3% Small Trees (Fig. 3). Herbaceous species are mostly used as medicinal plants as they are obtained from either secondary vegetations or home gardens. Herbs grow and disperse rapidly covering greater areas and quickly adapted to microclimatic conditions which provides suitable habitat for herb-dominating flora in the study area [10]. Further greater number of bioactive compounds drives people to select herbs as common source of medicine from a chemical view point of Ecology Apparency Hypothesis[27]. Similar result was reported by Rao *et al.,* [28] where wild herbaceous plants being predominant among indigenous medicinal plants from Charkhi Dadri district, Haryana. Leaves were mainly used (65%) in various mode of preparations while tuber and bark represented minimum usage (1%). However, in treatment of certain diseases the entire plant (8%) is used irrespective of any part (Figure 4).

For instance, decoction prepared from the entire plant of *Boerhavia diffusa* is given for the treatment of kidney disorders, cough, piles, skin disorders and jaundice. Leaves are preferred over other parts because they are continuously available as raw material, also their collection is easier compared to underground parts, fruits and flowers [29]. Further production of secondary metabolites by the leaves makes them a key candidate for medicine preparation[30].In the study low use of whole plant may be because it leads to the death of entire plant and the villagers prefer sustainable harvesting method. Of the total medicinal plants recorded, 69.8% of the medicinal plants were consumed and 30.1% were applied externally. The medicinal plants were administered in various forms. Pastes and decoction were predominantly used representing 27.6 and 24.62% respectively over other mode of preparation (Table 1). Paste from medicinal plants are the common mode of administration for treatment of diseases. According to the informants, plant parts either dried or fresh are grinded in oil or water to obtain paste from desired plants. For instance, roasted seeds of *Cleome viscosa* with gingelly oil made as paste is eaten with rice to reduce body heat and constipation. In addition, decoction also remains a choice of administration of medicinal plants where the plant parts are boiled in water or milk until the final volume is reduced to required concentration with preferred viscosity.

QUANTITATIVE ANALYSIS

The Relative Importance (RI) value ranged from 0.34 to 2.00 with highest recoded for *Boerhavia diffusa*(2.00) with seven pharmacological properties (PP) and five ailment categories (AC) with a normalised PP and AC (5/5) value of 1. The high RI value of *Boerhavia diffusa*is also supported by previous studies where it was used in the treatment of prostatic hyperplasia, Cardioprotective effect and Anti-inflammatory action[31]. Mishra *et al.*[32] also reported the use of *B. diffusa* for treating twelve diseases/organ system form different geographical locations of India. Further, Singh *et al.*[33] pointed out the partial or complete reversal of kidney damage and reduce the frequency of dialysis supporting the use of *B. diffusa* in treatment of kidney disorder by the villagers. The healing properties may be attributed to the presence of bioactive compounds in the extracts prepared from plant parts of *B. diffusa* [31]. Similarly higher relative importance value was been recorded for *Acalypha indica*, *Desmostachya bipinnata*, *Mimosa pudica* and *Solanum torvum* in previous ethnobotanical studies[34]. The high RI values of these medicinal plants in the study sites reflects high relative abundance. Similarly high resourcefulness of medicinal plants represents elevated array of bioactive compounds present in the species [24].

This suggests that some medicinal plants have diversified applications in comparison to other medicinal plants. Species Use Value (SUV)ranged from 0.02-0.82. The highest SUV was recorded for *Boerhavia diffusa* (0.82) followed by *Mimosa pudica* (0.75)and *Acalypha indica* (0.64) (Table 1). Higher SUV for *Boerhavia diffusa* which is further supported by Jana[35] who reported its use as medicine in some regions of India and also in other countries [36].The data obtained from RI and SUV clearly indicates the importance of *B. diffusa* among the villager as a therapeutic plant, which further suggests the easily accessibility and availability of this plant in the region. A direct relationship is observed between RI and SUV suggesting a link between the use of an individual medicinal plant and the number of informants interviewed, which is in accordance to the findings of Akhtar *et al.*[37]. The highest Family Use Value (FUV) was recorded for Poaceae (0.8) followed by *Annonaceae, Cleomaceae, Lythraceae, Phyllanthaceae* and *Nyctaginaceae*

(0.6) and the rest of the families had FUV values <0.6 (Fig. 2). Family Use Value indicates the high accessibility of families in the study site and the common use of dominant plant families by the villagers to treat diseases. High value of FUV indicates wider use of a plant species by the informant in the study area. The dominance of Poaceae is in accordance with other workers in folk medicine [38,39], plants belonging to Poaceae have been widely used for diarrhoea[40], liver damage, antioxidant activity, gastrointestinal ailments and gastric cancers [41].Diseases cured by the villagers using the medicinal plants were grouped into fifteen ailment categories. Gastrointestinal disorders (17) recoded the highest number of medicinal plants use followed by Respiratory disorders (13), Inflammation and pain; Dermatological disorder (10) and for other ailment categories less than ten medicinal plants were used. Gastrointestinal disorders are the most common ailments treated by the indigenous people of the study area using medicinal plants. Lack of proper hygiene and contaminated water leads to higher cases of gastrointestinal diseases. The Fidelity Level (FL) value of medicinal plants used ranged from 2.56 to 71.79 %.

Most of the plants were restricted to a particular disease however, certain plants were found to cure more than one ailment and were distributed among different ailment categories. *Desmostachya bipinnata* recorded the highest FL value (71.79%) for the treatment of Kidney stone followed by *Ricinus communis* (64.1%, Constipation), *Thespesia populnea*(61.54%, Piles) and rest had FL values <60% (Table 3).Reports from previous studies suggests that plants with high Fidelity level are mostly used for ethnobotanical purpose and should be used for further bioassays and phytopharmacological investigations[23]. Some species have low percentage of FL (2.56, 5.13%) explaining the low abundance of those plant in the study area. Species with low FL should not be neglected and their associated traditional knowledge should be preserved. The present investigation is the first quantitative valuation of ethnobotany of Karaikal. Results obtained represents useful ethnobotanical information that needs to be preserved as they are on the verge of extinction since the inclination of the newer generation towards modern medicines.

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Table 1. List of medicinal plants with Relative importance value > 0.60 and Species Use Value > 0.026 are presented below.

Sl. No	Scientific name	Family	Life form	Medicinal Uses and Mode of Preparation	RI	SUV
1	*Acalypha indica* L.	Euphorbiaceae	H	Leaf paste with salt and turmeric is applied to cure skin diseases. Decoction of leaves is used for cough, cold, indigestion problem and body pain	1.80	0.641
2	*Andrographis paniculata* (Burm. fil.) Nees	Acanthaceae	H	Leave paste used as an antidote for snake bite and roots are used for high blood pressure	0.80	0.051
3	*Annona squamosa* L.	Annonaceae	ST	The fruit is used to heal wounds, improves digestion and prevents constipation	1.00	0.077
4	*Basella alba* L.	Basellaceae	C	Leave decoction used to reduce body heat and cure ulcer	0.80	0.051
5	*Boerhavia diffusa* L.	Nyctaginaceae	H	Kidney disorders, cough, piles, skin disorders and jaundice.	2.00	0.821
6	*Cleome viscosa* L.	Cleomaceae	H	Roasted seeds with gingelly oil made as paste eaten with rice reduce body heat and constipation. It is used in rheumatic arthritis	1.20	0.077
7	*Clitoriaternatea* L.	Fabaceae	C	Root paste is used for skin related problems. The plant extracts relieve indigestion and helps metabolism of food	1.00	0.077
8	*Colocasia esculenta*(L.) Schott	Araceae	H	Regular intake of boiled tuber cures constipation and increases blood haemoglobin level	0.80	0.051
9	*Cardiospe*	Sapindaceae	C	The leave paste along with rice batter strengthens	0.80	0.051

	rmum halicacabu m L.			nervous system and cures rheumatism		
10	*Desmosta chyabipin nata* (L.) Stapf	Poaceae	H	Leaf paste used to treat skin disease, Decoction of roots treats diarrhoea, kidney stone.	1.60	0.103
11	*Ipomoea sepiaria* Koenig e x Roxb.	Convolvulac eae	C	Leaves are used as hair pack, reduces body heat, Increases hair growth	0.80	0.051
12	*Lawsoniai nermis* L.	Lythraceae	S	Leaves paste applied in nails to protects from fungus and taken in empty stomach with cow milk for 40 days cures itching and rashes.	1.00	0.077
13	*Melia azedarach* L.	Meliaceae	T	leaf Juice in empty stomach cures menstrual pain and worms	0.80	0.051
14	*Mimosa pudica* L.	Fabaceae	H	Leaf decoction is used to treat dysentery, leprosy, stomach worms, piles and urinary infection	1.60	0.769
15	*Morindaci trifolia* L., nom. cons.	Rubiaceae	T	Leaves along with Adathoda Tamarind, Nochi are boiled for body pain.Fruit decoction to heal cut wounds	0.80	0.051
16	*Ocimuma mericanu m* L.	Lamiaceae	H	The leaves are made into paste and applied for skin disease. The seeds are soaked in water is used to reduce body heat	0.80	0.051
17	*Phyllanth us niruri* L.	Phyllanthace ae	H	leaf Paste mixed with cow milk taken in empty stomach for 3 days cures jaundice. The leaf juice is used to bladder infections and diarrhoea	1.20	0.077
18	*Ricinus communis* L.	Euphorbiace ae	S	Applying oil in the abdomen area treats Menstrual pain and constipation	0.80	0.051
19	*Ruellia tuberosa* L.	Acanthaceae	H	Leaf paste is used against inflammation. Decoction of roots is given to reduce blood sugar level	0.80	0.051
20	*Solanum nigrum* L.	Solanaceae	H	The leaves used to cure stomach and mouth ulcers	0.80	0.051
21	*Solanum trilobatu m* L.	Solanaceae	C	The flowers are roasted with gingelly oil treats cold, cough and throat relate problems	1.00	0.077
22	*Solanum torvum* S w.	Solanaceae	S	leaf paste used against Wounds along with lime. Leaf juice is used to treat fever, asthma and stomach ache. Fruit used against malaria	1.60	0.103
23	*Tephrosia purpurea* (L.) Pers.	Fabaceae	H	Dried plant is used as a blood purifier. Fruit decoction is used against intestinal worm. Fruit extract is used to relieve body pain	1.20	0.077
24	*Thespesia populnea* (L.) Solan	Malvaceae	T	The decoction of bark is used to cure dysentery, piles and diabetes	1.00	0.077

	d. ex Cor rea				
25	*Tinospora cordifolia* (Willd.) Miers	Menisperma ceae	C	Leaf decoction is used to cure diabetes. It acts as a blood purifier.	0.80	0.051
26	*Vernonia cinerea* (L.) Less.	Asteraceae	H	Leaf paste is applied over the wounds and swelling. Root paste is applied against Elephantiasis	0.80	0.051
27	*Vitex negundo* L.	Lamiaceae	H	leaf juice in empty stomach cure chest mucus and cold. Boiled leaves for bath reduces body pain.	0.80	0.051

Note: Life form: S= Shrub, H= Herb, ST= Small Tree, SS= Sub Shrub, C= Climber, T= Tree
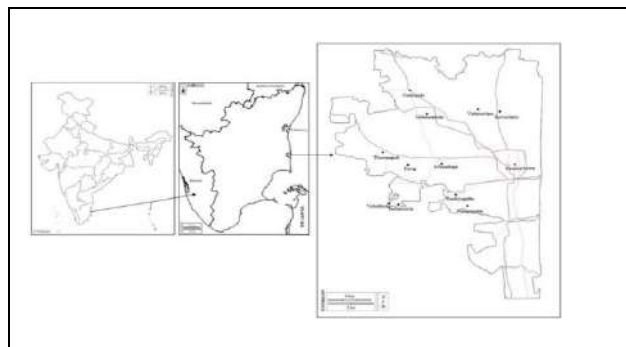
Figure 1: Location of the study area represented by Black dots in Karaikal district map. The shape file of the map is adopted from d-maps.com.
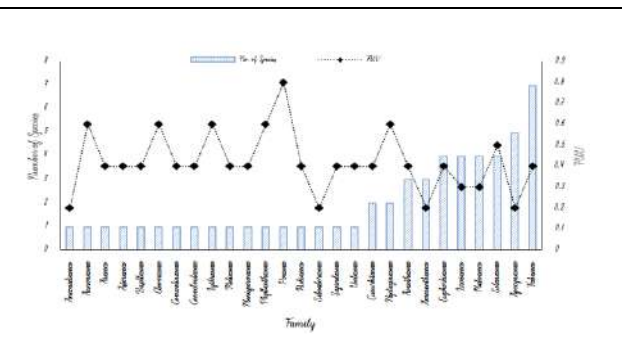
Figure 2. Number of species per family and Family Use Value (FUV) of medicinal plants.
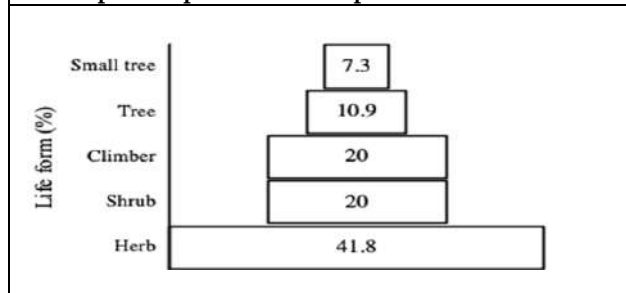
Figure 3. Percentage of Life form used by the villagers of Karaikal.
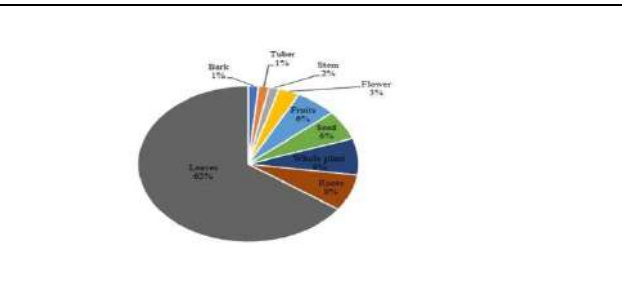
Figure 4. Percentage of medicinal plant parts used for various mode of preparation by the villagers of Karaikal.

Figure 5: Fidelity level (%) of medicinal plants used by the villagers of Karaikal. Medicinal plants with FL% > 25.0 are presented in the Chart.

RESEARCH ARTICLE

Simultaneous Estimation of Bempedoic Acid and Ezetimibe by RP-HPLC

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ABSTRACT

For the simultaneous determination of bempedoic acid and ezetimibe, a simple, accurate, trustworthy, quick, and reproducible reversed-phase high performance liquid chromatography technique was created and validated. On Xbridge C18 (250 4.6 mm, 5 m), chromatography is performed isocratic ally with a mobile phase that contains 0.1% orthophosphoric acid and acetonitrile in a ratio of 90:10 (v/v) and flows at a rate of 0.9 ml/min. A PDA detector operating at 290 nm was used for the detection process. According to the ICH-Q2 (R1) recommendations, parameters including linearity, precision, accuracy, recovery, specificity, and ruggedness are investigated. Bempedoic acid and ezetimibe had retention periods of 2.97 and 6.97 minutes, respectively. Bempedoic Acid's linearity range is 30-225 g/ml and Ezetimibe's is 150-1125 g/ml, respectively. Bempedoic acid and ezetimibe had correlation values of 0.9975 and 0.9782, respectively. The suggested approach may be helpful for pharmaceutical dosage forms and bulk manufacturing quality control.

Keywords: Bempedoic Acid, Ezetimibe , HPLC, Validation, Retention time.

INTRODUCTION

The treatment of adults with heterozygous familial hypercholesterolemia or established atherosclerotic cardiovascular disease who need additional lowering of LDL-C, bempedoic acid and ezetimibe are an adenosine triphosphate-citrate lyase (ACL) inhibitor and a cholesterol absorption inhibitor combination. Adenosine triphosphate-citrate lyase (ACL) inhibitor bempedoic acid. Bempedoic acid is also known by its chemical name, 8-hydroxy-2,2,14,14 tetramethyl-pentadecanedioic acid. The molecular weight per mole is 344.5 grams, and the chemical formula is $C_{19}H_{36}O_5$. Insoluble in water and aqueous solutions below pH 5, bempedoic acid is a white to off-white crystalline powder that is highly soluble in ethanol, isopropanol, and pH 8 phosphate buffer. Ezetimibe belongs to a group of lipid-lowering drugs that specifically prevents the absorption of cholesterol and related phytosterols from the intestinal tract. Ezetimibe's chemical name is 1- (4-fluorophenyl) - 3(R) (R) -[3-(4-fluorophenyl)-3(S)-hydroxypropyl] -4(S)-(4-hydroxyphenyl) -2-azetidinone. The actual equation is $C_{24}H_{21}F_2NO_3$. It has a molecular mass of 409.4. A white, crystalline powder known as ezetimibe is virtually insoluble in water but readily to highly soluble in ethanol, methanol, and acetone. Ezetimibe is stable at room temperature and has a melting point of around Various spectrophotometric and chromatographic techniques [1–13] are available for the simultaneous determination of ezetimibe in combination dose form together with other medications, according to the aforementioned literature review. This study presents a challenge for the creation of a novel high performance liquid chromatography technique. Additionally, there is currently no way for simultaneously estimating bempedoic acid and ezetimibe using liquid chromatographic techniques. In order to simultaneously estimate bempedoic acid and ezetimibe, a speedy, accurate, and high performance liquid chromatographic analytical technique was developed as the main goal of this study. The method was then validated in compliance with ICH recommendations[14-16].

MATERIALS AND METHODS

Instrumentation
On an Agilent chromatographic system with a 1200 series isocratic pump, a Rheodyne injector with a 20-l fixed volume loop, and a variable wavelength programmable UV detector, chromatographic separation was carried out. EZICHROME ELITE Chromatographic Software was used to monitor and integrate the output signal. Spectral analysis was performed using a double beam UV-Visible spectrophotometer (Labindia-3120), and UVWIN-5 software was utilized to record the results. Mobile phase and samples were degasified using a 1.5L ultrasonicator. Using a Shimadzu electronic analytical balance (AX-220), standard and sample medicines were weighed, and the pH of the mobile phase was adjusted using a Systronics digital pH meter.

Solvents And Chemicals
The HPLC grade was utilized for all compounds and reagents. The study's pure standards of bempedoic acid and ezetimibe came from MICRO LABS in Bangalore as a gift sample. The other chemicals utilized were HPLC grade water from Merck chemicals in Mumbai, India, Methanol and Acetonitrile from Qualigens ltd. in Mumbai, India, OrthoPhosphoric Acid from Hi-media in Mumbai, India.

Chromatographical Circumstances
HPLC was utilized for separation and estimation (waters-2469 with PDA detector); the Xbridge C18 (250 4.6 mm, 5 m) column was employed in the experiment. The mobile phase was made by combining 0.1% orthophosphoric acid, a buffer with a pH adjustment of 2.5, and acetonitrile in a 90:10 ratio. The detection was at 290 nm, and the injection volume was 20 l.

Standard stock solution preparation
By precisely weighing roughly 100 mg of the medication, transferring it to a 100 ml volumetric flask, and dissolving it in diluent, a standard stock solution of bempedoic acid and the pure medicine ezetimibe (1 mg/ml) was created.

Buffer preparation (pH adjusted to 2.5, 0.1% orthophosphoric acid)
One milliliter of concentrated orthophosphoric acid was accurately weighed and transferred into a volumetric flask with 1,000 milliliters of water. Then, 900 milliliters of milli-Q water, 1 milliliter of triethylamine, and 10 minutes of ultrasonic water bath degassing were added. Finally, the volume was made up with water, and the pH was then adjusted to 2.5 with a dilute orthophosphoric acid solution. Filter through 0.45 vacuum filtered material.

Setting up the Mobile Phase
The mobile phase was made up of newly made 0.1% OrthoPhosphoric Acid buffer solution (PH 2.5) and Acetonitrile in a ratio of 90:10 (v/v). Prior to use, the mobile phase was filtered through a 0.45 membrane filter and sonicated.

Making The Diluent
Add 50ml of milli-Q water and the measured 50ml of methanol to the 100ml volumetric flask. before use, filtered through a 0.45 membrane filter and ultrasonicated.

VALIDATION OF METHOD

Specificity
To test for potential interference peaks, a solution comprising a combination of tablet was made following the sample preparation process and injected into the system.

System suitability
On freshly generated standard stock solutions of bempedoic acid and ezetimibe, system suitability tests were conducted. The Standard concentration was blended well in an equal volume. The proposed method's system appropriateness was expressed using the results of the injection of 20 l of the sample into the produced solution into the HPLC system. The results were depicted in Table.1.

Precision & Range
Bempedoic Acid and Ezetimibe were synthesized in a series of standard concentrations ranging from 50% to 150% of the desired concentration. By performing a single test at various analyte concentrations with changing stock standard solution volumes diluted with the mobile phase to provide concentrations of 30, 75, 105, 150, 180, 225 g/ml of bempedoic acid and 50, 75 525, 750, 900, 1125 g/ml of ezetimibe, linearity was evaluated. Bempedoic Acid's linearity was discovered to be between 30-225 g/ml, whereas ezetimibe's was 50-1125 g/ml. To determine the linearity range, the peak area of the medication was plotted against the relevant concentrations on the chromatograms, which were then recorded. Table 2., Fig. 2., and Fig. 3. show the results.

Precision
The test sample assay technique with six duplicates was used to conduct the intra-day and inter-day precision experiments on both the same day and other days. Table presented the findings. No- 3.to 4.

Accuracy (Recovery)
By estimating the recoveries of bempedoic acid and ezetimibe using a standard adds technique, the method's accuracy was evaluated. The amount of Bempedoic Acid and Ezetimibe was estimated by measuring the peak areas and by fitting these values to the straight-line equation of the calibration curve. Known amounts of Bempedoic Acid and Ezetimibe were added to a pre-quantified sample solution (containing Bempedoic Acid and Ezetimibe in 100 g/ml proportion, respectively). The findings are shown in Table No-5. to 6.

Robustness

Changes in mobile phase ratio, mobile phase flow rate, and detector wavelength were used to test robustness. The test was run under chromatographic circumstances with a little fluctuation at a concentration equivalent to the standard concentrations of bempedoic acid and ezetimibe, 100 g/ml and 100 g/ml, respectively, and %change was computed. The results' percentage change was computed. The results were depicted in Table. No-7.

Limits of quantification and detection

The lowest concentration of an analyte that can be reliably distinguished from background levels is known as the limit of detection (LOD). The smallest amount of analyte for which a quantitative determination may be made with the necessary precision and accuracy is known as the limit of quantification (LOQ) of a certain analytical process. According to ICH recommendations, LOD and LOQ were determined using the following equation. Where is the standard deviation of the y-intercepts of regression lines and S is the slope of the calibration curve, LOD = 3.3% and L OQ = 1.0%.The results were depicted in Table. No- 8.

Solution Stability

Using standard and test stock solutions, the stability of the solution was evaluated. The% differences were calculated after these stocks were made and kept for 36 hours at room temperature and in a refrigerator (2-8°C).The results were depicted in Table. No.9 to 12.

Validation of filters

To find out how filters affected the assay, dissolution, and impurities, a research was undertaken. According to the test technique, a test solution was created. The aforementioned solution was divided into three portions, each of which was filtered through a 0.45 mm PVDF, PTFE, and nylon filter before being centrifuged and added to the HPLC apparatus. Calculated results for the percent differences between the centrifuged and filtered samples. The results were depicted in Table. No.13.

RESULTS AND DISCUSSION

Conditions were tuned in this RP-HPLC process to provide a good separation of eluted chemicals. To separate analytes, several mobile phase compositions were initially tested. Based on peak characteristics (height, tailing, theoretical plates, capacity, or symmetry factor), run time, and resolution, the mobile phase and flow rate were chosen. It was discovered that the 0.1% orthophosphoric acid buffer system in combination with acetonitrile (90:10) at a flow rate of 1.0 ml/min was a reliable approach. For the quantification of bempedoic acid and ezetimibe in pharmaceutical formulations, the developed method was validated in accordance with the ICH guidelines. Various system suitability parameters were subjected to a suitability test, and the results were within acceptable bounds of tailing factor 2.0 and theoretical plates >2000. Bempedoic Acid and Ezetimibe concentrations in the range of 30-225 g/ml and 50-1125 g/ml were used to generate the calibration curve. This led to the conclusion that the approach was linear across the whole range chosen. The measurement of excipients in the tablet dosage form of bempedoic acid and ezetimibe was examined for specificity. The findings showed that none of the excipients interfered with the analytes' retention period. As a result, the created procedure was particular. The repeatability of the method, which was established by a sufficient number of aliquots of a homogeneous sample during the day (intraday precision), and the following three days for inter day precision, was used to quantify the precision of the method. RSD was computed for each example and the results were within acceptable bounds.

The approach was accurate as evidenced by the low RSD results. Calculated recovery percentages for each case ranged from 99.98 to 100.18% for bempedoic acid and from 99.51 to 100.09 for ezetimibe, indicating that the results were acceptable. As a result, the developed method is accurate over the chosen range. Small variations in the chromatographic conditions were used to verify robustness, and a percentage change was determined. The results'% change was computed, and it was determined to be robust because the %change was less than 2.0%. The detection

limit may usually be estimated with a signal-to-noise ratio of 2:1. LOD for bempedoic acid is 2.50034 g/ml and for ezetimibe is 7.5767 g/ml, whereas LOQ is 2.94827 g/ml for bempedoic acid and 8.934 g/ml for ezetimibe. Since the area difference between the sample and the reference solution was less than 2.0%, they are both stable at 5 °C for 36 hours. Filter interference tests were conducted on three different types of 0.45-inch filters (Nylon, PVDF), and the results showed that the difference between sample solutions and standard solutions, when measured against centrifuged samples and standards, was less than 2.0%.

CONCLUSION

As a result, the approach created for this inquiry is straightforward, sensitive, accurate, hardy, robust, quick, and exact. The lack of extra peaks in the chromatogram demonstrated that the common excipients used in the tablets did not interfere with the analysis. As a result, the described approach may be used to estimate bempedoic acid and ezetimibe simultaneously in dosage forms using RP-HPLC.

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Table.1.System Precision of Bempedoic Acid and Ezetimibe

Retention Time	Bempedoic Acid	0.27 min
	Ezetimibe	0.73 min
Peak Area	Bempedoic Acid	1963213
	Ezetimibe	8824977
Theoretical plates	Bempedoic Acid	3699
	Ezetimibe	5430
Tailing Factor	Bempedoic Acid	1.4
	Ezetimibe	1.32
Resolution	Bempedoic Acid	-
	Ezetimibe	5.9

Table.2.Linearity and range of Bempedoic Acid and Ezetimibe

1	30	386185	50	956891
2	75	960922	75	1105678
3	105	1355242	525	6040731
4	150	1963213	750	8824977
5	180	2357969	900	10595121
6	225	2942729	1125	13242269
Concentration range		30-225µg/ml	150-1125ml	
Slope (m)		150036	18956	
Correlation coefficient		0.9975	0.9782	

Table. 3.Intraday precision data for Bempedoic Acid and Ezetimibe

Sample. No	Area of Bempedoic Acid	Area of Ezetimibe
1.	1440866	6484965
2.	1428777	6594345
3.	1430407	6560373
4.	1423047	6576012
5.	1421048	6524590
6.	1442223	6501156
Mean	1431061	6540240
SD	8841.45	43451.43
%RSD	0.617	0.664

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Table.4.Inter day precision data for Bempedoic Acid and Ezetimibe

Sample. No	Area of Bempedoic Acid	Area of Palonosetron
1.	1416000	6987622
2.	1463054	6906570
3.	1494373	6729675
4.	1437579	6762279
5.	1459677	6873276
6.	1458394	6729367
Mean	1454846	6814798
SD	26354.6	107067.2
%RSD	1.80	1.50

Table.5.Accuracy of Bempedoic Acid

Level of % recovery	Target Conc. (µg/ml)	Amount of drug Spiked (µg/ml)	Amount found (µg/ml)	% Recovery	Mean	SD	% RSD
80	180	144	144.29	100.20	99.62	0.86	0.86
			144.04	100.03			
			142.03	98.63			
100	180	180	180.04	100.02	100.04	0.02	0.02
			180.08	100.04			
			180.11	100.06			
120	180	216	214.68	99.39	100.20	0.85	0.85
			218.36	101.09			
			216.25	100.12			

Table.6.Accuracy of Ezetimibe

Level of % recovery	Target Conc. (µg/ml)	Amount of drug spiked (µg/ml)	Amount found (µg/ml)	% Recovery	Mean	SD	% RSD
80	900	720	721.45	100.20	99.62	0.86	0.87
			720.23	100.03			
			710.14	98.63			
100	900	900	900.23	100.03	100.05	0.02	0.02
			900.43	100.05			
			900.56	100.06			
120	900	1080	1078.32	99.84	100.35	0.99	0.99
			1096.18	101.50			
			1076.97	99.72			

Table. 7.Robustness of Bempedoic Acid & Ezetimibe

S. No	Parameter	Condition	Bempedoic Acid		Ezetimibe	
			Area (n=3)	% change	Area (n=3)	% change
1	Standard	Standard conditions	1438318	0	6529991	0
2	Mobile phase	0.1%OrthoPhosphoric acid (pH-2.5): Acetonitrile	1414243	0.1	6527790	0.14

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		0.1%OrthoPhosphoric acid (pH-2.5): Acetonitrile (95:5%v/v)	1446992	1.33	6536602	0.55
3	Mobile phase pH	2.7	1432336	0.83	6526608	0.11
		2.3	1423680	0.52	6553068	0.56
4	Wavelength	288nm	1446791	0.19	6490488	0.07
		292 nm	1438318	0.23	6527425	1.51
5	Flow rate	1.2	1414243	0.25	6490465	0.07
		0.8	1446992	0.18	6527234	1.51

Table. 8.LOD and LOQ of Bempedoic Acid & Ezetimibe

Parameter	Bempedoic Acid	Ezetimibe
LOD(µg/ml)	2.50034	7.5767
LOQ(µg/ml)	2.94827	8.9341

Table.9. Solution Stability of Bempedoic Acid at room temperature

Time	Standard stock			Test stock		
	Fresh	Stability Stock	% Diff.	Fresh	Stability Stock	% Diff.
Initial	1438318	1438543	NA	1438324	1438312	NA
6hrs	1414243	1414240	0.1	1414268	1414245	0.7
12hrs	1446992	1446981	0.0	1446911	1446993	0.9
20hrs	1432336	1432333	0.3	1432362	1432339	1.2
26hrs	1423680	1423626	0.8	1423682	1423681	0.1
30hrs	1446791	1446791	0.2	1446797	1446795	0.4
36hrs	1433727	1433761	0.5	1433729	1433721	0.8

Table.10.Solution Stability of Ezetimibe at room temperature

Time	Standard stock			Test stock		
	Fresh	Stability Stock	% Diff.	Fresh	Stability Stock	% Diff.
Initial	6529991	6529992	NA	6529993	6529990	NA
6hrs	6527790	6527793	0.1	6527795	6527793	0.7
12hrs	6536602	6536645	0.0	6536601	6536605	0.9
20hrs	6526608	6526662	0.3	6526607	6526601	1.2
26hrs	6553068	6553061	0.8	6553068	6553067	0.1
30hrs	6490488	6490482	0.2	6490481	6490489	0.4
36hrs	6527425	6527421	0.5	6527424	6527421	0.8

Table. 11.Solution Stability of Bempedoic Acid at refrigerated temperature

Time	Standard stock			Test stock		
	Fresh	Stability Stock	% Diff.	Fresh	Stability Stock	% Diff.
Initial	1438312	1438318	NA	1438318	1438311	NA
6hrs	1414241	1414243	0.1	1414243	1414247	0.7
12hrs	1446993	1446990	0.0	1446991	1446996	0.9
20hrs	1432335	1432336	0.3	1432356	1432332	1.2
26hrs	1423686	1423680	0.8	1423620	1423685	0.1
30hrs	1446792	1446791	0.2	1446701	1446790	0.4
36hrs	1433723	1433727	0.5	1433722	1433722	0.8

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Table. 12.Solution Stability of Ezetimibe at refrigerated temperature

Time	Standard stock			Test stock		
	Fresh	Stability Stock	% Diff.	Fresh	Stability Stock	% Diff.
Initial	6529991	6529993	NA	6529909	6529993	NA
6hrs	6527790	6527795	0.1	6527792	6527791	0.7
12hrs	6536602	6536602	0.0	6536601	6536600	0.9
20hrs	6526608	6526609	0.3	6526608	6526604	1.2
26hrs	6553068	6553060	0.8	6553062	6553012	0.1
30hrs	6490488	6490484	0.2	6490486	6490432	0.4
36hrs	6527425	6527422	0.5	6527423	6527421	0.8

Table. 13.Filter Interference Results for Bempedoic Acid   & Ezetimibe

Bempedoic Acid				
Filtration Method	Centrifuged	Nylon	PTFE	PVDF
Area (Inj. 1)	1438318	1438313	1438312	1438319
Area (Inj. 2)	1414243	1414244	1414241	1414242
Avg. Area	1446992	1446995	1446996	1446992
% Difference		-0.2	0.2	0.5
Ezetimibe				
Filtration Method	Centrifuged	Nylon	PTFE	PVDF
Area (Inj. 1)	6529990	6529990	6529994	6529991
Area (Inj. 2)	6527792	6527791	6527795	6527790
Avg. Area	6536603	6536602	6536602	6536602
% Difference		-0.4	0.3	0.5

163°C.

A	B
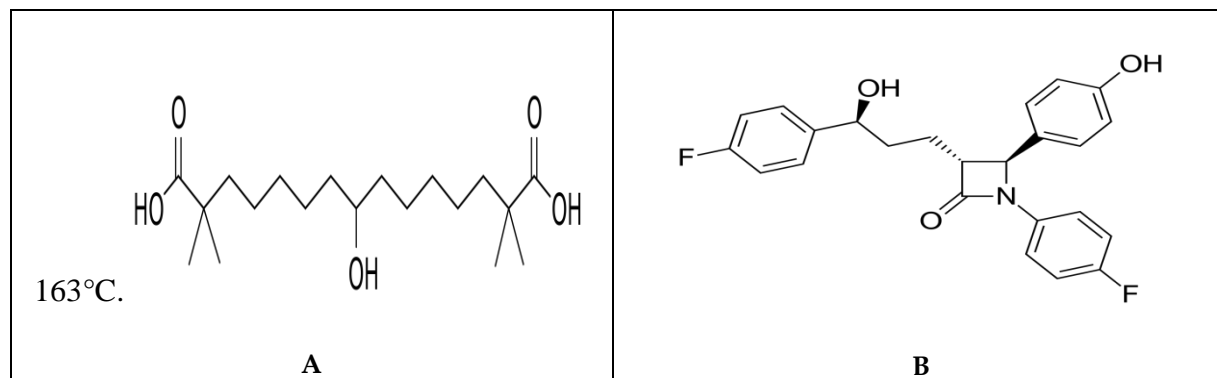
Fig.1.Chemical structures of A) Bempedoic acid B) Ezetimibe

Fig. 2: Linearity of Bempedoic Acid	Fig. 3: Linearity of Ezetimibe

51187
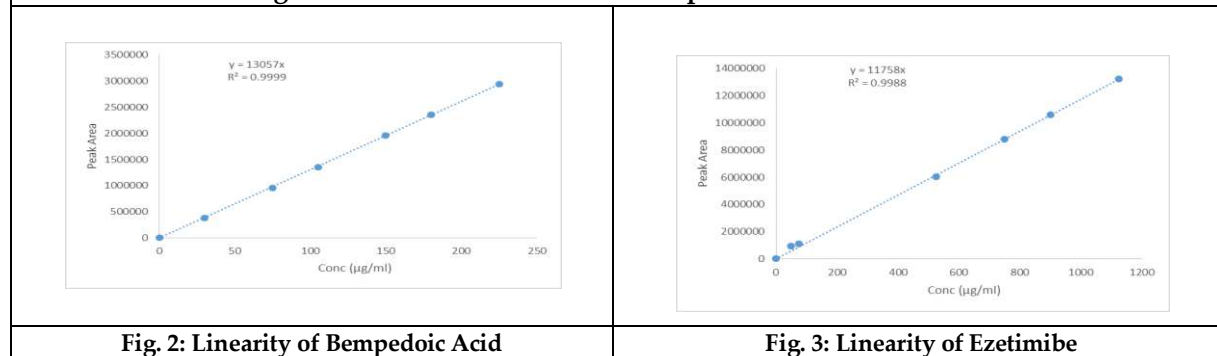
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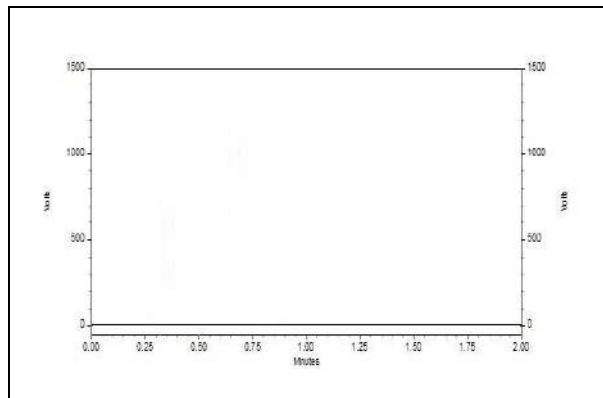
Fig.4: Blank chromatogram of Bempedoic Acid & Ezetimibe	Fig.5: Chromatogram of Bempedoic Acid & Ezetimibe
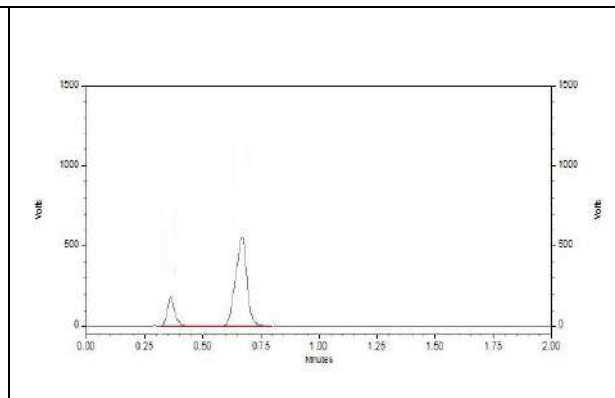
RESEARCH ARTICLE

Effect of Isolated Mixed Interval and Continued Training on Speed Components among College Level Kabaddi Players

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ABSTRACT

Sports reflect the changes in societies and cultural activities that range from individual values such as regulations and simplicity to collectives like equality, general ones like belief in effort. That is capitalistic belief of the survival of the fittest. Sports couldn't see the discretely in human being. Sports develop unity and diversity. It can even play a helpful role in integrating image building for individuals, groups or humanities. Kabaddi game is developing the physical and mental of the human being. The word of kabaddi says withhold breath due to increasing the body aerobic and mental concentration power. The present explored effect of isolated mixed interval and continued training on speed components among college level kabaddi women players. The study were conducted among 60 women college kabaddi player aged 18 to 25 years. The speed performance was evaluated to speed variables as speed stride length variables of kabaddi before the training and after 8 weeks of training. The subjects were randomly assigned into four groups, namely interval exercise group, continuous exercise group, combined interval and continuous group and control group. Statistically significant improvements in baseline scores in speed stride length variables kabaddi were comparable between the four groups of college kabaddi players. Speed stride length improved by 1.63 in continued group, 1.65 in the interval group 1.68 combined interval and continued group 1.52in the control group. Additional research on long-duration intervention in elite players may help to establish the role of combined interval and continued training in conventional kabaddi skills for training.

Keywords: Interval training, continued training, speed, kabaddi, stride length

INTRODUCTION

National and International level, sports and games have increased an important place for celebrities and become enormously popular. Sports reflect the changes in societies that range from individual values such as self-control and simplicity to collectives like equality, general ones like belief in effort. Sports couldn't see the discretely in social being. Sports develop unity and diversity. It can even play a constructive role in integrating image building for individuals, groups or cultures. In the most recent years, awareness has been focused on different methods of fitness programmes for improving performance. The professor and coach looking for the best emerging essential physical fitness qualities must consider various kinds of sports training. This has made the investigator grow a keen interest in that area to discover a form of exercise (interval exercise and continuous training) that develops both speeds and endurance parameters among Kabaddi players. The Game of kabaddi has various aerobic, anaerobic, explosive, cognitive and muscular strength factors (Dev 2012). Kabaddi game learns how to breathe; simply obtain flexibility and agility and speed (10 -12 m on the court). Because of flexibility, the player's eyes and body move fast. We can kick, spin and grapple with ankle legs. Strong muscle leg uses to kick by quickness acceleration. Kabaddi games have many more movement involving forward running, backward, side, jumping, grappling, touching, pushing and dogging. This movement is doing the short time with the strategic of skills. The players are intent every second during the game period. Kabaddi is a team game of physical components.

METHODOLOGY

The Methodology for the present investigation is on the effect of isolated mixed interval and continued training on speed components among college level women kabaddi players**.** The purpose of study 60 women students selected from various colleges in PeriyarUniversity Inter collegiate women players, Salem,Tamilnadu. Their age ranges between 18 to 25 years .the subjects were randomly assigned into four groups, namely experimental group I (interval training), Experimental group II (continued training), experimental group III (combined interval and continued training) and control group. In order to ensure the full cooperation from the subjects, the scholar had a meeting with them and explained the purpose of the study. It was made clear by explanation in order to ascertain that there was no abstruseness among the players regarding the effort, which they had to put in for the effective completion of this study. Experimental group I participated for a period of 8 weeks interval training. Experimental group II participated for a period of 8 weeks continued training. Experimental group III for a period of 8 weeks combined interval and continued training and Control group no training. The subjects were verified on selected criterion variables speed variables as stride length kabaddi players before the training and after 8 weeks of training.

Training Procedure
Experimental Group-I undertook interval training, experimental Group-II undertook continued training and experimental Group-III undertook combined training respectively. The control group was not exposed to any specific training / conditioning programme. The experimental treatments namely interval training, continued training and combined training was administrated for duration of 8 weeks and the number of session per week was confined to three alternative days and each session continued 60 minutes.

Statistical Technique
The collected data from the three groups prior to and after the experimental treatments on selected speed components variable was statistically analyzed by using the statistical technique of analysis of covariance (ANCOVA). Whenever the 'F' ratio for adjusted post-test means was found to be significant, Scheffe's test was followed as a post hoc test to determine which of the paired means difference was significant. In all the cases 0.05 level of confidence was fixed as a level of confidence to test the hypotheses.

RESULTS AND ANALYSIS

The influence of independent variables on each of the criterion variables is analyzed and presented below. The training period was limited to eight weeks. The dependent variables selected for this study was speed components stride length. All the subjects were tested prior to and immediately after the experimental period on the selected dependent variables. The data obtained from the experimental groups before and after the experimental period were statistically analyzed with dependent's'-test and Analysis of covariance (ANCOVA). Whenever the 'F' ratio for adjusted post-test means was found to be significant, the Scheffe's Post Hoc test was applied to determine the paired mean differences. The level of confidence was fixed at 0.05 level for all the cases.

CONCLUSION

The findings of the study showed that there was a statistically significant improvement in the speed components stride length variables kabaddi players as compared to control group.

1. The results of the study shows that the experimental group-I that had undergone interval training group, improved speed components namely stride length kabaddi players.
2. The results of the study shows that the experimental group-II that had undergone continued training group, improved speed components namely stride length kabaddi players.
3. The results of the study shows that the experimental group-III that had undergone combined training group, improved speed components namely stride length kabaddi players.

RECOMMENDATIONS

It is recommended that coaches and physical educators in the game of kabaddi should give due to include interval training group, continued training group and combined training group in their training schedules. In the physical exercise, while designing the training programme the effect of varied training modalities is explained on positively on physical fitness parameters and skill performance variables of kabaddi players, the physical education teachers and coaches can prefer this type of training so as to achieve aim in time.

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Table 1: Computation of Analysis of Covariance of pre test, post test and adjusted post test on Stride Length of Experimental groups and Control group

Test	Interval Exercise group	Continued exercise group	Combined group	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	F-ratio
Pre-Test Mean	1.53	1.53	1.53	1.52	Between groups	0.001	3	.000	0.21
					Within groups	0.060	56	0.001	
Post-Test Mean	1.63	1.65	1.69	1.54	Between groups	0.180	3	0.060	50.28*
					Within groups	0.067	56	0.01	
Adjusted Post-Test Mean	1.63	1.65	1.68	1.54	Between sets	0.170	3	0.057	58.64*
					Within Sets	0.053	55	0.001	

* Significant at 0.05 level of confidence

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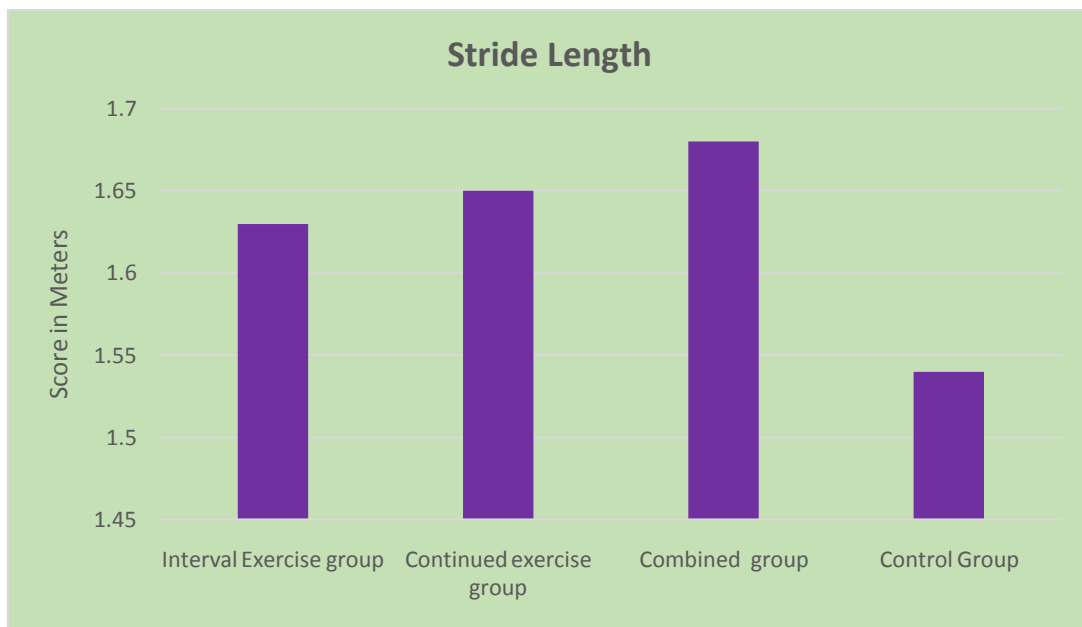
Figure 1. The Pre and Post test Mean Values of interval Training group, Continued Training group, combined training and Control group on Stride Length

RESEARCH ARTICLE

NANO Lipid based Drug Delivery System of Anti Malarials Formulation and Evaluation

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ABSTRACT

Artemether is an efficient antimalarial medication with a unique sesquiterpene lactone with a peroxy group that was obtained from the Artemisia annua (Compositae) plant. It is triggered by intraparasitic heme iron, which catalyzes the cleavage of the endoperoxide, inside malaria parasites. It has good antimalarial efficacy with low toxicity because of its unique structure and mode of action. Though long-term use of several medications, particularly artemisinin, might result in antimalarial resistance, WHO revised its guideline on treating malaria in February 2004 and suggested ending the use of single antimalarial treatments.

Keywords: Artemether - Nanolipid New chemical entity   nano-liposomes Differential screening calorimeter Artemether& lumefantrine Fourier transform infrared spectroscopy

INTRODUCTION

The most deadly illness, malaria, is common in tropical and subtropical regions of the world and kills between 1-2 million people annually (Carballeira et al, 2008; Greenwood et al., 2002). The four different species of Plasmodium that cause malaria in humans are *P. vivax, P. falciparum, P. malariae*, and *P. ovale.* There are very few clinically useful antimalarial medications currently being used. The major causes of the current antimalarial medicines' subpar clinical performance include issues with low and variable oral bioavailability, a lack of dosage proportionality, and gastrointestinal tract degradation. The main obstacles to combating malaria are rapid medication resistance and

widespread prevalence. Additionally, it takes a long time to discover new chemical entities (NCEs) and introduce successful formulations to the market. (Aditya et al., 2012). Artemether is an efficient antimalarial medication with a unique sesquiterpene lactone with a peroxy group that was obtained from the *Artemisia annua* (Compositae) plant. It is triggered by intraparasitic heme iron, which catalyzes the cleavage of the endoperoxide, inside malaria parasites. It has good antimalarial efficacy with low toxicity because of its unique structure and mode of action. Though long-term use of several medications, particularly artemisinin, might result in antimalarial resistance, WHO revised its guideline on treating malaria in February 2004 and suggested ending the use of single antimalarial treatments. Combination treatment, which involves the engagement of two antimalarial agents with separate site and mode of action, may show to be beneficial in enhancing the therapeutic efficiency of already available medications.

Artemether and lumefantrine (Figure 1.1) are the ACTs used most frequently to treat uncomplicated malaria. This discovery could be attributed to the combined benefits of lumefantrine and artemether. Plasmodium schizonts and a few of drug-resistant malaria strains respond to artemethrin initially. However, the short duration of effect and high recurrence rate of artemether have been cited as important drawbacks. Lumefantrine had a less than 95% death rate and a less than 5% recurrence rate for Plasmodium, however the impact took time to manifest. As a result, on April 8, 2009, the USFDA authorized the combination oral tablets. Even though this combination has a high percentage of effectiveness, its main drawback in the oral dose form is that it cannot be employed in clinical settings for malaria emergency treatment. Lumifantrine has a poor bioavailability, a low solubility in aqueous medium, and degrades at an acidic pH within the stomach despite the positive clinical outcomes. Additionally, patients should consume high-fat diets to prevent poor and/or unpredictable lumefantrine absorption. Lumefantrine must be administered at a higher dose and more often to be clinically effective. Lumefantrine doses have recently been raised to 1,840 mg and even 2,880 mg (Yufan et al., 2014). This would surely raise the financial burden and possibly hasten the emergence of medication resistance. It is important to create a novel formulation of artemether with lumefantrine for parenteral administration for the treatment of malaria emergencies in clinical settings in order to get around the aforementioned limitations. In the past, attempts to combat malaria have been made using solid dispersions (Abdul-Fattah et al., 2002), liposomes (Stensrud et al., 2000), date et al., 2007, immunoliposomes (Owais et al., 1995), polymeric nanoparticles (Rodrigues et al., 1995), and dendrimers (Bhadra et al., 2005).

Different forms of route of administration, including as transdermal and rectal methods, have been used to increase the effectiveness of the antimalarial drugs (Jeans et al., 1999). For parenteral administration, liposomes in the nano-sized range offer numerous advantageous qualities, including biocompatibility, physical stability, and simplicity of manufacture. Because liposomes have a phospholipid bilayer membrane structure, both hydrophilic and/or hydrophobic medicines can be effectively and concurrently captured there (Ma et al., 2009). Medication release in vivo can be slowed down by the use of liposomes, which also improves drug dispersion in living things (Lee et al., 2008; Kaiser et al., 2013). Nanoliposome-encapsulated drug's plasma concentration-time profile demonstrated a larger increase in the drug's bioavailability (Acosta., 2009; Huang et al., 2010). Nanoliposomes are suitable carriers for the combination of artemether and lumefantrine due to all of their good characteristics. Typically, liposomes are liquid, which causes stability issues such medication leakage, particle aggregation, and sedimentation (Sharma & Sharma 1997). These issues might be prevented with freeze-drying (Cui et al., 2006). While freezing, drying, and rehydration can also cause phospholipid membrane fusion. To avoid leakage or fusion, the use of adequate cryoprotectants is important (Tang et al., 2003; Alexopoulou et al., 2006).

BACKGROUND AND LITERATURE REVIEW
Malaria Progression and Pathogenesis
A potentially fatal infectious disease known as malaria is brought on by parasites of the species Plasmodium that are spread by Anopheles mosquitoes. In tropical and subtropical areas of the world, malaria continues to be a major cause of illness and death (Figure 2.1). (Gething et al., 2011). In 2016, there were around 300 million cases of malaria, and 8 lakh people died as a result, according to the WHO (WHO., 2016). Since 2000, there has been a global decline in malaria fatality rates of more than 20% as a result of improved preventive, control measures, and innovative treatment therapies. Early malaria diagnosis and treatment lower mortality rates by reducing the sickness, incidence,

and spread of the parasite. The five *Plasmodium* species affecting humans are: *P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi. P. falciparum* causes the most deadly, severe cases and affects naive adults, primigravid women and children. *P. vivax* produces less severe symptoms but it is more widespread and can cause a relapsing form of malaria due to the reactivation of hypnozoites in the liver. Development of drug resistance could result in an expansion of this debilitating and deadly infection (Baird et al., 2004; Price et al., 2009). The other species are found less frequently, representing only 5% of total malaria cases. Infection with malaria begins when a parasitized female Anopheles discharges sporozoites into the bloodstream and then to the liver during a blood meal (Figure 2.2). Within minutes of entering hepatocytes, sporozoites grow and multiply into thousands of young merozoites (Prudencio et al., 2006). Merozoites replicate to create between 16 and 32 daughter merozoites, which are discharged during egression, as they go through the ring, trophozoite, and schizont phases inside RBCs. The asexual blood-stage cycle can then be continued by free merozoites invading additional erythrocytes, resulting in an exponential rise in parasitemia (Prudencio et al., 2006). Sometimes, parasites can develop into sexually active erythrocytic stages, such as female or male gametocytes, which eventually reach the mosquito's midgut after a subsequent blood meal.

Here, fertilization of gametes occurs forming ookinetes which transform into oocysts from which sporozoites are released and migrate to the mosquito salivary glands to restart the cycle at the next blood meal. The high rate of asexual multiplication, effective evasion of host immunity through sequestration in the peripheral circulation, elevated antigenic variation, and redundancy in erythrocyte invasion pathways are just a few of the crucial aspects of *P. falciparum* biology that help the parasite survive and spread within a constantly changing host environment. Several parasite ligands interact with receptors on the RBC surface during *P. falciparum* invasion (Mackinnon et al., 2010). The malaria parasite is able to successfully infect humans by exploiting a variety of these receptors, changing the principal pathway used, and adjusting to variations in RBC surface receptors. Despite the substantial impact of this pathogen on human health, much of its basic biology is poorly understood (Callaway et al., 2007). Whilst each stage of the parasite lifecycle is the subject of intensive research, the centrality of blood stage infection to disease pathology has led to extensive effort towards understanding some of its core biological processes.

Aim and Objectives
AIM
The aim of the present work is to "Design and develop nano sized lipid vesicular carriers for parenteral delivery of combination of artemether and lumefantrine" for effective treatment of malaria.

Research Objectives
The specific objectives of the study are as follows:
- Design and development of nano-liposomes loaded with artemether and lumefantrine.
- Characterization of developed nano-liposomes of artemether and lumefantrine.
- *In vitro* evaluation of developed nano-liposomes of artemether and lumefantrine.
- *In vivo* evaluation of developed nano-liposomes of artemether and lumefantrine.

Proposed Approach and Rationale
BACKGROUND
1. For the treatment of malaria, the combination of artemether and lumefantrine is effective and is classified on the WHO list of essential medications. However, the combination suffers from the following drawbacks:
2. In clinical settings, combination oral pills cannot be utilized for malaria emergency therapy.
3. The therapy patient is less obedient when the dose and frequency are high (4 tablets to taken at once twice daily for 6 days).
4. Food consumption determines how much oral absorption occurs. It is administered together with meals, however during the acute phase of malaria, food consumption tends to be restricted, resulting in low medication absorption.
5. When the stomach's pH is acidic, both lumefantrine and artemether tend to deteriorate.

Proposed Approach

In order to address the aforementioned limitations, it is important to create a novel formulation of artemether and lumefantrine to utilize for parenteral administration for emergency treatment of malaria in clinical settings. A formulation that could be administered parenterally was predicted to come from encasing lumefantrine and artemether in a lipid-based vesicular carrier. Additional advantages of liposomal carriers, including as improved bioavailability and site-specific distribution, may help to further improve the formulation and make it more patient-friendly.

Rationale

Drugs: Artemether and lumefantrine

The combination of artemether and lumefantrine is effective when used orally to treat malaria, and it is featured on the WHO's list of essential medications. These medications' complementary mechanisms work well together. Artemether has a quick antimalarial effect. It disrupts mitochondrial function, affects host immunological response, interferes with parasite transport proteins, and lowers parasite biomass. Lumefantrine, in contrast, works gradually by impeding the transformation of heme into non-toxic hemozoin. Heme and free radical buildup cause the parasite to die. The combination has demonstrated an improved rate of cure and quick parasite elimination. Additionally, the combination also resolves the issue of medication resistance.

Carrier: Nanoliposomes

Due to their limited water solubility, artemether and lumefantrine are challenging to prepare for parenteral administration. Use of greasy cars might hurt the injection site. Additionally, oily injections are preferable for intramuscular use; nonetheless, both of these medicines' intramuscular absorption rates are said to be sluggish and unpredictable. According to reports, nanoliposomes are the ideal delivery method for parenteral administration. Both medicines might be loaded into lipid nanoliposomes. Additionally, they provide continuous medication release, which lowers dosage frequency and improves patient compliance. Additionally, these nanoliposomes might direct medication to the liver, which is where it acts.

EXPERIMENTAL PROCEDURES

MATERIALS

Artemether and lumefantrine were procured as a gift sample from IPCA Laboratories (Mumbai, India). Soy lecithin was provided as a gift sample by Kamani Oil Industries Ltd (Mumbai, India). Cholesterol was purchased from SD Fine Chemicals (Mumbai, India). All other solvents used in the study were of analytical grade and were purchased from Merck Ltd (Mumbai, India).

Preformulation Studies

Estimation by UV spectroscopy

The present work used a UV visible spectroscopic approach to analyze artemether and lumefantrine. Separately, methanol was used to dissolve a precisely weighed quantity of medicines to create a stock solution with a 2.0 mg/ml concentration. To create standard solution, which has a 200 g/ml concentration, stock solution was further diluted to 100 mL. In order to create working standard solutions with concentrations of 5, 10, 15, 20, 25, 30, 35, and 40 g/ml, the standard solution was serially diluted with methanol. Using methanol as a blank, the wavelength of the highest absorption was obtained using a double-beam UV/visible spectrophotometer. The standard plot was created by predicting the maximum absorbance wavelength for both medications and data using Microsoft Excel's linear regression analysis. Simultaneous estimation was done to observe interference of drugs with each other during analysis.

Validation of method of estimation

The method was validated by determining linearity, range, accuracy and precision for both the drugs. Solubility studies In various solvents, the solubility of lumefantrine and artemether was determined. In screw-capped glass test

tubes, excess amounts of both medicines were added to 5 mL of each solvent and agitated for 12 hours at room temperature (Christensen et al., 2007). Filtered and diluted, the solution was then used to estimate the drug's solubility using UV spectroscopy.

FTIR
To characterize the medications, Fourier transform infrared (FT-IR) spectroscopy will be employed. The absorbance mode of the potassium bromide disk technique was used to get the spectra of artemether and lumefantrine in the spectral range of 4000-400 cm1. To describe the medications, DSC Differential scanning calorimetry (DSC) scans of pure pharmaceuticals were performed using DSC (Mettler Toledo, Germany). The analysis was carried out in a nitrogen environment with a heating range of 10 °C to 250 °C and at a rate of 10 °C/min. The sample weighed around 5 milligrams total.

Vesicle Preparation
By using the ether injection procedure under regulated circumstances, liposomes were created. In a nutshell, soy lecithin and cholesterol were initially dissolved in ether (20 ml) in a glass beaker at various concentrations. Drugs were separately dissolved in chloroform, either singly or in combination.

Plasma and tissue sample analysis by LCMS/MS
Liquid-liquid extraction method and LCMS/MS using a HPLC system was devised for the extraction of artemether and lumefantrine from plasma and analysis of sample (Wahajuddin et al., 2011).

Pharmacokinetic and statistical analysis
Using WinNonlin, non-compartmental pharmacokinetics analysis was performed on plasma data (version 5.1, Pharsight Corporation, Mountain View, USA). By visually reviewing the experimental data, the highest plasma concentration (Cmax) that was seen was determined. The linear trapezoidal approach was used to determine the AUC0-t, or area under the plasma concentration time curve. The sum of AUC0-t and Clast/kel, where Clast denotes the last measurable concentration and kel denotes the terminal phase rate constant, was used to compute the entire area under the plasma concentration-time curve from time zero to infinity (AUC0-).

RESULTS AND DISCUSSION

Identification of artemether
The melting point value of artemether is reported to be 89–90 °C (Achhrish et al.,2012) and the DSC thermo grams of artemether also depict as the endothermic peak within the range of 89–90 °C .indicating that the obtained sample is of artemether. Further confirmation was obtained by FTIR analysis wherein the spectra obtained matches the standard spectra of artemether . The results of the assay indicate that the obtained artemether has a purity of 99.95 %. The DSC thermo grams of lumefantrine showed endotherm at 133.6 °C representing melting point of the drug which correlates well with reported value of 133- 135 °C (Achhrish et al., 2012).

Analytical (UV) Method Development
In the current study, a UV spectroscopic approach for the simultaneous measurement of ART and LUM was established. For both medicines, a calibration plot in the concentration range of 5–40 g/ml was made in methanol for UV spectrophotometer examination. The resulting absorbance values are tabulated, and calibration graphs are created. Dilutions were prepared for both the drugs from their respective stock solutions and scanned in the spectrum mode from 400 nm to 200 nm. ART and LUM showed absorbance maxima at 268 nm and at 302 nm, respectively. The overlain spectra of both these drugs is shown in Fig.

Biodistribution Studies

Fig. shows the tissue concentration of artemether and lumefantrine after intravenous delivery of ART+LUM solution and ART+LUM-NLs to critical organs as the liver, spleen, lung, kidney, and heart. In contrast to ART+LUM solution, ART+LUM-NLs showed that the liver (40.4%) and spleen (26.2%) had high drug concentrations. Since the liver and spleen are the main treatment sites for schozontocytes, the results themselves show the value of the developed formulation. Additionally, the system's effectiveness is reflected by the higher biodistribution of drugs in the liver and spleen thanks to the developed liposomal formulation. Additionally, liposomal formulation showed that, in comparison to solution, low drug concentrations were present in the kidney, lung, and heart. The liposomal formulation is significantly safer than solution formulation, according to the biodistribution pattern.

CONCLUSION

As a result of the aforementioned findings, nanoliposomes made using the successful ether injection approach and co-loaded with lumefantrine and artemether had improved safety and effectiveness profiles as shown by toxicity, pharmacokinetic, and biodistribution tests. Thus, an unique approach to treating malaria in urgent settings is the created liposomal formulation of artemether and lumefantrine for parenteral administration. In light of the aforementioned findings, nanoliposomes effectively generated by the ether injection approach and co-loaded with lumefantrine and artemether had improved safety and effectiveness profiles as shown by toxicological, pharmacokinetic, and biodistribution investigations. Consequently, an unique therapeutic approach is the developed liposomal formulation of artemether and lumefantrine for parenteral administration.

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Table.1 : Standard curve values for artemether and lumefantrine

S. No	Artemether		Lumefantrine	
	Conc. (µg/ml)	Abs. (268 nm)	Conc. (µg/ml)	Abs. (302 nm)
1	5	0.101	5	0.080
2	10	0.180	10	0.150
3	15	0.246	15	0.220
4	20	0.347	20	0.316
5	25	0.441	25	0.376
6	30	0.547	30	0.441
7	35	0.660	35	0.521
8	40	0.750	40	0.650

Table 2 : Pharmacokinetic data of ART-LUM solution and nanoliposome formulation

PK Parameter	Solution		Nanoliposomes	
	Artemether	Lumefantrine	Artemether	Lumefantrine
C_{max} (ng/ml)	2938.0 ± 362.5	2540.0 ± 227.9	2097.7 ± 374.4	1825.0 ± 325.7
AUC_{0-t} (ng.h/ml)	6352.4 ± 123.2	4319.5 ± 212.3	20750.5 ± 1453.6	11552.6 ±1251.4
$AUC_{0-\infty}$ (ng.h/ml)	6583.3 ± 136.3	4598.0 ± 111.6	20962.6 ± 1142.4	11864.4 ± 1264.3
MRT (h)	4.33 ± 0.32	3.87 ±0.42	13.86 ± 0.86	12.46 ± 0.45
V_d (L/kg)	2.28 ± 0.32	2.22 ± 0.16	2.58 ± 0.54	2.39 ± 0.56
CL (L/h/kg)	1.35 ± 0.83	1.33 ± 0.22	0.64 ± 0.12	0.54 ± 0.42
$t_{1/2}$ (h)	9.63 ± 5.73	8.78 ± 5.73	12.53 ± 3.12	11.42 ± 5.73

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Fig no:1. : Structure of (A) artemether and (B) lumefantrine

Figno:2.: Geographical distribution of *P. falciparum* malaria

Fig.no:3 : DSC thermograms of artemether

Fig. no:4 : FTIR spectra of artemether Identification of lumefantrine

Fig. no:5:DSC thermograms of lumefantrine

Fig no:6. : FTIR spectra of lumefantrine

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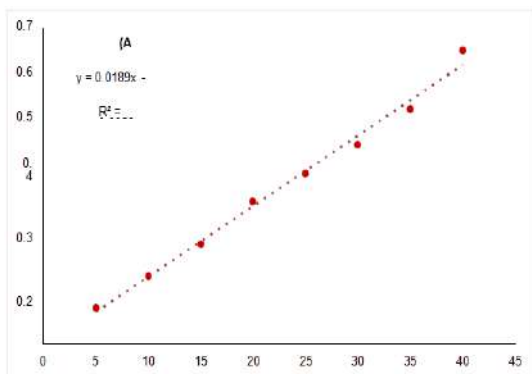
Fig. 7: Calibration plot of (A) artemether and (B) lumefantrine
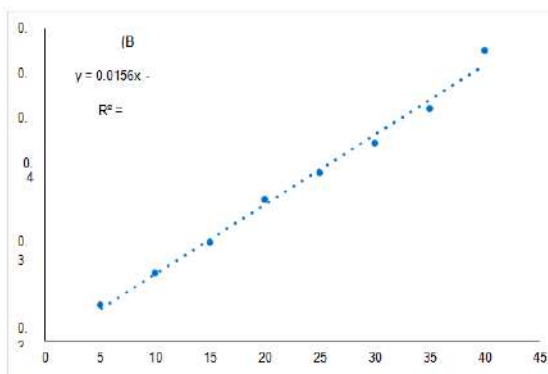
Fig. 8: Calibration plot of (A) artemether and (B) lumefantrine
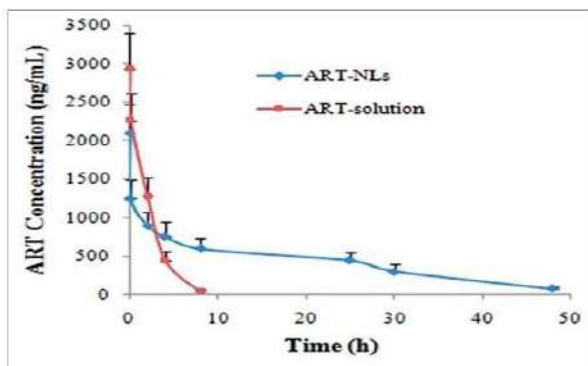
Fig. 9. : The mean blood concentration–time curve of artemether and lumefantrine following intravenous administration of ART+LUM NLs in Swiss albino
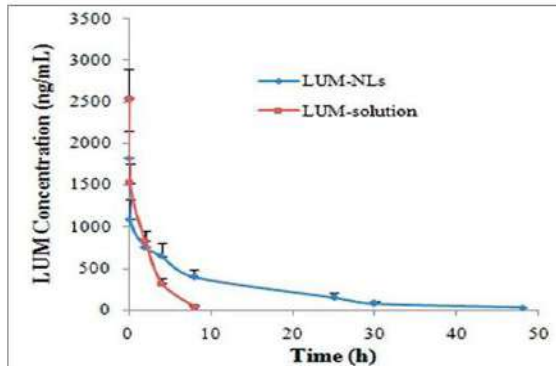
Fig. 10. : The mean blood concentration–time curve of artemether and lumefantrine following intravenous administration of ART+LUM NLs in Swiss albino mice
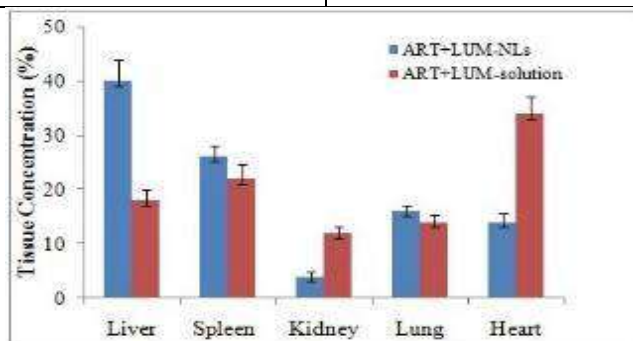
Fig. 11: Tissue concentration (%) of artemether and lumefantrine in liver, spleen, lung, kidney and heart following intravenous administration of NLs and solution

RESEARCH ARTICLE

Haematological and Histopathological Effects of Fipronil 80% on Fresh Water Fish *Oreochromis niloticus* (Nile Tilapia)

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ABSTRACT

This study was conducted to investigate the toxic effect of Fipronil 80% on *Oreochromis niloticus*. Fipronil is a neurotoxic insecticide is highly used in paddy field of Calicut area to prevent stem borer, green leaf hopper, leaf folder brown plant hopper. Fipronil is highly toxic to many non-target organism including fishes, honeybees and aquatic invertebrates. Thirty *Oreochromis niloticus* were distributed into five groups in triplicates. The first group served as control, other group were provided with different concentrations of Fipronil 80% namely 0.1mg/lit, 0.2 mg/lit, 0.3mg/lit and 0.4 mg/lit. The mortality was recorded after 24 hr, 48 hr, 72 hr and 96 hr was determined by the probit analysis method (Finney 1971). 0.3mg/lit was the obtained LC50 value. To determine the sub lethal concentration of Fipronil 80%, $1/10^{th}$ of the concentration of the LC50 value for 96 hours was taken, which is 0.03mg/lit. The experiment was designed to expose the fish to different concentrations of Fipronil 80% - 0.03mg/lit, 0.04mg/lit, 0.05mg/lit and 0.06mg/lit. One trough served as the control. Each trough contained six fish and the duration of the experiment was 30 days. And experiments were conducted as triplicate samples. Fish exposed to Fipronil 80% Showed significantly decreasing Haematalogical parameters include RBC, WBC, MCV, MCH, MCHC, Haemoglobin and Platelet. Liver, Gills and Muscle of Fish exposed to Fipronil showed different histopathological alternation. This study demonstrate that fipronil 80% insecticide cause alternation in histopathological and Haematological parameters in *Oreochromis niloticus*.

Keywords: Fipronil 80%, Haematological, Histopathological, *Oreochromis niloticus*.

INTRODUCTION

Pesticides, herbicides, and insecticides are used in agriculture globally due to their powerful effects in the control of pests, insects, rodents, weeds, and fungi but they also cause toxicity to a variety of non-target organisms including humans [1,2,3]. Among all ecosystems, freshwater ecosystems are the most susceptible to a severe loss of biodiversity [4]. The major threats to freshwater ecosystems are nutrient swings, habitat loss, climate alteration, acidification, biological invasions, resource exploitation and a considerable chemical contamination [5]. Pesticides affect non-target organisms more in aquatic ecosystem as compared to terrestrial ecosystem because they are transported easily from one point to another in hydrosphere [6,7,8]. Fipronil is a new broad-spectrum phenylpyrazole insecticide. The International Union of Pure and Applied Chemistry (IUPAC) name for fipronil is (±)-5-amino-1-(2, 6-dichloro-a, a, a-trifler-p-toll)-4-trifluoro methyl sulfinyl pyrazole-3-carbonitrile [9]. Moreover, Fipronil is identified by the US. Environmental Protection Agency (US. EPA) and is used as an alternative to organophosphate compounds Recently, Fipronil is gaining a considerable attention as a minute concentration of Fipronil is highly effective against various insects and pests of crops, notably rice insects, trips and termites [10], Owing to its lipophilicity and persistency properties. Fipronil, which is a phenylpyrazole (fiprole),   WHO class II hazardous and broad-spectrum insecticide, kills the insects by targeting the nervous system, blocking the glutamate chloride channels and gamma-aminobutyric, acid receptors [11,12,13]. Continuous use of fipronil significantly alters biochemical and physiological indexes in adult fishes, leading to defect in fish health and growth performance [14]. In recent years, the use of FP as an insecticide in agricultural areas has increased, but there are great concerns about the dangers of non-target organisms and humans [15,13]. As it is used in the control of harmful insects especially in rice production, it causes a wide range of water pollution [16,17]. Fipronil 80% is highly used in paddy field of Calicut area to prevent stem borer, green leaf hopper, leaf folder brown plant hopper. So the present study was carried out to evaluate the harmful effects of acute and chronic exposure to different concentrations of fipronil 80% on the health of *Oreochromis niloticus* by assessing the haematological and histopathological parameters.

MATERIALS AND METHODS

Experimental fish
All the experimental fishes of *Oreochromis niloticus* selected for the present study was purchased from Angel fish farm Near Kunnamangalam, Calicut district, Kerala, India. In total thirty live adult female fish had an average length of 10-14 cm and weight of 13-16 gram were collected during September 25 and September 30, 2021. Prior to acclimatization, fish were bathed in 0.01% potassium permanganate (KMnO4) solution for 15 minutes for two consecutive days to neutralize. Possible external infectious pathogenic microorganism like fungi. Fish was stocked in a big tank containing 500 liter of water and acclimatized for 10 days. Fishes were fed with artificial feed twice a day. The fish were treated in accordance with the guidelines of the local ethics committee. Studies involving unwarranted numbers of endangered or rare species may not be accepted.

Experimental design
 The fishes were divided into 5 equal groups consisting of 6 in plastic troughs of 20 liter capacity. One plastic trough served as the control and the other troughs were provided with different concentrations of Fipronil 80% namely 0.1mg/lit, 0.2 mg/lit, 0.3mg/lit and 0.4 mg/lit. The mortality was recorded after 24 hrs. , 48 hrs. 72 hrs. , and 96 hrs. Was determined by the probit analysis method [18]. Each data point is plotted and connected to form a graph. A horizontal line was drawn from 50% mortality point to intersect the plot. A vertical line from the intersection was the dropped to the abscissa. The intersection point on the abscissa corresponds to the 96 hours LC50. To determine the sub lethal concentration of Fipronil 80%, 1/10th of the concentration of the LC50 value for 96 hours was taken, which is 0.03mg/lit. The experiment was designed to expose the fish to different concentrations of Fipronil 80% - 0.03mg/lit, 0.04mg/lit, 0.05mg/lit and 0.06mg/lit. One trough served as the control. Each trough contained six fish and the duration of the experiment was 30 days. And experiments were conducted as triplicate samples. Feeding was provided during the experimental period. Each day the trough was replenished with fresh water and the respective

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concentration of Fipronil 80% in the experimental trough were maintained. Haemoglobin (Hb %) was measured by Sahli's Acid Haemoglobin method [19]. RBC counts were taken in Neubauer's hemocytometer using Hendrick's solution as diluting fluids. Packed cell volume (PCV) was determined by the microhaematocrit method. Differential leucocyte count (DLC) was carried out by preparing a thin blood smear and staining it with Leishman's stain. Calculation of mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and mean cell volume (MCV) was done using standard formulae [20]. Mean values were compared using one-way ANOVA.

Samples collection

At the expiration of the experiment, blood samples were collected by Puncturing caudal blood vessels using a medical syringe which was previously rinsed with EDTA solution (as anticoagulant) and shaken gently to prevent hemolysis of blood which is used for hematological analysis. Serum blood were collected without anticoagulant and stored at -20°C till measurement of haematological parameters. Then fish were sacrificed by decapitation and specimens from liver, muscle and gills from all groups were kept in neutral buffered formalin for histopathological examination [5].

Histopathological examination

Specimens from the liver, gills and muscle were gathered and fixed in 10% buffered neutral formalin solution, dehydrated in gradual ethanol (70-100%), cleared in xylene, and embedded in paraffin. Five-micron thick paraffin sections were prepared and then routinely stained with Hematoxylin and Eosin (H&E) dyes and then view under microscope [21].

RESULTS

LC50 of fipronil 80% at 24, 48, 72 and 96 hours are presented in Table 1. The calculated 96 hr LC50 value of fipronil 80% for *Oreochromis niloticus* was found to be 0.3 mg/lit. Table 2 shows that the impact of sub-lethal concentration of Fipronil 80% on the haematological parameters. Inversely to the increasing concentration of Fipronil, a decrease in the all haematological parameters such as total RBC, WBC, Hb, PCV, MCV, MCH, MCHC and platelet compared to control group. All the parameters except MCH and MCHC are significant at at ($P<0.01$) and MCH and MCHC are significant at ($p<0.05$) level. The results of histopathological studies suggested that once exposed to the sublethal concentration of Fipronil 80%, remarkable alterations in the ultrastructure of gill, liver and muscle tissues could be noticed. In the gill secetion of 0.03 mg/lit and 0.04 mg/lit fipronil 80% treated fish shows gills with feature of congestion as compared to control group. The gill of fish treated with 0.05 mg/lit and 0.06 mg/lit shows congestion, necrosis and epithelial cells of gill filament showed disintegration. The liver section of fish treated with fipronil 0.03 mg/lit and 0.04 mg/lit shows normal appearing hepatic lobules with feature of severe congestion and some hepatocyte necrosis. And the 0.05 mg/lit and 0.06 mg/lit treated fish shows many of the hepatocyte with fatty degeneration, hepatocyte necrosis and severe congestion in hepatic blood vessel. The histology of muscle tissue in the control, 0.03 mg/lit and 0.04 mg/lit fipronil treated groups fish after 30 days experiment shows normal appearance of muscle fibre without any abnormalities. In the 0.05mg/lit and 0.06 mg/lit shows muscle fiber with feature of congestion.

DISCUSSION

The present results show that fipronil 80% is highly toxic to *Oreochromis niloticus.* The observed 96 hour LC50 was 0.3 mg/lit. Toxicity of fipronil in fish varies according to species with lethal concentrations (LC50) ranging from 0.042 mg/lit in Nile tilapia (*Oreochromis niloticus*) to 0.43 mg/lit in common carp (*Cyprinus carpio*). It is highly toxic for bluegill (*Lepomis macrochirus*) at LC50 96 h = 0.085 mg/lit. For rainbow trout (*Oncorhynchus mykiss*) the LC50 of fipronil at 96 h was 0.248 mg/lit and it was 0.13 mg/lit for sheepshead minnow (*Cyprinodon variegatus*), and it affected larval growth in rainbow trout (*Oncorhynchus mykiss*) at concentrations higher than 0.0066 mg/lit [22]. There was

significant (P<0.05) decrease in erythrocyte count in fipronil treated groups compared with control in Nile tilapia [5] . The decreased values of erythrocyte could be due to toxic impacts of insecticide on blood producing tissues and on circulating erythrocytes [7]. Total leukocyte count in fipronil exposed fish showed significant (p <0.05) decrease compared with control group. This might be due to the fast oxidation of hemoglobin to methemaglobin or release of oxygen radical due to the toxic effect and oxidative stress induced by fipronil [23]. Reduction of hemoglobin (Hb) content might be due to rapid oxidation of hemoglobin (Hb) to methemoglobin or liberation of O_2 radically induced by the toxic stress of chlorpyrifos [24]. The PCV appears to be positively correlated with erythrocyte count. Fall in the number of red blood cells followed by PCV confirms anemia. The decrease in PCV may be attributed either to decreased cellular content and increased plasma content mainly in water [25]. The reduction in hematocrit values is an indication of anaemia or oligohemia [26]. Fish exposed to fipronil showed pale gills and gills of fish subjected to 0.014 mg/l of fipronil for 4 days; showed focal necrosis and sloughing in the covering epithelium of the secondary lamellae with intense lymphocytes infiltration. In some cases, focal epithelial proliferations and fusion were seen at the base of gill filaments besides severe congestion of the lamellar blood capillaries, edema and leukocytic infiltration [5]. Fish exposed to fipronil 0.014 mg/lit for 4 days showed focal areas of necrosis infiltrated with numerous lymphocytes and few erythrocytes. Severe congestion in hepatic blood vessels and sinusoid and hemorrhages among the hepatic cells were seen. Diffuse hydropic degenerations and vacuolations in the hepatocytes were also identified and the portal areas showed necrosis of the pancreatic acini and lymphocytes infiltration [5]. The histology of muscle tissue in the control, 0.03 mg/lit and 0.04 mg/lit fipronil treated groups fish after 30 days experiment show normal appearance of muscle fibre, without any significant pathological abnormalities. The muscle of fish treated with fipronil 0.05mg/lit and 0.06 mg/lit in 30 days show normal appearing muscle fibres with feature of congestion [5].

CONCLUSION

The contamination of fresh water with wide range of pollutants is due to increased human activity especially with rapid development of agriculture and industries. Several environmental pollutants can cause alterations in the hematological and histopathological parameters of non-target organisms. Among these pollutants, insecticides are one of the most known chemical to affect fish. Fish can serve as bio indicators of environmental pollution and can play significant role in assessing potential risk associated with contamination in aquatic environment. Fipronil 80% is highly used in paddy field of Calicut area to prevent stem borer, green leaf hopper, leaf folder brown plant hopper. Fipronil not only controls insect pest effectively but also show plant growth enhancement effect which result in higher yield. The main reason to use Fipronil is because it affects insects very well at low concentrations and only few gram is used in a hectare of land. When applied to paddy fields, it may cause some spillage in water bodies nearby. And it will affect non-target aquatic organisms mainly fishes. The current study illustrates that Fipronil 80% is highly toxic to tilapia fish *Oreochromis niloticus*. The exposure of fish to this insecticide showed a significant reduction in the studied haematological parameters and histopathological changes. Replacing Fipronil 80% insecticide in agricultural farms should be monitored to avoid continues leaching in to water bodies

ACKNOWLEDGEMENT

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Table.1: Percentage (%) mortality in *Oreochromis niloticus* in differentconcentrations of Fipronil 80%

S.NO	No. of Fishes	Toxicant Concentration mg/lit	Mortality In Test Animals	
			96 Hrs	**%**
1	6	0.09	0	0
2	6	0.1	1	16.6
3	6	0.2	2	33.3
4	6	0.3	3	50
5	6	0.4	4	66.6

Table. 2: RBC, WBC, Haemoglobin, PCV, MCV, MCH, MCHC and platelet count of *Oreochromis niloticus* After 30 Days of Exposure to Fipronil 80%.

Concentration	RBC in million /Cu mm	WBC in No. of Cell / Cu mm	HB in gm%	PCV in gm%	MCV in microns	MCH in gm%	MCHC in gm%	Platelet Count in No. of Cells /Cu mm
Control	3.80 ± 0.17	570 ± 4.35	9.8 ± 0.03	29.4 ± 0.34	88.6 ± 0.42	30 ± 1.73	33.5 ± 1.73	12000 ± 556.77
0.03 mg/lit	3.50 ± 0.04	500 ± 13.22	9.1 ± 0.17	27.9 ± 0.75	87 ± 0.88	28.8 ± 2.85	32.6 ± 1.00	8000 ± 624.49
0.04 mg/lit	2.90 ± 0.06	440 ± 13.45	8.4 ± 0.1	25.7 ± 0.52	84.1 ± 0.36	28 ± 0.75	32 ± 0.43	6000 ± 458.25
0.05 mg/lit	2.7 ± 0.05	380 ± 4.58	8.0 ± 0.2	24.0 ± 0.72	76.5 ± 1.60	27.2 ± 0.52	31.7 ± 1.80	4000 ± 556.77
0.06 mg/lit	2.0 ± 0.12	250 ± 8.66	6.0 ± 0.95	20.0 ± 0.43	70.4 ± 1.63	25.3 ± 0.26	29.4 ± 0.30	2000 ± 264.57

Values are expressed as mean ± SD

Table 3: One way ANOVA for haematological parameters of *Oreochromis niloticus* After 30 days of exposure to Fipronil 80%.
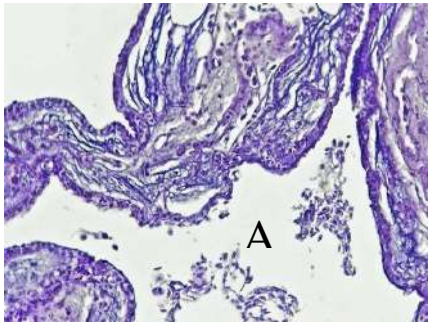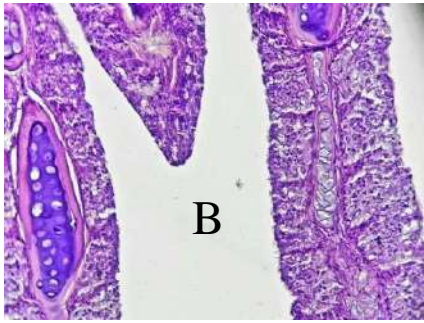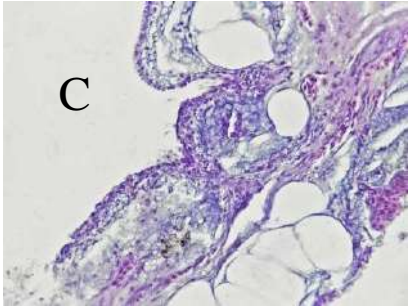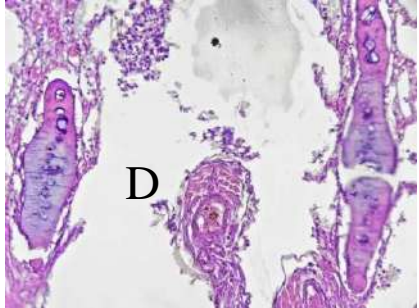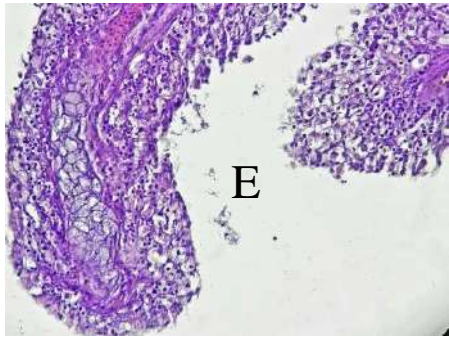
Analysis	DF	SS	MS	F	PROB	CV%
WBC	4	178840	44610	473.56	0.00**	25.55%
RBC	4	5.77	1.44	132.3	0.00**	20.97%
Haemoglobin	4	24.81	6.2	31.29	0.00**	16.18%
PCV	4	160.38	40.09	119.32	0.00**	13.00%
MCV	4	693.24	173.31	136.18	0.00**	8.44%
MCH	4	37.41	9.354	3.868	0.03*	7.27%
MCHC	4	28.31	7.077	4.564	0.02*	7.94%
Platelet	4	177600000	4400000	172.093	0.00**	54.15%

df – degrees of freedom; SS- Sum of Square; MS- Mean Square; F- F test; P- Probability;CV Coefficient of Variation; **- significant at p<0.01 level; *- significant at p<0.05.

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Figure 1 A: Section of *O.niloticus* gills of control group showing normal appearance

Figure 1 B: Section of *O.niloticus* gills of 0.03 mg/lit group treated with Fipronil 80% showing gill with feature of congestion

Figure 1 C: Section of *O.niloticus* gills of 0.04 mg/lit group treated with Fipronil 80% showing gill with feature of congestion.

Figure 1 D: Section of *O.niloticus* gills of 0.05 mg/lit group treated with Fipronil 80% show congestion, necrosis and epithelial cells of gill filaments showed disintegration.

Figure 1 E: Section of *O.niloticus* gills of 0.06 mg/lit group treated with Fipronil 80% show congestion, necrosis and epithelial cells of gill filaments showed disintegration.

Figure 2 A: Section of *O.niloticus* liver of control group showing normal appearance of hepatic cells, without any significant abnormalities

Figure 2 B Section of *O.niloticus* liver of 0.03mg/lit group treated with Fipronil 80% showing normal appearing hepatic lobules with feature of severe congestion and some hepatocyte necrosis.

Figure 2 C: Section of *O.niloticus* liver of 0.04 mg/lit group treated with Fipronil 80% showing normal appearing hepatic lobules with feature of severe congestion and some hepatocyte necrosis.

Figure 2 D: Section of *O.niloticus* liver of 0.05mg/lit group treated with Fipronil 80% showing many of the hepatocyte with fatty degeneration, hepatocyte necrosis and severe congestion in hepatic blood vessel.

Figure 2 E: Section of *O.niloticus* liver of 0.06mg/lit group treated with Fipronil 80% showing many of the hepatocyte with fatty degeneration, hepatocyte necrosis and severe congestion in hepatic blood vessel.

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Figure 3 A: Section of *O.niloticus* muscle of control group showing normal appearance of muscle fiber.	**Figure 3 B: Section of *O.niloticus* muscle of 0.03 mg/litl group treated with Fipronil 80% showing normal appearance of muscle fiber.**
Figure 3 C: Section of *O.niloticus* muscle of 0.04 mg/litl group treated with Fipronil 80% showing normal appearance of muscle fiber .	**Figure 3 D: Section of *O.niloticus* muscle of 0.05mg/litl group treated with Fipronil 80% showing normal appearing of muscle fiber with feature of congestion.**

Figure 3 E.Section of *O.niloticus* muscle of 0.06mg/litl group treated with Fipronil 80% showing normal appearing of muscle fiber with feature of congestion.

RESEARCH ARTICLE

Effectiveness of Structured Teaching Programme on Knowledge Regarding Hemodialysis among Haemodialysis Clients in Selected Hospitals, At Karimnagar, Telangana

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ABSTRACT

The kidneys are two bean shaped organs located near the middle of the back just below the rib cage. The major function of the kidneys is to remove waste products and excess fluid from the body. Kideny failure is a clinical syndrome in which there is a sudden decline in renal function and electrolyte balance, acid base homeostasis, erythropoiesis and minerals metabolism chronic renal failure is a progressive deterioration of renal function in uremia. Assess the level of knowledge regarding hemodialysis among hemodialysis clients. Determine the effectiveness of structured teaching programme on knowledge regarding hemodialysis among hemodialysis clients. find out the association between the post test knowledge score regarding hemodialysis among hemodialysis clients with their selected demographic variables .Quasi experimental research design was chosen to assess the knowledge .The sample size was 30 hemodialysis clients. Demographic variables and the level of knowledge among hemodialysis clients concerning regarding hemodialysis were collected by using structured questionnaire. The current knowledge level of hemodialysis clients regarding hemodialysis portrays that score in pre test 46.7% had below average knowledge and 53.3% had average knowledge score, where as in post test 20% had average knowledge and 80% of hemodialysis clients had above average knowledge score. The knowledge score in pre test mean 12.16 and standard deviation 3.30 and post test mean 20.3 and standard deviation 3.52. The difference in level of knowledge is found statistically significant by calculating 't'

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value which was found to be 9.35 which is more than the table value 2.05.The findings reveals that most of the hemodialysis clients improved their knowledge level after the structured teaching programme.

Keywords: hemodialysis, hemodialysis clients.

INTRODUCTION

Chronic kidney disease is defined as kidney abnormality or 'marker' such as protein in the urine and decreased kidney function for three months or longer ,and decreased urine output, dialysis treatments replace some of these functions through diffusion .(waste removal) and ultrafiltration.

STATEMENT OF PROBLEM
"Effectiveness of structured teaching programme on knowledge regarding hemodialysis among haemodialysis clients in selected hospitals, at Karimnagar, Telangana.**"**

OBJECTIVES
The objectives of the study were to:
- assess the level of knowledge regarding hemodialysis before and after structured teaching programme among hemodialysis clients.
- determine the effectiveness of structured teaching programme on knowledge regarding hemodialysis among hemodialysis clients.
- associate between the post test knowledge score regarding hemodialysis among hemodialysis clients with their selected demographic variables.

RESEARCH METHODOLOGY

Research Design: Quasi experimental research design was chosen to assess the knowledge.
Settings of the Study: The study was conducted in selected hospitals at Karimnagar.
Population; The study population comprises of hemodialysis clients in selected hospitals at Karimnagar.
Sample size; The sample of 30 hemodialysis clients who fulfilled the inclusion criteria is considered as sample for this study.
Sampling Technique: Convenient sampling technique was used for the selection of sample for the study.
Criteria for sample selection

Inclusion Criteria
- Clients who are undergoing hemodialysis in selected hospitals, at Karimnagar.
- Clients who are willing to participate in the study.
- Clients who are available at the time of study.

Exclusion Criteria
- Clients who are having other medical conditions.

Description of the tool
It consist of two sections

Section-A
It deals with demographic variables such as age, gender, educational qualification, health resources, source of information, since how many years on haemodialysis.

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Section B.
A structured questionnaire consisting of 30 multiple choice questions and each question has 4 choices, each correct response carries 1 mark and wrong response carries 0 marks.

Procedure for data Collection
Data was collected from hemodialysis clients after obtaining a formal written permission from the hospital authority of selected hospitals. Each person was assured for data collected from them was utilized only for the purpose of study and will be kept confidential. The investigator uses structured questionnaire to collect data.

Plan for Data Analysis
Descriptive and inferential statistics was used to analyze the collected data.

Section-I:
The demographic data was analyzed by using frequency and percentage.

Section-II:
Distribution of respondents according to pre-test and post-test scores was analyzed by mean and standard deviation.

Section-III:
Effectiveness of structured teaching programme was analyzed by paired 't' test.

Section-IV:
Association of post test knowledge score among hemodialysis clients regarding   hemodialysis with their selected demographic variables was analyzed by chi-square.

RESULTS

Descriptive and inferential statistics was used to analysis the collected data.

Section-I
Table-1 Frequency and percentage distribution regarding hemodialysis among hemodialysis clients according to their demographic variables.

Section-II
Part-I
Table-2 : Frequency and percentage distribution of hemodialysis clients according to their pre test knowledge score regarding hemodialysis. Table -2 Shows that 14 (46.7%) of hemodialysis clients had below average knowledge and 16 (53.3%) of hemodialysis clients had average knowledge and none of them had above average knowledge.

Part-II
Table-3 : Frequency and percentage distribution of hemodialysis clients according to their post test knowledge scores regarding hemodialysis.Table-3 :Shows that 24 (80%) of hemodialysis clients had above average knowledge and 6 (20%) of hemodialysis clients had average knowledge and none of the hemodialysis had below average knowledge.

Section-III
Table-4 : Comparison of pre test and post test scores of hemodialysis clients regarding hemodialysis. Table – 4 Shows that the mean knowledge score during pre test was 12.16 and standard deviation 3.30 where as during post test was 20.3 and standard deviation 3.52. This difference of knowledge score is found to statistically significant. The

computed 't' value is 9.35 that are more than the table value of 2.05 at 0.05% level. This reveals standard deviation between pre test and post test.

Section-IV
Table- 5 Association between post test knowledge scores of hemodialysis clients regarding hemodialysis with their selected demographic variables. Table-5 Shows that gender, educational qualification, since how many years on hemodialysis had significant association with knowledge score as the chi- square value is greater than critical value and there is no significance association between knowledge score and other demographic variables such as age, , source of information, health resources,

DISCUSSION

A study was to assess knowledge of hemodialysis clients regarding hemodialysis at selected hospitals. The study found that more than half of the hemodialysis clients had improved knowledge and less had average knowledge on hemodialysis among hemodialysis clients. There was a significant association between the level of knowledge with selected demographic variables .Similar result has been observed in another study done Rajeena Enoch Janet Lobo 2018 Conducted a pre experimental study to assess the effectiveness of structured teaching programme regarding home care management of hemodialysis among hemodialysis clients in Mumbai. A sample selected for the study by using convenient sampling method. The results revealed that in pre-test 20% had good knowledge ,10% had average knowledge ,70% poor knowledge and in post test 88.8% hemodialysis clients had good knowledge ,12.2% had average knowledge .The study concluded that structured teaching programme was improved the knowledge of hemodialysis clients.

CONCLUSION

The knowledge of hemodialysis clients regarding hemodialysis was below average and average before structured teaching programme where as the knowledge of hemodialysis clients was average and above average after structured teaching programme. The post test mean knowledge score of the hemodialysis clients was higher than pre test mean knowledge score.

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Table-1 Frequency and percentage distribution regarding hemodialysis among hemodialysis clients according to their demographic variables.

SI.NO	Demographic variable	Hemodialysis clients	
		Frequency	Percentage%
1.	Age in years a) <30 years b) 31-40 years c) 41-50 years d) 51-60 years e) >60 years	4 5 11 4 6	13.34 16.66 36.66 13.34 20
2.	Gender a) Male b) Female	21 9	70 30
3.	Education qualification a) Illiterate b) Primary education c) Secondary education d) Degree and above	5 11 10 4	16.67 36.66 33.33 13.34
4	Source of information a) Television b) Radio c) News papers d) Health professionals	9 1 5 11	30 3.34 16.66 50
5	Health resources a) Aarogyasree b) Others	26 4	86.66 13.34
6	Since how many years on hemodialysis a) 1 month-1 year b) >1 year- 3 years c) >3years-5 years d) More than 5 years	3 13 11 3	10 43.34 36.66 10

Table-2 : Frequency and percentage distribution of hemodialysis clients according to their pre test knowledge score regarding hemodialysis.   n=30

SI.No	Level of knowledge	Frequency	Percentage%
1.	Below average (1-10)	14	46.7%
2.	Average (11-20)	16	53.3%
3.	Above average (21-30)	-	-

Table-3 : Frequency and percentage distribution of hemodialysis clients according to their post test knowledge scores regarding hemodialysis.   n=30

SI.No	Level of knowledge	Frequency	Percentage%
1.	Below Average(1-10)	**-**	**-**
2.	Average (11-20)	6	20%
3.	Above average (21-30)	24	80%

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Table-4 : Comparison of pre test and post test scores of hemodialysis clients regarding hemodialysis. n=30

Parameters	Time interval	No.of subjects	Mean	Standard Deviation	t value	Critical value
Knowledge regarding hemodialysis among hemodialysis clients	Pre test	30	12.16	3.30	9.35*	2.05
	Post test	30	20.3	3.52		

*=Significant

Table- 5 Association between post test knowledge scores of hemodialysis clients regarding hemodialysis with their selected demographic variables.

SI. No	Variables	Category	Knowledge score			Chi-square	Df	Critical value
			1-10 below average	11-20 average	21-30 Above average			
1.	Age	a) <30 years	0	0	9	8.08 NS	8	15.50
		b) 31-40 years	0	1	2			
		c) 41-50 years	0	2	9			
		d) 51-60 years	0	3	2			
		e) >60 years	0	0	2			
2.	Gender	a) Male	0	0	16	8.56*	2	5.99
		b) Female	0	6	8			
3.	Educational qualification	a) Illiterate	0	0	6	13.32*	6	12.59
		b) Primary education	0	4	8			
		c) Secondary education	0	0	10			
		d) Degree	0	2	0			
4.	Source of information	a) Television	0	2	4	1.24 NS	6	12.59
		b) Radio	0	0	0			
		c) News paper	0	1	4			
		d) Health professionals	0	3	16			
5.	Health resources	a) Aarogyasree	0	6	22	2.13 NS	2	5.99
		b) Others	0	0	2			
6	Since how many years on hemodialysis	a) 1 month- 1 year	0	0	18	14.2*	6	12.59
		b) >1year-3 years	0	5	2			
		c) >3years-5 years	0	1	4			
		d) 5 years and above	0	0	0			

*=Significant, NS= Non significant

RESEARCH ARTICLE

Heat Transfer of A Peristaltic Electro - Osmotic Flow of A Couple Stress Fluid through an Inclined Asymmetric Channel with Effects of Thermal Radiation

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ABSTRACT

The presented article addresses the electro-osmotic peristaltic flow of a couple-stress fluid bounded in an inclined asymmetric micro-channel. The viscous dissipation, Joule heating and chemical reaction effects are employed simultaneously in the flow analysis. Heat and mass transfer have been studied under large wave length and small Reynolds number. The resulting nonlinear systems are solved numerically. The influence of various dominant physical parameters is discussed for velocity, temperature distribution, and the pumping characteristics.

Keywords: Peristaltic flow; Electro-osmotic flow; Couple stress fluid; Magnetic field; Heat transfer; Mass transfer; Inclined asymmetric micro-channel;

INTRODUCTION

Recent investigations in miniaturization and micro-fabrication have taken into assuming a lot of applications extending from organic to refrigerating of microelectronics in [1 - 9]. Many favors such as an important reduction in the utilization of required materials, ability to achieve in-vitro experiments on the continuous motion in a manner

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similar to the real situation in a living biological system, being portable and vibration-free are using micro fluidic devices. Electro-osmotic transports with thermal effects of liquids in micro channels are reported in [10]. The heat transfer investigation of electro-osmotic motion in a slowly varying non-symmetric micro-channel is presented in [11]. Stokes developed the couple stress fluid model. When additives are mixed in the fluid then cohesive forces of fluid resists additive factors. This resistance creates a combined force and then a couple stress is generated in the fluid. Such fluid is known as couple stress fluid. This model is regarded as generalization of Newtonian fluid model dealing with body couples and couple stresses in fluid medium. Note that couple stress fluid has an asymmetric stress tensor. Relevant studies in this direction are given in the investigations [12 – 18]. Bio-fluids propel from one place to another place by continuous process of muscle contraction and relaxation. This process is known as peristaltic transport. The peristaltic transport phenomenon is mainly due to the neuromuscular property of any tubular smooth muscle structure. This mechanism is responsible for the transport of biological fluids in several physiological processes such as urine transport from kidney to the bladder, the movement of chyme into the gastrointestinal tract, fluids in the lymphatic vessels, bile from the gallbladder into the duodenum, the embryo transport in non-pregnant uterus, the movement of spermatozoa in the ducts efferent of the male reproductive tract, the movement of the ovum in the fallopian tube and the circulation of blood in small blood vessels are depicted in [19 – 33]. Thus the major focus of this study is to analyze the viscous dissipation, Joule heating effects on MHD electro-osmotic peristaltic flow of couple stress fluid in an inclined asymmetric micro channel. Mathematical formulation of problem is presented. The results are obtained after employing long wavelength and low Reynolds number approximation. The velocity, temperature, concentration, pressure gradient and pressure rise have been proposed for the pertinent parameters of interest.

Mathematical Formulation and analysis

We analyze the electro-osmotic peristaltic flow of an electrically conducting incompressible couple stress fluid and heat transfers through an inclined asymmetric micro-channel with charged walls under the influence of an imposed the magnetic field. The flow is assumed to be asymmetric about x' and the liquid is flowing in the x'-direction. The hydrophobic micro-channel is bounded by slowly varying walls at $y' = h_1(x')$ and $y' = h_2(x')$ respectively, in which the length of the channel (L) is assumed to be much larger than the height, i.e., $L >> (h_1 + h_2)$. Fig. 1 below depicts the schematic diagram of the problem under current study.

Electrical Potential Distribution

The basic theory of electrostatics is related to the local net electric charge density ρ_e in the diffuse layer of EDL and charge density is coupled with the potential distribution ψ' through the Poisson-Boltzmann equation for the symmetric electrolyte is given by

$$\frac{d^2\psi'(y')}{dy'^2} = \frac{2n_0 e z_v}{\varepsilon} \sinh\left(\frac{e z_v \psi'(y')}{k_B T_{av}}\right) \qquad \text{... (3)}$$

where η_o represents the concentration of ions at the bulk, ε is the charge of a proton, z_v is the valence of ions, ε is the permittivity of the medium, k_B is the Boltzmann constant and T_{av} is the boundary conditions for potential function are taken as

$$\psi'(y') = \psi'_1 \qquad \text{at} \qquad y' = h'_1(x'),$$
$$\psi'(y') = \psi'_2 \qquad \text{at} \qquad y' = h'_2(x'), \qquad \text{...(4)}$$

where ψ'_1 and ψ'_2 are the electric potential at the upper and lower wall respectively. Let us now introduce the following non-dimensional variables,

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$$[\psi_O,\psi_1,\psi_2]=\frac{e z_v}{k_B T_{av}}[\psi',\psi_1',\psi_2'], \quad y=\frac{y'}{d_1'} \;\; \text{and} \;\; x=\frac{x'}{L} \tag{5}$$

The dimensionless form of Eqs. (1) - (2) and the Poisson-Boltzmann equation defined in (3) take in the following form,

$$h_1(x)=\frac{h_1'}{d_1'}=1+a\cos(2\pi x), \tag{6}$$

$$h_2(x)=\frac{h_2'}{d_1'}=-d-b\cos(2\pi x+\phi), \tag{7}$$

and

$$\frac{d^2\psi_O}{dy^2}=k^2\sinh(\psi_O), \tag{8}$$

where $a=\dfrac{a_1'}{d_1'}$, $b=\dfrac{a_2'}{d_1'}$, $d=\dfrac{d_2'}{d_1'}$ and $k=\dfrac{d_1'}{\lambda}$ is defined as the electro-osmotic parameter, λ_2 is the reciprocal of

the EDL thickness and is defined by $\dfrac{1}{\lambda}=\left(\dfrac{2n_o e^2 z_v^2}{\varepsilon k_B T_{av}}\right)^{\frac{1}{2}}$. Thus the electro-osmotic parameter is inversely

proportional to EDL thickness λ. The dimensionless form of boundary conditions defined in (4) using the dimensionless variables (5) reduce to

$$\psi_o(y)=\psi_1 \qquad \text{at} \quad y=h_1(x),$$
$$\psi_o(y)=\psi_2 \qquad \text{at} \quad y=h_2(x). \tag{9}$$

We assumed that the electric potential is much smaller than the thermal potential for which the Debye-Hiickel linearization principle can be approximated as $\sinh(x)\approx x$. On the basis of this assumption, the solution of Poisson-Boltzmann equation (8) takes in the form

$$\frac{d^2\psi_o}{dy^2}=k^2\psi_o \;. \tag{10}$$

Finally, by employing the boundary conditions (9), the closed form solution of the equation (10) is given as

$$\psi_o(y)=F_1\cosh(ky)+F_2\sinh(ky)\;. \tag{11}$$

Couple Stress fluid Model

The given set of pertinent field equations governing the flow, in laboratory frame is

$$\frac{\partial U}{\partial X}+\frac{\partial V}{\partial Y}=0 \tag{12}$$

$$\rho\left(\frac{\partial U}{\partial t}+U\frac{\partial U}{\partial X}+V\frac{\partial U}{\partial Y}\right)=-\frac{\partial P}{\partial X}+\mu\left(\frac{\partial^2 U}{\partial X^2}+\frac{\partial^2 U}{\partial Y^2}\right)-\eta\left(\frac{\partial^4 U}{\partial X^4}+2\frac{\partial^4 U}{\partial X^2\partial Y^2}+\frac{\partial^4 U}{\partial Y^4}\right)-\sigma B_0^2 U-\frac{\mu}{k_o}U+$$

$$\rho g\beta_T(T-T_0)\sin\alpha+\rho_e E$$

$$\tag{13}$$

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$$\rho\left(\frac{\partial V}{\partial t}+U\frac{\partial V}{\partial X}+V\frac{\partial V}{\partial Y}\right)=-\frac{\partial P}{\partial Y}+\mu\left(\frac{\partial^2 V}{\partial X^2}+\frac{\partial^2 V}{\partial Y^2}\right)-\eta\left(\frac{\partial^4 V}{\partial X^4}+2\frac{\partial^4 V}{\partial X^2 \partial Y^2}+\frac{\partial^4 V}{\partial Y^4}\right)$$
$$-\frac{\mu}{k_o}V+\rho g\beta_T\left(T-T_0\right)\cos\alpha \tag{14}$$

$$\rho c_p\left(\frac{\partial T}{\partial t}+U\frac{\partial T}{\partial X}+V\frac{\partial T}{\partial Y}\right)=k^*\left(\frac{\partial^2 T}{\partial X^2}+\frac{\partial^2 T}{\partial Y^2}\right)+Q_0-\frac{\partial q_r}{\partial Y}+\sigma B_0^2 u^2+\sigma E^2 \tag{15}$$

where (U,V) are the velocity components in the laboratory frame, ρ is the density, P is the pressure, μ is the viscosity coefficient , η is the couple stress viscosity parameter, σ is the electric conductivity of the fluid, B_0 is the applied transverse magnetic field, k_0 is the permeability parameter, g is the acceleration due to the gravity, β_T and β_C are the coefficient of thermal and concentration expansions, T is the temperature , α is the inclination angle, c_p is the specific heat at constant pressure, k^* is the thermal conductivity , Q_0 is the dimensional heat absorption coefficient, C is the concentration in the reference to fixed frame system, D is the coefficient of mass diffusivity, K_T is the thermal diffusion ratio, T_m is the mean temperature, k_1 is the chemical reaction parameter and α is the inclination angle. The radiative heat flux in the $X-$direction is considered as negligible compared to $Y-$direction. By using Rosseland approximation for thermal radiation, the radiative heat flux q_r is specified by

$$q_r=-\frac{16\sigma^* T_o^3}{3k^*}\frac{\partial T}{\partial Y} \tag{16}$$

where σ^* and k^* are the Stefan-Boltzmann constant and the mean absorption coefficient respectively.

The coordinates and velocities in the wave frame (x,y) and the laboratory frame (X,Y) in a coordinate system moving with the wave speed c in which the boundary shape is stationary and are related by

$$x=X-ct, y=Y, u=U-c, v=V, p(x,y)=P(X,Y,t), \bar{T}(x,y)=T(X,Y,t) \tag{17}$$

where u,v are the velocity components, p is the pressure, T is the temperature and C is the concentration in the wave frame. Introducing the following non-dimensional quantities

$$\bar{x}=\frac{x}{\lambda},\bar{y}=\frac{y}{d_1},\bar{u}=\frac{u}{c},\bar{v}=\frac{v}{c}, h_1=\frac{H_1}{d_1}, h_2=\frac{H_2}{d_1}, \bar{t}=\frac{ct}{\lambda}, \bar{p}=\frac{d_1^2}{\lambda\mu C}p, \delta=\frac{d_1}{\lambda},$$

$$d=\frac{d_2}{d_1},\ a=\frac{a_1}{d_1}, b=\frac{a_2}{d_1}, \mathrm{Re}=\frac{\rho c d_1}{\mu}, M=\sqrt{\frac{\sigma}{\mu}}B_0 d_1, Da=\frac{k_0}{d_1^2}, \gamma=\sqrt{\frac{\mu}{\eta}}d_1,$$

$$Gr=\frac{\rho g d_1^2 \beta_T\left(T_1-T_0\right)}{\mu C},\bar{\psi}=\frac{\psi}{c d_1},\mathrm{Pr}=\frac{\mu c_p}{k^*}, \theta=\frac{\bar{T}-\bar{T_0}}{\bar{T_1}-\bar{T_0}}, \beta=\frac{Q_0 d_1^2}{k^*\left(\bar{T_1}-\bar{T_0}\right)}, Sc=\frac{\mu}{\rho D},$$

$$\gamma_1=k_1\frac{d_1^2}{\upsilon}, Rd=\frac{16\sigma^* T_o^3}{3k^*\bar{\mu}_o c_f}, C_o=\frac{\left(-\dfrac{d\bar{p}}{d\bar{X}}\right)d_1^2}{\mu U_{HS}} \tag{18}$$

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where δ is the dimensionless wave number, Re is the Reynolds number, M is the Hartmann number, Da is the Darcy number, γ is the couple stress parameter, Gr is the local temperature Grashof number, Pr is the Prandtl number, Rd is the thermal radiation parameter, β is the heat generation parameter, γ_1 is the chemical reaction parameter, Sr is the Soret number and A is the Joule heating parameter. Using the above transformations (17) and (18) and non-dimensional quantities (19), the governing flow field equations (13) - (15), after dropping the bars, we get

The dimensional equations of the couple stress fluid are

$$\frac{\partial^4 \psi}{\partial y^4} - \frac{1}{\gamma^2}\frac{\partial^6 \psi}{\partial y^6} - \left(M^2 + \frac{1}{Da}\right)\frac{\partial^2 \psi}{\partial y^2} + \frac{d^3 \psi_o}{dy^3} + Gr\frac{\partial \theta}{\partial y}\sin\alpha = 0 \tag{19}$$

$$\frac{(1+Rd)}{\mathrm{Pr}}\frac{\partial^2 \theta}{\partial y^2} + Ec\left[\left(\frac{\partial^2 \psi}{\partial y^2}\right)^2 + \frac{1}{\gamma^2}\left(\frac{\partial^3 \psi}{\partial y^3}\right)^2\right] + EcM^2\left(\frac{\partial \psi}{\partial y}\right)^2 + A = 0 \tag{20}$$

with the corresponding boundary conditions are

$$\psi = \frac{F}{2},\ \frac{\partial \psi}{\partial y} + L\frac{\partial^2 \psi}{\partial y^2} = -1, \frac{\partial^3 \psi}{\partial y^3} = 0, \theta = 0 \ \text{at}\ y = h_1 = 1 + a\cos(2\pi x) \tag{21}$$

$$\psi = -\frac{F}{2},\ \frac{\partial \psi}{\partial y} - L\frac{\partial^2 \psi}{\partial y^2} = -1, \frac{\partial^3 \psi}{\partial y^3} = 0, \theta = 1 \ \text{at}\ y = h_2 = -d - b\cos(2\pi x + \phi) \tag{22}$$

where L is the velocity slip parameter and F is the flux in the wave frame and the constants a, b, ϕ and d should satisfy the relation

$$a^2 + b^2 + 2ab\cos\phi \leq (1+d)^2. \tag{23}$$

The dimensionless mean flow rate Θ in the fixed frame is related to the non-dimensional mean flow rate F in wave frame by

$$\Theta = F + 1 + d$$

(24)

and in which

$$F = \int_{h_1}^{h_2} \frac{\partial \psi}{\partial y}\,dy \tag{25}$$

Numerical Solution

The solution of system of coupled non –linear Eqs. (20) - (22) with corresponding boundary conditions in Eq. (23) – (24) are obtained using NDSolve in Mathematica computational software. This section contains the plots and related analyses for different embedded parameters. This section includes the graphs for velocity, temperature, concentration and pressure gradient.

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Velocity distribution

Fig. 2 displays the velocity profile for various values of Hartmann number. The velocity decreases and drops with Hartmann number M. Fig. 3 depicts velocity profiles of different values of parameter for osmosis parameter. Velocity profile is seen to raise as osmosis parameter k enlarges. Fig. 4 depicts that the consequences of the parameter λ_1 on the profile of velocity. It is clear that enhance the strength of λ_1 resulted in enhancing the velocity. Fig. 5 indicate that the velocity rises with increasing Da. Fig. 6 reveals that velocity is seen to decrease with the higher values of couple stress parameter. Fig. 7 shows that velocity diminishes with increasing L.

Temperature distribution

Fig. 8 – 11 depicts the deviations in temperature profiles for various values of parameters A, k, Ec and $\Pr$. Fig. 8 presents the consequences of the parameter A on the profile of temperature. It is clear that enhance the strength of A resulted in increasing the temperature. Fig. 9 shows that temperature rises with enhancing k. Fig. 10 shows that the temperature enhances significantly with a rise in Ec. Fig. 11 shows a very significant effect of $\Pr$ on the temperature profiles. It is clear from this figure that the Brinkman number has a impulse to diminish the temperature in the micro-channel. It may be inferred that the thermal conductivity of the fluid declines by enhancing the ratio of momentum diffusivity to thermal diffusivity.

Pumping characteristics

Figs. 13 - 15 represent the profiles of pressure gradient $\left(\dfrac{dp}{dx}\right)$ for the effects of Slip parameter (L), Osmosis parameter (k) and the couple stress parameter (γ). The pressure gradient has oscillatory behavior in the whole range of the x-axis. From all figures, it is clear that the pressure gradient diminishes with the higher values of L, k and γ. The pressure rise is a significant physical measure in the peristaltic mechanism. The results are prepared and discussed for different physical parameters of interest through Figs. 16 – 18 and which are plotted for dimensionless pressure rise ΔP_λ versus the dimensionless flow rate Θ to the effects of Hartmann number M, chemical reaction parameter γ_1, heat generation parameter β and couple stress parameter γ. The pumping regions are peristaltic pumping are $(\Theta > 0, \Delta P_\lambda > 0)$, augment pumping $(\Theta < 0, \Delta P_\lambda < 0)$, retrograde pumping $(\Theta < 0, \Delta P_\lambda > 0)$, co pumping $(\Theta > 0, \Delta P_\lambda < 0)$ and free pumping $(\Theta = 0, \Delta P_\lambda = 0)$. Fig. 16 is depicted that the pressure rise ΔP_λ depressing with an enhance in Hartmann number M in the both peristaltic pumping region and free pumping region. Fig. 17 depicts that the quite opposite nature that of for the effect of the heat generation parameter β .The influence of couple stress fluid parameter γ on the pressure rise is decreases and which is elucidated from Fig. 18.

Nusselt number

Figs. (19) – (21) exhibits the influence of incorporated parameters such as Hartmann number M, Osmosis parameter k and Joule heating parameter A respectively on magnitude of Nusselt number. The heat transfer coefficient has oscillatory in nature due to peristaltic motion of walls. The heat transfer rate enhances for M, k and A from Figs. 19 - 21.

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Sherwood number

The mass transfer coefficient shows the impact of different parameters of λ_1 and k from Figs. 22 – 23. Fig. 22 depicts the Sherwood number depresses with the impact of λ_1 whereas it observes the mass transfer coefficient enhances as the parameter k rises from Fig. 23.

Trapping Phenomenon

The phenomenon of trapping in flow of fluid is trapping and is presented by drawing streamlines in the Figs. 24 - 27. A bolus is having by splitting of a streamline under important conditions and it is followed along with the wave in the wave frame. This process is called trapping. The bolus of trapping is observed to expand by enhancing M from Figs. 24 – 25. However the size of bolus decreases by the rising effects of λ_1 as shown in Figs. 26 – 27.

Concluding Remarks

We have investigated the peristaltic transport of a heat and mass transfer of couple stress fluid on the combined impacts of electro-osmotically and pressure driven flow in an inclined asymmetric micro channel whose walls are varying sinusoidally with different wave trains. Effects of thermal radiation, chemical reaction and Joule heating have been accounted. The numerical solution for velocity, temperature distribution, concentration distribution and pumping characteristics are presented using small wave length and small Reynolds number. The important findings of present study are summarized as follows

• The Electro – osmotic flow of couple stress fluids in an inclined asymmetric channel is strongly depend on Debye length.

• Velocity diminishes with an enhance of L and γ.

• Temperature rises with an strength of A where as depresses with an enhance of Rd.

• It is observed that pressure gradient has oscillatory behavior.

• Pressure rise decreases with an effect of increasing γ

• The absence of Electro – Osmosis, our results are in good agreement with Gnaneswara Reddy *et al.* [33].

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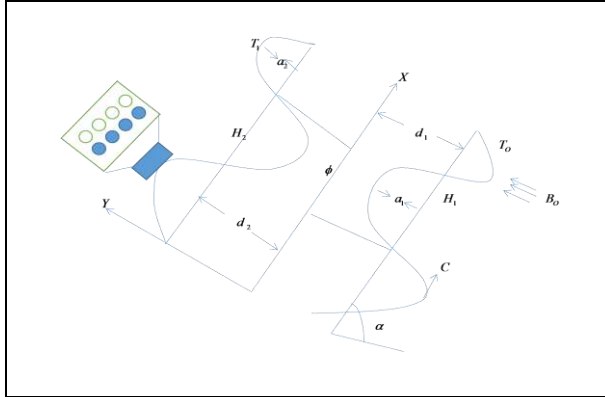
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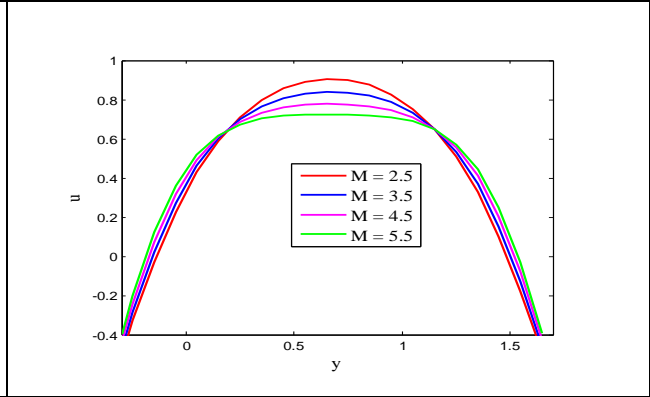
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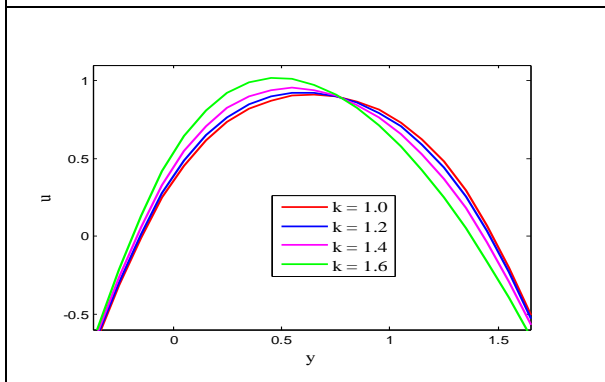
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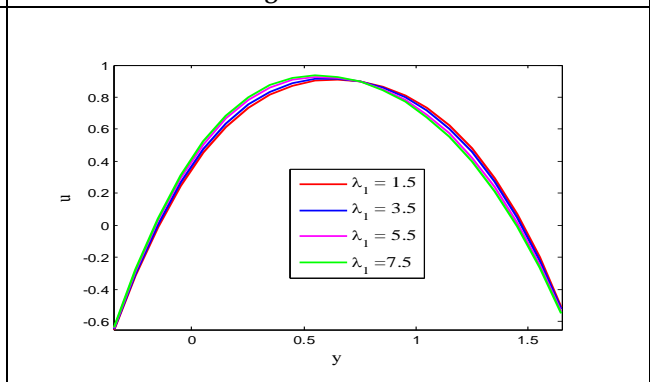
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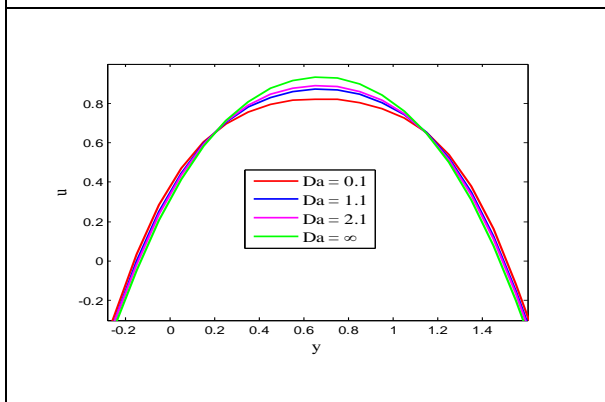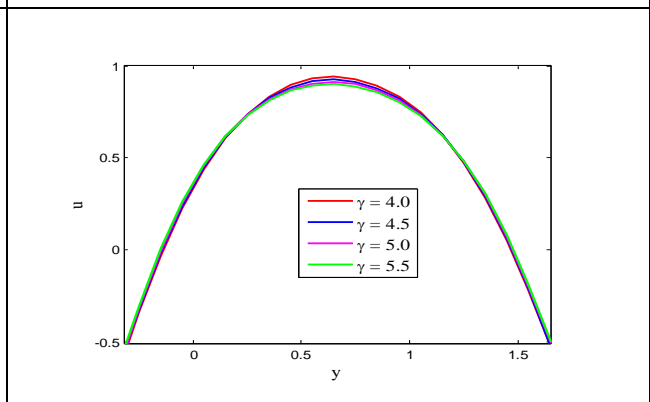
Fig. 5. u for Da

Fig. 6. u for γ

Fig. 7. u for L

Fig. 8. θ for A

Fig. 9. θ for k

Fig. 10. θ for Ec
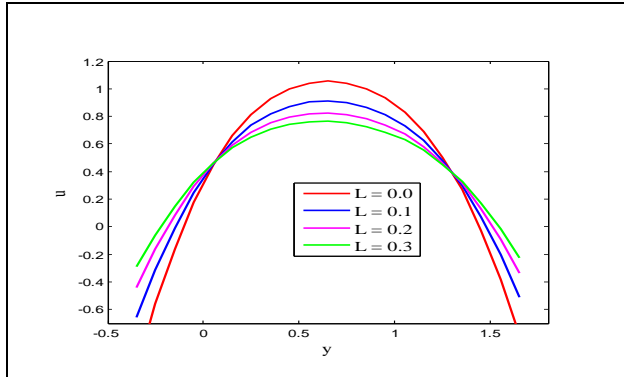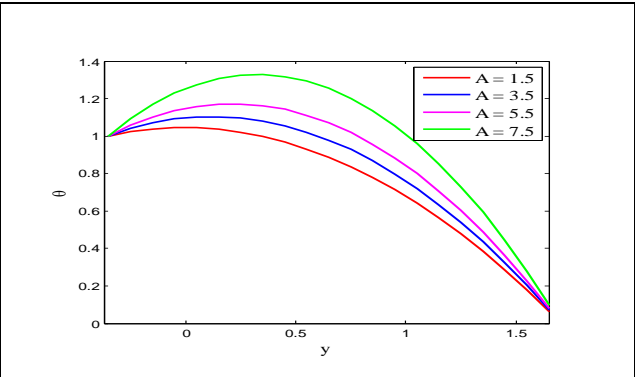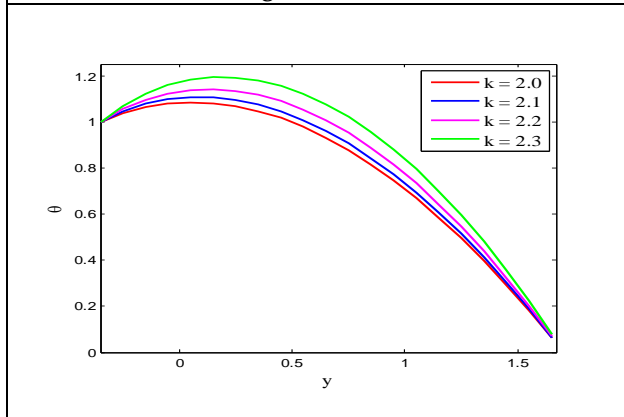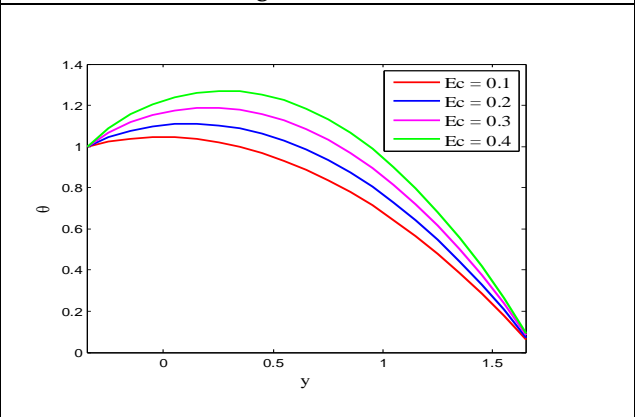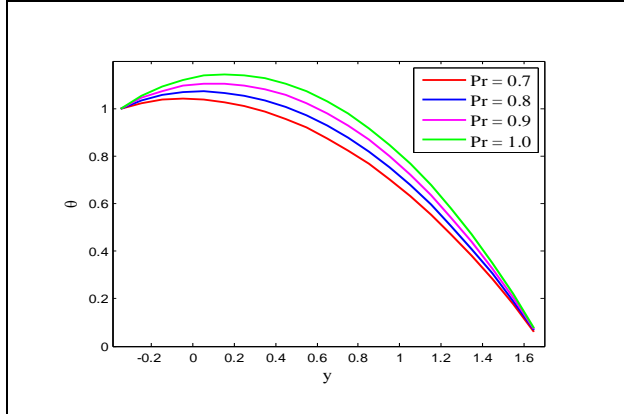
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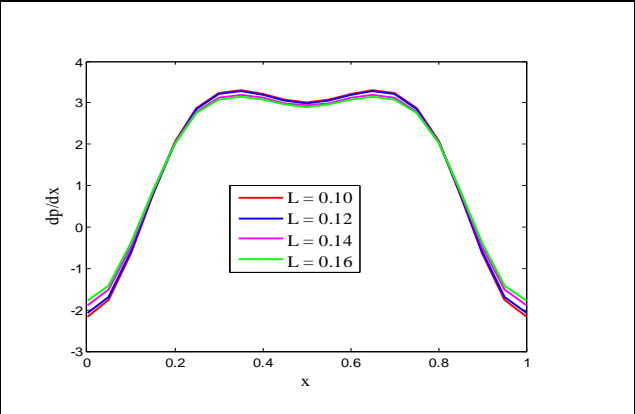
Fig. 12. $\dfrac{dp}{dx}$ for L
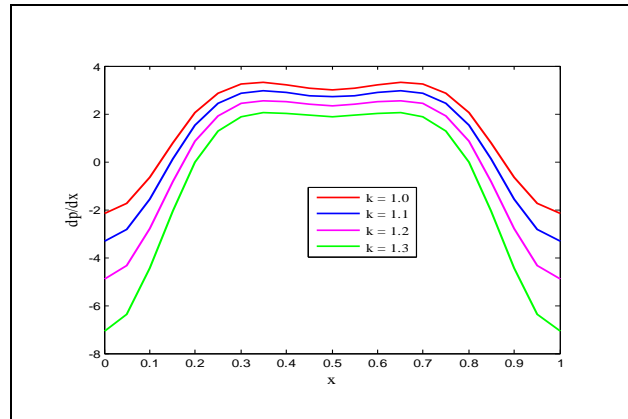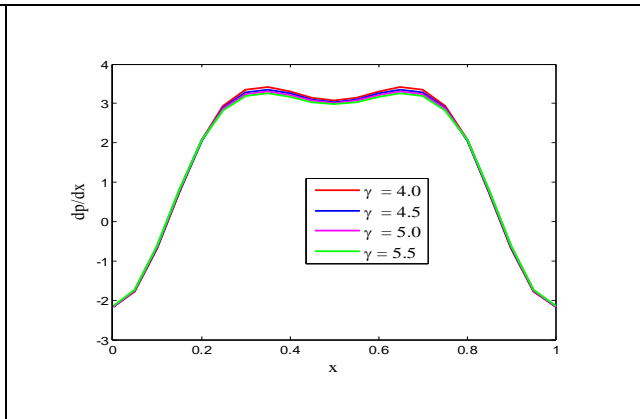
Fig. 13. $\dfrac{dp}{dx}$ **for** k

Fig. 14. $\dfrac{dp}{dx}$ **for** γ

Fig. 15 ΔP_λ **for** M

Fig. 16. ΔP_λ **for** β

Fig. 17. ΔP_λ **for** γ
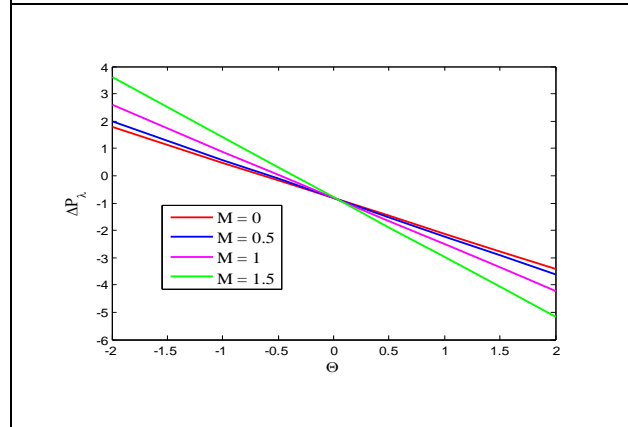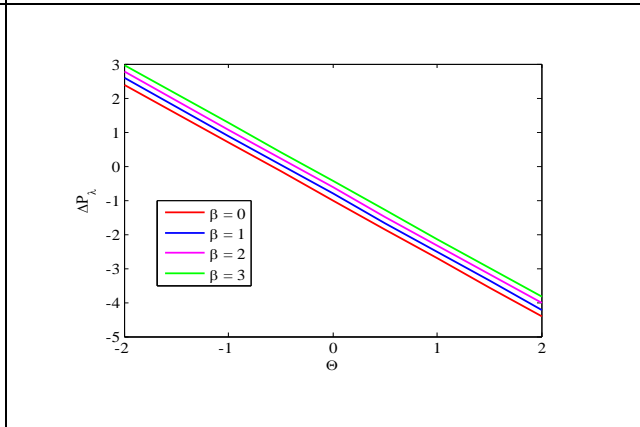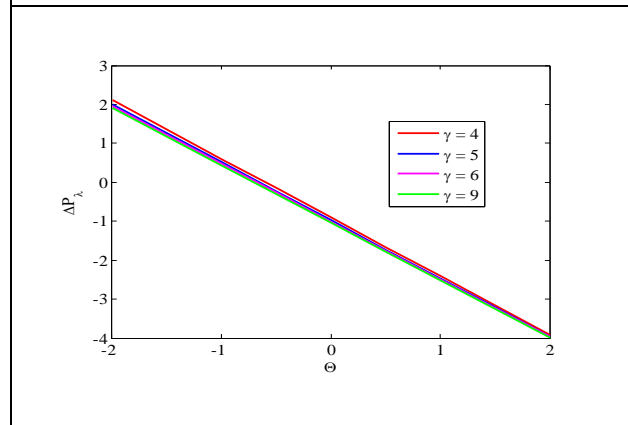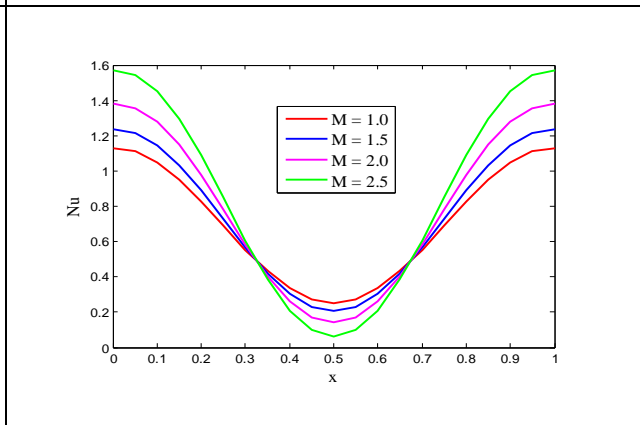
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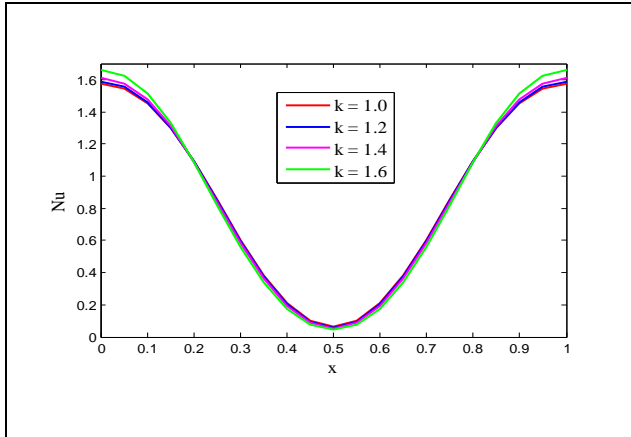
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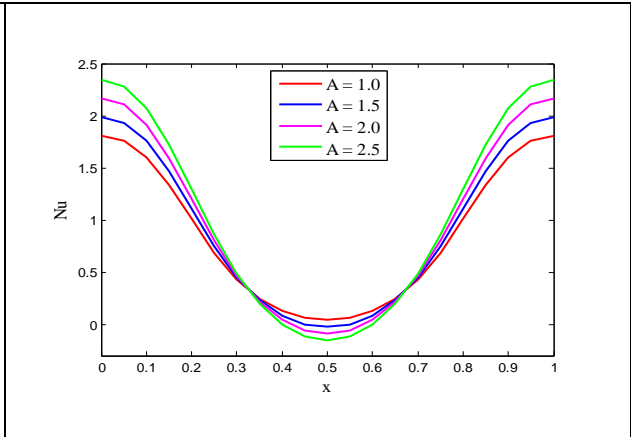
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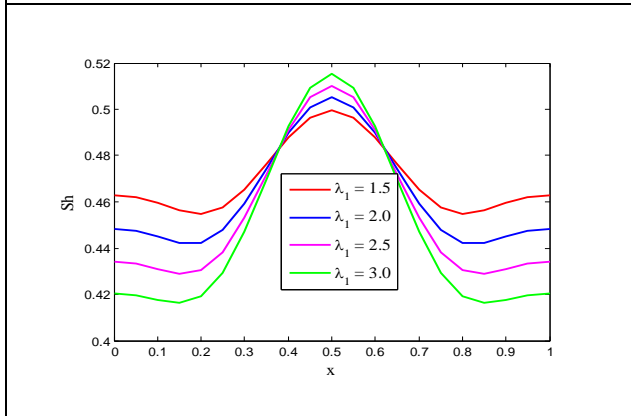
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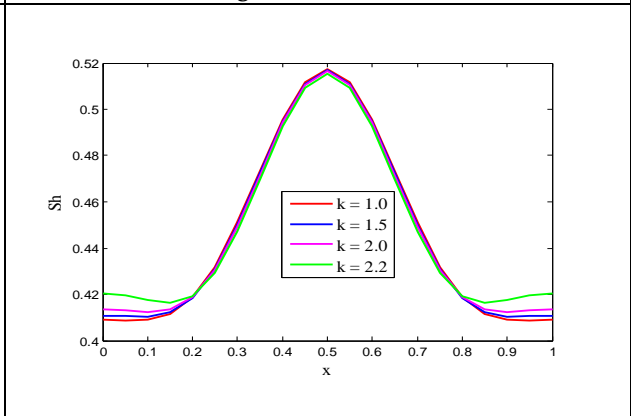
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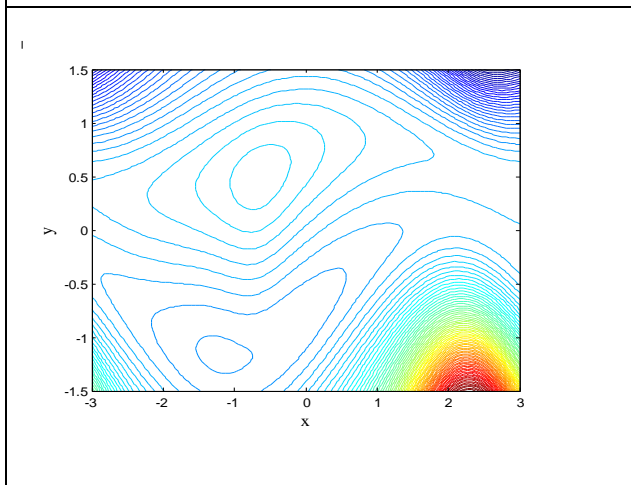
Fig. 23. Effect of M **on stream lines for** $M = 1.5$.
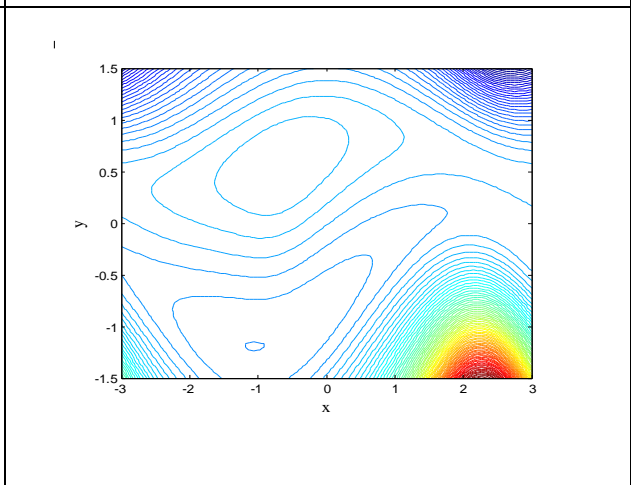
Fig.24. Effect of M **on stream lines for** $M = 1.6$.

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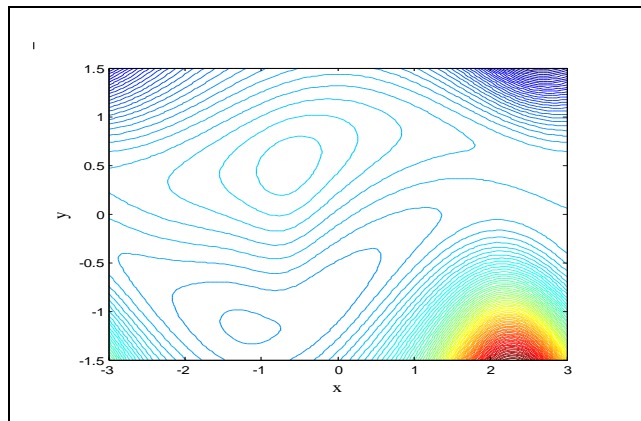
Fig.25. Effect of λ_1 on stream lines for $\lambda_1 = 1.5$.	Fig.26. Effect of λ_1 on stream lines for $\lambda_1 = 1.6$.
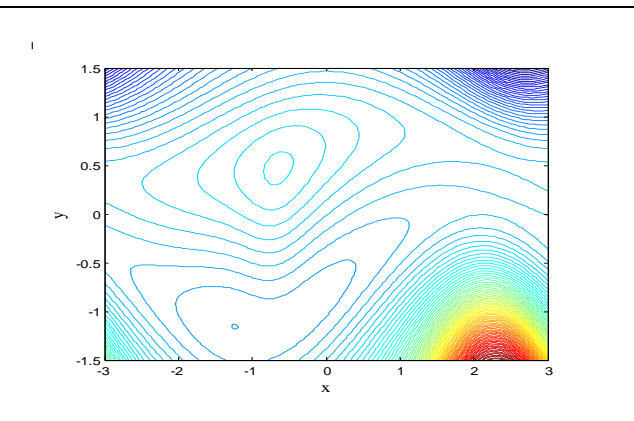
RESEARCH ARTICLE

Utilization of Maternal Healthcare Services by Tribal Women in Meghalaya, India

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ABSTRACT

Tribals make up 8.2% of India's population and are characterized by poor agricultural technology, high poverty, low literacy rates, and a lack of comprehensive health research. Inadequate accessibility and low utilization of maternal health services lead to high maternal mortality and morbidity among tribal women. Their socio-economic conditions have become barriers to access maternal healthcare services. This study was carried out to understand the maternal health-seeking behaviour and utilization of maternal healthcare services among the Koch tribal women of Meghalaya, India. This was a community based descriptive cross-sectional study conducted in March 2022 under the Dalu Community and Rural Development Block of West Garo Hills District of Meghalaya. Among the reproductive age group of women who had a child of less than five years during the interview were randomly collected by administering a semi-structured interview schedule. A total sample size of 70 was considered for the study. The collected data was analyzed using tables, average mean, and simple percentages. In the present study, 45 (64.3%) respondents had their first antenatal visit in the first trimester. Only 21 (30%) respondents have taken two dosages of Tetanus Toxoid, and 63 (90%) consumed more than 50 Iron and Folic Acid tablets. In addition, 59 (84.3%) respondents prefer government health centres and hospitals for delivery assistance. The number of ANC visits and TT dosages should be increased through community outreach activities and increased promotion of health workers at the village level. The present study

found that early pregnancy registration is critical to maternal healthcare services. So efforts should be taken to motivate tribal women to register their pregnancies in public health institutions.

Keywords: Maternal Healthcare, Tribal Health, Reproductive Health, Community Health.

INTRODUCTION

The WHO Constitution states that the highest attainable standard of health is a fundamental right of every human being. However, a lack of trained medical staff and access to essential medicines and medical facilities prevent access to more than half of the Indian population. As a result, 94 % of all maternal deaths occur in low and lower-middle-income countries. Every day approximately 810 women die from preventable causes related to pregnancy and childbirth [1]. Tribals make up 8.2% of India's population and are characterized by poor agricultural technology, high poverty, low literacy rates, and a lack of comprehensive health research. The maternal health care service is an integrated package of antenatal care (ANC), delivery care, and postnatal care. The findings of several studies in India show that tribal women tend to be at greater risk of adverse maternal and child health outcomes than non-tribal women [2]. The unequal utilization of maternal health care is not just a medical fact but a social phenomenon that negatively affects most socially disadvantaged groups such as Scheduled Castes and Scheduled Tribes [3]. In India, caste, socio-economic conditions, educational level, occupation, the standard of living, age at marriage, and perceptions of infant and child mortality affect maternal health services [4].

Meghalaya is one of the tribal-dominated states of India,   constituting   86.15%   of   the   state's population. It is home to three major tribes: The Khasis, Jaintias, and Garos. The minor tribes include the Hajong, Koch, Rabha, Boro, and Mann. According to NITI Aayog's first Multidimensional Poverty Index (MPI) report, Meghalaya is officially recorded as the fifth poorest state in India and the poorest state in the Northeast. With a malnourished population of 37.05%, Meghalaya ranks tenth among all states. Except for Assam (39.67%), the other states in the Northeast region are relatively better than Meghalaya in terms of nutrition. However, with 31.70%, Meghalaya has the fifth highest rate of women lacking maternal healthcare services [5]. Increasing maternal healthcare services among socially disadvantaged groups is a development challenge for policymakers and authorities in underdeveloped and developing countries. The Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) have also set targets for reducing reproductive mortality and morbidity. So, the present study was carried out to examine maternal health care services among tribal women in Meghalaya, India.

RESEARCH METHODS

The present study was conducted at Dalu Community and Rural Development Block of West Garo Hills District of Meghalaya state among the 'Koch' tribal women to examine their utilization of maternal healthcare services. The primary data were randomly collected from the reproductive age group of women who had a child of less than five years during the interview by administering a semi-structured interview schedule. A total sample size of 70 was considered for the study. The collected data were analyzed using tables, average mean, and simple percentages.

RESULTS AND DISCUSSION

The results of the study in table 1 depict the socio-economic conditions of the respondents, which is shown in Table 1 that the majority, 35 (50%) were in the age group of 26 to 30 years, 28 (40%) and 07 (10%) were from 31 to 35 years and 19 to 25 years of age, respectively. Most respondents (60%) were educated up to the primary level, followed by 08 (18.2%) who had studied until the secondary level. Only 05 (7.2%) respondents had studied till higher secondary level. Notably, 15 (21.4%) never attended formal schooling. More than half (70%) of the respondents worked for daily wages, and a small proportion was in government and private jobs. However, 13 (18.6%) of the respondents were

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housewives. Regarding monthly household income, the majority, 36 (51.4%), had an income within Rs.5000-10000, followed by 24 (34.3%) respondents below the income level of Rs. 5000. It is noted that only 10 (14.3%) had an income level above Rs.10000. Table 2 shows that all respondents had at least one Antenatal Care Services (ANC) visit, but 50 (71.4%) women were unsure of the number of ANC visits during pregnancy. About 20 (28.6%) women had at least three and more ANC visits that were medically prescribed for pregnant women. More than half (64.3%) made their first ANC visit in the first trimester. However, only 21 (30%) respondents received two doses of Tetanus Toxoid (TT), and more than 50, Iron and Folic Acid (IFA) tablets were consumed by the 63 (90%) respondents. Table 3 depicts that 59 (84.3%) respondents delivered in Primary Health Centre (CHC), Community Health Centre (CHC), and District hospitals and a small percentage, 03 (4.3%), gave birth in private hospitals, while 08 (11.4%) still gave birth at home. Women who gave birth in health facilities sought help from medical professionals, while those who delivered at home, 03 (4.3%) sought help from trained dai and 05 (7.1%) from untrained dai, relatives, and friends. Table 4 reveals that 58 (82.9%) respondents received postnatal care services, mainly from PHC, CHC, and district hospitals, while only 02 (2.9%) visited a private hospital. Among the respondents, 49 (70%) consulted Accredited Social Health Activist (ASHA) providers one to three times during the postnatal period, while only 21 (30%) consulted four times.

 More than half (52.9%) of tribal women were not aware of Janani Suraksha Yojana (JSY), and only 28 (40%) women received financial benefits and maternity kits under the JSY scheme. The socio-economic conditions of tribal women are found to be significantly low. Most respondents attended only up to the primary level of education, working as a daily wage and living with a household income below rupees 1000. Similarly, the study conducted with the 'Hajong' tribe of Meghalaya also found that they belong to the lower middle class [6]. It is understood from the field study that the majority of the daily wage workers benefit from the government implemented MGNREGA scheme, which provides adult members with a legal guarantee of one hundred days of employment. The preceding discussion on the utilization of maternal healthcare services by tribal women in Meghalaya, India, recorded that most respondents registered and received the ANC services from the public health services. The result was similar to the study conducted with primitive tribal women of Dakshina Kannada District of Karnataka State, examining the utilization of maternal health care services [7]. IFA consumption rates and adherence to TT injections were high. Similarly, the study conducted in the 'Savara' tribe of Andhra Pradesh also found a high rate of IFA consumption and adherence to TT injection [8]. The study reveals that ASHA plays a vital role in motivating and increasing the utilization of maternal health care services among the tribals.

CONCLUSION

The results of this study can help to make decisions and policymakers to improve the maternal health of tribal women in the country. Tribal women need adequate information on reproductive morbidity and treatment, especially for ANC and PNC services. Early pregnancy registration, increased general awareness about maternal health services, accessibility, and affordable and good quality services in the public health system are the need of the hour. As the study found, early pregnancy registration will have a more significant impact on the utilization of maternal health care services; therefore, efforts should be made to motivate tribal women to register their pregnancy in public health services as soon as they become aware of their pregnancy. ASHA workers and ANMs are the primary sources of maternal health care. Therefore, the government should design capacity-building programmes for more effective practice. In addition, awareness and promotion programmes on child immunization, family planning, and nutrition in tribal concentration areas should be organized.

ACKNOWLEDGEMENT

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Table 1: Distribution of Respondents According to Their Socio-Economic Condition

Variables	Frequency (%)
Age Groups (Years)	
19-25	07 (10)
26-30	35 (50)
31-35	28 (40)
Educational Status	
Illiterate	15 (21.4)
Primary	42 (60)
Secondary	08 (11.4)
Higher Secondary	05 (7.2)
Occupational Status	
Housewife	13 (18.6)
Daily wages	49 (70)
Government Service	05 (7.1)
Private Service	03 (4.3)
Monthly Household Income (in Rupees)	
Below 5000	24 (34.3)
5000-10000	36 (51.4)
Above 10000	10 (14.3)

Table 2: Distribution of Respondents According to Their Antenatal Care Utilization

Variables	Frequency (%)
Number of ANC visits	
Don't Know	50 (71.4)
3	07 (10)
4	04 (5.7)
Above 4	09 (12.9)
Time of first ANC visit	
1st trimester	45 (64.3)
2nd trimester	25 (35.7)

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TT dose taken	
Single dose	43 (61.4)
Two dose	21 (30)
Booster dose	06 (8.6)
IFA tablet consumed	
50<	05 (7.1)
50>	63 (90)
None	02 (2.9)

Table 3: Distribution of Respondents According to Their Assistance During Delivery

Variables	Frequency (%)
Place of Delivery	
PHC/CHC/District Hospital	59 (84.3)
Pvt. Hospital	03 (4.3)
At Home	08 (11.4)
Assistance sought	
Medical Professional	62 (88.6)
Trained Dai	03 (4.3)
Untrained Dai/Relatives/Friends	05 (7.1)

Table 4: Distribution of Respondents According to Their Postnatal Visits, Asha Consultation, And Jsy Benefits

Variables	Frequency (%)
Postnatal visits	
Yes	58 (82.9)
No	12 (17.1)
Source of PNC service	
PHC/CHC	60 (85.7)
District Hospital	08 (11.4)
Pvt. Hospital	02 (2.9)
Number of ASHA Consultation	
1 - 3 times	49 (70)
4 - 6 times	21 (30)
Aware About JSY	
Yes	33 (47.1)
No	37 (52.9)
Mother Kit under JSY	
Yes	28 (40)
No	42 (60)

Study on Utilization of Waste Plastic in Bituminous mix with Sugarcane Ash as Filler

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ABSTRACT

Most of the roads in India are paved with Bituminous Concrete due to its low-cost initial investment with respect to concrete pavement, Bituminous Concrete is a dense mixture of coarse aggregate, fillers and bitumen as binder. Fillers are very effective in stability and rut resistance properties in bituminous concrete. Sugarcane bagasse ash is waste material, which is generally disposed in open land after burning sugarcane bagasse in sugar mills. It is locally available material and can be utilized as a filler material. Performance of bituminous concrete with fly ash and sugarcane bagasse ash were tested by Marshall stability test. The laboratory result showed that Sugarcane bagasse ash can be used as filler with fly ash without significant reduction of stability of bituminous concrete. It was also found that excess addition of sugarcane bagasse ash can increased flow value. This type of study can be solution of sugarcane bagasse ash disposal problem.

Keywords: sugarcane bagasse, bituminous concrete, Bituminous Concrete

INTRODUCTION

Road traffic is carried by the pavement, which in engineering terms is a horizontal structure carried by in situ natural material. A road pavement is composed of stable layers constructed on earth mass todistribute load of vehicles over a wide area of the underlying sub grade soil and permitting deformation with elastic on allowable range and to provide adequate surface. All the layers should be properly designed and constructed to prolong the life of a pavement. In general pavements are categorized into 2 groups i.e., flexible and rigid pavement. The most common roads use flexible pavements due to their flexibility in nature. In flexible pavements bitumen used for the surface course to make the pavements stable and even surface for the traffic, it is the uppermost structural layer serves as the wearing course. Since it is directly exposed to traffic and environmental forces, it must be produced with highest quality material. Roads surface withnet bitumen can cause bleeding in hot climate may develop cracks in cold climate posses fewer loads bearing capacity and can cause serious damage because of higher axial load in present conditions due to rapid infrastructure development. India has to raise transportation system to higher level both in terms of length and quality. On the other hand, plastics are user friendly but not eco-friendly as they are non-biodegradable. Today in India nearly more than 14million tons of plastics are used. Visibility has been perceived as a serious problem and made plastic a target in the management of solid waste. They also have a very long lifetime and burning of plastics waste under uncontrolled conditions could also lead to generation of many hazardous air pollutants (HAPs). So, the use of waste in hot bituminous mixes can enhances pavement performance, protect environment and provide low-cost roads. So here in present study waste plastic is added to bituminous mix with sugarcane ash and stone dust as fillers in order to enhance the mix property.
The scope of the objective included the following

- Determination of physical properties of aggregate, bitumen, filler.
- Determination of OBC and OPC for conventional mix and modified bituminous mix.
- Determination of mechanical properties of bitumen mixes prepared with varying percentages ofwaste plastic (LDPE).
- Stability comparison of modified and conventional bituminous mixes using both fillers.

Background and Motivation
Because of increasing demand in highway construction, scientists and researchers are always endeavoringto enhance the execution of bitumen pavement. Because of increase in vehicles as of late the road surface has been presented to high movement bringing about deformation of pavements because of over- the-top pressure. Permanent deformation happens when pavement does not have adequate stability, improper compaction and lacking pavement quality. Because of fast industrial development in different fields together with population development, a conspicuous increase in waste age rates for different sorts of waste materials is observed. Disposal of that vast measure of wastes particularly non decaying waste materials turn into an issue of extraordinary worry in developed as well as in developing countries. Recycling waste into helpful items is thought to be a standout amongst the most reasonable answers for this issue. From down to earth encounters it is demonstrated that the modification of bitumen binder with polymer additives, offers a few advantages. To improve different engineering properties of bitumen numerous modifiers, for example, low density plastics have been utilized as a part of bitumen.

Waste plastic: the crisis
Presently a day, in India as the consequence of fast industrial development in different field with highly population development an obvious increase the utilization of plastics. Disposal of huge consumed plastics cause a natural pollution. Disposal of plastics waste in municipal solid waste is completed for the most part via land filling and burning strategy. There are two techniques isn't reasonable for plastic disposal. The land filling is transitory process it will impact to water recharge, diminish the soil properties, drainage issue in water line. While consuming of polymers, it delivers the gasses like CO, CO_2 which causes the air pollution. Plastics are non-biodegradable, in the event that it isn't recycled itwill impact to the earth, to lessen the effect of condition and furthermore to decrease

the strong waste disposal issue. The improper disposal of plastic may cause numerous dieses, reproductive issue in human and animals, genital abnormalities and considerably more. so the plastic wastes can be utilized as modifier for asphalt mix to enhance the execution of the mix configuration and additionally reasonable administration of waste plastic waste.

Role of polythene in bituminous pavements

Bitumen is a viscous material that has been gotten from crude petroleum and has been used in paving roads. Now a day's utilization of polyethylene in road construction in not new, as we are observer of numerous plastic roads over the world. Plastic roads predominantly utilize plastic carry-bags, disposable cups, LDPE packets, PET bottle that are gathered from garbage dumps as a vital element of the construction material. Polyethylene's get added to hot bitumen mixture and the mixture is laid on the road surface like a typical tar road. Making a modified bituminous mixture by utilizing recycled polymers (e.g., polyethylene) which upgrades properties of HMA mixtures would deliver a more durable pavement, as well as give a gainful method for disposal of a lot of recycled plastics.

LITERATURE REVIEW

Awwad and Shbeeb (2007) indicated that the modified mixture has a higher stability and VMA percentage compared to the non-modified mixtures and thus positively influence the rutting resistance of these mixtures. According to them modifying asphalt mixture with HDPE polyethylene enhances its properties far more than the improvements realized by utilizing LDPE polyethylene.

1. Sabina et al. (2009) evaluated the performance of waste plastic/polymer modified bituminous mix and observed that the results of Marshall stability and retained stability of polythene modified bituminous concrete mix increases 1.21 and 1.18 times higher than that of conventional mix by using 8% and 15% (by weight of bitumen) polythene with respect to 60/70 penetration grade of bitumen. But modified mix with 15% polyethylene showed slightly decreased values for Marshall stability than that of the mix with 8% modifier in their results.

2. Yousefi (2009) stated that the polyethylene particles do not tend to rip in bitumen medium and these particles prefer to join together and form larger interparticle attractive forces and the only obstacle in the modification process was the existence of partitions made from molten bitumen. According to the author whenever, particles had enough energy to come close together and overcome the thin remained bitumen film which was separating particles, the coalescence of polyethylene particles occurred and lead to polymer phase separation.

3. Jain et.al (2011) stated that the mitigation of rutting in bituminous roads by using the waste polymeric packaging materials (WPPM). The materials were used milk bags and other high-density polyethylene (HDPE) like carry bag. The grade of bitumen was 60/70, different size was used of WPPM is 5-10mm x 3-6mm. the WPPM varied from 0.1% to 0.6% (weight of bitumen). When the WPPM is modified with bitumen at the 0.2 to 0.3% the 30% stability increases. The Marshall quotient is 11.5% when addition of 0.3% WPPM. And increasing the WPPM at 0.4% the Marshall quotient is decreases. When adding of WPPM 0.3% the stiffness modulus increases. Rutting is depending on volumetric composition, shape of aggregates and characteristics of binder. For rutting test wheel tracking device used application of 20,000 cycles, by adding optimum quantity of 0.3% polyethylene in bituminous mix for road construction. Rutting values varies from 6.1mm and 16/2mm to 3.6mm and 3.9mm with different temperature. It was observed that it ultimately improves pavement performances, reducing disposal problems of waste polymeric packaging material WPPM for clean and safe environment.

4. Vidual et.al, (2012) stated that using the waste plastic bags the size was 60 of below for bitumen modification. The plastic were cut into pieces which were sieved through 4.75mm passing which is retained in 2.36mm.the bitumen were added in different percentage (4.5%, 5%, 5.5% and 6%) were the 10% of waste plastic was replaced for the bitumen the Marshall stability value ranges from 20.28KN to 21.81KN to 21.81 (4.5 to 6%) in the plain bitumen the Marshall value was 17.03KN to 17.61 (4.5 to 67%). The flow value also increases from 4.57 to 5.15mm, when

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increase the usage polymer decreased in the penetration value. The flash and fire point were increases when adding the polymer. The main reason for decreasing the ductility is interlocking of the polymer molecule in bitumen. The material cost of the project was reduced by 7.99% the optimum waste plastics were used (5- 10%).

5. Moghaddam and karim (2012) reported that the utilization of waste material in asphalt pavement would be beneficial in order to find an alternative solution to increase service life of asphalt pavement and reduce environmental pollution as well. form their study it is concluded that that polyethylene terephthalate (PET) reinforced mixtures possess higher stability value, flow, fatigue life in comparison with the mixtures without PET.

Experimental Work

The experimental work mainly includes 2 processes i.e.

I. Preparation of Marshall samples

II. Tests on sample

In the preparation of Marshall samples, the mixes were set up as indicated by the Marshall procedure determined in ASTM D1559. For DBM the coarse aggregates, fine aggregates and filler were mixed with bitumen and polythelene as indicated by the adopted gradation. First a study was done on DBM mix by utilizing stone dust as filler with and without polyethylene in mix. Again, a similar report was done on DBM mix by using sugarcane ash as filler with polyethylene in mix. Here optimum binder content (OBC) and optimum polyethylene content (OPC) was found by Marshall test. The mixing of ingredients was done according following procedure;

    I.   1200gm of aggregates (coarse aggregate, fine aggregate and filler) were taken in an iron pan.

    II.   The mix was kept in oven at a temperature of 1600C for 1hour.

    III.   Mould and rammer were kept pre heated at 950C-1400C.

6. Required quantity of bituminous binders were heated at temperature of 1200C to 1600C.

7. Required quantity of shredded polythene was taken and kept in a container.

8. The aggregates in the container were warmed on a controlled gas stove for a couple of minutes keeping of the above temperature. At that point the polyethylene was added to the aggregate and was mixed for two minutes.

9. Bitumen was added to the mix and was stirred uniformly for 15-20 minutes till they were properly mixed after thoroughly mix; this mix was placed on preheated mould.

10. Then compacted by rammer by height of 457mm,75 times on either side of the mould.

In Marshall test we need to make a specimen of diameter of 63.5mm×101.6mm by compressing it in a cylindrical mould. The principal target of Marshall Stability test is resisted to flow of cylindrical specimen of aggregate-bitumen mixture load on the lateral surface of cylindrical specimen. It is the load carrying capacity at 600C±10C, stability measured in kilo newton. It also includes density, durability, flexibility resist to skidding, workability during the construction of pavements.

RESULT DISCUSSION

This section manages test results and examination did in past part. This part is partitioned into 4 parts. In First part it manages estimation of optimum binder content (OBC). Second part deals with estimation of optimum polyethylene content and optimum binder content of DBM mixes using polyethylene and with stone dust utilized as filler. Third part deals with calculation of Marshall mix design for DBM, mixes with polyethylene by supplanting some level of sugarcane ash as filler. Fourth part deals with stability comparison of modified bituminous mix and conventional bituminous mix.

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Marshall Properties of modified bituminous mix with sugarcane ash as filler

Here marshal method mix design is carried out by using plastic as an additive and sugarcane ash as filler. Here OPC and OBC is taken constant to do mix design with sugarcane ash as filler. Here stone dust is replaced by sugarcane ash with percentage of 10-50% at an interval of 10%. The Marshall stability value, flow value, unit weight, Vv, VFB are evaluated.

Stability

Stability of bitumen mix increases as the SCA content increases till it reaches the pick at SCA content. 30% then it started to decline gradually at higher SCA content.

Flow Value

Flow is the total amount of deformation at maximum load. Flow of bitumen mix increasing till it reaching the peak.

Density

Density of bitumen mix increases as the SCA content increases till it reaches the peak at SCA content 30% then it started to decline gradually at higher SCA content.

Air Void (VA)

Va % is the percentage of air voids by volume in specimen or compacted bitumen mix. Va% decrease gradually as SCA content increases.

Void filled with bitumen (VFB)

From graph it is observed that void filled with bitumen increases as increases with SCA content.

Comparison of Marshall Properties of modified bituminous mix (Using both stone and dust and sugarcane ash as filler) with conventional mix

Here comparison is done between bituminous mix without polyethylene content and bituminous mix with polyethylene content. From the above table it clearly shows that the modified bituminous mix design having optimum plastic content of 6.24% having optimum binder content value of 4.63% which is less than conventional mix i.e. 4.86%. Generally, the stability of modified bitumen mix is higher than the conventional bitumen mix. All the values of stability for modified mix are higher than stability of conventional mix. Here maximum stability value is found 2141.62kg at plastic content of 6.24% with 30% sugarcane ash (SCA) as filler which is higher than highest stability value of modified bituminous mix using stone dust as filler i.e 1712.289kg and conventional mix i.e 1190kg the improvement of stability in plastic modified bitumen mixes can be clarified because of the better grip created between bitumen, plastics and aggregate because of the intermolecular bonding, these intermolecular attractions upgrade quality of bitumen mix, which thusly help to improve durability and stability of the bitumen. From the above table it is clearly shown density value of bituminous mix with polyethylene content has high density value than bituminous mix without polyethylene content. So the compatibility of modified bituminous mix is good. From the above table the bituminous mix with polyethylene content has less air void value than bituminous mix without polyethylene .so in modified bituminous mix aggregates can easily be coated with bitumen.

CONCLUSION

Consequently, in this investigation, DBM was set up with VG30 review of bitumen. The investigation was completed by addition of waste polyethylene in bituminous mix in level of 2%- 10% at an augmentation of 2%. a) Utilizing Marshall mix outline for DBM mix, the optimum binder content has been discovered 4.86% for plain bituminous mix and for bituminous mix configuration utilizing plastic as added substance has been discovered 4.63% with OPC 6.23%. So it's exceptionally useful in road development as it is required less measure of binder content.

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b)   The stability value of modified bituminous mix (utilizing both stone dust and sugarcane ashes filler) has been discovered more than plain bituminous mix however the stability value of modified bituminous mix utilizing just stone dust (SD) as filler.

c)   The addition of waste plastic (LDPE) limits the air voids which keeps the dampness retention and oxidation of bitumen by captured air. This has brought about upgrade of Marshall Stability.

d)   The bulk density of the mix is additionally expanded with addition of waste plastic to bituminous mix.

From the above perceptions it is reasoned that utilization of waste polyethylene in type of packets utilized as a part of milk packaging locally brings about enhanced designing properties of bituminous mixes.

Subsequently, this examination investigates not just in using most usefully the waste non degradable plastics, yet in addition gives an open door in bringing about enhanced asphalt material in surface courses subsequently making it more durable.

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Table 1 : Properties of bituminous mix after adding waste plastic (Sugarcane ash as filler)

Sugarcane ash content (%)	10	20	30	40	50
Stability(kg)	1656.242	1837.139	2141.62	1935.98	1630.92
Flow(mm)	2.4	2.9	3.8	4.2	4.4
Density(gm/cc)	2.44	2.448	2.452	2.443	2.441
Airvoid(%)	3.61	3.45	3.201	3.047	3.038
VFB(%)	73.422	74.330	75.1	75.33	76.755

Table 2 : Optimum Bitumen Content

Type of mix	Optimum polyethylene content (5%)	Optimum bitumen content(%)
DBM without polyethylene	0%	4.86%
DBM with polyethylene(using stone filler)	6.24%	4.63%

Table 3: Stability Comparison

Type of mix	Stability(kg)
DBM without polyethylene	1190
DBM with polyethylene(using ston and dust as filler	1712.289
DBM with polyethylene(using both the filler)	2141.62

Table 4: Density Comparison

DBM without polyethylene	2.4235
DBM with polyethylene (using stone dust as filler)	2.438
DBM with polyethylene (using both filler)	2.452

Table 5: Air Void Comparison

Type of mix	void Air(%)
DBM without polyethylene	
DBM with polyethylene(using stone dust as filler)	3.211
DBM with polyethylene(using both filler)	3.201
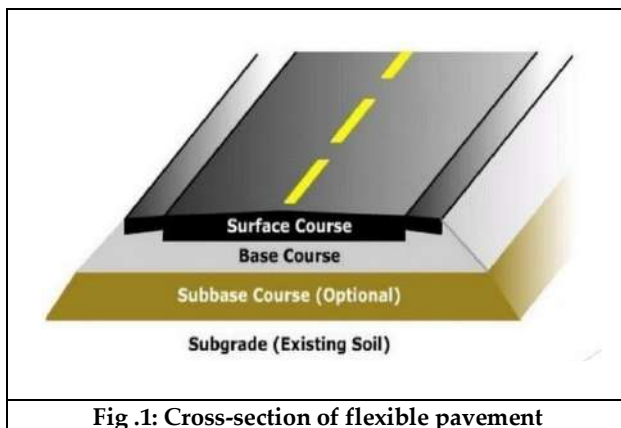
Fig .1: Cross-section of flexible pavement	Fig .2: Cross section of rigid pavement
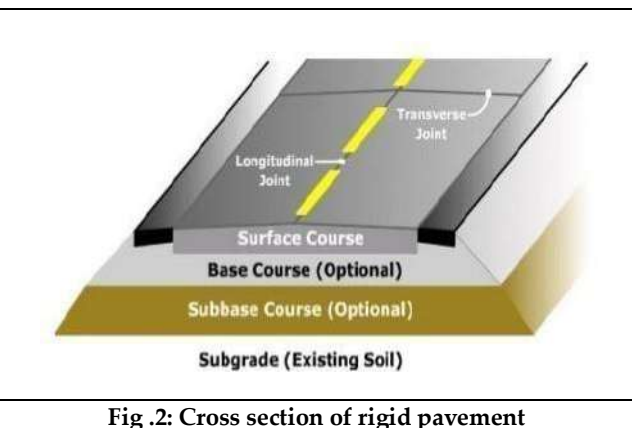
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Fig. 3: Marshall Sample	Fig .4: Marshall Stability test machine
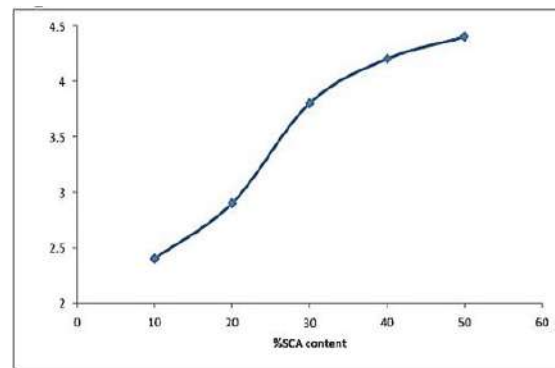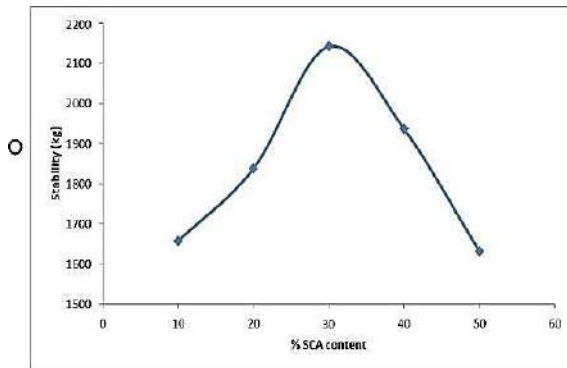
Fig. 5. Stability
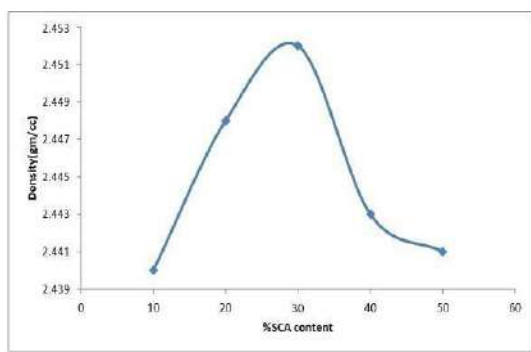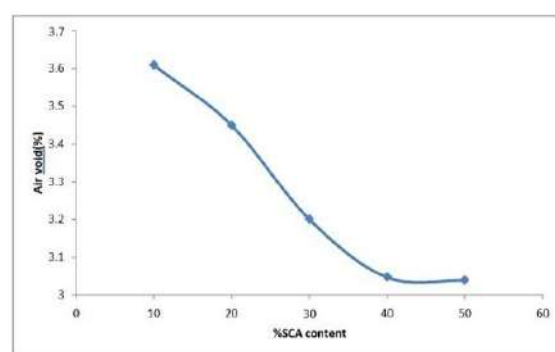
Fig.6.Density	Fig. 7. Air Void (VA)

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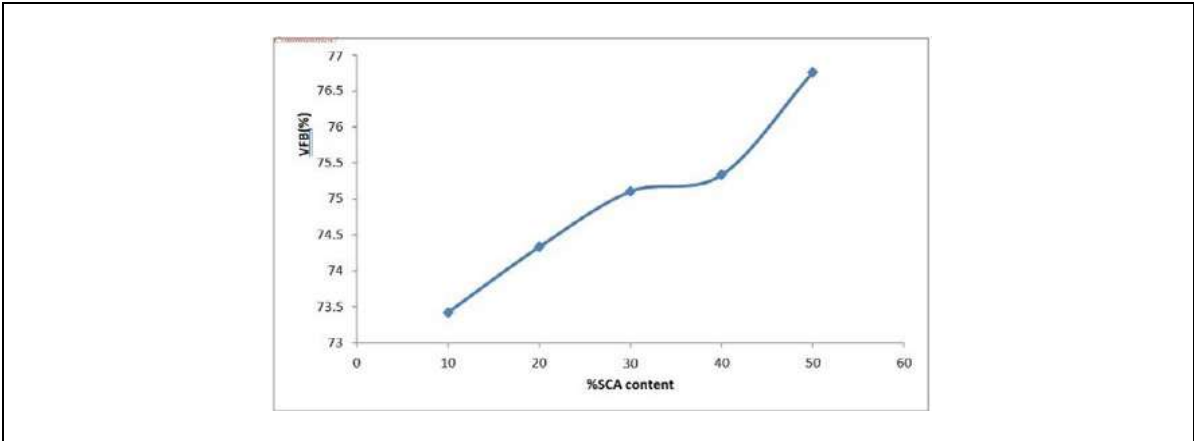
Fig. 8. Void filled with bitumen (VFB)

RESEARCH ARTICLE

Dietary Analysis of Nutritional Composition of Few Food Plants of *Cynopterus brachyotis* (Lesser Dog Faced Fruit Bat) in the Forests of Kalakad Mundanthurai Tiger Reserve

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ABSTRACT

Cynopterus brachyotis is a common fruit bat of forests distributed above 600 m elevation. On their wide nightly foraging routes they assess and search a number of plants for ripe which are distributed to all elevations starting from 600 to 4000 feet of KMTR (Kalakad Mundanthurai Tiger Reserve) forests. Throughout its range, this species occupies a variety of habitats including primary rainforests, disturbed forests, mangrove swamps, cultivated areas, orchards, gardens and urban areas. Fruit bats feed on a large number of different fruit species to meet their energy requirement and to avail balanced diet. The major dietary items observed throughout the year were identified and a few ripe fruits preferred by *C. brachyotis* were collected and the nutrient compounds were analysed in the fruits of *Ficus racemosa*, *Limonia triphylla, Strychonos nuxvomica* and *Syzygium jamboss.* In the present study, the *C. brachyotis* prefers fruits like *Limonia triphylla* (0.74mg/dl) because of the high amount of protein content, (50 mmol/l) with high level of sodium content for their body regulations and (32 mmol/l) with high level of chloride content to help the distribution of body fluids. The present chemical analysis has proved that among the tested fruits *Syzygium jamboss* (236mg/dl) possess high iron content. Chiropterophilic plants attract and reward the bats with chemical component rich resources (Food, Nutrients, Minerals, Secondary metabolites etc.). The present study has identified the Chiropterophilic plants attract and satisfy the quest of the bat to get balanced diet (nutrition), nutritive addictives and secondary metabolites to survive and reproduce. These cataloging of chemicals are very important and ideal to attract bats for the propagation

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of many rare, endangered, endemic plants and implementing Conservation Management Action Plans for forest restoration.

INTRODUCTION

Mutual relationship between plant-eating animals and their host plants represent one of the key ecological interactions where the animals play role as seed dispersers or pollinators or both (Howe and Westley 1988). In a fruit-seed disperser interaction, plants provide the animals with fruit pulp where as the animals provide seed dispersal services to the host plants (Howe and Smallwood1982, Bosque and Pacheco 2000). *Cynopterus* sp. are reliable seed dispersers and they play a significant role in evolution and maintenance of tropical and evergreen forest ecosystem of the southern Western Ghats. On faunally depauperate islands, pteropodids play keystone roles as principal pollinators and seed dispersers (Elmqvist *et al.* 1992, Shanahan *et al.* 2001, Fleming and Racey 2009, McConkey and Drake 2015, Florens *et al.* 2017), while their high abundance on some continents ensures they are important providers of ecosystem services (Redford *et al.* 2013, Baker *et al.* 2018, van Toor *et al.* 2019, Laurindo *et al.* 2020). Many plants visited by pteropodids are utilised by humans, and thus have economic importance (Fujita and Tuttle 1991, Kunz *et al.* 2011, Scanlon *et al.* 2014). *Cynopterus brachyotis* is the common fruit bat of forest distributed above 600 m elevation. On their wide nightly foraging routes they assess and search a number of plants for ripe fruits (Fleming, 1982 and 1988). According to Vanitharani (2006) and Jeyapraba (2008), they are distributed at all elevations starting from 600 to 4000 feet of KMTR forests. Throughout its range, this species occupies a variety of habitats including primary rainforest, disturbed forest, mangrove swamps, cultivated areas, orchards and gardens and urban areas. It is well adapted to anthropogenic conditions (Lim 1966, Medway 1983, Phua and Corlett 1989, Francis 1990,1994, Tan *et al.* 1997). Kalakad Mundanthurai Tiger Reserve forest is situated in the southern part of Western Ghats of India. KMTR is bound by forests in west, north and south and by villages in the east.

The Western Ghats is one among 25 biodiversity hotspots in the world. Agasthyamalai (1681 meters) which falls within the core zone of the Reserve is the 3rd highest peak in southern part of India. When foraging on plant parts or products such as fruits, leaves or nectar, animals are not only rewarded in terms of nutrients, but also deterred by the toxins produced by the plant itself, or by micro-organisms in the food (Janzen 1977, Harborne 1993, Cipollini 2000, Jakubska *et al.* 2005). However, the toxicity of these compounds is balanced by nutrients present in the same, or a different food item that the animal consumes. That is the reason why herbivores function better when offered combinations of different foods than fed with single-food diets (Freeland and Janzen 1974). Thus, nutrients from some plants act as complementary resource (Rapport 1980, Tilman, 1980); ingesting these resources together with other food, can earn more fitness to the forager. Fruit bats feed on a large number of different fruit species to meet their energy requirement and to avail balanced diet (Dobat and Peikert Holle,1985). Theories concerning diet selection and the evolution of feeding strategies in frugivorous bats have been primarily based on studies of neotropical fruit-eating bats (Phyllostomidae) along with corroborating studies on African fruit-eating bats (Pteropodidae) (Fleming 1982). A number of different physiological and behavioral strategies have been identified in mammals enabling them to accommodate increased energy demands at various stages of their life cycle.

 These strategies include either increase in food intake (Randolph *et al.* 1977, Millar, 1978, Hickling *et al.* 1991) or mobilization of fat reserves to fuel the demand (Fedak and Anderson 1982). Fruits contribute appreciable amounts of iron and calcium. Sodium, magnesium, and potassium contents account for the alkaline ash. In most chiropterophilic fruits these macro minerals are present in varying amounts. These elements are essential in the frugivores to meet, every aspect of metabolism, including muscle contraction, neural transmission, nucleic acid formation, as well as carbohydrate, fat, and amino acid metabolism (Robbins 1993). Frugivorous bats are known to digest carbohydrate-rich meals rapidly (Keegan, 1977; Winter, 1998) and efficiently (Craik and Markovich, 2000). Fruits are generally rich

in nonstructural carbohydrates, although they are typically low in fats and protein (Herrera 1987, Martinez del Rio and Restrepo 1993, Corlett 1996). Calcium is essential for maintaining normal cellular (acid–base balance), neuromuscular, and skeletal functions (Currey 1984, 1990, Nordin and Frankel 1989). Reduced calcium intake can lead to retarded growth, decreased food consumption, osteoporosis and bone fractures, and ultimately reduced survival (Robbins, 1993; Favus, 1996). Additionally, bats experience large shear stresses and tortional loads during powered flight (Swartz *et al.* 1992, Swartz 1998), especially when females withdraw calcium from their bone reserves during lactation (Kwiecinski *et al.* 1987; Bernard and Davison, 1996). Thus, calcium may be a limiting nutrient for both survival and reproductive success of bats (Barclay 1994, 1995). Fruits vary widely in their carbohydrate content (between 1.5% and 26%). Ripe fruit contain no starch; the main sugars are fructose and glucose which are often present in equal proportions. Fleshy fruits are regarded as being either nutrient dense or nutrient dilute (Izhaki 1993). Nutrient-dense fruits are considered to be relatively high in lipids, low in water and carbohydrates and variable in protein level whereas nutrient-dilute fruits are high in water, have fewer carbohydrates than lipid-rich fruits and are low in fiber and protein. Crude fiber is considered as the material left after digesting the fruit. It is manly composed of cellulose, lignin and some minerals. Cellulose and lignin in plant tissue are digested by reacting with acid and alkali of different part of the digestive tract in bats. (Snow, 1981; Herrera, 1982; Izhaki,1993).

MATERIALS AND METHODS

The study area of the present study, Kalakad Mundanthurai Tiger Reserve (KMTR) is situated in the Southern Western Ghats of Tirunelveli district, Tamil Nadu which, is the second largest protected area in the state. Part of Agasthyamalai hills in the core of the Reserve is considered one of the five centers of rich plant diversity and endemism in India (IUCN). This is the only area of Western Ghats which has longest raining period of about 8 months a year, and it is the only non-dipterocarp evergreen forest in the region. (Johnsingh 2001; Daniels 2001).The lesser dog-faced fruit bat (*C. brachyotis*) is a common plant visiting bat in the forests of South - East Asia. It is found widespread from sea level to 1,600 meters in altitude (Nowak 1997). The major dietary items observed throughout the year were identified and a few ripe fruits preferred by *C. brachyotis* were collected from Servalar forest area of KMTR. The fruits were sorted; the mature and unblemished ones were selected. The nutrient compounds were analysed in *Ficus racemosa, Limonia triphylla, Strychonos nuxvomica* and *Syzygium jamboss.*

Nutrient Composition Analysis
The fruits were washed and the pulp was separated from the endocarp using a sterile knife. The edible part of the fruit was homogenized in a blender and this homogenized mixture was dried at 100°C until it reached a constant weight. Subsequently the dried homogenate was stored at -20°C. Various standard chemical kits were used to detect the mineral composition, enzyme composition and for the secondary metabolites available in the plant resource through autoanalyser. The mixture was used for the estimation of, total protein, glucose, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), triglycerides (TGL) and minerals like calcium, magnesium, potassium and phosphorous .

RESULTS

Table 1 illustrates the nutrient composition of the selected chiropterophilic fruits which attracted *C. brachyotis* including HDL, LDL and TGL, proteins, glucose, iron, calcium, phosphate are the nutrients which attracted the bats and are the prime compounds present in the chiropterophilic fruits. Among the analysed fruits *S. nuxvomica* possess the highest amount (1285mg/dl) of glucose, (27 mg/dl) of Tocopherol cholesterol, (47 mg/dl) of HDL, (49 mg/dl) of LDL and (119 mg/dl) of TGL above 1500feet elevation. In the present study the *C.brachyotis* prefers fruits like *L. triphylla* (0.74mg/dl) because of the high amount of protein content, (50 mMl/l) with high level of sodium content for their body regulations and (32 mMl/l) with high level of chloride content to help the distribution of body fluids. The present chemical analysis has proved that among the tested fruits *S. jamboss* (236mg/dl) possess high iron content. Figuer1 -depicts the comparison on the relative level of glucose, Tocopherol cholesterol, protein, HDL, LDL, TGL,

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calcium, phosphorous, sodium, potassium, chloride and Iron in *Ficus racemosa, Limonia triphylla, Strychonos nuxvomica* and *Syzygium jamboss* respectively.

DISCUSSION

Fruit bats are very particular in food selection. Each fruit bat species has its own core plant species for dietary selection. Being a flying mammal bats need enormous amount of energy to support its increased rate of muscle metabolism during locomotion. In order to get a balanced diet they prefer eating diverse dietary items rich in energy sources. Molecular techniques have been more recently used to investigate pteropodid diet, and this has revealed more diverse diets than determined using traditional morphological or microscope analyses (Aziz *et al.* 2017, Lim *et al.* 2018, Chan *et al.* 2020).This preliminary analysis of fruit samples indicates not only the nutritional value of fruits but also enables to reason why the *C. brachyotis* depends on a particular fruit for their major energy needs. The impact of various nutritional components of *F. racemosa, L. triphylla, S. nuxvomica* and *S. jamboss* in *C. brachyotis* is discussed below.

Impact of Glucose
Glucose is the chief energy source in all organisms, from bacteria to humans. The present chemical analysis has proved almost all the tested chiropterophilic fruits possess high amount of glucose (above 600 mg/dl) and its derivatives. This glucose being a simple monosaccharide is a metabolic intermediate; as well as by products for cellular respiration both aerobic or anaerobic, or during fermentation used as an energy source for the brain and as organic carbon *(*Fred Schenck 2006).

Impact of Tocopherol cholesterol
Tocopherol Cholesterol (TC) is a combination of tocopherol and cholesterol. It acts in the form of free fatty acid transformation. It helps to cure the scaling and roughness of the skin. In the Indian Unani system of medicine, "hudar" is a mixture containing *S. nuxvomica* is used to elevate blood pressure and has shown to suppress allergen-specific Immunoglobulin E (IgE) (Govinda Rao *et al.* 2008). When the blood pressure becomes low due to deprived level of oxygen for the fruit bats during long flight *S. nuxvomica* helps to shoot up the blood pressure which supplies sufficient oxygen for the blood cells. *Cynopterus* sp. prefers fruits with high level of cholesterol content to repair worn out or injured cells, fluid balance and homeostatic regulation.

Impact of High Density Lipoproteins (HDL)
High-density lipoprotein (HDL) is one of the five major groups of lipoproteins, which, in the order of size, largest to smallest, can be arranged to chylomicrons, VLDL, IDL, LDL, and HDL. which enable the transport of lipids like cholesterol and triglycerides through the water-based blood stream (Toth Peter 2005). HDL plays a key role in protecting against vascular diseases via their role in reverse cholesterol transport, or the transport of excess cholesterol out of the body. By devouring fruits with high level fatty acids, bats derive most of the "good cholesterol" HDL. It acts as a part of the innate immune system and has the ability to bind a number of toxic substances in the blood (Kwiterovich 2000). This may be one of the reasons for the attraction of fruit bats to these fruits.

Impact of Low Density Lipoproteins (LDL)
Low-density lipoprotein cholesterol is a complex of lipids and proteins, with greater amounts of lipid than protein that transports cholesterol in the blood (Otvos 1999). The possession of LDL in animals generally causes internal transport; fatty acids and cholesterol from the body tissues to the liver, thus helping in storage and energy production (Invest, 1988). To get this, the bat *Cynopterus* sp., prefers the fruits with LDL content. It might have helped them to store excess fats for the future need at the time of food crisis.

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Impact of Triglycerides (TGL)

TGLs are formed by combining glycerol with three molecules of fatty acid. Studies of Parks (2002) have proved that TGL is the major form of stored fat in animal body. Fats stored in the form of TGL are used by the body to meet energy demand (Nelson and Cox 2000). In the present study it is found that *C. brachyotis.* prefers fruits with high level of TGL content to get more energy and also to build cellular materials.

Impact of calcium and phosphates

Calcium and phosphates are critical nutrients and top macro minerals which help in building and maintenance of bones and teeth, regulation of muscle tone and heartbeat, initiatives of blood clotting, facilitator of transport of chemicals across cell membranes, and activator of proteins, hormones and enzymes. The present chemical analysis has proved almost all the tested chiropterophilic fruits possess high calcium and phosphate content. Calcium is needed for the formation and maintenance of bones, development of teeth and healthy gums. It has a natural calming and tranquilizing effect and is necessary for maintaining a regular heartbeat and transmission of nerve impulses. It helps with lowering cholesterol, muscular growth, prevention of muscle cramps and normal blood clotting *(*Skulan 1997). Shapiro and Heaney (2003) stated that phosphorus performs a number of important cellular functions. It combines with calcium to form a relatively insoluble compound calcium phosphate, which gives strength and rigidity to bones and teeth. The earlier reports on the foliage and nectar feeding bats have also demonstrated the high requirement for calcium and phosphates for flight maintenance and reproductive requirements in bat life style (Karl 2004).

Impact of protein

The animal's body can synthesis most of the 20 amino acids it needs, however, some have to be supplied through the food. The main function of proteins is to build, maintain and repair body's worn out tissue in organs. Protein can also be used as energy source required to the body. Thus protein has a range of essential functions in the body (Steinke and Waggle 1992). Being a flying mammal bats select its fruit, pollen and nectar with high protein content. They form the building blocks of body tissue, and can also serve as a fuel source. It helps in essential body processes such as water balance, nutrient transport, and muscle contraction. Protein helps keep skin, hair, and nails healthy (Genten *et al.* 2010).

Impact of Iron

Iron is an important mineral that helps production of red blood cells; which deliver oxygen to all parts of the body and perform vital functions like cell diffusion in immune and central nervous systems. (Richard, 2007). This is one of the main reasons for the attraction of bats to these fruits. Iron is needed for the production of ATP molecules (Adenosine triphosphate) the main source of energy in the body.

Impact of Minerals

Minerals maintain body growth, development, and general health. Some minerals are very essential for transmitting nerve impulses maintaining heart beat and synthesis of hormones. Therefore the bat selects the fruits which are rich in potassium, zinc, iodine, magnesium, manganese, phosphorus, selenium and sodium. Plants need sodium in a very little amount and animals need a larger amount of it as to improve their nervous impulses and finer regulation of fluid balance (Zhu 2001, Kering 2008). Potassium is an essential mineral macronutrient and is the main intracellular ion for all types of cells like sodium important in maintaining fluid and electrolyte balance. Potassium is the major cation inside animal cells, while sodium is the major cation outside animal cells. Chloride ion is formed when the element chlorine, a halogen, gains an electron to form an anion (negatively-charged ion). As one of the mineral electrolytes, chloride works closely with sodium and water to help the distribution of body fluids (Green *et al.* 2001). Chloride is needed to keep the proper balance of body fluids. It is an essential part of digestive (Stomach) juices (Zumdahl and Steven 2009). The catholic food selection of fruit bats helps to reason out the nature of their food selection and to identify the chemical signals evolved by the chiropterophilic plants to attract the fruit bats to enhance their propagation. Chiropterophilic plants attract and reward the bats with chemical component rich resources (Food, Nutrients, Minerals, Secondary metabolites etc.). The present study has identified the

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chiropterophilic plants attract and satisfy the quest of the bat to get balanced diet (nutrition), nutritive addictives and secondary metabolites to survive and reproduce. These cataloging of chemicals are very important and may be helpful to attract bats for the propagation of many rare, endangered, endemic plants thus implementing Conservation Management Action Plans for forest restoration.

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Table 1: Nutrient composition of fruits preferred by *Cynopterus brachyotis*

S.No	Food plant	Name of the Components											
		Glucose (mg/dl)	Tocopherol cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	TGL (mg/dl)	Calcium (mg/dl)	Total protein (mg/dl)	Phosphorous (mg/dl)	Sodium (mmol/l)	Potassium (mmol/l)	Chloride (mmol/l)	Iron (mg/dl)
1	*Ficus racemosa*	208	0	2	1	0	6.10	0.05	2.00	46	10.80	22	0
2	*Limonia triphylla*	515	0	14	7	3	30.50	0.74	8.00	50	12.90	32	0
3	*Strychnos nuxvomica*	1285	27	47	49	119	4.40	0.55	6.40	48	15.70	31	5
4	*Syzygium jamboss*	474	12	2	0	9	2.50	0.45	3.70	46	9.40	21	236
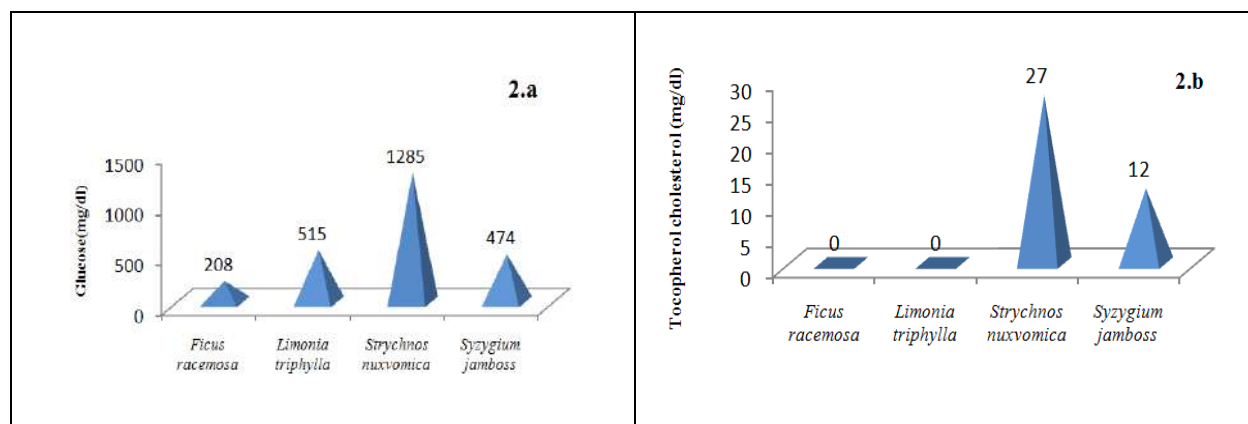
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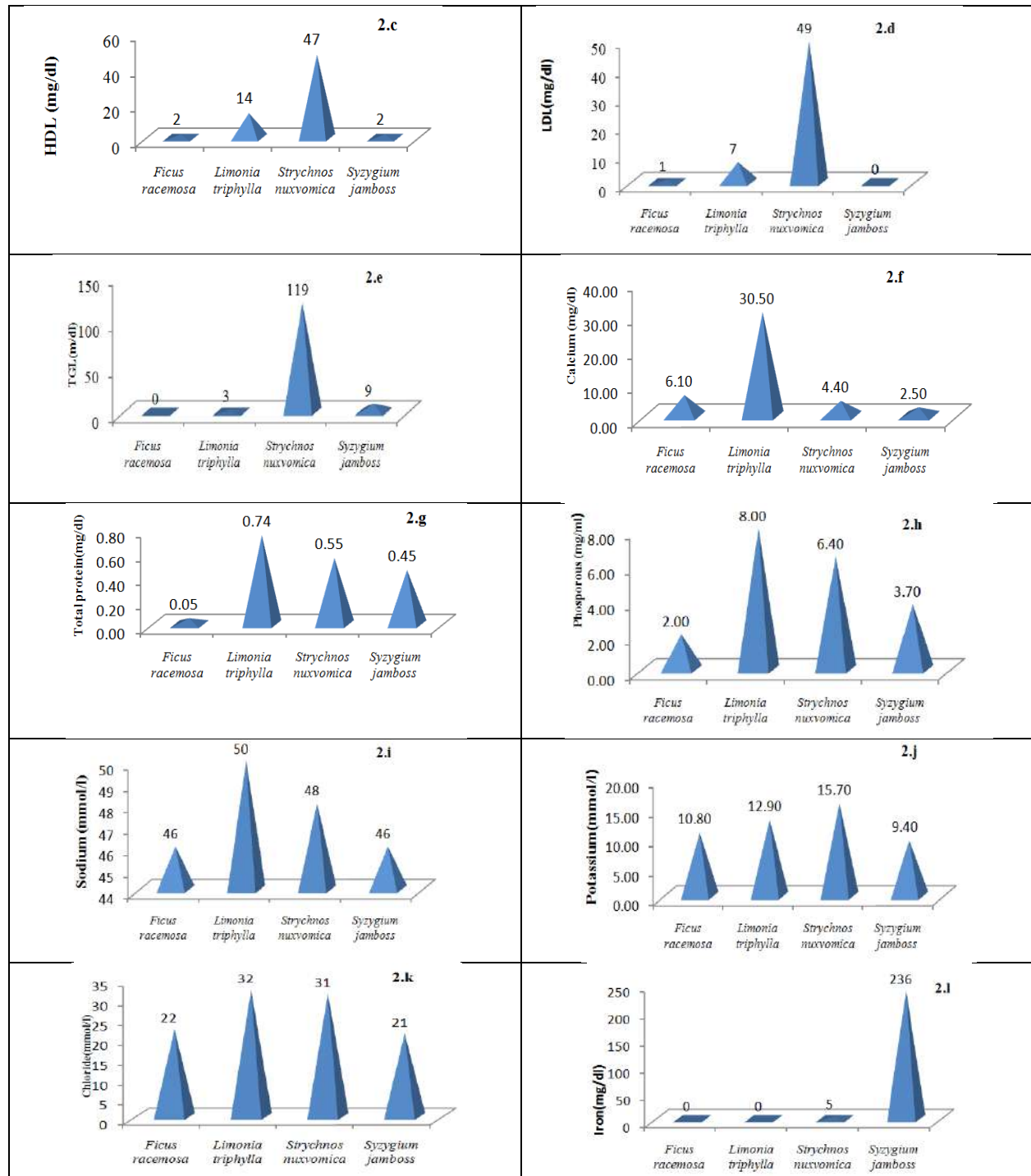
Figure 1. Comparison on the relative level of glucose, Tocopherol Cholesterol, Protein, HDL, LDL, TGL, Calcium, Phosphorous, Sodium, Potassium, Chloride and Iron in *Ficus racemosa, Limonia triphylla, Strychonos nuxvomica* and *Syzygium jamboss*

RESEARCH ARTICLE

A Survey on Prediction of Heart Disease using Machine Learning Algorithms

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ABSTRACT

Cardiovascular illnesses may be diagnosed *via* way of means of engaging in scientific checks and the usage of wearable sensors. However, extracting precious chance elements for coronary heart disorder from digital scientific checks is a difficult process as physicians attempt to speedy and appropriately diagnose sufferers. These digital scientific records (EMRs) are unstructured and growing in length continuously because of every day scientific checks. Currently, wearable sensors also are applied to constantly display the patient's frame internally and externally to locate coronary heart disorder. However, wearable sensor information for coronary heart disorder prediction are corrupted via way of means of signore facts which include slacking values and noise, which decreases machine overall performance and generates misguided results. The automated prediction of coronary heart disorder is one of the maximum essential and hard fitness troubles with inside the actual world. Heart disorder disturbs the capability of blood vessels, and reasons coronary artery infections that weaken the frame of the patient, mainly adults and antique people. The prediction to efficaciously treating cardiac sufferers earlier than a coronary heart assault occurs. This aim may be performed the usage of an excellent system getting to know version with wealthy healthcare information on coronary heart illnesses. Many structures primarily based totally on system getting to know had been provided currently to expect and diagnose coronary heart disorder. However, there are numerous boundaries in those models.

Keywords: coronary heart illnesses, patient's frame, blood vessels.

INTRODUCTION

The main topic is prediction using machine learning techniques. Machine learning is widely used now a days in many business applications like e commerce and many more. Prediction is one of area where learning used, our topic is about prediction of heart disease by processing patient's dataset.

LITERATURE SURVEY

A. K. Dwivedi, ''Performance evaluation of different machine learning techniques for prediction of heart disease,'' Neural Comput. Appl., vol. 29, no. 10, pp. 685–693, May 2018. At this juncture, the potential of six machine learning techniques was evaluated for prediction of heart disease. The recital of these methods was assessed on eight diverse classification performance indices. In addition, these methods were assessed on receiver operative characteristic curve. The highest classification accuracy of 85 % was reported using logistic regression with sensitivity and specificity of 89 and 81 %, respectively. C. B. C. Latha and S. C. Jeeva, ''Improving the accuracy of prediction of heart disease risk based on ensemble classification techniques,'' Inform. Med. Unlocked, vol. 16, Jan. 2019. This paper investigates a method termed ensemble classification, which is used for improving the accuracy of weak algorithms by combining multiple <u>classifiers</u>. The results of the study indicate that ensemble techniques, such as bagging and boosting, are effective in improving the prediction accuracy of <u>weak classifiers</u>, and exhibit satisfactory performance in identifying risk of heart disease. L. Ali, A. Niamat, J. A. Khan, N. A. Golilarz, X. Xingzhong, A. Noor, R. Nour, and S. A. C. Bukhari, ''An optimized stacked support vector machines based expert system for the effective prediction of heart failure,''.In this paper, we introduce an expert system that stacks two support vector machine (SVM) models for the effective prediction of HF. The first SVM model is linear and L1 regularized. It has the capability to eliminate irrelevant features by shrinking their coefficients to zero. The second SVM model is L2 regularized. It is used as a predictive model. To optimize the two models, we propose a hybrid grid search algorithm (HGSA) that is capable of optimizing the two models simultaneously. The effectiveness of the proposed method is evaluated using six different evaluation metrics: accuracy, sensitivity, specificity, the Matthews correlation coefficient (MCC), ROC charts, and area .S. M. Saqlain, M. Sher, F. A. Shah, I. Khan, M. U.

Ashraf, M. Awais, and A. Ghani, ''Fisher score and matthews correlation coefficient-based feature subset selection for heart disease diagnosis using support vector machines,'' Knowl. Inf. Syst., vol. 58, noIn this work, a machine intelligence framework for heart disease diagnosis MIFH has been proposed. MIFH utilizes the factor analysis of mixed data (FAMD) to extract as well as derive features from the UCI heart disease Cleveland dataset and train the machine learning predictive models. The framework MIFH is validated using the holdout validation scheme. Experimentation results show that MIFH performed well over several baseline methods of recent times in terms of accuracy and comparable in terms of sensitivity and specificity. MIFH returns best possible solution among all input predictive models considering performance criteria and improves the efficacy of the system, hence can assist doctors and radiologists in a better way to diagnose heart patientunder the curve (AUC). The experimental results confirm that the proposed method improves the performance of a conventional SVM model by 3.3%. S. Mohan, C. Thirumalai, and G. Srivastava, ''Effective heart disease prediction using hybrid machine learning techniques,'' IEEE Access,In this paper, we propose a novel method that aims at finding significant features by applying machine learning techniques resulting in improving the accuracy in the prediction of cardiovascular disease. The prediction model is introduced with different combinations of features and several known classification techniques. We produce an enhanced performance level with an accuracy level of 88.7% through the prediction model for heart disease with the hybrid random forest with a linear model (HRFLM). C. B. C. Latha and S. C. Jeeva, ''Improving the accuracy of prediction of heart disease risk based on ensemble classification techniques,'' Inform.

Med. Unlocked, vol. 16, Jan. 2019,This paper investigates a method termed ensemble classification, which is used for improving the accuracy of weak algorithms by combining multiple classifiers. Experiments with this tool were performed using a heart disease dataset. A comparative analytical approach was done to determine how the ensemble technique can be applied for improving prediction accuracy in heart disease. The focus of this paper is

not only on increasing the accuracy of weak classification algorithms, but also on the implementation of the algorithm with a medical dataset, to show its utility to predict disease at an early stage. The results of the study indicate that ensemble techniques, such as bagging and boosting, are effective in improving the prediction accuracy of weak classifiers, and exhibit satisfactory performance in identifying risk of heart disease. A maximum increase of 7% accuracy for weak classifiers was achieved with the help of ensemble classification. The performance of the process was further enhanced with a feature selection implementation, and the results showed significant improvement in prediction accuracy. D.R.PatiIand Jayshril S.Sonawane have given a paper named Prediction of Heart Disease Using Learning Vector Quan-tizationAlgorithm.Inthispapertheyexhibitanexpectationframework for heart infection utilizing Learning vector Quantiza-tion neural system calculation The neural system in this frame-workacknowledges13clinical includes as information and pre- dicts that there is an earn essornon attendance of coronary illness in the patient, alongside various execution measures. Ensemble classification technique for heart disease prediction with meta-heuristic-enabled training system Parvathaneni Rajendra Kumar, Suban Ravichandran und Satyala Narayana. This research work exclusively aims to develop a novel heart disease prediction framework including three major phases, namely proposed feature extraction, dimensionality reduction, and proposed ensemble-based classification. An elaborative analyses as well as discussion have been provided by concerning the parameters, like evaluation metrics, year of publication, accuracy, implementation tool, and utilized datasets obtained by various techniques. A. U. Haq, J. P. Li, M. H. Memon, S. Nazir, and R. Sun, ''A hybrid intelligent system framework for the prediction of heart disease using machine learning algorithms. The proposed system can easily identify and classify people with heart disease from healthy people.

Additionally, receiver optimistic curves and area under the curves for each classifier was computed. We have discussed all of the classifiers, feature selection algorithms, preprocessing methods, validation method, and classifiers performance evaluation metrics used in this paper. 0e performance of the proposed system has been validated on full features and on a reduced set of features. 0e features reduction has an impact on classifiers performance in terms of accuracy and execution time of classifiers. 0e proposed machine-learning-based decision support system will assist the doctors to diagnosis heart patients efficiently. Heart disease prediction using machine learning algorithms Harshit Jindal[1], Sarthak Agrawal[1], Rishabh Khera[1], Rachna Jain[2] and Preeti Nagrath[2].The research paper mainly focuses on which patient is more likely to have a heart disease based on various medical attributes. We prepared a heart disease prediction system to predict whether the patient is likely to be diagnosed with a heart disease or not using the medical history of the patient. We used different algorithms of machine learning such as logistic regression and KNN to predict and classify the patient with heart disease. A quite Helpful approach was used to regulate how the model can be used to improve the accuracy of prediction of Heart Attack in any individual. The strength of the proposed model was quiet satisfying and was able to predict evidence of having a heart disease in a particular individual by using KNN and Logistic Regression which showed a good accuracy in comparison to the previously used classifier such as naive bayes etc.

METHODOLOGIES

Naïve-Bayes Classification
Naïve-Bayes Classification: The Naïve-Bayesian classifier is predicated upon Bayes' hypothesis with autonomy suppositions amongst attributes [7-13]. A Naïve Bayesian output is in reality now no longer tough to run, without a entrapped repetitive parameter estimation which makes it specially supportive for wide datasets notwithstanding its effortlessness, the Naive Bayesian classifier commonly completes its process shockingly proper and is widely utilized in mild of the reality that it regularly outflanks excessive order strategies which can be complex. The Naïve Bayes treats each variable as impartial which facilitates it to expect despite the fact that variables don't have right relation.

Remote health monitoring (RHM)

Remote fitness monitoring (RHM) structures are getting extra broadly followed with the aid of using clinicians and hospitals to remotely reveal and speak with sufferers even as optimizing clinician time, lowering health center costs, and enhancing exceptional of care. In the Women's coronary heart fitness study (WHHS), we evolved Wanda-cardiovascular disease (CVD), whereincontributorsobtainedwholesomelife-styleschoolingobservedwith the aid of using six months of generation help and reinforcement. Wanda-CVD is a smartphone-primarily based totally RHM device designed to help contributors in decreasing diagnosed CVD threat elements *via* wi-fi training the use of remarks and activates as social help.

MAFIA and K-means algorithm

Records category is primarily based totally on MAFIA algorithms which bring about accuracy, the records is evaluated the usage of entropy primarily based totally move validations and partition strategies and the consequences are compared. Here the usage of the C4.fiveset of rules because the education set of rules to expose rank of coronary heart assault with the selection tree. Finally, the coronary heartsickness database is clustered the usage of the K-method clustering set of rules, if you want to cast off the records relevant to coronary heart assault from the database. The consequences confirmed that the medicinal prescription and designed prediction machine is able to prophesying the coronary heart assault successfully.2.4 K-Star algorithm. The model level intelligence system for the diagnosis of coronary heart disease is shown in Figure 1. Intelligence systems use classification algorithms, such as the multiclass K-star (K*). The K* algorithm can be defined as a clustering method that divides n data into k clusters, where each data entry in a particular cluster with an average viewing distance nearby. The K* algorithm is an instance-based learner algorithm that uses entropy to measure the distance [33]. The advantages of using entropy are that it provides a consistent approach to dealing with real-valued attributes, symbolic and missing values. algorithm, in that it uses entropy to measure the closeness of data.

Learning Vector Quantization

Learning Vector Quantization (or LVQ) is a type of Artificial Neural Network which also inspired by biological models of neural systems. It is based on prototype supervised learning classification algorithm and trained its network through a competitive learning algorithm similar to Self Organizing Map. It can also deal with the multiclass classification problem. LVQ has two layers, one is the Input layer and the other one is the Output layer.

DBSCAN, SMOTE-ENN, and XG Boost-based MLA

First, the coronary heart ailment datasets are collected. Second, the statistics pre-processing for statistics transformation and characteristic choice are conducted. Third, the DBSCAN-primarily based totally outlier detection technique is implemented to locate the outlier statistics given the most reliable parameter. Fourth, the detected outlier statistics are then eliminated from the schooling dataset. Fifth, the statistics balancing primarily based totally on SMOTE-ENN technique is used to stability the schooling dataset. Sixth, the XGBoost-primarily based totally MLA is used to study from the schooling dataset and generate the HDPM. Finally, the overall performance metrics are offered to assess the overall performance of the proposed version and the generated HDPM is then carried out in the CDSS.

Support Vector Machine

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyper plane. SVM chooses the extreme points/vectors that help in creating the hyper plane.

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Ensemble techniques

Ensemble is a strategy that can be used to improve the accuracy of a classifier. It is an effective meta classification technique that combines weak learners with strong learners to improve the efficacy of the weak learner. In this paper, the ensemble technique is used to improve accuracy of various algorithms for heart disease prediction. The aim of combining multiple classifiers is to obtain better performance as compared with an individual classifier.

CONCLUSION

This paper presented a survey and analysis of recent methods developed for the prediction of heart disease using machine learning algorithms. The survey includes different methodologies. This survey presents an overview of the prediction of heart disease using different combinations of machine learning algorithms.

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Table 1: Classification Techniques

REF NO	YEAR	METHOD	DATA USED	ADVANTAGES	DISADVANTAGES
1	2018	Machine learning techniques	the UCI Cleveland dataset.	accuracy	challenges
2	2019	ensemble techniques, such as bagging and boosting	UCI machine learning repository	bagging and boosting are efficient in increasing the accuracy of weak classifiers.	Number of attributes
3	2019	Support Vector Machines	the UCI Cleveland dataset.	efficient in terms of time complexity	complexity
4	2019	n R studio rattle	the UCI Cleveland dataset.	accuracy	challenges
5	2019	a machine intelligence framework MIFH	the UCI Cleveland dataset.	overall accuracy	complexity
6	2019	Classification and ensemble algorithms	the UCI Cleveland dataset.	classification accuracy	Combination of algorithms
7	2020	SVM,RF,KNN	the UCI Cleveland dataset	high accuracy	complexity
8	2018	K-NN, ANN, SVM, DT, and NB were used in the system.	the UCI Cleveland dataset	computation time of algorithms	More number of algorithms
9	2021	machine learning technics.	the UCI Cleveland dataset	Combination of algorithms	Time complexity
10	2021	Logistic regression, Random Forest Classifier and KNN	the UCI Cleveland dataset	Fast, reduces cost	Combination of algorithms

RESEARCH ARTICLE

Phytochemical Characterization and Assessment of Crude Extract from Rhizome and Leaves of *Bergenia ciliata* Sternb for Antimicrobial Activity

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ABSTRACT

To analyse the qualitative and quantitative phytochemicals and evaluate *in-vitro* antimicrobial properties of various alcoholic and aqueous extracts of leaf and rhizome parts of *Bergenia ciliata*. Preliminary phytochemical analysis for secondary metabolites was made by following standard procedures. In vitro antimicrobial activity of the species *Bergenia ciliata* was evaluated by disc diffusion method. The quantitative phytochemical analysis of the studied plants exhibited the presence of total alkaloids and flavonoids in considerable quantity. The *in vitro* antimicrobial activity of the species, *Bergenia ciliata* clearly demonstrate that the leaves, rhizomes and roots with prominent antibacterial property. Results of the present investigation indicates that *B. ciliata* has good phytochemical and antimicrobial activity, hence it could be used for future plant based antimicrobial drugs.

Keywords: *Bergenia ciliata*, Phytochemicals analysis, FTIR, *in vitro* antimicrobial activities.

INTRODUCTION

The genus *Bergenia* is widespread on different altitudinal zones and different soil types which make the plant preferable to study the various metabolic profiles in the wild population. It consists of about 30 genera and 580 species worldwide. Presence of therapeutically active compounds in medicinal plants is the most important characteristic as their presence and absence alters the medicinal property of a plants. *Bergenia ciliata* Sternb (*Saxifragaceae*) is an evergreen perennial herb, widely distributed in Central and East Asia, at high altitude (7000–1000ft) in the temperate Himalayas from Kashmir to Bhutan and in Khasia hill at 400ft [1]. It is commonly known as "Zakhm-e-Hayaat". This plant comes out between rocks and appears to break them or that it possesses lithotriptic property. It contains thick root- stock; the outer surface is rough and dark brown in colour, whereas the inner skin is smooth and pinkish. Plants are covered with sheaths of withered leaves on small herbaceous stem. Flowers are pink, white, or purple in terminal corymbs. It is considered as a miracle herb because it is used in treatment of several therapeutic activities such as antiurolithiasis [2], antibacterial, antioxidant activity [3], hemorrhage [4] and pulmonary infections [5]. Bergenin (C-glycoside of 4-O-methyl Gallic acid) (0.9%), Gallic acid (3,4,5 trihydroxybenzoic acid), (þ)-Catechin, 11-O-galloylbergenin and its glycoside, Gallicin, leucocya- nidin-3-gallate, 7-O-b-D-glucopyranoside, Paashaanolactone, β-Sitosterol, β -Sitosterol-D-glucoside, and (þ)-Afzelechin can be found in Bergenia as a major compound [6]. The present study was designed to investigate the presence of various phytochemical constituents and antimicrobial activity of various crude extracts of *B.ciliata* rhizomes and leaves. The selection of the plants for evaluation was based firstly on the traditional use for the treatment of infectious and other disease and secondly on the occurrence of as endemic plants.

MATERIAL AND METHODS

Collection, Identification, and Extraction of plant samples

The healthy plant samples of *Bergenia ciliata* were collected from Baramulla, Jammu and Kashmir, India in the month of September 2021. The authenticity of the plant was confirmed in Department of Botany Annamalai University Tamil Nadu, by referring the deposited specimen. The voucher number of the specimen is AUBOT-385. The rhizomes and leaves of *Bergenia ciliata* were cleaned, shade-dried, and converted into fine powder by crushing in an electronic processor.

Preparation of plant Extracts

The powdered plant samples (100 g/500 mL) were extracted successively with Methanol, Acetone and Water using Soxhlet apparatus at 55-85°C for 72 hours in order to extract the compounds. Each extract was concentrated by evaporating solvents under room temperature. The crude extracts were stored in amber vials and were placed at 4°C for further use.

Preliminary phytochemical analysis

The extracts of rhizomes and leaves of *Bergenia ciliata* obtained were subjected to the preliminary phytochemical analysis to identify the bioactive compounds present in the various alcoholic(methanol, acetone) and aqueous extracts *by using standard protocols as described by [7,8,9,10,11].*

Yield of extract (%):-

The crude extracts so obtained after Soxhlet extraction process was concentrated by permitting solvents to evaporate entirely in rotary evaporator (Heidolph) to obtain the actual yield of extraction. The percentage yield of extraction is very important in phytochemical extraction in order to estimate the standard extraction efficiency for a particular plant, different parts of the same plant or different solvents used.

Percentage yield =   Weight of the extract   ×   100
                                    Weight of the dry plant material

Quantitative estimation of chemical constituents
Determination of alkaloids

A total of 200 ml of 20 ml acetic acid was added to 5 g of leaf and rhizome powder of Bergenia ciliata taken in a three separate 250 ml beaker and covered to stand for 4h. This mixture containing solution was filtered and volume was reduced to one quarter using water bath. Concentrated ammonium acid is added to these samples, then ammonium hydroxide was added drop wise until the precipitate was complete. The whole solution was allowed to settle and the precipitate was collected by filtration and weight [12]. The percentage of total alkaloid content was calculated as:

Percentage of total alkaloids (%) = Weight of residue × 100/ weight of sample taken

Total flavonoids content

The total flavonoids content was estimated using the procedure described by[13]. A total of 1ml of plant extract was diluted with 200μl of distilled water separately followed by the addition of 150μl of sodium nitrite (5%) solution. This mixture was incubate for 5 min and then 150μl of aluminum chloride (10%) solution was added and allowed to stand for 6 min. The 2 ml of sodium hydroxide (4%) solution was added and made up to 5ml with distilled water. The mixture was shaken well and left it for 15 min at room temperature. The absorbance was measured at 510nm. Appearance of pink color showed the presence of flavonoids content. The total flavonoids content was expresses as rutin equivalent mg RE/g (RE indicates rutin equivalent) extract on a dry weight basis using the standard curve.

FTIR analysis

The IR spectrum of the alcoholic extract of *Bergenia ciliata* leaves and rhizomes was carried out using IRAffinity-1S Spectrometer (Shimadzu, IR Affinity1, Japan). 10 mg of the dried extract was encapsulated in 100 mg of KBr pellet, in order to prepare translucent sample disc. The powdered sample of extract was loaded in FTIR spectroscope, with a scan range from 400 to 4000 cm^{-1} with a resolution of cm^{-1}.The IR spectrum of the drug was recorded, and the major bands were noted [14].

Antimicrobial assay
Test microorganisms

In present study, the antimicrobial activity of Methanolic, Water and Acetone extract of *Bergenia ciliata* rhizomes and leaves were examined in several representative Gram-negative bacterial strains. The following Gram-negative microorganisms were evaluated: *Klebsiella pneumonia* ATCC 1536 clinical strain, *Escherichia coli* ATTC 2043 clinical strain, *Salmonella typhi* ATTC 1272 clinical strain and *Pseudomonas aeruginosa* ATTC2035 clinical strain. All bacterial strains were grown aerobically in Muller Hinton Broth for 24 h at 37°C. All the organisms were preserved at 4±2°C for further use.

Antimicrobial Activity

The antibacterial activity was evaluated using agar well diffusion method [16,17]. Petriplates were prepared by pouring 20 ml of Muller Hinton Agarto check the susceptibility test against bacteria. The plant crude extracts containing different concentrations corresponding to 100, 75, 50 and 25 mg/ml were prepared to check antibacterial activity. Chloramphenicol (30μg/ml) was used as positive control and DMSO was used as negative control. The plates were incubated for 24 hours at 37°C Zone of inhibition for each extract on each organism were measured All the experiments were done in triplicate method and bacterial activity was expressed as the mean of inhibition diameters (mm).

Statistical analysis

Data were analysed with statistical software. Analysis of variance (ANOVA) and Duncan's multiple range method were used to compare any significant differences between solvents and samples. Values were expressed as mean ± standard deviations.

RESULTS AND DISCUSSION

The yield of extracts obtained from the rhizomes and leaves of *Bergenia ciliata* by using Acetone, Methanol and Water as solvents are represented in the (Table 1). Percentage yield was high in aqueous extract as compared to methanol and acetone which showed lesser yield than aqueous extracts. Rhizomes and leaves of *Bergenia ciliata* were screened for their phytochemical compounds and percentage yield. It was found that all the plant extracts have significant percentage of important phytochemicals that were easily identified by qualitative tests. The results of qualitative phytochemical analysis of the crude powder of rhizomes and leaves of *B. ciliata* are shown in (Table 2). Acetone extract of *Bergenia ciliata* rhizome and leaves showed the presence of Flavonoids ,Resin, Tannins, Steroids, Carbohydrates, Terpenoids and showed negative result for the Volatile oils, Alkaloids, Proteins, Saponins and Glycosides. While the methanolic extract showed the presence of Alkaloids, Glycosides, Saponins, Terpenoids, Resin, Steroids and Tannins but showed negative result for Saponins, Proteins and Volatile oils. The water extract showed the presence of Flavonoid, Tannin, Saponins and Carbohydrates while showed negative result for Glycosides, Terpenoids, Alkaloids, Proteins and Volatile oils. Our present research has shown the presence of Tannins, Flavonoids and saponins and antimicrobial activity by the methanolic extract of rhizomes and leaves of *Bergenia ciliata*. Our result is in accordance with the result of [16, 17] there by showing the presence of phytochemicals like tannins, Saponins and flavonoids and antimicrobial, antifungal and antioxidant activity.

FTIR spectrums of Acetone extract of *Bergenia ciliata* rhizomes
FT-IR spectral study of acetone extract of *Bergeniaciliata* rhizomes was evaluated to identify the functional groups of the active compounds and the results are shown in (Table 3). The result of FT-IR analysis of acetone extract of *Bergenia ciliata* rhizomes as predicted in (Fig. 1) showed presence of Alcohol, Alkane, Aldehydes, Carbon dioxide, Carbodiimide, Aldehyde, Amide, Alkene and Nitro compounds at 3337.063, 3211.745, 2817.582, 2850.064, 2728.487,2323.144,2105.032,1697.489,1689.841,1605.626 and 1517.139 cm^{-1}respectively.s

FTIR spectrums of acetone extract of *Bergenia ciliata* leaves
FT-IR spectral study of acetone extract of *Bergenia ciliata leaf* was evaluated to identify the functional groups of the active compounds and the results are shown in (Table 4). The result of FT-IR analysis of acetone extract of *Bergenia* ciliataleafaspredictedinFig.2confirmedthepresenceofAlcohols, Alkyne, Alkenes, Alkanes, Aldehyde, Thiocyanate, Ketone, Nitro Compounds, Carboxylic acid, Sulfonamide, Amine compounds at 3377.994, 3263.561, 3006.350, 2923.140, 2852.644,2729.003,2127.798,1698.567,1608.326,1509.062,1440.717,1360.475 and 1227.447cm^{-1} respectively**.**

Determination of flavonoids and alkaloids
The analysis of total flavonoids content in various crude extracts of rhizome and leaf parts of *Bergenia ciliata* exhibited that higher flavonoid content in methanolic crude extract of rhizome (19.29mg RE/100 g extract) followed by aqueous crude and water extract (13.20 mg RE/100 g extract and 13.17mg RE/100 g extract) respectively. The leaves of *Bergenia ciliata* also exhibited higher content of flavonoids in methanolic crude extract (21.73 mg RE/100g extract) followed by acetone crude and water extract (19.52 mg RE/100g extract and 19.20 mg RE/100g extract). The determination of total alkaloid contents in leaf and rhizome parts of *Bergenia ciliata* exhibited that higher alkaloid content was present in root powder (3960.21 mg/100g of sample) than that of leaf powder (2578.16 mg/100g of sample).

Antimicrobial assay
The results of the antimicrobial activity of methanolic, hexane and water extract of *Bergenia ciliata* rhizomes and leaves examined against different human pathogenic microorganisms. The results of the study were categorized on the basis of zone of inhibition (ZOI) as not effective (ZOI<14mm), effective (ZOI≥14mm) as shown in (Table5).T he result showed that among all the extracts the methanolic extract of *Bergenia ciliata* rhizomes and leaves was highly effective against all the bacterial strains at the

concentration of 100mg/ml. The zone of inhibition showed by methanolic extract of roots and leaves against *Klebsiella pneumonia* (14.2 ± 1.75and 14.2 ± 1.75),*Pseudomonas aeruginosa* (4.7 ± 0.08and 5.3±0.57), S.typhi (00.0±0.00and00.0±0.0), *E.coli*(5.1± 0.67 and 4.7 ±0.61). The methanolic extract of *Bergenia ciliata* rhizomes and leaves was highly effective against *Klebsiella pneumonia* (14.2 ± 1.75and 14.2 ± 1.75) and *Escherichiacoli*(5.1± 0.67and4.7 ± 0.61). The high antibacterial activity in the methanolic extract may bedue to the presence of alkaloids, terpenoids and flavonoids. These medicinally bioactive components exert antimicrobial action through different mechanisms. Terpenoids are responsible for the dissolution of cell wall of microorganisms by weakening the membranous tissue[21].

Flavonoids have been found to be effective antimicrobial substance against a wide range of microorganisms in vitro is known to be synthesized in response to microbial infection by plants. They have ability to complex with extracellular and soluble proteins and to complex with bacterial cell walls [19]. Steroids are known for their antibacterial activity specifically associated with membrane lipids and cause leakage from liposomes. The saponins have the ability to cause leakage of proteins and certain enzymes from the cell [20].The highest antibacterial activity was shown by methanol extract of *B.ciliata* rhizomes and leaves at the concentration of (100 µg/µl) against *Klebsiella pneumonia*. The activity of methanolic extract was dose dependent as the increased activity against pathogens was observed at 100mg/ml. The water extract of the plant studied showed moderate activity as compared to methanol which showed highly potent antimicrobial activity. Yet, acetone extract showed relatively low ZI compared to methanol and water .The correlations between concentrations of root and leaf extracts against all the pathogens showed that 50 and 25 mg/ml of the extract were not significantly different, as there was no antimicrobial activities exhibited by the extracts at said concentrations.

CONCLUSION

From the overall analysis, it was concluded that the plants studied werefound rich in phytochemical constituents. This research demonstrates the antimicrobial potential of leaves and rhizomes from *Bergenia ciliata*. The methanolic extract was especially active against the mentioned pathogens. The next steps are focused on the isolation and identification of active compounds in each extract which could be used as lead molecules in the development of new antimicrobial drugs.

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Table 1: Percentage yield of plant extracts

Name of Plants	Percentage Yield (%)		
	Acetone	**Methanol**	**Water**
Bergenia ciliata Rhizome	17.33%	14.6%	36%
Bergenia ciliata leaves	10%	10%	18%

Table 2: Preliminary studies of *Bergenia ciliata* roots and leaves

	Bergenia ciliate Root			Bergenia ciliate leaf		
Secondary metabolites	**Acetone**	**Water**	**Methanol**	**Acetone**	**Water**	**Methanol**
Alkaloids	-	-	++	-	-	+
Flavonoids	++	+++	+	+	++	++
Glycosides	-	-	+	++	++	+
Resin	++	-	+++	+	-	-
Tannins	++	+++	++	++	+	++
Steroids	++	-	++	++	+	-
Saponins	-	+++	-	-	+++	-
Carbohydrates	+	+	++	+	+	++
Proteins	-	-	-	+	++	++
Terpenoids	+	-	++	++	+	++
Volatile oils	-	-	-	-	+	-

(+++) highly present, (++) moderately present, (+) Low, (-) absent

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Table 3: FT-IR absorption and functional groups of methanolic extract of *Bergenia ciliata* rhizome

S. No.	Frequency (Cm⁻¹)	Molecular motion	Functional groups	Absorption spectrum
1.	3337.063	Alcohol	O-H stretch	Broad, Strong
2.	3211.745	Alcohol	O-H stretch	Broad, Strong
3.	2817.582	Alkane	C-H stretch	Medium
4.	2850.064	Alkane	C-H stretch	Medium
5.	2728.487	Aldehydes	C-H stretch	Medium
6.	2323.144	Carbon dioxide	O=C=O stretch	Strong
7.	2105.032	Carbodiimide	N=C≡N stretch	Strong
8.	1697.489	Aldehyde	C=O	Strong
9.	1689.841	Amide	C=O stretch	Strong
10.	1605.626	Alkene	C=C stretch	Medium
11.	1517.139	Nitro compounds	NO_2 stretch	Strong
12.	1445.223	Alkane	C-H stretch	Medium
13.	1330.651	Alcohol	O-H stretch	Medium
14.	1282.914	Fluro compound	C-F stretch	Strong
15.	1203.143	Alkyl aryl ether	C-O Stretch	Strong
16.	1089.238	Alcohol	C-O stretch	Strong
17.	1029.086	Sulfoxide	S=O stretch	Strong
18.	989.484	Alkenes	C-H stretch	Strong
19.	857.572	Alkenes	C=C stretch	Strong
20.	815.530	Alkenes	C=C stretch	Medium
21.	763.305	Alkenes	C=C stretch	Medium

Table 4: FT-IR absorption and functional groups of acetone extract of *Bergenia ciliata* leaf

S. No.	Frequency (Cm⁻¹)	Molecular motion	Functional groups	Absorption spectrum
1.	3377.994	Alcohols	O-H stretch	Strong
2.	3263.561	Alkyne	C-H stretch	Strong
3.	3006.350	Alkenes	C-H stretch	Medium
4.	2923.140	Alkanes	C-H stretch	Medium, Strong
5.	2852.644	Alkanes	C-H stretch	Medium, Strong
6.	2729.003	Aldehyde	C-H stretch	Medium
7.	2127.798	Thiocyanate	S-C≡N	Strong
8.	1698.567	Aldehyde	C=O	Strong
9.	1608.326	Ketone	C=C stretch	Strong
10.	1509.062	Nitro Compounds	NO_2 stretch	Strong
11.	1440.717	Carboxylic acid	O-H stretch	Medium
12.	1360.475	Sulfonamide	S=O	Medium
13.	1227.447	Amine	C-N stretch	Medium
14.	1124.589	Alcohol	C-O stretch	Strong
15.	1090.302	Alcohol	C-O stretch	Strong
16.	1037.595	Anhydride	CO-O-CO stretch	Strong, Broad
17.	991.890	Alkenes	C=C stretch	Strong
18.	859.502	Alkenes	C=C stretch	Medium
19.	818.162	Alkenes	C=C stretch	Medium
20.	764.447	Alkenes	C=C stretch	Medium

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Table 5: Antimicrobial assay of crude extract of *Bergenia ciliata* rhizome

S.NO	Bacterial strains/plant extracts prepared with different solvents	Mean zone of inhibition (mm)					10%DMSO
		Different Concentrations of crude extract of *Bergenia ciliata* roots					
		25 µg/mL	5 0 µg/mL	75 µg/mL	100 µg/mL	Chloramp henicol (30µg/ml)	
1	*K.pneumonia*						
	Water	7.2 ±0.00	9.7 ±0. 2	12.4±0.00	13.7 ± 3.4	20±1.52	0
	Hexane	4.2 ±0.7	5.0 ±0.0	6.5 ± 3.2	8.9±0.24	20±1.52	0
	Methanol	5.2 ± 0.3	8.0 ± 0.3	15.2±0.24	17.7± 2.45	20±1.52	0
2	*P. auroginosae*						
	Water	3.2 ± 0.0	3.7 ±1.2	4.5±0.12	4.9 ± 0.6	21.1±1.3	0
	Hexane	0.49 ± 3.4	0.53 ± 4.2	0.63±0.24	0.83 ± 0.2	21.1±1.3	0
	Methanol	4.7 ± 0.08	5.3 ± 0.34	6.3±0.57	6.9 ± 0.67	21.1±1.3	0
3	*S. typhi*						
	Water	0	0	0	0	20±0.12	0
	Hexane	0	0	0	0	20±0.12	0
	Methanol	0	0	0	0	20±0.12	0
4	*E. coli*						
	Water	6.0±0.12	7.5 ±0.03	11.4±2.21	12.3 ± 1.6	11.4±2.3	0
	Hexane	0	0	0	0	11.4±2.3	0
	Methanol	5.1± 0.67	8.7 ± 0.5	18.3±0.23	21.0 ± 0.5	11.4±2.3	0
5	*K. Pneumonia*						
	Water	11 ± 0.4	10.3±0.12	8 ± 0.0	7 ± 0.57	11.9±0.57	0
	Hexane	8.2 ± 0.2	7.8±0.24	6.2 ±0.00	5.0 ± 0.12	11.9±0.57	0
	Methanol	14.2 ± 1.75	13.2±0.00	8.2 ± 0.7	7.2 ± 0.24	11.9±0.57	0
6	*P. auroginosae*						
	Water	8.0 ± 0.57	8.76 ± 1.3	10.0±0.00	12.2 ± 0.5	12.7±0.57	0
	Hexane	5.9 ± 1.42	5.3 ± 1.24	7.23±0.57	8.8 ± 0.21	12.7±0.57	0
	Methanol	5.3±0.57	7.5± 0.02	9.3±0.12	10.2 ± 0.58	12.7±0.57	0
7	*S. typhi*						
	Water	0	0	0	0	0	0
	Hexane	0	0	0	0	0	0
	Methanol	0	0	0	0	0	0
8	*E.coli*						
	Water	4.3 ± 0.5	5.42±0.67	6.5±0.57	7.8 ±0.00	12.5±0.00	0
	Hexane	0	0	0	0	12.5±0.00	0
	Methanol	4.7 ± 0.6	5.0 ± 0.0	7.8±0.12	8.4± 0.00	12.5±0.00	0

Data are expressed as the mean ± standard deviation of three separate experiments.

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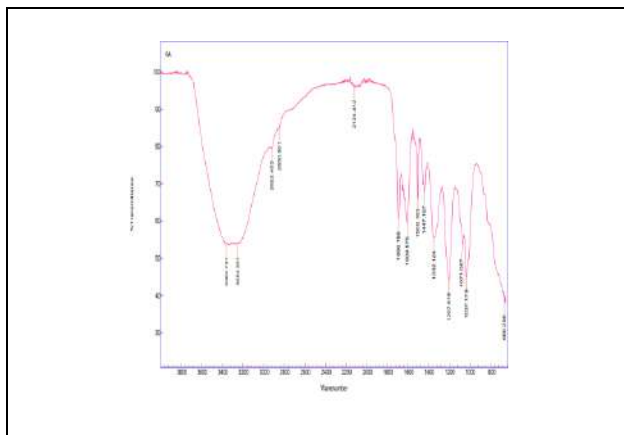
Fig: 1.FT-IR Analysis of acetone rhizome extract of *Bergenia ciliata*	**Fig: 2. analysis of acetone root extract of** *Berberis lycium* **roots**
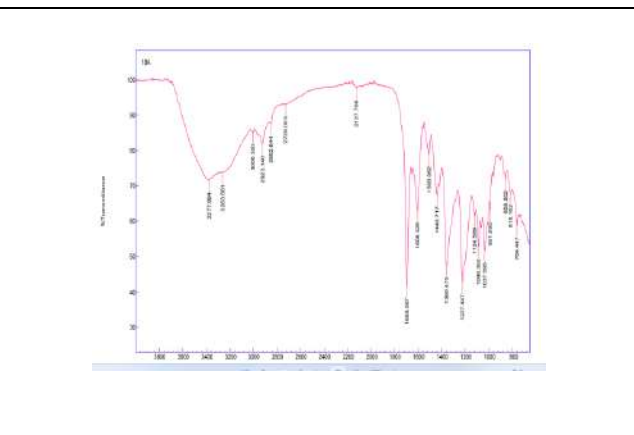
RESEARCH ARTICLE

Crop Quality Prediction using Image Processing

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ABSTRACT

Traditionally, quality of food products is defined from its physical and chemical characteristics using human senses. The Physical parameter used to deduct are grain size, shape, moisture content, chalkiness, whiteness, milling degree, bulk density, etc. This project paper focuses on grain size and shape analysis using image processing techniques and the main objective of the proposed method is to provide an alternative solution for crop (primarily rice for now) quality analysis by automating some aspects of a crop grading pipeline, which minimizes the required time and cost to do the same in the long run.

Keywords: Rice, grain, quality, grading, image processing

INTRODUCTION

The agricultural industry is one of the oldest and most widespread industry in the world. One of the key requirements of a successful industry are quality control, which plays an important role in the agriculture industry as well. There are various ways to grade the quality of grains; like moisture content, lustre, chalkiness, length and breadth measurements. Some of these parameters like length and breadth are then used for classification based on their aspect ratio, but due to the time-consuming process it is to measure individual grains, this type of grading is seldom done. We propose computer vision-based approach to automate the process of extracting these length and breadth features, so as to make the process fast and devoid of human errors. Our implementation consists of two primary objectives:

- To develop an algorithm which can determine the quality of provided food grains using parameters like length and breadth.
- Create an easy to use GUI to use the above algorithm-based approach for classifying the grain samples.

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The second objective is important specially because a lot of research exists for topics related to this paper, but most of them are either unavailable to be used as GUI Applications or are not user friendly. For the first objective, we referred several papers and standards to find out what parameters we can use that satisfy our requirements and are viable to implement in our use case, a brief summary of different standards explored is given in the following section.

LITERATURE REVIEW

There is a lot of established and ongoing research in the area of crop grading. S. Rajalakshmi et al., [14]. Demonstrate how can we use deep learning techniques to get optimal prediction for wheat grading, Qing Yao et al., [15]. Have developed pipeline to grade rice based on chalkiness parameters, Yoshioka et al.[16] also discuss about a similar technique for rice quality predication. Apart from these research papers, we have referred the following quality standards.

Bureau of Indian Standards

Rice Standard Organization, (BIS) [1], Manak Bhavan, New Delhi, India (FAD16 10730_12092016 2016) has provided standards for testing methodology and tolerances for analysis of food grain in part I of FAD 16 (10730)-C. specific to photometric measurements, including the equipment to use. The standards are provided for the wheat, maize, paddy, rice, barley and gram pulses.

CODEX Standards

CODEX STAN [4] 198-1995 classifies seed based on dimension criteria as given below:

1. Kernel length / width ratio: (Long grain – length width ratio of 3.1 or more, medium grain – length / width ratio 2.1-3.0, short grain – length /width ration 2.0 or less)
2. Kernel length: (long grain – kernel length 6.6 or more, medium grain – kernel length of 6.2 mm or more but less than 6.6 mm, short grain – kernel length less than 6.2 mm

- Combination of kernel length and length / width aspect ratio:
- (long grain – a kernel length of more than 6.0 mm and with a length / width ratio of more than 2 but less than 3, or; a kernel length of more than 6.0 mm and with a length/width ratio of 3 or more.
- Medium grain - kernel length of more than 5.2 mm but not more than 6.0 mm and a length/width ratio of less than 3.
- Short grain - has a kernel length of 5.2 mm or less and a length/width ratio of less than 2 mm.

Moreover, these standards would be based on milling degree (Milled rice, under milled rice, well-milled rice and extra-well-milled rice). It gives definitions for paddy, husked, milled, parboiled and glutinous rice. This standard defines maximum percentage of allowable other organic extraneous matter.

Directorate of Marketing Inspection

Directorate of Marketing & Inspection (DMI) [3], Ministry of Agriculture and Farmers Welfare, Government of India (DMI 2016) has considered CODEX 192-1995 (adopted in 1995 and revised yearly till last 2016) standard as a base and provides standards for all agricultural foods. It has provided maize standards (Agmark net-Maize 2016), which includes foreign matter (organic and inorganic), damaged grains, immature/shriveled grains, weevilled grains, other edible grains, admixture of different varieties and Moisture content in sample. Based on percentage existence of different types of grain kernel in sample the maize quality is categorized in Grade –I, II, III and IV. It has also provided standards for rice and wheat (Agmark-Wheat 2016), which is based on consideration of wholesomeness, appearance, color, foreign matter (organic and inorganic), damaged grains, broken grains, immature / shriveled grains, weevilled grains, wheat of other variety, other food grains and moisture content. Based on percentage existence of different types of grain kernel in sample the wheat quality is categorized in Grade –I, II, III and IV.

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ARSO: ARS 464 (English)

The African Organisation for standardization standard (ARSO [5]: ARS 464 (English) - Milled Rice Specification2012): ARSO divides grain seeds into head, broken and chip seed. Broken seed is further classified in long broken, medium broken and small broken. ARSO CD-ARS 464:2012(E) classifies seed with below criteria:

- Head rice (Length greater than L x (3/4))
- Whole kernel (Length L - L x (9/10))
- Broken Length (various subgroups)

The ARSO standard gives definitions for paddy, husked, milled, parboiled and glutinous rice.

METHODOLOGY

Two classifications that we zeroed upon to base our implementation are the Codex Standard and the Indian Institute of Rice Research Standard. Both of them are based on length and breadth characteristics. The generic process flow is shown in figure 1. Here, the image gets retrieved from storage, goes to a preprocessor and finally to the grading function. In this process, we use Computer vision to first separate individual rice seeds and then classify them on the basis of length, breadth and length breadth ratio. We place the grains under consideration on a flat surface(preferably black in case of rice grains) and adjust the camera aperture and time of exposure until the grains image is clearest, this step depends on the individual setup and needs a standardized controlled environment for predictable results. There may be some non-linearity of camera and uneven light source usually resulting in the unevenly bright background of grains image. Also, the image may contain noise and the grains may not be perfectly separated. It would affect the characteristic values of appearance and quality of grains. We do several preprocessing steps to overcome the challenges posed by these problems and try to get maximum possible area of a grain as a separated image.

Thresholding

First step in our pipeline is thresholding [7]. In thresholding, if pixel value is greater than a threshold value, it is assigned one value (white), else it is assigned another value (black).We first convert our image into a gray-scale image, and apply threshold at 160 pixel intensity, which we received after trialed error, and which also depends on the setup used.

Average Filtering

We require to blur the binary image to remove the high frequency content [8]. (e.g: noise, sharp edges) from the image. Image blurring is achieved by convolving the image with a low-pass filter kernel. This is done by convolving the image with a normalized box filter. We takes the average of all the pixels under kernel area and replace the central element with this calculated average.

Morphological Transformations

Morphological transformations [9] are operations based on the image shape [9], normally performed on binary images. It needs two inputs, one is our original image, second one is called structuring element or kernel which decides the nature of operation. We apply Erosion and Dialation for reasons explained below.

Creating Structuring Element [10]

For our case, we create a elliptical structuring element, which we use to do erosion and dilation. Ellipse tends to give better results in case of grains because of its ability to round the corners which is not optimal if we use a square structuring element.

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Erosion

This operation erodes away the boundaries of foreground object (white in color). In this process, the kernel slides through the image (as in a 2D convolution) and a pixel in the original image (either 1 or 0) will be considered 1 only if all the pixels under the kernel is 1, otherwise it is eroded(made zero).

Dialation

In this process, a pixel element is '1' if at least one pixel under the kernel is '1'. So it increases the white region in the image or size of foreground object increases. In our implementation for noise removal, erosion is followed by dilation. Because, erosion removes white noises, but it also shrinks our object. So we dilate it. Since noise is gone, they won't come back, but our object area increases back approximately to original size.

Edge detection

We apply edge detection to find out the region of boundaries of rice grains. There are several methods available for edge detection like differentiation, gradient, perwitt, Roberts, sigma and Sobel. We used Canny edge detection method for edge detection in our implementation, because it gives a good localization, response and is immune to a noisy environment [11].

Feature Extraction

After getting the count of rice grains, edge detection algorithmic applied on the image and outcome of the applied algorithm is the endpoint values of each grain. After getting the value of length and breadth we can calculate length-breadth ratio. Also, we can use multiplication factor to convert between digital length to physical length. Such a factor is fixed after trial and error and is setup dependant. Physical measurements we are able to detect from our implementation are shown in Table 1.

Object Classification

We are able to validate the computer-generated measurements using a Vernier Caliper to measure the actual values for a given sample. Based on predetermined characteristics, we can characterize rice into standard classes. Currently, we have coded two classifications inside the program, Codex Standards (Table II)and Indian Institute of Rice Research (IIRC) Standard (Table3).

Implementation And Results

The above-mentioned methodology is implemented in Python3 [12], while the frontend UI is created using tKinker [13].

Main Window

The main window (figure 2) contains all the required parameters that one needs to tune for their measurements. It includes the selection dropdown for the standard to use, along with the source: an image file or camera stream. There is an additional debugger button, which if enabled, will show intermediate steps as to how we reached the final prediction.

File selection

File selection pane (figure 3) comes up when we select the source to local file instead of camera stream. In case of a camera stream, the picture is silently taken from the default camera of the device (with the ID Zero).

Output Panel

Majority of lower portion of our application is dedicated to show results of the predication (figure 4). The results are shown in a scrollable text pane which gets refreshed after each operation.

Debugging Info

Debug mode (figure 5) enables displaying intermediate results to see the process in detail. The new window that popsup also has the feature to zoom and save the intermediate results. Apart from this, the program also logs a lot of information into the console of the system on which it is running, which includes the error traces and dumps if they occur due to any reason.

RESULTS

We tested our implementation simulating various imaging scenarios using images obtained in different conditions. The results we obtained look promising and specimen of various conditions are displayed below.
• Image with noise (text in background): Correct Prediction(figure 6)
CODEX: 'Short Grain':9, 'MediumGrain':3, 'Long Grain':1
IIRC: 'Slender':9, 'Medium':2,'Bold':2
• Image with overlapping text: Correct prediction (figure7)
CODEX: 'Long Grain':1, 'MediumGrain':3, 'Short Grain':4
IIRC: 'Slender':1, 'Medium':2,'Bold':5
• Image with a lot of noise: Incorrect prediction (figure 8)
CODEX: 'Short Grain':91, 'MediumGrain':4 'Bold':16, 'Round':77,'Medium':2
• Heavily cropped and distorted image: Incorrect prediction(figure 9)
CODEX: 'Short Grain':5
In current state, we are able to calculate the ratio of separate rice grains successfully. We can conclude that the implementation fails only when the image is not clear, has a lot of blur and/or is obstructed by something else. If the rice grains are separated properly, have enough light and the background contrast is distinguishable, the results tally with real world measurements. Even in cases when noise is present, we maybe able to get away with noise removal techniques used in the implementation, though the accuracy will depend on the remaining data that we have after the noisy part is removed.

CONCLUSION AND FUTURE WORK

We demonstrated the viability of a computer vision agent capable of grading rice grains based on their length and breadth parameters. Such an agent performs reasonably good in ideal and sub-ideal conditions, and can be relied upon for rice quality prediction, based in set parameters. As a part of future work, we propose implementing the same process for other crops, and checking the performance when the crop is close to circular. We also propose creating a portable compute box, enabled with Raspberry-Pi to do the capture and processing without the need of a computer in hand(figure 10). Having such a device also has the added benefit of a controlled environment, which can further be leveraged to do length measurement in millimeter precision. Finally, we can create a pipeline capable of doing multiple grain prediction, detecting the grains by itself, or manually taking it as an input parameter and thereafter performing the relevant calculations.

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Table 1: Supported Measures

Major Axis Length
Minor Axis Length
Area of a rice grain
Correlation of measured quantities in real life

Table 2: Classification: Codex Standard

S. no	Aspect Ratio	Classification
1.	≥ 3.1	Long Grain
2.	< 3.1 and ≥ 2.0	Medium Grain
3.	< 2.0	Short Grain

Table 3: Classification: Iirc Standard

S. no	Aspect Ratio	Classification
1.	≥ 3.0	Slender Grain
2.	< 3.0 and ≥ 2.1	Medium Grain
3.	< 2.1 and ≥ 1.1	Bold Grain
4.	< 1.1	Round Grain
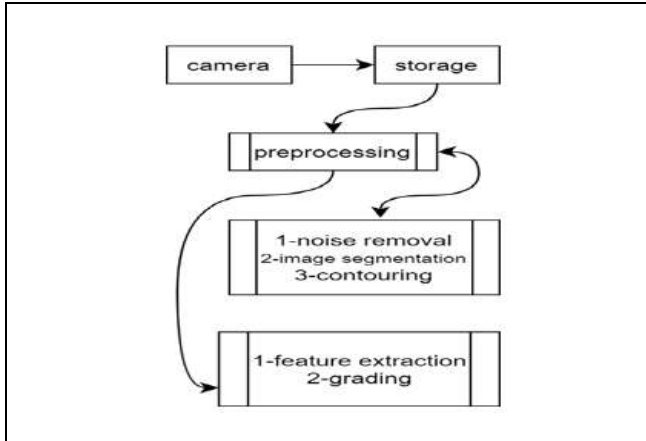
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Fig. 1. Process Flow	**Fig. 2. Main Screen**
Fig. 3. File Selection	**Fig. 4. Displaying Output**
Fig. 5. Intermediate Steps	**Fig. 6. Accurate Prediction 1**
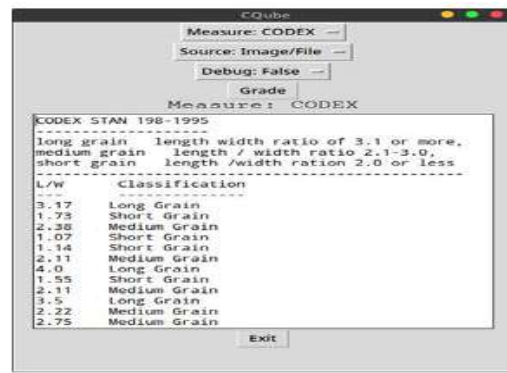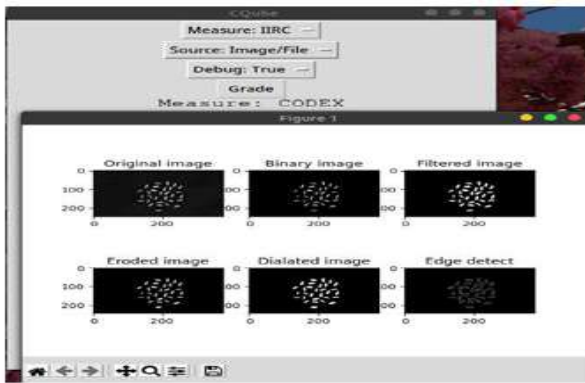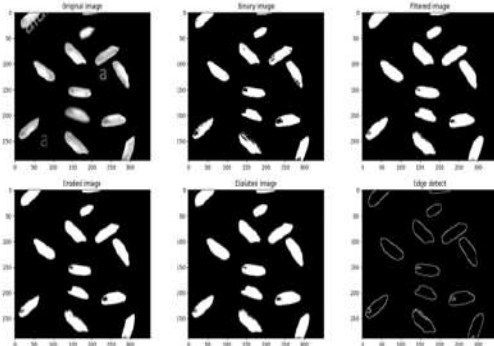
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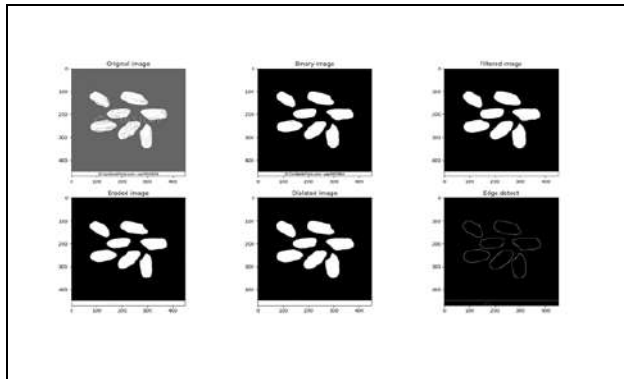
Fig. 7. Accurate Prediction 2	**Fig. 8. Bad Prediction 1**
Fig. 9. Bad Prediction 2	**Fig. 10. Portable Implementation**
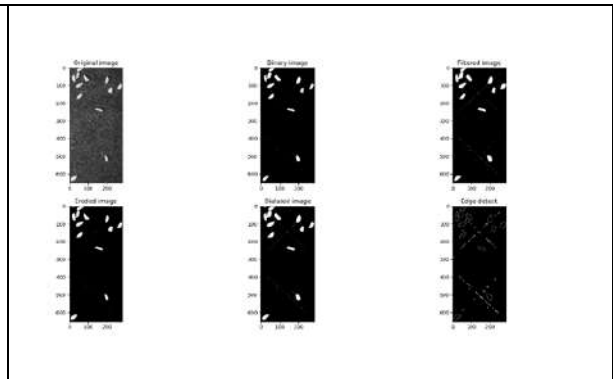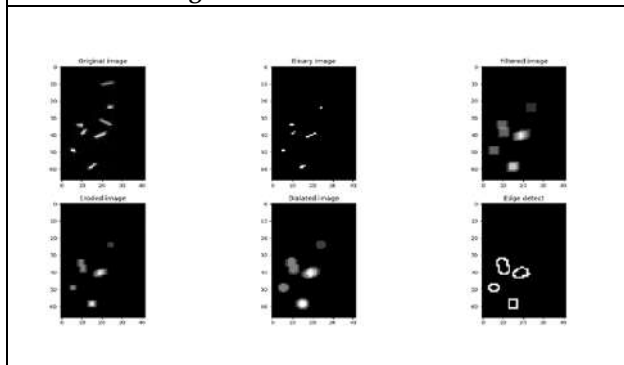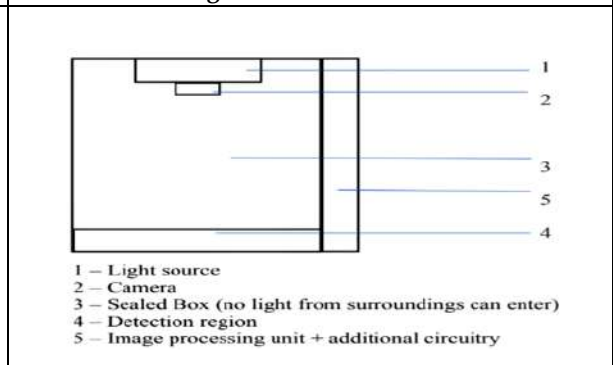
A Review on Detection and Prediction of Bipolar Disorder using Deep Learning

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ABSTRACT

In the present times, not only the physical health of human beings but also the mental health is being affected due to various problems that are increasing. The psychological illness refers to certain problems that arise due to the high stress that psychologically causes on humans. These problems can lead to problems such as misconceptions, misunderstandings, excessive anger and stress. And ignoring this can make the problem bigger. This paper gives survey data on the various methods proposed to deal with Psychological illness in the deep learning method. It constantly examines and classifies the best treatments for patients, mental health improvement methods, and selection methods and analyzes for stress relief. Furthermore the results of the deeper learning methods are also analyzed so the results of the better and improved methods are more likely to be further enhanced and its calculation rate adjusted.

Keywords: Psychological Illness, Various Problems, Deep Learning Methods, Mental Health, Stress Relief

INTRODUCTION

Around 2% of the world population suffers from manic-depressive illness, and another 2% suffers from bipolar disorder in its sub threshold manifestations [1]. According to the World Health Organization, bipolar disorder is one of the top 10 leading causes of disability-adjusted life years among young adults [2]. According to Nordentoft [3], 7.8% of men and 4.9% of women who have bipolar disorder end their lives by committing suicide. As a direct consequence of this, patient life expectancy decreases by nine years [4]. The diagnostic processes that are now in place for bipolar illness may not be completely successful, and there is typically a ten-year gap between the onset of

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symptoms and the delivery of a formal diagnosis [5]. This model shows the different ways that bipolar disorder can be treated, diagnosed, and prevented. Through the use of evidence-based medicine, we have gained a better understanding of risk factors, prognosis and effective treatments associated with the disorder, where the statistical model provides results on an average scale [6]. Greenhalg et al. [7]. Have brought to our attention the fact that individuals in clinical trials might not necessarily reflect the patients' profile. Because clinical heterogeneity plays an important role in bipolar disorder, this may be especially true in that area of research. As a result of these discoveries, psychiatric research is focusing more and more on techniques like deep learning, whose goal is to make care that is tailored to the needs of each patient [8]. The speed at which new datasets are being produced is referred to as big data, and the term big data is used to describe extremely large and complicated data sets. Big data is characterised by a wide range of levels at which data is generated, ranging from the molecular to the clinical to the socio-demographic to the administrative to the environmental and even social media data.

This is one of the most essential properties of big data. Those in research [9]. In recent years, a great number of deep learning algorithms, which are also known as pattern recognition are developed for the purpose of analysing vast volumes of data. In a nutshell, the algorithm initially conducts an analysis of a dataset referred to as training in order to develop a function that is able to differentiate between individuals belonging to various categories. It is possible to determine how accurate the model is by applying it to a new dataset and contrasting the results with the original dataset. Alterations to the algorithm or a further reduction in the amount of data may be utilised in order to effect further improvements in this model [10]. Therefore, these algorithms are ideal for analysing complicated diseases and calculating the particular outcome probability on an individual basis [11]. This research looked at the results of patients with bipolar disorder who had previously been evaluated using these methods. The techniques employed in this research come from the field of deep learning. Research studies that looked at diagnoses were our key area of interest in our inquiry. It was also taken into consideration to include research evaluating treatment and prognosis, as well as the development of data-driven phenotypes. In view of the fact that these approaches are still in the process of being developed in the field of psychiatry, we have provided a concise explanation of the most significant ideas in deep learning as well as some of the limitations that come with it. In the end, one of our goals was to show how the implementation of these novel approaches can improve clinical decisions in the years to come.

Research Problem

Bipolar disorder, also known simply as BD, is a prevalent mental illness that causes people to go through dramatic shifts in their mood. The most prevalent causes of this condition are disruptions in thought, which can range from extreme enthusiasm and exhilaration to severe sadness [12]. According to the findings of an epidemiological study [13], it is getting increasingly more widespread. BD has been associated with an elevated chance of passing away at an earlier age [14]. People with bipolar disorder have a life expectancy that is 9 to 17 years lower than the average life expectancy of the general population. As a result, these patients struggle with a variety of issues throughout their lives. Numerous studies conducted in nations, whereby it demonstrates the mortality gap are widening continuously over the course of the most recent few decades [15]. There are certain deaths in Bangladesh that can be attributed to unforeseen circumstances. Nevertheless, the vast majority of deaths can be attributed to cardiovascular disease and diabetes. Patients diagnosed with BD have a much higher risk of committing suicide compared to the general population [16]. Patients diagnosed with BD experience a suicide attempt rate that is 10–20%age points higher than the general population [14]. The circumstances show that the narrator knows a lot about bipolar disorder. Primary exposure to mental disorders is an essential component in properly identifying BD issues and delivering suitable treatment for such issues. In contrast to other long-term conditions, which rely on statistical analysis and laboratory trials, BD is often diagnosed based on the patient own self-reporting in questionnaires meant to expose particular feelings[14]. Deep Learning (DL) shows promise for assisting psychiatrists in improving their clinical decisions and assessments [17]. These skills are also proving to be effective for broadening our understanding of the various issues pertaining to mental health. Over the past few years, the improved performance of AI techniques has been demonstrated by an increasing number of data-rich frameworks [18] [29]. In an earlier review, Diego et al. [20]investigated the use of DL algorithms in the process of BD diagnosis. The five primary application areas of DL in BD that were reviewed by the researchers were diagnosis, prognosis, treatment, and research. In contrast to that, the

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purpose of this review is to investigate how DL can be applied to diagnose BD based on research that has been done in the past and published. To the best of our knowledge, no other study has investigated the role that differential diagnosis plays in the process of diagnosing BD and the various subtypes that the disease can take. We also look at the positives and negatives of the work that has been done so far, as well as potential research guidelines that can help bridge the gap between diagnostic laboratory procedures and individual patient diagnoses. People who have BD frequently have their depression misdiagnosed as bipolar disorder, which makes it challenging and time-consuming to treat them for their disease. People diagnosed with bipolar disorder (BD) are more likely to seek treatment for their depression than those without BD [21]. According to the findings of China National Chinese Mental Health Survey [22], during the course of a period of one year, there was a rise in the certain age of people who recognised bipolar illness as a kind of depression. As a direct consequence of this, there is an immediate and pressing need to appropriately diagnose BD. In an effort to achieve superior clinical results, diagnostic laboratory (DL) services are becoming progressively more involved and intricate [23]-[25]. Accordingly, in light of the information presented, it is necessary to conduct a comprehensive analysis of all potential applications of DL for the diagnosis of BD. The aim of the study is to study different ways that DL algorithms can be used to improve the accuracy of BD diagnosis.

Deep Learning Method Available for the detection of bipolar disorder

In order to do deep learning, the necessary hardware must be able to perform matrix and vector multiplications. Because of advancements in hardware technology, such as graphics processing units, it is now possible to perform vector and matrix multiplications in parallel. Such implementation without GPUs would have to be carried out in serial on the CPUs, which simply would not have been conceivable (CPUs). Deep learning training may be made to run more quickly with the help of GPU parallelism, which also enables it to be applied to solving problems that occur in the real world. Even the most basic problems can now be tackled successfully by applications of deep learning. MLPs can be used to implement even the most basic of deep learning approaches. Some of the methods that are utilised in this thesis are Convolutional Neural Networks (CNN), Encoder Networks and Residual Neural Networks (ResNet). Detailed explanations of these methods are provided throughout the thesis. They were developed initially for use in computer vision, but their functionality has now been adapted such that they may also be used in time series applications [21]. In this study, the classification of BD is accomplished using the application of deep learning on bipolar datasets that is of time series or speech data or medical image data, where the deep learning framework is illustrated in Figure 1.

Convolutional Neural Networks

Deep learning was initially used to solve the problem of time series analysis in 2017 [26], and it did so by employing CNNs to solve computer vision problems. Despite having a lower total number of dimensions, one-dimensional convolutional neural networks are notoriously difficult to visualise. One example of the multiple channels that can be utilised as input for visualisation tasks is a camera frame RGB channels. Convolution is performed in parallel on each of the channels, and the results are then added to the next layer. The convolution is performed by means of the channels; nevertheless, in two-dimensional issues, the channels are temporal inputs that are sampled simultaneously. In 2016, a suggestion was made regarding the application of Fully Convolutional Neural Networks (FCNNs) for the classification of time series. This research provides a strong basis for deep learning time series categorization, as it acts as a foundation. In that particular investigation, the last layer of the network does not have any fully connected nodes. The global average pooling (GAP) layer is used to figure out the average value of the temporal dimensions instead of using layers that are all connected. The typical machine learning approaches by having the highest accuracy in predicting the diseased from the control group. After the framework has been developed, we will discuss the characteristics that the model discovered in order to gain an understanding of the biological markers of the disease. As a consequence of this, we carried out a post-analytical study in order to identify the most significant contributors to the development of this disease. We found that the order in which the facts were presented could result in complications. Exome sequencing community practises such as these, which are widely recognised and highlighted as a way of data preparation with drawbacks, are examples of the type of practises that fall into this category.

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Residual Neural Networks (ResNet)

In a wide variety of classification tasks, convolutional neural networks have been shown to perform well. The success of convolutional neural networks in generating very deep models by stacking extra layers has prompted researchers to investigate whether or not the learning ability of these networks may increase proportionally with the number of layers they contain. However, when the depth of the network is substantial, the accuracy begins to sharply decline, which is why it is important to use approaches such as normalised initialization. There are several different ways to solve the problem of vanishing and exploding gradients. Each of these solutions has their own advantages and disadvantages. After that critical juncture in the procedure, the accuracy of the training also begins to suffer, which means that over fitting cannot be to blame. Residual neural networks (RNNs), often known as ResNet, are employed as a solution to the challenge of constructing deeper networks. Residual blocks were introduced by ResNet; these are essentially shortcuts to the network. Identity mappings are what are used to make the connection between these blocks and the layers below them. These layers connect the layers that came before them to the layers that will come after them so that the shortcut can be used. Because adding the shortcut layers doesn't add any learnable parameters to the network, it doesn't make the network any more or less complicated [27]. As more convolutional layers are added to the input, the dimensions of the tensor get increasingly reduced. However, the shortcut connections are making an effort to incorporate these earlier layers into the convoluted outcome. In order to accomplish this, a linear projection matrix is multiplied by an identity mapping. This is done in order to increase the total number of accessible shortcuts. These shortcuts are introduced to various intermediate sections of the networks so that the networks can be made deeper. In their most extensive design, Wang et al. [28] classified time series using an 11-layered network with residual connections. Instead of the more common two-dimensional filters, one-dimensional filters are used when working with convolutional neural networks.

Encoder Network

Encoder networks are the foundation on which neural network architectures, such as CNNs, are built [29]. Convolutional layers are utilised by both CNNs and encoder networks in order to accomplish the same goal: the extraction of temporal correlations along the time axis. For example, the outputs of fully convolutional networks are fed into layers that are responsible for normalisation. Following the completion of the normalisation process, the output is fed into the PRELU activation functions and dropout. In order to apply the findings, one-dimensional max-pooling layers are utilised. The categorization of time series is primarily reliant on the synthesis of information from several dimensions for series that contain numerous variables. CNN uses a methodology known as Global Average Pooling in order to complete this summary using that methodology. Encoder networks use a different attention mechanism in place of the Global Average Pooling layer in the network second part. The encoder networks used by CNNs operate very differently with regard to this strategy. Following an instance normalisation layer as the final step of the neural network, the output that was generated is then passed on to fully connected layers in order to generate classification output. Using this strategy, transfer learning was first proposed as a way to classify time series. However, training the network from scratch has shown promising results as well [30].

Lakshman, S., et al. [15] studied the diseased group from the control group with a level of accuracy that exceeds that of other conventional machine learning techniques. After the framework has been developed, we will discuss the characteristics that the model discovered in order to gain an understanding of the biological markers of the disease. As a consequence of this, we carried out a post-analytical study in order to identify the most significant contributors to the development of this disease. We found that the order in which the facts were presented could result in complications. Exome sequencing community practises such as these, which are widely recognised and highlighted as a way of data preparation with drawbacks, are examples of the type of practises that fall into this category. Deep learning has not been widely used in very many health-related applications, with the exception of voice processing. When it comes to tasks involving the recognition of healthy lifestyles, the corpora that are often accessible are typically very small. This is true both in terms of the overall amount of data and the number of people present. The Bipolar Disorder corpus for the 2018 Audio/Visual Emotion Challenge only used 218 audio samples total, coming from 46 different individuals. These kinds of circumstances call for the application of a multi-instance learning framework, such as the one that Ren, Z., et al. [16] presented. To get started, we cut the large audio recordings into

more manageable chunks by segmenting them into smaller pieces. The fact that chunks are labelled with the label of the relevant voice file, which may or may not accurately reflect the content of the chunk, is one of the most significant problems with this approach. Following that, in order to solve this problem, we train a multi-instance learning model that is based on deep learning (ensemble). According to the results, this method can improve the accuracy of feed forward, recurrent, and convolutional neural networks on mania classification tasks. When convolutional neural networks are used, the accuracy of these neural networks also gets better.

Limitations and Future Work

There are a number of interesting pieces of research that have been incorporated, but they are not yet beyond the proof-of-concept stage and are missing appropriate external validation. For the purpose of structural neuroimaging research, for instance, patients who have a history of psychiatric illness and the use of medication are frequently used. It can be challenging to ascertain whether or not anatomical alterations in the brain play a part in the progression of disease. Despite this, neuroimaging and deep learning have a wide range of applications in many different fields. In addition to determining who is at risk, it can be used on patients who are afflicted with chronic diseases in order to investigate cognitive impairments, the status of neuroprogression, and establish disease phenotypes. A significant majority of the deep learning approaches that have been discussed have not been validated by population research, which is yet another limitation of these approaches. Clinicians will be able to make decisions about treatment options, ways to prevent illness, and prognosis orientations with the help of very accurate predictive models. Deep learning allow for more efficient patient categorization than the categorization algorithms we currently use, allowing patients to be grouped together according to their shared traits. We would be able to better stratify our patients if we had a better staging system that would assist us in discovering groupings of patients who had outcomes that were similar to one another. To make sure that big data analytics and deep learning models can actually help patients, one of the most important challenges of the future will be to come up with ways for doctors to access these complex features and algorithms in a way that is not only possible but also useful.

CONCLUSIONS

In addition to assisting us in gaining a deeper understanding of the pathophysiology of mental diseases, the findings of this study indicated that neuroimaging investigations can assist in distinguishing bipolar disorder from healthy controls and other diagnoses. In the field of brain disorders, this method might be able to help reduce the number of incorrect diagnoses as well as diagnostic delays (BD). Deep learning techniques evaluates individuals at risk i.e. youngsters who have a family history of bipolar disorder. These techniques take data and turn it into information on the likelihood of individual's receiving a future diagnosis. Using deep learning to help design individualised interventions for high-risk patients can help prevent such individuals from progressing from prodromes to full-blown illness. After a diagnosis has been established, it is anticipated that it will be possible to utilise deep learning to determine which treatment a patient is most likely to benefit from. It possible that knowing how your body will react to medication based on the treatment. Researchers discovered that outcomes such as hospitalisation, suicide, and relapses may be predicted reliably by using deep learning models. Further the research shows that integration with social media and mobile devices may also be a good way to figure out a patient mental state and alert a therapist before an episode starts.

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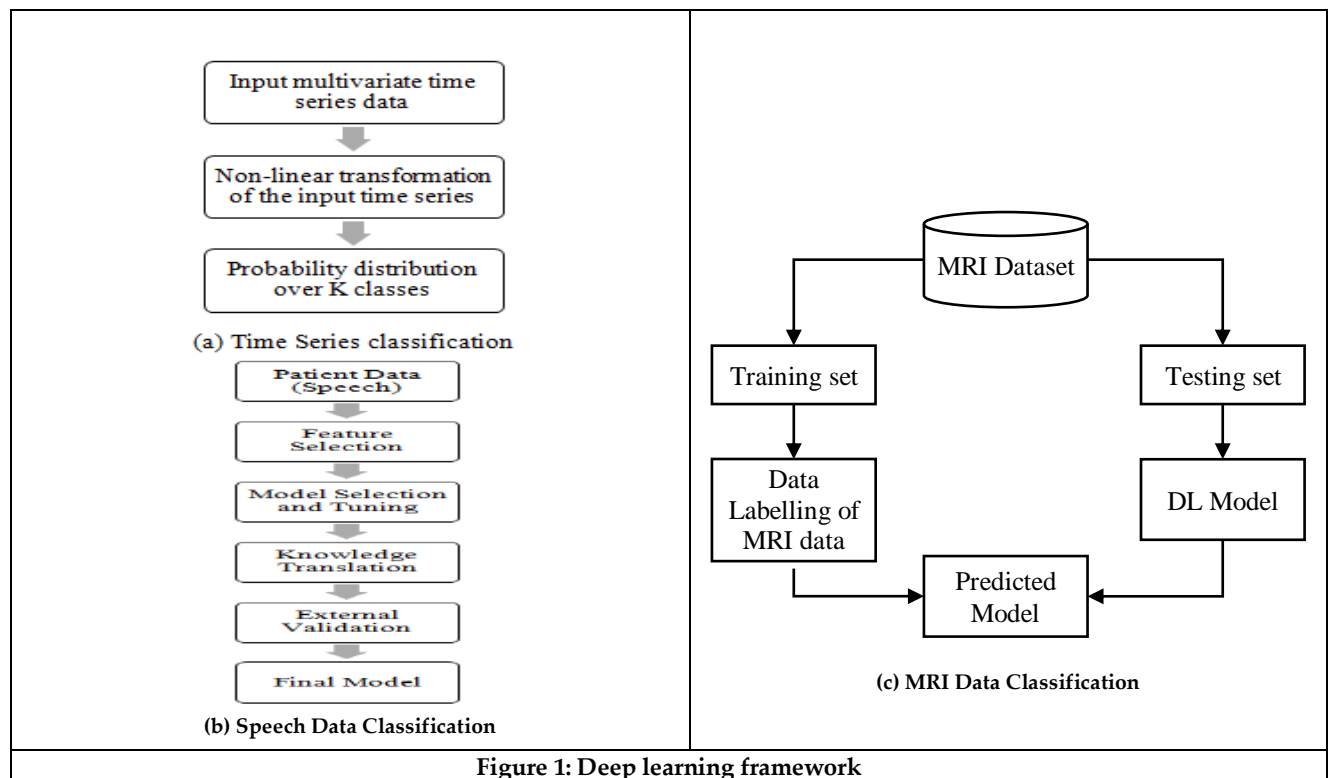
Figure 1: Deep learning framework

RESEARCH ARTICLE

Complex Picture Fuzzy Soft Matrices and its Application

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ABSTRACT

In this article, we initiate the notion of complex picture fuzzy soft matrices ($\tilde{C}$PFSMs).The authenticity of this approach provides suitable examples. Finally, we construct the$\tilde{C}$PFSMs in decision making based on different types of $\mathcal{T}$-norm operators for selecting the best missile.

Keywords: Complex fuzzy set,Picture fuzzy set, Picture fuzzy matrices

INTRODUCTION

Zadeh [8] introduced the fuzzy set (FS) in 1965. Atanassov [1], approaches the concept of intuitionist fuzzy set (IFS). In 1999, Molodtsov [6] approaches the Soft Set (SS) theory, which has a rich potential for uncertainty and vagueness. Cagman [2], presented the theory of fuzzy soft matrix (FSM) in 2012. Ramote et al.,[7] discussed complex fuzzy set($\tilde{C}$FS), in which he presented new operations such as reflections and rotations. Zhang [9] study the concept of fuzzy complex number limit theory. Cuong [4], approaches the concept of picture fuzzy sets(PFS) in 2014. Dogra and Pal [5] studied picture fuzzy matrix (PFM), which was characterized by a degree of positive, neutrality and negative memberships satisfying as long as their sum is not more than one. In recent years, Chinnadurai and Thayalan [3]. studied the concept of complex interval-valued Pythagorean fuzzy set and its application.

COMPLEXPICTUREFUZZYSOFTMATRIX
Let $\mathbb{U}=\{u_1, u_2, \dots, u_n\}$ be the universal set and $\mathbb{E}$ be the set of parameters given by $\mathbb{E}=\{e_1, e_2, \dots, e_n\}$ and $\mathbb{A} \subseteq \mathbb{E}$. A complex picture fuzzy soft matrix over $\mathbb{U}$ is defined as a pair $(\mathbb{C}_\mu, \mathbb{A})$ where $\mathbb{C}_\mu$ is a mapping given by, $\mathbb{C}_\mu: \mathbb{A} \rightarrow P^{\mathbb{U}}$ and $P^{\mathbb{U}}$ is a power set of $\mathbb{U}$, then the complex picture fuzzy soft set $(\mathbb{C}_\mu, \mathbb{A})$ can be expressed as a matrix form as, $[\tilde{c}_{m \times n}^{\mathcal{P}}] = |\tilde{c}_{ij}^{\mathcal{P}}|$ for i=1,2,…,m and j=1,2,…,n.

Where $|\tilde{c}_{ij}^{\mathcal{P}}| = \{< |\mathcal{T}_{p}(e_i), \mathcal{I}_{p}(e_i), \mathcal{F}_{p}(e_i)|_j >\}$

Here,$< |\mathcal{T}_{p}(e_i), \mathcal{I}_{p}(e_i), \mathcal{F}_{p}(e_i)|_j >$, ($\{\mathcal{T}_{p}(e_i), \mathcal{I}_{p}(e_i), \mathcal{F}_{p}(e_i)\}_j$ is a complex picture fuzzy set) represent the element of $\tilde{c}^{\mathcal{P}}$ corresponding to the element $\tilde{c}_j^{\mathcal{P}}$ of $\mathbb{U}$, for j=1,2,…,n and $< |\mathcal{T}_{p}(e_i), \mathcal{I}_{p}(e_i), \mathcal{F}_{p}(e_i)|_j > = \mathbb{M}_{rc}$ such that $\mathbb{M}_{rc} \in$ [0,1]. r=1,2,…,m and c=1,2,…,n. Also satisfying, $0 \leq |\mathcal{T}_{p}(e_i) + \mathcal{I}_{p}(e_i) + \mathcal{F}_{p}(e_i)|_j \leq 1$.

Example

Suppose that there are three cars under consideration namely the universes $\mathbb{U} = \{c_1, c_2, c_3\}$ and the parameter set $\mathbb{E} = \{e_1, e_2, e_3\}$, where e_i stands for Price, Quality, Mileage respectively. Consider the mapping $\mathbb{C}_{\mu}$ which describes the "outlook of cars" that is considering for purchase. Then fuzzy soft set $(\mathbb{C}_{\mu}, \mathbb{A})$ is given as,

$[\mathbb{C}_{\mu}, \mathbb{A}] = [< |T_P(e_i), I_P(e_i), F_P(e_i)|_j >]_{(m \times n)}$, Where, $\mathbb{C}_{\mu}(e_1) = \{(\mathcal{C}_1, |0.10e^{i\frac{\pi}{2}}, 0.70e^{i2\pi}, 0.10e^{i\frac{\pi}{4}}|, \mathcal{C}_2, |0.60e^{i\frac{\pi}{6}}, 0.30e^{i\frac{\pi}{4}}, 0.10e^{i\frac{\pi}{2}}|, \mathcal{C}_3, |0.10e^{i\frac{\pi}{3}}, 0.50e^{i\frac{\pi}{2}}, 0.30e^{i2\pi}|)\}$

$\mathbb{C}_{\mu}(e_2) = \{(\mathcal{C}_1, |0.40e^{i\frac{\pi}{3}}, 0.20e^{i2\pi}, 0.40e^{i\frac{\pi}{6}}|, \mathcal{C}_2, |0.70e^{i\frac{\pi}{4}}, 0.10e^{i\frac{\pi}{3}}, 0.20e^{i2\pi}|, \mathcal{C}_3, |0.50e^{i\frac{\pi}{6}}, 0.30e^{i\frac{\pi}{2}}, 0.10e^{i\frac{\pi}{4}}|)\}$

$\mathbb{C}_{\mu}(e_3) = \{(\mathcal{C}_1, |0.40e^{i\frac{\pi}{2}}, 0.30e^{i\frac{\pi}{6}}, 0.30e^{i\frac{\pi}{4}}|, \mathcal{C}_2, |0.20e^{i2\pi}, 0.60e^{i\frac{\pi}{3}}, 0.20e^{i\frac{\pi}{2}}|, \mathcal{C}_3, |0.10e^{i\frac{\pi}{6}}, 0.30e^{i2\pi}, 0.60e^{i\frac{\pi}{3}}|)\}$

Consider the values for $\mathbb{C}_{\mu}(e_1)$ of $\mathcal{C}_1, \mathcal{C}_2 \text{ and } \mathcal{C}_3$,   where

$0.10e^{i\frac{\pi}{2}} = 0.10(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}) = 0.10(0+i) = |0.10i| = \sqrt{0.01} = 0.10.70e^{i2\pi} = 0.70(\cos 2\pi + i\sin 2\pi) = 0.70(0+i)$

$= |0.70i| = \sqrt{0.49} = 0.70.10e^{i\frac{\pi}{4}} = 0.10(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}) = 0.10(0.70+i0.70) = |0.70+0.70i|$

$= \sqrt{0.0049+0.0049} = 0.09.0.60e^{i\frac{\pi}{6}} = 0.60(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}) = 0.60(0.8+i0.5) = |0.48+0.3i| = \sqrt{0.23+0.09} = 0.56.0.30e^{i\frac{\pi}{4}} = 0.30(\cos\frac{\pi}{4}$

$+ i\sin\frac{\pi}{4}) = 0.30(0.70+i0.70) = |0.21+0.21i| = \sqrt{0.04+0.04} = 0.28.0.20e^{i\frac{\pi}{2}} = 0.10(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}) = 0.10(0+i) = |0.1i|$

$= \sqrt{0.01} = 0.1.10e^{i\frac{\pi}{3}} = 0.10(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}) = 0.10(0.5+0.86i) = |0.5+0.86i| = \sqrt{0.002+0.006} = 0.08.0.50e^{i\frac{\pi}{2}} = 0.50(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}) =$

$0.50(0+i) = |0.5i| = \sqrt{0.25} = 0.50.30e^{i2\pi} = 0.30(\cos 2\pi + i\sin 2\pi) = 0.30(1+0i) = |0.30| = \sqrt{0.09} = 0.3$. Proceeding in this manner, we can find $\mathbb{C}_{\mu}(e_2)$ and $\mathbb{C}_{\mu}(e_3)$. Now we represent this complex picture fuzzy soft set in matrix form

as, $[\tilde{C}_{m \times n}^{\mathcal{P}}] = |C_{ij}^{\mathcal{P}}| = \begin{bmatrix} < 0.1, 0.7, 0.09 > & < 0.31, 0.2, 0.35 > & < 0.4, 0.26, 0.28 > \\ < 0.5, 0.3, 0.1 > & < 0.69, 0.08, 0.2 > & < 0.2, 0.56, 0.2 > \\ < 0.08, 0.5, 0.3 > & < 0.46, 0.3, 0.09 > & < 0.08, 0.3, 0.56 > \end{bmatrix}$

APPLICATION OF $\tilde{C}$ PFSMs FOR SELECTING THE BEST MISSILE

In this section, we using the different types of $\mathcal{T}$-normoperatorsfor $\tilde{C}$PFSMs. Also, we provide an application of $\tilde{C}$PFSMsto solve MCDM for selecting the best missile.

MINIMUM OPERATOR-$\tilde{\mathcal{T}}^{\mathcal{M}}$

Let us discuss the $\mathcal{T}$-norm minimum operator of (n×n)

$\tilde{C}$PFSMs $\tilde{\mathcal{T}}^{\mathcal{M}} = \min(|\mathcal{T}_1(e_i), \mathcal{T}_2(e_i), \dots, \mathcal{T}_n(e_i)|_j), \min(|\mathcal{I}_1(e_i), \mathcal{I}_2(e_i), \dots, \mathcal{I}_n(e_i)|_j), \min(|\mathcal{F}_1(e_i), \mathcal{F}_2(e_i), \dots, \mathcal{F}_n(e_i)|_j)$

PRODUCT OPERATOR - $\tilde{\mathcal{T}}^{\mathcal{P}}$

Let us discuss the $\mathcal{T}$-norm product operator of (n×n) $\tilde{C}$PFSMs

$\tilde{\mathcal{T}}^{\mathcal{P}} = \prod_{i,j=1}^{n} (|\mathcal{T}_1(e_i), \mathcal{T}_2(e_i), \dots, \mathcal{T}_n(e_i)|_j), \prod_{i,j=1}^{n} (|\mathcal{I}_1(e_i), \mathcal{I}_2(e_i), \dots, \mathcal{I}_n(e_i)|_j), \prod_{i,j=1}^{n} (|\mathcal{F}_1(e_i), \mathcal{F}_2(e_i), \dots, \mathcal{F}_n(e_i)|_j)$

BOUNDED OPERATOR - $\tilde{\mathcal{T}}^{\mathcal{B}}$

Let us discuss the $\mathcal{T}$-norm Bounded operator of (n×n) $\tilde{C}$PFSMs

$\tilde{\mathcal{T}}^{\mathcal{B}} = \frac{1}{n}\left\{\sum_{i,j=1}^{n}\{\mathcal{T}_1(e_i), \mathcal{T}_2(e_i), \dots, \mathcal{T}_n(e_i)\}_j^{\frac{1}{n}}, \sum_{i,j=1}^{n}\{\mathcal{I}_1(e_i), \mathcal{I}_2(e_i), \dots, \mathcal{I}_n(e_i)\}_j^{\frac{1}{n}}, \sum_{i,j=1}^{n}\{\mathcal{F}_1(e_i), \mathcal{F}_2(e_i), \dots, \mathcal{F}_n(e_i)\}_j^{\frac{1}{n}}\right\}$

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ARITHMETIC MEAN FOR $\tilde{C}$PFSM

Arithmetic mean $(\mathcal{A}.\mathcal{M})$ of (n×n) $\tilde{C}$PFSMs

Let $\tilde{\mathcal{C}}_{\mathcal{AM}}^{\mathcal{P}} = \frac{|\mathcal{T}_p(e_i) + \mathcal{I}_p(e_i) + \mathcal{F}_p(e_i)|_j}{3}$

GEOMETRIC MEAN FOR $\tilde{C}$PFSM

Geometric mean $(\mathcal{G}.\mathcal{M})$ of (n×n) $\tilde{C}$PFSMs

$\tilde{\mathcal{C}}_{\mathcal{GM}}^{\mathcal{P}} = \{\mathcal{T}_p(e_i).\mathcal{I}_p(e_i).\mathcal{F}_p(e_i)\}^{\frac{1}{3}}$

ALGORITHM

Step-1: Choose the set of parameters.

Step-2: Construct the $\tilde{C}$PFSMs.

Step-3: Compute $\tilde{\mathcal{T}}^{\mathcal{M}}$, $\tilde{\mathcal{T}}^{\mathcal{P}}$ and $\tilde{\mathcal{T}}^{\mathcal{B}}$.

Step-4: Evaluate the Arithmetic mean and Geometric mean of $\tilde{C}$PFSMs as$\tilde{\mathcal{C}}_{\mathcal{AM}}(\tilde{\mathcal{T}}^{\mathcal{M}})$, $\tilde{\mathcal{C}}_{\mathcal{AM}}(\tilde{\mathcal{T}}^{\mathcal{P}})$,$\tilde{\mathcal{C}}_{\mathcal{AM}}(\tilde{\mathcal{T}}^{\mathcal{B}})$ and $\tilde{\mathcal{C}}_{\mathcal{GM}}(\tilde{\mathcal{T}}^{\mathcal{M}})$, $\tilde{\mathcal{C}}_{\mathcal{GM}}(\tilde{\mathcal{T}}^{\mathcal{P}})$,$\tilde{\mathcal{C}}_{\mathcal{GM}}(\tilde{\mathcal{T}}^{\mathcal{B}})$ respectively.

Step-5: Find the highest membership value.

STATEMENT OF THE PROBLEM Suppose amissile production company produces four types of missiles m_1, m_2, m_3, m_4 such that $\mathcal{M} = \{m_1, m_2, m_3, m_4\}$ and $\mathcal{S} = \{s_1, s_2, s_3, s_4\}$ be the set of parameters. Here, we explained the four types of parameters as followed by,s_1= targeting, s_2 = guidance system , s_3 = flight system , s_4 = warhead.Now, the problem is to present the values in $\tilde{C}$PFSMsfor selection of the best missile.

(1) Form$\tilde{C}$PFSMs

$$\tilde{\mathcal{C}}^{\mathcal{P}} = \begin{bmatrix} <0.11,0.69,0.08> & <0.12,0.53,0.22> & <0.23,0.51,0.16> & <0.63,0.12,0.19> \\ <0.21,0.32,0.34> & <0.36,0.15,0.33> & <0.17,0.25,0.35> & <0.28,0.32,0.40> \\ <0.61,0.13,0.12> & <0.51,0.25,0.10> & <0.12,0.36,0.42> & <0.27,0.38,0.35> \\ <0.59,0.21,0.13> & <0.16,0.50,0.07> & <0.32,0.53,0.11> & <0.29,0.09,0.43> \end{bmatrix}$$

$$\tilde{\mathcal{C}}^{\mathcal{Q}} = \begin{bmatrix} <0.25,0.01,0.64> & <0.34,0.43,0.29> & <0.16,0.26,0.36> & <0.39,0.31,0.24> \\ <0.61,0.05,0.20> & <0.21,0.30,0.49> & <0.30,0.20,0.50> & <0.21,0.31,0.47> \\ <0.33,0.43,0.06> & <0.05,0.73,0.09> & <0.64,0.21,0.02> & <0.18,0.38,0.11> \\ <0.42,0.16,0.25> & <0.27,0.32,0.40> & <0.09,0.72,0.09> & <0.52,0.25,0.21> \end{bmatrix}$$

$$\tilde{\mathcal{C}}^{\mathcal{R}} = \begin{bmatrix} <0.51,0.08,0.34> & <0.11,0.22,0.33> & <0.36,0.61,0.01> & <0.02,0.01,0.91> \\ <0.66,0.22,0.10> & <0.23,0.56,0.17> & <0.13,0.23,0.33> & <0.79,0.01,0.09> \\ <0.21,0.42,0.03> & <0.37,0.46,0.13> & <0.25,0.06,0.68> & <0.22,0.33,0.40> \\ <0.42,0.34,0.24> & <0.70,0.09,0.01> & <0.37,0.12,0.13> & <0.14,0.08,0.61> \end{bmatrix}$$

$$\tilde{\mathcal{C}}^{\mathcal{S}} = \begin{bmatrix} <0.36,0.24,0.40> & <0.12,0.23,0.65> & <0.11,0.47,0.31> & <0.25,0.32,0.33> \\ <0.46,0.12,0.07> & <0.22,0.33,0.40> & <0.41,0.32,0.24> & <0.32,0.46,0.11> \\ <0.24,0.05,0.70> & <0.71,0.12,0.01> & <0.8,0.01,0.06> & <0.01,0.01,0.93> \\ <0.35,0.09,0.41> & <0.49,0.39,0.12> & <0.15,0.45,0.24> & <0.09,0.01,0.80> \end{bmatrix}$$

(2) The computation of $\tilde{\mathcal{T}}^{\mathcal{M}}$ is as below:

$$\tilde{\mathcal{T}}^{\mathcal{M}} = \begin{bmatrix} <0.11,0.01,0.08> & <0.11,0.22,0.22> & <0.11,0.26,0.01> & <0.02,0.01,0.19> \\ <021,0.05,0.07> & <0.21,0.15,0.17> & <0.17,0.20,0.24> & <0.21,0.01,0.09> \\ <0.21,0.05,0.03> & <0.05,0.12,0.01> & <0.12,0.01,0.02> & <0.01,0.01,0.11> \\ <0.35,0.09,0.13> & <0.16,0.09,0.01> & <0.09,0.12,0.09> & <0.09,0.01,0.21> \end{bmatrix}$$

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(3) The computation of $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{M}})$ is as below:

$$\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{M}}) = \begin{bmatrix} <0.06 & 0.18 & 0.12 & 0.07> \\ <0.11 & 0.17 & 0.20 & 0.10> \\ <0.09 & 0.06 & 0.05 & 0.04> \\ <0.19 & 0.08 & 0.10 & 0.10> \end{bmatrix}$$

(4) Add each entries and find the highest value for $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{M}})$

(5)

$$\Rightarrow \begin{bmatrix} 0.43 \\ \mathbf{0.58} \\ 0.24 \\ 0.47 \end{bmatrix}$$

(6) The computation of $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{M}})$ is as below:

$$\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{M}}) = \begin{bmatrix} <0.04 & 0.17 & 0.06 & 0.03> \\ <0.19 & 0.17 & 0.20 & 0.05> \\ <0.06 & 0.03 & 0.02 & 0.02> \\ <0.15 & 0.05 & 0.09 & 0.05> \end{bmatrix}$$

(7) Add each entries and find the highest value for $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{M}})$

$$\Rightarrow \begin{bmatrix} 0.30 \\ \mathbf{0.61} \\ 0.13 \\ 0.35 \end{bmatrix}$$

(8) The computation of $\tilde{\mathcal{T}}^{\mathcal{P}}$ is as below:

(9)

$$\tilde{\mathcal{T}}^{\mathcal{P}} = \begin{bmatrix} <0.0050,0.0001,0.0001> & <0.0005,0.0115,0.01360> \\ <0.0388,0.0004,0.0004> & <0.0038,0.0083,0.01090> \\ <0.0101,0.0011,0.0001> & <0.0060,0.0100,0.00001> \\ <0.0364,0.0010,0.0031> & <0.0148,0.0043,0.00003> \end{bmatrix}$$

$$\begin{bmatrix} <0.0014,0.0380,0.00010> & <0.0012,0.0001,0.0136> \\ <0.0027,0.0036,0.01380> & <0.0148,0.0004,0.0018> \\ <0.0153,0.00004,0.0003> & <0.0001,0.0004,0.0143> \\ <0.0015,0.0206,0.00030> & <0.0019,0.0001,0.0440> \end{bmatrix}$$

(8) The computation of $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{P}})$ is as below:

$$\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{P}}) = \begin{bmatrix} <0.0017 & 0.0085 & 0.0131 & 0.0049> \\ <0.0132 & 0.0076 & 0.0067 & 0.0170> \\ <0.0037 & 0.0053 & 0.0052 & 0.0049> \\ <0.0135 & 0.0063 & 0.0074 & 0.0153> \end{bmatrix}$$

(9) Add each entries and find the highest value for $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{P}})$

$$\Rightarrow \begin{bmatrix} 0.0282 \\ \mathbf{0.0445} \\ 0.0191 \\ 0.0425 \end{bmatrix}$$

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(10) The computation of $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{P}})$ is as below

$$\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{P}}) = \begin{bmatrix} < 0.00036 & 0.00430 & 0.00174 & 0.00117 > \\ < 0.00183 & 0.00730 & 0.00511 & 0.00224 > \\ < 0.00103 & 0.00084 & 0.00056 & 0.00090 > \\ < 0.00464 & 0.00124 & 0.00210 & 0.00134 > \end{bmatrix}$$

(11) Add each entries and find the highest value for $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{P}})$

$$\Rightarrow \begin{bmatrix} 0.0075 \\ \mathbf{0.0161} \\ 0.0033 \\ 0.0010 \end{bmatrix}$$

(11) The computation of $\tilde{\mathcal{T}}^{\mathcal{B}}$ is as below

$$\tilde{\mathcal{T}}^{\mathcal{B}} = \begin{bmatrix} < 0.26,0.25,0.27 > & < 0.22,0.27,0.27 > & < 0.24,0.29,0.23 > & < 0.26,0.23,0.28 > \\ < 0.29,0.23,0.23 > & < 0.25,0.26,0.27 > & < 0.25,0.25,0.27 > & < 0.28,0.25,0.25 > \\ < 0.27,0.25,0.24 > & < 0.28,0.27,0.18 > & < 0.28,0.22,0.26 > & < 0.22,0.25,0.28 > \\ < 0.28,0.23,0.25 > & < 0.28,0.26,0.22 > & < 0.24,0.29,0.21 > & < 0.25,0.20,0.29 > \end{bmatrix}$$

(13) The computation of $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{B}})$ is as below

$$\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{B}}) = \begin{bmatrix} < 0.26 & 0.25 & 0.25 & 0.26 > \\ < 0.25 & 0.26 & 0.26 & 0.26 > \\ < 0.25 & 0.24 & 0.25 & 0.25 > \\ < 0.25 & 0.25 & 0.24 & 0.24 > \end{bmatrix}$$

(14) Add each entries and find the highest value for $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{B}})$

$$\Rightarrow \begin{bmatrix} 1.02 \\ \mathbf{1.03} \\ 0.99 \\ 0.98 \end{bmatrix}$$

(15) The computation of $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{B}})$ is as below:

$$\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{B}}) = \begin{bmatrix} < 0.26 & 0.25 & 0.25 & 0.25 > \\ < 0.25 & 0.26 & 0.26 & 0.26 > \\ < 0.25 & 0.24 & 0.25 & 0.25 > \\ < 0.25 & 0.25 & 0.24 & 0.24 > \end{bmatrix}$$

(16) Add each entries and find the highest value for $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{B}})$

$$\Rightarrow \begin{bmatrix} 1.01 \\ \mathbf{1.03} \\ 0.99 \\ 0.98 \end{bmatrix}$$ From the above result shows that, $\boldsymbol{m_2}$ missile will be preferred by $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{M}})$, $\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{P}})$,

$\mathcal{AM}(\tilde{\mathcal{T}}^{\mathcal{B}})$ and $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{M}})$, $\mathcal{GM}(\tilde{\mathcal{T}}^{\mathcal{P}})$, $\mathcal{G}(\tilde{\mathcal{T}}^{\mathcal{B}})$ of $\tilde{C}$PFSMs.

CONCLUSION

In this document, we propose complex picture fuzzy soft matrix $\tilde{C}$PFSM with suitable examples. Further, we construct the $\tilde{C}$PFSMs in decision making based on different types of $\mathcal{T}$-norm operators for selecting the best missile.

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RESEARCH ARTICLE

Assessing the Effectiveness and Risk for Resistance with Antibiotic use during the Covid-19 Pandemic: A Cross-Sectional Study on South Indian Population

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ABSTRACT

Inappropriate use of antibiotics during the pandemic could be a global threat causing widespread antimicrobial resistance. The study aimed to assess the effectiveness of antibiotic and risk for resistance during the pandemic. A cross-sectional study among South Indian population was carried out. The predesigned questionnaires was designed using Google form and circulated through online platforms such as Email and WhatsApp. Two Google forms were circulated among the population. Data obtained were then analyzed using Statistical package for the social sciences (SPSS).A total of 501 participants from South India were included in the study. About 56.5% people had taken more than one antibiotics for the management of COVID-19. 55.4% COVID positive respondents reported that antibiotics were ineffective for COVID. For infections other than COVID-19, 42.2% people had taken more than one antibiotics within a month. About 78.4% of patients who took antibiotics for COVID-19 did not complete the course of treatment.

Keywords: COVID-19, antibiotic, effectiveness, resistance.

INTRODUCTION

The outbreak of highly contagious viral illness, COVID-19 has remarkably impacted the lives of millions of people. In twenty first century so far, the world has come across with three prominent deadly pandemics, which were associated with novel coronaviruses: Severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS) and COVID-19. All these were contagious in nature and act mainly by causing respiratory tract infections. Their emergences had caused high mortality rates all over the world. COVID-19, which was the most recent one, was a rapidly spreading viral infection caused by another zoonotic novel coronavirus named severe acute respiratory syndrome coronavirus (SARs-CoV-2)[1]. In order to control the spread of the disease, Indian government announced a nationwide lockdown on March 25, 2020. The disease has strained our medical and public health facilities. Major challenge during the outbreak was the treatment. Although hospitals have been taking care of COVID patients, there is no specific treatment discovered other than vaccines[2]. According to new findings, the number of COVID-19 patients diagnosed with bacterial co-infection during hospitalization is increased rapidly. Antibiotics have no effect on SARS-CoV-2. Viral respiratory infections frequently culminate in bacterial pneumonia. Hence for the prevention and treatment of bacterial co-infection, various types of antibiotics are used. Bacterial co-infections are thought to be the important risk factors for COVID-19 severity with lasting implications. It has particularly in high risk groups such as those with immunodeficiency or immunosuppression[3][4]. Nearly, 90% of the patients were given empirical antibiotics during the pandemic to prevent mortality due to secondary infections[5]. Due to the early indications of improved outcomes in patients treated with the AZM and the emergence of SARS CoV-2 has catapulted AZM into the spotlight[6]. Despite the paucity of high quality evidence, AZM has been quickly adopted as a repurposed medicine for the treatment of COVID 19 [7].

Although there is no direct evidence of AZM activity in COVID-19, some scientific authorities have suggested that the antibacterial properties of AZM remain beneficial for effective treatment. AZM is also known to have antiviral characteristics that could help antiviral medications to perform better together. This macrolide antibiotic has been shown in preclinical tests to have antiviral actions against the Zikavirus, Rhinovirus and Ebola virus. Antiviral effects in COVID-19 patients on the other hand, have yet to be established [8]. Overall, because of the increased usage of antibiotics, the pandemic may be hastening the threat of antimicrobial resistance (AMR). Antibiotic therapy or prophylaxis is not recommended for patients with the mild or moderate COVID-19 unless symptoms of bacterial infections are present, according to WHO guidelines. Antibiotics should not be used to prevent or treat COVID-19 and should only be used if there is a strong clinical suspicion of additional bacterial infections[9]. Due to the fear of getting infected or lack of knowledge about the antibiotic use, people were more prone to irrational use of antibiotic which may lead to high risk of resistance. Hence the emergence of antibiotic resistance becomes an additional burden in the current scenario. WHO, proposed guidelines in 2019, to halt the misuse and overuse of antibiotics for the treatment of COVID19. Several antibiotic stewardship programs were implemented to provide antibiotics awareness. Hence the study has evaluated the knowledge and attitude of antibiotic use among COVID and non-COVID population during the pandemic era. This observation study aimed to assess the effectiveness of antibiotics in curing the symptoms associated with the COVID-19. The risk for antibiotic resistance during the pandemic also assessed in our study. The outcomes of this study could aid the government in proposing new policies to control AMR and for assessing effectiveness of antibiotics in relieving the symptoms associated with the COVID-19.

MATERIALS AND METHODS

Study design: Prospective cross-sectional study.

Study population: South Indian population from Kerala, Tamil Nadu, Andhra Pradesh, Karnataka and Thelangana, during 2021-2022 who satisfied the inclusion and exclusion criteria were selected for the study.

Inclusion criteria

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People who have taken any antibiotic during the pandemic.
- General public willing to take part in the study.
- People residing in South India.
- English literate.

Exclusion criteria
- People who do not take antibiotics during pandemic.
- Pediatric population.

Sample size determination

Cochran's formula for calculating sample size when the population is infinite: $n0 = z^2pq/e^2$

Where,

n0 = Sample size

z = selected critical value of desired confidence level ()

p = estimated proportion of attribute that is present in the population (Assuming the maximum variability of 50% (p =0.5) q = 1 –p e = desired level of precision. Based on the above equation we calculated our sample size requirement taking 95% confidence level with ±5% precision, the calculation for required sample size will be as follows: p = 0.5 and hence q=1 - 0.5 = 0.5; e = 0.05; z = 1.96 N=$(1.96)^2$*(0.5)(0.5)/$(0.05)^2$= 384.16 = 385**.**Hence a total of >385 patients were finally considered for the study.

METHODOLOGY

This study was conducted on a population of about 501. Initially, the link was send to WhatsApp groups, Email and then each group was asked to send the form to other people irrespective of education, gender or occupation. Two Google forms were circulated to assess the effective use of antibiotic during the pandemic. First form consisted of three sections. First part of the section was the informed consent. The second section enquired about socio-demographics, including age, gender, state and profession. Then the third section consists of 18 items, which was subdivided into three parts. First part dealt with knowledge and attitude of patients before providing awareness, second part consisted of questions regarding antibiotic use among COVID-19 patients and third part involved questions about antibiotic use among non-COVID patients. Google form 2 were provided with an awareness video about rational use of antibiotics followed by questions related to it.

Statistical analysis

All the data received were entered into Statistical package for the social sciences (SPSS) and calculated using paired t-test. The obtained results were tabulated and presented graphically as charts. Maximum responses were received from Kerala (123) and least from Thelangana.

Paired t test
Hypothesis
H_0: There is no significance difference between knowledge and attitude of taking antibiotic by patients before and after awareness.
H_1: H_0 is false. We reject the null hypothesis if the p value is less than 0.05.

Here the p value for both knowledge and attitude is 0.0001<0.05, so we reject the null hypothesis. Therefore we can conclude that there is a significance difference between knowledge and attitude of patients before and after attending the awareness. The mean values of both knowledge and attitude are highly increased after the awareness. Response to question on whether antibiotics were effective in relieving the symptoms. About 55.4% of participants reported that their symptoms were not relieved after taking antibiotics. Response to question on whether the patient had a

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prescription from the doctor for all the antibiotics taken. Nearly 62.2% and 67.3% of COVID positive and COVID negative patients had taken antibiotics without prescription. Response to question on whether the patient have taken two or more antibiotics within a month without prescription. About 56.5% of COVID positive and 42.4% of COVID negative patients had taken two or antibiotics within a month. Response to question on if the patient get the same infection, they will take the same antibiotic without prescription. Response to question on whether the patient had completed the course of antibiotic prescribed to them. Nearly 78.4% and 81.3% of COVID positive and COVID negative patients do not complete the course of antibiotics.

DISCUSSION

This study aimed to assess the effectiveness and risk for resistance with antibiotic use during the COVID-19 pandemic. The study findings involved collection of data from 501 people living in the Southern states of India.

Knowledge of patients before providing awareness
Knowledge on antibiotic use was assessed based on four questions. As per question 1 (a-d) for knowledge, it was evident that there is a confusion among the people regarding the use of antibiotics. Among COVID positive population only 1.64% and in COVID negative population 3.06% of respondents reported that they can overcome common cold without taking antibiotics. It is related to the study conducted by Miao Yu et al in china[10]. In question 1(b), 1.53% and 1.31% of participants from COVID negative and positive stated that they can overcome cough without taking antibiotics. These results indicates that only 2% of the respondents had the knowledge that antibiotics were not effective against viral infections. This is in line with the previous study conducted by H.karuniawati *et al.* that indicates 73.1% of the respondents assume that antibiotics can be used to treat viral infections[11]. Similarly, minority of the population, i.e. 2% from COVID negative and 1.6 % from COVID positive reported that antibiotics were not needed in ringworm and nail fungal infection respectively. The results point out that, majority of the respondents were not aware that ringworm and nail fungal infections are not caused by bacteria. Thus the above findings stipulate that poor knowledge about antibiotic use were widely existing.

Attitude of patients before providing awareness
Knowledge alone cannot be considered as a factor for the appropriate antibiotic use. Attitude of the people also plays a major role. Attitude of the people was assessed based on question 1(e-h). As it is depicted in table (2) minority of the population i.e.,5.1% from COVID negative and 4.6% from COVID positive population agreed on the necessity of completing the antibiotic course. Since respondents stops using antibiotics once they feel better. Similar study conducted in Jordan by Dawood et al reported that 32% of the respondents did not complete the course of Antibiotics[12]. In question 1 (f), 5.1% from COVID negative and 6.9% from COVID positive showed appropriate attitude by disagreeing to share the antibiotics with others without prescription. Only 3.1% and 1.3% of participants from COVID negative and positive were showed proper attitude to take antibiotic without prescription. Similar study conducted in Saudi Arabia shows 70% of respondents were taking self-prescribed antibiotics[13]. The above findings suggest that, substantial respondents had poor attitude towards the use of Antibiotics.

Change in knowledge and attitude after providing awareness
To enlighten, the importance of appropriate antibiotic use, an awareness video on effective use of antibiotics was included in the second Google form and was circulated. After watching the video, same questions related to knowledge and attitude was asked and recorded. Awareness video had created a great impact on the knowledge and attitude of the participants. The difference between knowledge and attitude of patients taking antibiotics before and after awareness was tested using Paired t test. From table (5), the p value for both knowledge and attitude is <0.05 (t value is -46.91& -50.79). It was showed that the knowledge before awareness was 46.73% and is increased to 88.95% after awareness. Similarly, the attitude of the respondents raised to 94.19% after awareness which was only 52.70% before awareness. Thus the study findings shows a significance difference between the knowledge and attitude of patients taking antibiotics before and after awareness.

Effectiveness of antibiotic use in COVID population

Question no.4 enquired about whether the antibiotics were effective in relieving symptoms. Majority of participants (55.4%) reported that their symptoms were not relieved after taking antibiotics. About 44.5% (135) patients said that their symptoms were relieved. It indicates that antibiotics were ineffective for treating COVID-19 symptoms. Majority of the patients take AZM for their COVID-19 symptoms. Although there is no direct evidence of azithromycin's effectiveness in COVID-19 patients, certain scientific bodies have claimed that azithromycin's antibacterial capabilities are useful in the empirical treatment of community acquired pneumonia in COVID-19 patients[14]. As per WHO guidelines, antibiotics was prescribed only if the patient experiences a secondary bacterial infection.

Risk for resistance with antibiotic use

Question no.5: Had prescription for antibiotic. Self medication of antibiotics was found to be evident in both COVID and non-COVID respondents. In ' Increased antimicrobial use during COVID-19: The risk of advancing the threat of antimicrobial resistance by Mahesh Jampani et.al shows similar practice of taking antibiotics without prescription during pandemic[15]. Our study found a significant prevalence of self-medication of antibiotics which are not considered as the appropriate medications for prevention and management of COVID-19 as stated by current COVID-19 guidelines by WHO. Nearly 62.2 % of people had taken antibiotics without prescription. Since they have no prescription they must have taken the antibiotics either by over the counter or from their relatives or friends in the false belief that COVID-19 can be completely cured by antibiotics. Anita Kotwaniet.al in his study ' Over the counter sale of antibiotics in India: A qualitative study of providers perspective across two states, points out the increase in over the counter are of antibiotics considered as one of the helping hand in the emergence of AMR[16]. Self-medication was also evident in case of COVID negative respondents as 67.3% of people had taken different antibiotics without prescription for various infections. These findings indicate the increasing practice of taking antibiotics when they are not needed or without proper consultation of physician during the pandemic which can be a stepping stone towards antibiotic resistance.

Question 6: Taken two or more antibiotics within a month without prescription. It is clear that 56.5% people had taken more than one antibiotics for the management of COVID-19. These findings revealed that people are irrationaly using antibiotics as they might feel an urge to take more antibiotics to get better fastly, while in reality COVID is not a bacteria, it's a virus [17]. For other infections 42.2% people had taken more than one antibiotic within a month and it indicate the danger of overuse. This practice may be either due to not getting good result from the previous one or to when others recommend a better antibiotic.

Question 7: If I get the same infection, I will take the same antibiotic without prescription.73.8% people confirmed that they will take the same antibiotic without prescription if they get the same infection. This finding clearly arises concern about risk for antibiotic resistance.

Question 8: Course of antibiotics completed. On asking question involving the complete usage of antibiotics, it could be noted that 21.5% completely uses the antibiotic while 78.4% stated that they do not complete the course of antibiotics. This represents their inadequate knowledge on appropriate use of antibiotics and also the findings suggest that the left over antibiotics may be given to relatives or friends when they have similar symptoms without proper evidence. It can lead to serious consequences later.18.6% complete the course of antibiotics and 81.3% stops the antibiotics before completing its proper course in case of COVID negative respondents. This irrational use of antibiotics reduces its effectiveness in completely curing the specific infection and can put the patient at increased risk of drug resistant infections. It's tempting to stop the antibiotics as soon as everyone feel better. If we don't take an antibiotic as prescribed, we need to start treatment again later. If we stop taking it, it can also promote the spread of antibiotic resistant properties among harmful bacteria. According to research led by Washington University School of medicine in St.Louis, there had been tremendous use of antibiotics during the pandemic.

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ANNEXURE
ASSESSING THE EFFECTIVENESS AND RISK FOR
RESISTANCE WITH ANTIBIOTIC USE DURING THE PANDEMIC: A CROSS-SECTIONAL
STUDY ON SOUTH INDIAN POPULATION

1. If you choose to participate, please click on the " I consent " button below

    ⬭ I consent

    ⬭ I choose not to participate

2. Email:

3. Age:

4. Gender

    ⬭ Male

    ⬭ Female

    ⬭ Prefer not to say

    ⬭ Other

5. State

    ⬭ Kerala

    ⬭ Tamil Nadu

    ⬭ Karnataka

    ⬭ Andhra Pradesh

    ⬭ Telangana

6. Profession

    ⬭ Student

    ⬭ Health care

    ⬭ Technical

    ⬭ Agriculture

    ⬭ Other:

Effective use of antibiotics

1. I am certain that I can :-

	20%	40%	60%	80%	100%
a. Overcome common cold without taking antibiotic	○	○	○	○	○
b. Overcome cough without taking an antibiotic	○	○	○	○	○
c. Overcome ringworm infection without taking an antibiotic	○	○	○	○	○
d. Overcome nail fungal infection without taking an antibiotic	○	○	○	○	○
e. Could complete the course of antibiotic prescribed	○	○	○	○	○
f. Avoid taking antibiotics prescribed to another person	○	○	○	○	○
g. Take antibiotics without prescription	○	○	○	○	○
h. Will not recommend antibiotics to my relatives without prescription	○	○	○	○	○

Pandemic Effect on Antibiotic Use

If you have ever tested Covid positive within the past two years, kindly fill the "Covid related questions ". If no , kindly fill the "non Covid related questions".

COVID Related Questions

2.The antibiotics taken by me for my COVID positive case were

- ○ Azithromycin
- ○ Amoxicillin
- ○ Doxycycline
- ○ Amoxicillin clavulanic acid
- ○ Other:

3.COVID related symptoms experienced by me

- ☐ Fever
- ☐ Loss of taste or smell
- ☐ Cough
- ☐ Body pain
- ☐ Other:

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4. Antibiotics were effective in relieving my symptoms

◯ Yes

◯ NO

5. I had a prescription from the doctor for all the antibiotics taken by me

◯ Yes

◯ NO

6. I have taken two or more antibiotics within a month

◯ Yes

◯ No

◯ Maybe

7. If yes, Name the antibiotics

8. If I get the same infection, I will take the same antibiotic without prescription

◯ Yes

◯ NO

9.I have completed the course of antibiotic prescribed to me.

◯ Yes

◯ NO

Non COVID Related Questions
1.   Name the illness for which the antibiotic was used:
2.   Antibiotic taken by me for the above illness:
3.   Symptoms of the above illness:
4.   Antibiotics were effective in relieving the symptoms

◯ Yes

◯ NO

5. Antibiotics were prescribed to me by a doctor.

◯ YES
◯ NO

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6. I have taken two or more antibiotics within a month

( ) Yes

( ) No

( ) Maybe

7. If yes, Name the antibiotics:

8. If I get the same infection, I will take the same antibiotic without prescription

( ) Yes

( ) NO

9. I have completed the course of antibiotics

( ) Yes

( ) NO

Effective Use Of Antibiotics

After awareness

1. Email:
kindly watch the video and answer the following questions. http://youtube.com/watch?v=pxnXzRmevAM

2. The video helped me to understand the importance of proper use of antibiotics

	1	2	3	4	5	
Not helpful	( )	( )	( )	( )	( )	Very helpful

3. I will not :

	20%	40%	60%	80%	100%
Take antibiotics for common cold	( )	( )	( )	( )	( )
Take antibiotics for cough	( )	( )	( )	( )	( )
Take antibiotics for ringworm infection	( )	( )	( )	( )	( )
Take antibiotics for nail fungal infection	( )	( )	( )	( )	( )
Take antibiotics without prescription	( )	( )	( )	( )	( )
Share my antiobiotics with others without prescription	( )	( )	( )	( )	( )

4. I will complete the course of antibiotics

- ⬭ 20%
- ⬭ 40%
- ⬭ 60%
- ⬭ 80%
- ⬭ 100%

5. I am certain that improper use of antibiotics can result in antibiotic resistance

- ⬭ 20%
- ⬭ 40%
- ⬭ 60%
- ⬭ 80%
- ⬭ 100%

RESEARCH ARTICLE

Gut Dysbiosis and Cognitive Impairment in Depression and its Management

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ABSTRACT

Depression is a psychiatric disease that is chronic and recurrent and is characterized by a wide range of symptoms that vary from patient to patient is currently regarded as the world's second largest cause of disability. Depression is the most common mental disorder, according to epidemiological studies, and depressive symptoms are significantly more common in other diseases as well. Patients' quality of life and recovery are severely harmed by cognitive deficits found across psychiatric illnesses like depressive disorder. As a result, there is an essential need to consider cognitive impairment in the treatment of depression. The commonality of cognitive deficits across depression like disorders suggests that common mechanisms may be involved in their development. This review explains in detail the interlink between cognition and dysbiosis in depression through inflammation, while highlighting the effect of gut modulatory formulations on cognitive impairment management.

Keywords: Bidirectional, Depression, Gut Microbiota, Cognition, Inflammation, Gut Dysbiosis.

INTRODUCTION

Depression is a psychiatric disease that is chronic and recurrent and is characterized by a wide range of symptoms that vary from patient to patient is currently regarded as the world's second largest cause of disability [1]. Depression is the most common mental disorder, according to epidemiological studies, and depressive symptoms are significantly more common in other diseases as well [2]. Patients' quality of life and recovery are severely harmed by cognitive deficits found across psychiatric illnesses like depressive disorder [3]. As a result, there is an essential need to consider cognitive impairment in the treatment of depression. The commonality of cognitive deficits across depression like disorders suggests that common mechanisms may be involved in their development. This review explains in detail the interlink between cognition and dysbiosis in depression through inflammation, while highlighting the effect of gut modulatory formulations on cognitive impairment management. The role of gut microbiota in neurological diseases [4]. has been one of the prominent topics of research in recent times. Scientists have proven that there exists a strong interdependent relationship between the gut and the CNS [5]. Further, the specific contributions of the dysbiotic gut in the pathogenesis of depression and depression-like disorders along with depression induced dysbiosis are being understood in detail. As of now, we know that the dysbiotic gut releases metabolites from the bacteria that cause acute and chronic inflammation in systemic circulation and CNS [6]. As the relationship of the gut-brain axis is bidirectional it can be described as inflammation is a contributor to depression, due to increased levels of inflammatory biomarkers/ cytokines like TNFα, interleukins, IFN and chemokines [7]. The inflammation passes from the systemic circulation to CNS through circulating astrocytes and dendritic cells [8]. Through hyper activation of HPA and increased levels of ACTH the systemic inflammation mediated the central depletion of NE and serotonin which are hall marks of depression [9]. The activation of microglia (M1 and M2 phenotype) and macrophages in CNS continue to prolong inflammation-induced depression through NOD-like receptors, CD14, CD11b, toll-like receptors and free radicle stress which is supported in both human and animal data [10]. As a result of these events, the permeability of the BBB increases and the integrity is lost, therefore causing easier progression inflammation. The connection of inflammasomes in depression is through cognition in normal physiological conditions NLRP3 inflammasome promotes memory formation and long-term potentiation while in pathological conditions due to over expression it causes loss of synaptic plasticity and decreased cognition [11]. The cholinergic, serotonergic and GABAergic level decline affects the memory and cognition in depressive patients. The loss of neurogenesis, decreased in hebbian plasticity, hippocampal volume and grey matter contributes to evident loss of cognition in depression [12]. The gut-microbiota-hippocampal inflammation-behavior nexus was elucidated through PPARGC1A, PLA24GA, PTGES2, and gut microbiota PC2 or PC3 in depression [13]. This evident interlink between gut microbiota mediated inflammation and alterations in cognition among depressive disorders suggests a hypothesis of cross-disorder approach through pharmacological strategies like antidepressants, probiotics and prebiotics [14].

Gut dysbiosis , inflammation and cognition in depression
As understood the gut and brain axis can contribute to the pathogenesis of each other but proving the role of gut dysbiosis in multiple types of depression has been the recent aim of the scientific community. linking depression and gut activity Metagenomic sequencing in a trial demonstrated that patients with bipolar depression had alterations in the gut microbial constitution which correlated to the brain function causing the aggravation and precipitation of this condition, while the control patients had no such alterations [15]. As the gut is a hub of microbial flora dysbiosis refers to the entry of microbes and microbial metabolites like lipopolysaccharides into the systemic circulation, eliciting an inflammatory response as a result causing acute systemic inflammation and chronic neuroinflammation [16]. The inflammation by pro-inflammatory marker induced microglial activation causes neuroinflammation which further is known to manifest in depression and anxiety-like behavior by modifications in the neuronal plasticity in the basolateral region of the amygdala, hence the inflammatory cascade which started in the systemic circulation by dysbiotic gut caused depression and anxiety-like behavior in mice [17].

To understand clearly the role of inflammation induced by gut microbial metabolites a study was conducted that injected lipopolysaccharide and related in depressive behavior in mice, the levels of NF kappa B, SOD2, and cytokine were found to be increased which proved that the inflammatory pathway was the cause of depression, further to reverse this an anti-depressive drug was administered which relieved the depressive behavior and thereby inflammatory markers were decreased [18]. Alterations in neurochemicals as a result of the hippocampus's structure and function plasticity. The concentrations of 38 metabolites differed significantly when compared between germ-free (GF) and wild-type (WT) mice in a study of the cerebral metabolome, signifying that the intestinal microbiome plays a significant part in brain health and major functions like growth, learning, memory, and behavior patterns [19]. A study of hippocampus micro RNA expression in GF conventional and GF colonized mice revealed a rise in miR-294-5p expression in GF animals following colonization, suggesting that the gut microbiota plays a critical role in modulating small RNAs that regulate hippocampal gene expression[19]. The activity-dependent synaptic plasticity along with mental disorders are modulated by brain-derived neurotrophic factor (BDNF), whereas CREB controls genes relevant to neuronal differentiation, synaptic plasticity, and memory [20].

Absence of the gut microbiome from birth was linked to lower hippocampus CREB levels, but with increased phosphorylated CREB (pCREB), According to a microarray investigation [21]. which can be recovered by colonisation with microbiota; hippocampus pCREB expression can be condensed by antibiotic-induced isolation of the gut microbiota in SPF mice [22]. The current findings implies that the gut microbiota may influence hippocampus-dependent behaviours via neurochemicals, neurotrophic factors, transcriptional factors, neurogenesis, and the plasticity of pyramidal and granular cells [23] The cornerstone to susceptibility and recovery from psychiatric diseases like depression might be inflammation in the hippocampus area. The gut microbiota has been linked to alterations in the hippocampus inflammatory response and associated behaviors in a number of studies. [24]. A study found that eating a low-magnesium diet modified the gut microbiota's composition, which was correlated to hippocampus interleukin-6 (IL-6) levels [25]. Another study found that a meal high in sugar and saturated fatty acids but low in polyunsaturated fatty acids reduced hippocampal-dependent location recognition memory and changed gut bacteria composition. Further investigation revealed a strong link between hippocampus IL-1b, TLR4, PPARGC1A, PLA24GA, PTGES2, and gut microbiota PC2 or PC3 [26] representing that gut-microbiota-hippocampal inflammation-behavior nexus exists. Tea saponin, one of the most active components in tea, which proven to reduce gut microbial changes produced by high-fat diet and improve recognition memory, and reduce neuroinflammation impairments. It was specified by levels of TLR4, MyD88, p-JNK, NF-κB, IL-1β, IL-6, and TNF-α in hippocampal area [27]. Evidence suggests that in long-term depression down-regulation of NMDA receptor is observed which is associated with spatial memory and cognition, and depicts that in depression and depression-like behavior impairment of cognitive ability is observed, due to loss of Hebbian plasticity [28].

AMPA receptors are homeostatic receptors that compensate for the postsynaptic activity loss by bringing it into the normal range [29] which is also found to be down regulated in depressive mice. In a depressive situation when there is down regulation of AMPA receptors and loss of Hebbian plasticity and it is reported that neurogenesis is impaired which is yet another explanation for the impairment of cognitive function and there of memory [30], these events are an indication of impairment in brain function due to inflammatory cascade in the systemic and neuronal level caused by the gut-derived microbial metabolites in depressive patients [31]. Due to loss in neurogenesis, there is a reduction in synthesis of brain-derived neurotrophic factors, kynurenine pathway and Dysregulation of HPA axis culminating in modulation and impairment of learning and memory [32], the loss of the kynurenine pathway is due to proinflammatory markers which are generated by active microglia and astrocytes. Apart from being the immune cells of the brain the microglial cells are also involved in memory function when depleted or activated they negatively affect memory and cause inflammation-induced neuronal dysfunction [32]. TNF-derived from glia strongly influences neuronal homeostatic plasticity by inducing AMPA receptor exocytosis and blocking astrocyte glutamatergic transporters at the synapse. The physiological control of memory processes requires pro inflammatory cytokines IL-1, IL-6, and tumour necrosis factor-α and interrupting their signalling route impacts neuronal plasticity, resulting in impaired learning and memory [33]. and over expression on TNF-α and IL-1β is known to disrupt

memory and learning in normal physiological conditions [34] and it's naturally increased in inflammation in major depressive disorders it further causes memory and cognitive impairments. TNF- is known to play a dual function in adult neurogenesis, owing to the distinct effects of its receptors TNF-R1 and TNF-R2, while over expression is linked to progressive learning and memory loss [35]. Microglial activation and inflammatory mediators modulate the amounts of neurotrophic factors in MDD patients, that has an indirect effect on biological systems associated to cognition [36]. The proof that cytokines affects BDNF levels and activity, which is found to be higher in both depressed mice and people, shows a relationship between inflammation, cognition, and neurotrophic factors [37]. Tryptophan an amino acid that supports with energy metabolism, inflammation, as well as plays a role in depressive illnesses. The enzymes indoleamine 2,3-dioxygenase 1 (IDO1), IDO2, and tryptophan 2,3-dioxygenase were discovered to regulate tryptophan concentrations in tissues.

Serotonergic neurotransmission, which is known to underpin certain psychopathologies, has recently been related to changes in IDO1 and TDO activity [38] by modulating the HPA axis as it is involved in memory and learning via the serotonergic pathway, as depressive patients [39] have decreased levels of serotonin it is associated with memory impairment. Now as there is enough proof to support the hypothesis cognitive and memory impairment linked to inflammation, which disrupts the gut brain axis, the following summarises the possible mechanism. The gut-derived microbial metabolites that are released in gut dysbiosis are responsible to elicit inflammatory cascade in both CNS and systemic circulation, this inflammation through various interleukins, TNF alpha, microglial, and astrocyte activation causes neuroinflammation and neurodegeneration, further in as there is impairment in the kynurenine pathway, serotonergic levels, down regulated brain derived neurotropic factors, Dysregulation HPA axis and neurogenesis, it finally precipitates depression or aggravates the pathogenesis in depressed patients causing MDD.

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Table 1: Correlation of Gut Modulation and Cognitive Impairment in Depression.

Sl. No	STUDY	TREATMENT	INFERENCE
1	A randomized, double-blind, and placebo-controlled multicentre trial was conducted to determine the effects of probiotics on cognition and mood in community-dwelling older adults.	Probiotics containing Bifidobacterium bifidum BGN4 and Bifidobacterium longum BORI was administered for 12 weeks	Probiotics promote mental flexibility and alleviate stress in healthy older adults, along with causing changes in gut microbiota.(1)
2	Investigate the Beneficial effects of probiotics on psychological well-being, as measured by changes in mood like cognitive reactivity to sad mood, depression, and anxiety.	The probiotic mixture containing *Lactobacillus fermentum* LF16, *L. rhamnosus* LR06, *L. plantarum* LP01, and *Bifidobacterium longum* BL04	The consumption of probiotics was noted to exert a positive effect on depressive mood state and cognition. This effect was specific for the experimental group, thus ruling out confounding factors like learning, expectations or maturation. It was suggested, with caution, that these findings provide new support to the notion that probiotics may exert a beneficial psychological influence.(2)
3	Probiotic gut effect prevents the chronic psychological stress-induced brain activity abnormality in mice	The probiotic formulationof (Lactobacillus helveticus R0052 and Bifidobacterium longum R0175 combination	These data suggest that chronic stress-induced abnormal brain plasticity and reduction in neurogenesis can be prevented by a pre-treatment with the Probiotic formulation(3)
4	Role of probiotic *Lactobacillus Plantarum 299v* on cognitive functions in patients with major depression	The probiotic bacteria *Lactobacillus Plantarum 299v (LP299v)*	Augmentation of SSRI treatment with probiotic bacteria *Lactobacillus Plantarum 299v* improved cognitive performance and decreased KYN concentration in MDD patients(4)
5	A randomised, triple-blind, placebo-controlled trial of probiotics for depressive symptoms	The probiotic powder mixture(Bifidobacterium bifidum W23, Bifido-bacterium lactis W51, Bifidobacterium lactis W52, L. acidophilus W37, Lactobacillus brevis W63, Lactobacillus casei W56,	Patients in probiotic group showed improvement in cognitive function compared to placebo and control group (5)

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		Lactobacillus salivarius W24, Lactococcus lactis W19 and Lactococcus lactis W58)	
6	A Pilot Randomized Controlled Trial to Explore Cognitive and Emotional Effects of Probiotics.	Probiotic pills containing (*Lactobacillus Rhamnosus GG®, Casei, Acidophilus,* and *Bifidobacterium Bifidus*was administered to subjects.	results indicated that probiotics improved impulsivity and decision-making in the subjects.(6)
7	Probiotic supplement attenuates chemotherapy-related cognitive impairment in patients with breast cancer	Probiotic pills	Probiotics supplement significantly decreased the incidence of CRCI, improved the allover cognitive functions, changed the gut microbial composition and modulated nine plasma metabolite changes(7).
8	To study impact of consuming a milk drink containing a probiotic on mood and cognition.	probiotic containing milk drink	The consumption of a probiotic-containing yoghurt improved the mood and cognition of those whose mood was initially poor(8).
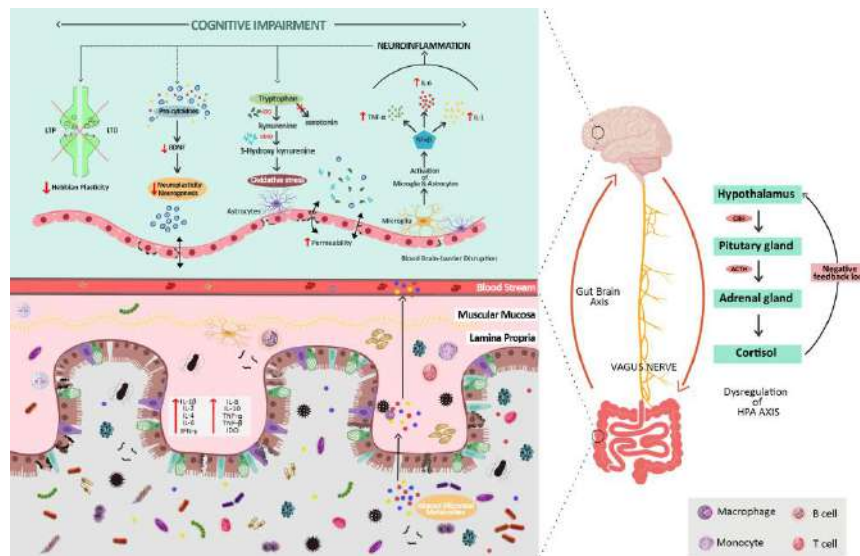
Fig.1.Cognitive Impairment

RESEARCH ARTICLE

Screening of Hundred Rice (*Oryza sativa* L.) Genotypes for Reproductive Stage Drought Tolerance

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ABSTRACT

Present experiment was to evaluate 100 rice genotypes for various physio morphological characters towards reproductive stage drought tolerance. Field level screening for drought stress was carried at Randomized Block Design with three replications were subjected to D^2Mahalanobis analysis of genetic divergence. Under the readings of eight characters in drought, analysis of variance was significant to all the traits. Using D^2 analysis, the 100 rice genotypes were grouped into 25 clusters. The traits like plant height, number of tillers per plant, number of productive tillers per plant, number of grains per panicle, thousand seed weight and grain yield denoted higher gcv, pcv, heritability and genetic advance signaling that selection could be effective for desired genetic improvement for these traits. From the results obtained from D^2 analysis and principle component analysis, the genotypes Pisini, Sneha, Virendra, KarunakKuruvai, Ratna, KulieVedichan, CR Dhan 201 can be presumed to be on par with the performance of drought tolerant genotypes while the genotypes like ADT-43 and ADT-45 appeared to be comparable with the performance of drought susceptible check genotype. Hence these genotypes with contrasting characteristics for drought stress could be recommended as parents in crossing program.

Keywords: Principal component analysis, cluster, quantitative factors, indigenous varieties, biplot.

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INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food grain for more than 70% of our country's population, as well as an income stream for 120-150 million rural households and the cornerstone of Indian agriculture. India stands first in cultivable rice acreage and second in production, with 117.94 million metric tonnes produced, representing for 20% of total world rice production globally [1]. Advanced strategies are vital to advocate breeding programs to complement crop productivity, principally for adverse effects of climate change on food security and on the environmental sustainability of cropping systems in order to satisfy the demands of the expanding population [2-3] proposed that genetic worthiness could not be ascertained just by a single trait, but rather by a linear function of measurable phenotypic values. As a consequence, using a selection index would enhance genetic gain for complex traits like drought tolerance [4].Drought tolerance is a complex trait that is governed by a multitude of morpho-physiological attributes controlled individually by more than two genes [5]. Rice varieties with improved drought stress adaptability are significant for minimizing yield losses in water-stressed areas and generating greater rice production [6]. The D2 statistics of Mahalanobis is a valuable tool for investigating clustering patterns, focusing on the relationship between genetic and geographical divergence, and examining the roles of various quantitative factors in determining maximum divergence [7]. PCA is a multivariate approach for analysing a data in which observations are represented by multiple inter-correlated quantitative dependent variables [8]. Its objective is to capture the essential information from the table, interpret it as a series of new orthogonal components called principal components, and map the structure of resemblance of the observations and variables. With this context, the proposed experiment was intended to screen 100 rice genotypes for drought tolerance and assess several physio-morphological traits associated to drought tolerance in the selected genotypes using cluster analysis and principle component analysis.

MATERIALS AND METHODS

To investigate the impact of drought stress on Traditional rice, Cuttack rice and Tamil Nadu ruling rice varieties of 100 rice genotypes were obtained from diverse Tamil Nadu Agro-climate Zones. Drought tolerant types like APO and Anna-(R)-4 were deployed as drought tolerant check, while IR 20 was used as a susceptible check. The rice samples were collected from various research institutes and villages (Table 1) shows a list of 100 rice genotypes. A separate field of the Plant Breeding Farm was used to screen chosen rice genotypes for drought tolerance, with appropriate check cultivars as controls. Under drought conditions, field experiments were carried up to the reproductive stage. Three replications of randomized block arrangement were used in the experiment. Before transplanting, the field was completely prepared and leveled so that water would not become stagnant following rains in a drought-stressed farm. Following 25 days, one seedling per hill was transplanted in each genotype in a four-row plot with a spacing of 20 cm between rows and 15 cm between plants. Appropriate agronomic procedures and measures were followed. All vegetative drought stress experiments were conducted in higher fields without standing water. Irrigation was first given at 3-4-day intervals, and the soil was kept saturated in pressure areas for up to 25 days after seeding. The stress treatment was then commenced by withholding irrigation. The amount of gravimetric soil water was determined by soil sample at a depth of 15-30 cm at three different locations in each replication as the soil dried up. Fresh ground sample was weighed and oven-dried to evaluate moisture 2-3 days after sampling [(fresh sample wt. - dry sample wt.) / (dry sample wt.) x 100].The drought stress treatment was prolonged every season until stress indicators such as excessive leaf rolling and tip drying manifested in the plants. The stress treatments were re-watered by flooding the field with water at a depth of 30 cm when the gravimetric soil moisture was around 12 percent and the soil water potential was around -15 kpa. Analysis of variation (ANOVA) was calculated to determine the significant variance among the genotypes.

Genetic variability measures such as phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were computed[9].Heritability was obtained using the genotypic variance ratio and presented as a percentage [10].Genetic Advance was obtained using the method provided by [11]. The genetic divergence and clustering

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pattern were analyzed after the correlated variables were turned into uncorrelated variables using the principal component analysis and the genotypes were segregated into defined clusters[12]

RESULTS AND DISCUSSION

On the phenotypic data of 100 genotypes, the Mahalanobis D^2 analysis was applied. The dispersion analysis of variance was significant for all of the traits that satisfied the diversity requirements of the study (Table 2). The 100 genotypes were sorted into 25 groups. Clusters IX and XIV housed the most genotypes, with a total of nine. Cluster XI had eight genotypes, followed by Cluster XIII, which featured seven genotypes. Clusters II, XIX, and XXIV, on the other hand, had the fewest genotypes, with only one (Fig.1). The cluster four marked the drought tolerant check genotypes while the cluster XVI included the drought susceptible check genotype [13]. Established three clusters and out groups while studying 22 genotypes of upland rice. The genotypic coefficient of variation and phenotypic coefficient of variation were furnished in (Table 3) and heritability and genetic advance in percent were tabulated (Table 4).   Days to 50 percent flowering recorded a general mean value of 90.45 days ranging from 61.66 (CR Dhan 306) to 131.89 (Chandrama). The genotypic and phenotypic coefficients of variation estimates observed for days to 50% flowering were moderate *i.e.*, 20.40% and 20.56%, respectively suggesting a moderate range of genetic variability. The observed heritability estimate for this character was high (98.51%) with a high genetic advance (41.7242) indicating the preponderance of high additive variance. As a result, this attribute may be enhanced further by easy selection. The plant height exhibited a range from 64.823 cm (APO) to 149.3 cm (Neelan Samba) with an average of 109.615cm. The GCV and PCV estimates observed for this trait were moderate *i.e.*, 17.71% and 17.92%, respectively indicating the existence of moderate range of genetic variability. Heritability estimate for this character was also high (97.68%) with high genetic advance (36.06%), signaling an excellent opportunity for selection of plants with desirable height. The average panicle length was 20.778 cm, extending from 12.717 cm (ADT-43) to 27.303 cm (Pal Kudaivazhai).

This attribute's GCV and PCV were both low, at 6.35 percent and 9.33 percent, demonstrating a narrow range of genetic variability. The heritability (40.84 percent) was moderate, but the genetic advance (2.08) was low, revealing that selection for improvement may be unsuccessful. The number of tillers per plant ranged from 6.85 (Kandasali) to 23.617(APO) with a general mean value of 14.3. High GCV and PCV were observed for this trait (20.11 and 21.08) indicating the existence of wider genetic variability. The heritability estimates for this trait were high (91%) coupled with high genetic advance (39.53). Hence, selection could be effective for desired genetic improvement for this trait. The number of productive tillers per plant ranged from 6.070 (SivappuKavuni) to 19.587(kottara samba) with a general mean value of 14.3. High GCV and PCV were observed for this trait (21.89 and 22.89) indicating the existence of wider genetic variability. The heritability estimates for this trait were high (92.23%) coupled with high genetic advance (43.3231%). Hence, selection could be effective for desired genetic improvement for this trait. The average number of grains per panicle spanned from 74.343 (CR Sugandh Dhan-910) to 195.420 (Milaga Samba), with a mean of 14.3. This characteristic has moderate GCV and PCV (18.66 and 18.95, respectively), suggesting the presence of wider genetic variability. This trait's heritability estimations were high (96.92 percent), indicating a substantial genetic advance (37.8439). As a result, selection may be effective in achieving the required genetic improvement for this characteristic. The thousand seed weight ranged from 11.257 (Kandasali) to 27.913 (Mappillai Samba) with a general mean value of 14.3. Moderate GCV and PCV were observed for this trait (17.99 and 18.49) indicating the existence of wider genetic variability. The heritability estimates for this trait were high (94.63%) coupled with high genetic advance (36.0516). Hence, selection could be effective for desired genetic improvement for this trait. The grain yield varied from 7.453 (Tulasi Vasanai Seraga Samba) to 46.320 (Kalurundai), with a mean of 14.3. This trait had high GCV and PCV (27.95 and 28.82, respectively), showing the presence of wider genetic variability.

This trait has a high heritability value (94.04 percent) and a high genetic advance (55.8419). As an outcome, selection may be vital in achieving the desirable genetic improvement for this trait. Principal components analysis was performed using yield components on rice germplasm (Table 5). Out of eight, only five principal components (PCs)

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exhibited more than 0.5 eigen values and showed about 92.47% total variability among the characters were studied. The PC1 showed 45.02% while, PC2, PC3, PC4, and PC5 exhibited 20.41%, 10.38%, 9.26%, 7.41%, and 3.54% variability, respectively among the germplasm for the traits. So, these five PCs were given due to importance for further explanation [14]. Found 4 PCs more than 1 eigen values and PC1, PC2, PC3 and PC 4 with 27.73%, 19.12%, 15.27% and 10.12% variability respectively accounting for 72.24% of variability which was far different.

Scree plots represented the fraction of variation associated with each principal component acquired by graphing eigenvalues and principal component numbers (Fig. 2). PC1 revealed 45.02 percent variability with an eigenvalue of 3.6014, which thereafter subsequently declined. Likewise, [15] found the greatest variability in PC1 with eigenvalues greater than 1.0. After five PCs, the semi-curve line inclined to become straight, with minimal variance recorded in each PC. The graph demonstrated that PC1 had the most variation in contrast to the other PCs. As a direct consequence, choosing lines from this PC 1 would be effective in future breeding program for the improvement of the traits contributing maximum variability. The rice germplasm used in this study for PCA analysis on the eight yield and quality parameters, all of which were evaluated using principal component scores (PC scores) and are shown in (Table 5). All the eight traits showed positive loading in PC1 while the traits like days to fifty per cent flowering (-0.5067), plant height (-0.6352), panicle length (-0.4667) and thousand seed weight (-0.1103) showed negative loadings in PC2. PC3 signified positive loading for traits except days to fifty per cent flowering (-0.6703), number of productive tillers per panicle (-0.0848), number of grains per panicle (-0.4388) and grain yield (-0.0543). PC4 addressed positive loading for panicle length (0.6267) and number of grains per panicle (0.5326) and negative loading for other traits. PC5 was able to account positive loading for days to fifty percent flowering (0.2827), panicle length (0.5014), number of tillers per panicle (0.3184) and number of productive tillers per panicle (0.1925) against the negative loading for other traits. PC 6 unveiled negative loading for traits like plant height (-0.5025), number of tillers per panicle (-0.3853) and number of productive tillers per panicles (-0.4357) while positive loadings were obtained for the other traits.

The traits like plant height (0.0625), panicle length (0.1542), number of productive tillers per panicle (0.2528) and grain yield (0.6658) were reported with positive loadings and the others traits were given negative loadings in PC 7. In PC 8 traits like plant height (0.0880), number of tillers per panicle (0.6277) and grain yield (0.3147) were established with positive loading and the others were given negative loadings [16] based on their study in 49 rice landraces reported positive loading for traits like number of productive tillers and flag length with other traits exhibiting negative loading in PC1.Hence, the selection of traits with higher variability will be rewarding for future breeding programme. In this study, the distribution and nature of diversity for genotypes and quantitative traits are described in the biplot diagram (Fig.3). Between PC1 and PC2. The trait days to fifty per cent flowering showed maximum vector length indicating its contribution to the total divergence followed by plant height and panicle length [17]identified flag leaf area, plant height, panicle length, flag leaf length, flag leaf breadth and panicle breadth as vital traits contributing to variability in wild rice MAGIC population under sodic soil condition. The angle between the trait vectors indicated the direction of association between the traits. Out of the eight traits studied, the traits *viz.*, thousand seed weight, number of grains per panicle, panicle length, number of tillers per plant, number of productive tillers per plant and plant height showed a positive correlation with grain yield. All the genotypes were widely scattered across different quarters.

The genotypes that lie alongside the drought tolerant genotypes like Anna-(R)-4 and APO (Drought tolerant check) were Pisini, Sneha, Virendra, Karunak Kuruvai, Ratna, Kulie Vedichan, CR Dhan 201 and Kalurandai while the genotypes like ADT-43 and ADT-45 were scattered close to IR 20 (drought susceptible check). The traits like plant height, number of tillers per plant, number of productive tillers per plant, number of grains per panicle, thousand seed weight and grain yield denoted higher gcv, pcv, heritability and genetic advance signaling that selection could be effective for desired genetic improvement for these traits. The 100 genotypes were assigned to one of 25 groups. Clusters IX and XIV have the most genotypes, aggregating nine. Cluster XI had the most genotypes, with eight, followed by Cluster XIII, which contained seven. Clusters II, XIX, and XXIV, on the other hand, have only one genotype. Drought resistant check genotypes were found in cluster four, whereas drought sensitive check genotypes

were found in cluster XVI. The trait days to fifty per cent flowering showed maximum vector length indicating its contribution to the total divergence followed by plant height and panicle length. From the pooled results obtained from D2 analysis and principle component analysis, the genotypes Pisini, Sneha, Virendra, KarunakKuruvai, Ratna, Kulie Vedichan, CR Dhan 201 can be presumed to be on par with the performance of drought tolerant genotypes while the genotypes like ADT-43 and ADT-45 appeared to be comparable with the performance of drought susceptible check genotype. Hence these genotypes with contrasting characteristics for drought stress could be recommended as parents in crossing program.

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hazardous materials and pesticides of leachate in contaminated ground water. Environmental Research., 201: 111590

Table 1. List of rice varieties used in the study

S.No	Variety	S.No	Variety	S.No	Variety	S.No	Variety
1	Iravai Pandi	26.	Ottatam	51.	Neela	76.	CR Dhan 300
2	Kottara Samba	27	AnandanoorSanna	52	Naveen	77	CR Dhan 306
3	Anaikomban	28	Kalanmak	53	Panidhan	78	Maudamani (CR Dhan 307)
4	Kuruvai Kalangium	29	Navara	54	Pooja	79	Mukul (CR Dhan 311)
5	Sooran Kuruvai	30	AthurKitchili Samba	55	Ratna	80	Reeta (CR Dhan 401)
6	Cochin Samba	31	Kalurundai	56	Chandrama	81	Sumit (CR Dhan 404)
7	Pal Kudaivazhai	32	KarunkKuruvai	57	Chandan	82	Binadhan 11 (CR Dhan 406)
8	KattuePonni	33	SeruMilagu	58	Sneha	83	CR Dhan 500
9	Pisini	34	Karutha Kar	59	Dharitri	84	Jalamani (CR Dhan 800)
10	Kulie Vedichan	35	Milagu Samba	60	Savitri	85	CR Dhan 510
11	Kamban Samba	36	Katti Samba	61	Moti	86	CR Dhan 601
12	Kulla Kar	37	Salem Sanna	62	Virendra	87	Swarna MAS (CR Dhan 800)
13	VellaiKudaivazhai	38	Poongkarr	63	Varshadhan	88	Subhas (CR Dhan - 802)
14	KudaiVazhai	39	Tenkai Poo Samba	64	Sattari	89	CR Sugandh Dhan 910
15	Vaikunda	40	Illupai Poo Samba	65	Kaling I	90	CR Dhan 907
16	Sanna Samba	41	Rasakadam	66	Kaling III	91	ADT-36
17	Vadan Samba	42	Adukkunel	67	Lunishree	92	ADT-39
18	Tulasi Vasanai Seraga Samba	43	SeeragaSanna	68	Binadhan -8	93	ADT-42
19	Panam Kattu Kudai Vazhai	44	Sembuli Samba	69	Radhi	94	ADT-43
20	Kalarpalai	45	Thanga Samba	70	Shatabdi (IET- 4786)	95	ADT-45
21	Kala jeera	46	Karuppu Kavuni	71	(CR Sugandh Dhan 3)	96	ADT-48
22	Kandasali	47	Thooyamalli	72	Nua Kalajeera	97	CO-51
23	SivappuKowni	48	MapillaiSampa	73	Kamesh (CR Dhan 40)	98	ANNA -(R) - 4
24	Pal Kodai Valai	49	Arupatham Kuruvai	74	Satyabhama (CR Dhan 100)	99	APO
25	Neelan Samba	50	KothamalliSampa	75	CR Dhan 201	100	IR – 20

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Table 2 .Analysis of variance for 100 genotypes for 8 characters in rice (*Oryza sativa*. L)

Source	Df	Days to fifty percent flowering	Plant height	Panicle length	Number of tillers per plant	Number of productive tillers per plant	Number of grains per panicle	1000 seed weight	Grain yield
MEAN SUM OF SQUARES									
Replication	2	11.64	27.52	3.85	2.43	2.00	40.08	1.92	16.16
Genotypes	99	1027.33**	1140.11**	34.25**	25.64**	19.70**	1294.51**	38.57**	128.43**
Error	198	5.15	8.96	1.07	0.81	0.53	13.59	0.71	2.65

Table 3 - Genotypic and Phenotypic coefficient of variation among 8 different characters in rice genotypes.

S.No	Characters	PCV %	GCV%
1	Days to fifty percent flowering	20.56	20.40
2	Plant height	17.92	17.71
3	Panicle length	16.76	16.00
4	Number of tillers per plant	21.08	20.11
5	Number of productive tillers per plant	22.80	21.89
6	Number of grains per panicle	18.95	18.66
7	1000 seed weight	18.49	17.99
8	Grain yield	28.82	27.95

Table 4 - Heritability and Genetic advance as percent of mean for 8 characters

S. No	Characters	Heritability	GA as percent of mean
1	Days to fifty percent flowering	98.51	41.7242
2	Plant height	97.68	36.0671
3	Panicle length	91.17	31.4797
4	Number of tillers per plant	91.00	39.5320
5	Number of productive tillers per plant	92.23	43.3231
6	Number of grains per panicle	96.92	37.8439
7	1000 seed weight	94.63	36.0516
8	Grain yield	94.04	55.8419

Table 5. Eigen values, per cent variability, cumulative variability and character loading of principal components for agro-morphological traits in rice genotypes

	PC I	PC II	PC III	PC IV	PC V	PC VI	PC VII	PC VIII
Eigen values	3.6014	1.6327	0.8301	0.7409	0.5926	0.2832	0.1996	0.1195
Variability %	0.4502	0.2041	0.1038	0.0926	0.0741	0.0354	0.0249	0.0149
Cumulative %	0.4502	0.6543	0.7580	0.8506	0.9247	0.9601	0.9851	1.0000
Trait	Factor loadings							
DFPF	0.0891	-0.5067	-0.6703	-0.4039	0.2827	0.1718	-0.1151	-0.0147
PH	0.1459	-0.6352	0.1670	-0.0534	-0.5295	-0.5025	0.0625	0.0880
PL	0.2054	-0.4667	0.2246	**0.6267**	**0.5014**	0.1414	0.1542	-0.0404
NTPP	0.4590	0.2074	0.0099	-0.0492	0.3184	-0.3853	-0.3161	**0.6277**
NPTPP	0.4622	0.2126	-0.0848	-0.1228	0.1925	-0.4357	0.2528	-0.6543
NGPP	0.3556	0.1152	-0.4388	**0.5326**	-0.4398	0.1469	-0.3895	-0.1322
1000SW	0.3956	-0.1103	**0.5193**	-0.3563	-0.0522	0.4242	-0.4476	-0.2275
GY	0.4705	0.0911	-0.0543	-0.1147	-0.2318	0.3978	**0.6658**	0.3147

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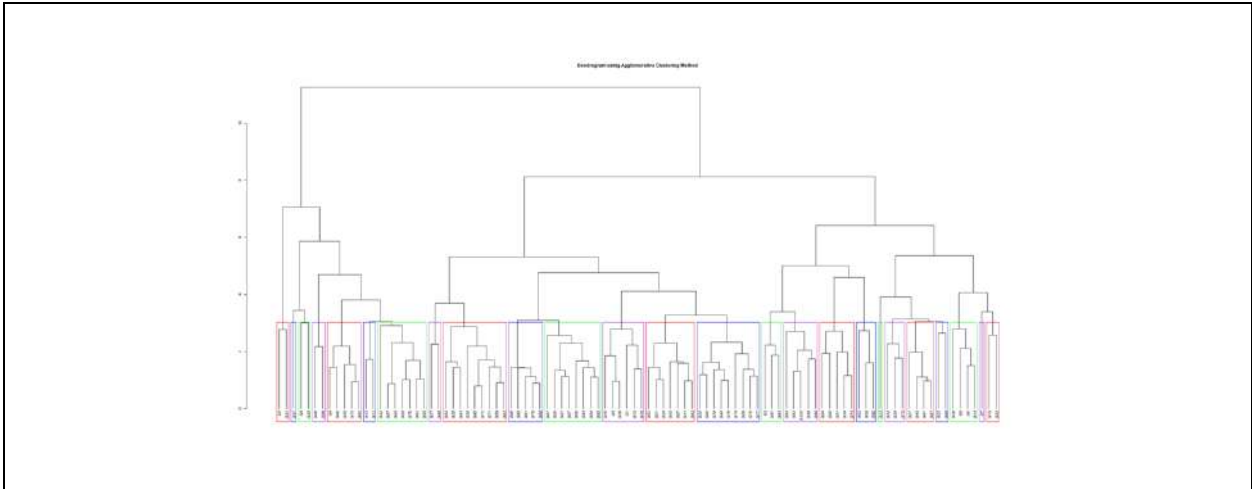
Figure 1. Cluster analysis of 100 rice genotypes for reproductive stage drought
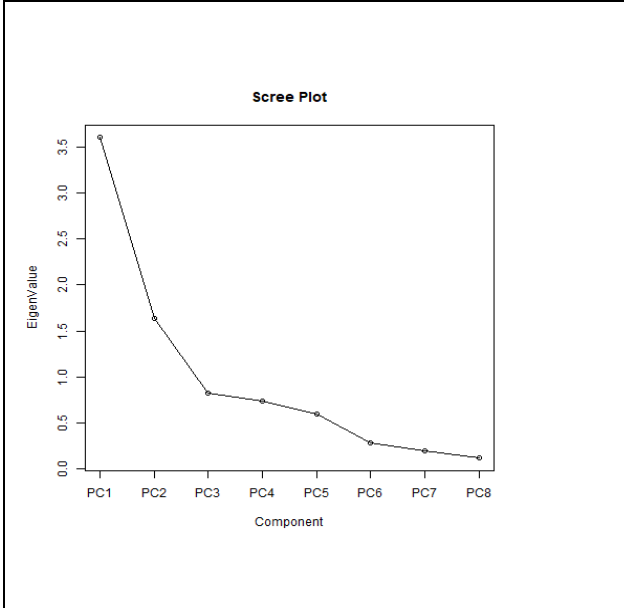
Figure 2. Scree plot showing eigen values variation
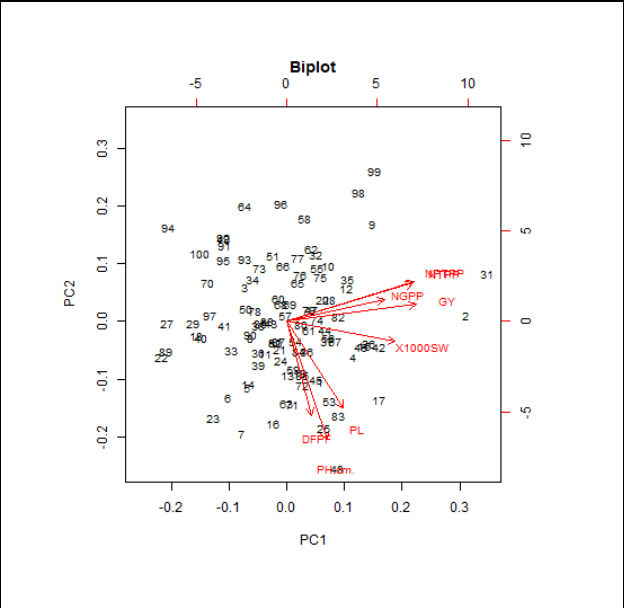
Figure 3. Plot of the score for the first (PC1) and second (PC2)

RESEARCH ARTICLE

Gender Determination using Bigonial Width- an Orthopantomographic Study

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ABSTRACT

An OPG is a panoramic or wide view x-ray of the lower face, which displays all the teeth of the upper and lower jaw on a single film. An OPG may also reveal problems with the jawbone and the joint which connects the jawbone to the head, called the Temporomandibular joint or TMJ. OPG can be used to identify the height , age and gender of an individual with the help of bigonial width, bigonial angle and other various parameters. The aim of the study is to determine the gender using bigonial width. About 30 OPG's were collected from the department of oral medicine and radiology from Saveetha dental college and hospitals and were analysed using a software known as (PLANMECA) in order to measure the bigonial width. According to the results obtained the bigonial width of males were higher compared to females. Independent T test shows p value of 0.001 which was statistically significant. From the limitations of the study males have higher bigonial width than females. Bigonial width serve as an useful tool for sex determination. Further studies need to be done with a larger sample group to get a better result.

Keywords: Bigonial width, Forensics, Forensic odontology, Gender determination, Sex determination, innovative technology, novel method

INTRODUCTION

The diagnosis of gender is very much important in forensic anthropology. When bones are incomplete, anthropological estimation cannot be performed. Cranial anthropometric measurements provide an important framework for Forensic Medicine. Cranial anthropometrics analyzes living individuals or bones, directly or through studies in lateral or frontal radiographs. Therefore, it is essential to have parameters that allow the detection of sexual dimorphism [1]. The difficulty in determining sex of skeletal remains is a known problem that limits anthropological research and forensic practice[2].So they have developed numerous methods to carry out the determination of sex , on such method is Panoramic radiographs, they are normally used in routine dental practices to assess mandibular and maxillary structures. They are used to survey dental conditions by providing information about all aspects of dentistry. Panoramic radiographs is an important tool to study the morphological changes that occur with gender and age. This study aims to identify the gender of the person from Orthopantomogram using bigonial width. Bigonial width was measured as the linear distance between the two Gonia, which are points at the external angle of the mandible. This is measured with the aid of a pachymeter. Radiological examination can identify sex of an individual to an extent of 88% [3]. Various studies have been conducted on (Gender determination using bigonial width) some of this include [4],[5] ,[6] . In most of the studies the author states that the bigonial width can be used to differentiate the gender of an individual. Our team has extensive knowledge and research experience that has translate in to high quality publications [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26]. The aim of the study is to determine the gender using bigonial width.

MATERIALS AND METHODS

A retrospective study was conducted at our department utilising digital panoramic radiographs randomly collected from the database (SIRONA Orthophos XG5 Digital OPG Machine) of 40 subjects in the age group between 30-40 years. Panoramic radiographs showing pathological fractures, developmental disturbances of the mandible and edentulous mandible were excluded from the study. The method that was used for gender determination is bigonial width which comes under gonial method. The bigonial width is the distance between both Gonia. Gonian is the most inferior, posterior and lateral point on the external angle of the mandible. It was measured horizontally from the right to left gonia. These measurements were performed using a computerised software and the measurements were compensated to the magnification (19%) of the panoramic machine. All the measurements were made with the observers being blinded to the age and sex of the patient's radiographs.

RESULTS

This study was performed using OPG'S collected from the department of oral medicine and radiology at saveetha dental college . Total of 29 OPG's were analysed for bigonial width using a software known as (PALENMECA) out of which 15 were females and the remaining 14 were males. After collecting the data , it was put into spss (version 5) and was later developed into a t-test graph with a significance of 0.001. (Figure 2)

DISCUSSION

Forensic odontology is the application of dental science to the administration of the law and the furtherance of justice. It is a challenging and fascinating branch of forensic science that involves application of dental sciences in the identification of deceased individuals through the comparison of ante and post mortem records[27].It also provides an important community service in both the civil and criminal jurisdiction. Forensic dental services are of value both in death investigations and in clinical forensic medicine for evaluation of living victims of sexual assult, child abuse and other domestic violence cases. Forensic dentistry plays a major role in identification in man made or natural disasters, these are events that result in multiple fatalities that may not be identifiable through conventional

methods such as fingerprints. Gender of an individual can be determined based on data from the morphology and metric features of skull and mandible. Among human bones, pelvis and skull are the most reliable source of gender determination. In absence of a complete pelvis, the mandible becomes an important source for gender confirmation. The mandible is the most durable facial bone that retains its shape better than others [28]. Mandible is the most strongest part of the skull which formed the chief articulating segment of the skull. Its morphological features show changes with regards to age, gender and race [29]. Bigonial width is measured as the linear distance between the two gonia, which are points at the external angle of mandible, in posterior view. This method is considered to be an easy and reliable source for sexual dimorphism.

Various investigations were carried out to determine whether there was any correlation between bigonial width and gender in orthopantomogram radiographs in the North Tamil Nadu population. It was found that males have a larger bigonial width than females. In a study done by Jodi Leversha et al 2015 stated that, Gender differences were statistically significant with males having a higher value of bigonial width than females. On the other hand the study also revealed that bigonial width significantly decreased as age increased. However, it was not significant when comparing 19-29 to 30-39 or 40-49 and 50-59 to 60-69 age group [30]. In a study done by Palak H Shah et al 2020, stated that the bigonial width of participants coming under the age group 30-40 years have a mean bigonial width of 220.82 and a standard deviation of 14.99 [31]. In a study done by Usha Jambunath et al 2016, stated that the mean bigonial width of males is 196.80 and for females it is 190.05 whereas in our study the mean bigonial width for males and females are 225.47 and 206.75 respectively [32]. Further research should be conducted across other areas of India. Cone beam computed tomography is a relative new technology introduced over the last decade. It gives accurate display of dimensions and could be an appropriate direction for future studies of gender differences of the mandibular parameters. Research should be performed on different skeletal patterns and levels of edentulism for better enhancement of results.

CONCLUSION

Bigonial width can differentiate between sexes, as the stages of mandibular development , growth rates and duration are distinctly different in both sexes. For the present study it can be concluded that bigonial width can be used as an aid for gender determination. Further study has to be done with a larger sample for better understanding. Also, since growth could affect the assessment of gender difference, further studies need to be done in both the younger age group and elder age group for better accuracy.

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| Figure 1: Measurement of bigonial width in an orthopantomograph | Figure 2: The bar graph represents the association between gender and the mean bigonial width. X axis represents the gender and Y axis represents the mean bigonial width. Blue denotes males and green represents female. Mean bigonial width of male is 226.029 (Blue)and for female it is 206.753(Green). Mean bigonial width in males is higher when compared to females. Independent T test shows p value of 0.001. (p value < 0.05), Hence it is statistically significant. |

RESEARCH ARTICLE

Antidiabetic, Hepatoprotective and Antihyperlipidemic Effect of Polyherbal Drug in Streptozotocin Induced Hyperglycemic Rats

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ABSTRACT

The study aimed to establish the mechanism of antidiabetic activity of ethanol extract of polyherbal drug in streptozotocin induced rats. 250mg/kg of the polyherbal drug were administrated orally to diabetic rats for 35 days on daily basis to evaluate the antidiabetic, hepatoprotective and antihyperlipidemic effects. The effect of polyherbal drug on diabetic rats and normal control rats were examined by body weight, food intake, water intake, blood glucose, insulin, HbA1c, antioxidant and biochemical parameters. Type 1 diabetes significantly altered these parameters, while administration of the ethanol extract of polyherbal drug improved them in the treated rats. The present research concluded that the oral administration of ethanol extract of polyherbal drug in diabetic rats showed potent antidiabetic activity and also it protects the liver.

Keywords: Polyherbal drug, Blood glucose, Insulin, Biochemical parameters, Antidiabetic effect, Hepatoprotective, Antihyperlipidemic effect.

INTRODUCTION

Diabetes mellitus is a progressive metabolic disorder with a wide range of health consequences and problems[1]. Diabetic patients account for more than 90% of all patients. Obesity, a sedentary lifestyle, and unhealthy diet are all major contributors to the development of diabetes [2]. According to a recent assessment on the prevalence of diabetes mellitus around the world, 463 million individuals are currently affected by the disease. According to the research, the figure might grow to 10.2 percent (578 million by 2030) and 10.9 percent (700 million by 2045)[3]. Diabetes is most commonly caused by a lack of insulin secretion [4]. Diabetes is the most important predisposing factor for the development of various clinical conditions such as heart disease, peripheral neuropathies, and poor wound healing, reducing patients' life expectancy [5]. Free radicals appear to have a role in the progression of diabetes and its complications, according to a number of experimental and clinical investigations [6]. The production of free radicals or the alteration of their endogenous scavengers can destroy beta cells in the pancreas [7]. Although most of the currently available medicines have a variety of side effects, effective diabetes treatment is seen as a serious challenge for the medical community [8].

Various research has studied into diabetic treatment alternatives that have equal therapeutic effects of conventional therapeutic medicines but don't have as many side effects [9]. Furthermore, no alternate treatment methods for diabetes have been offered too far. 1200 species of medicinal plants have the ability to treat diabetes and its complications, according to ethno botanical knowledge [9]. Numerous plant extract-based medicines have been used in Asian countries as well as other regions of the world to treat a variety of ailments. Scientists are currently researching the use of numerous plant extracts to treat a variety of diseases, including diabetes [10,11]. Kolli hills peoples are an excellent example of a traditional knowledge system in which smaller towns prevent incurable diseases using traditional methods passed down from their ancestors [12], which have been found to be more effective and reliable in the discovery of new medicines with no side effects. Traditional herbal plants have been used by the tribal people of Kolli Hills, Namakkal District, Tamil Nadu, to treat diabetes mellitus. Thus, the focus of this research was to find out how polyherbal plant formulation (*Andographis paniculata, Andrographis alata, Adhatoda zeylanica, Gymnema sylvestre, Syzygium cumini, and Justica globra*) protects diabetic rats induced by streptozotocin.

MATERIALS AND METHODS

Collection of plant materials
Whole plant of *A. Paniculata, A. alata, G. sylvestre* and *J. glabra,* leaves of *A. zeylanica*, bark of *S. cumini* were collected from the Thembalam village of Kolli hills, Namakkal district, Tamil Nadu.

Preparation of extract
The polyherbal drug was prepared by mixing equal quantity of whole plant of *A. paniculata, A. alata, G. sylvestre and J. glabra,* leaves of *A. zeylanica,* bark of *S. cumini* powder. Then it was extracted by cold extraction method using ethanol. They were concentrated to a dry mass by vacuum evaporator and stored separately in desiccators until use.

Test model
Healthy adult male Wistar albino rats, *Rattus norvegicus* with body weight ranged between 150 and 200 g were used as test model for the present study. The rats were obtained from Tamilnadu Veterinary and Animal Science University, Chennai and brought to the laboratory and maintained under controlled environment. All rats were fed with standard pellet feed (Sai Durga Feeds and Foods, Bangalore) and water *ad libitum*. The principles of animal care were followed throughout the experimental period and the experimental protocols of the present study were approved by the Institutional Animal Ethical Committee (Ethical Committee's Approval No.BDU/IAEC/2014/NE/31/Dt.18.3.14).

Induction of diabetes

Diabetes mellitus was induced in fasted rats. A single intraperitoneal injection of STZ (50mg/kg body weight and it's dissolved in ice cold citrate buffer).

Experimental design

Healthy adult male albino rats were divided into seven groups of three rats each and caged in separates cages. Ethanol extract of polyherbal drug at a dose of 250 mg/kg body weight / day for 35 days.

Evaluation of antidiabetic, hepatoprotective and antihyperlipidemic activity

Antidiabetic activity of different extracts of polyherbal drug were evaluated by estimating the levels of serum blood glucose, glycosylated haemoglobin, serum insulin, serum protein and liver glycogen in experimental diabetic rats were compared with that of normal rats. Liver markers and lipid profiles were studied to evaluate the hepatoprotective antihyperlipidemic effect of polyherbal drug, respectively. Besides vital organ such as pancreas, liver and kidney were dissected out and weighed to know the changes in the wet weight of organs, due to STZ treatment and extract treatment. Changes in the body weight, daily food intake and water intake were also studied.

Statistical analysis

Values were represented as Mean ± Standard Error. To compare the means of different experimental groups with normal groups, Analysis of Variance (ANOVA) (both one and two way) was performed at necessary places. The post hoc test (Student-Newman Keuls test; SNK) was performed to investigate the influence of the drug on various biochemical parameters in the extract treated rats. All statistical analyses were performed by using windows-based SPSS package (Statistical Package for Social Sciences/Statistical Product and Service Solutions).

RESULTS AND DISCUSSION

Traditional medicines have been used by humans for thousands of years. Many crude drug formulations for the treatment of various disorders are reported in Ayurveda and Unani, two indigenous systems of alternative medicine. These medicines have a long history using herbal extracts in their compositions [13]. Many medicinal plants have been utilised as a potential treatment for diabetes in various civilizations and are used as a folk medicine in various cultures [14]. While the availability of various oral and systemic antidiabetic drugs on the market, the demand for natural antidiabetic products is growing as a supplemental therapy [15].

Effect of polyherbal drug on bodyweight

The body weight of the rats treated with ethanol extract of polyherbal drug of different groups during the experimental period are represented in Table 1. Week wise body weight loss was observed in the STZ induced diabetic rat group. The diabetic rat showed reduction in body weight (157.6 ± 4.52). Ethanol extract of polyherbal drug treated rats prevent (182.4 ± 2.48) weight loss and recovered the body weight to the normal level.

Food intake

The untreated diabetic (18.6 ± 0.28) rats showed polyphagic condition and consumed more quantity of food compared to control rats (11.7 ± 0.47). The treatment of ethanol extract of polyherbal drug significantly reduced (11.8 ± 0.45) the food intake in diabetic rats (Table 1).

Water intake

Water consumption desperately increased (70.9 ± 4.12) in the untreated diabetic rats. Treatment of polyherbal drug extracts moderately reduced (41.6 ± 6.17) the water intake in the diabetic rats. The results revealed that untreated diabetic rats exhibited polydipsia condition and the extracts treatment recovered the polydipsia condition in the diabetes rats (Table 1). Diabetes is consistently related with body weight loss due to metabolic pathway imbalances [16] . In STZ-induced diabetic rats, oral administration of ethanol extracts of polyherbal drugs at a dose of 250 mg/kg

b.wt elicited a considerable and constant weight increase over the duration of the experiment. It denotes that the polyherbal drug treatment controlled the weight loss and restored the body weight to its original level. By lowering food and water consumption, the polyherbal extracts were efficient in avoiding polydipsia and polyphagia. Many researchers noted comparable result when treatment STZ-induced diabetic rats using medicinal plants [17,19] The polyherbal extracts' ability to restore body weight may be attributed to their enhanced glycemic management. The metabolic abnormalities were repaired in diabetic rats treated with plant extract after 30 days, as evidenced by a reduction in polyphagia (high food intake), polyuria (frequent urination), and polydipsia (high water consumption). As a result, it is obvious that the herbal medicine increased glucose metabolism, resulting in increased body weight in the rats.

Relative organ weight

The untreated diabetic rat exhibited slight decrease in relative weight of pancreas (0.1± 0.03 g/100g b.wt) as compared to control rats (0.28 ± 0.33 g/100g b.wt.). The continuous administration of glibenclamide and polyherbal drug to the diabetic rats were able to restore the loss of pancreas weight back to normal level. With regard to the liver, STZ induction significantly increased the wet weight of liver (5.4 ± 0.43g/100g b.wt.). After the treatment of glibenclamide and polyherbal drug recovered the increased weight of liver in the diabetic rats to that of normal control rats. Both right and left kidney weights were increased in untreated diabetic rats when compared to normal rats. Treatment with glibenclamide and polyherbal drug reduced the weight of kidney to the normal levels.

Blood glucose

Figure 1 show the week wise blood glucose level in control, untreated diabetic rat and ethanol extract of polyherbal drug treated rat. The STZ induced diabetic rat exhibited a hyperglycemic condition throughout experiment with a high blood glucose level of 605.3± 76.63mg/dl on week III. However, during the second week the blood glucose level was highly increased from the previous week. The treatment of polyherbal drug extract to the diabetic rats gradually reduced the level of blood glucose. The continuous treatment with ethanol extract of polyherbal drug to the diabetic rat significantly reduced the blood glucose level to the normal level (141.0 ± 3.05mg/dl and 142.7 ± 20.30 respectively) at the end of the experiment.

HbA1c

The treatment of glibenclamide to the STZ induced diabetic rat significantly alter the HbA1c level (6.1 ± 0.03%). Similarly, an administration of polyherbal drug extract restored the loss in HbA1c level to reach the normal value. The increased synthesis of glycated haemoglobin in diabetic rats resulted in a low total haemoglobin level (HbA1c). Excess blood glucose reacts with the globin component of haemoglobin to produce high amounts of HbA1c, which lowers haemoglobin levels in the blood. This study reveals that HbA1c levels and blood glucose levels have a direct link [20,21]. The oral administration of ethanol extract of polyherbal drug considerably boosted blood levels while also significantly lowering HbA1c levels in diabetic rats, showing that ethanol extract of polyherbal drug has the ability to restore normal glycemic activity. The diabetic rats, on the other hand, had an aberrant lipid profile as compared to the control group. This may be due to an imbalance in the numerous metabolic and regulatory pathways that have developed due to insulin insufficiency [22].

Liver glycogen

Regarding the liver glycogen level, the untreated diabetic rat exhibited significant decline in liver glycogen level 64.3±10.68 mg/dl as compared to the control rats (125.0±33.74 mg/dl). In contrary, treatment of glibenclamide and the ethanol extract of polyherbal drug to the STZ induced diabetic rats showed notable increase in liver glycogen.

Serum insulin

The intraperitoneal injection of STZ in to the albino rats resulted a declined of insulin level from 8.4 ± 0.07µIU/ml to 3.7 ± 0.07 µI U/ml as compared with normal control rats. On the contrary serum insulin level had been significantly improved after the treatment of ethanol extract of polyherbal drug to the diabetic rats. According to the literature, rats given nicotinamide/streptozotocin developed type 2 diabetes, whereas rats given streptozotocin alone had type 1

diabetes [23-26]. Streptozotocin causes a diabetic condition by specifically damaging the pancreas' insulin-secreting cells. Moreover, these experimental rats show a variety of diabetes consequences, including cardiomyopathy, retinopathy, nephropathy, and neuropathy, all of which are caused by oxidative stress [27]. The present study's findings demonstrate that diabetic rats' fasting blood insulin levels are significantly lower. These findings are comparable to those seen in rats with type 2 diabetes caused by nicotinamide/streptozotocin [23].

Serum protein
SNK post hoc test showed high reduction of protein level in diabetic rat group with ethanol extract of polyherbal drug restored level of protein very close to those of normal control rats.

Serum albumin
A slight decrease (3.8 ± 0.16g/dl) in the albumin level was noticed in untreated diabetic rats compared to normal control rats (3.8 ± 0.16 g/dl). In contrary, glibenclamide treated rats exhibited a high increase (4.6 ± 0.71 g/dl) in the albumin level when compared to diabetic rats. Similarly, the treatment of ethanol extract of polyherbal drug to the diabetic rats restored the albumin level which was more or less similar to normal control rats.

Serum globulin
The STZ induced diabetic rat explicated a high level of globulin (1.9 ± 0.49g/dl) when compared to control rat (4.4 ± 0.24 g/dl). The glibenclamide and polyherbal drug treated rat recovered the loss of globulin level (3.5 ± 0.61 g/dl) to reach the normal value.

Protein levels of different tissues
The intraperitoneal injection of STZ into the rats resulted in heavy loss of protein in kidney (24.0 ± 3.53mg/g), liver (7.7 ± 2.47 mg/g) and pancreas (3.2 ± 0.87 mg/g) compared to control rats. The oral administration of glibenclamide to the diabetic rats significantly increased the loss of protein level in kidney (33.8 ± 0.87 mg/g), liver (28.6 ± 6.11 mg/g) and pancreas (29.1 ± 7.94 mg/g). Consequently, the administration of polyherbal drug restored loss of protein level in pancreas, liver and kidney of STZ induced diabetic rats.

Hepatoprotective activity of polyherbal drug

SGOT
The STZ induced diabetic rats exhibited marked increased in SGOT enzyme level (77.7 ± 7.79U/L) when compared to normal control rats (15.7 ± 0.51U/L). Continuous administration of glibenclamide and polyherbal drug to diabetic rats showed significant decrease compared to untreated diabetic rats.

SGPT
The SGPT enzyme level was increased remarkably (119.1 ± 20.10 U/L) in STZ induced untreated diabetic rats. The glibenclamide treatment to diabetic rats significantly decreased the elevated levels of SGPT. Similarly, ethanol extract of polyherbal drug treatment decreased the elevated SGPT level (16.5 ± 3.87 U/L) of diabetic rats as close to normal control rats.

ALP
After intraperitoneal injection of STZ to the albino rats, the ALP enzyme level (359.8 ± 79.78U/L) was drastically reduced when compared to control rats (171.1 ± 45.07 U/L). In reverse, there was moderate reduction in ALP level in diabetic rats after the treatment of glibenclamide. The polyherbal drug treatment to diabetic rats decreased the elevated level of ALP compared to untreated diabetic rats.

ACP

Similar to all other liver marker enzyme, the ACP level was high in untreated diabetic rats. However, the oral administration of glibenclamide and polyherbal drug showed decreased level of ACP when compared to untreated diabetic rats. In type 2 diabetic patients, an increase in liver enzymes is usually linked to their glycemic condition [28]. Various liver enzymes, such as ALT, AST, and ALP, were shown to be elevated in diabetic rats in this research. Increased transaminases may play a role in the progression of diabetic ketogenesis and gluconeogenesis [29]. In diabetic rats, however, ethanol extract of polyherbal medication administration lowered liver transaminases activity considerably. The present study results, suggests that an ethanol extract of a polyherbal medication could protect the liver in diabetics.

Bilirubin

The STZ injection to the albino rats increased the levels of bilirubin as compared to normal control rats. However, the treatment of polyherbal drug and glibenclamide restored the elevated levels of bilirubin as close to control rats.

Antihyperlipidemic activity

Cholesterol level

The STZ induced diabetic rats showed a drastic increase in the level of cholesterol (214 ± 16.19 mg/dl) when compared to control rats (69.6 ± 6.40 mg/dl). However, glibenclamide treatment to diabetic rats showed a decrease level of cholesterol (76.8 ± 4.93mg/dl) to restore the normal level. Similarly, the polyherbal drug treated diabetic rats showed a reduction in the cholesterol level as close to control rats.

Triglyceride

The STZ induced diabetic rats resulted an elevation in the triglycerides level (183.0 ± 8.90mg/dl) as compared with control rats (88.8 ± 5.38 mg/dl). In reverse, the glibenclamide treatment to the STZ induced diabetic rat recovered (84.2 ± 29.4mg/dl) the elevated level of triglycerides level as close to normal control rats. Ethanol extract (58.9±10.54 mg/dl) showed a heavy reduction of triglycerides as very low to those of control rats.

HDL

The high density lipid cholesterol was drastically lowered in STZ induced diabetic rats (1.9±0.26 mg/dl) as compared to normal rat (6.3±0.29mg/dl). In contrast, an increased (16.5±1.79 mg/dl) level of HDL was observed in glibenclamide treated diabetic rats when compared to untreated diabetic rats. Similarly, the levels of HDL in polyherbal drug extracts treated to diabetic rats increased the loss of HDL level.

VLDL

VLDL level of STZ induced diabetic rats was significantly higher (36.6 ± 1.78 mg/dl) than the control rats (17.7 ± 1.07 mg/dl). However, the extract treatment and glibenclamide treatment to the diabetic rats recovered the elevated level of VLDL to back to the normal level.

LDL

After the injection of STZ to the albino rats, the bad cholesterol LDL was significantly elevated (176.2 ± 18.07mg/dl) as compared to normal control rats (45.6± 5.67mg/dl). On the other hand, the glibenclamide (43.4 ± 6.65 mg/dl) and the polyherbal drug treatment to the STZ induced diabetic rats remarkably reduced the elevated level of LDL to that of normal control rats. The diabetic rats in this research had higher serum creatinine and urea levels, indicating that the kidneys were having trouble filtering harmful or waste substances out of the body. The reduction in blood cholesterol, triglycerides, LDL, and HDL cholesterol supports the theory that the extract's main roles are to protect important tissues (kidney and liver), including the pancreas, reducing the risk of diabetes in experimental animals [30]. Secondary metabolites such as saponins, flavonoids, phenolic compounds, and triterpenoids have been found to have hypolipidemic action by many authors [31,32].

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Effects of polyherbal drug on renal function

Serum creatinine level

The creatinine level of STZ induced diabetic rats was increased (0.89± 0.02mg/dl) as compared to that of control rats (0.64 ± 0.02 mg/dl). Treatment of glibenclamide to the diabetic rats showed notable decreased creatinine level (0.5±0.15 mg/dl) as close to normal control rats. Similarly, the polyherbal drug favorably decreased the level of creatinine.

Serum urea level

The mean urea level was significantly increased to 0.3 ± 0.02mg/dl in STZ induced diabetic rats when compared to the control rats (0.2 ± 0.04mg/dl). A decreased level was observed (0.1±0.01mg/dl) after continuous treatment of glibenclamide in diabetic rats. Polyherbal drug treated rats exhibited a decrease in the level of urea. The serum urea and creatinine levels are considerably raised in renal impairment caused by diabetes hyperglycemia [33].

Uric acid

The untreated diabetic rat showed an increase in the uric acid level (2.9 ± 0.77 mg/dl) as compared to that of control rats (1.6±0.16 mg/dl). The glibenclamide treatment slightly reduced the elevated levels of uric acid (2.0 ± 0.5 mg/dl), but not close to the values of normal control rats. Administration of ethanol extracts of polyherbal drug to the diabetic rats slightly reduced the level of uric acid. The presence of different types of active secondary metabolites such as saponins, flavonoids, and phenolic compounds, each with a single or broad range of biological activities, may explain the hypolipidemic qualities of test poly herbal drug. The ethanol extract has the potential to alter the hyperglycemic condition, protects the liver and reverse the hyperlipidemic condition that arises in STZ-induced diabetic rats, according to the current data.

CONCLUSION

The present study confirms the effects of an ethanol extract of polyherbal medication, lending support to its folkloric use in the treatment and/or control of type 2 diabetes. The polyherbal plant has a variety of chemical compounds that can produce a variety of pharmacological effects through various processes. As a result, depicting a sensible conclusion on the style of action is difficult. However, evidence from this study implies that hypoglycemic effect resulting from either an increase in insulin synthesis via stimulating beta cells or an increase in peripheral cellular glucose uptake cannot be ruled out.

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Table.1: Effect of polyherbal drug on body weight, Food intake and Water Intake of STZ induced diabetic rats. Values within the parentheses are range of respective mean

Parameters	Group	Week-I	Week-II	Week-III	Week-IV	Week-V
Body weight	I	157.1 ± 1.01 (150 – 160)	162.6 ± 0.89 (160 – 170)	169.8 ± 0.73 (160 – 180)	173.3 ± 1.05 (170 – 180)	174.3 ± 1.30 (170 – 190)
	II	193.6 ± 4.07 (170 – 240)	176.2 ± 1.29 (160 – 180)	170.0 ± 1.83 (160 – 180)	166.7 ± 2.79 (150 – 180)	157.6 ± 4.52 (130 – 180)
	III	200.0 ± 0.98 (190 – 210)	175.2 ± 1.31 (170 – 190)	174.3 ± 1.63 (160 – 190)	184.3 ± 2.35 (170 –200)	186.7 ± 2.79 (170 – 200)
	IV	169.3 ± 3.91 (140 –190)	172.4 ± 2.50 (155 – 190)	172.9 ± 2.84 (150 – 190)	174.8 ± 1.74 (160 – 190)	182.4 ± 2.48 (170 – 210)
Food intake	I	11.9 ± 0.43 (10.0 – 13.3)	11.7 ± 0.47 (10.0 – 13.3)	12.4 ± 0.40 (11.7 – 14.33)	11.8 ± 0.45 (10.0 – 13.3)	11.3 ± 0.23 (10.0 – 11.7)
	II	15.2 ± 1.13 (11.7 – 18.3)	18.6 ± 0.28 (17.3 – 19.3)	17.9 ± 0.46 (16.7 – 19.3)	17.7 ±0.42 (16.7 – 19.3)	17.1 ± 0.67 (13.3 –18.3)
	III	12.2 ± 0.58 (10.0 – 14.3)	11.3 ± 0.44 (10.0 – 13.3)	12.9 ± 0.34 (11.7 – 14.0)	12.8 ± 0.57 (10.0 – 14.3)	12.5 ± 0.56 (10.0 – 14.3)
	IV	13.1 ± 0.42 (11.7 – 14.3)	11.8 ± 0.45 (10.0 – 13.3)	13.1 ± 0.26 (12.3 – 14.3)	13.2 ± 0.29 (11.7 – 13.2)	12.1 ± 0.50 (11.0 – 12.3)
Water intake	I	24.2 ± 2.24 (15.7 – 34.0)	19.4 ±1.02 (15.0 –23.3)	20.1 ±1.02 (17.3 – 23.3)	26.5 ± 1.59 (21.7 – 33.3)	27.6 ±1.71 (20.3–31.7)

	II	48.5 ± 5.52 (30.0 – 67.0)	70.9 ± 4.12 (50.3 – 82.7)	63.7 ± 3.98 (40.0 –69.3)	58.9 ± 2.17 (52.7 – 68.7)	59.0 ±2.72 (45.0 – 68.0)
	III	36.0 ± 5.37 (23.3 – 65.7)	31.8 ± 5.12 (22.7 – 61.7)	29.8 ± 1.13 (26.0 – 33.7)	30.6 ± 1.61 (22.7 – 36.7)	31.0 ± 2.02 (23.0 – 39.3)
	IV	42.5 ± 5.59 (30.0 – 69.3)	41.6 ± 6.17 (24.7 – 67.0)	47.9 ± 5.99 (13.3 – 60.3)	34.7 ± 2.27 (26.3 – 45.0)	26.2 ± 1.68 (20.7 – 32.7)

I: Control rats, **II:** Diabetic control rats, **III:** Diabetic rats treated with glibenclamide, **IV:** Diabetic rats treated with ethanol extract of polyherbal drug

Table.2: Results of Student-Newman-Keuls (SNK) post hoc test show the variations and similarities in lipid profile among the different group of rats. Mean values are arranged in ascending order

Parameters	Groups			
Cholesterol (mg/dl)	69.6 (I)	76.8 (III)	88.2 (IV)	214.8 (II)
Triglycerides (mg/dl)	58.9 (IV)	84.2 (III)	88.8 (I)	183.0 (II)
HDL (mg/dl)	1.9 (II)	6.3 (I)	9.8 (IV)	16.5 (III)
VLDL (mg/dl)	11.7 (IV)	16.8 (III)	17.7 (I)	36.6 (II)
LDL (mg/dl)	43.4 (III)	45.6 (I)	66.4 (IV)	176.2 (II)

Table 3: Results of Student-Newman-Keuls (SNK) post hoc test show the variations and similarities in total protein, albumin and globulin, among the different group of rats. Mean values are arranged in ascending order.

Parameters	Student-Newman-Keuls Post hoc test			
	Groups (Subset for alpha = 0.05)			
Protein (g/dl)	5.5 (II)	7.9 (IV)	8.1 (III)	8.3 (I)
Albumin (g/dl)	3.6 (II)	3.8 (I)	4.6 (III)	4.9 (IV)
Globulin (g/dl)	1.9 (II)	3.1 (IV)	3.5 (III)	4.4 (I)

Horizontal lines connect similar means.

*Groups:

I: Control rats, **II:** Diabetic control rats, **III:** Diabetic rats treated with glibenclamide, **IV:** Diabetic rats treated with ethanol extract of polyherbal drug

Table 4: Results of Student-Newman-Keuls (SNK) post hoc test show the variations and similarities in tissue protein level among the different group of rats. Mean values are arranged in ascending order.

Parameter	*Groups (Subset for alpha = 0.05)			
Protein(L) (mg/g tissue)	7.7 (II)	19.2 (IV)	19.9 (I)	28.6 (III)
Protein(K) (mg/g tissue)	18.5 (V)	24.0 (II)	33.8 (III)	42.5 (I)
Protein(P) (mg/g tissue)	3.2 (II)	15.2 (IV)	16.8 (I)	29.1 (III)

Horizontal lines connect similar means.

*Groups:

I: Control rats, **II:** Diabetic control rats, **III**: Diabetic rats treated with glibenclamide, **IV:** Diabetic rats treated with ethanol extract of polyherbal drug

Table 5: Results of Student-Newman-Keuls (SNK) post hoc test show the variations and similarities in organ weight among the different group of rats. Mean values are arranged in ascending order.

	Student-Newman-Keuls post hoc test				
Organs	*Groups (Subset for alpha =0.05)				
Pancreas (g/100gb.wt.)	0.1 (II)	0.24 (IV)	0.28 (I)	0.3 (III)	
Liver (g/100gb.wt.)	3.7 (I)		3.9 (III)	4.1 (IV)	5.4 (II)
Right Kidney (g/100gb.wt.)	0.31 (IV)	0.4 (III)	0.42 (I)	0.5 (II)	
Left Kidney (g/100gb.wt.)	0.33 (IV)	0.4 (III)	0.41 (I)	0.6 (II)	

Horizontal red coloured lines connect similar means.

*Groups:

I: Control rats, **II:** Diabetic control rats, **III:** Diabetic rats treated with glibenclamide, **IV:** Diabetic rats treated with ethanol extract of polyherbal drug
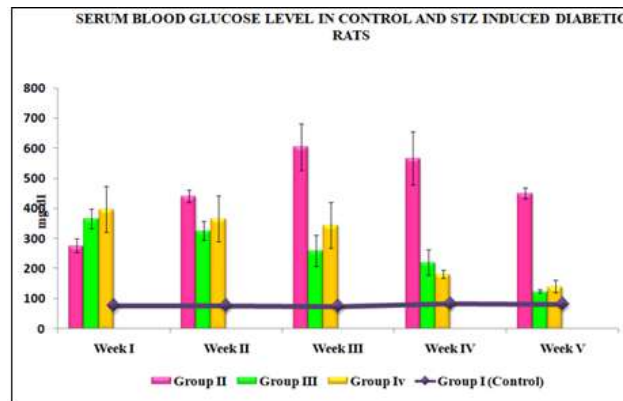
Figure 1: Effect of polyherbal extract on blood glucose levels in STZ induced diabetic rats during different weeks of experiment.
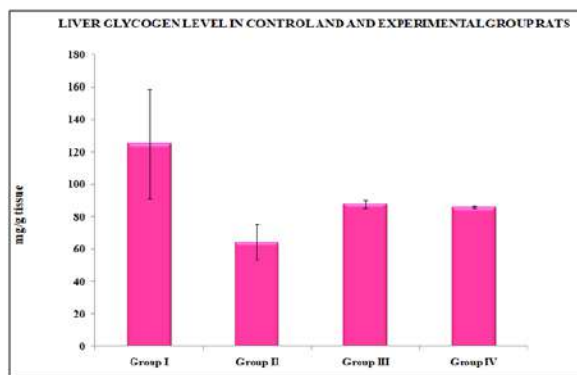
I: Control rats
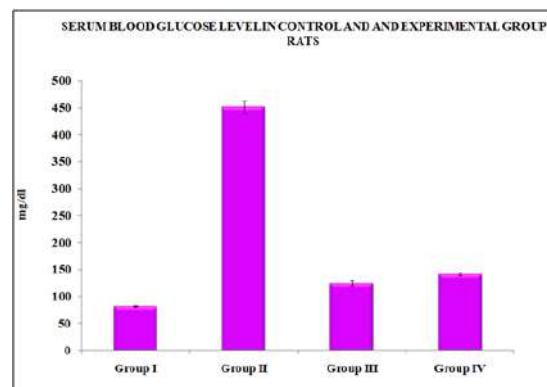
II: Diabetic control rats
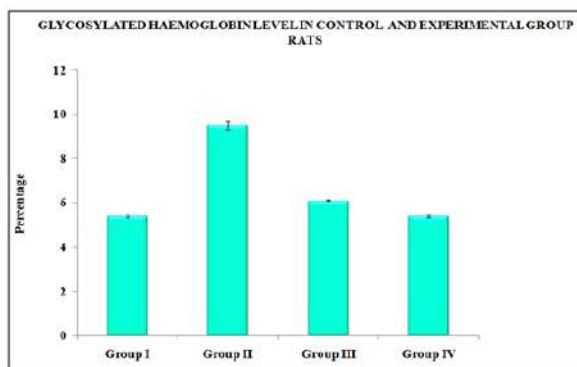
III: Diabetic rats treated with glibenclamide
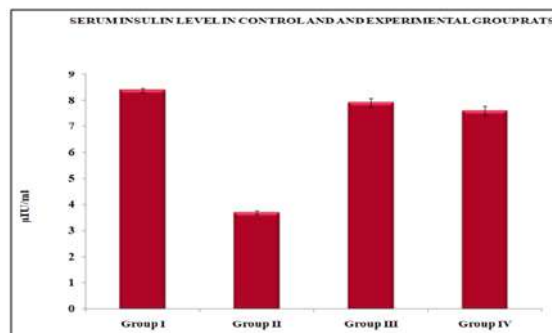
IV: Diabetic rats treated with ethanol extract of polyherbal drug

Figure 2: Effect of polyherbal extract on blood glucose, HbA1c, liver glycogen and serum insulin levels in STZ induced diabetic rats.

I: Control rats

II: Diabetic control rats

III: Diabetic rats treated with glibenclamide

IV: Diabetic rats treated with ethanol extract of polyherbal drug

Figure 3: Effect of polyherbal extract on liver marker enzymes in STZ induced diabetic rats.

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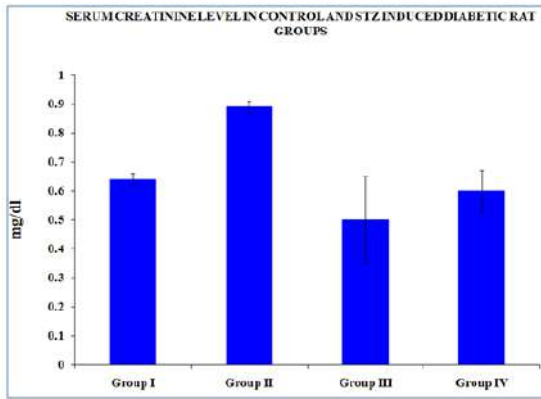
I: Control rats
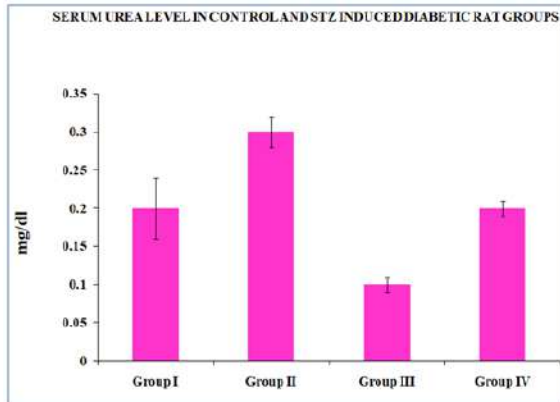
II: Diabetic control rats
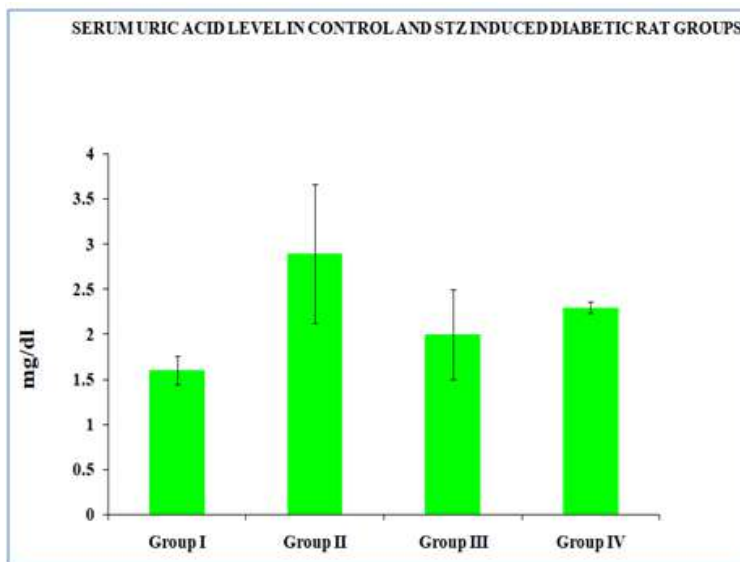
III: Diabetic rats treated with glibenclamide, IV: Diabetic rats treated with ethanol extract of polyherbal drug,
Figure 4: Effect of polyherbal extract on renal profiles of STZ induced diabetic rats

RESEARCH ARTICLE

Zooplanktons of Junagadh, Gujarat, India

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ABSTRACT

Junagadh is a historical city in the Saurashtra region of Gujarat, situated at the foot of the Girnar Hills. Many freshwater bodies may be found in the vicinity of these hills. The present study investigates the biodiversity of zooplankton and physico chemical parameters of seven different sites of Junagadh city. Study was carried out for a period of eight months from August 2021-March 2022. Samples were collected on a monthly basis. Zooplankton communities belonging to eight different groups were recorded during the study. A total of 70 species of zooplankton were recorded from all the selected sites of Junagadh district. Highest zooplankton diversity was recorded from S6 (31) and lowest from S5 (12). A total of five physico-chemical parameters have been selected for water analysis, the physico chemical parameters revealed that water quality of S1 is the best and S5 is polluted. Zooplankton play a key role in the aquatic food chain by controlling phytoplankton production and shaping pelagic ecosystems and serve as indicator species. Zooplankton are sensitive to fluctuations in water quality and as per the zooplankton status recorded during the study, most of the sites are tending fast towards eutrophication due to anthropogenic stress and urbanized location.

Keywords: Zooplanktons, Zooplankton diversity, Physico-chemical parameters, Junagadh

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INTRODUCTION

Freshwater ecosystems are fundamental in the climate change mitigation. They do so by providing a number of ecosystem services, including flood control and water purification. Rivers and streams deliver salts and nutrients from the foothills to lower-elevation lakes, ponds, and wetlands, and lakes exchange nutrients year-round.River and small lake ecosystems are under great threat [1] due to phenomena such as eutrophication, acidification, invasion of exotic species and pollution. Although, ecosystems are subject to change on a regular basis due to seasonal changes but these changes are triggered even more due to above mentioned anthropogenic stress which also affects the freshwater faunal biodiversity [2]. An important component of this freshwater ecosystem is zooplankton. Zooplankton are any minuscule biota (varying in size from microns to centimeters) living in water and drifting at the whim of currents [3]. Plankton -derived from the Greek word meaning drifter and was coined by[4]. Broadly, they are divided into two categories holoplankton (permanent plankton) which spend their entire lives as plankton and meroplankton (Temporary plankton) which is the larval stage of adult invertebrates. Plankton can produce clouds that block the sun's harmful rays in an indirec t way. Plankton create DMSP, a chemical molecule that acts as a cell wall for layer plankton. This chemical is broken down by bacteria and converted to DMS by sunlight(www.science.org/content/article/tiny-sea-creatures-are-making-clouds-over-southern-ocean). In a simple aquatic food chain, zooplankton act as primary and secondary consumer with phytoplankton as producers and fishes as the top carnivore. Zooplankton show diel-vertical migration and are considered as Bio indicators [5]. Seasonal variations have an impact on zooplankton as well. The leading phytoplankton species might change from season to season within a year. Physical-chemical bottom-up effect) and predation (top-down effect) influence these changes mostly through the aquatic food chain [6]. Junagadh city has population of 2.66 lakh and present water demand is 30 mld. Water is supplied through 25,000 tap connections by three major surface water sources. Junagadh City area limit was extended in January-04 increasing its area from 13.47 Sq. km to 57 Sq. Km. (https://junagadhmunicipal.org/water-works/). Along with the dams, Kalwa river and lakes of the city can be also used as a resourceto meet the water demand of people living in the Junagadh city if the sewage disposal and pollution into the river and lakes are checked. Therefore, the present study investigates the biodiversity of zooplankton and physico chemical parameters of seven different sites of Junagadh city. This assessment will help in understanding the role of zooplankton in the aquatic food chain and the study of physico chemical parameters will help in assessing the water quality.

MATERIALS AND METHODS

Study Area
Junagadh is a historical city in the Saurashtra region of Gujarat, situated at the foot of the Girnar Hills. Many freshwater bodies may be found in the vicinity of these hills. From the city of Junagadh, seven sample collection sites were chosen which are listed below in the table. Samples were taken from the surface, from each of the selected site and The GPS location was recorded therein. Figure 1: Location of selected sites for study: Junagadh, Gujarat, India (Source: https://earth.google.com/web/). Table 1 showing Site no, name and GPS location of selected sites.

Sample Collection
Physio-chemical parameters and zooplankton analysis samples were collected on a monthly basis throughout the duration of the study (August 2021 to February 2022). For sampling, a plankton hand net made of nylon bolting cloth with a mesh size of 25 μm was "'utilized. Concentrated plankton sample treated and stored in 4 percent immediately after sample collection. Plankton samples were examined under a compound binocular microscope and identified using standard literature up to the genus and species level wherever possible [7].

Physico-Chemical Parameters
These collected water samples were evaluated for a total of 6 physio-chemical characteristics. pH, TS, TDS, TSS, DO, BOD, and other parameters are among them. The analysis was carried out using standard procedures [8].

RESULT

A total of 70 species of zooplankton were recorded from all the selected sites of Junagadh district. A total of 3827 individuals were recorded from all the sites. (Lackey's drop count method). Highest zooplankton diversity was recorded from S6 (31) and lowest from S5 (12).

DISCUSSION

Physico chemical parameters
Fluctuations in the values of various physico chemical parameters at seven selected sites are shown in table. The highest pH value was observed in S1 (7.75) and the lowest in S7 (6.95). Increased value in S1 May be due to decomposition of organic matter and reduced rate of photosynthetic activity**[9]**. Decreased pH in S7 is due to release of free carbon dioxide as a result of oxygenation of organic matter and the respiratory activity of micro fauna [10]. Highest DO was recorded in S1 (5.22 mg/l) and lowest in S5 (3.01). Lowest DO in S5 is possibly due to sewage discharge in the river and increased eutrophic conditions. Highest BOD was recorded in S2 (2.94 mg/l) and lowest in S5 (1.82 mg/l). Highest BOD in S2 is due to higher rate of decomposition of organic matter [11]. Lower BOD in S5 is due to release of sewage and domestic wastewater and decreased rate of decomposition of organic matter [12]. Highest TS was recorded in S7 (653.41 mg/l) and lowest in S4 (194.68 mg/l). TS is positively correlated with TDS. Highest TSS was recorded in S5 (62.16 mg/l) and lowest in S4 (47.81 mg/l). Higher turbidity in S5 accounts for increased TDS levels [13]. Highest value of TDS was recorded in S7 (594 mg/l) and lowest in S4 (146.87 mg/l). Decomposition of large amount of organic matter that results when dense stands of water hyacinth (*Eichornia crassipes*) lead to an increase in TDS levels in S7 [14]. Lower levels of TDS in S4 indicate minimal disturbance and proper management of the reservoir.

Zooplankton
A total of 70 species of zooplankton were recorded from all the selected sites of Junagadh district. A total of 3827 individuals were recorded from all the sites. (Lackey's drop count method). Highest zooplankton diversity was recorded from S6 (31) and lowest from S5 (12). The increased diversity in S6 may be due to its central location in the city, optimum temperature and humidity. Ciliates and rotifera were more abundant in S6 which may be due to toxic conditions and hypertrophic conditions of pond at higher temperature and lower water level [15]. Presence of *Brachionus angularis, Trichocerca, Filinia longiseta* are indicators of eutrophication of water bodies [16]. Phytoplankton population directly influences the population of zooplankton. Dead rotifers were used as food by scavenger ciliates (*Colepshirtus* and *Tetrahymena* pyriformes) hence, increasing their population. Lowest diversity in S5 may be attributed to sewage discharge and plastic pollution which results in highly toxic conditions of the river. *Paramoecium caudatum* and *Paramoecium aurelia* are found to survive in toxic conditions of water. *Nepa*waterfly, Parasitic egg, *Drosophila melanogaster* larva, Drain fly larva were found only in S5. According to [17], *Ceriodaphnia sp.* are considered as indicators of of eutrophic status of waterbodies. Ciliates were most abundant group in S2, S4, S6, S7, this is attributed to their omnivorous feeding habits which enable them to occur in both hard and polluted waters [18]. Some studies were conducted by [19], [20] and [21]. *Microstomum*, Damsel fly nymph were found to be present in S1. *Zoothamnium, Peritricha***,** *Trachelius ovum*, *Cosmeriumbrebisonii, Brachionusplicatilis, Ancylostoma duodenale, Stentor niger* were found only in S2. *Eutardigrade*, Stenostomum, *Daphnia carinata*, *Rotarianeptunia* were found only in S7, their increased population may be due to their adaptability in *Eichornia crassipes* infested area. *Paramoecium caudatum* was found to be present in all seven sites.

Diversity Indices
Diversity indices serve as good indicator of the overall pollution of water. Non-polluted waters are often characterized by high diversity and no single species dominating in numbers over others. With pollution, sensitive species are eliminated and tolerant species increase in number. Six diversity indices Dominance D, Simpson_1-D, Shannon H, Brillouin, Menhinick and Margalef were calculated for all the seven sites. The value of diversity indices

ranges from 0-1. Higher the value, greater is the diversity and evenness (except for Dominance). Higher asset values of Dominance were found in S5(0.1161) and lowest in S6(0.04487). For other diversity indices, highest values were obtained from S6 and lowest from S5. This indicate that Dominance was found to be negatively correlated with other diversity indices. Simpson's index and Shannon wiener index was found to be highest in S6 (1-D- 0.9551, H-3.241) and lowest in S5 (1-D-0.8839, H-2.319). Decreased value indicate eutrophic state of water bodies. As the value for diversity indices fall, level of pollution rises and shows unhealthy status of water body. Hence, S5 shows least diversity and S6 represents highest diversity among all the selected sites. On the basis of classification of waters for various for various uses given by Central Pollution Control Board (http://cpcb.nic.in/Water_Quality_Criteria.php). The water of S1 categorised as D, S2, S3 and S4, S6 as C and S7 as E. S5 has deteriorated water quality and S1 has good water quality.

CONCLUSION

Based on the present study, the physico chemical parameters revealed that water quality of S1 is the least polluted as compared to other selected sites and S5 is highly polluted as compared to other selected sites. Status of zooplankton revealed that diversity of S6 is highest and that of S5 is lowest. Presence of organic matter drives the zooplankton diversity to highest in S6 and high sewage discharge and garbage dumping limits the zooplankton diversity. As per the zooplankton status, most of the sites are tending fast towards eutrophication due to anthropogenic stress and urbanized location.

ACKNOWLEDGMENT

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Table 1 Showing Site no, name and GPS location of selected sites.

Sr No.	Site no.	SITES	GPS location
1.	S1	Sudarshan Lake	21º31'38.03"N 70º30'12.62"E
2.	S2	Sonrakh River	21º32'23.59"N 70º27'57.20"E
3.	S3	Narayan Dharo	21º31'37.91"N 70º29'29.46"E
4.	S4	Willingdon Dam	21º30'17.39"N 70º28'52.23"E
5.	S5	Kalva River	21º30'33.21"N 70º26'06.30"E
6.	S6	Narsinh Mehta Lake	21º31'05.98"N 70º27'20.77"E
7.	S7	Vadla Talav	21º28'22.73"N 70º24'04.67"E

Table 2. Status of zooplankton of selected sites in Junagadh district

ZOOPLANKTON	S1	S2	S3	S4	S5	S6	S7
PROTOZOA							
Amphileptus procerus	+	+	-	-	-	-	-
Aspidisca sp.	-	-	+	-	-	-	-
Carchesiumpolyponium(Linnaeus,1758)	-	-	+	-	-	-	-

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Colepshirtus	+	-	+	+	+	+	+
Cosmeriumbrebisonii	-	+	-	-	-	-	-
Dileptus sp.	-	-	+	-	-	+	-
Epistylissp	-	-	-	-	-	+	-
Euglena acus (Ehrenberg 1830)	+	-	-	-	-	-	+
Euglena gracilis (klebs, 1883)	+	-	-	+	+	-	+
Euglena virdis (O F Mueller)	+	+	+	+	-	+	+
Euplotes patella (Ehrenberg, 1830)	-	+	-	-	-	+	-
Frontonia elliptical	-	-	-	-	+	-	-
Heliozoa	+	-	-	-	-	-	+
Loxophyllum sp. (Dujardin, 1840)	-	-	-	-	-	+	-
Paramoecium aurelia (Ehrenberg, 1838)	-	-	-	+	+	+	-
Paramoeciumcaudatum (Muller, 1773)	+	+	+	+	+	+	+
Peritricha sp.	-	+	-	-	-	+	-
Phacussp (Dujardin, 1841)	+	+	-	+	-	+	+
Stentor niger	-	+	-	-	-	-	-
Stentor roeselii	+	-	-	+	-	-	+
Stentor sp.(Free swimming)	-	-	-	+	-	+	-
Tetrahymena pyriformes (Sonneborn, 1937)	-	-	-	-	-	+	-
Trachelius ovum	-	+	-	-	-	-	-
Vorticella campanula	-	+	+	-	-	-	+
Vorticella infusionium	-	+	+	-	-	-	-
Zoothamnium	-	+	-	-	-	-	-
ROTIFERA							
Asplanchnaherrickii(De Guerne,1888	-	+	+	-	-	-	-
Asplanchnapriodonta	-	+	-	-	-	-	-
Asplanchnasp	-	-	-	+	-	+	+
Brachionus angularisangularis (Gosse, 1851)	-	-	-	-	-	+	+
Brachionuscaylciflorus (Pallas, 1776)	+	+	+	-	-	+	+
Brachionusdiversicornis (Daday, 1883)	-	-	-	-	-	+	-
Brachionusplicatilis	-	+	-	-	-	-	-
Brachionusquadridentatus (Hermann, 1783)	-	-	-	-	-	+	-
Brachionusrubens (Ehrenberg, 1838)	-	-	-	-	-	-	+
Brachionusurceolaris (Muller, 1773)	-	-	-	-	-	-	+
Filinialongiseta (Ehrenberg, 1834)	-	+	-	-	-	+	-
Keratella quadrata (Muller, 1786)	-	+	+	-	-	+	-
Keratellatropica (Apstein, 1907)	-	-	-	-	-	+	-
Lecane bulla (Gosse, 1851)	-	+	-	-	-	+	-
Philodinaroseola(Ehrenberg,1830)	+	+	+	-	-	-	-
Polyarthravulgaris (Carlin, 1943)	-	+	-	+	-	+	-
Rotarianeptunia (Ehrenberg, 1832)	-	-	-	-	-	-	+
Trichocercarattus (Muller, 1776)	-	-	-	+	-	+	-
COPEPODA							
Mesocyclops sp.	+	+	+	+	-	+	+
Heliodiaptomusviddus (Gurney, 1907)	-	-	-	-	-	+	-
Nauplii sp.	-	-	+	+	-	+	+
CLADOCERA							
Ceriodaphniapulchella (Sars, 1862)	-	-	-	+	-	+	+

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Ceriodaphnia sp.	+	-	-	-	+	+	-
Daphnia carinata (King, 1853)	-	-	-	+	-	-	+
Daphnia obtusa (Kita, 1874)	+	-	+	-	-	+	-
Daphnia pulex (Wotzel, 1937)	-	+	-	+	-	+	-
OSTRACODA							
Hemicyprisanomala (Klie, 1938)	-	-	+	-	-	-	+
Ostracod nauplii	-	-	+	-	-	-	-
Stenocypris major major (Baird, 1859)	-	-	+	-	-	-	-
WORMS							
Aelosoma sp. (Ehrenberg, 1828)	-	+	-	-	-	-	+
Ancyclostoma duodenale	-	+	-	-	+	-	-
Chaetogaster	-	+	-	-	-	-	-
Microstomumsp	+	-	-	-	-	-	-
Propsilocerussaetheri (Wang liu and Paasivirta, 2007)	-	-	+	-	-	-	-
Stenostomum unicolor (Schmidt, 1848)	-	-	-	-	-	-	+
TARDIGRADA							
Eutardigrade sp. (Goeze, 1773)	-	-	-	-	-	-	+
MEROPLANKTON							
Chironomidae larva	-	-	+	-	+	+	-
Damsel fly nymph	+	-	-	-	-	-	-
Drain fly larva	-	-	-	-	+	-	-
Drosophila larva sp.	-	-	+	-	+	-	-
Ephemeroptera nymph	-	-	-	-	-	+	-
Nepa water fly	-	-	-	-	+	-	-
Parasitic egg	-	-	-	-	+	-	-
Water mite sp	-	-	+	-	-	-	-

Table 3. Variation in physico chemical parameters among selected sites

Physico-Chemical Parameters	S1	S2	S3	S4	S5	S6	S7
pH	7.75	7.41	7.39	7.52	7.12	7.36	6.95
DO	5.22	3.81	3.95	3.22	3.01	4.53	3.74
BOD	2.66	2.94	2.25	1.97	1.82	2.55	1.97
TS	337.15	402.625	455.65	194.68	557.5	316.97	653.41
TDS	283.75	347.75	400.75	146.87	495.37	267.62	594
TSS	53.43	53.76	54.88	47.81	62.16	49.35	59.41

Table 4. Relative abundance of zooplankton among selected sites

Zooplankton Communities	Relative abundance
Protozoa	51.53
Rotifera	15.26
Copepoda	8.57
Cladocera	11.86
Ostracoda	1.1
Worms	4.67
Tardigrada	0.14
Meroplankton	6.87
Total	100

Table 5. Diversity indices among selected sites

Diversity Indices	S1	S2	S3	S4	S5	S6	S7
Dominance_D	0.07411	0.07266	0.06613	0.08026	0.1161	0.04487	0.05678
Simpson_1-D	0.9259	0.9273	0.9339	0.9197	0.8839	0.9551	0.9432
Shannon_H	2.717	2.821	2.851	2.646	2.319	3.241	2.961
Brillouin	2.641	2.719	2.774	2.551	2.284	3.124	2.852
Menhinick	0.7398	1.126	0.8367	0.8307	0.4174	1.304	1.058
Margalef	2.552	3.871	3.103	2.535	1.745	4.734	3.461

Figure 1: Location of selected sites for study: Junagadh, Gujarat, India (Source: https://earth.google.com/web/)
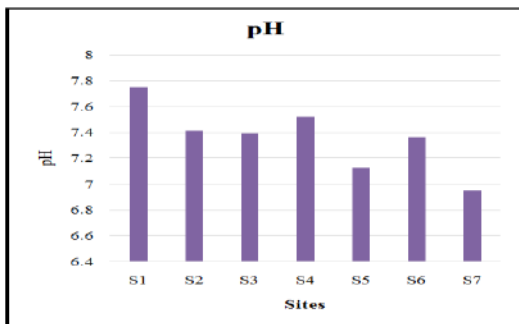
Figure 2: Variation in pH among selected sites
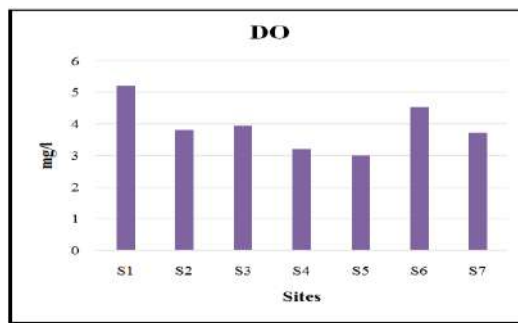
Figure 3: Variation in DO among selected sites
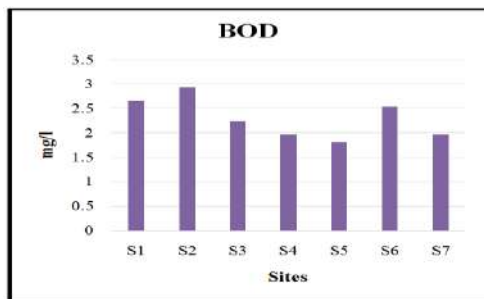
Figure 4: Variation in BOD among selected sites
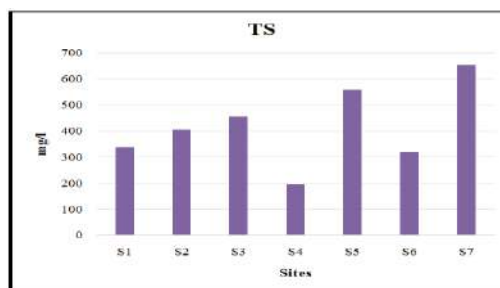
Figure 5: Variation in TS among selected sites

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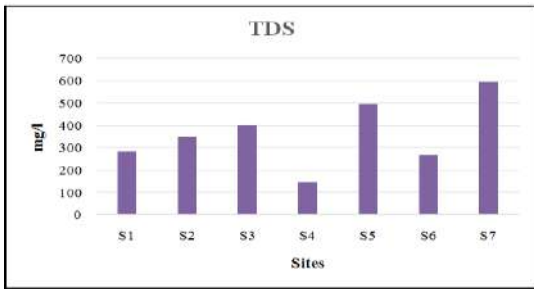
Figure 6: Variation in TDS among selected sites

Figure 7: Variation in TSS among selected sites
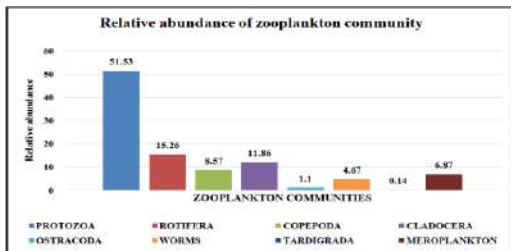
Figure 8: Relative abundance of zooplankton community
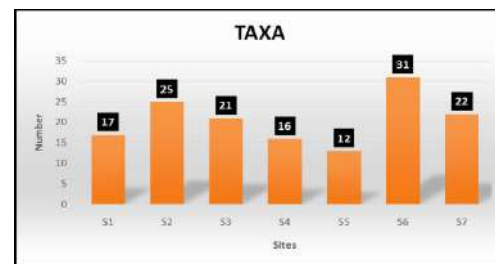
Figure 9: Taxa of zooplankton community among selected sites
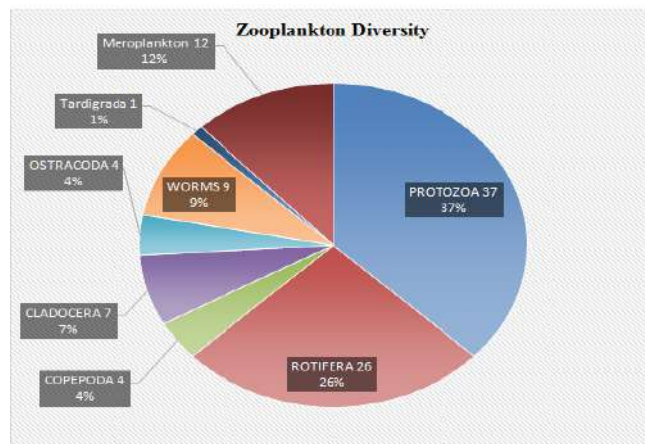
Figure 10: Zooplankton diversity among selected sites of Junagadh district

RESEARCH ARTICLE

Influence of Training System and Nano Nitrogen on Certain Growth and Flowering Characters in Ridge Gourd (*Luffa acutangula* L.) COH 1

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ABSTRACT

The nano nitrogen fertilizer balanced up to 50% loss of the conventional nitrogen by volatilization and another 5-10% by leaching that leads severe environmental consequences such as eutrophication. Also nano nitrogen is increasing the nitrogen use efficiency and plant nutrient uptake by limiting losses of nutrients. The foliar application of nano fertilizer leads to higher nutrient use efficiency (NUE) and has given a rapid response to the growth of crops. An experiment was conducted during the year 2020 to find out the best training system and nano nitrogen dose level on ridge gourd at Chidambaram, Tamil Nadu, India. The data collected from the growth and flowering parameters were put through to Analysis of Variance for randomized block design (RBD). The result generated from the experiment was statistically significant ($P \geq 0.05$) for all the growth characters recorded. The training system (Pandal system) and nano nitrogen was observed to be significantly superior over other training systems, as it has recorded profuse growth in respect of maximum vine length (9.23m), number of primary branches (7.50vine^{-1}),total chlorophyll content (3.67 mg g^{-1})and number of leaves(239.67 vine^{-1}) and leaf area (6260.78 cm^2), and Days taken to first female flower appearance(44.63),Days taken to first male flower appearance (39.86) and number of female flowers (29.87 vine^{-1}) are found significantly superior over all the other nano nitrogen levels and training systems. This study has identified that nano nitrogen and training system (Pandal system) have the significant influence on certain growth and flowering characters on ridge gourd.

Keywords: Ridge gourd, Growth, Flowering, Nano nitrogen, Training system.

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INTRODUCTION

Training is an important practice in vegetables to obtain optimum vegetative growth, flowering, higher yield and good quality produce (Narayan *et al.,* 2008). Balaji *et al.,* (2016).In their study, they have reported that ribbed gourd cultivated under pandal system in 3 villages each of Anamalai block and Madukkarai block has given an average yield of 17.50 tones with net returns of Rs.1,45,285 per hectare which was technologically improved practice over traditional method of ribbed gourd cultivation in Tamil Nadu.Nanotechnology is one of the new technologies that entered almost all sides of our lives and are being used in agriculture production. Nowadays nanotechnology has expanded horizons in all fields of science. It can be used in crop production to improve growth and increase yield (Reynolds, 2002).Substituting traditional methods of fertilizer application with nano-fertilizers is a way to release nutrients into the plant gradually and in a controlled way (Naderi and Abedi, 2012). Hence, nano-fertilizers are either nano-materials which can supply one or more nutrients to the plants resulting in enhanced growth, flowering and yield, or those which facilitate for better performance of conventional fertilizers, without directly providing crops with nutrients. The application of nano particles to plants can be beneficial for growth and development due to its ability for greater absorbance and high reactivity (Liu and Lal, 2015).The farmer grows this crop with a support or trailing the ridge gourd. The importance of providing supports (training) to the vines has been emphasized by the number of workers in ridge gourd. The advantages of these supports are attributed to efficient disease and pest management, easy harvesting and improving yield and quality of fruits. Therefore, present investigation was under taken to study the effect of nano nitrogen and different training systems on growth and flowering characters in ridge gourd (COH 1).

MATERIALS AND METHODS

This experiment was undertaken during the year 2020 in the area of Varagoorpettai a village located near Annamalai nagar, Chidambaram, Tamil Nadu, India. The experimental location contains sandy clay loam soil with clay loam texture. The climate is subtropical, warm and humid, with average rainfall and high humidity as distinguishing features. The experimental site received approximately 968mm of rainfall per year, with a mean minimum temperature of 26^0C, a maximum temperature of 35^0C, and a relative humidity of 78%.The experiment was conducted in the area of $435.6m^2$ divided into $14.52m^2$sized plots of each one. The experiment was set up in a Randomized Block Design and three replications consisting of ten treatments. Total ten treatments were tried namelyT_1-Control (Ground trailing without nutrients),T_2-Flatbed + Nano Nitrogen @4 ml/ lit of water,T_3-Flatbed + Nano Nitrogen @3ml / lit of water,T_4-Flatbed + Nano Nitrogen @2ml/ lit of water,T_5-Staking + Nano Nitrogen @4 ml/ lit of water,T_6-Staking + Nano Nitrogen @3ml / lit of water,T_7-Staking + Nano Nitrogen @2ml/ lit of water,T_8-Pandal system+ Nano Nitrogen @4 ml/ lit of water,T_9-Pandal system+ Nano Nitrogen @3ml / lit of water, T_{10}- Pandal system+ Nano Nitrogen @2ml/ lit of water, COH1 hybrid seeds are sown in Rabi season and various levels of nano nitrogen with different training systems, all suggested cultural practices and plant protection measures were followed throughout the growing season. Following field preparation, seeds were planted at a rate of two seeds per hole and at the plant spacings to achieve the necessary population densities. The crop was supplied with 25 tons per hectare of well rotten farm yard manure along with nitrogen 100 kg phosphorous and 100 kg potash as perthe recommended dose of fertilizers and nitrogen was applied through nano form (foliar spray). All P, K and 1 /4th N were applied at the time of land preparation and another 3/4th of N in three equal parts as top dressing. Also the system of training(flat bed, staking and pandal) and nano nitrogen(3 levels) were applied as per the treatment schedule. The ridges and furrow irrigation method were used for surface irrigation. Observations were recorded for five different growth parameters related to vine length (m), number of primary branches vine^{-1}, number of leaves vine^{-1}, leaf area(cm^2),total chlorophyll content(mg g^{-1}),days taken to first female flower appearance and days taken to first male flower appearance and number of female flowers vine^{-1}. The data were taken from all the growth and flowering characters in all treatments and replication.

Data collection and analysis
Data was taken from five plants randomly selected from each plot and tagged for the purpose of collecting data.

Vine length (m)
The length of vine from the crown or collar to the tip was measured after the final harvest and expressed in meter.

Number of primary branches vine $^{-1}$
The total number of branches were recorded for each sample plant at the time of final harvesting and expressed in number.

Chlorophyll content(mg g^{-1})
Fully expanded fifth leaf from the tip of the plant was taken for the chlorophyll extraction. Chlorophyll was extracted in 80% acetone and the absorption at 663 nm and 645 nm read in spectrometer, using the absorbance co-efficient, the amount of chlorophyll was calculated and expressed in milligram per gram of tissue.

Formula
Chlorophyll A = 12.7 (A_{663})-2.69(A_{645}) X V/1000 X W
Chlorophyll B = 22.9 (A_{645})-4.68(A_{633}) X V/1000 X W
Total Chlorophyll = 20.2 (A_{645})-8.02(A_{633}) X V/1000 X W
A = Length of light path in the cell (cm)
V = Volume of extract in ml
W = Fresh weight of the sample

Number of leaves vine^{-1}
The total number of leaves per plant was counted on 120 days after sowing and expressed in numbers.

Leaf area(cm^2)
The leaf area (cm^2)was calculated.

Days taken to first female flower appearance
The number of days taken from the date of germination to the date of opening of first female flower and expressed in number.

Days taken to first male flower appearance
The number of days taken from the date of germination to the date of opening of first male flower and expressed in number.

Number of female flowers vine $^{-1}$
The number of female flowers were recorded by counting all the female flowers that occurred during cropping period.

RESULTS AND DISCUSSION

Vine length (m)
The data on the effect of training system and nano nitrogen on the vine length (m)of ridge gourd is presented in table 1.Among the treatments, maximum vine length was observed in T_8 (9.23) and it was followed by T_5(8.53). The minimum vine length (m) was found in control T_1 (4.02), which was significantly differed from all other treatments. The maximum values in vine length (m) by imposing the increased level of nano nitrogen with the pandal training system could be due to better performance in branching leads to obtain the better results that are in close agreement

with the finding of Khospeyak *et al.*, (2016) who reported that the system of trailing the plant on pandal had a greater influence on the all morphological characters. Also, (Mandeh *et al*., 2012; Song *et al.*, 2013) who reported that the significantly higher values in vine length (m)with nano fertilizer treatment over conventional fertilizers.

Number of primary branches vine^{-1}

Ridge gourd COH1 showed significant variation in number of primary branches vine^{-1} and ranged from 2.72 to 7.50. Among the treatments the maximum number of primary branchesvine^{-1} were observed in T_8 (7.50)., followed by T_5 (7.02). The minimum number of primary branches vine^{-1} were observed in control T_1 (2.72), The increase in number of primary branches vine^{-1} with increase in nano nitrogen rate may be due to the fact that nitrogen promoted vegetative growth and branching on the inflorescence (Khospeyak *et al.*,2016). Also, Premalatha *et al.* (2006) reported that the increase in number of branches vine^{-1} could be due to increase in trailing height.

Chlorophyll content (mg g^{-1})

The data on chlorophyll content(mg g^{-1})as influenced by application of various combination of training system and nano nitrogen are presented in Table 1. There were significant influence on total chlorophyll content (mg g^{-1}). The maximum chlorophyll content (mg g^{-1})was recorded in T_8 (3.67) which was followed by T_5 (3.05) and T_9 (3.01). The minimum chlorophyll content was recorded in control T_1(1.05). The higher chlorophyll content(mg g^{-1})could be due to the application of Nitrogen in nano form which results in better absorption and less nutrient loss and more nutrient use efficiency due to small size to large surface area volume. This results was consonance with the findings of Khospeyak *et al.*,2016 and Udit 2014. Also Nitrogen plays chief role in chlorophyll synthesis which result in dark green leaves and promotes healthy leaves and other vegetative parts of plant. (Bloom,2015).

Number of leaves vine^{-1}

Significant differences were found in the number of leaves vine^{-1}with various training systems and nano nitrogen as mentioned in table 1. The maximum number of leaves vine^{-1}were observed under T_8 (239.67), it was followed by T_5(213.67). The minimum number of leaves vine^1 were noted under T_1(139.53), which was significantly differ from all other treatments. It could be due to application of Nano fertilizers makes more availability of nutrients to leaves, consequently increase the nutrient use efficiency. This was supported by the findings of Suppan(2013).The trailing system produced the taller plant which leads increase in number of leaves vine^{-1}. Similar results were reported by Premalatha *et al.* (2006).

Leaf area (cm^2)

There was significant difference observed in the leaf area (cm^2)in table 1. It was maximum (6260.78) while impose the treatment combination of pandal system of training and higher level of nano nitrogen (T_8). Which was followed by T_5 (6029.63). The minimum leaf area(cm^2) was noticed in T_1 (4209.23).Increased values in leaf area(cm^2) could be due to the increased level of auxin, carbohydrates and other compounds produced as a result of higher Nano- Nitrogen supplied to the plants. The result was in line with the results of experiments carried out by (Bloom, 2015 and Balaji *et al* ., 2016).

Days taken to first female flower appearance

Different training systems and various levels of nano nitrogen on days taken to first female flower appearance is depicted in table 1. All the treatments proved to be significantly superior to control in advancing the appearance of the first female flower. The earliest induction of female flower was observed in T_8 (44.63), followed by T_5 (46.20) and T_9 (46.97). The T_1 took maximum days taken to first female flower appearance T_1 (58.44). It isinline with the experiments of (Laware and Shilpa Raskar, 2014) who envisaged that the number of days to 50% flowering is an important criterion that governs the earliness of a crop. It is influenced by diverse factors like genetic, environmental, physiological, nutritional, hormonal and cultural. It was supported by the findings of (Zeevaart, 2006).

Days taken to first male flower appearance

Significant differences were found in days taken to first male flower appearance with varied training systems and different levels of nano nitrogen as mentioned in table 1. Days taken to first male flower appearance ranged from 39.86 to 53.57. Among the treatments minimum days taken to first male flower appearance was observed in T_8 (39.86) which was significantly different from all other treatments. The maximum days taken to first male flower appearancewas observed in T_1 (53.57).The earliness obtained in flowering could be due to the application of nano nitrogen which is the main component of protein, and all types of enzymes are mainly composed of proteins, nucleotides, co-enzymes, phospholipids and cytokinins. Previous studies have also confirmed that many hormones such as gibberellin and cytokinin are closely related to the regulation of flowering (Bernier and Perilleux, 2005).This might be due to the more vegetative growth and accumulation of leaf unit extend the maturity period. Similar result was reported by Premalatha *et al*. (2006).

Number of female flowers vine^{-1}

Significant differences were found in number of female flowersvine^{-1} under training systems and nano nitrogen as mentioned in table 1. Number of female flowers vine^{-1} ranged from 29.87 to 19.23.Among the treatments maximum number of female flowers vine^{-1} was observed in T_8 (29.87) which was significantly different from all other treatments. The minimum number of female flowersvine^{-1} was observed in T_1(19.23) which were also significantly different from all other treatments. It could be due the accumulation of nano nitrogen during the vegetative phase which increased the plant growth and got transferred to the reproductive organs. The result is in close agreement with (Osama *et al*. 2015). Also the pandal system of training has facilitates the trailed plants to get good sun light and aeration which leads more production of female flowers (Okonmah, 2011). This results was consonance with the findings of (Jaffar and Wahid., 2014).

CONCLUSION

New techniques and new methods have been used in order to avoid the detrimental effect of these factors. The nano technology is one of the new technologies that into being to be used in Agriculture production. The researchers indicate many of the potential benefits of nanotechnologies. Based on the present findings it could be concluded that replacing nitrogen fertilizer has increases the growth of ridge gourd "COH1". The application of nano nitrogen fertilizer can reduce harmful effects of nitrogen to the environment by reducing harmful nitrogen inputs. Among the various training system, the pandal training system proved as the best method due to its production of vine length (m), number of primary branches vine^{-1}, chlorophyll content (mg g^{-1})and number of leaves vine^{-1}, leaf area(cm^2) as well as, days taken to first female flower appearance, days taken to first male flower appearance, number of female flowers vine^{-1} ultimately the highest growth.

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Table 1.Influence of training system and nano nitrogen on certain growth and flowering characters in ridge gourd (*Luffa acutangula* L.) COH1.

Treatments	Vine length (m)	Number of primary branches vine^{-1}	Total chlorophyll content (mgg^{-1})	Number of leaves vine^{-1}	Leaf area (cm²)	Days taken to first female flower appearance	Days taken to first male flower appearance	No of female flowers vine^{-1}
T₁- Control (Ground trailing without nutrients)	4.02	2.72	1.05	139.53	4209.23	58.44	53.57	19.23
T₂- Flatbed + Nano Nitrogen @4 ml/ lit of water	5.20	4.69	1.84	158.73	4810.02	53.47	49.72	23.91
T₃- Flatbed + Nano Nitrogen @3ml / lit of water	4.67	4.02	1.69	149.65	4532.24	55.30	50.36	22.15
T₄- Flatbed + Nano Nitrogen @2ml/ lit of water	4.53	3.51	1.29	142.34	4325.10	56.83	52.51	20.67
T₅- Staking + Nano Nitrogen @4 ml/ lit of water	8.53	7.02	3.05	213.67	6029.63	46.97	41.13	28.42
T₆- Staking + Nano Nitrogen	6.23	5.89	2.21	173.27	5150.73	49.41	45.28	25.81

@3ml / lit of water								
T7- Staking + Nano Nitrogen @2ml/ lit of water	5.64	5.32	2.01	161.04	5013.43	52.36	47.49	25.33
T8- Pandal system+ Nano Nitrogen @4 ml/ lit of water	9.23	7.50	3.67	239.67	6260.78	44.63	39.86	29.87
T9- Pandal system+ Nano Nitrogen @3ml / lit of water	7.56	6.76	3.01	204.87	5923.28	46.20	42.92	27.23
T10- Pandal system+ Nano Nitrogen @2ml/ lit of water	6.72	6.21	2.62	182.54	5441.49	48.19	44.64	26.64
S.E.D	0.18	0.16	0.07	5.15	106.69	1.49	0.96	0.73
C.D (p=0.05)	0.38	0.33	0.14	10.82	316.99	3.14	2.87	1.53

RESEARCH ARTICLE

Decentralized Municipal Solid Waste Management and Institutional Arrangements: A Case Study of Chottanikkara Panchayat.

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ABSTRACT

Decentralized Solid Waste Management is widely practiced in developing countries worldwide. But due to lack of proper communication and participation, along with socio-cultural and financial challenges this management system goes in vain without a sustainable solution. Rapid urbanizing of rural areas along with advancing technology and lifestyle factors, pressurize the local bodies to adopt a cost-effective sustainable system for proper management of this garbage menace. This paper presents a specific case of such a local body in Ernakulum district of Kerala successfully practicing a multi-pronged sustainable waste management approach of collection, storage, and transport. The study focuses on the institutional arrangements and strategies which helped the local body in proper functioning and efficacy in service delivery. The data was collected from extensive filed work done from July 2019 to January 2020 and secondary sources. The findings of the case suggest a systematic organizing principle by utilizing all available resources and making the 'waste' itself as a valuable resource via properly managed system. This model can be an inspiration to other local bodies in developing countries.

Keywords: Decentralized Municipal Solid Waste Management; Green economy; Local Body; Chottanikkara Model; Kerala.

INTRODUCTION

Solid Waste Management tackles amalgamated with waste generation, inadequate collection, transport, and disposal is a confronting phenomenon in developing countries. Solid Waste, which is a byproduct of socio-economic activities vary from place to place based on its nature and quantity (Ganeshan, 2017).It is estimated that global waste generation per year is about 500 million tons (Shen, Guo & Xin, 2012).Waste segragation from the source towards disposal points are rare in developing countries. And results in leaving 'resource' useless in dumping yards (Ikiara , Karanja & Davies,2004).High content of organic matter is a characteristic of unsorted waste with respect to that of developed countries(Ziraba, Haregu & Mberu, 2016).Total waste composition of India consists about more than 50 % organic components, 31% inert waste and 18% recyclable waste (Earth Engineering Centre, 2012).Proportion of plastics, paper, glass materials, metallic components, and rubber in the waste composition is also constantly increasing(Singh, n.d.). Huge volume of waste generation with continuously altering physical constitution and quantity of solid waste as a result of rapid urbanization, population redistribution, economic development, average income level, source, changing life style and constant change in consumption pattern and social behaviour, climate, packing and other industrial productions and the market for waste materials has created meloncholy situation to a country like India to cope with it. This cause environmental impacts and affect the public health(Varma, 2006; Singh, n.d; Ancog, Archival,& Rebancos, 2012; Subramani, Umarani & Bharathidevi, 2014;Kumar, Smith , Fowler, Velis, Kumar, Arya, Kumar, Cheeseman,2017).

Recycle, Reuse, Reduce, Compost, and Sanitary land filling are the widely accepted modern waste management approaches but least practiced (Ziraba,Haregu & Mberu, 2016).Decentralized solid waste management practices are put forward as a practical solution to increasing risk of garbage. "The Decentralized Solid Waste Management (DSWM) is a system to provide a clean environment and hygienic living condition by reducing the quantity of waste at source"(Karthykeyan, Aziz, Chatri & Shah, 2012; Singh, n.d.). Solid waste management within the locality is the core idea behind this system. It can be the best sustainable and financially viable practices if implemented properly. It can also helps to ameliorate the standard of living, quality life and working conditions of the waste pickers(Singh, n.d.). A coordinated effort of the local government in partnership with the community and civil society can bring this in to effect. The public-private partnership can help advance in waste management particularly on the aspects of capacity interventions and scientific treatments of waste. Also it can enhance the calibre of local self government institution units to provide basic public services along with attaing environmental goals. This paper aimed to present the specific case of Chottanikkara Panchayat in its efforts to address the waste issues and concerns at all levels. Chottanikkara is a leading Panchayat with ISO certification with prestige pilgrimage in its town which is a famous tourist destination. The Panchayat, with an urban nature receive a large number of transient visitors, usually for religious or cultural purposes. The floating population and existing population more than 22600 aggravates the generation of solid wastes, creating a menace in waste management. Chottanikkara Panchayat is one of the leading local bodies in Kerala practicing a multi-pronged sustainable waste management approach of collection, storage and transportation of waste (Krishnakumar, 2019).

METHODOLOGY

Data for this paper were collected from extensive field work carried out from July 2019 to January 2020 and from secondary sources, including academic publications, official records of Chottanikkara panchayat, Haritha Kerala Mission publications, newspapers-Mathrubhumi, The Hindu, Times of India, websites of Suchitwa Mission, Haritha Kerala Mission, Kudumbasree, Mission, Local Self Government, District Administration, KILA, IRTC, Clean Kerala Company and so on.

RESULTS AND DISCUSSION

Location and Population

Chottanikkara Panchayat with an area of 12.56 sq. km is an urban agglomeration which is part of Kochi city in Ernakulam District.

District   :Ernakulam
Taluk   : Kanayannur
Block   :Mulanthuruthy
Legislative assembly   : Piravom
Population   :22,656 (2011 census)
No. of Houses   : 8197
No. of Commercial Establishments : 480

Economy

The machinery industry is one of the main economic mainstay of this area along with tourism industry as Chottanikkara temple located in the town is a famous testimonial pilgrim centre.

Solid Waste Profile

Local Self Government Institution (LSGI) of Chottanikkara is responsible for the management of solid waste generated in the Panchayat. There are 9 public toilets in use for areas such as Bus depot and tourist places. The administration has been decentralized into14 wards. The Assistant Secretary is the overall in-charge of solid waste management in the Panchayat along with aid from Village Extension Officer(VEO). Around 78 tons of biodegradable wastes and 3 tons of non-biodegradable solid waste is generated every month. The Major sources of solid waste generation includes households, shops and establishment, schools, temples, hotels, bakeries, street vendors, market ,vegetable shops, meat shops, hospitals, clinics, industries and others. The local body had spent an amount of Rs.10,43,656 only for solid waste management during the year 2018-19.

Institutional Arrangements and Strategies Implemented for Solid Waste Management

The institutional arrangements in Chottanikkara Panchayat for solid waste management lies between and among key actors that include the local government, the community, and the private sector.

Registration and User Fee

As an initial step, voluntary participation of community is appreciated with a registration number and their consent to hand over segregated waste from households and commercial establishments with a fixed user fee ranging from 50 to 500. The user fee is based on 'polluter should pay' principle of Solid Waste Management Rules, 2016 amended in 2020. It is a strategy to make people aware that one who generates waste has the responsibility to dispose it as well along with an expectation of reduction in generation. A fixed fee of 50 rupees from households and ranging from 100 to 500 rupees based on quantity from commercial institutions are collected on monthly basis as user fee in Chottanikkara Panchayat. By this time, 6205 houses and 480 commercial Institutions have been registered (Karun, & Haritha Keralam Mission team, 2020b).

Infrastructure
Collection Scheme

The collection schemes have been implemented at three different levels- Household level, Community level and Block Level. The collection is done with Haritha Karma Sena, the task force in each ward. As the residents are sensitized towards the need for source level sorting for better management, basic segregation of bio degradable and non-biodegradable wastes takes place at household/institutional level itself. Community level biodegradable wastes from hotels, bakeries, markets and so on are collected to produce organic fertilizer and the household level biodegradable wastes are disposed at source itself. Material Collection Facility (MCF) centre is the place where the

collected non-biodegradable wastes are segregated and stored before shifting to the linkage. The above-mentioned schemes are supplemented with Block level Resource Recovery Facility (RRF) centres (in progress), where there will be machinaries for bailing and shredding the segregated wastes before selling to the respective recyclers.

Green Technicians –Haritha Karma Sena (Task Force)

Social stigma towards waste collectors is not a new phenomenon which has its roots from years back. Introducing trained task force 'Haritha Karma Sena (HKS)' as Green technicians with uniforms and necessary equipments and other gadgets, brings recognition for them among the society. The activities of Haritha Karma Sena, was inaugurated in the panchayath on 2nd October 2018. Two women volunteers from each of 14 wards are selected to form Kudumbasree units constituted with 28 members in total. They collect the segregated non bio degradables at door step.

Capacity building and training

Haritha Karma Sena is provided with training from the resource persons of Haritha Kerala Mission, Suchitwa Mission, Kudumbasree Mission and Intergrated Rural Technology Centre(IRTC)-Haritha Sahaya Stapanam, the supporting institution for the local body to collect and segregate the wastes and in formation of consortium, providing financial literacy among them and so on.

Office

Chottanikkara Panchayat was the first among the panchayats in Ernakulam district to open own office for a better administration purpose of Haritha Karma Sena. Attendance registers are also there to ensure their commitment and participation.

Sources of Income

Haritha Karma Sena (HKS) collects around 160000/- per month and each member earn minimum of Rs.5000 and extra, based on their performance. They collected a total amount of 18 lakh in 2019. Segregated materials are sold to Clean Kerala Company and it also fetches an extra remuneration for them. They are trained to start green business like Cloth bag making, Soap Making to earn more income along with this. Collection of non-biodegradable waste during festival seasonof Mandala Kala Maholsavam from the Chottanikkara Bagavathy Temple also add their income.

Information, and Education Campaigns (IEC)

The success story of Chottanikkara Panchayathas its credit hidden in the wide varieties of awareness programme conducted to ensure active participation from public. Ward based cluster meetings and rallies were conducted to sensitize people. Cluster committee headed by the ward member to deal with the issues and complaints regarding the plastic collection. Pamphlets were distributed among every households via Haritha Karma Sena. 14 Rallies were conducted to convey the message to people. Two major all party meetings were also conducted for the better organization. The IEC activities in the community were complemented with programs at Anganwadi and school by the names, 'Pencil Camps', 'Haritholsavam', and 'Jaagratholsavam' through stories, poems and songs which are basically aimed at increasing the level of awareness and participation among children. The result of which shows 100% participation from commercial establishments and 75% of participation from households within one year.

Green Protocol

Green protocol, is a set of measures focusingon waste minimization by avoiding usage of disposables. And alternately, using reusables like glass /stainless/ porcelain cutleries. Zero waste is the core result in successful implementation of Green Protocol in any event. If waste is generated, then has to be scientifically treated in an environment friendly manner. In many functions including weddings, religious functions, festivals, parties, public meetings, games, and so on it has been accomplished volunteerly by masses. The Panchayat has succefully implemented Green protocol in 10 institutions and 15 public programs.

Declaration of Green, Clean Panchayt

Chottanikkara Grama Panchayat has been declared as 'Green, Clean Panchayat' by Member of Legislative Assembly (MLA)-Anoop Jacob, on October 26th 2019, a year after successful completion with decentralized waste management practices. This strategy also make people aware of their responsibility to take part in the system.

Cluster formation

Clusters of 50 households were formed with a committee of 10 members including a convenorin all wards of the Panchayat to ensure full participation of the households.

Prioritization in Panchayat Services

The registered households are given priorities in the services provided by Panchayat. This strategy indirectly force people to participate in the system.

Biodegradable Waste to Compost

226 Houses, two Educational Institutions and a hospital were given source level bio degradable waste management devices to produce fertilizers from waste. Thumboormuzhi model aerobic bin units at community level for composting the organic waste are also established in the Panchayat to help the hotels, bakeries and markets to deal with organic waste. Converted compost can be used for soil conditioning including gardening, farming and so on.

Enforcement activities

Panchayat committee has passed a by-law for waste management and strict punishments were imposed against the violators. Cameras have been installed at selected locations to prevent illegal dumping of waste. By this time, Rs.15000 has been collected as penalty from individuals and institutions, and warning notices issued to several persons.

Outsourcing Strategies and Activities

Haritha Kerala Mission

Haritha Keralam Mission is a people-centric Endeavour for the cause of clean and green **Kerala.** Hygienic Waste Management is one among the core submissions of Haritha Kerala Mission.

Capacity building Interventions

Capacity building and trainings are properly provided to them with resource persons. Haritha Niyamavali (Green Laws) training inculcating the laws and penalties from different departments like Food Safety, Police, Health, Pollution Control Board etc to build consciousness in public. Panchayat President, Secretary, Vice-president, Assistant Secretary, Health Inspectors, selected Resource Persons, Residents Association and Club Representatives from every wards of Panchayat were given training. Major aim was to make the people understand and the need to comply with the laws and ordinances. Resource materials including Manuals, Brochures, Resource materials on Green protocol, Harithaniyamavali, and so on are provided to general public. A National Level Workshop cum exhibition for alternatives of plastics, 'Suchitwa Sangamam 2020' was organized with participation of local bodies from every district of the State. Creating linkage to Clean Kerala Company, Recyclers, Service Providers, KEIL and other departments is also one of the interventions.

Suchitwa Mission

Suchitwa Mission, is the technical support group and nodal agency for assisting LSGIs in all waste management aspects through implementing Swachh Bharat Mission, Communication and Capacity Development Unit (CCDU).

Information, Education and Communication (IEC)

Information Education and Communication unit is functioning in Suchitwa Mission for bringing attitudinal and behavioural change in waste management practices. IEC tools like posters, leaflets, banners, videos, audios, art forms

etc has been used by Suchitwa Mission in disseminating messages and sensitizing public regarding scientific waste management, sorting at source, waste minimization, reuse and recycling habit. Capacity Building Interventions including training for Haritha Karma Sena is also provided by Mission. Allocation of the Funds from Swachh Bharat Mission-Gramin, Suchitwa Keralam-Rural is another area.

Kudumbasree Mission
Kudumbashree Mission was initiated as a poverty eradication programme and women empowerment under the State Poverty Eradication Mission (SPEM) (1997). Now it has got new facets. Idea of 'Self Help Group' has got worldwide recognition. Formation of Micro Enterprise Group of Haritha Karma Sena is the major idea. It will result in local economic development as well promote green enterprises and thus lead to women empowerment.

Clean Kerala Company
Clean Kerala Company formed under the Local Self Government Department, Government of Kerala for hygiene management through successful innovative, scientific methods and technology, with the public and private sectors. It also deals with the management of harmful rejections. It provides linkage to Kerala Enviro Infrastructure Limited (KEIL) and other dealers of recycling industry. Clean Kerala Company also owns district level ware house for storing segregated waste in Edayar.

Kerala Enviro Infrastructure Limited (KEIL)
KEIL is a public limited Company for the treatment and disposal of hazardous waste in Kerala. Scientific land filling site for hazardous waste in Ambalamedu, Ernakulam district is taken care under KEIL.

Kerala Institute of Local Administration
Kerala Institute of Local Administration (KILA) is an autonomous institution functioning with capacity building interventions for the Local governments in Kerala especially by providing trainings and resource materials.

Haritha Sahaya Stapanam-Technical Support Agency
Integrated Rural Technology Centre (IRTC) is an autonomous institution (1995) with set of initiatives of knowledge dissemination to bind science and humanity. IRTC is recognized service provider and a technical support agency in waste management. It is termed as 'Haritha Sahaya Stapanam' which on the basis of agreement for one year with Chottanikkara LSGI to provide necessary capacity building intervention programmes for proper solid waste management in the Panchayat to form clusters in. Panchayath has installed 'Thumburmuzhi aerobic composting' unit with the help of IRTC, to process biodegradable waste from hotels and bakeries. Haritha Karma Sena were trained in segregation, to handle the Thumburmuzhi Composting unit.

Residents Associations, Merchants Union, NSS volunteers
Voluntary service from Residents Associations, Merchants Union, and NSS students are available in helping the Panchayat in effective management of solid waste. Cleaning of public roads with the help of residence association, Merchants union along with Haritha Karma senawere done.

Corporate Social Responsibility (CSR) Funds
Corporate Social Responsibility is an approach by companies to incorporate environment and society in the sustainable development by providing funds. By this time, CSR Funds from different companies are used to provide bio pots to all the registered houses are in progress.

System Components
Collection System
Garbage collection from households operates within first 12 days of each month by Task force, Haritha Karma Sena at door step which will be taken later by garbage truck. The remaining days are used to sort the waste into different grades. 6205 houses and 480 commercial Institutions are registered as users to handover non bio- degradable waste

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to HKS. On a monthly basis. Haritha Karma Sena follow time table for door to door collection of clean and dry non-biodegradable waste as plastics, glass, leather, paper and so on. Since the quantity of plastic waste is more, plastic waste collection is regular and others are given a fixed time period with a duration of 3 to 6 months gap. The collected materials then carried to the Material Collection Facility (MCF) centre and segregated into 8 different (in the case of plastic)grades. Around 3 tons of non-biodegradable materials are collecting monthly by HKS. By November 2019, Haritha Karma Sena collected 3.5 ton of glass bottles, glass pieces from households and handed it over for recycling.

Transportation

Panchayat owns a vehicle for the transport of collected waste from households to MCF. The loading and unloading of waste is done manually as the clean wastes are segregated at source and tied in sacks. As the workers are provided with protective hand gloves and uniforms, direct exposure to the waste is also prevented.

Disposal

From the MCF, Haritha Karma Sena sorts the waste into 8 categories. After segregation, it is handed over to Clean Kerala Company. The un-segregated, non-valuable materials are send to Kerala Enviro Infrastructure Limited (KEIL) for scientific landfill with aid from Clean Kerala Company. The panchayat doesn't have disposal sites. Management of biomedical waste (BMW) is taken care by a private agency IMAGE.

Challenges

Unanticipated natural disasters like floods, rapidly increasing online shopping, increasing plastic wastes, sanitary napkins etc poses the major challenge in sustainable functioning of the system.

CONCLUSION

The entire operation of Solid Waste Management encompassing segregation at source, timely and proper collection by Haritha Karma Sena, and transportation is optimized. As the system is functioning properly, there is a huge outcry from public for sanitary waste disposal. It is one of the major issue through which the Panchayat is undergoing and the demand is inevitable and its solution relays on scientific sanitary land filling which is non-existent in Kerala.

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RESEARCH ARTICLE

Preliminary Phytochemical Studies on Some Medicinally Important Fern Species Collected from Udhagamandalam, Tamil Nadu, India

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ABSTRACT

The present report is about the study of phytochemicals of some medicinally important fern species collected from Udhagamandalam, the Nilgiri district, Tamil Nadu, India. Standard methods were used to examine the secondary metabolites like alkaloids, proteins, carbohydrates, flavonoids, terpenoids, glycosides phenolic compounds, and tannins in the plant extracts. Using a Soxhlet apparatus, the material was shade dried and powdered fronds (50g) were extracted progressively with 250 ml of methanol, ethanol, acetone, and distilled water for 7 hours at a temperature of 50-65 ºC. (not greater than the boiling point of solvent). Among the forty tested extracts, thirty extracts showed the presence of carbohydrates (75%) and 37 extracts showed proteins and free amino acids 92%), 17 (42%) flavonoids, 21 (52%) phenolic compounds and tannins, 22 (55%) glycosides, 22 (55%) terpenoids, 16 (40%) alkaloids. The findings reported the existence of several bioactive elements that could be utilized for future therapeutic applications. Based on the results of this study, it can be determined that the 10 medicinal ferns chosen contain more bioactive constituents. The potent ferns have the potential to be exploited as bio control agents.

Keywords: Extraction, Ferns, Phytochemicals, Solvent, Udhagamandalam

INTRODUCTION

Pteridophytes are immune to microbial infections, which may be one of the reasons for their evolutionary achievement and long lifespan of over 350 million years [1]. The plant kingdom is rich with potential pharmaceuticals and there has been a growing awareness of the importance of medicinal plants in recent years.

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Plant-based drugs are readily available, inexpensive, safe, and effective, with fewer side effects. Traditional medicines are utilised by more than 80% of the world's population for basic health care, according to the World Health Organization (WHO). Since the beginning of time, plants and their parts (barks, leaves, fruits, roots, flowers, seeds, and so on) have been utilised in phytomedicines [2]. Plant chemical components must be implicit before they can be used in medicine or for the production of complex chemical compounds [3]. Angiosperms, rather than *Pteridophytes* in general, have been the focus of studies on phytochemical pharmacology. It is well known that plant-derived chemicals have a vast range of pharmacological applications [4-5]. Angiosperms have more variety, a wider range of adaptations, and are more widely distributed, making them more accessible to a wider number of research organisations. *Pteridophytes* are thought to be used for medical purposes in regions where they are found, implying that they produce secondary metabolites with specialised ecological functions connected to herbivore defence [6]. The vascular plant category *Pteridophytes* is divided into two monophyletic lineages: *lycophytes* and ferns. Ferns vary from *lycophytes* phylogenetically in that they are more closely connected to seed-bearing plants [7].Ferns are an essential evolutionary link in the botanical kingdom, connecting lower and higher plants. Due to their evolutionary history and biology, they produce a unique variety of secondary metabolites, many of which are not found in other plants. There are nearly 12,000 species of ferns on the planet, the majority of which are found in tropical and subtropical climates. India as a mega diversity country has a massive and rich diversity of fern and their allies represented by 1157 species [8]. Kolli hills are a part of Eastern Ghats in Tamil Nadu, India supporting large growth of diverse ferns [9, 10]. About four hundred species of *pteridophytes* occur in south India of which ferns are a part [11].

South Indian ferns were determined in Palani hills [12], Western Ghats [13], Nilgiri hills etc [14]. Ferns have existed since the *Palaeozoic* era, and they have been subjected to numerous speculative interference that has forced them to adapt to a wide range of environmental changes [15]. As a result, ferns are expected to have a higher concentration of useful secondary metabolites than other plants. Ferns contain a wide range of alkaloids [16], flavonoids [17], polyphenols [18], terpenoids [19], and steroids, according to phytochemical studies [20]. Consequently natural drug preference has risen rapidly around the world [21]. Alkaloids, flavonoids, phenols, steroids, triterpenoids, different amino acids, and fatty acids are among the many beneficial phytochemicals or secondary metabolites discovered in ferns [22]. Furthermore, they contain phytochemicals that are not found in higher plants [23]. Plants are enriched with numerous phytochemical molecules such as vitamins, terpenoids, lignin's, suberins, , flavonoids, phenolic acids, tannins quinones, coumarins, alkaloids, betalains, amines, and other metabolites, which are rich in antioxidant activity [24, 25]. Investigations have shown that many of these antioxidant compounds possess anti-inflammatory, anti-atherosclerotic, antimutagenic, antitumor, anticarcinogenic, antibacterial, and antiviral activities [26, 27]. Natural antioxidants of ferns have been linked to a lower risk of cancer, cardiovascular disease, diabetes, and other age-related disorders when consumed [28, 29]. Hence, the current study is focussed to ascertain the phytochemical constituents of *Adiantum venustum, Asplenium adiantum-nigrum, Asplenium trichomanes, Cystopteris fragilis, Pteridium aquilinum, Pteris cretica, Salvinia molesta, Athyrium attenuatum, Deparia allantodioides, Blechnum orientale.*

MATERIALS AND METHODS

Procurement of plant materials and extraction
The study material utilized for the current study was collected from district Udhagamandalam of Tamil Nadu, India. The identification of ferns was done with the help of an artificial key given by Manickam and Irudayaraj for South Indian fern flora. The plant materials utilized for phytochemical screening was washed thoroughly under running tap water to remove all debris and soil, and then shade dried for two weeks at room temperature. The air-dried plant material was finely crushed and stored in self-sealing, air-tight polythene bags. Using a Soxhlet apparatus, 50 g of powder was extracted sequentially with 250 mL of methanol, ethanol, acetone, and distilled water for 7 hours at 50-65 ℃ (not greater than the boiling point of the solvent). All of the extracts were concentrated and kept in an airtight bottle until they were needed again.

Phytochemical Screening

The tests used to screen for phytochemicals are mentioned below.

Alkaloid Test

Dragendroff's test

2ml of Dragendroff's reagent is added to 1ml of extract. The presence of alkaloids is indicated by the formation of an orange-red precipitate.

Glycoside Test

Keller- Killiani test

1ml of glacial acetic acid with traces of ferric chloride and 1ml of strong sulphuric acid were carefully mixed with 1ml of extract. The presence of glycosides is shown by the presence of a brown ring at the contact. Below the brown ring, a violet ring may emerge.

Carbohydrates Test

Molisch's test

A few drops of Molisch's reagent (-naphthol, 20% in ethyl alcohol) were added to 1 mL of extract. Then belatedly, 1ml of strong sulphuric acid was poured along the tube's sides. The presence of carbohydrates is indicated by the formation of a violet tint.

Proteins and free amino acids Test

Ninhydrin test

1ml of Ninhydrin solution was added to 2ml of extract. Boil on water for some time. The presence of amino acids is indicated by the appearance of a blue to purple tint.

Phenolic compounds and tannin Test

Ferric chloride test: 1 mL ferric chloride (5%) solution (made in ethanol) was added to 1 mL extract. The colour appeared to be blue black or dark green.

Flavonoid Test

Shinoda test: A few drops of concentrated HCl were applied to 1ml of extract. 0.5 gram of magnesium turnings were added to this solution. The presence of flavonoids was shown by the presence of pink colouring.

Terpenoids Test

Salkowski test

2ml of chloroform and few drops of concentrated sulphuric acid were added carefully to 1ml of extract along the sides of tube to form a layer. Positive results for the presence of terpenoids were shown by a reddish brown colouring of the interface.

RESULTS

Each of the forty extracts of the selected ferns contains at least four chemicals. Alkaloids are present in methanol, ethanol and water extracts of *Adiantum venustum, Asplenium trichomanes, Pteridium aquilinum, Deparia allantodioides* and all four extracts of *Blechnum orientale*. Glycosides are present in methanol, ethanol and water extracts of *Adiantum venustum, Salvinia molesta,* ethanol, acetone and water extracts of *Asplenium adiantum-nigrum*, ethanol and methanol extracts of *Asplenium trichomanes*, methanol, acetone, water extracts of *Pteris cretica* and *Athyrium attenuatum*, acetone extract of *Deparia allantodioides* and all extracts of *Blechnum orientale*. Free amino acids and proteins occur in all extracts of species except water extract of *Blechnum orientale*. Carbohydrates are present in methanol, acetone and water extracts of *Adiantum venustum*, *Cystopteris fragilis, Pteridium aquilinum, Pteris cretica, Athyrium attenuatum,*

methanol and water extracts of *Asplenium trichomanes, Blechnum orientale*. Ethanol, acetone and water extracts of *Salvinia molesta* and all four extracts of *Asplenium adiantum-nigrum* and *Deparia allantioides.* Flavonoids are present in water extract of *Adiantum venustum* and *Asplenium adiantum-nigrum,* ethanol extract of *Asplenium trichomanes,* ethanol, methanol and acetone extracts of *Cystopteris fragilis*, ethanol, methanol and water extracts of *Pteris cretica*, acetone and water extracts of *Salvinia molesta*, ethanol and water extracts of *Athyrium attenuatum* and all four extracts of *Blechnum orientale*. Phenolic compounds and Tannins are present in ethanol and water extracts of *Asplenium venustum* and *Pteris cretica*, ethanol, methanol and water extracts of *Asplenium adiantum-nigrum* and *Cystoptris fragilis*, ethanol, methanol and acetone extracts of *Pteridium aquilinum*, *Blechnum orientale*, ethanol, acetone and water extracts of Athyrium *attenuatum*, ethanol extract of *Salvinia molesta*, water extract of *Asplenium trichomanes*. Terpenoids are present in methanol, water extracts of *Adiantum venustum* and *Cystopteris fragilis*, ethanol, methanol and water extracts of *Asplenium adiantum-nigrum*, ethanol and water extracts of *Asplenium trichomanes*, ethanol, acetone and water extracts of *Pteris cretica*, ethanol, acetone and water extracts of *Salvinia molesta*, ethanol, methanol and acetone extracts of *Athyrium attenuatum* and all four extract of *Blechnum orientale*.

DISCUSSION

In the current study 10 species of ferns were analyzed for the phytochemical constituents. Screening were carried out with methanol, ethanol acetone, and water extracts of the plants that form a total of 40 extracts. In this empirical study, alkaloids, carbohydrates, proteins, free amino acids and terpenoids were observed in all extracts. Out of 40 tested extracts alkaloids were present in 16 extracts (40 %), glycosides in 22 extracts (55 %), free amino acids and proteins in 37 extract (92 %), carbohydrates in 30 extracts (75 %), flavonoids in 17extracts (42 %), phenolic compounds and tannins in 21 extracts (52 %) and terpenoids in 22 extracts (55 %) respectively. Water and methanol exhibited more phytochemicals than ethanol and acetone among solvents. Ferns have therapeutic properties, and some have been used medicinally since ancient times. Plant parts such as stems, fronds, rhizome, and spores are used in a variety of ways by tribal people and ethnic groups all over the world to treat a variety of diseases [30]. The purpose of the current study was to use four solvent extracts to investigate the chemicals found in several Indian medicinal ferns. Antimicrobial activity can be found in alkaloids and flavonoids. Tannins could potentially be used as cytotoxic agents [31]. Tannins are anti-cancer compounds. Antimicrobial and insecticidal properties are mostly derived from phenolic chemicals. This study also leads to further research in isolating and identifying the bio-active chemicals from the selected ferns. It will also aid in the development of novel drugs with fewer side effects, lower costs, and more efficacy in the treatment of many infectious diseases in the future.

Conflict of interest statement
We declare that we do not have any conflict of interest.

ACKNOWLEDGEMENT

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Table: 1. **Preliminary studies of** *Adiantum venustum* **and** *Asplenium adiantum-nigrum*

	Adiantum venustum				*Asplenium adiantum-nigrum*			
Alkaloids	Ethanol	Methanol	Acetone	Water	Ethanol	Methanol	Acetone	Water
Glycosides	+	+	+	-	-	-	-	-
Flavonoids	+	+	+	-	+	-	+	+
Carbohydrates	-	+	+	+	+	+	+	+
Proteins & FAA	+	-	-	+	+	+	-	+
Flavonoids	-	+	-	-	-	-	-	-
Phenolic Compounds & Tannins	+	+	+	+	+	-	-	+
Terpenoids	-	+	+	+	+	+	-	+

Table 2: Preliminary studies of *Asplenium trichomanes* **and** *Athyrium attenuatum*

	Asplenium trichomanes				*Athyrium attenuatum*			
Alkaloids	Ethanol	Methanol	Acetone	Water	Ethanol	Methanol	Acetone	Water
Glycosides	+	+	+	-	-	-	-	-
Flavonoids	+	+	-	-	-	+	+	+
Carbohydrates	-	+	+	+	-	+	+	+
Proteins & FAA	+	+	-	+	+	-	-	+
Flavonoids	+	-	+	-	+	+	-	+
Phenolic Compounds & Tannins	+	-	-	+	+	-	+	-
Terpenoids	+	-	-	+	+	+	+	-

Table 3: Preliminary studies of *Blechnum orientale* **and** *Cystopteris fragilis*

	Blechnum orientale				*Cystopteris fragilis*			
Alkaloids	Ethanol	Methanol	Acetone	Water	Ethanol	Methanol	Acetone	Water
Glycosides	+	+	+	+	-	-	-	-
Flavonoids	+	+	+	+	-	-	-	-
Carbohydrates	-	+	-	+	-	+	+	+

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Proteins & FAA	-	-	-	+	+	+	-	+
Flavonoids	+	+	+	+	+	+	+	-
Phenolic Compounds & Tannins	+	+	+	-	-	+	+	+
Terpenoids	+	+	+	+	-	+	-	+

Table 4: Preliminary studies of *Deparia allantodiodes* and *Pteridium aquilinium*

	Deparia allantodiodes				*Pteridium aquilinium*			
Alkaloids	Ethanol	Methanol	Acetone	Water	Ethanol	Methanol	Acetone	Water
Glycosides	+	+	+	-	+	+	+	-
Flavonoids	-	-	+	-	-	-	-	-
Carbohydrates	+	+	+	+	-	+	+	+
Proteins & FAA	-	+	-	+	+	+	-	+
Flavonoids	-	-	-	-	-	-	-	-
Phenolic Compounds & Tannins	-	-	-	-	+	+	+	-
Terpenoids	-	+	-	-	-	-	-	-

Table 5: Preliminary studies of *Pteris critica* and *Salvinia molesta*

	Pteris cretica				*Salvinia molesta*			
Alkaloids	Ethanol	Methanol	Acetone	Water	Ethanol	Methanol	Acetone	Water
Glycosides	-	-	-	-	-	-	-	-
Flavonoids	-	+	+	+	+	+	-	+
Carbohydrates	-	+	+	+	+	-	+	+
Proteins & FAA	+	-	-	+	+	+	+	+
Flavonoids	+	+	-	+	-	-	+	+
Phenolic Compounds & Tannins	+	-	-	-	+	-	-	+
Terpenoids	+	-	+	+	+	-	+	+

+ = Present, ++ = more present, - = Absent

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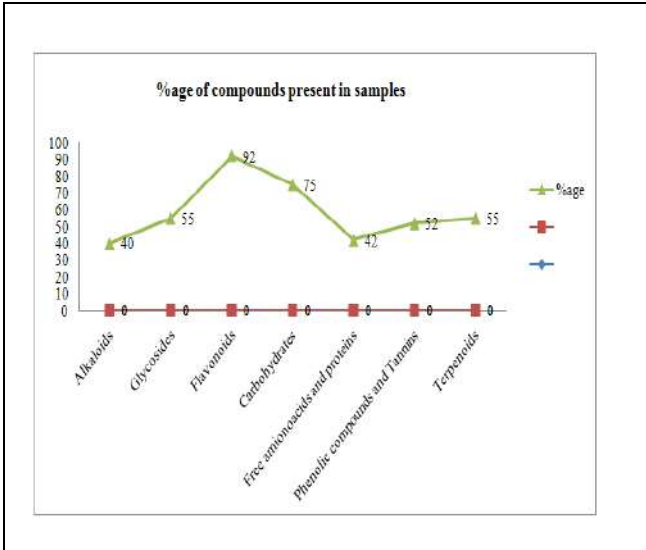
Graph 1. %age of compounds present in samples	Graph 2. Compounds present in number of samples
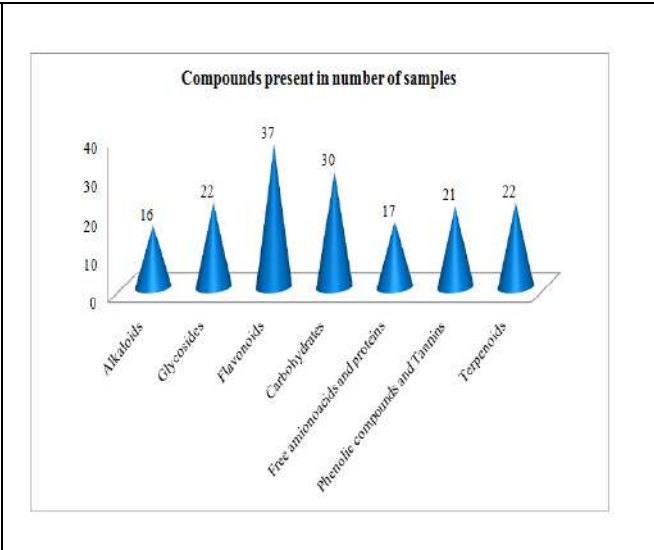
RESEARCH ARTICLE

Quality Assessment and Comparative Study of Different Marketed Brands of Atenolol

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ABSTRACT

Atenolol (2-{4-[2-hydroxy-3-(propan-2-ylamino) propoxy] phenyl} acetamide), belonging to beta blocker is widely prescribed drug for lowering high blood pressure in treatment of hypertension, angina pectoris and cardiac arrhythmias. Various generic brands of atenolol are available in market so their quality needs to be assure to determine its efficacy and to make the treatment cost effective. Depending upon these facts, the present study was conducted to check, compare and prove the quality standards of commercially available local pharmaceutical brands of atenolol tablets with each other as prescribed by IP as well as USP. All the tablets from each formulation passed weight variation test, as the % weight variation was within the pharmacopoeial limits of ± 10 % of the weight and thickness is almost same (0.4-0.6 mm). Hardness between 4-7 Kg/cm 3 and friability less than 1 ensures that all the tablets of each brand were mechanically stable. More than 85% of drug got release in less than 45 minutes with disintegration time less than 5 minutes indicates better bioavailability of all brands. The amount of drug content in all brands was found between 99-101% that make it sure that the amount of active ingredient in each brand complies the pharmacopeial limits. Thus it can be concluded that as all brands show parameters within the official limit so these formulations can be used interchangeably.

Keywords: Atenolol, Brand, Quality Assessment, Generic

INTRODUCTION

Owing to the rapid development in pharmaceutical companies, there is bombardment of various pharmaceutical products in market so identifying the genuine quality product from multiple stock has become a chief concern for manufacturers as well as consumers [1]. A single drug with same appearance but different brand name may be manufactured and sold by various pharmaceutical industries at different costs[2, 3]. As far as if primary standards are maintained in terms of quality as well as efficacy, there may not be any problem and they can be used interchangeable[4, 5], but some manufacturers in lieu of earning more money are not following the proper guidelines which not also effects their quality and efficacy but also cause toxicity [6]. This practice is more followed in developing countries due to improper regulatory guidelines and scarcity of medicines at affordable price[7, 8]. Therefore, to ensure the safety as well as consistency, it should be the responsibilty of pharmaceutical manufactures to maintain all the pharmacopoeial specifications as indicated in reference books like IP, BP, USP etc [9, 10]. These days, post market qualitative studies are also performed to verify the quality of available drugs for patient compliance[11]. Atenolol (Fig.1), chemically 4-[2-hydroxy-3-[(1-methylethyl) amino] propoxy] benzene acetamide (Mol. formula $C_{14}H_{22}N_2O_3$, mol. wt 266.341 g) is a beta blocker widely prescribed for treatment of hypertension and cardiac arrhythmias[12]. It mainly lowers heart rate by suppressing renin rand angiotensin-II release [13, 14]. Its use in migraine has also been reported [15]. Different brands of atenolol are accessible to consumers in market so it becomes difficult for them to judge the suitable one. Therefore, the present study deals with in-vitro assessment of different quality control parameters viz. weight variation, hardness, friability, disintegration, dissolution and content uniformity of selected brands of atenolol and compare them with brand product to assure their efficacy and to aware people that generic drugs can also show effective therapeutic action as brand drugs if proper guidelines are followed [16, 17].

MATERIAL AND METHODS

Chemicals and reagents
Pure sample of Atenolol was gifted as a sample and was used as such without further purification. Three easily available marketed brands A, B and C (one branded and two generic respectively) of atenolol (50 mg) tablets were purchased from market nearby Ambala and were used during the whole study. All reagents used were pure and of analytical grade and distilled water was used throughout the project work.

Instrumentation
Different instruments and apparatus viz. UV-Visible spectrophotometer (double beam, UV-1800, Shimadzu, Japan), digital balance, Vernier caliper, Monsanto Hardness Tester (for hardness), Friability Tester (for friability), Dissolution Apparatus (for drug release rate), Disintegration Apparatus were used.

Parameters Assessed for Evaluation [3, 19-23]
Physical Parameters
Tables were selected randomly and their thickness using Vernier caliper and visual properties like color, shape and texture were visualized (Table 1). Thickness was found consistent in all selected brands with proper color, shape and texture.

Uniformity of Content
Twenty tablets (randomly selected) of each brand were weighed individually using caliberated weighing balance to identify any weight variation. The average weight and percentage (%) deviation from mean were calculated (Table 2). As per IP as well as USP standards, for tablets (with weight less than 130mg and 80mg respectively), there should not be a deviation of more than 10% in two tablets and no tablet should differ by more than twice the limit[20, 21].

$$\% \text{ of weight variation} = \frac{\text{Average weight} - \text{Individual weight} \times 100}{\text{Average weight}}$$

Hardness and Friability Test

Hardness, another important parameter, determined using Monsanto Hardness Tester can be used for governing the rate of release. More hardness means more disintegration as well as dissolution time so slow release rate. But it should also be considered that tablets should possess specified hardness sufficient to bear pressure during handling and transportation as well as disintegrate properly after administration. Similarly, friability can be determined using Roche friabilator at 100 revolutions for 4 min (25rpm) to evaluate their strength in different environmental conditions during chipping, packaging, storage etc. Twenty tablets from each brand, selected randomly, were initially weighed and then subjected to hardness as well as friability test. In case of friability testing, the tablets were then again weighed after 100 revolutions to determine their final weight and then percent friability using given formula was calculated to obtain weight loss and it should not be more than 1% as per both IP and USP specifications.% Friability = [(Initial weight – Final weight)/Initial weight] × 100.In case of hardness testing, the pressure required for crushing tablet is determined to evaluate hardness. The crushing strength should be between 3-10 kg/cm^2 (as per IP) and 4-10 kg/cm^2 (as per USP). The results are specified in Table 2.

Disintegration Test

Dsintegration test is performed to ensure their sufficient absorption in proper time as per the guidelines. Six tablets were selected randomly from each brand and placed in beaker containing liquid medium (distilled water, HCl etc. at 37°C) attached to disintegration apparatus and then time required by tablet for disintegration in solvent is observed to evaluate whether the time required for disintegration in liquid medium is as per the specifications or not (Table 2). As per the IP, The uncoated tablets should disintegrate within 15 minutes as per IP and 30 minutes as per USP. All tablets (Brand A, B and C) are disintegrated within 5 min in specified solvent.

Dissolution Test

Drug dissolution testing is vital parameter used to determine in-vitro release of drug from solid dosage form which will further decide their bioavailability. Dissolution rate was observed using ERWEKA dissolution apparatus using paddle method at 50rpm with 0.1N HCl (900mL) as dissolution medium (37±0.5 ^{0}C) as per prescribed procedure. 10 ml of sample was withdrawn at intervals of 5, 10, 15, 30, 45, 60 minutes and diluted to measure its absorbance at 224nm. Fresh dissolution medium (10ml) was added after each sampling to maintain the sink conditions. The percentage of drug release is calculated (Table 3) using the formula and then plotted against the time in minutes (Fig. 2).

% of drug release = $\underline{\text{Amount of drug release}}$ x 100
                               Drug content in tablet

All the brands show more than 85% drug release in 45 minutes and more than 94% release in 60 minutes indicating that release pattern of drugs was same so they can be used interchangeably although manufactured by different companies.

Content Assay

The assay studies are performed to analyze the drug content which further ensures their potency and effectiveness.

Preparation of Standard Solution

50 mg of pure drug was dissolved in 0.1N HCl to get a solution of 500 μg/ml. 1 ml of the solution is further diluted to get working standard solution of 10μg/ml.

Preparation of Calibration Curve

The prepared solution was scanned between 200-400 nm UV range to measure λ_{max}. Appropriate aliquots from standard stock solution were diluted with sufficient solvent to get solution of 2, 4, 6, 8, 10, 12, 14, 16 and 18μg/ml. Their absorbance was observed and then calibration curve was obtained by plotting the measured absorbance against their respective concentration (Fig. 3) to determine linearity equation which is used for further calculations.

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Assay

Twenty tablets from each brand were weighed individually and crushed. Powder equivalent to 50 mg was weighed and dissolved in 0.1N HCl to prepare 1000 µg/ml. The solution was further diluted (10µg/ml) and its absorbance was then observed at 224nm to determine its concentration using linearity equation obtained (Table 4). All the brands contain active ingredient, atenolol in the range of 99-101% which is acceptable as per IP as well as USP.

DISCUSSION

All selected brands of atenolol accomplish the required quality as well as efficacy according to the IP as well as USP guidelines. The tablets are white, round and smooth in appearance with approximate similar thickness (Table 1). The content uniformity is also within specified limits. % friability less than 1% in all brands with hardness between 4-7 kg/cm^2 indicated good friability as well as strength (Table 2). Disintegration time (less than 5 minutes) indicates excellent disintegration of all tablets. As indicated from dissolution studies, in all cases, more than 85% drug got released within 45 min and more than 94% got release in 60 minutes confirming that the release pattern of all drugs is same and are efficacious (Figure 2). The amount of drug content in all brands was found between 99-101% which specifies that amount of active ingredient in each brand is as per the pharmacopeial limits. As all selected brands possess the specified parameters (both IP and USP) within the official limit therefore these formulations can be used interchangeably.

CONCLUSION

The present study reflects that quality control and assessment plays a significant role in ensuring the stability, efficacy and potency of any drug. Therefore, pharmaceutical companies should strictly adhere to the issued guidelines at every step during pharmaceutical drug manufacturing as well as dispensing. If proper guidelines are followed, any drug manufactured by any pharmaceutical industry can be considered pharmaceutically equivalent and thus can be used confidently.

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Table 1. Physical Parameters

Brand Name	Color	Shape	Texture	Thickness (mm)
A	White	Round	Smooth	0.5 ± 0.024
B	White	Round	Smooth	0.5 ± 0.026
C	White	Round	Smooth	0.6 ± 0.013

Table 2. Weight variation, friability, hardness and disintegration studies

Brand	Average Weight	% Deviation Allowed (± 10%)	Friability (%)	Hardness (kg/cm²)	Disintegration Time
A	196 mg ± 0.469	176.4-215.6	0.11	4.6	1:05
B	196 mg ± 0.959	176.4-215.6	0.62	5.4	1.51
C	220 mg ± 0.55	198-242	0.55	4.85	0.55

Table 3.Dissolution studies

Time	% of drug release		
	Brand A	**Brand B**	**Brand C**
5	15.54	16.87	18.96
10	36.65	38.53	40.67
15	58.68	57.32	59.29
30	72.96	71.45	76.56
45	85.52	85.31	91.65
60	94.85	97.65	97.89

Table 4. Assay studies

Brands	Label Claim (mg)	Amount Found (mg)	%
Brand A	50	50.3	100.6%
Brand B	50	50.5	101%
Brand C	50	49.7	99.4%
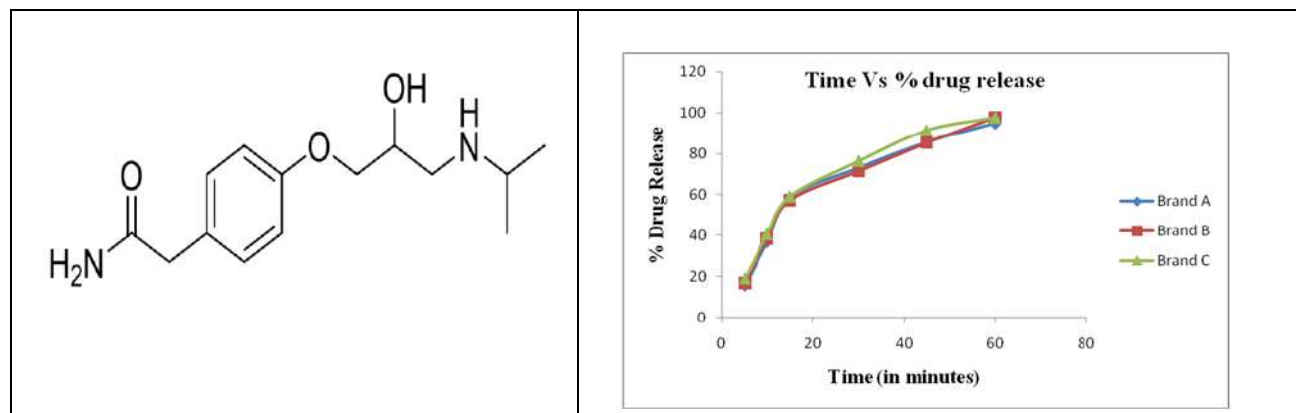
Fig. 1. Atenolol	Fig. 2. Drug Release
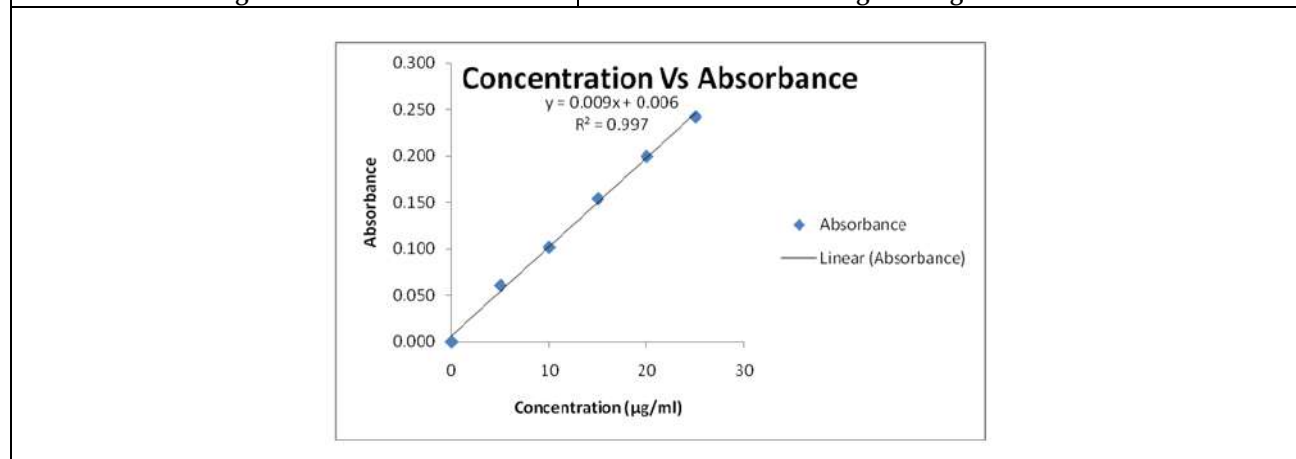
Fig. 3. Linearity graph

RESEARCH ARTICLE

Antibiotic Susceptibility Profiling and Multiple Antibiotic Resistance Indexing of Gram-Positive Bacteria from Poultry Litter

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ABSTRACT

Poultry farms use a large amount of antibiotics to treat bacterial infections and promote growth. This can result in the accumulation of residual antibiotics in poultry litter that can lead to the development of antibiotic resistant microorganisms. The release of antibiotic resistant bacteria (ARB) into the environment poses huge risks to both human and veterinary health. The spread of ARB from poultry to the environment should be monitored, and this study determined antibiotic resistance in bacteria isolated from poultry litter. Three bacterial isolates *Arthrobacter nicotianae*, *Bacillus koreensis*, and *Staphylococcus* sp. were pre-identified from the poultry litter and were evaluated for their antibiotic resistance. Kirby Bauer disc diffusion (DD) and broth microdilution (BMD) tests were used to find out the antibiogram profile of bacterial isolates to different antibiotics. Antimicrobial susceptibility test (AST) results show that all three bacterial isolates are resistant to multiple antibiotics such as ampicillin, erythromycin, streptomycin, and tetracycline from different groups. The role of glutathione S-transferase (GST) in bacterial resistance was assessed with tetracycline, and the results showed that all three isolates had

increased GST activity in the presence of tetracycline. GST activity was found to be higher in *Staphylococcus* sp. than *Arthrobacter nicotianae* and *Bacillus koreensis*.

INTRODUCTION

Antibiotics are metabolites produced by microorganisms that can kill or inhibit the growth of susceptible bacteria [1,2].They are crucial pharmaceuticals for the treatment of bacterial infections in both human and veterinary health. Administration of antibiotics in the poultry sector has been drastically increased due to the need for improved meat production to meet the market demand and disease prevention in farm animals [3]. The growth-promoting nature of antibiotics is harnessed in poultry farming, and antibiotics are supplemented as feed additives at sub-therapeutic dosage level [4]. Different types of antibiotics from major antibiotic groups such as ampicillin, penicillin (ß-Lactam penicillines) ciprofloxacin (flouroquinolones), erythromycin (macrolides), kanamycin, gentamycin, streptomycin, tobramycin (aminoglycosides), tetracycline, oxytetracycline (tetracyclines), etc, are used in poultry [5,6]. Studies estimate that nearly 63,000 tons of antibiotics will be used in poultry farms by 2030 worldwide: This is 67 % higher than the utilization of antibiotics in 2010 [7,8]. Over exploitation of antibiotics in clinical settings and livestock farms is the main reason for the emergence of antibiotic resistant bacteria (ARB)[9,10]. Orally supplemented antibiotics in farm animals are poorly absorbed in the animal gut, and around 30-90% of them are released into the environment through urination and defecation. Antibiotics in poultry excretion remain in their active metabolite form without any degradation [11–13]. Residual antibiotics in litter can facilitate the development of resistance among litter bacteria. Resistant bacterial in poultry litter can transfer resistance to other pathogenic and non-pathogenic bacteria through integration of antibiotic resistant genes (ARGs) into bacterial plasmids or via transposons [14]. Gram-positive bacteria found in chicken intestine and litter have more antibiotic selection pressure than gram-negative bacteria. Thus, they are the main reservoir of ARGs and transfer resistance trait between different environments [15].ARB resistance genes from poultry litter can be distributed between different environments through horizontal gene transfer (HGT).

Lands amended with litter as manure, treatment plants receiving wastewater from the farms, and areas used for disposal of farm sediments have a high chance of ARG transfer [16].The spread of antibiotic resistance decreases the effective control of pathogens in humans and animals. Reports show that around 10 million people may die by 2050 due to infections caused by ARB [17].Characterization and identification of ARB offer value in disease diagnosis, bacterial drug susceptibility patterns, and food and water quality [18,19]. Disc diffusion (DD) susceptibility test is a standard and are routinely used method to define the antibiotic susceptibility characteristics of bacteria [20]. This standard procedure estimates susceptibility and clinical efficacy of antibiotics and gives reliable results. DD can be recognized for a long period of time [21]. Besides DD, the minimum inhibitory concentration (MIC) is a gold standard for determining susceptibility characteristics of microbes against a broad range of antibiotics. Unusual resistance can also be confirmed by MIC with definitive results. The broth micro dilution (BMD) method is widely adopted to determine the MIC breakpoints that differentiate susceptible, intermediate, and resistant microorganisms based on epidemiological cut-off, pharmacokinetics, and pharmacodynamics of antimicrobials [22,23]. BMD requires one to prepare various dilutions of selected antibiotics in suitable solvents because semi and non-polar antibiotic compounds will not dissolve in water. The solubility of antimicrobials in a solvent is also a crucial factor in determining MIC values because they may affect drug efficacy. Moreover, the solvents used to dissolve antimicrobials may influence the growth of microbes to be tested [24]. There are fewer reports concerning the inhibitory effects of such solvents on the growth of microbes. Thus, it is essential to ensure the effect of these solvents on the growth of test bacteria. Beyond AST, the activity of glutathione S-transferase (GST) helps to characterise resistance in the bacterial community. Reports suggest that an increase in GST activity is associated with bacterial resistance towards antimicrobials. This is an important cellular detoxification enzyme that catalyses the reclamation

of harmful compounds such as xenobiotics, pesticides, and antimicrobials[25,26].GSTs metabolize a wide range of compounds through conjugation of reduced glutathione (GSH) with 1-chloro-2, 4-dinitrobenzene (CDNB). They also facilitate the elimination of the oxidatively produced compounds and their metabolism as well as protect cells from the oxidants formed by such compounds [27]. GST activity can be triggered by antibiotic stress and helps bacteria resist such stress [28]. Thus, GST can be a universal biomarker to reveal bacterial resistance. This study determined the antibiotic susceptibility profile of bacterial isolates in poultry litter samples collected from commercial farms. The antibiotic susceptibility characteristics of the selected bacterial genera were determined using DD and BMD. The study also identified the effect of ethanol in MIC determination to dissolve antibiotics on ARB isolates; this study also assessed the GST activity of bacterial isolates to confirm their resistance.

MATERIALS AND METHODS

Bacterial strains and antibiotics
Three pre-identified gram-positive bacterial strains (*Arthrobacter nicotianae* (KTSMBNL-76), *Bacillus koreensis* (KTSMBNL-70), and *Staphylococcus* sp (KTSMBNL-73) from the 22nd day poultry litter sample [29]were used. To test the antibiotic susceptibilities for these isolates, eight antibiotics from six major antibiotic groups (Table 1) were selected based on the widespread antibiotic administration pattern in poultry farming. All antibiotics were purchased from HiMedia, and the stock solutions were prepared according to the manufacturer's instructions.

Assessment of antibiotic susceptibility
Disc diffusion test
The antibiotic susceptibility of bacterial isolates (*Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus* sp) were determined against eight antibiotics using the Kirby Bauer disc diffusion method based on clinical and laboratory standards institute (CLSI) guidelines [30]. The test was done by swab-inoculating 0.5 McFarland, density-calibrated inoculum on the surface of each Mueller-Hinton agar (MHA) plate and dispensing the appropriate amount of different antibiotic discs on it (not more than 5-6 discs on a single 100 mm plate). After incubation at 37°C, the results were interpreted according to CLSI standard interpretative criteria [31].

Effect of ethanol on bacterial growth
The effect of ethanol on the growth of *Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus* sp were assessed using the method reported by Ansel to obtain the proper MIC [32]. To evaluate this, cell suspensions of each isolate were adjusted to 0.5 McFarland-turbidity and inoculated to the Muller Hinton broth (MHB) tubes with ethanol concentrations ranging from 1 to 6 % (V/V) in 1 percent increments. The MHB tubes containing only bacterial inoculums served as a control. The tubes were incubated at 37°C for 16-20 h under agitation and the optical density was measured at 600 nm (UV-1700 Shimadzu, Japan) after incubation.

Determination of minimum inhibitory concentration
The minimum inhibitory concentration (MIC)of each bacterial isolate against selected antibiotics was evaluated using the BMD [30]. To test the MIC, different concentrations (0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, and 128 µg/mL) of antibiotics were prepared in a two-fold dilution with sterile broth based on the dilution scheme described in CLSI guidelines [31]. Each bacterial isolate was reactivated in MHB medium and adjusted to 0.5 McFarland turbidity (1×10^8 CFU/mL of cells). Within 15 min, this suspension was further diluted to a 1:20 ratio to obtain the final bacterial concentration of 5×10^4 CFU/mL. The standardized inoculum was added to each well of the micro dilution plates with antibiotic broth solution in a ratio of 1:2. The micro dilution plates were incubated at 35±2°C for 16-20 h to determine the MIC.

Multiple antibiotic resistance analysis
Multiple antibiotic resistance indices (MARI) were calculated for each bacterial isolate to determine their resistance towards multiple antibiotics [33]. MAR indices were obtained by dividing the number of antibiotics to which the

bacterial isolates were resistant by the total number of antibiotics to which the bacterial isolates were exposed (MAR index = a/b).

Determinationof glutathione S-transferase activity:

The glutathione S-transferase **(**GST) activity of *Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus* sp were assayed for tetracycline (<16μg/ml). An antibiotic concentration less than the resistance breakpoint was chosen for the assay according to CLSI interpretative criteria [31].

Growth condition and cell lysate preparation

Arthrobacter nicotianae, Bacillus koreensis, and *Staphylococcus* sp were grown overnight at 37°C in Luria-Bertani (LB)broth with and without antibiotics. The overnight grown bacterial cells were harvested by centrifugation (5000×g for 15 min at 4°C). The pellets were rinsed twice with phosphate buffer saline (PBS) at pH 7.4and resuspended in the same PBS. Subsequent cell lysis was achieved by homogenization under ice bath conditions. The cell debris was removed by centrifugation (10000×g) for 10 min at 4°C and the cell lysate was collected. Protein in cell lysate was measured by the Bradford method using bovine serum albumin (BSA) as standard[34]. This lysate was used for the GST assay.

GST assay

Estimation of GST activity in *Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus* sp was carried out as previously reported by Habig [35].To conduct *in vitro* GST assay, an aliquot mixture of 0.1 M phosphate buffer (pH 6.5), 1 mM 1-chloro-2,4-dinitrobenzene(CDNB), and 1 mM glutathione (GSH) was prepared with cell lysate and incubated at 25°C. Enzyme activity was measured with a UV-Vis spectrophotometer at 340 nm for 3 min. One unit of GST activity was directly proportional to the total amount of enzyme utilized to produce 1 μmol of GS-DNB conjugate per minute.

RESULTS

Antibiotic susceptibility profile:

The isolates *Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus* sp were tested for their susceptibility to eight antibiotics representing six antibiotic groups (Table 1) and categorized as sensitive, intermediate, and/or resistant according to CLSI guidelines.

Disc diffusion susceptibilities

Arthrobacter nicotianae was resistant to ampicillin, erythromycin, kanamycin, streptomycin, and tetracycline; it was intermediate to ciprofloxacin and sensitive to chloramphenicol and tobramycin. The susceptibility profile of *Bacillus koreensis* indicates resistance to ampicillin, erythromycin, streptomycin, and tetracycline; intermediate to ciprofloxacin and kanamycin; and sensitive to chloramphenicol and tobramycin. *Staphylococcus* sp was resistant to ampicillin, ciprofloxacin, erythromycin, kanamycin, streptomycin, tetracycline, and tobramycin; itwas sensitive to chloramphenicol(Table 2). All three isolates shared resistance towards four antibiotics: ampicillin, erythromycin, streptomycin, and tetracycline from four different classes including penicillin groups of β-lactams, macrolides, aminoglycosides, and tetracyclines. *Staphylococcus* sp was also resistant to ciprofloxacin, kanamycin, and tobramycin from the family of fluoroquinolone and aminoglycosides. Similar to *Staphylococcus* sp, *Arthrobacter nicotianae* was also resistant to kanamycin. Both *Arthrobacter nicotianae* and *Bacillus koreensis* showed intermediate susceptibility to ciprofloxacin, but *Bacillus koreensis* was intermediate to kanamycin as well. *Staphylococcus* sp was not intermediate to any of the antibiotics tested. All three isolates were commonly sensitive to chloramphenicol, but *Arthrobacter nicotianae* and *Bacillus koreensis* also were sensitive to tobramycin.

Effect of ethanol on bacterial growth

The effect of ethanol at different concentrations (1-6%) on the growth of *Arthrobacter nicotianae, Bacillus koreensis,* and *Staphylococcus sp* is shown in Fig. 1. There was no significant inhibitory effect at any tested concentrations (1-6%) of ethanol versus isolates grown without solvents.

Minimum inhibitory concentration of antibiotics for bacterial isolates

Antimicrobial susceptibility testing based on MIC by BMD method was used to differentiate phenotypic changes in the bacteria in response with antibiotics. The MIC screened for *Arthrobacter nicotianae, Bacillus koreensis,*and *Staphylococcus* sp. for eight antibiotics (Figs. 2, 3 and 4) show thatall of them fall into different interpretative categories as susceptible (S), intermediate (I), and resistant (R) towards the different antibiotics(Table 3). *Arthrobacter nicotianae* was resistant to ampicillin, erythromycin, kanamycin, streptomycin, and tetracycline; intermediate to chloramphenicol; and sensitive to ciprofloxacin and tobramycin. *Bacillus koreensis*was resistant to ampicillin, erythromycin, streptomycin, and tetracycline; it was sensitive to ciprofloxacin, chloramphenicol, kanamycin and tobramycin;there was no intermediate susceptibility to any antibiotic. *Staphylococcus* sp was resistant to ampicillin, ciprofloxacin, erythromycin, kanamycin, streptomycin, tobramycin, and tetracycline; it was intermediate to chloramphenicol. MIC analysis revealed that all three bacterial isolates were commonly resistant to four antibiotics such as ampicillin, erythromycin, streptomycin, and tetracycline from four different antibiotic classes including penicillin group β-lactam antibiotics, macrolides, aminoglycosides, and tetracyclines. Concurrently, *Arthrobacter nicotianae* and *Bacillus koreensis* shared sensitivity to aminoglycoside and fluoroquinol one antibiotics (ciprofloxacin and tobramycin); however,*Bacillus koreensis* was also sensitive to one of the broad-spectrum phenicol (chloramphenicol) and another aminoglycoside antibiotic (kanamycin). *Staphylococcus* sp was not sensitive to any of the antibiotics, but it showed intermediate susceptibility to chloramphenicol similar to *Arthrobacter nicotianae.*

Multiple antibiotic resistance indices:

All three isolates were resistant to three or more classes of antibiotics and were categorized as multiple-antibiotic resistant bacteria (MARB) in AST. Multiple-antibiotic resistance indices (MARI) confirm the multiple antibiotic resistance of isolates. Table 4 represents the MAR index of the three isolates: 0.625, 0.500; 0.500, 0.500; and 0.875, 0.750 in DD and BMD tests for *Arthrobacter nicotianae, Bacillus koreensis* and*Staphylococcus* sp respectively. Among the three isolates, *Staphylococcus* sp has the highest MAR index compared to *Arthrobacter nicotianae* and *Bacillus koreensis.*

Glutathione S-transferase activity

Increased enzymatic levels of GST activity were found in all three bacteria amended with tetracycline compared to control (non-antibiotic amended samples; Table 5). However, the highest level of enzyme activity was observed in *Staphylococcus* sp (0.1839 U/ml) versus *Arthrobacter nicotianae* (0.1698 U/ml) and *Bacillus koreensis* (0.1273 U/ml).

DISCUSSION

This study assessed the antibiotic susceptibility of three gram-positive bacterial isolates that exhibited resistance to different antibiotics; the results are comparable with the previous reports [36,37].The three organisms also expressed intermediate susceptibility and sensitivity to some of the tested antibiotics similar to previous results [38,39]. The resistance exhibited by *Arthrobacter nicotianae* might be due to the complex enzyme networks that aids in the degradation of a wide range of heterogeneous materials including antibiotics. Resistance may also be due to the high adaptation and fast response to environmental alterations [36]. In the presence of kanamycin, this organism tends to form aggregates, which lead to the development of pseudo mycelium and thus show resistance [40]. *Arthrobacter* sp. also harbours the kanamycin-resistance gene*aph* (aminoglycoside phosphotransferase). *Arthrobacter sp.* expresses resistance to antibiotics through mechanisms like co-resistance and cross resistance. The *mdrL* gene helps to gain resistance to erythromycin, and it increases the tolerance to other heterogeneous substances [41].Reports shows that sequencing antibiotic-resistant *Arthrobacter* sp. revealed the presence of different genes involved in antibiotic resistance like *aadA9* and *aadA2* genes in encoding streptomycin resistance and *dfrB2a* genes encoding for

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trimethoprim resistance [42]. Resistance of *Bacillus koreensis* to different types of antibiotics may be due to horizontal gene transfer of resistance genes. This was aided by biofilm formation in *Bacillus* sp [43]. Zhang reported that the accumulation of multiple putative ARGs isresponsible for resistance of *Bacillus flexus* to antibiotics such as erythromycin, gentamicin, vanomycin, fosfomycin, fosmidomycin, tetracycline, and teicoplanin. *Bacillus flexus* contains several potential MarR family transcriptional regulators in its genome [39]. These work as a globally conserved antibiotic resistance regulator for a wide variety of antibiotics, toxic chemicals, and other essential biological processes. The antibiotic susceptibility patternof *Bacillus koreensis* strain is similar with *Bacillus flexus* [39]. According to Lim, it has been reported that *Bacillus koreensis* had a sequence similarity of 96.8% with *Bacillus flexus* and 96.2% with other *Bacillus* sp [44]. Emergence of resistance in *Staphylococcus* is an important concernbecause it is a critical nosocomial pathogen, and its resistance could become a global threat [45]. The unconstrained and routine use of antimicrobial agents may lead to resistance in *Staphylococcus* sp [46]. Acquisition of antibiotic resistance in *Staphylococcus* might be attributed by a wide array of mechanisms in which the transfer of mobile genetic elements plays crucial role [47,48].The efflux pump mechanism could also contribute to S*taphylococcus* resistance towards number of different antibiotics [48].

Prolonged selection pressure of antibiotics and other substrates on *Staphylococcus* sp under diverse environmental factors may accelerate the expression of efflux system-encoding genes leading to drug resistance [49]. Foster reported that *Staphylococcus* sp has three main types of pumping proteins: *QacA, NorA,* and *Smr*. These wereall involved in antibiotic resistance [50,51].Costa established that the *NorA* pumping protein existed in *Staphylococcus aureus* as a part of its core genome and is resistant to antibiotics [52]. Our study found a notable level of antibiotic resistance expressed by gram-positive organisms, which might due to the existence of *class1 integron* and *tet* gene; the presence of these genetic elements results in the development of resistance to multiple antibiotics [42]. Ager so and Sandvang report that soil bacteria present in close vicinity to poultry have an important role in the horizontal spread of multi-drug resistance through plasmid-mediated resistance encoded by *class 1 integron* gene cassettes and the*tet* gene [42]. Mobile genetic elements (MGE) such as transposons are also a crucial factor in the transfer of ARGs between different bacteria through HGT *via* plasmids or phages [53]. Reports show the intergenic transfer of Inc plasmids between gram-negative and gram-positive bacteria could lead to transfer of resistant genetic elements [42]. The resistance expressed by the isolated organisms may be due to the spread of the same genetic elements. These transfers of resistant genes from one organism to another could affect the susceptibility pattern. Few antimicrobial compounds are insoluble in water due to their hydrophobic nature; hence, they should be dissolved in suitable solvents for MIC determinations in BMD tests. The chosen solvents should not have any impact on the growth of test bacterial isolates [54].The results indicate that ethanol at low concentrations is lesstoxic to all three bacterial isolates.

This result agrees with Ilieva who reported that ethanol (EtOH) and 2-methoxyethanol (MeOH) do not affect bacteria when applied below 25% [55]. The *in vitro* effect of solvents may depend on different factors including physiochemical characteristics of the solvents, growth medium, and species of the bacteria tested [55,56]. Antibiograms of the three gram-positive bacterial isolates of our study expressed multiple antibiotic resistance. The relatively high MAR indices are directly proportional to the high multiple antibiotic resistance suggesting a high risk of ARB. Liyanage and Manage reported gram-positive bacteria with a high MAR index ranging from 0.08 - 0.51 similar to our study [57]. Chita and stated that a MAR index less than 0.15 and 0.2 suggesting low and moderate risks of antibiotic resistant contaminants, respectively [58]. A MAR index over 0.25 suggests high-risk point sources. Our MAR index of isolates from poultry litter is 0.5 to 0.875. This proves that the risk associated with the poultry litter containing MARB is high. Our results also suggest that poultry livestock has been exposed continuously to antibiotics and thus lead to resistance to bacteria for selected antibiotics. Meng reported MAR index values of 86 isolates between the range of 0.0 to 0.8, which proves that the high usage of antibiotics and its high selective pressure [59]. Multiple antibiotic resistance of bacterial isolates is certainly due to the multidrug resistance efflux pumps that are known for their resistance against a diverse range of toxic substances [60]. Parastan described that when resistant bacteria are involved in bio film formation, they express multiple drug resistance[61]. Study shows that multiple antibiotic resistance may also due to the over exposure of bacterial strains to sub-lethal antibiotic concentrations [38]. The MAR index precisely indicates the indiscriminate application of antibiotics in poultry farms, which may lead to

the development of multiple resistance among bacteria [62]. The glutathione S-transferase catalyses reduced glutathione conjugation with different ranges of hydrophobic chemicals including antibiotics [25,63]. An earlier study stated that GST plays a major role in the antibiotic resistance of bacteria and is comparable to our research[25]. Tetracycline is a representative antibiotic employed in poultry and tetracycline gene, *tetA* is commonly used as a selectable marker for antibiotic resistance [64,65] and thus the GST activity of bacterial isolates was estimated for tetracycline. Park and Choung reported data consistent with our work where the activity of tetracycline is inhibited by GST [65]. Similar results have been reported for *Arthrobacter* sp and *Bacillus* sp. where the activity of GST was observed [25]. Bacterial GST activity may due to the expression of GST genes in response to detoxification of antibiotics. This also confers resistance [66,67]The GST activity in bacteria might also increase due to the difference in pH, exposure to the high concentrated cleansing agents, oxidative stressors including certain antibiotics, etc.[68]. Previous studies report that bacterial GST involves the biodegradation of ciprofloxacin by peroxidase-intermediated oxidation, hydrolysis, and dehalogenation [69].

CONCLUSION

This study concludes that all three bacterial isolates from poultry litter were MARB. This proves that poultry litter can be a major environmental reservoir for MARB. Effective characteristic measures of bacterial resistance are essential to better understand antibiotic resistance. Determination of MIC using the BMD method and DD test are reference methods to characterize ARB. Broth dilution requires the use of different solvents to dissolve certain antibiotics. It is better to test the effect of solvent ethanol on the growth of bacterial test isolates because different microorganisms may exert varying susceptibility to ethanol. Solvent effects will help to improve the accuracy for MIC determination.GST also plays a vital role in antibiotic resistance of bacteria. Examination of GST activity in ARB can also act as a resistance indicator. The GST inhibition might control ARB in the future. This knowledge about bacterial characteristics can aid to monitor antibiotic resistance between zoonotic and human pathogens from poultry. Multidrug resistant bacterial infections have a critical impact on human health due to the difficulties in treating them. They are expensive with a high mortality rate. Poultry litter has an important role in horizontal transfer of ARGs, and thus characterisation of antibiotic resistance in poultry bacteria can help target preventive measures to control MARB. The baseline information from this study can lead to surveillance or monitoring of antibiotic usage in animal husbandry and human medicine.

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Table 1: List of antibiotics used

Antibiotic	Antibiotic abbreviation	Disc concentration(mcg)	Antibiotic classes
Ampicillin	AMP	10	Penicillin group of β- lactam antibiotics
Ciprofloxacin	CIP	10	Fluoroquinolones
Chloramphenicol	CHL	30	Broad spectrum phenicols

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Erythromycin	ERY	15	Macrolides
Kanamycin	KAN	30	Aminoglycosides
Streptomycin	STP	10	Aminoglycosides
Tobramycin	TOB	10	Aminoglycosides
Tetracycline	TET	10	Tetracyclines

Table 2 : Disc diffusion susceptibility of bacterial isolates

Antibiotics	Disc Concentration (μg)	*Arthrobacter nicotianae*		*Bacillus koreensis*		*Staphylococcus* sp	
		Zone diameter (mm)	Susceptibility pattern	Zone diameter (mm)	Susceptibility pattern	Zone diameter (mm)	Susceptibility pattern
Ampicillin	10	18±0.28	R	21±0.23	R	19±0.23	R
Ciprofloxacin	10	19±0.06	I	20±0.29	I	26±0.09	R
Chloramphenicol	30	20±0.00	S	24±0.26	S	18±0.09	S
Erythromycin	15	4±0.07	R	8±0.22	R	4±0.03	R
Kanamycin	30	8±0.07	R	16±0.29	I	6±0.06	R
Streptomycin	10	16±0.07	R	18±0.07	R	16±0.07	R
Tobramycin	10	13±0.30	S	17±0.31	S	9±0.00	R
Tetracycline	30	11±0.50	R	7±0.07	R	4±0.03	R

Values are expressed as Mean ± SEM (R – Resistant; I – Intermediate; S – Sensitive; SEM – Standard Error of Mean)

Table 3: MIC of bacterial isolates

	MIC (μg/mL)	Susceptibility pattern	MIC (μg/mL)	Susceptibility pattern	MIC (μg/mL)	Susceptibility pattern
Ampicillin	≥ 8	R	≥ 4	R	≥ 8	R
Ciprofloxacin	≥ 0.5	S	≥ 0.25	S	≥ 16	R
Chloramphenicol	≥ 16	I	≥ 4	S	≥ 16	I
Erythromycin	≥ 2	R	≥ 16	R	≥ 16	R
Kanamycin	≥ 64	R	≥ 8	S	≥ 64	R
Streptomycin	≥ 128	R	≥ 64	R	≥ 128	R
Tobramycin	≥ 4	S	≥ 2	S	≥ 32	R
Tetracycline	≥ 32	R	≥ 16	R	≥ 32	R

(R – Resistant; I – Intermediate; S – Sensitive)

Table 4: MAR index of bacterial isolates

Bacterial isolates	DDMARI	BMD MARI
Arthrobacter nicotianae	0.625	0.500
Bacillus koreensis	0.500	0.500
Staphylococcus sp	0.875	0.750

(DD – Disc Diffusion; BMD – Broth Microdilution; MARI – Multiple Antibiotic Resistance Index)

Table 5: GST activity of bacterial isolates

GST Specific activity (U/ml)			
Test	*Arthrobacter nicotianae*	*Bacillus koreensis*	*Staphylococcus sp*
Activity with TET	0.1698	0.1273	0.1839
Activity without TET	0.0140	0.0082	0.0310
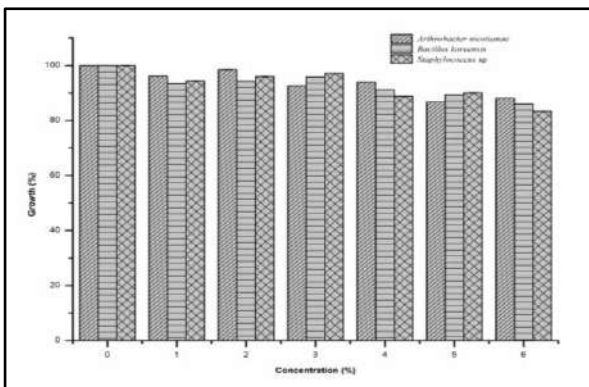
Fig 1: Effect of solvents on the growth of bacterial isolates	**Fig 2:MIC of *Arthrobacter nicotianae*** (AMP – ampicillin; CIP – ciprofloxacin; CHL – chloramphenicol; ERY – erythromycin; KAN – kanamycin; STP – streptomycin; TOB – tobramycin; TET – tetracycline)
Fig 3: MIC of *Bacillus koreensis* (AMP – ampicillin; CIP – ciprofloxacin; CHL – chloramphenicol; ERY – erythromycin; KAN – kanamycin; STP – streptomycin; TOB – tobramycin; TET – tetracycline)	**Fig4 : MIC of *Staphylococcus* sp.** (AMP – ampicillin; CIP – ciprofloxacin; CHL – chloramphenicol; ERY – erythromycin; KAN – kanamycin; STP – streptomycin; TOB – tobramycin; TET – tetracycline)
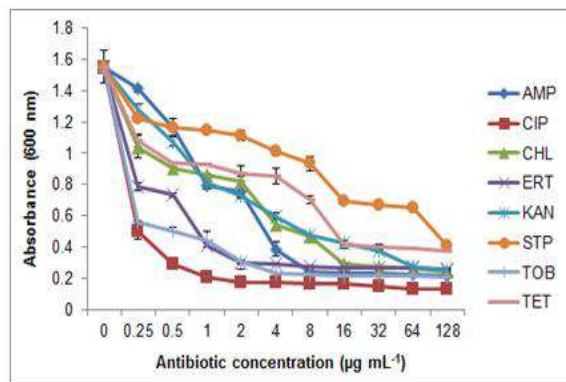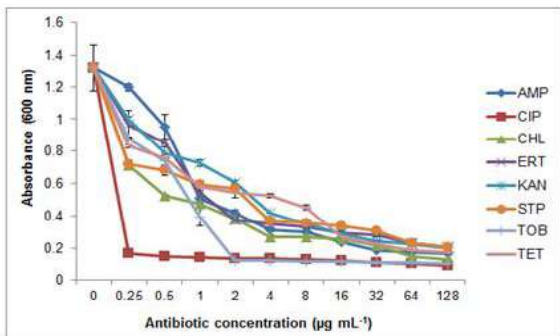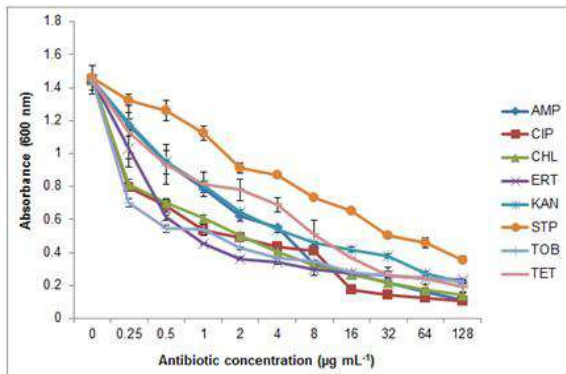
RESEARCH ARTICLE

A New Distributional Record of *Bombax insigne* Wall. (Malvaceae) from Banaskantha, North Gujarat

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ABSTRACT

The present paper deals with indigenous taxa of Angiosperm belonging to family Malvaceae. It is reported as an addition to the flora of Banaskantha district and a new record from North Gujarat. In this paper evidently defines species with unambiguous citation, detailed, description, flowering and fruiting time, followed by ecological notes along with photographs and longitudinal and latitudinal is also provided and mention.

Keywords: *Bombax insigne* Wall., Malvaceae, New distribution, North Gujarat

INTRODUCTION

During botanical exploration the author has collected some specimen of *Bombax insigne* Wall. from Karza village of Dantiwada taluka, Banaskantha district, North Gujarat. It is belonging to Malvaceae (APG-IV). It's locally known as "Shimlo" in Gujarat and Yellow Silk Cotton tree. It was first recorded from Valsad district, Gujarat (Patel *et al.* 2018). Earlier studies it has not enumerated from North Gujarat (Shah, 1978; Cooke, 1908; Inamdar, 1968; Reddy, 1987; Vora, 1980: Dabgar*et al.*, 2012; Meena 2011, 2012 and 2012; Patel *et al.*, 2011; Patel, 2000, Patel, 2001).

Taxonomy

Bombax insigne Wall. Pl. Asiat. Rar. (Wallich). 1: 74. t. 79. A large deciduous perennial tree very similar and often mistaken for the red Silk Cotton Tree. The species name *insigne* means striking, noted, spectacular. Leaves compound with 8 - 9 leaflets arranged on a common, petiole 12-16 cm long. Leaflets are 11-14 cm, obovate in shape, with a pointed tip, petiole very short. Flowers 7.5 to 9.5 cm, very showy, yellow white to creamy, pedicle 1.5 to 2.0 cm, actinomorphic, hermaphrodite, hypogynous. Sepal 3-4 gamopetalous, sepal tube is urn-shaped, slightly 2- lobed, 2.5 to 2.8 cm long, sometimes prickly outside, densely silky. Petals 5 polypetalous, valvate, 8.2 to 9.2 cm long and 3.8 to 4.2 cm wide. Stamens are long and numerous, arranged in bundles of more than 80 and completely filling the flower cup, arranged in 6 bundles, about 13 – 15 in each. Anther filament 4 to 5 cm long, rainy form. Gynoecium pentacarpellary, ovary syncarpous, 0.9 to 1.0 cm. Capsule reaching almost a 15 to 17 cm long and 5.0 to 5.5 cm in diameter, distinctly five- locular, filled with silky cotton.

Flowering and Fruiting: February - April

GPS: 24o20'53.8" N; 72o26'27.0" E (DMS)

Distribution: Karza, Dantiwada, Banaskantha, North Gujarat

Ecology

Tree attracts most of birds during flowering and fruiting season. Birds are depended on fruits of tree during fruiting time. In Karza village of Dantiwada there are only single individuals is observed.

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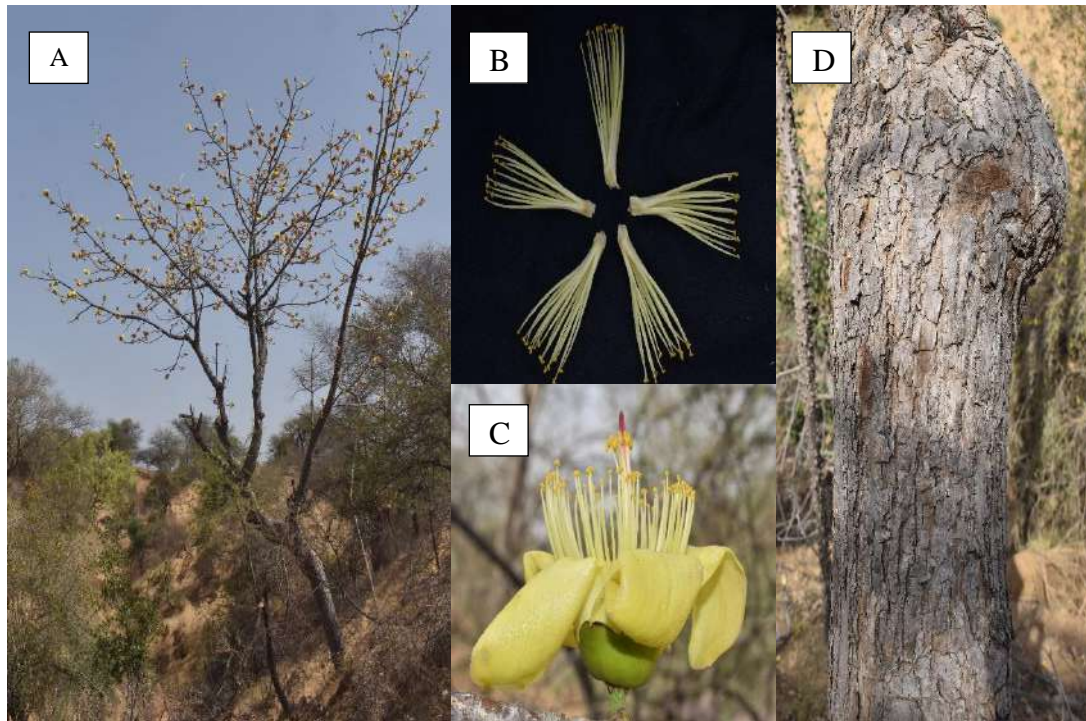
Figure: 1 *Bombax insigne* **Wall. A. Habit of tree B. Androecium C. Flower D. Stem**

RESEARCH ARTICLE

Effect of Different Types of Preservative Chemicals with Sucrose on Quality and Shelf Life of *Jasminum auriculatum* cv. Santhana Mullai Loose Flowers

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ABSTRACT

The post harvest study in *Jasminum auriculatum* cv. Santhana mullai was carried out with different types of preservative chemicals such as boric acid at 2, 4 and 6 %, citric acid, calcium carbonate and potassium nitrate each at 1, 2 and 3% along with 3 % sucrose to assess the quality attributes and shelf life. The experiment was laid out in Completely Randomized Design with 13 treatments and a control in three replications. In physiological parameters the maximum relative water content % with the values of 94.62 (76.59), 83.64 (66.14) and 61.00 (51.35), minimum physiological loss in weight % with the values of 6.91 (15.24), 15.91 (23.51) and 46.00 (42.71), minimum cumulative physiological loss in weight % with the values of 6.91 (15.24), 22.95 (28.67) and 53.00 (46.73), maximum moisture content per cent with the values of (99.87), (80.96) and (60.99) in day 1,2 and 3 respectively, the biochemical characters like maximum total phenol content (86.57 mg g^{-1}, 81.40 mg g^{-1} and 74.76 mg g^{-1}), minimum electrolytic leakage with the values of (46.69 per cent), (61.79 per cent) and (80.89 per cent) were obtained in day 1,2 and 3 respectively. The quality parameters like flower opening index (6.32, 13.23 and 46.93), freshness index (100, 85.48 and 53.55), colour index (98.76, 86.96 and 65.70) in day 1, 2 and 3 respectively and the maximum shelf life of 71.72 hours were recorded and the result revealed that sucrose 3% + boric acid 4 %

(T₃) was found to be the best preservative chemical with sugar solution and proved better in terms of shelf life and its dependent parameters when compared to control.

Keywords: Boric acid, Citric acid, Calcium carbonate, Potassium nitrate, Post harvest treatments, Sucrose and Shelf life.

INTRODUCTION

Floriculture is a conventional farming activity in India having immense potential for providing gainful self-employment among small and marginal farmers (Kumar *et al.,* 2019). It is often argued that horticulture and allied activities have to be given importance in view of the field's potential in employment and income generation (Harisha, 2017). India is on the 18th rank with contributing 0.6 % share in global floriculture trade. India's total export of floriculture was Rs. 575.98 crores or 77.84 USD millions in 2020-2021 (APEDA Agri Xchange, 2021). As per National Horticulture Database (Second Advance Estimates) published by National Horticulture Board, during 2020, the area under floriculture production in India was 305 thousand hectares with a production of 2301 thousand tones loose flowers and 762 thousand tones cut flowers. More than two third of this large area is meant for traditional flowers which are marketed as loose flowers *viz., jasmine, tuberose, marigold, chrysanthemum, nerium, gaillardia, lotus, gomphrena* and *crossandra* (Flower and Seeds, APEDA 2021). Among the traditional crops grown for loose flowers in Tamil Nadu, the largest area is under *jasmine*. *Jasmine* is the oldest of fragrant flowers cultivated by man. *Jasmine* flowers in view of their fragrance, they are very popular as loose flowers and also used in garlands and veni (used for hair adornment). These are also used for the production of essential oils in the form of 'concrete' and 'absolute' used in cosmetic and perfumery industries (Jawaharlal *et al.,* 2012).

There are about 89 species of the genus *Jasminum* found to exist in nature (Velusamy *et al.,* 1973), out of which the major cultivated species in Tamil Nadu are *Jasminum sambac (*Gundu malli*), Jasminum auriculatum* (Mullai), *Jasminum grandiflorum* (Pitchi) and *Jasminum multiflorum (*Kakaratan*).* Among them, *Jasminum sambac, Jasminum auriculatum* and *Jasminum grandiflorum* are the popular jasmines cultivated for their sweet fragrance. *Jasminum auriculatum* is ashrub by/ climbing plant having shiny leaves with auricles. Flowers are white, sweet scented, borne in compound cymes; corolla lobes are elliptic; carpels are solitary and globose. Fruits are black (Ranchana *et al.,* 2017). All these loose flowers are highly perishable in nature. Hence, it becomes important to extend the shelf life and to maintain freshness of the loose flowers (Bhattarcharjee, 2006 and Jadhav *et al.* 2014). Therefore, it is essential to study the post-harvest changes accompanying these loose flowers and are to be studied to derive strategy for extending shelf life. One common procedure used is to store the flowers at low temperatures and supplying solutions containing sugar immediately after the harvest (Abou El-Ghait *et al.,* 2012 and Reid and Jiang, 2012). The preservative chemicals like boric acid, citric acid, $CaCo_3$ and KNo_3 are also used to extend the shelf life of loose and cut flowers(Manimaran *et al.,* 2018). Soaking or foliar application of preservative chemicals with sucrose will be used as a tool or method to extend or prolong the shelf life of the flowers. It will be effective in extending the shelf life in loose flowers. In light of the above facts, the present study entitled, "Effect of different types of preservative chemicals with sugar on quality and shelf life of *Jasminum auriculatum* cv. Santhana mullai loose flowers" was carried out.

MATERIALS AND METHODS

The experiment was carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar, Chidambaram during 2021 – 22. The loose flower of *Jasminum auriculatum* cv. Santhanamullai were obtained from the well-maintained farmers field at Keezhamungiladi during the entire period of study. The loose flower jasmine harvested in bud stage during the early hours of the day were used for the study. The flowers were carefully brought to the laboratory without causing any damage. The investigation were carried out with different types of preservative chemicals such as boric acid at 2, 4 and 6 %, citric acid, calcium carbonate and potassium

nitrate each at 1, 2 and 3% along with 3 % sucrose in Completely Randomized Design with 13 treatments and a control in three replications. The treatments schedule was made such as T_1-control; T_2-Sucrose 3 % + Boric acid (2 %); T_3-Sucrose 3 % + Boric acid (4 %); T_4-Sucrose 3 % + Boric acid (6 %); T_5-Sucrose 3 % + Citric acid (1 %); T_6- Sucrose 3 % + Citric acid (2 %); T_7- Sucrose 3 % + Citric acid (3 %); T_8- Sucrose 3 % + Calcium Carbonate (1 %); T_9- Sucrose 3 % + Calcium Carbonate (2 %); T_{10}- Sucrose 3 % + Calcium Carbonate (3 %); T_{11}- Sucrose 3 % + Potassium Nitrate (1 %); T_{12}-Sucrose 3 % + Potassium Nitrate (2 %) and T_{13}-Sucrose 3 % + Potassium Nitrate (3 %). The flowers were kept at 80 per centrelative humidity in ambient room temperature under 40 W cool white fluorescent light to maintain 12 hours of photoperiod throughout the study period. The observations such as relative water content, physiological loss in weight, cumulative physiological loss in weight, moisture content, flower opening index, freshness index, colour index, total phenol content, electrolytic leakage and shelf life were observed on 1st, 2nd and 3rd day respectively. Relative water content was assessed according to the procedure described by Barrs (1968), physiological loss in weight, cumulative physiological loss in weight, moisture content, flower opening index, freshness index, colour index and shelf life were assessed by the procedures described by Madhu (1999),total phenol content was assessed by the procedure described by Swain and Hills (1959)and electrolytic leakage was assessed by the procedure described by Najib *et al.* (1997). Differences between treatments were evaluated by Least Significance Difference Test (LSD) at5%level of significance (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

The present experiment was carried out to standardize the best preservative chemicals in combination with sucrose 3 % over the control. The results of present investigation revealed that all the treatments differed significantly in improving the quality and shelf life of *Jasminum auriculatum* cv. Santhana mullai over the control.

Physiological parameters
With regard to the relative water content, the highest relative water content was recorded in the flowers treated with sucrose 3 % + boric acid 4 % (T_3) with the values of 94.62 per cent on day 1, 83.64 per cent on day 2 and 61.00 per cent on day 3, followed by sucrose 3% + boric acid 2% (T_2) with the values of 93.61 percent on day 1, 82.68 per cent on day 2, and 57.96 per cent on day 3 respectively (Table 1). The relative water content of the flowers are an important factor for the water status of the flower petals. Boric acid has been used as a mineral salt that could increase the osmotic concentration, thus improving their water balance and longevity in flowers as reported by Manimaran *et al.* (2018) in jasmine flowers. Data pertinent to the flower physiological characters like physiological loss in weight, cumulative physiological loss in weight and moisture content, the minimum physiological loss in weight of (6.91 per cent, 15.91 per cent and 46.00 per cent on day1, 2 and 3 respectively) and the minimum cumulative physiological loss in weight of (6.91 percent, 22.95 percent and 53.00 percent on day 1, 2 and 3 respectively) (Table 1) and the maximum moisture content of (99.87 per cent, 80.96 per cent and 60.99 per cent on day 1, 2 and 3 respectively) were recorded in the flowers treated with the treatment sucrose 3 % + boric acid 4 % (T_3), followed by sucrose 3 % + boric acid 2 % (T_2) (Fig 1). In agreement with the experiment, Manimaran *et al.* (2018) studied that increased physiological and cumulative physiological loss in weight leads to decline in fresh weight of flowers, which is expressed visually as senescing symptoms such as wilting of flowers. Similar reduction in moisture content due to rapid water loss in petals has also been reported in *Rosa hybrida* by Carpentar and Rasmussen, (1974). Similar findings are reported by Zahed Hossain *et al.* (2006) in gladiolus and Thamaraiselvi, (2010) in jasmine.

Biochemical parameters
The biochemical attributes like total phenol content and electrolytic leakage were significantly influenced by the treatments. The highest total phenol content of ($86.57 mgg^{-1}$on day 1, 81.40 mg g^{-1} on day 2 and 74.76 mg g^{-1} on day 3 respectively) and the least electrolytic leakage of (46.69 per cent on day 1, 61.79 per cent on day 2 and 80.89 per cent on day 3 respectively) were recorded in the treatment sucrose 3%+ boric acid 4 % (T_3) and was found to be the best, followed by sucrose 3 % + boric acid 2 % (T_2) (Fig 2 and Fig 3). Manimaran *et al.* (2018) in jasmine flowers studied that the highest level of total phenol content in the flower petals, which in turns helps in delaying the onset of senescence.

The increased electrolytic leakage in the prolonged storage condition clearly indicated that the disintegration in the cell membrane integrity which may bring about all the earlier discussed physiological changes like change in pigmentation and spontaneous ethylene production as reported by Karuppaiah *et al.* (2006) in jasmine and tuberose flowers.

Quality parameters

Among the characters studied, the flower quality characters like, the minimum flower opening index (6.32 on day 1, 13.23 on day 2 and 46.93 on day 3 respectively), the maximum freshness index (100 on day 1, 85.48 on day 2 and 53.55 on day 3 respectively) and the maximum colour index (98.76 on day 1, 86.96 on day 2 and 65.70 on day 3 respectively) were recorded in sucrose 3 % + boric acid 4 % (T_3), followed by sucrose 3 % + boric acid 2 % (T_2) (Table 2). Hashemabadi *et al.* (2011) in tuberose reported that, it might be due to the boric acid which helps in membrane stability and resistance enhancement against senescence related changes. The maximum freshness index and colour index were recorded in the flowers treated with sucrose 3 % + boric acid 4 % (T_3), followed by sucrose 3 % + boric acid 2 % (T_2). The increase in freshness index could be attributed to boric acid which decreased microbial growth thereby helped in increasing shelf life as reported by Chawla *et al.* (2020). Similar results had also been recorded in gladiolus by Singh *et al*. (2000). The highness in colour index in flower might be due to effectiveness of boric acid in increasing the antioxidant activity besides an anti- ethylene activity and had reduced percent of solute leakage from the florets indicating increased membrane integrity of florets due to which the good colour retention is observed by Chawla *et al*. (2020). Sucrose is the best sugar source; it might be due to the exogeneous supply of carbohydrates which replaced the depleted endogenous carbohydrate utilized during the post harvest life of flowers reported by Kumar(2005).The potential of the boric acid has also been reported earlier by Bhattacharjee (2002) in crossandra. Preservative chemicals treatments significantly enhanced the shelf life of *Jasminum auriculatum* cv. Santhana mullai over the control. Among the various treatments, the combination of sucrose 3% + boricacid 4% (T_3) recorded 71.72 hours of shelf life, followed by sucrose 3 % + boric acid 2 % (T_2) recorded the shelf life of 71.26 hours (Table 2). The longevity of florets with boric acid treatment may be attributed to its action on retention and translocation of the sugars to the corolla and most probably due to anti-ethylene activity of the boric acid which retards the early senescence as reported by De and Barman (1998). Boric acid also resulted in almost complete inhibition of the climacteric ethylene production in carnation florets observed by Serrano *et al*. (2006). These results are in line with the findings of Khongwir *et al*. (2018) in tuberose loose flower, Yathindra *et al*. (2018) in jasmine and Farooq *et al*. (2021) in digitalis cut flower.

CONCLUSION

Hence, the right combination of sucrose 3 % + boric acid 4 % (T_3) might be useful to maintain the *Jasminum auriculatum* cv. Santhana mullai loose flowers in a conducive manner which in total might be responsible for the enhancement of shelf life in the best treatment combination, followed by sucrose 3 % + boric acid 2 % (T_2).

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Table 1. Effect of different types of preservative chemicals with sucrose on physiological parameters of *Jasminum auriculatum* cv. Santhana mullai loose flowers.

Treatments	Relative Water Content (%)			Physiological loss in weight (%)			Cumulative Physiological loss in weight (%)		
	Day 1	Day 2	Day 3	Day 0-Day 1	Day 0-Day 2	Day 0 –Day 3	Day 0-Day 1	Day 0-Day 2	Day 0 –Day 3
T_1	67.86 (55.47)	36.52 (37.18)	25.91 (30.59)	54.78 (47.74)	90.02 (71.58)	98.92 (84.04)	54.78 (47.74)	91.92 (73.49)	99.95 (88.72)
T_2	93.61 (75.36)	82.68 (65.40)	57.96 (49.58)	8.60 (17.05)	17.93 (25.05)	46.73 (43.13)	8.60 (17.05)	26.76 (31.15)	55.61 (48.22)
T_3	94.62 (76.59)	83.64 (66.14)	61.00 (51.35)	6.91 (15.24)	15.91 (23.51)	46.00 (42.71)	6.91 (15.24)	22.95 (28.67)	53.00 (46.73)
T_4	92.22 (73.80)	80.89 (64.08)	55.87 (48.37)	9.87 (18.31)	20.91 (27.21)	47.80 (43.74)	9.87 (18.31)	30.86 (33.75)	57.84 (49.51)
T_5	84.94 (67.17)	73.91 (59.28)	47.88 (43.79)	13.58 (21.63)	35.88 (36.80)	49.90 (44.94)	13.58 (21.63)	49.66 (44.81)	63.64 (52.92)
T_6	76.82 (61.22)	62.90 (52.47)	41.41 (40.06)	17.96 (25.08)	41.74 (40.25)	53.00 (46.72)	17.96 (25.08)	59.82 (50.66)	71.01 (57.43)
T_7	90.97 (72.51)	78.90 (62.66)	54.84 (47.78)	11.84 (20.13)	31.92 (34.40)	48.84 (44.33)	11.84 (20.13)	43.86 (41.48)	60.83 (51.26)
T_8	79.81 (63.30)	66.41 (54.58)	43.95 (41.52)	16.47 (23.94)	40.00 (39.23)	51.94 (46.11)	16.47 (23.94)	56.62 (48.80)	68.66 (55.96)
T_9	71.98 (58.04)	56.81 (48.92)	35.72 (36.71)	24.58 (29.72)	49.59 (44.76)	55.84 (48.35)	24.58 (29.72)	74.47 (59.65)	80.66 (63.91)
T_{10}	74.88 (59.92)	60.92 (51.31)	39.61 (39.00)	19.72 (26.37)	43.72 (41.39)	53.88 (47.23)	19.72 (26.37)	63.63 (52.91)	73.81 (59.22)
T_{11}	81.29 (64.37)	68.94 (56.13)	46.66 (43.09)	14.77 (22.60)	37.04 (37.49)	50.90 (45.52)	14.77 (22.60)	51.89 (46.08)	65.83 (54.23)
T_{12}	81.88 (64.81)	75.02 (60.01)	52.90 (46.66)	12.63 (20.82)	34.00 (35.67)	49.01 (44.43)	12.63 (20.82)	46.71 (43.11)	61.76 (51.80)
T_{13}	73.77 (59.19)	57.77 (49.47)	36.71 (37.29)	21.78 (27.82)	45.91 (42.65)	54.82 (47.77)	21.78 (27.82)	67.81 (55.44)	76.77 (61.18)
SED	0.12	0.085	0.08	0.155	0.07	0.06	0.155	0.09	0.09
CD(p=0.05)	0.24	0.17	0.16	0.31	0.14	0.12	0.31	0.18	0.18

(Figures in parentheses are arcsine transformed)

Table 2. Effect of different types of preservative chemicals with sucrose on quality parameters of *Jasminum auriculatum* cv. Santhana mullai loose flowers.

Treatments	Flower opening index			Freshness index			Colour index			Shelf life (h)
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3	
T_1	73.51	100	100	57.80	0.00	0.00	71.84	20.80	0.00	24.33
T_2	6.84	14.82	48.95	99.81	80.81	52.85	97.86	85.94	64.75	71.26

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T₃	6.32	13.23	46.93	100	85.48	53.55	98.76	86.96	65.70	71.72
T₄	7.42	15.67	50.44	99.32	78.53	52.37	97.36	85.37	63.85	71.04
T₅	8.93	26.77	56.46	97.47	72.97	50.69	96.10	81.82	61.76	68.87
T₆	10.20	30.80	59.88	95.86	65.75	46.56	93.87	79.58	59.29	66.95
T₇	7.13	19.31	52.98	99.01	77.48	51.72	96.94	83.94	63.11	70.39
T₈	9.77	28.85	57.36	96.44	68.51	47.52	95.18	79.94	60.21	67.25
T₉	13.81	38.53	64.56	94.75	57.98	44.19	91.41	75.47	38.51	63.90
T₁₀	10.89	32.41	59.22	95.37	63.83	45.68	93.32	77.79	57.96	66.73
T₁₁	9.77	28.31	58.00	96.85	70.10	50.17	95.81	81.22	60.81	67.89
T₁₂	8.34	26.24	54.86	98.18	75.78	51.18	96.48	83.53	62.90	70.15
T₁₃	12.19	34.50	61.84	94.75	60.98	44.98	91.96	76.14	49.00	64.26
SED	0.07	0.065	0.145	0.08	0.25	0.16	0.65	0.11	0.175	0.065
CD(p=0.05)	0.14	0.13	0.29	0.15	0.51	0.32	0.13	0.22	0.35	0.13
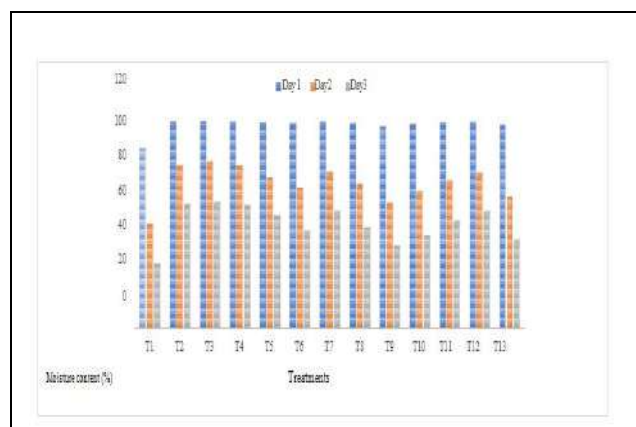
Figure 1: Effect of preservative chemicals with sucrose on moisture content (% of initial moisture) of *Jasminum auriculatum* **cv Santhana mullai loose flowers**	**Figure. 2. Effect of preservative chemicals with sucrose on total phenol content (mg g⁻¹) of** *Jasminum auriculatum* **cv Santhana mullai loose flowers**
Figure 3: Effect of preservative chemicals with sucrose on electrolytic leakage (%) of *Jasminum auriculatum* **cv Santhana mullai loose flower**	**Figure 4: Scape of the best treatments of santhana mullai over control,** *Jasminum auriculatum* **cv. Santhana mullai loose flowers**
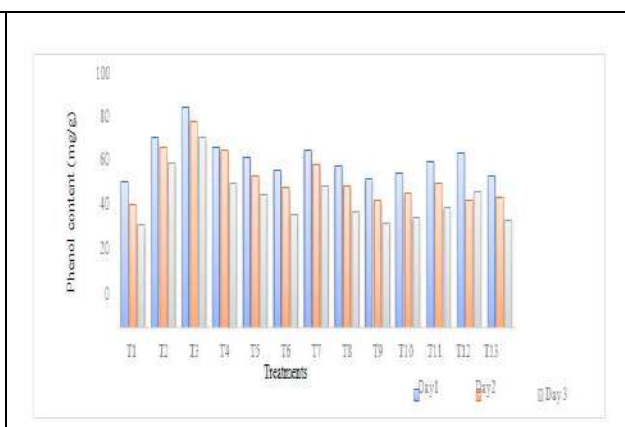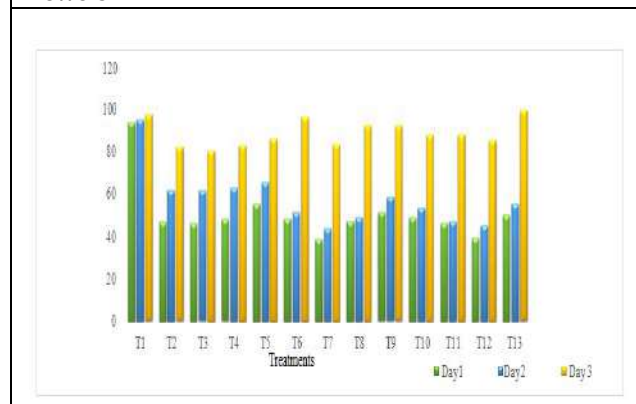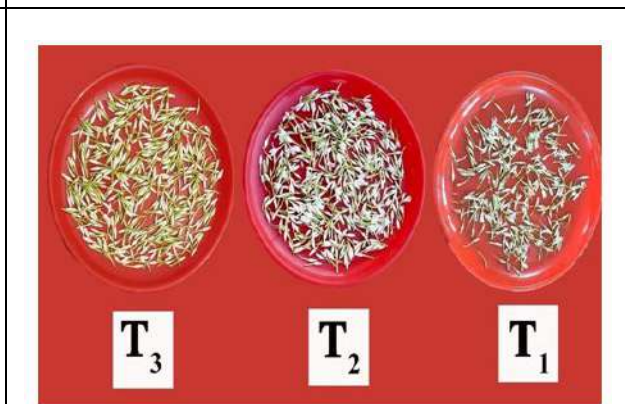
RESEARCH ARTICLE

Pigment Production by Filamentous Fungi using Agro-Industrial by Products

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ABSTRACT

Microbial pigments have numerous beneficial properties like anticancer, antiproliferative, immunosuppressive, antibiotic, biodegradability etc., many microorganisms, including bacteria, fungi, yeast and mould etc., are employed for the industrial production of various pigments by using fermentation technology. There is global interest in process development for the extracellular biosynthesis of pigments from microorganisms owing to serious safety issues with many artificial synthetic colorants, which have widely been employed in cosmetics, pharmaceutical manufacturing and food stuff processes. In this context the present study was planned to isolate filamentous fungi from rhizopheric soil. Serial dilution was performed for isolation. The isolated fungi were subjected to identification using Lactophenol cotton blue mounting technique. Identified Filamentous species are *Aspergillus niger* and *Fusarium oxysporum.* Agro industrial wastes are collected from industries such as wheat bran and wheat straw. These wastes are utilized for pigment production undergo for submerged fermentation using effective PDA and malt extract for pigment production. Compared to *Fusarium oxysporum , Aspergillus niger*(0.526 Abs/ml) was produced more pigment using wheat bran as a substrate. Pigment production was optimized at the p^H level 3, incubation period at 13th day. Hence, pigment production is one of the emerging fields of research to demonstrate its potential for various industrial applications and research works.

Keywords: Pigment, Filamentous species, Wheat bran, Wheat straw.

INTRODUCTION

Pigment production using microorganisms can be easily controlled and performed with in expensive raw material sand minor environmental coasts, as some agro industrial waste products can be used as substrates. Bacteria, fungi, and algae have been used to produce pigments such as carotenoids, melanin and many of these have shown industrially and pharmaceutically relevant biological activities(Venil *et al.*, 2013). Pigments used in the food, feed and cosmetic industries are obtained via synthetic or natural routes (Gudsinar *et al.*, 2014).The first synthetic pigment "mauve"(aniline purple), by William Henry Perkin in 1856, marked the beginning of the modern color industry. This led to the replacement of natural pigments by synthetic ones mainly due to their lower cost, higher stability, large-scale production possibilities. Microbial pigments have numerous beneficial properties like anticancer, antiproliferative etc. Many microorganisms, including bacteria, fungi, yeast mould etc, are employed for the industrial production of various pigments by using fermentation technology. These microbial pigments have area of applications, mainly in food, pharmaceutical and textile industries (Abhishek kumar *et al.,* 2015). Agricultural residues are rich in bioactive compounds. These residues can be used as an alternate source for the production of different products like biogas, biofuel, mushroom and temp has the raw material in various researches and industries. The use of agro-industrial wastes as raw materials can help to reduce the production cost and also reduce the pollution load from the environment. Agro-industrial was test are used for manufacturing of biofuels, enzymes, vitamins, antioxidants, animal feed, antibiotics and other chemicals through Solid State Fermentation (SSF). Agro-Industrial By-Products (AIBP) are mostly derived from agricultural processing industries such as cereal grain milling, oilseed extraction, brewery, malt production, fruit and vegetable processing.

These represent a vast potential source of animal feed , which are currently not fully exploited. Agro-waste is defined as waste which is produced from various agriculture activities. These agro-waste includes manures, bedding, plant stalks, hulls, leaves and vegetable matter. Agro-waste is usually produced through farming activities. Many fungi have been reported to produce non-carotenoid pigments but only a few of those have been explored as possible food colorants (Sameer *et al*.,2006). Microbes can produce a large amount of stable pigments such as anthraquinones, carotenoids, flavonoids, quinines,   rubramines. Fungi are more ecological and interesting sources of pigments, as they produce stable colorants (Devi *et al*., 2014). Filamentous fungi like *Aspergillus sp* produce pigments. *Aspergillus niger* produces yellow color pigments using agro industrial residues. There is a growing preference for natural colorants in among consumers because of their advantages over synthetic colorants in of both healthy and environmental aspects. *Fusarium oxysporum* is an filamentous fungi able to produce pigments. Most *Fusarium sp* are soil fungi and have a worldwide distribution. Some are plant pathogens, causing root and stem rot, vascular wilt or fruit rot. Colonies are usually fast growing, pale or bright-colored (depending on the species) with or without a cottony aerial mycelium. The cultures of *Fusarium oxysporum* produce purple pigment.

MATERIALS AND METHODS

Sample collection
Therhizopherics oil sample was collected from the agricultural are as in and around Thiruvarur district, Tamil Nadu, India. Soil samples were collected in polythene bags were labeled and took to the laboratory where further investigation was carried out.

Isolation of fungi
Serial dilution technique

Procedure
After sample collection, serial dilution was performed for isolating fungi growth from the collected samples. For this 10ml of sterile distilled water was taken in attest tube.1g of soil was added. The tubes were vigorously vortexed with 3 minutes to obtain uniform suspension of organism. A series of tubes labeled as 10^{-1}upto 10^{-8} were filled with 9ml of

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sterile distilledwater.1ml of diluted samples were transferred into the 10^{-1} marked tube. It is further continued up to 10^{-8} dilution and from last dilution 1ml was discarded. The rose bengal agar medium plates and potato dextrose agar medium plates were inoculated with $10^{-3}, 10^{-4}, 10^{-5}$ dilution for fungi and incubated at 37°c for 72 hours.

Identification of fungi using Lactophenol cotton blue staining technique
The identification of filamentous fungi was done by microscopically (or) slide culture method and wet mount technique.

Procedure
A drop of Lactophenol cotton blue stain was added to a grease free slide. The inoculating looper needle was sterilized and cool edit then transferred mycelia growth on to LCB stain and pressed it gently so that easily mixed with the stain. Then the clean cover slip was placed on mycelia growth + LCB. Wiped the excess stain using blotting paper. Observed under low and high objectives of the microscope.

Agro-industrial byproducts
Agro-industrial residues such as wheat bran and wheat straw were collected from the local agricultural farms, mannargudi. The biomass were washed with distilled water to removes and particles. The biomass were dried at60°c for 48 hours. The biomass was stored in an airtight container.

Submerged fermentation (Paul *et al.,* 2014)
The biomass such as wheat straw and wheat bran were used in submerged fermentation (SMF). 1.0g of wheat bran and 2.0g of wheat straw were taken in 250ml flasks & Distilled water added to make 50ml volume. The cotton plugged were sterilized in autoclave, inoculated with5mlinoculums and placed in an incubator at 27.5°cfor15 days. Sample were taken every 3rd day for estimation of fungal growth, pigment activity, soluble /insoluble nutrient composition, and biomass composition analysis. All experiments were performed in triplicate.

Media and culture condition
The selected fungi such as *Aspergillus niger* and *Fusarium oxysporum* were cultivated on agro-industrial residues through submerged fermentation. Wheat bran, wheat straw were used as agro industrial residues. The source and the compositional features of each residue. All residues were used at 10 g/L concentration as only source of nutrients, salts were not added and initial pH was set at 6.5, adjusted before the sterilization. The sterilization was performed using autoclave for 15 min at 121 °C. The fungi were also cultured in potato dextrose broth. Cultivations were performed for 7 days, at 30 °C and 125 rpmin250-mL Erlenmeyer containing 50mL of the medium. These in oculums contained 106 conidia/mL and described previously (Dedavid *et* al., 2008).Cultures were filtered through What man no. 1 filter to separate the mycelium. All cultivations were performed in duplicate.

Pigment analysis (Nagia *et al* .,2007)
The filtrates were analyzed in a spectrophotometer (UV-mini 1240, Shimadzu, and Tokyo, Japan). A scan was performed from 400 to 700 nm to determine the wavelength of maximum absorption. The results were expressed in units of absorbance (UA/mL) at a given wavelength (λ), multiplied by the dilution factor. A blank with the autoclaved media was used to discount the own color of the culture media, for the insoluble media a previous centrifugation (10,000×g for10 min) was performed, to avoid the interference of the particles. The color parameters L, a*, b*, and h from the CIELAB system were determined using equipment. The CIELAB colorimetric system was interpreted as follows: L* indicates lightness read from 0 (black) to 100(white). The positive a *value indicates the red color while the negative a*value represents the green color.

Cultivation of fungi pigments
The isolated fungi were cultivated individually on defined medium. The mineral salts glucose medium was used.

Extraction and purification fungal pigments
After dilution with about 60% of the solvent volume needed, the resulting mixture kept on the rotatory shaker at 180 rpm at 30˚C for15 min. Centrifuge the ethanol mixture at 3780 rpm for15 min. Once the supernatant has recovered disperse the residues in the remaining volume of ethanol and centrifuged again at 3780 rpm for 5 min. Collect the supernatant sand filter through pre weighed Whattman's filter paper(47mm)and further diluted with 95%(v/v)ethanol to a final volumetric dilution factor of 20. Absorption spectrum in between 300-600 mm using spectrophotometer was done.

Yield is calculated by: E=A/C Lr.

In vitro pigment analysis and assay (Velmurugan et al., 2008)
The pigment was extracted and 5g of chilled fresh mycelia mat was taken carefully and washed with sterile distilled water repeatedly changing the water for every wash until the flow of water becomes clear. Ethanol (90%) was added to the test tube at 1:10 ratio (10 ml ethanol pergm of biomass).The mycelia mat immersed in ethanol were heated on a boiling water bath for 30min to extract the pigments. Thereafter, the mycelia mat was homogenized to make slurry in a clean sterilized mortar and pestle with a pinch of acid washed and oven sterilized sand to remove any pigments that may linger in the mycelia mats. The slurry was shaken using an orbital shaker at 2000 rpm for 1h, allowed to stand for 15 min and filtered through What man No.1 filter paper. Absorbance of the colored extract or pigment obtained was measured at 500 nm by taking 95%ethanolordistilledwater as blank and pigment yield was expressed as Abs/ml.

Statistical analysis (Gupta et al., 1997)
Random sampling was used for the entire test. The data was statistically analyzed as mean± standard deviation by using the formula.
$\bar{x}=\Sigma x$ /N.

RESULTS

This study was aimed to isolate filamentous fungi from rhizopheric soil and investigate the pigment production by isolated fungi from agricultural areas of Mannargudi, Thiruvarur (Dt) Tamil Nadu, India. From the soil sample, fungal species were isolated and identified.

Isolation of filamentous fungi
The soil samples were serially diluted and plated on both Rose Bengal Agar Medium and Potato Dextrose Agar Medium and the plates were incubated.

Identification of filamentous fungi
On the Rose Bengal Agar Medium, the organism produced mature colonies within 2- 6days. Growth begins initially as a yellow colony that soon developed into a black, dotted surface as conidia were produced with age, the colony become colour. Microscopically, this organisms exhibited septatehyphae. Long conidiophores that support spherical vesicles of brown rough-walled conidia were observed. From organism was identified as *Aspergillus niger*. On the Potato Dextrose Agar medium, the organism produced abundant white cottony mycelia colonies and dark – purple colonies were undersurface on PDA. The microconidia are oval to ellipsoid or kidney shaped. Microconidia were oval tapering and septated on PDA were observed there it was identified as *Fusarium oxysporum*.

Submerged fermentation using agro-waste

The agro-industrial byproducts such as wheat bran and wheat straw were used for the pigment production by using submerged fermentation. The selected fungi such as *Aspergillus niger* and *Fusarium oxysporum* (Table-2) were cultivated on agro-industrial residues through sub merged fermentation. The dried biomass of 1.0g of wheat bran and 2.0g of wheat straw, Potato Dextrose Broth were taken in three 250ml conical flasks. Distilled water was added to the conical flasks. The conical flasks were individually inoculated with 5ml fungi cultures of *Aspergillus niger* and *Fusarium oxysporum.* The conical flasks were cotton plugged and incubated for 27.5 °c for 15days.

Pigment analysis using spectrophotometer

The filtrates were analyzed in spectrophotometer. A scan was performed from 400 to 700nm to determine the wavelength of maximum absorption. Used to measure light intensity as a function of wavelength. The color parameters of CIELAB system were determined. The CIELAB colorimetric system was performed. The color determination identified within spectral range.

Pigment production on agro-industrial residues

The fungi were cultured on agro-industrial byproducts such as wheat bran and wheat straw to verify the production of pigments. The pigments were analyzed by spectrophotometer. The fungi *Aspergillus niger* showed the production of pigments in large number using wheat bran. The predominant colors of the pigment produced were yellow, as observed by the maxima absorption in wavelengths around 400 nm. The filtrate that had more intense color is the wheat bran from *Aspergillus niger,* which is an agreement with higher luminosity of L^* 39.14.Otherwise, the filtrate with lower luminosity was potato dextrose broth from *Fusarium oxysporum* with the L^* 21.37.The negative a^* value 9.43 represents the yellow pigment in the filtrate, the higher a^* value was obtained in wheat bran filtrate from *Aspergillus niger.* The positive b^*value inallfiltrates confirm the predominance of pigment color. The filtrate showed the higher purity C^* 19.55 was wheat bran from *Aspergillus niger.* The negative a^* 9.25 value represent pigment color and positive b^* value confirm the predominance of purple pigment from *Fusarium oxysporum* (Table-1).

Cultivation of fungal pigments

The isolated fungi were cultivated individually on Mineral salts glucose medium. Inoculated the flask containing mineral salt glucose medium by a mycelia disk from PDA culture. They were grown at 37°c. After incubation period of 6 weeks, the mycelia structures were observed. The mycelium were harvested and filtered the supernatant using What's man filter paper.

In vitro pigment analysis

In vitro pigment extraction was performed by homogenization of the harvested mycelia mat. *In vitro* pigment assay was performed to estimate the pigment. It was concluded that *Aspergillus niger (*Figure-1)was able to produce the pigment from fifth day (0.163 Abs/ml) and this production was continued up to thirteenth day (0.526 Abs/ml) and *Fusarium oxysporum* (Figure-2)was able to produce pigment from fifth day (0.126 Abs/ml) and this production was continued up to thirteenth day (0.473 Abs/ml). *Aspergillus niger* produced more pigment using wheat branasa substrate under submerged fermentation. Itproduced0.526Abs/ml on thirteenth day of incubation after submerged fermentation.

SUMMARY AND CONCLUSION

Pigment is a very important component for the consumer's appreciation especially for a food. Filamentous fungi are known to produce a wide variety of secondary metabolites play an important role in pigment production. Effective use of available agro-industrial residues for microbial pigments can make the process cost effective and environment friendly. The soil samples were collected from agricultural areas. The collected samples were serially diluted and plated. The fungal species isolated and identified namely *Aspergillus niger* and *Fusarium oxysporum* by using standard laboratory manual. These fungal species were subjected to produce pigments by fermentation process using agro-

industrial residues such as wheat bran and wheat straw. The pigment produced by. *Aspergillus niger* higher than *Fusarium oxysporum* up to thirteen days of incubation period. *Aspergillus niger* produce more pigments in wheat bran as a substrate under submerged fermentation. Production of pigment by filamentous fungi is gaining industries owing to their used as food colorants, cosmetics and textiles, because of the important biological activities of the compounds. Further study is to be needed to evaluate suitable filamentous fungi, optimize the parameters and molecular identification of the fungi is to be planned with suitable agro waste products.

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Table:1 : Spectrophotometric data of fungal pigments

S. No	Filamentous fungi	Culture medium	Maximum absorption (nm)	H*	L*	a*	b*
1	*Aspergillus niger*	Potato dextrose broth	45.29	23.66	19.55	9.43	11.35
		Wheat bran	72.4	39.14	17.23	1.62	17.61
		Wheat straw	54.2	32.73	15.47	8.38	12.42
2	*Fusarium oxysporum*	Potato dextrose broth	42.33	21.37	12.22	0.18	6.36
		Wheat bran	51.3	31.54	13.46	3.10	7.19
		Wheat straw	67.4	21.72	14.93	9.25	10.49

Table-2: *In vitro* pigment production at different incubation period

S.NO	Incubation period (days)	*Asperillus niger* (Abs/ml) Mean ± SD	*Fusarium oxysporum*(Abs/ml) Mean ± SD
1	5	0.163±0.09	0.126±0.03
2	7	0.420±0.21	0.331±0.12
3	9	0.431±0.33	0.362±0.26
4	11	0.482±0.27	0.452±0.21
5	13	0.526±0.46	0.473±0.61
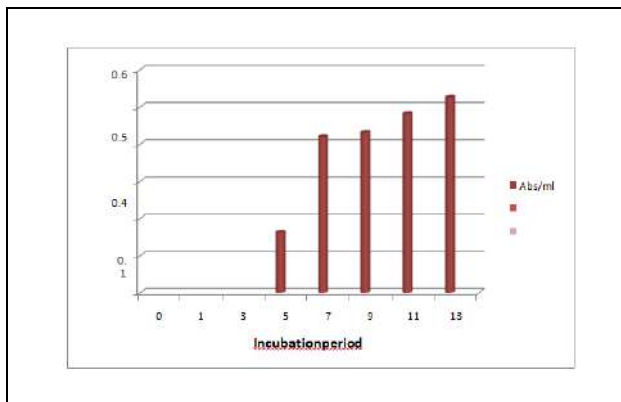
Figure 1 : *In vitro* pigment production using *Aspergillus niger*	**Figure 2:** *In vitro* pigment production using *Fusarium oxysporum*
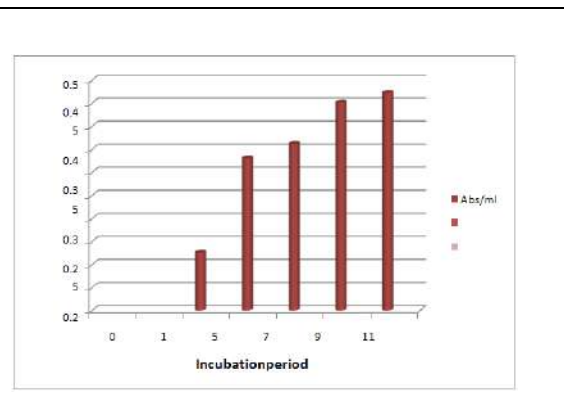
RESEARCH ARTICLE

Study on the Physicochemical Parameters of Brackish water in Vembanad Lake, Alleppey, District, Kerala, India

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ABSTRACT

The brackish water bodies are extremely active that promote fishing, as it is an important habitat for many residential and migratory aquatic fauna of biological and economic significance. Physicochemical parameters in brackish water are an important factor in determining the species' diversity and density. Hence, in the present study Parameters such as Salinity, Temperature, pH, Dissolved Oxygen, Turbidity, Calcium, Nitrate, Phosphate, Total Hardness, and Total Alkalinity were examined. All parameters showed substantial seasonal variations at Vembanad wetland in Alappuzha, Kerala.

Keywords: Aquatic fauna, Brackish water, Habitat, Physicochemical, Vembanad.

INTRODUCTION

The Vembanad wetland system (Lat. 9°36'18" N and Log. 76°21'57" E) is one of the largest wetland systems on the southwest coast of the Indian peninsula[1]. The maximum length is 96.5 km, the maximum width is 14 km, the surface area covered is 2033 km²and the maximum depth is 12 m. It is fed by 10 rivers, covering an area of 1512 sq. km, and is parallel to the Arab sea from Munambam in the south to the northern part of Alappuzha[1]. The Vembanad backwaters are well known for the clam in the winter months and also it has India's third largest aquatic waterfowl population. This system is a protected area against floods and has importance in groundwater recharge and the local economy, of the coastal districts, Alleppey, Kottayam and Ernakulam. The Vembanad wetland system is a complex aquatic system consisting of coastal waters, streams, rivers, mangroves and recovered lands with a complex network of natural and human canals and related reservoirs giving opportunities for about 20,000 fishery activists with an estimated annual fish production 72,000 tonnes. The major problems in this wetland is caused by anthropogenic interventions like dams and bunds, land resettlement, commercial, agricultural and domestic pollution, and organic pollution due to the recovery of coir, tourism, lime shell mining, and natural resource exploitation. The distribution

and variability of nutrients in backwaters have been extensively studied by Lakshmanan *et al.,*[2]. The eutrophication of Vembanad Lake has been studied using a dynamic model by Bindu and Harikumar[3]. In conjunction with the decrease of the flushing rate, the backwaters system has a nutrient increase; appears to be a nutrient drain. Unnikrishnan and Nair [4]. Noticed that due to the existence of a salination barrier, the water quality of the southern half was significantly affected by the lack of proper flush of backwaters, which receive a large volume of pesticide and agrochemical waste. The physical and chemical parameters of the system contribute to the quality of life. The most important variables affecting organism abundance in the estuarine ecosystem are temperature, salinity, dissolved oxygen, pH, turbidity and conductivity [5]. The natural water quality of Vembanad Lake has degraded due to numerous anthropogenic activities such as manufacturing industries creating a troubling situation in the field of waste and untreated sewage. Untreated waste contaminants from domestic and industrial wastewater, agricultural runoff, and other sources may have short-term and long-run impacts on water quality [6]. The research aimed to observe the Physicochemical characteristics of Lake Vembanad in order to gain insight into the health of the lake's water quality.

METHODOLOGY

The present work was conducted atthe highly brackish Vemband Lake in the district of Ernakulam, Kerala during 2018-2019 in order to undertake the seasonal variation in Physicochemical parameters. Temperature, Salinity, pH, Dissolved Oxygen, Turbidity, Calcium, Nitrate, Phosphate, Total Hardness, Total Alkalinity and Total Dissolved Solutes of the water samples collected from the study area were analysed according to standard methods [7-8]. Statistical analysis was done using MS Excel. Data represented as Mean ± SEM.

RESULTS AND DISCUSSION

The Vembanad backwaters sample analysis showed a seasonal variation in the different Physicochemical parameters analysed

Temperature
The water temperature is important for many aquatic organisms but it varies depending on the season. The temperature in the study area ranged from 29.0ºC to 30.5ºC with the highest temperature recorded in Pre-monsoon followed by Post Monsoon. The significant lowest temperature was recorded in the Monsoon season. According to Choudary and Panigrahy[9]. The combined effects of freshwater, low air, surface temperature, and a general cooling of the atmosphere could be responsible for the lower temperature during the monsoon season. During dry months, the highest temperature occurs due to high evapotranspiration, high air temperature, and reduced water flow during post-and pre-monsoon seasons [10]. The seasonal variations in atmospheric heating cause warming up of surface waters during summer. The increased pattern from Post-monsoon to Pre-monsoon is pointed the earlier reports[6].

Salinity
The salinity refers to the degree of salinity and in particular, the dissolved solids content in the waters. In this study, salinity ranged between 0.1 g/Lto 7.4 g/L with the highest salinity duringpre-monsoon and the lowest salinity during the Monsoon. The salinity in brackish water can range from 0.5g/L to 30g/L[12-13]. Salinity showed a typical pattern with maximum values Pre-monsoon period and minimum values during monsoon period. A decrease of salinity during monsoon months is due to of fresh water from land runoff through the monsoon fed. The salinity in brackish water at any point is dependent on the state the tide, time of the year, rainfall extent of fresh water inflow [14,15,16].

Turbidity
Water turbidity is due to colloidal dispersions, which is an important parameter for the quality of water. Turbidity reduces the penetration of light into the water, in turn decreasing the photosynthesis of plants[16]. The seasonal variation of turbidity in the present study shows the highest values of turbidity in Pre-Monsoon followed by Post-

Monsoon and Monsoon respectively. The highest value during Monsoon is attributed to the finely divided organic and inorganic matter and the lowest value was recorded during Post-monsoon.

Dissolved Oxygen (DO)

Dissolved oxygen is a very critical water quality parameter, which is an index of the physical and biological processes in water. Dissolved oxygen is one of the key limiting factors of the aquatic environment because if oxygen levels fall to zero, most species other than anaerobic die quickly. Thus Dissolved oxygen is a vital environmental parameter to decide ecological health of aquatic ecosystem [17, 18]. According to Belzunce *et. al.,*[8]. The permissible value of DO is 4ppm. Low DO results in organisms being stressed, and suffocated and death may occur. The DO ranged between 5.5 ppm to 7.9 ppm with the lowest during pre-monsoon and highest during Monsoon. In the seasonal dissolved oxygen content, very less fluctuations were observed in the study. The amount of DO in water varies with its solubility, which depends on the temperature, the pressure and salinity of the water, and oxygen [19].

Hydrogen ion concentration (pH)

The measurement of hydrogen ion in the water body is pH. The acid-base equilibrium calculation in the ecological system is an important parameter in the assessment of water quality [20]. Almost neutral pH was recorded during all the seasons and the values ranged from 5.8 to 6.9 with an increasing range during Pre-Monsoon and Monsoon respectively. The decreased pH during Post-Monsoon might be due to the acidic nature of the discharge from industries as supported by the observations of Choudary and Panigrahy [9] and Damotharan *et al.,*[26].

Total Hardness

The natural deposition of salts from the soil and geological formations and contamination from industrial effluents is responsible for the hardness of water rising. Hardness -suggests the calcium and magnesium ion concentrations, since both are greater than other cations [21]. The Total Hardness of the samples tested ranged between 16 ppm to 252 ppm with 16.53 ppm in Monsoon, 252.83 ppm in Pre-Monsoon, and 46.44 ppmin Post Monsoon values respectively with the highest range during Pre-monsoon and lowest in Monsoon season.

Calcium

Calcium is an important macronutrient in the aquatic world and is the fifth factor of abundance and is essential in large amounts by mollusks and vertebrates. The concentration of calcium ranged between 1.0mg/L and 33mg/L with maximum calcium during the pre-monsoon season and minimum value during the Monsoon season. Calcium is found in water because of its movement by or over deposits of calcareous materials, dolomite, and gypsum. It is attributed that it may be leached from there to the overlying waters, being present in high amounts in the present study area of Vembanad backwaters [22].

Total Alkalinity

The higher alkalinity is the indication of the total hardness of water and it also favors the phytoplankton growth [23]. The Indian standard permissible limit of alkalinity value is about 250ppm and in the present study, the total alkalinity ranged between 24ppm and 75ppm respectively, which is less than the standard value.

Nitrate and Phosphate

The most significant source of nitrate is the biological oxidation from sewage and industrial waste. Nitrate is the final result of organic nitrogen aerobic stabilisation and is normally found in surface water traces [24, 25]. Phosphate is one of the key nutrients which limits autotrophic growth and monitors the system's biological productivity. The primary source is the disposal of household waste, detergents, farm waste, fertilisers, ores or minerals and industrial effluents. It also exists in metabolic waste of animals. High phosphorus concentrations suggest contamination [26, 27]. In the present study, the nitrate and phosphate concentration was found to be below detectable limits, which shows the sample tested is not contaminated.

CONCLUSION

Physicochemical parameters are most vital in the assessment of the quality of the aquatic life and ecosystem and such continuous assessment would help in understanding the health of these ecosystems. Hence monitoring these ecologically significant ecosystems is crucial to understanding the physicochemical and biological conditions. The present study shows that the water quality parameters are within the standard range of physicochemical characteristics at Vembanad Lake and it is recommended to monitor hydrobiological parameters for a better understanding of such eco-sensitive zones.

CONFLICT OF INTEREST

Authors declares there are no conflict of interest.

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| Fig. 1. Changes in Water-Temperature | Fig. 2. Changes in the level of salinity |
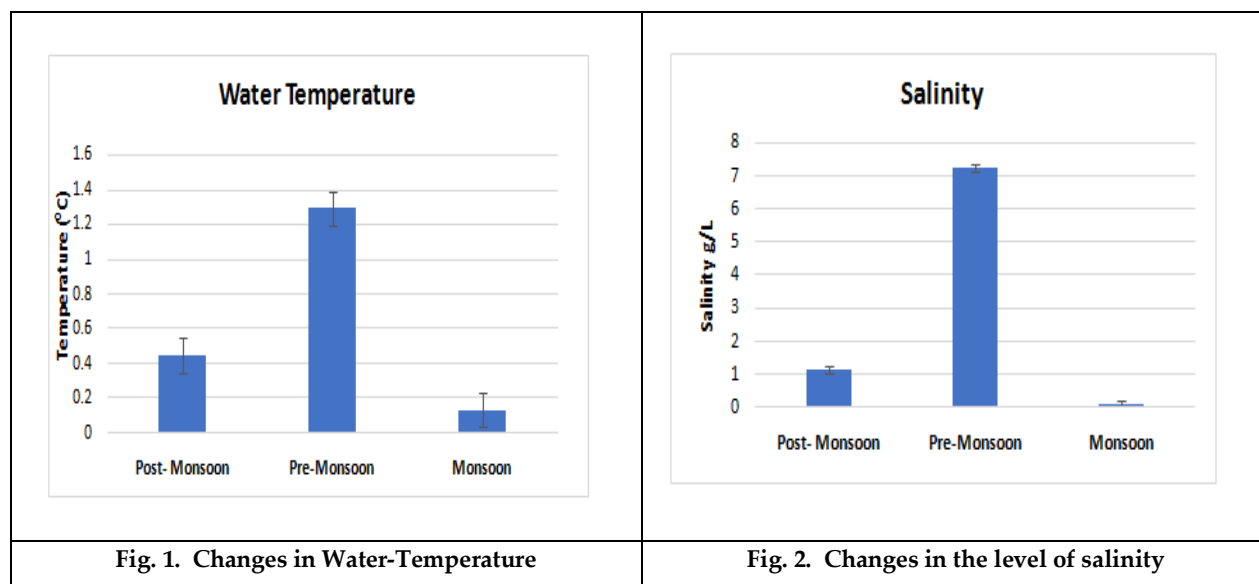
Prathibha and Usha Anandhi
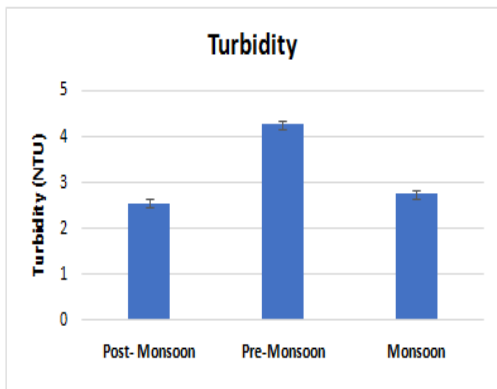
Fig. 3. Changes in Turbidity
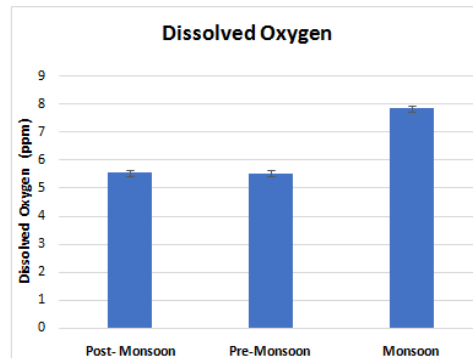
Fig. 4. Changes in Dissolved Oxygen
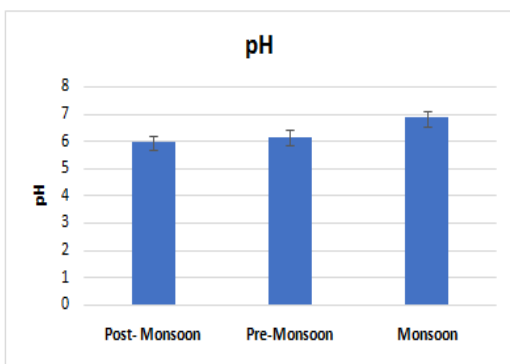
Fig. 5. Changes in pH
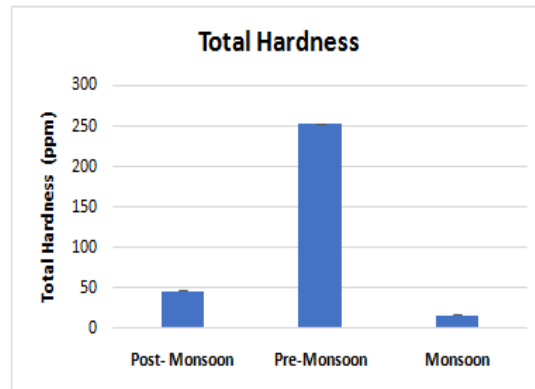
Fig. 6. Changes in Total hardness
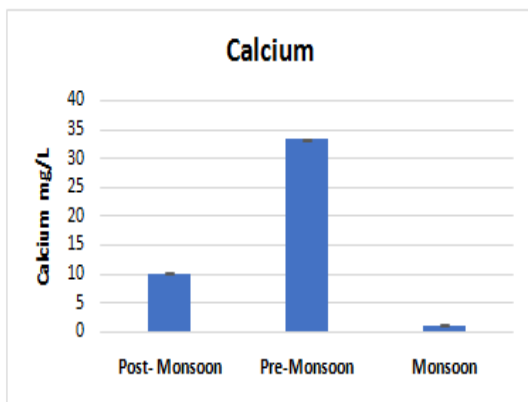
Fig. 7. Changes in the concentration of Calcium levels
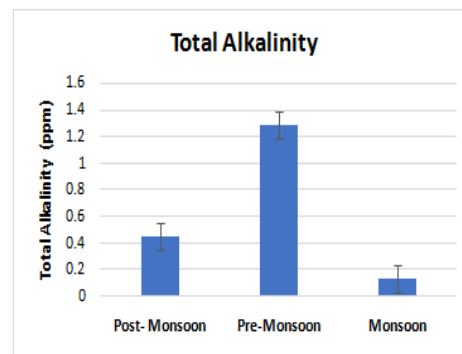
Fig. 8. Changes in Total alkalinity
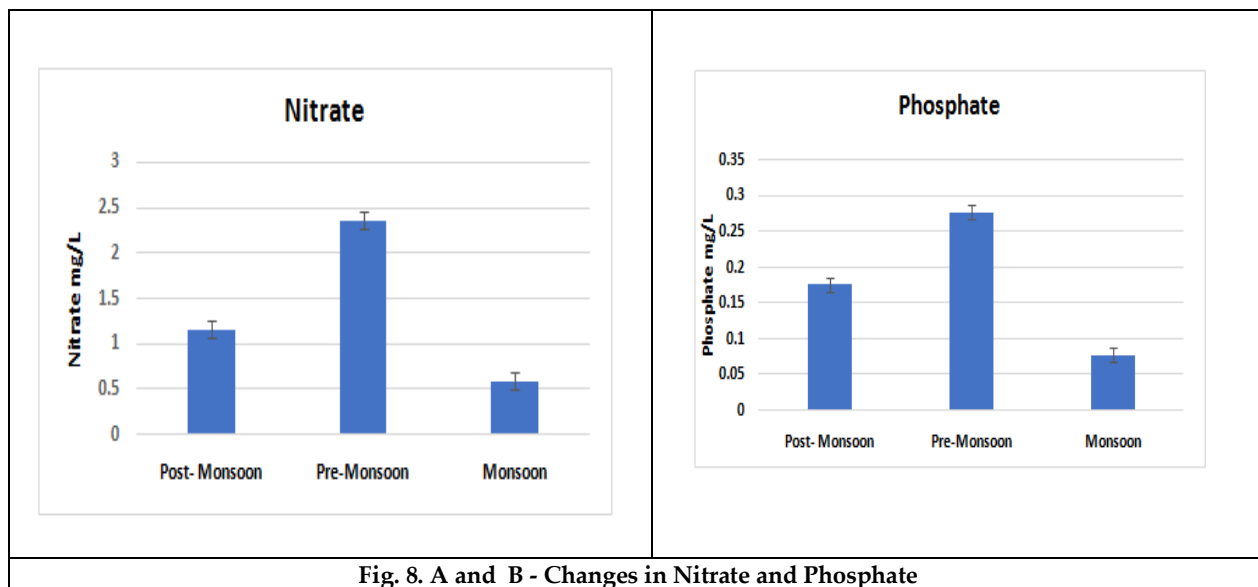
Fig. 8. A and B - Changes in Nitrate and Phosphate

RESEARCH ARTICLE

Ancient Sanskrit Text and Scientific Development

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ABSTRACT

Sanskrit language continued to be the vehicle of all sort of knowledge through ancient and medieval India. The Sanskrit text is the repository of the scientific knowledge with that is not adequately taken note of by the modern researchers. The colonial discourse has conditioned majority of mines to believe that scientific developments are the results of western thoughts. The prevalent post-colonial discourse as one of its concerns makes an attempt to trace the evolution of many of modern scientific development back to ancient and medieval India through the source of Sanskrit text. The Present study makes an attempt to explore the origins of some of modern scientific concepts in Indian ancient and medieval Sanskrit text.

Keywords: Sanskrit Language, Scientific Development, Colonial discourse, Post-colonial discourse and ancient India.

INTRODUCTION

Knowledge has never been the monopoly of any particular race, religion, community or nation. Generation of knowledge is always a consequence of intense curiosity of few individuals. These great minds can belong to any strata of society and any region from the world. Protracted political and economic domination of Afro-Asian countries including that of India for more than two centuries has harmed these societies in multiple ways.

Hegemony of Euro-centric discourse that was put into practise in all domains of life with the clearest intension to acquire domination over will and thinking of native subjects. Corollary to it was the entire machinery that was employed by the British in India to firmly establish British system of Education so as to condition Indian minds in the ways and values that they endorsed. It laid not only to the creation of a large army of clerks who could only be employed in Government offices at the subsidiary positions but in the long run generations of English educated people became oblivious of their glory and greatness that flowed from the wisdom and knowledge of ancient and medieval Indian culture. Their mind was so conditioned that they came to perceive anything related to ancient India as worthless and valueless. In their zeal to imitate western ways of life they went on to adopt and endorse anything and everything that flowed from the western world. In the post-industrial era huge economic resources that the western world appropriated by the ruthless exploitation of the East, enabled them to register faster, progress in scientific and technological domains. It does not undervalue the great contribution of ancient and medieval India to the development of scientific concepts. For centuries together Sanskrit enjoyed a place of prominence in Indian Society. It was the language of education, intellectual debates, and historical, scientific, sociological writings. It is wrong to presume that Sanskrit Language was used by the Indian masses only for the purpose of day-to-day conversation. Owing to the increasing importance of post-colonial discourse, more and more scholars have turned their attention to unearth the lost treasures of Indian knowledge that has been preserved in Sanskrit Language. Rekindled interest in glory of India and greatness of Sanskrit Language has laid to discover that many of modern scientific concepts and theories have their original traces in ancient/medieval Sanskrit text.

Aim

The Present study makes an attempt to explore the origins of some of modern scientific concepts in Indian ancient and medieval Sanskrit text. For the purpose a few Sanskrit shlokas have been picked out. The paper also aims at accelerating the process of post-colonial discourse and thereby contributing to the decolonising the mind so that the contemporary individuals can better appreciate the value and significance of ancient and medieval Sanskrit text that has significantly contributed to the origin and development of various branches of knowledge including that of modern science.

Review of Literature

A host of scholars have devoted their attention to find out how far science and technology had developed in ancient and medieval India. Sanskrit text has emerged as the most significant source to reveal this knowledge as Sanskrit continued to be the Language of expression of knowledge for all the domains of life. The evolution of modern scientific discoveries, processes and methods can be traced back to the ancient India through the medium of Sanskrit Language. Some of the research studies done in this area are as under;

1. The rich tradition of powder metallurgy in Indian system talks that Indians have had the knowledge of converting metal in to powdered form traditionally for a very long time before this process was introduced in modern world. The ancient Indian scriptures and texts like 'Shukraniti' also provide indications to the use of gun powder. The Ayurvedic texts have procedures and explanations for preparing the powder of metals like gold, silver, iron, copper (Joshi, Akhilesh& Dandekar, Indraja, 2017).

2. Paraasharatantra Ancient Sanskrit Text on Astronomy & Natural Sciences; points out ancient Sanskrit texts of India are a treasure trove of knowledge. Parāśaratantra- Ancient Sanskrit Text on Astronomy and Natural Sciences a reconstructed text with translation and notes by R.N. Iyengar is a fruition of a long journey of research and investigation into History of Science in India. The book is divided into 21 chapters with an intellectually lettered introduction. These chapters present a compilation of Sanskrit texts by Parāśara, a sage and scholar from ancient India dispersed in the commentaries of scholars such as Varāha-mihira, Utpala, Ballāla-Sena and Bhāskara-Yogi living between 6th and 13th century.(Iyengar, R.N,2013)

3. Science and Technology in Ancient Indian Texts talks about the volume comprises seminar presentations by experts from India and abroad involved in the study of development of the natural sciences in ancient India. It offers eighteen papers from the seminar that showcase and project the Vedic literature as a treasure trove of vast knowledge that covers various branches of learning. The papers in particular discuss the ancient developments in science and technology: logic, mechanics in Sanskrit literature, Indian mathematics and its application in the

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Vedas, besides production technology and mechanical engineering, environmental science and roots, applicative wonders and scientific validation of Ayurveda (Singh, Balram ; Jha, Girish ; Singh, Umesh & Mishra, Diwakar2012)

4. Some mathematical concepts in ancient Sanskrit works discusses that the Vedas are the earliest records of human wisdom. Some number systems and related concepts that are exists in Vedas were discussed. The content is divided into four small sections. Some concepts: numbers, zero, π value, infinity, and the importance of mathematics in sutras, that exist in Vedas were presented. Some slokas/poems like " yadasikhamayuranam ….. ganitammurdhanisthitam " , " Purnamidaha, purnamidam ……purnamevaavasisyate " that are more related to mathematics were also discussed(Satyanarayana, Dr Bhavanari&Satyasri, Dr.2012).

Ancient Sanskrit Text and Scientific Development

Ancient and medieval Sanskrit text is a repository of vast knowledge that still remains untapped and unexplored. Owing to the increasing influence of post-colonial discourse, more and more scholars are turning their focus on exploration and analysis of vast body of Sanskrit text to understand modern developments. This has also led to the demolition of the myth of superiority of the West with regard to scientific inventions. Here, we have pointed out some of the linkages that exists between modern scientific concepts and pieces taken from Sanskrit text.

Discovery of Zero

Discovery of zero (soonya) and use of zero was first explained by Indian astronomers and mathematicians Aryabhata, in 5th Century. Later on, it was included in the series of whole numbers as 0,1,2,3…… While explaining the number and notations in mathematics, it is interesting to mention the development of numeral 0. It is accepted that zero was discovered by Indian Pingalacharya's Chandasastra (200 BC) appears to be the first book in which application of Soonya is given for writing number as follows:

गायत्रे षड्संख्यामर्धे/पनीते द्वयङ्के अवशिष्ट स्त्रयस्तेषु
रूपमपनीय द्वयङ्काध: शुन्यं स्थाप्यम् ।।

(Kak S. AryabhatiyaEncyclopedia of India 2005)

In gayatrichands, one pada has 6 letters. When the number is made half, it becomes three (that is pada can be divided into two). Remove one from three and make it half to get one. Remove one from it, thus gets the zero (Soonya).

Subsequent development of mathematics and Physics, would not have proceeded in the desirable direction without the contribution of zero by Indian astronomer. Zero is foundation of modern science. Even the Noble laureate, the great physicist Albert Einsteinhas quoted ' We owe a lot to Indians, who taught us how to count, without no worth-while scientific discovery could have been made.'(German - Physicist March 14, 1879 - April 18, 1955)

Value of π

Those who have even the slightest understanding of mathematics would endorse the statement that without the value of pi (π) many complicated modern mathematical calculations or models would have remained an impossibility. The Indian contribution in the form of discovery of value of π another mile stone in the evolution of science.

The value of π has an approximate value of 3.14 which was well explained much before modern western mathematicians could understand the value of it.

चतुरधिकं शतमष्टगुणं द्वाषष्टिस्तथा सहस्राणाम्
अयुतद्वय विष्कम्भस्य आसन्नो वृत्तपरिणाह:

(Aryabhatiyam 2.10)

It says that add four to one hundred multiply by eight then add sixty two thousand then divide by twenty thousand. Result is approximately circumference of a circle having diameter twenty thousand.

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4+100 = 104

104*8 =62832

Pi(π) = Circumference/ Diameter = 62832/20000 =3.1416Aryabhata(Jacobs, Harold R. (2003) knew that he was talking about a mathematical constant, because he uses the term rule, indicating the value remains the same, even when the numbers change. And we know the ratio of the circumference of any circle (whatever its size) to its diameter is always the same – pi. He uses the term 'approached', indicating that the value is not exact, but rather an approximation. This could well have been very first reference to the irrational nature of pi. Modern world in fact discovered that pi was irrational when proved so by Lambert in Europe as late as 1761.(Lambert, Johann Heinrich (2004)

Sound of alphabet

Among all the languages, acoustics of Sanskrit is far superior. There is almost exact correspondence between the sound and a letter of the alphabet. Modern computing tools have started heavily relay upon conversion of speech to text and vice-versa. The whole range of software that perform this function derive their effectiveness from the quality of acoustics Sanskrit. It is to be noted that it is not necessary that the alphabet of Sanskrit is used in the development of such software but the point to be put on record is that the very principle that shows precise relation between sound and text was well known to the ancient Indian Philologist and perhaps, it accounted for unusual correspondence between the letters of Sanskrit alphabet and their sounds. The above statement is corroborated by Sanskrit shlokas.

आत्मा विवक्षमाणोऽयं मनः प्रेरयते, मनः ।
देहस्थं वह्निमाहन्ति स प्रेरयति मारुतम् ॥३॥
ब्रह्मग्रन्थिस्थितः सोऽथ क्रमादूर्ध्वपथे चरन् ।
नाभिहृत्कण्ठमूर्धास्येष्वाविर्भावयति ध्वनिम् ॥४॥
व्याघ्री यथा हरेत् पुत्रान् दंष्ट्राभ्यां न च पीडयेत् ।
भीता पतनभेदाभ्यां तद्वद् वर्णान् प्रयोजयेत् ॥

(Mohanty Monalisa Jan 2014 ,PaniniyaShiksha 25)

The meaning of shloka is :The process of the manifestation of sound in the human body. Desirous of speech the individuated being impels the mind activates the battery of power stationed in the body, which in its turn stimulates the vital forces. The vital force stationed around the root of the navel, rising upwards gradually manifests nada in the navel, the heart, the throat, the cerebrum and the cavity of the mouth as it passes through them.

Further the following shloka says as does a tigress carry her cub by the teeth with a firm yet gentle grip so that the cub does not fall down, so should letters be uttered.

Baudhayana theorem/ Pythagoras theorem

It was very well explained in Sulba sutras of vedic mathematics 540 B.C. Later on1114A.D.it is standardized by Pythagoras. The modern research has shown that Pythagoras thermo was discovered in India approximately 1000 years before Pythagoras was born in Greece. The credit of this discovery goes to Baudhayana (800 BC - 740 BC) who propounded Sulbasutras that provides necessary guidance to solve complicated mathematical problems. Some of important sulbasutras include (Kak Subhash, Pythagorean Triples and Cryptographic,2010)

a. Circling a square.

A circle almost equal in area to a square and vice versa was constructed by Baudhayana.

b. Value of π

Baudhayana's sulba sutras also provided accurate calculation for the value of 'pi'. It was one of the earliest calculations to understand the value of π.

c. The method of finding the square root of two (2).

Sulbasutras of Baudhayana also provided the calculation for the measurement of the length of the diagonal of a square in terms of its sides, which is equivalent to a formula for the square root of 2.(Kak Subhash, Pythagorean

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Triples and Cryptographic,2010)
d. Baudhayana theorem
 Pythagoras theorem finds a mention in the book entitled, "BaudhāyanaŚulbasûtra".

Gravitational force

Development of any concept in science far from being an event that is ascribed to a particular scientist due to his significant contribution to the development of that concept or because of his instrumental efforts to articulate or popularise that concept but this does not mean that a particular idea or a concept was entirely unknown to the mankind earlier. To illustrate this point we can refer to the Newton's discovery of gravitational force. Though he is credited to propound the idea of gravitational force in the form of Newton's laws of motion, this does not mean that the concept of gravity was not discussed by earlier scholars. It is true that Newton presented in a rationally understandable manner confirming to the prevalent canons of science but the idea was not only discussed but also documented by the Indian scholars in their scientific treatises in the form of different sutras(Sinha Nandalal 'Vaishesika-Sutra with commentary'1923). As has already been mentioned due to the dominance of colonial discourse across the domains of knowledge the work of Indian scholars had been pushed to background. The following paragraphs make an attempt to bring forth the valuable contribution of India to understand the concept of gravity. There are 6 different schools of Indian Philosophy. Each of them discusses a different dimension of life or presents a different perception to understand it. It was the time when water tight compartmentalisation between philosophy and science did not prevail. Rishi Kanada who is believed to have propounded theory of gravity and that every object is made of atoms somewhere between 6th century and 2nd century BCE. His discoveries find expression in Vaisheshika Sutra which is a part of 6 schools of Indian Philosophy. The concept of Atoms was also formulated by

Acharya Kanada in Vaisheshika- Sutra. Vaisheshika Sutra discusses the role of Gravity in mainly three events:
a. The first sutra describes why any object falls to the ground

आत्मकर्म हस्तसंयोगाश्च ।
Action of body and it's members is also
from conjunction with the hand.

(V.S. 5.1.6)(Ibid)

As the above sutra describes that it is due to conjunction with hand object remains. Then the next Sutra describes that in the absence of conjunction, object fall results due to Gravity.

संयोगभावे गुरुत्वात्पतनम (V.S. 5.1.7)
In the absence of conjunction falling
results from Gravity.

(V.S.5.1.7) (Ibid).

Thus it clearly recognizes objects fall downward due to Gravity.

b. The next sutra throws light as why an object falls after a few seconds to the ground when it is thrown into the air. Then Vaisheshika sutra discusses the role of Gravity in falling of moving objects. It gives through the analogy of arrow. First, it gives mechanism of arrow projection in Sutra.

नोदनाधभिषोः कर्म तत्कर्मकारिताच्च संस्कारादुत्तरं तथोत्तरमुत्तरं च ॥

The first action of arrow is from impulse; the next is resultant energy produced by the first action, and similarly the next next.

(Ibid).

Then it explains why it falls in next sutra

संस्काराभावे गुरुत्वात्पतनम (V.S. 5.1.18)

In the absence of resultant/propulsive energy generated by action, falling results from Gravity.

V.S.5.1.18 (Ibid).

c. The third sutra explains the process of evaporation and rainfall

अपां संयोगाभावे गुरुत्वात्पतनम (V.S. 5.2.3)

The falling of water in absence of conjunction is due to Gravity.

V.S.5.2.3 (Ibid).

Then it discusses the flow of water.

द्रव्थात्स्यन्दनम् (V.S. 5.2.4)

Flowing results from fludity.

Then it discusses why water rises.

नाड्यो वायुसंयोगादारोहणम् ।(V.S. 5.2.5)

The Suns rays (cause) the ascent of water through conjunction with air.

V.S.5.2.3 (Ibid).

The big massive bodies are attracted powerfully towards the earth by her own (gravitational) force. As a result, they fall on the surface of earth. This means the concept of gravitation was mentioned in 1114A.D in the form of sutra in the granth Siddhanta shiromani by Bhaskara II. Later on it was standardised by Famous PhysicistIsaac Newton(1642-1727 A.D) (Jha Muralidhara Pandit Jyautish acharya 'Siddhanta Siromani: A Treatise on Astronomy Hardcover – December 2010).

आकृष्टि शक्तिस्तु मही यत् स्वस्थम् गुरु स्वाभिमुखम् स्वशक्त्या ।
आकृष्यते तत् पततीव भाति समे समन्तात् वच पतत्ययं रवे ॥

Thus from above discussion it can be established that Indian ancient scholars were aware of working of Gurutwa that is known as Gravity (Jha Muralidhara Pandit Jyautish acharya–December 2010).

Occurrence of Eclipses

Even before Aryabhata the knowledge about the movement of earth and moon was known. Aryabhata who earned the distinction of being the greatest astronomer in ancient India put forth his argument based on geometrical

calculations that at the time of eclipses either moon comes between the earth and the sun or it takes the position under the shadow of the earth. In other words, Aryabhata on one hand used the previously available knowledge of tracing the movements of earth and moon and on the other by employing right geometrical calculations made it possible to predict time, date and nature eclipses.

It is also noted that even at conjunction if the vertical separation is more than the sum of the angular radii of the Sun and the Moon, then no eclipse would occur. The method discovered by the ancient astronomers made it possible to predict the occurrence of an eclipse accurately. The method enabled them to foretell the time, type and date of the occurrence of eclipse. The ancient text made a mention of at least one eclipse that was accurately predicted before it could happen in 1128AD. (Subbarayappa, 2008). The credit to demystify eclipse eons goes to Araybhatta. It was much later that other people would understand the reasons behind the occurrence of eclipses. (Ibdi)

छादयति शशी सूर्यं शशिनं महती च भूच्छाया। -   (Aryabhatiya Golapaadah 37)-499 CE(Pingree David 'Astronomy in India', in Christopher Walker, ed., 1996)

Further the planetary Motion i.e. the planets move on their orbits in eccentric circles. was stated by Aryabhata in the 5th century AD, much before the first law of planetary motion given by Kepler in 17th century CE.(Holton, Gerald James; Brush, Stephen G. (2001).

कक्षाप्रतिमण्डलगा भ्रमन्ति सर्वे ग्रहाः स्वचारेण ।

मन्दोच्चादनुलोमं प्रतिलोमं चैव शीघ्रोच्चात्॥ **(**Vedic Texts: 'Solar Eclipse' in Vedas (the vedic texts.blogspot.com)

यत्त्वासूर्यस्वर्भानुस्तमसाविध्यदासुरः।
अक्षेत्रविद्यथामुग्धोभुवनान्यदीधयुः।।5।।
यंवैसूर्यस्वर्भानुस्तमसाविध्यदासुरः।
अत्रयस्तमन्वविन्दन्ब्रह्मान्येअशक्नुवन्।।9।।Rig Veda 5.40.5,5.40.9
 (Vedic Texts: 'Solar Eclipse' in Vedas (the vedic texts.blogspot.com)

7. Metallurgy in Sanskrit text:
It is approximately more than 7000 years ago, Indians were aware of various methods of extracting metal from ores. This is also evidence from the fact that metal wares widely in use in the ancient India. Sanskrit literature contains some of the verses that describe various methods used in metallurgy.
जरतीभिरोषधीभिःपर्णोभिःशकुनानम्।
कार्मारो अश्मभिर्द्युभिर्हिरण्यवन्तमिच्छतिन्द्रायेन्दो परि स्त्रवII Rig Veda 9.112.2

The above verse is a testimony that the ancient Indians were aware of the method of extracting mental from ores. It clearly describes how it can be done.(Wilson H. H. 'Rig Veda'translation and commentary, 1866)
Besides, other metals copper and bronze were extensively used in ancient India. It is evident that the word syamam that stands for copper is frequently mentioned in the Sanskrit text.
चतुःसहस्रंगव्यस्यपश्वःप्रत्यग्रभीष्मरुश्मेष्वग्रे।
धर्मश्रित् तप्तः य आसीदयस्तम्वादाम विप्रा IIRig Veda 5.30.15**(**Wilson H. H. 'Rig veda' translation and commentary, 1866)
There are references in Rigveda to the different tools of metal used by people that includes metallic tip of the arrow made of iron, kettles, cups, bowls, heater, pans of iron and oven. The things made of metal were categorized into two classes syāmaayas or iron and the lohitaayas or copper or bronze

श्याममयोऽस्य मांसानि लोहितमस्य लोहितम्(अथर्ववेदः/काण्डं ११/सूक्तम् ०३.७)

(Translation of Atharvavedasamhita)

As there are four different vedasviz, Rig veda, Atharvveda, Sam Veda and Yajurveda .Six types of metals find mentioned in Yajurveda that includes gold, iron, copper, lead, tin and bronze. Further Crucible (Musha) and furnace (KosthiYantram) used in laboratories for purifying materials as well as for making various alloys and compound was proposed well advanced before scientific discoveries by this particular shloka

मुष्णाति दोषान् मूषा या सा मूषेति निगद्यते । - (Rasaratnasamuchchaya 10.2)(Shastri ,Ambikadatt 'A book Rasa Ratna Sammuchchaya)

उपादानं भवेत्तस्याः मृत्तिका लोहमेव च ।। - (Rasaratnasamucchaya 9-43, (12th Century CE)) (Shastri ,Ambikadatt 'A book Rasa Ratna Sammuchchaya)

CONCLUSION

The study has made an attempt to point out the modern scientific discoveries and inventions that are credited to the western scientists, in reality the concepts or even the processes of such discoveries and inventions were very much known to ancient Indian Scholars. A wide range of references describing scientific processes and methods can be found in Sanskrit text. As the British could not understand Sanskrit Language and they suffered from a high sense of self-complacency thereby summarily rejecting the idea that the ancient Sanskrit text could contain scientific knowledge or information, they fostered the belief that the ancient India was devoid of the high mark of Intellect and Scholarship that amounts to the discovery of Scientific process and methods. Owing to number of reasons majority of Indians adopted the attitude of servility little realising that India had achieved a considerable height in terms of scientific development. This study has without putting the western scientists on the discount has made a sincere effort to showcase a comprehensive understanding with regard to scientific development. In other words, it is a humble attempt to give legitimate credit to the Indian Scientists and scholars who laid the foundation of many of the scientific processes and methods in different domains of knowledge including Physics, Mathematics, Astronomy, Metallurgy and so on. Scientific development cannot be viewed in isolation that it has taken place either in the West or in the East. Neither it can be perceived exclusively independent whether it has taken place in the ancient time or modern time. Rising above these boundaries of time and space, the evolution of science has to be accepted as a continuous process that thrives on the notion of validation and revalidation governed by the cannons of science and rationality.

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दीर्घस्याक्षणया रज्जुः पार्श्वमानी तिर्यङ्मानी च यत् पृथग्भूते कुरुतस्तदुभयं करोति ॥

$AC^2 = AB^2 + BC^2$

Figure.1. Baudhayana theorem   (Kak Subhash, Pythagorean Triples and Cryptographic, 2010

RESEARCH ARTICLE
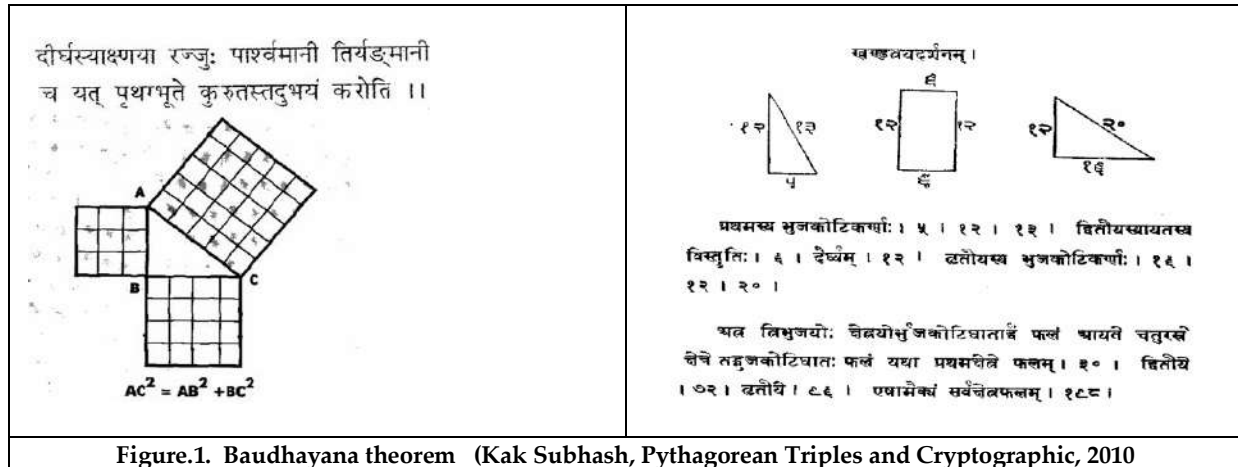
PMUY (Pradhan Mantri Ujjwala Yojana): A way forward towards Women Empowerment

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ABSTRACT

The purpose of this study is to address the need of the hour; replacement of unclean solid cooking fuel (Cow dung cake, firewood etc.) with a clean substitute i.e. LPG. This study focuses on some eye opening facts like how out of 24 crore households in India, 10 crore were deprived of an LPG connection, (Times of India, 2018) and 80% of the 6,00,000 premature deaths in South-East Asia occur annually due to exposure to IAP-Indoor Air Pollution, (Global Alliance for clean cook stoves, 2013). The need for the government to formulate this policy is grounded on the adverse effects that the hazardous smoke emitted from the traditional cook stoves has on the health of women and their children. The aim of this study is to analyze the multi-dimensional impact of PMUY and understand how this scheme has worked in the direction of women empowerment, emphasis has been given to the following variables like health impact, monetary impact, impact on girl child education, impact on family well-being and women empowerment. To investigate the facts, data has been collected from primary sources through questionnaire method from places in the rural parts of Rajasthan like Sikar, Dausa, Kukas, Alwar etc. Secondary data has also been collected for this purpose from the official website of PMUY and NFHS IV (2015-16) and various other government sites. The findings of the research are PMUY scheme of the government reflect a positive impact in the lives of rural women at the same time reflecting the inefficiency in the Government subsidy transfer mechanism.

Keywords: Women empowerment, clean cooking substitute, Girl child education, Government subsidy.

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INTRODUCTION

India is a developing country with a colonial background of almost 200 years, where 23.6% of its population lives below the basic poverty line (World Bank, 2011). Almost half of its population still depends on agriculture and related activities for their livelihood. In such economic conditions, where incomes of quite a number of households is 5000 per month at max (India Today, 2015) it is virtually impossible for families to get an LPG cooking gas connection for their homes. Out of 24 crore households in India, almost 10 crore households were deprived of an LPG gas connection (Times of India, 2018). India accounts for 80% of the 600,000 premature deaths that occur in south-east Asia annually due to exposure to IAP Indoor Air Pollution (Global Alliance for Clean Cook stoves 2013). Nearly 70% of rural households in India don't even have ventilation. The option is either to use smokeless chullahs or stoves which would use clean energy for cooking purposes. About 65,000 people died from HAP (Household Air Pollution) in Rajasthan in 2016 according to GBD (Global Burden of Disease) 2016. About 68% of the population in Rajasthan relied on solid fuels for cooking in 2015-16 according to the National Family Health Survey IV (IIPS, 2017) compared to about 40% globally. The sufferers include both women who cook and children who stay indoors. The utilization pattern is such that about 68% of the population in Rajasthan relied on solid fuels for cooking in 2015- 16 according to the National Family Health Survey IV (IIPS, 2017). Villagers tend to use solid fuels like firewood, dung cakes, coal, crop residue, kerosene etc. which are non-renewable in nature and will get exhausted over a period of time which is why people need to opt other alternative sources for domestic sources of energy. These traditional fuels consume a lot of time in collection and gathering and are treacherous and hazardous for the health of women who cook and children who inhale the smoke emitted from these unclean fuels. The concern for IAP (Indoor Air Pollution) can be seen in few of the past government policies as well but no direct remedies have been suggested to control the threat of rising pollution levels.

BACKGROUND OF THE STUDY

Government Initiatives

Women empowerment has been one of the most important concerns of the government. In Rajasthan it began with the, 'sathins' (voluntary workers) which was considered "the rising tide that will lift all boats" Other schemes which are ongoing for this concern are: Mukhya Mantri Rajshree Yojana, Bhamashah Yojana, Gramin Balika Sarakshan Avum Saman Yojana etc.

Immense focus has been laid on the health of women, for this purpose certain initiatives are:

a) **Rajiv Gandhi Grameen LPG VitaranYojana (RGGLVY)** - launched in 2009 by MoPNG(The ministry of Petroleum and Natural Gas), this scheme aims to increase rural access of LPG by setting up distribution agencies by providing dealerships for small sized low-cost agencies which provide at least 600 Cylinders per month.

b) **National Program for Improved *Chulhas* (NPIC) -** as fuel efficiency was the major focus of NPIC but with better understanding of health benefits, need for quality service and climate change the NBP aimed to provide the same quality of energy service as LPG with biomass cook stoves (Venkatraman, Sagar, Habib, Lam, & Smith, 2010).

c) **National Biogas and Manure Management Program (NBMMP)-**since 1981,the program has installed 45 lakh plants by 31st March 2013(Planning Commission, 2013).

The common drawbacks of these schemes included corruption, poor implementation, lack of awareness among beneficiaries etc.

Understanding the Problem

Around 41% of the households in India still use unclean solid fuels for cooking. Both affordability and accessibility are key issues to the rural people. When people use the more conventional and traditional sources for cooking, like firewood, dung cake etc. these unclean fuels (fuels which show incomplete combustion and leave residue, mostly smoke behind) create an excessive amount of smoke, which is very harmful for the ones who breathe it. Also, the

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biomass used in many occasions is extracted from the local forest and wastelands causing heavy deforestations sometimes. The indoor air pollution created from use of such un-cleaned fuel adversely affects the health of women, children and other people residing nearby such households causing respiratory diseases/ disorders like lung cancer, heart disease, stroke and chronic and obstructive pulmonary diseases. From study it is revealed that, the smoke inhaled by women while cooking on such unclean fuel is equal to burning of 400 cigarettes in an hour. An estimate around five lakh deaths occurs annually in India while a large number of people suffer from respiratory disorders due to use of unclean cooking fuels (WHO Summit at Geneva -2009 on Public Health and the Environment). In households where the families use these unclean sources a lot of time is required for the collection of these fuels. The factor of time is not only prevalent in the collection of these traditional fuels for cooking, but also in the process of cooking itself. When these traditional fuels are used for the purpose of cooking, they require the use of the traditional '*chulhas*' they are not made for the modern gas stoves. The '*chulha*' requires a good amount of effort and time to be lit up, not to mention the techniques one must be aware of to light the firewood or any other unclean fuel.

Alternatives for cooking with solid fuels

Demand for clean energy is directly proportional to the economic development (UNDP,2001).Fortunately, technology has paved the way for alternatives such as biogas plants, smokeless stoves, solar water heater, solar cooker, solar street lights, pumps, wind electric generators, biomass gasifiers and small hydro electric generators to name a few. However, their use is limited because of weak institutional arrangements. To name a few:

Improved biomass cook stoves

Improved biomass cook stoves are designed to be more energy efficient and to generate less smoke than traditional cook stoves or cooking over open fire. Such stoves therefore have the potential to reduce harmful emissions. The success of stove promotion programs – i.e., high household adoption rates, sustained use, proper maintenance, and repair of the cook stove, depends on factors such as household acceptability of the characteristics of the stoves being promoted, stove financing arrangements, household perceptions of benefits of the cook stoves. Program follow-up in terms of monitoring, promotion of sustained use of the stoves and proper stove maintenance and repair are required. Free provision of LPG connection to poor households and a 50% reduction of subsidies to LPG fuel are other two interventions which can help people to switch to clean fuels.

Nirdhoom Chullah: Nirdhoom Chullah

Nirdhoom Chullah: Nirdhoom challah or the smokeless challah tries to remove the shortcomings in the design of our traditional chullah by using up to 50% less firewood than traditional chullah. It is durable, requires less maintenance and its design is such that adequate oxygen is supplied in burning area continuously. This results in efficient combustion, which in turn results in up to 80% less smoke.

Its benefits include: improved environment, reduced pollution and less emissions carbon dioxide.

Barriers for adoption of Smokeless Chullah:
- Food habits and cooking practices
- Economic and Financial Barriers -Price of clean stove is a major roadblock
- Technical and Quality Related Barriers
- Absence of Testing Labs

The Pradhan Mantri Ujjwala Yojana (PMUY)

The word 'Ujjwala' in Sanskrit means 'bright or lustrous. The Pradhan Mantri Ujjwala Yojana (PMUY) The word 'Ujjwala' in Sanskrit means 'bright or lustrous'. The Pradhan Mantri Ujjwala Yojana is a flagship scheme of the Indian government, which aims to provide cooking gas (LPG) connections to approximately 5 crore households free of cost, who have been living below the poverty line (BPL families) according to the Socio-Economic Caste Census of 2011. The scheme also provides a subsidy of 1600 which is directly transferred to the Jan Dhan bank account of the woman head of a particular household to curb corruption and ensure women empowerment. It chiefly aims at brightening the lives of women. The Pradhan Mantri Ujjwala Yojana was launched on 1st May, 2016 by the Prime

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Minister in the Ballia district of Uttar Pradesh. The district was specifically chosen because of it having a very small number of households who had an LPG gas connection. The ministry of Petroleum and Natural Gas (MoPNG) was fully involved on planning and execution of PMUY, this scheme provides financial support in terms of 50% of the total cost or INR 1600 to poor households to help them purchase LPG stoves. This is done by subsidizing LPG connections for the economically weaker and socially marginalized BPL (Below Poverty Line). The key drivers of LPG diffusion in the country include push from the natural gas companies, multilateral and bilateral financial institutions, increased literacy, income and aspirations of rural community, demand for clean energy from the vocal sections of rural and urban households who are vote banks for the political parties, and government's development agenda.

Benefits of the scheme

As we know health plays a crucial in the functioning of a person, "A healthy nation can only strive to become a wealthy nation". It is acknowledged with open eyes that women play an equal role as men in the development of the nation, therefore the government targeted the rural women whose heath had been neglected for a very long time and decided to initiate The Pradhan Mantri Ujjwala Yojana (PMUY) scheme which would serve the multifold purpose of uplifting women by saving their time and efforts, protecting the children from significant number of acute respiratory illnesses caused by indoor air pollution, saving the environment from harmful emissions, Reducing the number of deaths in India due to unclean cooking fuel. One of the most important benefits which were kept in mind while devising and launching the Pradhan Mantri Ujjwala Yojana is the benefit of Women Empowerment. (In terms of better health conditions, they can earn money in the time saved by cooking on LPG stoves and also become aware of the functioning of the bank as the subsidy is transferred in their bank accounts which give them a chance to learn the functioning of banks and use the money according to their own preferences). Bringing up every household towards the use of cleaner fuel has been the target of every successive government for a decade by slowly covering the urban to semi urban and then the rural through different programs like Rajiv Gandhi Gramin LPG Vitran (RGGLV), Deepam scheme etc that is the reasons for continuing the subsidy on domestic LPG for such a long time. However the pace of coverage was very slow. Reforms like PMUY are much needed in a country like ours as women spend most of their lives in the kitchen doing household chores and health of the children and the females is mostly neglected. There is a very famous quote in English which says- "Time is money". The logic behind this quote is applicable in this situation also, which also highlights the importance of the monetary benefits of the PMUY. If women were able to save the time that is used by them in cooking activities, they can use the time in other activities where they can earn some extra money. In many households, the women of the house also ask their daughters (if any) to help in the kitchen work so that they can save some of their time. It has been observed that these girls often have to drop out of schools owing to household work, especially that of the kitchen. If time is saved in the kitchen, these girls can be enrolled in schools, and thus will be able to receive education. Other countries have also undertaken similar reforms but the trust with which the reforms have been implemented differs from time to time a, country to country, development strategy and philosophy of the times. In our country we have about 3,000 caste and 25,000 sub castes it is very difficult for the government to move towards inclusive growth. In order to achieve it PMUY focuses on social inclusion which can be described as the process of improving the ability, opportunity and dignity of people disadvantaged   on the basis of their identity to take part in the society. (World Bank, 2013) It not only helps in drudgery reduction, girl child development but also is a major step towards rural development.

Economic Rationale

Under this scheme, 5 Cr LPG connections will be provided to BPL families with a support of Rs.1600 per connection in the next 3 years. Ensuring women's empowerment, especially in rural India, the connections will be issued in the name of women of the households. Rs. 8000 Cr. has been allocated towards the implementation of the scheme. Identification of the BPL families will be done through Socio Economic cast census data. PMUY is likely to result in an additional employment of around 1 Lakh and provide business opportunity of at least Rs. 10,000 Cr. over the next 3 Years to the Indian Industry. Launch of this scheme will also provide a great boost to the 'Make in India' campaign as all the manufacturers of cylinders, gas stoves, regulators, and gas hose are domestic.

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Target Population

The target population under PMUY scheme is rural BPL (Below Poverty Line Women) of various states of India like MP, UP, Rajasthan, Tamil Nadu etc. It was launched in May 2016, initially targeted 50 million connections to below poverty line (BPL) families by 2019, with the support of Rs 1,600 to each family. So far, 58.5 million connections have been given under the scheme across 715 districts. The scheme, aimed at supplying free liquefied petroleum gas (LPG) connections to poor families, had a target of reaching out to 80 million families by 2020.

Pattern of Subsidies

After a series of debate on the matter of how subsidies should be provided to the beneficiaries so that they reach the target segments, The Indian Government decided to roll out DBT (Direct Benefit Transfer) scheme for January 2013. Under this scheme, beneficiaries were asked to pay the market price for the LPG cylinder and the subsidy due on the cylinder was transferred directly to their bank accounts. Another mechanism PAHAL (Pratyaksh Hanstantrit Labh) scheme requires a beneficiary to purchase the LPG cylinder at prevailing market price. On purchase the subsidy due is credited to her bank account. The systematic digitalizations of records pertaining to LPG connections of PAHAL have led to the elimination of millions of duplicate LPG connections.

Procedure for Applying

The procedure for applying as a beneficiary of the scheme is as follows:

- A woman of the BPL household may apply for a new LPG connection (in the prescribed format) to the nearest LPG distributor.
- While submitting the application form, the woman needs to submit detailed address, JanDhan Bank Account and Aadhar number of all members of the household.
- The connection will be issued by the Oil Marketing Companies (OMCs) to the eligible beneficiaries after processing the application.

The scheme has received its funding based on savings from the 'digitalization of the LPG subsidy' and 'Give-It-Up campaign'. To fund this scheme on March 27, 2015 Prime minister of India appealed to those LPG users who could purchase at market price to voluntarily forego their subsidy. As on September, 2017 about 10.4 million LPG consumers had given up their subsidy.

Role of the IT Sector

There has been a significant role of the IT sector in the promotion and execution of the PMUY scheme. IT sector played a major role in the Give-It -up campaign as people could easily give up their subsidies on the online government platform. Appreciation letters were given to the people who gave up their subsidies and a SMS was also sent informing them the name of the BPL beneficiary who had been given the LPG connection because of their giving up of subsidy. Issue of new connections and list of distributors has been made available online. Refilling of cylinder, transfer of subsidy, monitoring the progress and information sharing has become easier. It has been noted that almost 60% of the new LPG domestic connections given across the country in 2016-17 were PMUY connections (PPAC, 2017).

Problems/ shortcomings of the scheme

Some shortcomings of this scheme are

While Aadhaar based 'know-your-consumer' steps and bank account details of consumers are necessary to prevent spurious connections and LPG diversion, they can be another barrier for poor households as highlighted by studies (Parikh, Sharma, Singh, & Neelakantan, 2016). PMUY connection data is provided only at a state-level and no district-wise disaggregation is available. In contrast, other government schemes such as the Deen Dayal Upadhyay Grameen Jyoti Yojana (DDUGJY) and Pradhan Mantri Awas Yojana (PMAY) provide information about the progress of the respective schemes at the district and village level. The government encountered a lot of problem in identification of the beneficiaries. It was observed that the distribution system involved problems of corruption, errors in payment of subsidy, bank account detail mismatches etc. Government issues primarily included accessibility, affordability and awareness among people.

REVIEW OF LITERATURE

Giri, A. and A.Aadil (2018) "the demand side diagnostic of LPG refills". Researcher observed that LPG cylinders were accessible to the deserving segment. Among the beneficiaries 90% live in kutcha houses and were dependent on unclean cooking fuel options. Also, it was surveyed that rural households consists of many members and a requirement of large cooking pots and pans is generated which usually do not fit on a conventional stove easily. Three key areas in the paper are Affordability, accessibility and behavioral aspects. The research has selected a four round assessment pattern in UP, MP and Chhattisgarh through qualitative enquiry supported by quantitative surveys. It was found that firstly, the scheme targeting is laser precise and has made LPG stoves accessible to low income groups. Secondly, there exists a low rate of refilling the LPG. In states of MP, UP and Chhattisgarh 23% did not refill even once. Thirdly, most beneficiaries agreed that LPG reduces drudgery and improves cleanliness. Ahmad, N., S. Sharma, and A. K. Singh (2018)," Pradhan Mantri Ujjwala Yojana (PMUY) Step towards Social Inclusion in India"conducted a research to understand PMUY as a step towards social inclusion in India. It was shocking to know that even after 68 years of independence 41% households i.e. about 10 crore households are still dependent on fossil fuel for cooking. The research undertaken is descriptive and explorative in nature, empirical study has been done. It is based on reports, news and survey for descriptive analysis. The research paper throws light on the idea of social inclusion which refers to the inclusion of an individual or group in economy, social life and political life of nation which reduces social tension and promotes economic development.

It was found that 74% of people in India use solid fuels which has had a major impact on rural women and children who come in direct contact with the unclean fuel. Amose, T. and N. Sreedevi (2017), "An economic to Pradhan Mantri Ujjwala Yojana (PMUY) scheme of the central government of India" conducted a research to understand the economic assessment of PMUY scheme of the central government of India. It was found that India has been ranked as the third most energy consuming country in the world. The need for energy has been increasing with the increase in GDP. Barua, S.K. and S.K.Aggarwalla (2018), "Lighting up Lives through Cooking Gas and transforming society" conducted research on the major attempt of the government at transforming the society through a simple mechanism of cooking gas (LPG) to the marginalized in the society. Jain, A., et al. (2018), "Access to Clean Cooking Energy and Electricity", conducted research on clean cooking energy to understand the energy access and consumption among rural households at a granular level CEEW (Council of Energy, environment, and water) conducted energy access survey in India ACCESS (Access to Clean Cooking energy and electricity) in six major states of India –UP, Bihar, Jharkhand, MP and West Bengal. The assessment is done through the multi-dimensional, multi-tier approach. The electricity access framework captures the capacity, duration, quality, reliability, affordability and legal status of power provision. For cooking energy, the framework covers availability, health and safety, quality of cooking, convenience of cooking and affordability. It was recorded that the share of households using LPG in these six states increased from 22% to 58% and the share of households using LPG as their primary cooking fuel has increased from 14% to 37%.

Dabadge,A., A.Sreenivasand A.Josey (2018), " Pradhan Mantri Ujjwala Yojana: What we need to know", conducted research on PMUY to analyze the scheme of the central government of India. The research paper talks about the two levels at which PMUY has been accessed: The first is against the overtly stated objective of disbursing connections. The second is against the intended objective of tackling the adverse health effects of using traditional solid fuels. It was found that PMUY has totally been on track. Over 70% of the target of 5 crore connections have been disbursed in about two thirds of the intended time. However, the real objective of this scheme can only be achieved if households not only get LPG connections but use it for most preferably all their cooking needs a sustainable basis. Parikh, J.K., A. Sharma et al (2016,), "Providing Clean Cooking Fuel in India: Challenges and solutions" conducted a research to analyze the access of energy in context of Ghaziabad district.250 households in Ghaziabad district were surveyed using a structured household questionnaire that was delivered between August 5 and October 10, 2015.It has been concluded that a shift from tradition/ primary sources might have a cost attached to it in the beginning but has long term benefits in terms of money, time and health. Das S.S, Panda H. (2017) "Smokeless Chulha- A Way for

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Enhancing Quality of Life" investigates that the Clean Energy use and human development are closely linked. Access to and affordability of clean energy results in better quality of life. More specifically, biomass use for cooking leads to health hazard from inhaling smoke and drudgery from fetching the fuel. Although, State Govt and at Central level have formulated numerous programs for ensuring use of clean fuel for cooking. Unfortunately, in spite of technological progress, the use of smokeless chulha has not been up to expectation because of organizational and social factors. This paper analyses the challenges of adoption of smokeless chulha and suggests implementation strategy for large scale use of it. Larsen B. (2017), " Benefits and Costs of Household Air Pollution Control Interventions in Rajasthan", this paper evaluates the benefits and costs of three interventions affecting household air pollution caused by the use of solid fuels for cooking. Benefits and costs are presented as a ratio of annualized benefits and annualized costs (benefit-cost ratios) over the expected useful life of each intervention.

RESEARCH METHODOLOGY

Research Gap
There has been a conspicuous gap in the studies dealing with the idea of how Pradhan Mantri Ujjwala Yojana can be used as a tool to empower women. The matters of how far this scheme is successful, the efficiency of the subsidy mechanism, the time and money saved need elaboration.

Objectives of the study
To study the multifold impact of PMUY on women empowerment, girl child, and environmental protection, the objectives of the study are as follows:

1. To study the various government schemes towards women empowerment same as PMUY.
2. To explore the conventional and traditional sources for cooking with unclean fuels
3. To identify the alternative uses of cooking and its impact on women empowerment and environmental protection.
4. To investigate the impact of PMUY on women empowerment, financial literacy, environment protection, girl child education, girl's enrollment ratio, family well-being and government subsidy

Area of study
Location of Study: four district of Rajasthan namely; Sikar, Dausa, Kukas and Alwar

Null Hypothesis
H01= PMUY has a significant impact on the social well-being of women living in the rural parts of Rajasthan.
H02= PMUY has a significant impact on the health status of women living in the rural parts of Rajasthan.
H03= PMUY has a significant impact on the Girl child education
H04= PMUY has a significant impact on women empowerment
To test the preset hypothesis researcher analyses the same on the basis of following criteria:
1. The social well-being of women
2. Environmental protection
3. Health status of women
4. Financial Literacy of women
5. Girl child education and upliftment
6. Girl child enrollment ratio

Data Collection
This study is based on primary data. The data has been collected from primary sources through questionnaire method. Secondary data has also been collected from the government official website of PMUY and NFHS IV (2015-16) and various other government departments.

Research Question

This paper addresses the following research questions to clarify the understanding and workability of Pradhan Mantri UjjwalaYojana (PMUY).

- Has PMUY(Pradhan Mantri Ujjwala Yojana) scheme brought women empowerment in the true sense?
- What have been its results in saving time and money?
- Is the subsidy mechanism working efficiently?
- Has the health of rural women shown any significant improvements?

Selection of the Beneficiaries

The survey has four components: -

- Personal information
- Women/Girl child upliftment
- Health aspect
- Overall Improvements

Process of Data Collection

The researcher had personally interacted with sixty beneficiaries from places like Sikar, Dausa, Kukas, Alwar. The first attempt was made to try and convince the beneficiary to give answers to the questionnaire; if she was not available a respondent on her behalf was approached.

RESULT ANALYSIS

The research analyzed the preset objectives, on the basis of four sections which are as follows:

1. Understanding the household schedule
2. Understanding the impact on girl child upliftment
3. Understanding the health impact
4. Understanding the overall impact

Understanding the household schedule (Section A)

Under Section -A of the questionnaire a detailed account was collected for the personal schedule of beneficiaries, for this purpose information related to beneficiaries like: caste wise number of beneficiaries, number of family members their educational qualification and occupation, the type of kitchen, frequency of using LPG cylinders etc. was collected.

Following are the findings for data collected under section A

1. The greatest numbers of beneficiaries in the selected areas were mostly SCs and STs as this scheme aims to provide LPG connections to BPL families solely.
2. The beneficiaries of this scheme i.e., women in were traditionally engaged in household work like taking care of their children and houses followed by agriculture and allied activities.
3. Most of the kitchens (62%) were semi built with a mechanism to accommodate both LPG cylinder and cookstove along with the chullah, exhausts were missing in these kitchens.
4. Mostly people (43%) were using LPG cylinders to cook one meal daily around 12:00 PM which provides energy to the villagers for the entire day. The food items mostly included roti, daal and one seasonal vegetable.
5. 28% of the household did not have one or more required documents like Aadhar Card, BPL, Bhamashah Card due to which they were facing difficulty in availing their subsidies.
6. Government introduced PMUY to the population through various fairs, newspaper, advertisements, street plays, short skits etc.
7. The current cost of cylinder is Rs.260 while Rs 80 is credited to the bank account of the beneficiary, in spite of this due to existence of traditional practices of cooking and lack of accessibility people do not avail refills.

8. Due to inadequate delivery mechanism a large number of beneficiaries were unable to continue the usage of cylinders.
9. Either due to errors and mismatches in bank details or not submitting the required documents beneficiaries were unable to avail their subsidies.
10. People who were unable to understand English and Hindi both faced difficulty in using the IVRS.

Understanding the impact on girl child upliftment (Section B)

Under section B of the questionnaire questions which focused on the well-being of girls were asked like who collects the fuel in the house and has there been any difference in girl's performance in schools. These questions were asked to inquire if the only adverse impact of cooking with solid fuels exposure to the IAP (Indoor Air Pollution) was or were there others like drudgery of carrying firewood, absenteeism from classes in order to help their mothers from carrying heavy firewood. This not only affects their growth but also their ability to become independent in the future.

- Around 20% of the households sent their daughters to collect solid fuel for cooking, as a result, they were unable to attend school and had to miss their classes.
- The government through introduction of PMUY aimed at eliminating the tedious task of collecting firewood which has enabled families to send their daughters to school.
- It was found that the attendance and regularity of girls in schools improved as they no longer had to help their mothers in collecting the solid fuel for cooking. Now as they are sent to schools their area of awareness remains increases which benefit them throughout their lives.

Understanding the health impact (Section C)

The PMUY scheme was launched with aim to reduce the adverse health impact on women from IAP, protecting their eyes from the harmful emissions, aiming at reduction in cooking time which saves them from backaches and incorrect postures.

Following are the findings for data collected under section C

The Pre - post analysis suggests that health related problems like redness in eyes, backache, cough and other breathing related problems have reduced by switching to LPG cylinders for cooking food as shown in figure 2

Understanding the overall impact (Section D)

To understand the overall impact information related to the following sub- topics was collected- better understanding of banks, improvement in the role of women in financial decisions, increased awareness and market exposure. Beneficiaries were asked to rank the benefits of this scheme according to their preferences**.**

1. Post PMUY most beneficiaries had a positive overall impact in their understanding of banks, awareness, Market exposure etc. shown in figure3.
2. Maximum Number of beneficiaries acknowledged and appreciated the reduced amount of smoke emitted at the time of cooking, other benefits also made a difference in their health and productivity (figure-4).
3. To understand the overall perspective of the beneficiaries regarding the PMUY scheme of the government the study was divided in two parts (figure-5.1 &5.2):
    Part A-On one hand people were happy with the improvement in health, governance of the scheme on the other they were not entirely satisfied with the accessibility, home delivery and subsidy mechanism
    Part B-Beneficiaries were satisfied with the affordability, time saving, drudgery reduction and clean environment as a result of the scheme but dissatisfied with the distribution mechanism.

FINDINGS AND CONCLUSION

- It can be concluded that the scheme has fulfilled its objectives of protecting the health of women and empowering them by reducing the number of health issues caused by the usage of solid fuels reducing the drudgery of carrying fuel.
- The beneficiaries have been found to have a better understanding of markets, banks and more control in financial decisions.
- As there is no need to collect solid fuels the attendance and regularity of the girl child has improved.
- It has been found due to incomplete documents submitted by the beneficiaries or mismatches in bank account details approximately 30% of the people are unable to avail their subsidies.
- This scheme is a step towards clean environment as it assuredly reduces the amount of IAP (Indoor Air Pollution) and social inclusion.
- The scheme lacks in the following aspects: Home delivery, IVRS **(**Interactive voice responses) and accessibility of the LPG cylinders.

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Table 1: Summary of benefit, cost, and interventions

S.No	Interventions	Benefit	Cost	Quality of Evidence
1.	Promotion of improved biomass cook stoves	29,385	3,041	Medium
2.	Free provision of LG connection to poor households	68,556	14,449	Medium-Strong
3.	50% reduction of subsidies of LPG fuel	9,963	24,142	Medium-Strong

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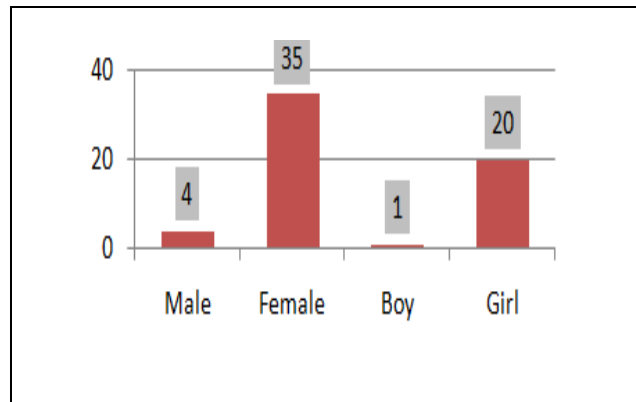
Figure 1. Collection of Fuel
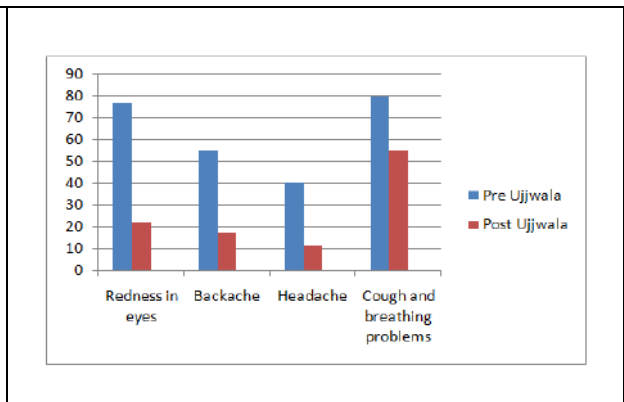
Figure 2: Pre and Post Ujjwala study
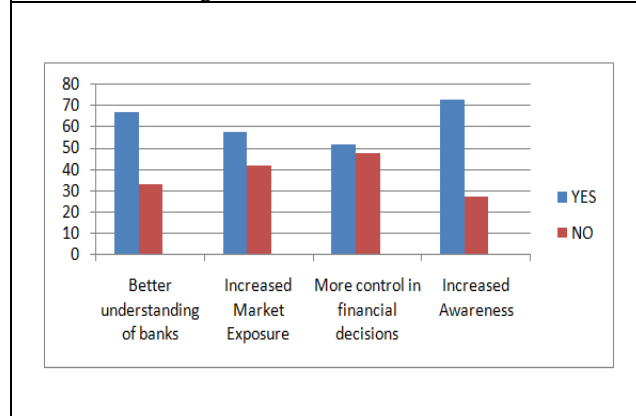
Figure 3: Evaluating the benefits Post Ujjwala
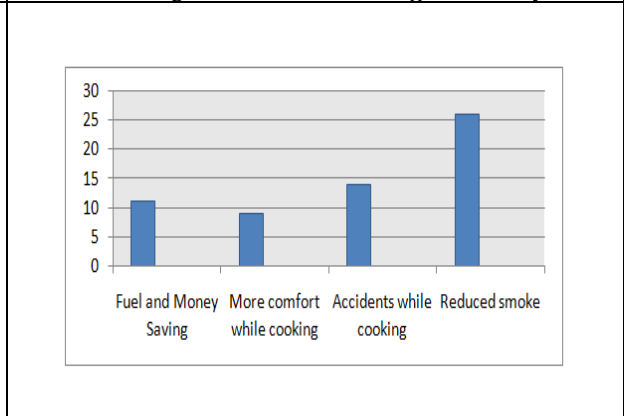
Figure 4: Ranking of benefits
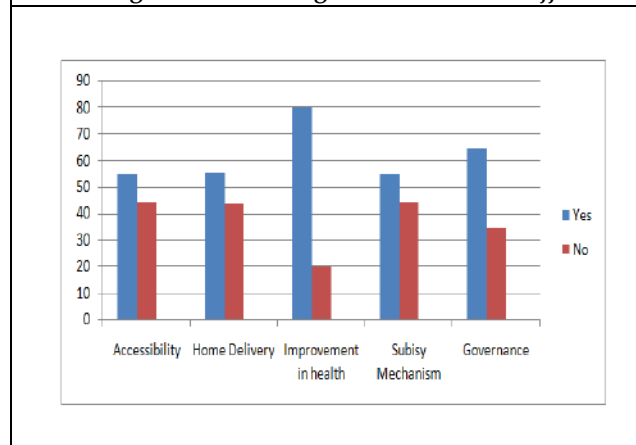
Figure 5.: Satisfaction of beneficiaries- (A)
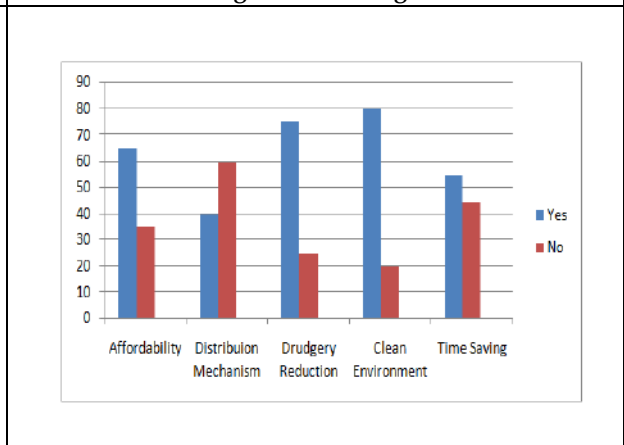
Figure 5.: Satisfaction of beneficiaries- (B)

RESEARCH ARTICLE

Comparative Study of Total Resistance Exercise (TRX) Training Vs Calisthenics on Fitness Parameters in College Going Students

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ABSTRACT

To maximize physical fitness, a versatile plan of action with activities to improve strength as well as aerobic capacity is necessary. Among them, TRX and calisthenics techniques are characterized as cardio and resistance training combined, often seen as circuit training. So the aim of this study is to see the effectiveness of TRX training and calisthenics on fitness parameters in college going students. 40 college going students, aged between 18-25 years were taken. Subjects were given TRX and Calisthenics training for 40-45 minutes of duration. 3 days/week, for 8 weeks. fitness parameters were used such as Vo2max by Queens college step test and Muscle Strength by 1 minute modified push-ups, curl-ups and squats in college going students. Paired t-test showed significant improvements in both groups (p<0.05). TRX showed greater improvement in Curl-ups and Modified push-ups, but there was no significant difference between TRX and Calisthenics in Squats and VO2max (p>0.05). TRX has superiority in Curl-ups and Modified push-ups in college going students, while both group showed equal effect to improve performance of Squat and VO2max.

Keywords: Total resistance exercise training (TRX), Calisthenics, Fitness parameters

INTRODUCTION

The degree of ability to accomplish a physical task under various surrounding conditions is the measure of physical fitness. Ordinarily five factors of fitness are taken as: flexibility, muscle strength, muscular endurance, aerobic capacity, and body composition. Now a day it is main health indicator, as well as a determinant of morbidity and mortality for cardiovascular disease [CVD] and for all causes [1]. Work out is one of the Physical Activity. Due to clench of skeletal muscles there is a potential improvement in caloric requirement over energy expenditure resulting in bodily movement which is called PA [2]. As per the (World Health Organization) people between 18-64 years of age need to do at least 150 minutes of moderate-intensity aerobic exercise and at least 75 minutes of vigorous-intensity activity in a week [3]. People performing enough physical activity will have a greater chance to maintain a healthy weight; their muscular and cardio respiratory level of fitness will be higher; their BMI will be better, as per WHO's asserts [3]. Total Resistance Exercise Training (TRX) Suspension Training is an admired substitute method of physical activity [4]. Suspension exercises are not a new thing, but contrary from other suspension equipment such as gymnastic rings, bars or single ropes, the "new" suspension tool, such as TRX®, which mainly includes one anchor point which tears in two handles and foot cradles in which hands and feet are placed [5].The TRX, which pushes gravity and the person's body weight to accomplish a variety of exercises, is mostly utilized as functional training equipment. So the training permits people to use their body weight as resistance during activity with many muscles and joint groups [6]. Suspension training is denoted as cardio as well as resistance training, ordinarily seen in circuit training. Usually circuit training is split by various parts where the participants has to perform a various form of exercises [7].The deep core muscle covers the muscles and the function of this muscles is stabilization, whereas the motions of body is occurred by the global muscles [8].

Primarily TRX training is to develop the stability of the deep muscles, lower strength, upper strength, which accentuates the maintenance of time gradually increased, instead of increased weight [9]. One study concluded that body weight activities are feasible option to free weights or resistance tools [10]. Body weight exercises viz. calisthenics, use body weight as resistance aiming to improve strength through a sort of movements such as push-ups, inverted raw, and curl-ups. Also the exercises are considerably simple to learn, permits to perform in a lot, decrease the chances of trauma, and impart a unique exercise experience perhaps more enjoyable for participants [11]. It is practicable to initiate small and large muscle groups using this. In that person feels the resistance by own body weight with every movement, which results short muscle contraction mainly. The motion of Core and calisthenics exercises enhances the flexibility and strength of the body as well as muscle endurance and cardiovascular fitness levels [12]. Maximal Oxygen Uptake is one of the best measure to assess cardio respiratory fitness at long period of exercise. Maximal oxygen consumption (VO2max) is one of them which define as maximum amount of O_2 that person can use during maximal exercise [13]. It is best indicator to assess the cardio respiratory endurance [14]. Queens College Step Test is one of the test in sub maximal exercise tests. When advanced instruments are not possible to use at that time we can measure VO2max (litters /min or in milliliters /kg/min.) easily by this method as a fitness indicator [15,16,17]. As strength is one of the most preferable outcome measure to assess physical ability to perform activities [11]. Better muscle strength shows good active life style and quality of life. Hence, the present study evaluates cardio respiratory fitness by measuring VO2 max (Queens college step test) and muscular fitness by measuring 1minute modified push-ups test, 1minute curl-ups test and 1minute squats.

MATERIALS AND METHODOLOGY

Total 40 subjects were selected by A simple random sampling for an experimental study from Ahmedabad Physiotherapy College for 3 days/week, up to 8 weeks of duration.

Inclusion Criteria
Normal M/F subjects between age group of 18-25 years, not performing regular exercise from last six months, Non-smokers and non-alcoholic subjects, Willingness to participate in the research.

Exclusion Criteria

Students on any medication that restrict them to participate in study**,** Student's under-going regular physical training, history of chronic diseases including cardiovascular diseases, metabolic diseases that affects the participants to perform exercise**,** history of fracture or trauma since last 6 months.

Procedure for Outcome Measure

Queen's college step test (QCT)

The individuals were requested to rest before the test, and then baseline characteristics such as heart rate and respiration rate were measured. QCT approach was used to determine VO2max indirectly. A tool with a height of 16.25 inches was used to perform the step test. Stepping was performed for 3 minutes at a metronome-determined rate of 24 steps per minute for males and 22 steps per minute for females. From the fifth to the twentieth second, the carotid pulse rate was monitored. The VO2max was calculated using the equation below [18].males: VO2max = 111.33 – [0.42 × pulse rate beats/min] [18] females: VO2max= 65.81– [0.1847×pulse rate beats/min] [ml/kg/min] [18].

Modified push ups

The 1-minute modified push-ups test was used to assess upper body strength. Participants were instructed to flex their elbows until their chests touched the floor. The test was carried out on the ground with knee support [19].

Curl-ups

The 1-minute curl-ups test was performed to evaluate abdominal strength. Subjects began curling up until their elbows touched their thighs, then returned to the starting position. In one minute, the number of trials accurately done was counted [19].

Squats

The 1-minute squats test was used to assess lower body strength. Try to bent the knees at a 90-degree angle. Come back to a standing erect position by pressing into their heels and straightening their legs. The number of correct attempts was noted.

Procedure of Intervention

GROUP – A TRX training (n=20):30-40 minutes, three sessions per week, eight weeks of training. The training protocol was performed using the TRX tool and it was arranged on suspension frame by connecting 2.44 meters above the floor. All the subjects of TRX group were familiarized with protocol before the training[20]. Warm-up: 10 minutes of Low intensity aerobic exercise [9].TRX training (Image 1-7):15-20minutes of whole body muscle training (upper limb, core, lower limb), including Biceps, Triceps, Pectoralis Major, Erector spinae, internal and external obliques, latissimus dorsi, Rectus abdominis, Quadriceps and Hamstrings. 8-12 repetitions of each [9].Cool down: 10 minutes of low intensity aerobic or stretching [9].

GROUP-B Calisthenics (n=20)

participants were performed the exercise on a stable ground with the use of mat. All the subjects of calisthenics group were familiarized with protocol before the training. Whole body exercises (upper limb, core and lower limb) were performed by the participants within 15-20 minutes. Warm-up: 10 minutes of low intensity aerobic exercise. Calisthenics protocol (Image 8-10): (a) wide grip modified push-ups; (b) squats (c) fixed bar inverted row; (d) curl-ups; and (e) narrow grip modified push-ups.8-12 repetitions of each. Cool down: 10 min of general stretching exercises (1 x 30 sec for the major muscle groups) [11].

RESULT

Statistical analysis was administered using the paired sample t-test to assessed pre-post measures within groups and independent sample test was used to assessed comparison between groups. SPSS version 25 was used for data analysis. 10 males & 30 females were similarly arranged in both the groups out of total 40 subjects.

Curl-ups
Both groups showed significant improvement in curl-ups (p=0.000).Between groups results showed that, TRX given more significant improvement than calisthenics group. Graph 2 shows mean of post curl-ups in calisthenics and TRX. (p=0.008**).**

Modified Push-ups
Both groups showed significant improvement in modified push-ups (p=0.000). TRX given more significant improvement than calisthenics group. Graph 2 shows mean of post modified push-ups in calisthenics and TRX. (p=0.008).

Squats
Both groups showed significant improvement in Squats(p=0.000). Between groups results showed similar improvement, so there was no significant result as p= 0.073. In which mean of post Squats seen in graph 2**.**

VO2max
Both groups showed significant improvement in Squats(p=0.000). Between groups results showed equal effects in both groups. There was no significant between group differences following the interventions as p=0.369. In which mean of post VO2max seen in graph 2.

DISCUSSION

The current study demonstrates the value of regular fitness training. This happens somewhat due to as per studies both techniques work on strength principle and user's body weight and also characterized as cardio and resistance training combined. Hence, it improves the cardio respiratory endurance by transportation & utilization of oxygen and improves the muscle strength by increase the capacity of muscle work. Within a 13 week of training, Dannelly et al. found that both traditional and TRX groups had improved upper-body strength [21]. Maté-Muoz et al. found that young males treated in both unstable and traditional training groups improved their upper limb strength following seven weeks of resistance exercise [22]. Furthermore, Janot et al., discovered better lower-limb strength in middle-aged and young groups following seven weeks of TRX resistance training[6]. Hamid Arazi et al. concluded that, TRX training was more effective compared to traditional resistance training [20]. E Thomas et al. showed that, positive effects of a calisthenics exercise on strength, posture and body composition. Mainly these improvements were seen due to the pushups and pull ups exercises, which is approximately increase of 16.4% and 39.2%. The electromyographic assessments showed the more involvement of upper limb muscles (extensors, deltoid, triceps, serratus anterior, pectoralis minor, teres minor and major) during lean phase, protraction and retraction phase of push-ups [23,24]. Some muscles involved in part of stabilization like erector spinae and rectus abdominis [25].

Their findings were consistent with the current study, suggesting that both training groups had increased upper-body strength as well as the lower body strength. However, when compared to Calisthenics, TRX resulted in a greater increase in muscular strength after 8 weeks of training, according to the current study. The rise in muscular strength seen in the study is very certainly due to neural changes caused by eight weeks of training in college students. Because TRX training for the suspension state involves the entire nervous system, neural adaptations protect the strength discovered in the study. The neural system of motor units is frequently used to determine strength, in addition to muscle mass. As a result, strength improves in the initial weeks of a strength training

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programed [20]. Raji Susan Varghese et al. stated that, VO2max constitutes the person's highest oxygen utilization when subjected to long duration or intense exercise. As a result, it is the maximum amount of oxygen one can consume in a minute to produce ATP aerobically that decides aerobic capacity, and achieving VO2max necessitates the integration of the respiratory, cardiovascular, and neuromuscular systems [18]. In present study there was significant increase in VO2max in participants after 8 weeks of TRX ([t=18.070] [p=0.000]) and calisthenics([t-13.284] [p=0.000]) training. The mechanism behind increase VO2max is somewhat due to simultaneously increased in muscular endurance and cardio respiratory endurance after 8 weeks of long training period.

CONCLUSION

Basically, the findings of the present study showed that the performance of TRX and Calisthenics both tends to increase muscular strength and cardio respiratory endurance. TRX has superiority in Curl-ups and Modified push-ups in college going students, while there was no significant difference between TRX and Calisthenics in Squats and VO2max so, both group showed equal effect to improve performance of Squat and VO2max.

Limitations: Long term follow up

Further recommendation
To find out the training effect on cardio respiratory endurance with the use of direct method of VO2max, to see the effect of TRX and Calisthenics along with progression, to include more health related parameters of fitness such as flexibility, muscular endurance and body composition.

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Fig. 1: TRX (Obliques)
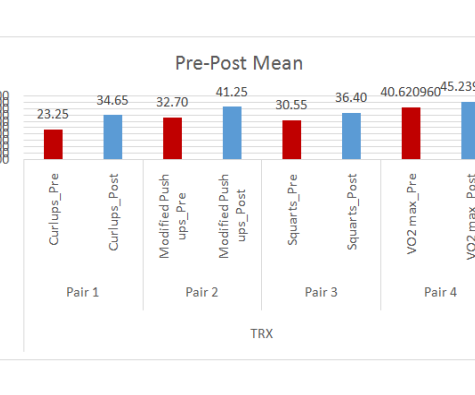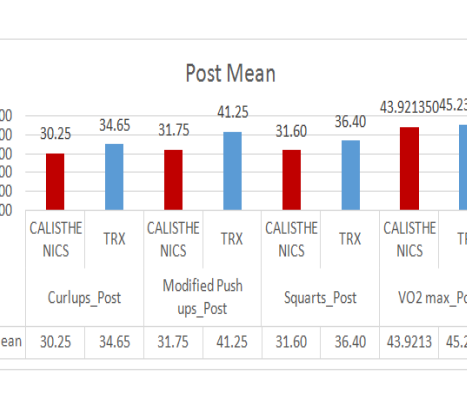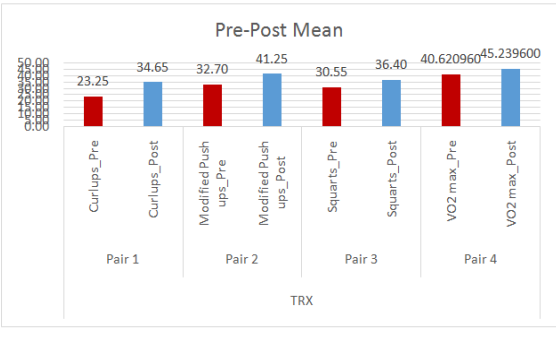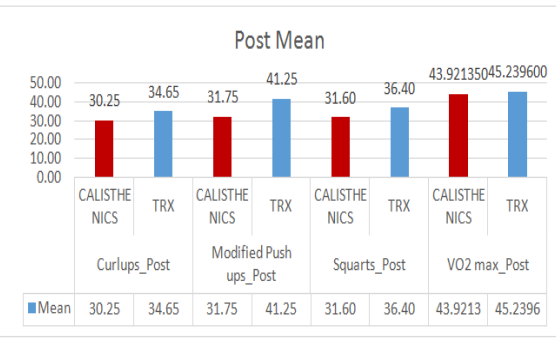
Fig. 2: TRX (Erector spinae)

Fig. 3: TRX(Hamstrings)	Fig. 4: TRX(rectus abdominis)
Fig. 5: TRX (Triceps)	**Fig. 6: TRX(latissimus dorsi)**
Fig. 7: TRX(Quadriceps)	**Fig. 8: Calisthenics group[CG] (squats)**
Fig. 9: CG (wide grip modified pushups)	**Fig. 10: CG (fixed bar inverted row)**
Graph 1: Paired sample test for TRX group.	**Graph 2: Independent Sample test for between groups**

RESEARCH ARTICLE

Stochastic Model When Inter Contact Time Form a Poisson Random Variables

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ABSTRACT

In this study a stochastic model for estimating the statistical measures for seroconversion have been derived under the assumption that the time interval between successive contacts forms Poisson random variables. The transmission of HIV from the infected to other on successive contact to the contribution of antigenic diversity of the antigen which in turn increase the survival of the antigens. In this study a random variable of the threshold level of antigenic diversity is Erlang Truncated Exponential Distribution. Numerical illustration is used to study the behaviour of the expected time and its variance.

Keywords: Antigenic Diversity Threshold, Cumulative damage process, Poisson Process, Inter contact time.

INTRODUCTION

The antigenic diversity threshold is an important aspect of consideration in the studies relating to HIV infection. Successive sexual contacts are the modes of transmission of HIV would result in occurring more of HIV which contributes to the antigenic diversity of the antigens. The determination of the intensity of antigenic diversity has been studies several author .Nowak and May (1991) have studied the same. According to Stilianakis *et al.* (1994) , the total virus population may escape control through continued generation of new mutants until the total number of different HIV strains exceeds the diversity threshold. Kirschner *et al.* (2000) have discussed the cell population dynamics which changes due to homing process and apoptosis of the CD4 cells in the human system. In this paper we propose a stochastic model for the estimation of statistical measures of seroconversion of HIV transmission at a

time 't' with 'n' contacts in which the antigenic diversity threshold level is a Erlang Truncated Exponential distribution with the damage process acting on the immune system of the infected individual is non linear and cumulative. The detailed account of the same could be screening Esary *et al.* (1973) and Sathiyamoorthi and Kannan 2001. In developing such a model basic assumption made was that the inter contact timing between successive contact are identically and independently distributed random variables. In this model it is assumed that the inter contact timing between successive contacts are Poisson random variables. In developing such a stochastic model a generalized Poisson distribution and it application have been discussed Anil (2001) is used. The numerical illustration is used to study the behaviour of statistical measure of Seroconversion time.

Assumptions of the model

i. There is a random amount of contribution to the antigenic diversity of an individual on successive occasion of sexual contacts with an infected.

ii. If the cumulative antigenic diversity due to successive contact exceed a particular level called antigenic diversity threshold, the immune system of infected will breakdown, and hence seroconversion occur.

iii. An individual is exposed to damage process is assumed to be non – linear and cumulative.

iv. The inter contact times are random variable which are i.i.d. The random amount of contribution to the antigenic diversity and threshold are independent.

Notations

X_i = a random variable denoting amount of contribution to the antigenic diversity due to successive contacts, i=1,2,....k and X_i has probability density function g(.) and cumulative distribution function G(.).

Y = a random variable which denote the threshold level and Y has probability density function p.d.f h(.) and cumulative distribution function H(.).

U_i = the random variable denoting the interarrival times between contacts and U_i has probability density function f(.) and cumulative distribution function F(.).

Z = a random variable denoting the time between damage

$g_k(.)$ = the probability density function of r.v $\sum_{i=1}^{k} x_i$

$F_k(.)$ = k convolution of F(.)

T = a continuous r.v denoting the seroconversion.

$L^*(.)$ and $f^*(.)$ are the respective transform

$V_k(t)$:   Probability of exactly k contact in (0,t].

RESULTS

The Probability density function (p.d.f) of the Erlang Truncated Exponential Distribution is given by

$f(x) = \theta(1\ e^{-\lambda})\ e^{-\theta x(1-e^{-\lambda})}$ $x \geq 0, \theta, \lambda \geq 0$

and the corresponding c.d.f is

$F(x) = 1 - e^{-\theta x(1-e^{-\lambda})}$ $x \geq 0,\ \theta, \lambda \geq 0$ and

$\bar{H}(y) = e^{-\theta x(1-e^{-\lambda})}$ ----------- (1)

since Y ~ Erlang truncated exponential (λ, θ)

$P\left[\sum_{i=1}^{k} x_i < y\right] = \int_0^\infty g_k(x)\bar{H}(x)dx$ ----------- (2)

Using (1) in (2), we get

$P\left[\sum_{i=1}^{k} x_i < y\right]\quad =\quad \int_0^\infty g_k(x)\bar{H}(x)dx$

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$$= \int_0^\infty g_k(x)\, e^{-\theta x(1-e^{-\lambda})} dx$$

$$= [\, g^*(\theta(1-e^{-\lambda}))\,]^k$$

The survival function $S(t) = P(T > t)$

$$= \sum_{k=0}^{\infty} \text{Pr \{there are exactly k contacts in (0, t]\}} * \text{Pr \{the threshold is not crossed\}}$$

$$\therefore S(t) = \sum_{k=0}^{\infty} \frac{e^{-at}\,(at)^k}{k!}\, [\, g^*(\theta(1-e^{-\lambda}))\,]^k$$

$$= e^{-at}\,[1 + \frac{at\,g^*(\theta(1-e^{-\lambda}))}{1!} + \frac{at\,g^*(\theta(1-e^{-\lambda}))^2}{2!} + \cdots]$$

$$S(t) = e^{-at}\, e^{at\,g^*(\theta(1-e^{-\lambda}))}$$

if $g \sim \exp(\mu)$ then

$$g^*(\theta) = \frac{\mu}{\mu+\theta} \quad \text{and} \quad g^*(\theta e^{-\lambda}) = \frac{\mu}{\mu+\theta e^{-\lambda}}$$

$$\therefore \quad L(t) = 1 - S(t)$$

$$= 1 - e^{-at}\, e^{at\,g^*(\theta(1-e^{-\lambda}))}$$

$$= 1 - (\, e^{-at\,(1-g^*(\theta(1-e^{-\lambda}))}$$

$$= 1 - \left[e^{-at} \left(1 - \frac{\mu}{\mu+\theta} - \frac{\mu}{\mu+\theta e^{-\lambda}} \right) \right]$$

$$= 1 - \left[e^{-at} \left(1 - \frac{\mu^2+\theta\mu e^{-\lambda}-\mu^2-\mu\theta}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) \right]$$

$$= 1 - \left[e^{-at} \left(1 - \frac{\theta\mu(e^{-\lambda}+1)}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) \right]$$

$$= 1 - \left[e^{-at} \left(\frac{\mu^2+\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) \right]$$

$$= 1 - \left[e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} + e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} \right]$$

$$\therefore \quad \Psi(t) = \int_0^\infty \frac{d}{dt}[L(t)]$$

$$= \left[\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} + \left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} \right]$$

$$\therefore E(T) = \int_0^\infty t\Psi(t)\, dt$$

$$= \int_0^\infty t\left\{ \left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} + \left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right) e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t} \right\} dt$$

$$= \frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \int_0^\infty t\, d\left[\frac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)} \right] + \frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \int_0^\infty t\, d\left[\frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)} \right]$$

$$E(T) = \frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} I_1 + \frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} I_2 \qquad \text{-------------- (3)}$$

Where,

$$I_1 = \int_0^\infty t\, d\left[\frac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)} \right] \quad \text{and} \quad I_2 = \int_0^\infty t\, d\left[\frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \right)} \right]$$

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Now $I_1 = t \left[\dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]_0^\infty - \displaystyle\int_0^\infty \dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\ dt$

$\qquad = \dfrac{(\mu+\theta)(\mu+\theta e^{-\lambda})}{a\mu^2} \left[\dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]_0^\infty$

$\qquad I_1 = \dfrac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4}$ -------------- (4)

$I_2 = \displaystyle\int_0^\infty t \left[\dfrac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]_0^\infty - \displaystyle\int_0^\infty \dfrac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\ dt$

$\qquad = \dfrac{(\mu+\theta)(\mu+\theta e^{-\lambda})}{a\theta^2 e^{-\lambda}} \left[\dfrac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]_0^\infty$

Now $I_2 = \dfrac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}}$ -------------- (5)

Substituting equation (5) & (4) in (3) we get

$E(T) = \dfrac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} * \dfrac{(\mu+\theta)^2(\mu+\theta e^{-\lambda})^2}{a2\mu4} + \dfrac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} * \dfrac{(\mu+\theta)^2(\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}}$

$$\boxed{E(T) = \dfrac{(\mu+\theta)(\mu+\theta e^{-\lambda})}{a\mu^2} + \dfrac{(\mu+\theta)(\mu+\theta e^{-\lambda})}{a\theta^2 e^{-\lambda}}}$$

$E(T^2) = \displaystyle\int_0^\infty t^2\left[\dfrac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} * e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t} + \dfrac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} * e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}\right] dt$

$\qquad = \left(\dfrac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right) \displaystyle\int_0^\infty t^2 e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}\ dt\ \left(\dfrac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right) \displaystyle\int_0^\infty t^2 e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}\ dt$

$\qquad = \dfrac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} I_3 + \dfrac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} I_4$ --------------- (6)

Where $\quad I_3 = \displaystyle\int_0^\infty t^2 e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}\ dt$

$\qquad I_4 = \displaystyle\int_0^\infty t^2 e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}\ dt$

$\qquad I_3 = t^2\ d\left[\dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]$

$\qquad I_3 = t^2 \left[\dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)}\right]_0^\infty - \displaystyle\int_0^\infty \dfrac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)2t}\ dt$

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$$= \frac{2}{\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \left\{ t \left[\frac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \right] - \int_0^\infty \frac{e^{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \, dt \right\}$$

$$= \left[\frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4} \text{ x } \frac{(\mu+\theta)(\mu+\theta e^{-\lambda})}{a\mu^2} \right]$$

$$I_3 = \frac{2(\mu+\theta)^3 (\mu+\theta e^{-\lambda})^3}{a^3\mu^6} \qquad \text{---------------- (7)}$$

$$I_4 = t^2 \ d \left[\frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \right]$$

$$I_4 = t^2 \left[\frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \right]_0^\infty - \int_0^\infty \frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \ 2tdt$$

$$= \frac{2}{\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \left\{ t \left[\frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \right]_0^\infty - \int_0^\infty \frac{e^{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)t}}{-\left(\frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})}\right)} \, dt \right\}$$

$$= \frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}} \ * \ \frac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})}{a \ \theta^2 e^{-\lambda}}$$

$$I_4 = \frac{2(\mu+\theta)^3 (\mu+\theta e^{-\lambda})^3}{a^3\theta^6 e^{-3\lambda}} \qquad \text{------------ (8)}$$

Substituting equation (8) and (7) in (6), we get

$$E(T^2) = \frac{a\mu^2}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \ * \ \frac{2(\mu+\theta)^3(\mu+\theta e^{-\lambda})^3}{a^3\mu^6} \ + \ \frac{a\theta^2 e^{-\lambda}}{(\mu+\theta)(\mu+\theta e^{-\lambda})} \ * \ \frac{2(\mu+\theta)^3(\mu+\theta e^{-\lambda})^3}{a^3 \theta^6 e^{-3\lambda}}$$

$$E(T^2) = \frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4} \ + \ \frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}}$$

The variance of the seroconversion time

$$\mu_2 = V(T) = \mu_2^1 - (\mu_1^1)^2$$

$$= \frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4} \ + \ \frac{2(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}} \ - \ \left[\frac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4} + \frac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}} \right]$$

$$\boxed{V(T) = \frac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\mu^4} \ + \ \frac{(\mu+\theta)^2 (\mu+\theta e^{-\lambda})^2}{a^2\theta^4 e^{-2\lambda}}}$$

CONCLUSION

From the table 1, we observe that for fixed 'λ', 'θ' and 'μ' when 'a' the contact rate increases the mean time to seroconversion and its variances are decreases. If α which is the parameter of the random variable X denoting the magnitude of increases in antigenic diversity increases then $E(X) = \frac{1}{\mu}$ decreases. Hence there is an increase in E(T) and also its variance V(T). This is given in table 2 and figure 2. It is observed from the table 3 and also from figure 3, the value of 'θ' which is the parameter of the truncated exponential distribution of the threshold increases whereas the mean time to seroconversion decreases. It could be seen that has the value of 'θ' increases the variances

decreases. From the table 4, we observed that for a fixed 'a', 'θ' , 'μ' and when 'λ' is allowed to increase then E(T) decreases. The same tendency is also noted on the V(T) of the HIV transmission.

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Table. 1. Numerical Illustrations

a	λ=0.3 , $\theta = 0.5,\ \mu = 0.2$	
	Mean	**Variance**
1	12.1379	104.2883
2	6.0690	26.0721
3	3.9539	10.8678
4	2.9654	6.1131
5	2.3723	3.9124
6	1.9769	2.7169
7	1.6945	1.9961
8	1.4827	1.5283
9	1.3180	1.2075
10	1.1862	0.9781

Table. 2. Numerical Illustrations

μ	a=1 , $\lambda = 0.5,\ \theta = 0.1$	
	Mean	**Variance**
0.1	8.5106	27.3446
0.2	14.8477	104.6370
0.3	25.3885	345.7011
0.4	39.4156	876.7566
0.5	56.8097	1867.5687
0.6	77.5344	3527.8600
0.7	101.5749	6107.0095
0.8	128.9242	9893.9944
0.9	159.5784	15217.3740
1	193.5352	22445.2836

Table. 3. Numerical Illustrations

θ	Mean	Variance
	a=2 , $\lambda = 0.5$, $\mu = 1$	
0.1	96.7676	9250.2988
0.2	28.4048	769.3996
0.3	14.8430	198.6563
0.4	9.8333	81.0887
0.5	7.4239	42.5051
0.6	6.0885	26.1601
0.7	5.2853	18.0648
0.8	4.7803	13.6434
0.9	4.4579	11.0914
1	4.2553	9.5959

Table. 4. Numerical Illustrations

λ	Mean	Variance
	a=1 , $\theta = 0.2$, $\mu = 0.1$	
0.1	10.7577	76.4683
0.2	10.3283	68.4401
0.3	9.9572	61.7371
0.4	9.6407	56.1644
0.5	9.3756	51.5641
0.6	9.1594	47.8163
0.7	8.9899	44.8178
0.8	8.8651	42.4849
0.9	8.7842	40.7770
1	8.7460	39.6434

| **Figure.1. Numerical Illustrations** | **Figure.2. Numerical Illustrations** |
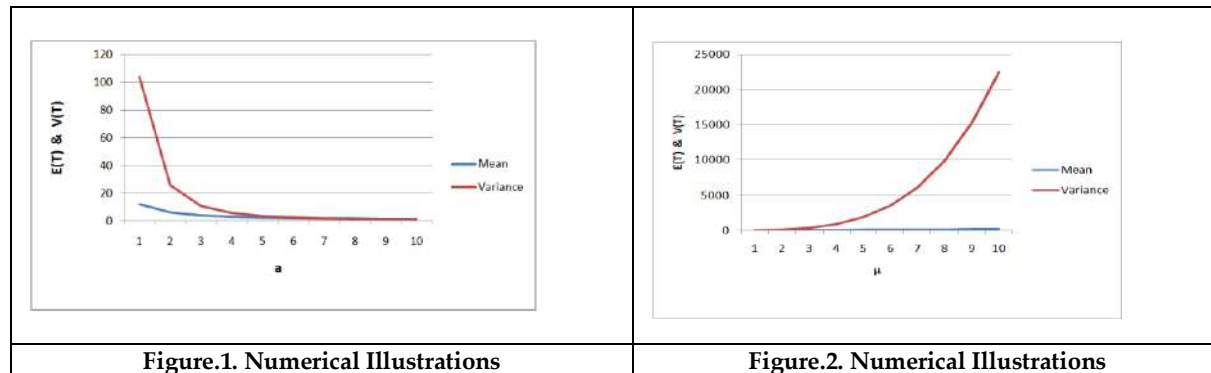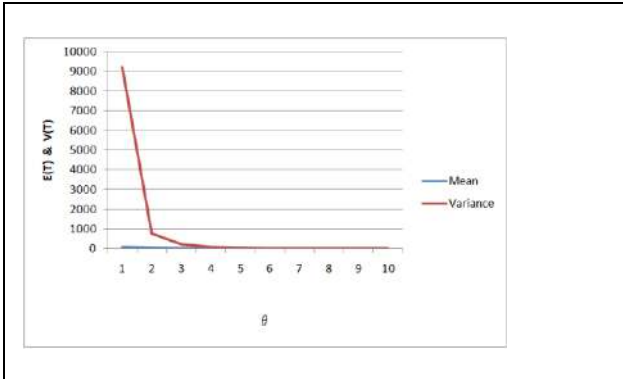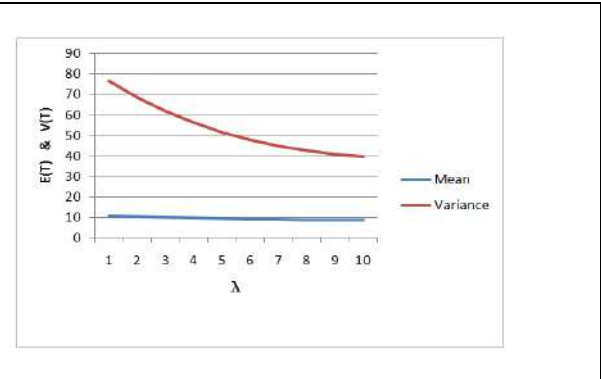
Figure.3. Numerical Illustrations	**Figure.4. Numerical Illustrations**

RESEARCH ARTICLE

Deep Neural Network based Model for Real-Time People Detection in the Crowded Places

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ABSTRACT

World Health Organization have set minimum of 2 meters physical distancing as safety measure in public places to avoid spread of Covid-19 pandemic. The proposed algorithms to multiple object simple online and real-time tracking with YOLOv5 leads to detect and monitor individuals in social distancing. The model has been trained and evaluated against with the real-time surveillance camera dataset with superior performance measures compared to the other state-of-art models. The Deep learning based detection algorithm identifies individuals using bounding boxes, the bounding box centroid distances of individuals are determined by using the Euclidian distance. To find the social distance violations between the individuals in crowded places by setting a threshold value. An algorithm is used to detect individuals in surveillance videos that the individual who breaches the social distance threshold value is being tracked and monitored. The evaluation has been done under difficult conditions such as obstruction, partial vision etc., with the performance measures such as Precision, Recall, F-Measure and mAP. The proposed methodology is designed to detect, track and monitor individuals to maintain social distancing in the public places with high accuracy and efficiency of proposed model.

Keywords: Tracking, Monitoring, People Detection, Social Distancing, YOLOv5.

INTRODUCTION

In late December 2019, a new variety of virus called Corona virus (COVID-19) was identified in Wuhan, China. In 2020, this virus was becoming a worldwide pandemic after just a few months. The World Health Organization (WHO) declared the condition pandemic in May 2020 [1]. Despite the expanding number of infected peoples, the virus currently has no viable cure or remedy. While healthcare organizations, scientists and researchers are constantly working to develop prescribed medication or antiviral drugs for the contagious disease, no definitive effectiveness has been revealed at the end of this study period, and no specific treatment or suggestion for preventing or curing these contagious diseases exists. As a result, the entire globe takes steps to prevent the spread of disease infection. Due to the difficult conditions, global societies have been compelled to seek new methods of limiting the virus's spreading or growth. Social distancing refers to precautionary measures taken to avoid the spread of disease by reducing the similarity of human physical interactions in crowded or congested public areas for example Market places, Theatres, Park, Schools, Colleges, Workplaces, Gyms, etc. to preventing or stopping the spread of infection risk. In addition to wearing face masks, social distancing now appears to become even more essential than thought previously, and one of the great options to prevent the spread of infectious infection. Almost every country today considers it a fundamental prerequisite. Based on Government guidelines, the person must follow a minimum distance of 6 feet at least [2].

Computer Vision and Machine Learning methods can help to automate it. They also allow for the tracking and monitoring of crowd movement and the detection of abnormalities such as congested areas, curfew violations, and unnecessary gatherings [3]. Social media platforms are flooded with comments from users about travel reviews and other topics relevant to their searches. The south India tourism reviews used in this study presents a fantastic chance for tourist planners to examine the behaviors [4], recommendations, and feelings of visitors about the city whether they maintain social distancing or not. Multiple people's identification is addressed in the design of a Computer Vision based social distance measurements and crowd tracking and monitoring. Deep Learning approaches presently working on distance measuring between person detection and tracking methods to recognize social distance violations [5]. Furthermore, use bounding boxes to locate human beings, which might be overly large or inadequate, resulting in strict distance estimation mistakes. As a result, we present a confidentiality appropriate social distance estimation and crowd monitoring system that can be used in combination with any current Surveillance and CCTV infrastructure. A YOLOv5 is the most recent model throughout the YOLO series, introduced in May 2020. Different pre-trained models are available in YOLOv5 to optimize speed and accuracy. We found that the YOLOv5 is the lightest variant with the highest speed and also most accurate detection findings in our research outcome. Furthermore, deep neural networks allow us to retrieve significant features from raw data, allowing us to analyze and categorize those detection and monitoring would provide a most exact view of the images. The necessity of ensuring a high level of accuracy, precision, working with a number of situations, interference, and real-time performances are all possible challenges in this area.

The following is the main contributions of this research

Multi object simple online real-time tracking is an effective Deep Neural Network (DNN) model for detecting, tracking, and estimating distance between people. This will allow us to follow people's movements and behavior, evaluate the percentage of social distance violations to the overall number of people in the entire image or video, and identify high-risk zones over short and extended periods of time [6]. Whenever determining the distance among each foot combination, the positioning of both the recognized pedestrians is approximated using bottom centre point of a bounding box instead of the centroid. According to the researchers, pragmatics provides for a higher degree of performance than that which is possible even though only images are considered [7].

MATERIALS AND METHODS

As a whole strategy for social distancing monitoring and region infectious risk assessments, we present a multiple approach that includes individual people detection, monitoring and tracking and distance estimation between individuals. With actual performance efficiency, the technology can be implemented and utilized to all types of CCTV security cameras. Reducing the prevalence is a significant component, and social distancing is an efficient strategy to minimize infection and stop the infection from spreading in public, according to a review of papers using multiple mitigation techniques. Susceptible, Infected, or Recovered is a concept used by many researchers. It is an infectious modeling approach that calculates the potential number of sick individuals in a particular community throughout a particular period of time [8]. Rather than extracting each one separately with SVM classifier model, this innovative method uses CNN to process the entire image. Then it utilizes both the RoI as well as a subsequent feed forward networks for classifiers, pooled on the convolution layer. The research in assesses the pedestrian's frequency in an input dataset, rather than monitoring specific locations [9]. The author determines how often people are breaking social distance using a centroid tracking technique. The set threshold value serves as the starting point for the centroid tracking method. The outcome of the study reveals definitely that our deep learning system effectively recognizes those who breach social distancing [10]. The authors suggested a multifunctional Convolution Variation Auto-encoder (CVAE) fusion architecture that uses information from optical, infrared, audio, and acceleration devices as input information. According to the researchers, pragmatics provides for a higher degree of performance than that which is possible even though only images are considered [11].

By analyzing the image in a regional or global approach, crowd monitoring tries to achieve a high-level overview of crowd behavior. Local aspects are ignored by macroscopic techniques such as crowd counting, crowd density, and movement estimation, which concentrate on the image overall. Microscopic approaches, on the other hand, begin by identifying individual pedestrians before grouping their characteristics to describe the crowd circumstance. With perspective of the effectiveness trade-off, these two strategies are compatible. In plenty of other words, macroscopic methods perform well in high-density crowds, but microscopic techniques work well in scattered groupings [12]. The multi - linear matrices decomposed image is generated by determining the co - variance prediction on identifying its perpendicular element after the patterns characteristics are obtained through a decomposition method. Run Length Encoding technique is then applied to achieve the matrices decomposition [13]. The majority of research in social distancing measuring has been tested and trained using CCTV footage of pedestrians crossing. While previous research has focused on CCTV footage that encapsulates individuals mainly walking in a large open space, we discuss the complexities of social distancing monitoring on public area, primarily ones related to low resolution images, camera position, and constraints throughout this research article.

Among the most effective specific single-stage object detectors is YOLOv5. [Figure 1] depicts the YOLOv5 network architecture. Add three more object identifiers such as λ_1, λ_2, λ_3 to the head of YOLOv5, and change the loss objective functions to prefer oriented object recognition accuracy. The CSPDarknet53 is a necessary component as it is the backbone for identifying deep features and creating bounding boxes. FPN and PAN are really the main necks of our method. From top to bottom, FPN provides significant semantic contextual features, whereas PAN conveys substantial positional features. The characteristics of multiple detection levels are collected from distinct backbone layers using FPN and PAN. Finally, Head generates the directional box's categories, probability, and specifications, which include a rectangular bounding box (r,s,w,h) and three primarily ratio focuses as λ_1, λ_2, λ_3. The obliquity of the oriented or perpendicular bounding boxes is also determined using the effective area λ_1 between the moving shaft and its tiniest confined rectangle bounding box. The normal bounding box is picked as the definitive detection if the equatorial bulge factor of each person exceeds the threshold, indicating that the underneath object is generally perfectly straight. Therefore, the final features extraction approach is orientated bounding. The CCTV camera captures video or image as input data, produces segments, and sends those segments into a deep neural network machine learning model. The model's result sounds like this: Individuals in the picture or video have their own localization border boxes. There are three sections of the most recent DNN-based object detectors. Head to anticipate the category and angular position in the report, input data module and expansion, and feature extraction backbone.

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Backbone Architecture

Because YOLOv5 is a combination of multiple strategies, we conducted an in-depth analysis of each approach to obtain the maximum benefit for our single-class individual person detection classifier model and to beat the state-of-the-art. Expanding the region of interest and increasing the performance of the system by adding additional layers is a simple way to strengthen the reliability and efficiency of CNN-based detectors; although, this approach makes it increasingly challenging to validate the system model. For the convenience of development, we recommend a human detection model as shown in [Figure 2].

Neck Module

Several current proposed methods have included additional layers in between the head and the backbone, referred to as the neck, which are used to extract features from various levels of the backbone network. In order to give more precise picture characteristics for the head, the neck part outlines from several top-down and bottom-up routes to capture and aggregate system parameter configuration in distinct layers. This can cause two problems: first, we won't be equipped to handle low-resolution photos; and second, detecting tiny objects will be tough. To address the first problem, we can use established approaches such as Fully Convolution Networks (FCNs). Such models, including YOLO, lack FC-layers and can thus handle images of various sizes. To address the second difficulty, dealing with small objects, we used a pyramid technique to improve the receptive field and extract different scales of the image from the backbone, followed by multi-scale detection in the head section.

Head Module

The head of a DNN is in charge of identifying the objects such as bikes, cars, buses, individuals, and so on, as well as computing their sizes and the positions of the bounding boxes. A systematic approach is used to retrieve a collection of object classifiers based on possible bounding boxes. Here we symbolize the class function called "Human" with a four variables (r, s, l, w), where r and s is the bounding box centre, l and w represents length and width respectively. The network classifier predicts a bounding box somewhere at central area (r̂, ş) and the size diameter of (Í, ŵ) also with respective offset and dimensions of (Ƃ$_r$,Ƃ$_s$, Ƃ$_l$,Ƃ$_w$) using the different grid point of context (C$_r$, C$_s$) at the top left corner of the target object image and the bounding box just before with the length and width (P$_l$, P$_w$). σ is the score function of sigmoid confidence between the ranges of 0 and 1 are as follows:

$$r̂ = \sigma(Ƃ_r) + C_r \quad \text{............................. (1)}$$

$$ş = \sigma(Ƃ_s) + C_s \quad \text{...........................…… (2)}$$

$$Í = P_l e^{Ƃ_l} \quad \text{…………………….…….. (3)}$$

$$ŵ = P_w e^{Ƃ_w} \quad \text{……………………………… (4)}$$

Although each geographical position has many anchor boxes, a single object can be related to numerous anchor boxes. To minimize the anchor box interaction, use the Exterior Maximal Optimum Repression strategy and compute intersection over union (IoU). We utilize Entire IoU (EIoU) as mentioned in Equation-6 as an alternative of fundamental IoU as mentioned in Equation-5 as a component of the weight correction and loss minimization procedure. The EIoU analyses the aspect ratio of such derived bounding boxes to the dimension size of both the ground level-truth bounding box and the position and proximity of the prospective individual bounding boxes to the ground level truth bounding box.

$$IoU - \frac{|B̆ \cap B̆^{gtb}|}{|B̆ \cup B̆^{gtb}|} \quad \text{..............................(5)}$$

The ground level-truth box is B^{gtb} = (r^{gtb}, s^{gtb}, l^{gtb}, w^{gtb}), whereas the expected box is B = (r, s, l, w). We utilize EIoU as an error function as well as a detection criterion. The Ɇ̆ is the Euclidean distance between both the ground level-truth B^{gtb} and B referred as projected bounding box. The smallest bounding box covering both boxes B and B^{gtb} has a

diagonal length size is referred asḍ, where ṕ is a great trade-off criterion. ç Determines the aspect ratio consistency are represented in Equation-8.

$$LF_{EIoU} = 1 - IoU + \frac{|\acute{E}^2(\acute{B},B^{gtb}|}{\acute{d}^2} + \acute{p}\acute{c} \quad \ldots\ldots\ldots\ldots (6)$$

$$\acute{p} = \frac{\acute{c}}{(1-IoU)+\acute{c}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\acute{c} = \frac{4}{\pi^2}\left(tan\frac{w^{gtb}}{l^{gtb}} - tan\frac{w}{l}\right)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Tracking of Human Individuals

Following detection process, the next step is to monitor and track the individuals. To monitor the people, we apply the Exterior Maximal Optimum Repression. as a platform for the Kalman filter and the Hungarian optimization approach. Depending on the latest assessment at period interval and computational analysis of individual movements, the Kalman filter estimates the positioning of the individual at time t + 1. This is a good approach to maintain track of the human in the event of blockage. [Figure 3] depicts a individuals of individual people detection, We subsequently analyze the extent of social distance violations and increased risk regions in the scenario using this common video or picture data sets. Every $\acute{I}p$ i.e., Individual person's specification in a frame is represented as

$$\acute{I}p = \left[b_h,\, b_v, \dot{x}, \dot{y}, b_h^{'}, b_v^{'}, \dot{x}^{'}\right]^T \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

where (b_h, b_v) specifies the objective of the bounding box's horizontal and vertical coordinates of the centroid. $\dot{x}$ Denotes the size of the scale area, and $\dot{y}$ denotes the aspect ratio of the ground level-truth bounding box sides. The predicted correlation coefficients of Kalman filter for horizontal plane, vertical plane, and centroid bounding box are $b_h^{'}$, $b_v^{'}$ and $\dot{x}^{'}$ respectively.

Estimating Distance

Straight points are connected at the frontier, individual people further away from the camera appear to be significantly shorter than those nearer to the matching point. The center or reference point of every bounding box in three-dimensional space is characterized by three attributes (x, y, z), however in the picture collected from the single camera, the actual three-dimensional region is compressed to two-dimensions of (x, y), and the profundity component (z) is not accessible. The application of the Euclidean distance metric to quantify cross person distance prediction would be incorrect in just such a reduced region. To perform a corrected transition, we should first recalibrate the cameras by assigning z = 0 to remove the viewpoint impact.

RM is the Rotation Matrix and it is represented as follows

$$RM = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & cos\theta & -sin\theta & 0 \\ 0 & sin\theta & cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

TM is the Translation Matrix and it is represented as follows:

$$TM = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -\frac{h}{sin\theta} \\ 0 & 0 & 0 & 1 \end{vmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots. (11)$$

IP_C is the intrinsic parameters of the single cameras and it is represented by the following Equation 12.

$$IP_C = \begin{vmatrix} f * IP_{hp} & 0 & \check{S}_x & 0 \\ 0 & f * IP_{vp} & \check{S}_y & 0 \\ 0 & 0 & 1 & 0 \end{vmatrix} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots (12)$$

RESULTS AND DISCUSSION

The dataset consisted of a number of different person categories, with the majority of them being appropriate for human detection and identification. The bounding box annotations on every frame, as well as the matching dimensions of every label, were used to annotate the dataset.

Performance evaluation
We selected busy locations and real-time video as a novel and complicated piece of data to analyze the effectiveness of the object detection approach. In order to determine and analyze our generated models with three commonly used computer vision object identification metrics, such as Precision Rate, Recall Rate, and F-Measure Rate. The plots show that after several iterations, we were able to demonstrate an ideal trade-off position for not only the testing and training losses, but also the loss function in the DS variant in a quick yet seamless and consistent changeover. [Table 1] outlines each framework and the outcomes of the experiments conducted using the real-time video dataset. [Figure 4] shows the performance evaluation. The effectiveness of the suggested detectors in various difficult indoor and outdoor conditions was collected from various sources of datasets, such as the Real Time Video from Survilance Camera Dataset as shown in [Figure 5].

Evaluation of Social Distancing
The Cartesian coordinates of the bottom corners of the specified bounding boxes served as our frames of reference. After the inverse perspective translation, we should obtain the positioning of each individual in the monochromatic area of the intermediate perspective region with a constant distance approximation. Any two people Pi, Pj with a Euclidean distance less than r were considered contributors to social distancing breaches or violations in the inverse perspective space: Due to the type of conflicting and the violation evaluation criteria, we develop a Violation Identification method such as U_I with the input variable parameters as Ᵽ of image and pixel readings as β, the specified difference of either 6 ft or 2 m safe distance of ʐ, the location of the Search Individual $\acute{S}_I$, and the Closest Neighboring Individual $\acute{C}_I$.

$$U_I = \mathcal{P}_\beta \ (\acute{S}_I, \acute{C}_I, \mathsf{z}) \quad \dots\dots\dots\dots\dots\dots\dots (13)$$

[Figure 6] shows total number of detected and violated individuals. No matter whether the individuals who are participating are a pair or not, if there is a break between two nearby couples, either between a pair and an independent, everyone concerned will change to red square. Governments and medical associations can move forward with various forms of inspections and assessments for the spread of the disease because of the scalability of our methodology in evaluating various circumstances. [Figure 7] shows the performance measures of the proposed methodology. Finally, the suggested proposed methodology expected to reach many of the evaluated modeling techniques of efficiency, accuracy and speed. The proposed techniques delivered significantly superior results compared to the other state-of-art of models.

CONCLUSION

In addition to monitoring social distancing measures in the COVID-19 period and throughout, we suggested a Deep Neural Network Based person detection framework to recognize and identify stable and moving persons in public spaces. Modern heads, necks, and backbones of various kinds were assessed and tried to look into. We used the Complete IoU loss function and data augmentation on multi-viewpoint real-time surveillance video datasets to

enhance the training program, which finally resulted in a consistent and valid human detector. One of the contentious suggestions we got from the medical experts was how to handle families and spouses in social distance monitoring. Experts argued over whether couples and families should be allowed to move close together again without being considered a violation of social distance. People thought social distance should extend to every single person without any exception. We also thought about how to turn on the pair detection. This will be useful when we want to identify unsafe areas through different statistical analysis of people's movements and social distance breaches over a medium or long duration.

ACKNOWLEDGEMENT

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Table 1: Framework of Research outcomes.

Method	Precision	Recall	F-Measure	mAP
DAL	84	76	82	80
YOLOv3	80	68	75	78
SSD	69	60	63	65
FASTER RCNN	86	73	78	82
Proposed Method	92	82	86	88
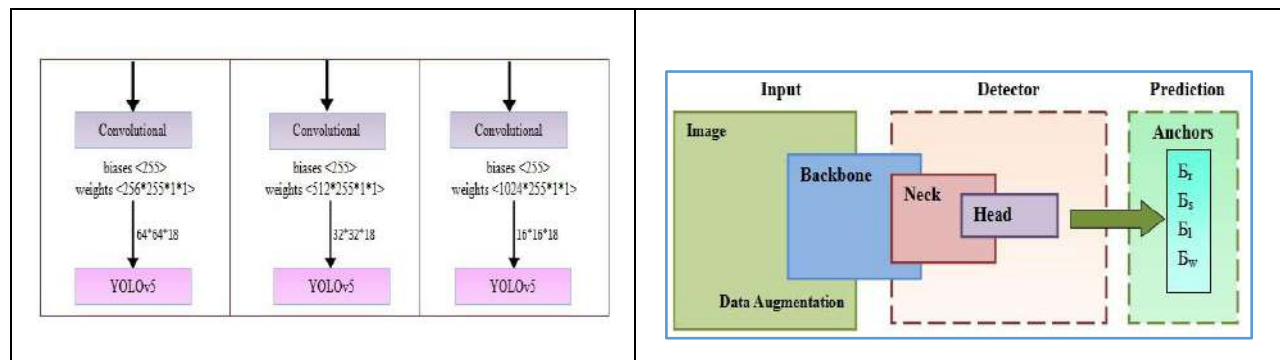
Figure 1: YOLOv5 Network Architecture

Figure 2: Human Detection Model.

Figure 3: People Detection.
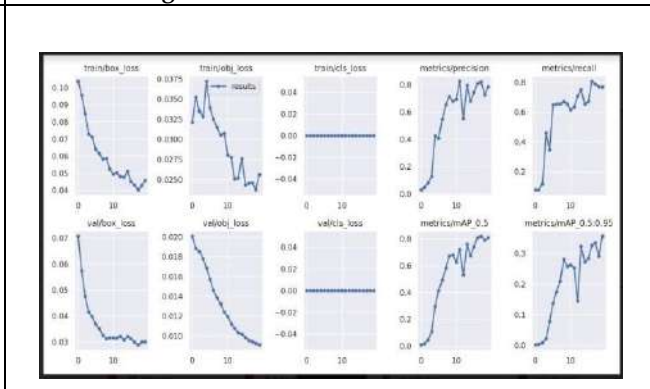
Figure 4: Performance evaluation.

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Figure 5: Tracking and Monitoring Individuals.
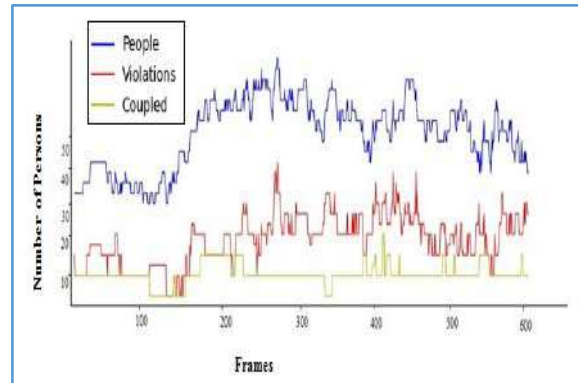
Figure 6: Total Number of Detected and Violated Individuals.
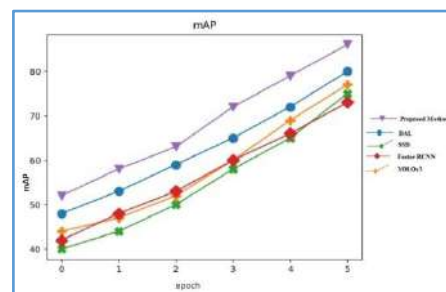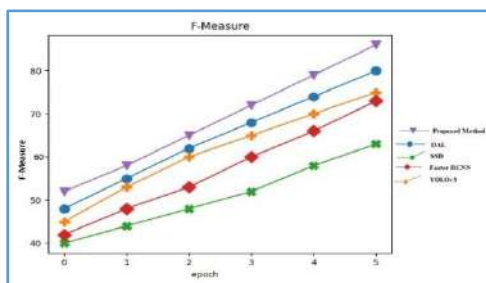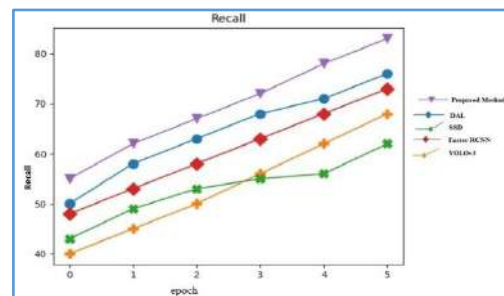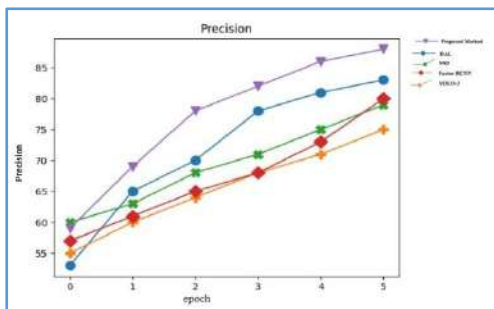
Figure 7: Performance Measures

RESEARCH ARTICLE

A Study on the "Modernization of Software Engineering"

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ABSTRACT

Software Engineering is the art of developing software-intensive products in which various characteristics like functionality, reliability, portability, durability, and security should be equilibrated rationally. Though the foundations of all technologies are everlasting, their palingenesis is most significant to compete with real-world modernity. The field of software engineering has also certainly been renovated since the period of Lovelace. Started with room-size computers, ENIAC, the EDVAC, which was human-computer interface programming, and now the recent trend is reality computation. The innovations in the field of software engineering are highly tremendous and diversified. Hence this comprehensive study completely explores, analyses, and summarizes the most modern strategies and approaches used in software engineering. This systematic literature review (SLR) will be more beneficial to the researchers, software engineers, industrialists, and academicians in gaining a deep understanding of the innovations employed in the field of software engineering, as well as aiding them to travel toward an inventive and productive angle in their technological path.

Keywords: Software Engineering, BOT, AI, IoT, Start-Up.

INTRODUCTION

In the early 1960s, Margaret Hamilton, a mathematician and computer science researcher, first coined the term "Software Engineering". It is an engineering discipline aimed at producing software products that satisfy users' needs by applying theories and technologies from computer science and project management. (Zhang Xiaoxiang. Encyclopedia of Computer science and technology. Second edition, Beijing: Tsinghua University Press, 2005). The

evergreen goal of SE is producing and managing usable, reliable, portable, scalable, and secure software products within the stipulated time and budget.

How and Why this article
Traditional software engineering theories and frameworks are developed in relatively closed, static, and stable environments [2]. But in this meta era, software must sense, comprehend, interact, and react on its own. "The growth of technology is still so much bigger than the past, it is part of our everyday life"[1]. From its inception to the present, the software field has produced a wide range of milestones. So progressing a systematic review on the renovations of this field would be more useful to the academics and IT developers.

Even though numerous researchers have conducted significant surveys and studies in the domain of software engineering, this work summarizes the innovations of more than 2 decades that is from the year 2001 to 2022. Nearly, 50 research publications of this period were considered and analyzed to complete this article.

The structure of this article is as follows. Section 2 covers the research questions, search strategy, inclusion and exclusion criteria, and study selection basics. Section 3 analyses and highlights the trends and developments of software engineering from the year 2001 to 2022. Section 4 exhibits the pros and cons of the milestones and Section 5 concludes the article.

MATERIALS AND METHODS

The systematic approach employed by the author in this review was PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses), and the checklist of the AMSTAR (Assessment of Multiple Systematic Reviews) was also successfully fulfilled in every step of the survey. Initially, the research questions were developed using the standard method called as PICO (Population - Intervention-Comparison-Outcome) model and a research protocol, which included the i) Search strategy ii) Inclusion/Exclusion criteria iii) Data extraction iv) Dissemination of results was followed in the subsequent steps to produce this article effectively.

Research questions
The purpose of conducting an extensive study is to accurately summarize the current IT trends and methodologies and to serve as a standard for various stakeholders to master the domain, allowing the IT experts to progress even further in this sector. The authors pose the following questions as a first step of this review.

Searching strategy
To begin resolving the proposed questions, the author had been using a conventional information source, which comprises a wide range of research databases, digital libraries, and search engines that are listed in Table 3[1]. The next stage is to figure out how to find papers that are pertinent to our viewpoint. The proposed technique is based on two important constraints: i) Only articles published from January 2001 will be selected for the study. (ii) Search phrases, keywords, and queries that are used to locate relevant content. By researching scholarly information sources using the search keywords indicated in Table 3, relevant studies were found and extracted. At first, 55 documents were found, 44 from conventional research databases such as IEEE, Science Direct, Scopus, Springer, Web of Science, and others, and 11 from nonhabitual sources. The count of valid articles is further restricted to an extent by using appropriate inclusion and exclusion criteria. According to the PRISMA guidelines, the following basic methods were applied to select deserved publications for this review: identification, screening, eligibility, and inclusion[1]. The systematic search-strategy method is depicted in Figure 4. Ultimately, there are 20 standard full-text papers used for the meta-analysis. These papers were categorized and reviewed to obtain answers to the research questions posed at the start of this segment. As a result, a comprehensive and detailed examination of all relevant literature was carried out, and this systematic review is undoubtedly a significant contribution to the science community.

RQ1: How and where did the software engineering domain start?

The term software engineering has been deliberately chosen as being provocative at the 1968 NATO Conference on Software Engineering[3]. In the first computers, the coding was manually tweaked and mostly written in Assembler which was mainly used in industry batch-oriented systems. The style of computer usage known as timesharing was popular in the second half of the 1960s, and the major purpose was to decrease the clerical parts of coding. The incremental compilation, source-level editing and debugging, and automatic test data creation were among the software technologies created during this time[3]. The next operation was interactive mode. Lower CASE tools were the tools developed during this time frame. "Code and fix" and "spaghetti code" were used to explain the problems that were identified. People began to realize that programming has a lot in common with other lifecycles and that the most dangerous parts of the process could be the pre-testing and even pre-coding phases. This sparked a new way of thinking about the field and ushered in a new era. Software engineering became a field of study during this period. The period generally spans 1968 through 1982.

The Process Period

During this time, the key goal was to reduce development risks while also improving quality and productivity. This prompted research into the causes of failed software projects, the collection of cost per activity data, and the analysis of software error data. Each organization replied by issuing a set of development guidelines, most of which outlined a tiered approach to development. The waterfall model was introduced, as well as several refined variants of it. During this time, the most important lesson learned was that the quality of a product cannot be determined solely by looking at the finished product, which is the result of the development cycle.

Formal Period

This is the era since 1983. The emergence of the PC marks a watershed moment. The purpose of formal techniques is to increase the dependability of software while also increasing productivity through automation. Software specification, transformation, and verification can all benefit from formal approaches.

The Structured Period

Software engineering appeared to be self-sustaining. It marked the beginning of the CASE euphoria.

The Object-Oriented Period

This is the process of transforming a non-object-oriented system into an object-oriented structure, hence creating a new technological foundation that can be extended and reused [3].

RQ2 - What are the significant milestones present in the pathway of software development methodologies?

The following figure completely depicts the significant milestones that occurred in the pathway of software development.

RQ-3: What are the recent trends used in the field of software engineering?
RQ-4: How do the recent software trends meet the real-time requirements?

The research articles include the recent software recent domains. The selected papers are grouped as AI, Block Chain, IoT, Start-ups, Machine Language, Quantum Computing, and Security in Table 4.

CONCLUSİON

This systematic study investigates what and how modern software engineering developments are applied in recent, diverse academic disciplines. There has been a lot of ongoing research in the domains we looked into, however, our study focused on managing software repositories used in AI, IoT, Blockchain, Quantum computing, and start-ups. These insights will aid academics and developers in comprehending current software engineering trends.

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Table1: Research Questions

RQ. No	Research Question	Motivation
1.	How and where did the software engineering domain start?	The answer to this question turns up the history of software engineering
2.	What are the significant milestones present in the pathway of software development methodologies?	The answer to this question lists the significant developments that happened in the software field
3.	What are the recent trends used in the field of software engineering?	The answer to this question identifies the latest techniques and technologies used in software engineering
4.	How do the recent software trends meet the real-time requirements?	The answer of this question analyzes how much the recent software trends meet the real-time requirements.

Table 2. Sources of information

Information SOURce	URL
ACM Digital Library DBLP Google Scholar Search Engine IEEE Xplore Research gate Science Direct – Elsevier Scopus Database Springer Digital Library Web of Science Wiley Online Digital Library	http://dl.acm.org/dl.cfm https://dblp.org/ https://scholar.google.com/ http://ieeexplore.ieee.org/Xplore/home.jsp https://www.researchgate.net/ http://www.sciencedirect.com/ http://www.scopus.com/ https://www.springer.com/ https://www.webofknowledge.com/ https://onlinelibrary.wiley.com/

Table 3. Search Queries

history of software engineering
significant improvements in software engineering
recent trends in software engineering
software engineering for machine learning
software engineering for iot
software engineering for ai and bots
software engineering for data science

Table 4: Research Domains and SE Technologies

Citation Reference	Domain	Technology Used	Real-time purposes
[4]	ML in SE	• End-to-end pipeline support • Data availability, collection, cleaning, and management • Education and Training • Model Debugging and Interpretability • Model Evolution, Evaluation, and Deployment • Compliance	• Improving data accessibility, accuracy, authoritativeness, freshness, latency, structuredness, ontological typing, connectedness • Knowledge of AI and ML • Simplify error analysis and debug ability
[5]	AI in SE	AI/ML specific activities Modeling Principles AI/ML Practical considerations	• To avoid model over fit • To balance the challenges in data handling

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[6]	Bots in SE	• Management of pull requests • Code clones management • Dependency management tools • Source code maintenance and refactoring • Checking the test failures • Automated Program Repair	To manage software repositories and improve the process of software development and data accessing method in Q&A systems.
[7]	Quantum Computing in SE	• Management of quantum domain projects • Evolution of quantum software • QSE quality policy • QSE promotes the reuse of quantum software • QSE resolves security and privacy issues • Governance and management of software.	• To deliver quantum programs with zero defects • To assure the quality of quantum software
[8]	Quantum Computing in SE	• Software design of quantum hybrid systems • Testing techniques for quantum programs • Quantum programs reengineering and modernization	• To transform the current classical computing into hybrid systems • To work in a multilevel architecture • To guarantee the correctness and alignment with an algorithm's functional requirements. • To bring a new golden age and contribute importantly to the advance of our society
[9]	Block Chain in SE	• BOSE:Waterfall • Agile • DevOps in BOS • Software Process Improvement in BOS • Software Project Management in BOS	• Linear and sequential approach - work well for simple, straightforward projects • Agile project management focuses on both the quality ,customer value and stipulated project limits stomer • Combination of software development (Dev) and operations (Ops) to focus on cross-departmental integration and automation. • Reduction of time, cost, and resources, and helps to manage knowledge used to perform SPI

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[10]	BC with SE	Software Blockchain Network	• To ensure transparency, integrity, and full traceability of software engineering
[11]	IoT in SE	• Multidisciplinary Process • Co-operative Process • Bespoke process • Agile-driven Process • Secure-aware Process • Test-Driven Process • Energy-aware Process	• Incorporate agile practices into the IoT system development process • To define bespoke development processes concerning the choice of IoT hardware and software technologies • Create a cross-functional team and develop an interactive communication between hardware and software • To monitor and control software and physical objects in all the steps of development lifecycle and system layers
[12]	SE for IoT-Driven DA	• SE for IoTs • SE for IoT DA • Software Architecting • Process Driven Engineering	A unified framework of SE, IoT development, and DA methods to develop next-generation IoT-DA Applications
[13]	SE for startup companies	• Develop vision and strategy • Requirements Engineering • Software Design • Software Engineering Professional Practice • Software Quality • SE Management • Software Testing	• To form a bridge between Marketing and Engineering • To decide the problem and solution area • To requirements prioritization • To define software architecture • To practice SE • To improve software quality
[14]	Security in SE	• Systems Security Engineering Capability Maturity Model • Building Security in Maturity Model • Misuse case Modelling • Role-based Access control model • MS SDL	• To provide all levels of Security • SSDL maturity and control risk • Security from the beginning • Required authentication for accessing restricted resources • To give full code security

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[15]	Gamification in SE	• Requirements • Development • Testing • Project Management • Support Process • General Activities	• To Facilitate the stakeholder's requirements • To encourage code review • To perform test activities • To support gamification
[16]	Sustainable Software Engineering	• Sustainable Software Development Process • Sustainability dimensions and Models • Sustainability Tools	• To improve good sustainable practices • To observe the perception of respondents about sustainability • To support sustainability in SE practices
[17]	SE in Start-ups	• Inception • Stabilization • Growth • Maturity	• Ideation of the product and its first release • First product release and Scaling • To attain the desired market share • Start-up to the established organization
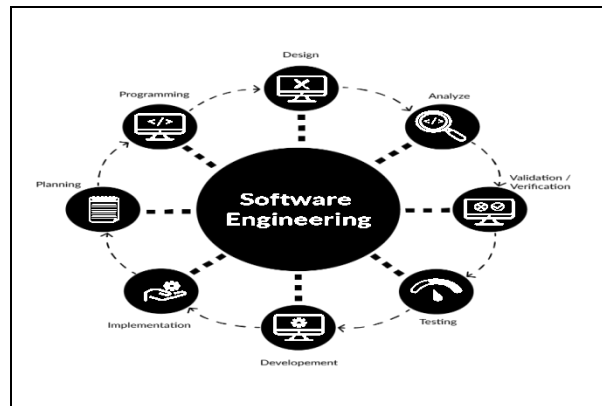
Figure 1: Software Engineering[1]	Figure 2: Milestones in Software Engineering
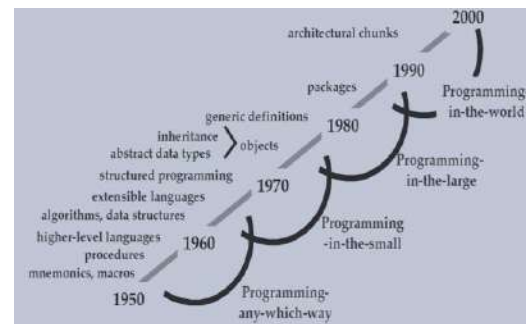
RESEARCH ARTICLE

To Compare the Effectiveness of Kabat Rehabilitation Versus Facial Nerve Mobilization to Reduce Facial Disability in Bell's Palsy

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ABSTRACT

Bell's palsy is characterized by pain and partial paralysis over half side of face. Causes of Bell's palsy are relapse of latent herpes virus in facial nerve, exposure to cold and remain unknown. Neural mobilization plays an important role in restoring movement and elasticity of the nervous system promoting return to normal function. Kabat rehabilitation is a manual resistance technique that works by stimulating fundamental patterns of movement through stimulation of the proprioceptors result in either facilitation or inhibition. To compare the effectiveness of Kabat rehabilitation versus Facial nerve mobilization to reduce facial disability in Bell's palsy. 30 Subject were selected. Group A (N=15) were given Kabat rehabilitation & Group B (N=15) were given facial nerve mobilization for 5day/week for 4 weeks along with conventional physiotherapy. Patients were assessed by House Brackmann Scale and Facial disability index before and after intervention. There were statistically significance improvement is present in Group A and Group B for outcome House Brackmann scale and Facial Disability Index. But group B showed more significant improvement for reducing symptoms related to Bell's palsy. This study concluded that Kabat rehabilitation and Facial nerve mobilization is effective but Facial nerve mobilization is more effective to reduce facial disability in Bell's palsy.

Keywords: Facial nerve palsy, Proprioceptive neuromuscular facilitation, disability, resisted exercises, Physiotherapy

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INTRODUCTION

The facial nerve is the seventh cranial nerve in humans, and it controls salivary gland and lacrimal gland secretions as well as muscular, sensory, and face motion. The facial nerve receives axons from the superior section of the solitary nucleus and superior salivary nucleus, which form the nervous intermedius specifics, and motor efferent fibers from the contra lateral motor cortex for all facial motion except the forehead, which has bilateral [bicortical] input [1]. It goes posteriorly to the abducent nerve and anteriorly to the vestibulo-occipital nerve, beginning on the brainstem's side. It passes through the temporal bones' facial canal, exits near the stylomastoid foramen, and branches into terminal branches on the parotid glands' posterior boundary. The facial nerve contains motor innervations for the facial muscle groups that control facial expression, parasympathetic innervations for the salivary gland and lacrimal gland, and sensory innervations for the tongue's anterior 2/3[2]. Bell's palsy is a lower motor neuron facial palsy that seems to be isolated [3]. The geniculate ganglion became infiltrated with a recurrent herpes simplex virus [HSV - 1] has been suggested as one probable cause of Bell's palsy. The presence of HSV-1 in intratemporal facial nerve endoneurial fluid collected during nerve compression, as well as the ability to instigate facial palsy in an animal model through primary contamination and reactive delivery via immune modulation, support an idea with HSV-1, Relapse of latent herpes virus within the cranial nerve 7 ganglion, Traumatic injury, Exposure to cold, Surgery in vicinity, Nerve compression caused by arterial spasm, venous congestion or ischemia and narrowing of bone canal [4,5]. Proprioceptive Neuromuscular Facilitation focuses on diagonal mass movement that resembles deliberate movement. The human body does not function in parts, but rather as a whole. PNF focuses on the developmental sequence of motion and how the agonist and antagonist muscle tissues collaborate to provide volitional motion. PNF accentuates diagonal, functional-like mass movement patterns.

The body functions as a whole rather than a piece. PNF derives a multisensory approach that emerges the auditory, visual, and tactile senses to encourage these mass movement patterns [6]. Using the help of many senses PNF aids the patients to realize what normal movement feels like. PNF treatment is mostly concentrated on three things: 1) Increase the agonist's motor learning by repeating an activity and introducing rhythmic beginning. 2) Reverse the antagonist's motor patterns 3) Learning to relax muscles can help to gain more range of motion and reduce stiffness [6]. PNF focuses on assisting a weak muscle's voluntary response and prioritizes consistency of facial movement patterns of isolated muscle control that is strong to resistance, while excluding activities that encourage mass contraction of muscles relevant to many facial expressions (synkinesis). Proprioceptive neuromuscular facilitation is a manual resistance strategy that combines prompting fundamental patterns of movement combined proprioceptors stimulation, resulting in both facilitation and inhibition [6]. Neurodynamics refers to the communication between different parts of the nervous system's relationship to the musculoskeletal system. It has been proven that the nerves circulate independently from different tissues. The primary theoretical goal of using neural mobilization to treat damaged neurodynamics is to restore dynamic stability between the relative motion of neural tissues and mechanical interfaces in the environment, allowing for lower intrinsic pressures at the neural tissue and, as a result, selling the most appropriate physiological function [7]. Neuron gliding is facilitated, nerve adhesion is reduced, noxious fluids are dispersed, neural vascularity is increased, and axoplasmic fluid is created, among other benefits of such approaches [7]. There are so many techniques are in practice to reduce facial disability and many studies have been carried out to find the effective technique which can be used for Bell's palsy. But there is a lack of evidence that comparing Kabat rehabilitation and facial nerve mobilization to reduce facial disability in Bell's palsy. The purpose of the study is to compare the effectiveness of Kabat rehabilitation and facial nerve mobilization to reduce facial disability in Bell's palsy.

METHODS AND MATERIALS

A comparative study was carried out at Sainath Hospital. Ethical clearance was taken from ethical committee of Sainath hospital. 30 subjects with Bell's palsy were taken in the study according to inclusion criteria. They were divided into two groups, 15 in each group. Group A were treated with Kabat rehabilitation along with conventional

physiotherapy. Group B were taken facial nerve mobilization along with conventional physiotherapy. The inclusion criteria are: (a) Age: - 18 to 65 years (b) Men and women (c) Diagnosed as Bell's palsy by neurologist (d) First episode of Bell's palsy. Exclusion criteria are: (a) Psychological unstable patient (b)History of stroke (c)Epilepsy (d)Any recent surgery around the face (e)Any skin disorders around the face (f)Diabetic patients.Outcome measures of present study are House Brackmann Scale and Facial Disability Index. House brackmann scale is used for grading of facial paralysis and Facial disability index is taken for measuring facial disability in Bell's palsy. The Facial Disability Index is a self-assessment tool for people with facial palsy to evaluate everyday functional disability and quality of life. The FDI is a ten-item questionnaire with the following subscales: Physical characteristics are represented by five objects, whereas social characteristics are represented by five items. The physical function subscale is used to measure problems with eating, drinking, speaking, lacrimation, and oral hygiene. The social function scale includes examines patients anxiety, irritation, and isolation, as well as sleep problems and social constraints [8] . House-Brackmann scale is among the more regularly used measures for measuring facial nerve activity. This scale ranges from 1 (normal) to VI (severe) and is entirely based on functional disability (no movement) [9] the grade is determined by the upward motion of the midportion from its top of a brows and the outward motion of the oral commissure [10].

Group A was treated with Kabat rehabilitation along with conventional exercises. The activation of the frontal, corrugators, & orbicularis muscles in the upper fulcrum (forehead & eyes) was brought out through its upward and downward traction in a vertical plane. Utilizing traction movements in a vertical line, the homologous elevator muscle of the nasal or upper lip has been recruited in the intermediate fulcrum (nose). For a lower fulcrum (mimic-chewing), both risorium as well as orbicularis oris muscles got stimulated inside the horizontal plane, whereas the mentalis muscle remained activated mostly in vertical plane. Stretching one muscle at a period at one fulcrum, preceded by stretch, resistance, and reciprocal inhibition, led in weak muscular facilitation. Likewise, at a separate fulcrum, another weak muscle being strengthened. For facilitation, perform 3-5 repetitions per muscle for 2-3 sets of each stretch, irradiations, and stretch resistance. Exercise: rest is 1:1(to avoid tiredness because these are little muscles) one session/ day for 30 minutes,five days a week for four weeks[11]. Raise your brows and use your fingers to apply resistance for 5 seconds. Furrow your brows and apply resistance with your fingers for 5 seconds. Close your eyes for 5 seconds and apply resistance with your fingertips. Wrinkles your nose for 5 seconds by applying resistance with yourfingertips. Smile without opening your mouth; prevent the movement with your fingersfor five seconds. Purse your lips as you're whistling, then coach resistance with your palmsfor five seconds. Raise the angle of your mouth for five seconds while observing resistancewith your palms.

Lower your lips for 5 seconds and provide resistance with your fingers. Close your mouth and clench your teeth; apply resistance with your fingersfor 5 seconds. Open your lips wide and follow resistance with your fingers for five secondswith your head elevated. Make a chin wrinkle; use your fingers to apply resistance for 5 seconds [12]. Group B was treated with facial nerve mobilization along with conventional physiotherapy**.** Patient position: Patient position is in supine lying. Therapist position: Therapist is in sitting position. Neural mobilization is performed by gently holding the bottom part of the ear witha combination of the index and thumb fingers. The thumb is now positioned near the external auditory meatus' outlet, while the index finger is positioned behind the auricle. The volume of discomfort reported by the patient determines the depth of auricular traction twists. The patient was able to tolerate 3-4 units of moderate horizontal traction and circular movement 25 times with a five-second rest in between. 3-4 sets/ sessions per day, 5 days a week for 4 weeks[13]. Conventional exercises are Use tapping, effleurage, and finger and thumb kneading, and stroking to massage the treatment together. An anode electrode in the nape of the neck and a cathode electrode across a nerve trunk anterior to the earlobe should be used in faradic electric stimulation. The cathodic pen electrode is employed for precisely find the facial nerve for excitation (biphasic current, pulse time 300ms, frequency 60 Hz, 20 contractions, and rest 10 seconds)[13].

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RESULT

A comparative study was done on 30 Bell's palsy patients aged between 18 to 65 years. The subjects were randomly divided into two groups and intervention given in form of Kabat rehabilitation and facial nerve mobilization along with conventional physiotherapy. Independent t – test was too used to see the pre and post treatment effects. Table 1 show the mean values of Group A. Table 2 shows mean values of Group B. Table 3 shows comparison of mean values of Group A and Group B pre and post mean of House brackmann scale and facial disability index (Physical and social) Result shows that significant improvement in all the outcome measures in both the groups but group B showed more significant improvement.

DISCUSSION

When the mean reduction values of the House Brackmann scale plus the Facial disability index were assessed within the groups in present study, they were significant statistically in both. However, when the two groups were analyzed, they were statistically significant, with the exception that the mean values of neural mobilization were higher than the Kabat rehabilitation in reducing facial disability in Bell's palsy; finding appears similar with previous observations. Faizan Kashoo et al. who did study on neural mobilization in Bell's palsy. It is a case study shows that clinical outcome of patient improve house brackmann scale before and after 4 weeks. They concluded that in early stage of Bell's palsy neural mobilization is effective. They said that nerve is connected with soft tissue via connective tissues; when traction is applying in micro mm the stretching and movement is occur at the nerve side [13]. Alejandro et al. conducted a study on the effectiveness of soft tissue and/or neural mobilization in the treatment of tension-type headaches and discovered that patients' clinical outcomes improved stress ache threshold and headache impact test- 6 before and after the four-week intervention. They discovered that a protocol that includes moderate tissue and neural mobilization is significantly efficient at controlling FETTH and CTTH. They claimed that blending neural mobilization techniques to soft tissue techniques enhances peripheral or essential receptors, resulting in a mechanical and neurophysiologic interplay which might contribute to an improvement throughout its mechanosensitivity of the above internal structures and, as a result, a reduction in stress levels in patients using TTH. Because neuronal mobilization is beneficial, it was included in the feature set although neural mobilization techniques have the ability to induce inhibitory processes that regulate the neuromusculoskeletal tissue's mechanosensitivity, it was included. when used to deal with unpleasant emotions, neural mobilization can be highly successful. Neurodynamics' fundamental theoretical focuses on restoring the dynamic equilibrium of some of the reciprocal motions among brain parenchyma with their ambient mechanical interfaces, permitting for decreased intrinsic stresses on neural cells and so promoting the greatest physiological function. Some of the hypothesized benefits of such procedures include improved neuron gliding, reduced nerve adhesion, dispersion of unpleasant fluids, enhanced neural vascularity, or the production of axoplasmic fluid [14].

Kanwal Khandaja et al. conducted a study to assess the efficacy of Kabat rehabilitation and face exercise combined with nerve stimulation in people with Bell's palsy. The results show that the patients clinical outcomes improved, indicating a better and faster recovery. The study involved fifty patients, with outcome measures such as the Sunnybrook facial grading scale and the facial disability index taken before and after the three-week intervention. Kabat rehabilitation combined with nerve stimulation is more beneficial than facial exercises combined with nerve stimulation, according to their findings. They stated that PNF is a technique in which global stretching and resistance are performed sequentially to promote the voluntary contraction of a weakened muscle so its motion with the help of resistance, which may be done both verbally and manually [15]. S P Adhikari et al. completed a study on Kabat treatments with facial expressive and functional exercises for better and faster recovery in Bell's palsy and found that clinically, patients recover quickly and effectively. The study involved eight patients, with outcome measures including the Sunnybrook facial grading scale, functional facial impairment, and the House Brackmann scale taken before and after the four weeks. According to their findings, Kabat therapy accompanied facial expressive exercises

improves functional level in Bell's palsy patients significantly. They said that the improvement was more pronounced in the first two weeks than in the second, which they believe is due to the combination of functional exercises included in the intervention[16].The excitability of cells may be increased when impulses are started from the CNS and sensory receptor organ. It suggests an improvement in central excitation and is a way of facilitating neuromuscular mechanism responses. It may also reduce the synaptic threshold of alpha motor neurons by repeated use of the pathway, facilitating the passage of impulses and producing movement responses. PNF uses a diagonal stretching pattern to produce extremely powerful muscle contractions. The stronger side's muscle contractions facilitate and strengthen the action on the more affected side, and preventing full motion on the stronger side promotes activity and increases strength on the weaker side by irradiation, resulting in early recovery, which makes PNF more effective. Improvements in the House Brackmann scale and the Facial Disability Index may be due to this mechanism.

CONCLUSION

The current study found that following the study intervention, the participants of both the groups improved by lowering facial impairment. As a result, it was determined that neural mobilization is more successful than Kabat rehabilitation in reducing facial impairment in Patients with Bell's palsy. These treatments were relatively basic and easy to employ to treat patients experiencing Bell's palsy. As a result, it can be incorporated into Bell's palsy treatment plan.

Future Recommendation of the Study
The same study might be repeated with a longer follow-up period. Future research should focus on the efficacy of different strategies and modalities.

Conflict Of Interest: Nil

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Table 1 : Shows Comparison of Pre and Post Values of Group A

Group A	House Brackmann scale Pre	House Brackmann scale post	Facial disability index (Physical) Pre	Facial disability index (Physical) Post	Facial disability index (Social) Pre	Facial disability index (Social) Post
Mean	3.2667	1.2000	55.0000	94.2333	43.2000	22.1333
Standard deviation	.45774	.41404	11.38608	11.38608	10.27619	7.38596
P values	<.001		<.001		<.001	

Table 2: Shows Comparison of Pre and Post Values of Group B

Group B	House Brackmann scale Pre	House Brackmann scale post	Facial disability index (Physical) Pre	Facial disability index (Physical) Post	Facial disability index (Social) Pre	Facial disability index (Social) Post
Mean	3.2667	1.0667	51.3333	105.5667	42.4000	20.8000
Standard deviation	0.45774	0.25820	12.58779	12.58779	11.78861	4.32930
P values	<.001		<.001		<.001	

Table 3: shows Group A and Group B pre and post mean of HB and FDI.

	House Brackmann scale Pre	House Brackmann scale Post	Facial disability index (Physical) Pre	Facial disability index (Physical) Post	Facial disability index (Social) Pre	Facial disability index (Social) Post
GROUP A	3.2667	1.200	55.0000	94.2333	43.2000	22.1333
GROUP B	3.2667	1.066	51.3333	105.5667	42.4000	20.8000

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Graph 1.1 shows comparison of pre and post HB and FDI of Group A

Graph 1.2 shows comparison of pre and post HB and FDI of Group B

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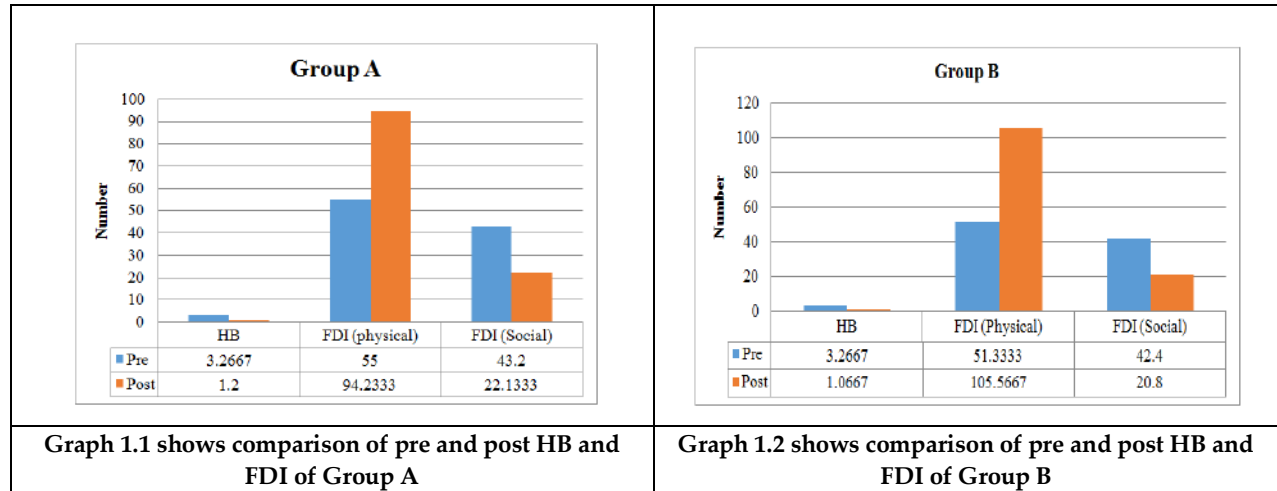
COVID-19 and Diabetes: Pathology, Complications, and an Integrated Clinical Management

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ABSTRACT

Pandemic disease COVID-19 (Corona virus disease-2019) has ravaged millions of people globally. The COVID-19 infection causes worsening clinical status in diabetic patients. This review evaluates the possible interrelation between diabetes and COVID-19 pathophysiology, clinical management as well as how virus infection can intensify diabetic crises in long-term pathogenesis. Phytochemical function in anti oxidative defense mechanisms, immunomodulation of severe COVID-19 infectious disease, herbal medications, and the proclivity for direct viral toxicity of pancreatic beta cells and insulin action sites. This study can be used as a guide for treating diabetic patients with COVID-19 utilizing traditional to

recent medication. In the future, clinical data will be required to assess the efficacy of traditional and recent medicines.

Keywords: COVID-19, Corona virus, Diabetes, Pandemic disease, Pancreatic β cells.

INTRODUCTION

Corona virus disease-19 (COVID-19) caused by Coronavirus-2 (SARS-CoV-2), which was first identified in December 2019 in Wuhan, China, and has subsequently wiped off the global population [1]. Then, a significantly modified SARS-CoV-2 strain with a fluctuating mortality rate was discovered [2].The World Health Organization (WHO) database had 211,730,035 confirmed cases of COVID-19 as of August 23, 2021, with 4,430,697 deaths. As per reports of Center for Disease Control and Prevention, patients with Type 2 Diabetes Mellitus (T2DM) and metabolic syndrome are 10 times more likely to die if they get COVID-19. SARS-CoV-2 is a positive-stranded RNA virus that causes severe acute respiratory syndrome. It has a single-stranded RNA genome, a protein-decorated lipid bilayer and SARS-CoV-2 is 82% similar to human SARS-CoV [3]. Corona virus is transmitted primarily by virus-bearing respiratory droplets. COVID-19 patients normally develop symptoms 5-6 days after contracting the virus [4]. Angiotensin-converting enzyme 2 (ACE2) is the only known human homologue of ACE, with about 42 percent similar protein sequences (the major regulator of blood pressure). Since its discovery in 2000, ACE2 has been linked to cardiac function, hypertension, and diabetes, with its effects mediated in part by its ability to convert angiotensin 2 to angiotensin 1-7 [5].It is the primary cellular entry receptor for SARS-CoV-2 in human cells, and it is abundant in lung alveolar cells, vascular endothelial cells, cardiac myocytes, and a variety of other cells [6]. COVID-19 mortality rates are thought to be influenced by diabetes and respiratory inflammation. Acute and chronic inflammations are related to COVID-19 and diabetes [7]. Both diseased conditions can have an effect on clinical development and outcome.

There are a few other unique mechanistic aspects of corona virus infections that must be understood separately and may have clinical implications for better treatment of chronically infected patients. An increasing amount of research demonstrates that the viral illness mechanism is directly linked to the metabolic and endocrine systems. It has been documented those infected patients with well-controlled blood glucose have better outcomes, suggesting that diabetes control before infection may influence COVID-19 results. However, people with type 1 and type 2 diabetes mellitus (T1DM and T2DM) are at a higher risk of receiving COVID-19 [8]. T2DM and T1DM both enhance the chance of serious COVID-19 disease when compared to other COVID-19 patients, according to many recent studies [9]. As a result, clinicians must ensure that all COVID-19 patients receive prompt and comprehensive metabolic regulation. As a result, it's important to review research on the impact of these diseases on one another, as well as the pharmacological approach to diabetes management when COVID-19 is present.

Immune response after infection of COVID- 19
Because COVID-19 is a respiratory illness, most individuals only experience symptoms in their lungs. However, clinical symptoms can be worse in certain patients with such co morbidities. The mechanism of infections is human-to-human propagation by frequent proximity. The risk of infection by droplets is increased by close encounters, like sneezing and coughing via an infected individual or interactions between health workers and COVID-19 patients. The virus can be transferred during the incubation period, which lasts between 2 and 14 days. The innate immunological status of infected individuals against SARS-CoV-2 infection is unclear. COVID-19 patients exhibited substantially greater neutrophil, interleukin (IL-6), and C-reactive protein (CRP) levels, as well as lower lymphocyte tiers, according to one study [10].

Effect of COVID-19 on Diabetes

In a retrospective study of 1591 critically ill patients who were hospitalized to an intensive care unit in Italy, hypertension was the most common comorbidity (49%), followed by cardiovascular disease (21%), hypercholesterolemia (18%), and diabetes (17%) [11]. There are many clinical studies that show a close connection between COVID-19 severity and diabetes. By releasing glucocorticoids and catecholamines into the bloodstream, COVID-19 infection exacerbates diabetes mellitus tension. Glycemic regulation is disturbed, and the development of glycation end products increases in a variety of organs, all of which impair the prognosis of diabetes. T2DM and COVID-19 have a bidirectional link, according to recent research [12]. In older T2DM patients, there is a relationship between COVID-19 and hyperglycemia [13], Owing to a loss of both innate and adaptive immunity, people with diabetes, regardless of type, have a higher risk of infection. In addition to diabetes, the three most prevalent comorbidities were hypertension, cardiovascular disease, and lung disease. Diabetes patients have a high risk of severe consequences. Natural killer cells, namely CD^{4+} and CD^{8+} cells, as well as CD^{4+} and CD^{8+} lymphocytes, are significantly reduced after acute COVID-19 infection [14]. The number of comorbidities is a predictor of mortality in COVID-19.

COVID-19 and glucose metabolism

The research found that a higher blood glucose level is positively correlated with a higher rate of SARS-CoV-2 replication. The glycolytic pathway, on the other hand, aids in the inhibition of SARS-CoV-2 replication by increasing the quantity of mitochondrial reactive oxygen species and causing a larger level of hypoxia-inducible factor [15,16]. In mice, comorbid T2DM caused a dysregulated immune response, infected with MERS-CoV, as a result of which there is significant and widespread lung pathology [17].

Immunomodulation

Innate immunity, the initial line of defense against SARS-CoV-2, is impaired in individuals with uncontrolled diabetes, allowing the virus to circulate freely throughout the host. COVID-19 has been associated with both type 1 and type 2 diabetes via processes that overlap with immune function pathways. The impact of aging on immune responses on COVID-19 susceptibility and severity might be equivalent. The impact of aging on immune function may be equally as relevant in terms of COVID-19 susceptibility and severity. Age is the most important risk factor for developing T2DM, and the effect of aging on immune function may be comparable for COVID-19 susceptibility and severity. In diabetes mellitus, macrovascular problems have been connected to hyperglycemia, and a dysregulated immune system has been associated with diabetes mellitus [18].

Pathogenesis of COVID-19 and diabetes

COVID-19 is a respiratory infection that is spread by respiratory droplets. The incubation period is 2-14 days from the time of exposure to the onset of symptoms [19]. The respiratory system is the first to be affected, resulting in pneumonic alterations. The corona virus surface protein S-glycoprotein is related to the ACE2 receptor in host lung cells. Finally, they will enter the cell via endocytosis [20, 21]. Spikes on the virus surface contain S1 and S2 subunits and make up the S-glycoprotein. Diabetic patients have higher levels of furin, a viral entry-enhancing protease [22]. The surface spike proteins S1 and S2 domains are cleaved, which improves viral entry. The presence of proteases such as cathepsin, as well as an acidic environment, is both favorable conditions for viral replication in the cytosol [23]. Type 1 diabetes is caused by a complete lack of insulin, while insulin resistance causes type 2 diabetes [24].Chronic hyperglycemia, which induces glucotoxicity in bodily tissues, is the most prevalent metabolic aberration linked with diabetes. These operations commonly result in diabetes complications. Lipotoxicity is another aspect to consider [5]. Diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar states are two acute consequences of diabetes.

The Interrelationship of COVID-19 and Diabetes Infection at the Receptor Level

Dipeptidyl Peptidase-4 (DPP-4) is a dipeptidyl peptidase that is defective in T2DM, where in cretins such as glucagon-like peptides and stomach inhibitory peptides are lacking. They help to increase insulin secretion. T2DM is hypothesized to be lacking in incretins such as glucagon-like peptides and stomach inhibitory peptides. They help to

increase insulin secretion. However, the intestinal enzyme DPP-4 can degrade these in cretins, decreasing their effectiveness. In an active state, DPP-4 is a transmembrane glycoprotein with a molecular mass of 220 kDa that exists as a dimer [25]. DPP-4 inhibitors work by preventing this degrading enzyme from working, allowing inscretins to secrete more insulin.

Glucagon-like peptide -1 and its analogs

Most glucagon-like peptide 1 (GLP1) analogs reduced the incidence of severe adverse cardiac events in T2DM patients, according to cardiovascular outcome data. GLP1 has a role in glucose homeostasis, and its activation results in a range of pleiotropic symptoms. GLP1 therapies diminish inflammatory cytokines and immune cell infiltration in the kidney, liver, brain, lung, and cardiovascular system. Native GLP1 infusions lowered plasma levels of IL-6, intercellular adhesion molecule 1, and oxidative stress indicators in T1DM patients [3]. The GLP1 and GLP1 analogs have been found in human trials to help cure chronic inflammatory illnesses such as nonalcoholic fatty liver disease, atherosclerosis, and neurodegenerative disorders. Obese COVID-19 patients experienced lower lung compliance and health outcomes than non-obese COVID-19 patients, and healthcare practitioners struggle to locate the proper mask size and had mask ventilation issues. As a result, people suffering from obesity or T2DM may benefit from GLP1 analogs with weight-loss capabilities.

Sodium-glucose co transporter 2 inhibitors

T2DM is treated with sodium-glucose co transporter 2 (SGLT2) inhibitors (SGLT2i), which lower blood glucose levels by acting on the kidney. Treatment with SGLT2 decreased inflammatory cell infiltration into arterial plaques as well as mRNA expression levels of specific cytokines and chemokines such as TNF, IL-6, and monocyte chemo attractant protein 1 (MCP1) in T2DM patients [26].

Insulin

In diabetic patients, insulin treatment provides the best glucose-lowering impact, and it is suggested that insulin be used as the primary therapy in COVID-19 diabetic hospitalized patients [27]. Patients with hyperglycemia who got insulin infusion were less likely to suffer a severe illness than those who did not. As a result, insulin infusion can be an effective technique of attaining glycemic control and enhancing COVID-19 patient outcomes [28]. Insulin is usually given to diabetic individuals who are ill and have SARS-CoV-2. The COVID-19 epidemic began in China, with the whole medical sector grappling with the consequences of diabetes patient death. The COVID-19 virus affects cell function and causes a fatal diabetic state, prompting researchers to explore novel pathways, as illustrated in Figure 1[29]. Optimal glucose management with insulin infusion lowered inflammatory cytokines and enhanced COVID-19 strength in a statistically meaningful way. In the wake of the global pandemic, theoretical considerations revealed that metformin's activation of AMPK in diabetic patients may help to control influenza. As a result of the functional shifts, ACE2 is phosphorylated [30]. Metformin has been demonstrated to reduce inflammatory markers in patients with SARS-CoV and MERS, and it appears to help with viral infections, especially hepatitis C. (HCV). Metformin not only lowers liver fibrosis in patients with HIV infection, but it also reduces insulin resistance in HCV patients, affecting the cellular response to infection. Metformin can be beneficial in COVID-19 infection because it disrupts viral binding potential and thus prevents viral entry into the cell. Metformin lowers blood glucose levels, improving insulin sensitivity in COVID-19 patients.

Antidiabetic agents in patients with COVID-19

The diabetic patients care is multifaceted, and it should involve not only preserving glycemic homeostasis but it also treating a variety of comorbid conditions which can further exacerbate the clinical features. Diabetics prefer ACE inhibitors or angiotensin-2 antagonists as antihypertensive medicines. These drugs not only reduce blood pressure and albumin level in urine, but also help to develop diabetic nephropathy. There is currently inconclusive and contradictory information on their use in the COVID-19 pandemic, which may result in a rise in infection risk caused by rising ACE-2 concentrations. It is crucial to highlight that there is no conclusive data supporting or opposing the use of ACEI/ARB in diabetics who are at risk of or have already been infected with SARS-CoV-2 [31]. Some of the

drawbacks of antidiabetic agents of hyperglycemia in domestic medical treatments have been presented in Table 1 [32].

Diabetes management during the COVID-19 outbreak

Diabetic patients require continuous blood glucose management and monitoring, which is especially critical during the COVID-19 epidemic. There is no evidence that any anti-diabetes drug raises the risk of COVID-19 infection, so diabetic patients can continue to take their daily medications without the risk of infection. Blood sugar levels should be controlled and regular drug treatment should be followed even if a diabetic patient has been infected with SARS-CoV-2. If the patient suffers serious problems as a result of SARS-CoV-2 infection, changes in dosage or therapy may be explored [33].

Mechanism and action of anti-diabetic agents

The antimalarial drug hydroxyl chloroquine lowers blood sugar levels by improving insulin sensitivity and pancreatic cell function [34,35]. As a result, in certain countries, it is prescribed as an anti-diabetic drug [36]. Diabetes and COVID-19 are both linked to acute and chronic inflammation. Both diseases may have an effect on each other's clinical development and outcome. As a result, research on the effect of these diseases on one another, as well as the pharmacological approach to treating diabetes in the presence of COVID-19, must be reviewed [37].

Metformin-AMPK-ACE2-SARS-CoV-2

SARS-CoV-2 uses the ACE2 receptor, which has killed over 1.7 lakh people worldwide. When its spike proteins (S1) bind to the N-terminal region of ACE2, it enters the human body. The RBD-PD complex is formed when the virus's receptor-binding domain (RBD) binds to the ACE2 receptor's protease domain [38]. One of the most prevalent consequences in COVID-19 patients is acute respiratory distress syndrome. There have been case reports published regarding individuals with newly diagnosed T1DM who developed ketoacidosis at the onset of COVID-19 and for several weeks after apparent recovery from COVID-19 [37]. SARS-CoV-2 is a virus that has the potential to induce metabolic illness [39,40].

Camostat mesylate

Camostat mesylate is an anti-inflammatory, anti-fibrotic, and antiviral serine protease inhibitor. Camostat mesylate inhibits transmembrane protease serine 2 (TMPRSS2), making it easier for viruses to enter the host cell [39]. This enzyme also inhibits interleukin-1 beta, interleukin-6, tumor necrosis factor-alpha, and other pro-inflammatory cytokines. As a consequence, pancreatic inflammation and fibrosis are reduced. In patients with chronic pancreatitis, camostat mesylate medication was reported to reduce the risk of new-onset diabetes mellitus and COVID-19 mortality [41]. Camostat mesylate can be useful for COVID-19 associated Coagulopathy (CAC), myocardial damage, and other cardiovascular disease (CVD) complications because of these beneficial effects. In this area of study, further clinical trials are needed.

Herbal medicine

The use of herbal medicines such as curcumin, quinine, and echinacea, which contain active compounds with immunostimulatory, anti-inflammatory, antimicrobial or antiviral properties, is a recent pattern in the culture. Because of their potential to influence the immunological response, these herbal substances are effective in the prevention and treatment of COVID-19 [42-45].SARS-CoV-2 infections were treated with the antimalarial medicines chloroquine and hydroxychloroquine [46]. The two major mechanisms of action of hydroxychloroquine are thought to be the inhibition of viral spike protein cleavage at the ACE2 binding site, as well as its anti-inflammatory and immunomodulatory actions [47]. As a result, reports indicate that herbal medicines have higher safety margins than reference drugs, implying that clinical studies on how these herbal preparations can be used as adjuvants/supplements in the treatment of respiratory viral diseases and COVID-19 are required. The following are some herbs that may be useful in the fight against COVID-19.

Echinacea purpurea

It is one of the most often used herbal medications in Europe and North America due to its promising benefits against viral infections. Its common name is purple coneflower. Echinacea's immunomodulatory impact is more of an immunosuppressor than an immunological stimulator due to the inhibitory action of various cytokine releases. It contains bioactive components such as chicoric and caffeic acids, alkyl amides, and polysaccharides [48].

Curcuma longa

Because of its antioxidant, anti-inflammatory, antimutagenic, anticancer, and antibacterial characteristics, *Curcuma longa*(C. *lomga*) has been used as a medication or supplement in many Asian nations for millennia. Diabetes, cardiovascular disease, obesity, neurodegenerative illness, inflammatory bowel disease, and other disorders are all treated with it [49]. (C. *lomga*), also known as turmeric, is a rhizomatous herbal plant. As a result, the medical and scientific communities are very interested in this herb. Curcumin reduces blood pressure by blocking angiotensin-II receptor type-1 activation (AT1). This procedure either prevented or reduced the number of angiotensin II molecules that could bind with AT1. The inhibition of the binding process resulted in the blood vessel's failure to contract, a decrease in renal and another tissue perfusion, and a reduction in blood pressure. Since ACE levels rise with hypertension, an ACE inhibitor is an antihypertensive drug that lowers blood pressure by inhibiting ACE. Quinine works in the same way as chloroquine, a synthetic antimalarial drug used to treat malaria, does. Quinine alkaloids, found in the bark of the trees, have been used to treat malaria for over a thousand years. As a result, it's referred to as an achloroquine analogue. Quinine sulphate is one of today's most sought-after medications for COVID-19 therapy. According to a clinical investigation, when combined with azithromycin, hydroxyl chloroquine enhances the SARS-CoV-2 virus load in COVID-19 patients.

Andrographis paniculata

Andrographis paniculata(A.*paniculata*) is a type of *andrographis paniculata* (Burm.f.) The common names for A.*paniculata* are Kalmegh, Kirayat, and Nelavembu, and they are all used as main ingredients in commercial preparations. Kabasura Kudineer is an herbal powder that is currently being used by Ayush as a COVID19 preventive formulation. More than 55 ent-labdane diterpenoids, 30 flavonoids, 8 quinic acids, 4 xanthones, and 5 unique noriridoid compounds are found in A.*paniculata* [50]. Furthermore, it has a wide variety of pharmacological functions, the most appealing of which is the antidiabetic function of these plant extracts. Various research on the pharmacological activity of A.*paniculata* have been conducted; andrographolide compounds have been declared as a possible anti-diabetic agent through in-vivo and in vitro studies, and clinical trials in humans for their safety and efficacy have also been conducted [51]. Diabetes individuals are more sensitive to SARS-CoV-2 infection, the medication that claims to have a potent synergistic effect on diabetic as well as antiviral and immunostimulant activity may be a good candidate for treating COVID-19 infected diabetic patients. As a result, in-depth research into the numerous phytocompounds found in this plant species is critical for identifying a possible drug molecule for treating COVID 19-infected diabetics.

COVID-19 versus host cell proteins

Corona viruses are distinguished by their spike or surface (S) glycoproteins, which give rise to their shape and name. These facilitate viral entrance into host cells via the receptor-mediated entrance. ACE2, which has a complicated receptor recognition pattern, is the primary host cell receptor of human pathogenic corona viruses. In principle, herbal products that block ACE2 can be utilized as the first line of defense against infection. Despite the fact that the COVID-19 pandemic is still ongoing, all herbal medicines with anti-inflammatory and immunomodulatory properties are not to be used in large amounts in the event of flu symptoms unless the patient has been confirmed negative [52]. Potential ACE2 enhancers include plant metabolites such as baicalin, tanshinones, magnolol, curcumin, and rosmarinic acid.

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CONCLUSION

The pathophysiological relationship between diabetes and COVID-19 is still being studied. However, some well-established pathophysiological relationships are ACE2 function, immunological down-regulation, which is causing severity of COVID-19 infection in diabetics. As a result, uncontrolled diabetes mellitus appears to be a major predictor of mortality, not only because it alters pathogenesis and physiological processes, but also because it predisposes the person to a variety of complications. Despite the fact that certain anti-diabetic drugs affect cellular entry molecules, no evidence of worsening diabetes regulation in COVID-19 infection has been found in randomized controlled trials. Anti-inflammatory medications that help diabetics maintain good glycemic regulation. Insulin and herbal treatments are especially significant in COVID-19 diabetic individuals. More research and randomized controlled trials are needed to address some of the unanswered questions concerning the mechanistic and pharmacological links between diabetes and COVID-19 infection.

DECLARATION OF COMPETING INTEREST
The author declares that there is no conflict of interest.

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Table 1. Antidiabetic agents with their potential adverse effects

Antidiabetic agents	Potential adverse effects
Metformin	Lactic acidosis, Gastrointestinal side effects
Dipeptidyl peptidase 4(DPP 4)	Kidney injury, Respiratory tract infections, and Pancreatitis
Insulin	Risk of hypoglycaaemia, required glucose monitoring often
Glucagon-like peptide 1 (GLP 1)	Diarrhoea and electrolyte depletion
Sodium-glucose contransporter 2 (SGLT2) inhibitors	Increased risk of ketoacidosis

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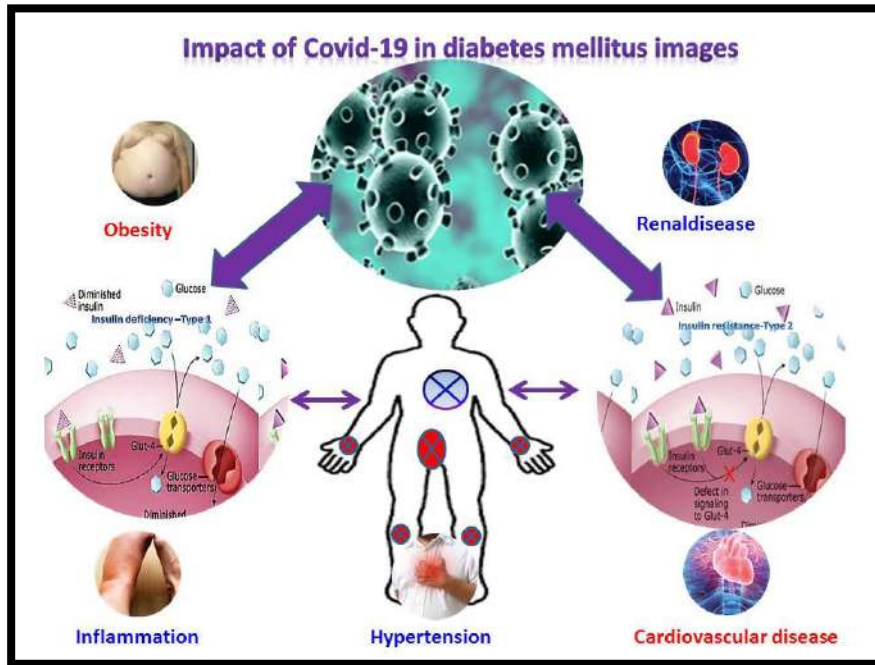
Figure 1. The relationship between diabetes and COVID-19 is biunivocal

RESEARCH ARTICLE

Nitrogen Dioxide as Ozone Precursor for Delhi City with Specific Reference to Covid-19 Lockdown Period of 2020 (2019-2021)

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ABSTRACT

The pandemic of COVID-19 has been discussed in length with regards to its impact on air quality for primary pollutants. However, secondary pollutants, particularly Ozone are less discussed in this context. Ozone has its precursors in the troposphere, in which Nitrogen Dioxide gas is amongst the leading causes of its formation. The present study is an attempt to calculate the correlation between Nitrogen Dioxide and Ozone generation for the city of Delhi, one of the most polluted cities of the world. The purpose here is to observe whether the absence or presence of human activities is responsible for concentration of both the pollutants and is there any causative explanation between Nitrogen Dioxide in the formation of tropospheric Ozone for the city? The periods of restricted human activity in the form of COVID-19 complete lockdowns of 2020 and partial lockdown of 2021 form the time periods of analysis; extended retrospectively to the same time frame for 2019 for comparison. Correlation analysis is conducted for 14 air quality monitoring stations of the city for the selected time periods of lockdown for all the three years. Findings indicate a fluctuating trend of Ozone for the city in the light of comparison with Nitrogen Dioxide, but no specific pattern of Ozone formation can be established either in the presence or absence of human activities.

Keywords: COVID-19, Lockdown, Ozone, Nitrogen Dioxide, Delhi

INTRODUCTION

Corona viruses (CoV) come under the category of viruses causing mild to severe illness and COVID-19 pandemic which spread from China (WHO, 2021), has claimed more than 6 million lives as of May 2022 (Worldometers, 2022).

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The restrictions it has introduced on human life have had far reaching impacts across the world and the 'recognized' periods of shut offs named as 'lockdowns' have been time stamps for humanity (Kerimray, *et al.* 2020). In this context for environmental impacts, it was generally observed that air quality improved across the world; this being true for the spatio-temporal context of the city of Delhi as well (Sharma, *et al.* 2020; Mahato, *et al.* 2020) and this has been a notable exception for the city (Kotnala, Mandal, Sharma, & Kotnala, 2020). Ozone (O_3) gas as a component of air presents a specific context to study. It is naturally present in the atmosphere as 'good Ozone' but when it is generated at the ground due to human activities, it is termed as 'bad Ozone' (Agency, 2021) and is, then, termed as a criteria pollutant (Nathanson, n.d.). Hence, it is also termed as a secondary pollutant (Agency, 2021). The current attempt is extended to examine the relationship between Nitrogen Dioxide (NO_2) as an O_3 causative factor for the urban center. The nature of O_3 as a secondary pollutant is very different in generation and concentration owing to its nature (Kotchenruther, *et al.* 2001). The derivation of O_3 as a pollutant takes place in the presence of other pollutants when they react with sunlight to produce 'bad Ozone'(Agency, 2021). O_3 is, therefore, termed as both, a saviour and a killer (Kotchenruther, *et al.* 2001) and these chemical compounds are called O_3 precursors (Agency, 2021).

The budget of tropospheric O_3 is dependent on O_3 precursors (Sharma, Sharna, Rohtash, & Mandal, 2016). Further, the sensitivity of O_3 regimes is location specific (Walaszek, *et al.* 2017). Air pollutants are observed in two categories- primary and secondary (OECD, 2021). Ozone gas comes under the category of secondary pollutants as it is formed when oxides of nitrogen (NOx) and volatile organic compounds (VOCs), which are mainly generated from vehicles and industries, chemically react in the presence of sunlight (Agency, 2021). Thus, anthropogenic pollutants have a major role to play in affecting the tropospheric budget and disturbing it (Honrath, *et al.* 1996). O_3 is formed in situ by chemical reactions and is present mostly in the lower and middle troposphere. The precursors of O_3 include chemicals such as Nitrous Oxide- including Nitric Oxide gas and Nitrogen Dioxide gas (NO_2), Methane, Carbon Monoxide, Non-Methane Volatile Organic Compounds, Volatile Organic Compounds and others (Agency, 2021). Ground level O_3 formed in such a manner is a harmful pollutant (Kotchenruther, *et al.* 2001; Agency, 2021). It reaches extreme levels in urban areas particularly during summers in the presence of sunlight from the harmful chemicals generated by industries and automobiles (Agency,2021). Strategies are required to control O_3 precursors (Xue, et al., 2013). The process of formation of O_3 at the ground level is also similar in nature with the difference being that here NO_2 provides the main source of O_3 formation as its prime precursor (John, *et al.,*1998). It is also observed that a decline in NO_2 as an Ozone precursor can, in fact, increase the levels of Ozone in the troposphere (Orlando, *et al.* 2010). Even short lived O_3 precursors can generate significant impacts on the creation of O_3 gas (Derwent, *et al.* 2001). In the current study, an examination is attempted for the periods of lockdown of 2020 as the base time period to study O_3 and NO_2 correlation and the same is repeated for 2019 and then for 2021 as well; in which 2021 has also experienced lockdown for almost the same period due to COVID-19 resurgence (Bureau, 2021). The findings will give a useful indication as to whether continuation or stoppage of human activities have a role in determining the trend of Ozone gas in the geographical space of the city.

MATERIALS AND METHODS

The study focuses on the city of Delhi, the national capital. Delhi is located between 28 degrees 23' 17" North – 28 degrees 53' 00" North latitude and 76 degrees 50'24" East – 77 degrees 20'37" longitude in the interior of north India at an elevation of about 231-305 meter (Mallick, Kant, & Bharat, 2008). The landscape of the city is marked by River Yamuna in the east, rocky Aravalli hill Range in the south and south west, and a plain in the middle of the region (Sundaram, Vernon, & Rao, 2022). It is rich in biodiversity, experiences different climatic seasons ranging from hot and dry from mid- March to the end June with the rainy season replacing it from July to September. A change in season from post rainfall from October-November to winters in December-February months follows then (Sundaram, Vernon, & Rao, 2022). The city has an area of 1,484 sq.km. with a rapidly growing population at approximately 31 million. The population density is 29,259 people, which is amongst the highest in the world (Review, 2022). The National Capital Territory (NCT) of Delhi is at the core of the Delhi Metropolitan Region and the National Capital Region (Board, 2017). High density urban area dominates land use of the city (Roy, Singh, &

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Kumar, 2011) which is growing rapidly (Dutta, Rahman, Paul, & Kundu, 2019). Besides being the national capital (Sundaram, Vernon, & Rao, 2022), it is also amongst the most polluted cities in the world and is cited as the world's most polluted capital city (Thiagarajan, 2022). The current study tries to observe the behavior of O_3 vis a vis its significant precursor of Nitrogen Dioxide (NO_2) gas. In the COVID-19 Lockdown periods O_3 concentrations have also been observed to have increased as an outcome of decline in NO_2 levels owing to restricted human activities. This was observed for Chinese cities of Beijing, Shanghai, Guangzhou, and Lanzhou (Xue, *et al.*, 2013; Zhao, *et al.*, 2020; Wang *et al.* 2017), Southern European cities (Nice, Rome, Valencia and Turin), in Wuhan and around 800 stations of China (Shi & Brasseur, 2020), Rio de Janiero, Brazil (Sicard, *et al.,* 2020; Siciliano, Dantas, Silva, & Arbilla, 2020), Baghdad city (Hashim, Naseri, Maliki, & Ansari, 2021), city of Hyderabad (Allu, Reddy, Srinivasan, Maddala, & Anupoju, 2021), a mixed trend for the city of Chennai (Singh & Tyagi, 2021) and a declining trend for Mumbai (Bedi, Dhaka, Vijay, Aulakh, & Gill, 2020). The relationship of O_3 gas via NO_2 gas is examined here through the Karl Pearson's Coefficient of Correlation. Data has been generated from the Central Pollution Control Board, Government of India website- https://app.cpcbccr.com/. The database provided by the website deals with multiple parameters related to air quality monitoring through recording of values at the air quality monitoring stations across the country. Ground level data for O_3 for the for all these time periods taken for analysis here is from the website (CPCB, 2021). The Karl Pearson's correlation coefficient method, is a quantitative method which provides numerical value to establish the intensity of linear relationship between variables. Such a coefficient correlation is represented as 'r'. It is categorised in the value range of -1 to +1. Value of -1 signifies strong negative correlation while +1 indicates strong positive correlation (Warner, 2013).

RESULTS AND DISCUSSIONS

On this basis the respective yearly data is analysed using the following time line of study
a. **Pre-lockdown period-** 1 Jan -24 March for 2019, 2020 and 2021.
b. **Lockdown period of 2020**- From 25 March' 20- 31 May'20. The Nationwide Lockdown period for 2020 was as under (Correspondent, 2021):
- Phase 1: 25 March' 20 – 14 April' 20 (21 days)
- Phase 2: 15 April' 20 – 3 May' 20 (19 days)
- Phase 3: 4 May' 20 – 17 May' 20 (14 days)
- Phase 4: 18 May' 20 – 31 May' 20 (14 days)

The same time period is considered for 2019 and 2021 for comparative study. The purpose of this selection is to minimise the observation of other effects assuming 'other things being equal' and bring out how human activity, through its absence and presence, is generating variations in the level of the pollutant and in what manner, if any. Following were the observations on correlation between O_3 and NO_2 as its precursor. Table I provides data analysed for 14 air quality monitoring stations of CPCB for which pollution data was available for both the parameters simultaneously. It is clearly observable here that for the selected time periods, there does not exist any specific relationship between NO_2 as an O_3 precursor. A negative correlation is dominantly observed between the two gases at all stations during the lockdown period; with the exception of Jahangirpuri station. However, this is not a trend affected by lockdown itself as in 2019 and 2021, a similar trend is observed. There is no clear indication of the fact that NO_2 is causing an increase in O_3 and vice versa. Secondly, at few stations a positive relationship whenever observed, is a weak positive one with only a few exceptions.

CONCLUSIONS

It can be clearly mentioned that no direct trend of correlation is observed for the city as a whole for NO_2 as being an O_3 causative factor. This holds true for all time periods of the study. It can also be forwarded that O_3 gas does not exhibit any relation with the presence or absence of human activities in the region. This highlights the complexity of

the nature of the pollutant as operating for the city. Probably some other set of factors and/or precursors are operating in determining O_3 concentration in the city.

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Table 1. Correlation between O_3 and NO_2 through Ground Data Record from Delhi-CPCB air pollution monitoring stations (Pearson's r)

S. No.	Pollution Monitoring Station/Years	Time Period (Co – relation coefficient Values)						
		1Jan.-24Mar.	25 Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1 Sep.	2Sep.-31Dec.
1.	Station-ASHOK VIHAR							
	2019	-0.06	0.13	-0.47	-0.15	0.32	0.15	-0.14
	2020	-0.14	-0.60	-0.21	0.05	-0.01	0.17	-0.01

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		2021	0.32	0.27	-0.15	-0.22	0.71	0.39	-
2.	Station-BAWANA	1Jan.-24Mar.	25 Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.04	-0.26	-0.18	-0.57	-0.005	-0.17	0.22
		2020	-0.09	0.48	-0.49	-0.13	-0.03	0.47	0.19
		2021	0.32	0.15	0.29	-0.25	0.25	0.31	-
3.	Station-DTU	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17 May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.05	-0.29	-0.07	-0.17	-0.11	-0.00	-0.37
		2020	-0.04	0.47	-0.87	-0.70	-0.00	0.19	-0.08
		2021	-0.06	0.03	-0.03	-0.57	-0.41	-0.12	-
4.	Station-DWARKA SEC8	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17 May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.25	-0.31	-0.32	-0.42	-0.30	0.41	-0.10
		2020	-0.37	-0.18	-0.67	-0.44	-0.18	0.07	-0.02
		2021	0.47	0.02	-0.14	-0.12	0.42	-0.01	-
5.	Station-ITO	1Jan.-24Mar.	25Mar.-14 Apr.	15Apr.-3May	4May-17 May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.37	0.39	0.40	-0.04	0.04	0.10	-0.32
		2020	0.19	-0.76	0.16	-0.81	0.44	0.18	-0.06
		2021	0.38	-0.60	0.31	-0.11	-0.71	0.07	-
6.	Station-JHANGIRPURI	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17 May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	0.26	0.32	0.22	0.24	0.49	0.10	0.36
		2020	0.03	-0.36	-0.39	-0.47	-0.34	-0.54	0.46
		2021	0.08	0.12	0.05	-0.30	0.34	0.18	-
7.	Station-DKSSR	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	0.15	0.58	-0.18	-0.31	0.13	0.25	0.10
		2020	-0.25	0.41	-0.48	-0.47	-0.26	-0.54	0.45
		2021	-0.13	-0.60	-0.25	-0.10	0.69	0.37	-
8.	Station-JLNS	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.12	-0.09	0.59	0.23	0.49	0.28	0.16
		2020	-0.29	0.36	-0.62	-0.37	0.07	0.11	-0.20
		2021	0.16	0.15	-0.10	0.08	0.06	0.31	-
9.	Station-PATPARGANJ	1Jan.-24Mar.	25Mar.-14Apr	15Apr.-3May	4May-17May	18 May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	0.11	0.16	0.21	-0.49	-0.11	0.46	-0.29
		2020	-0.28	0.16	-0.68	-0.79	-0.91	-0.12	-0.65
		2021	-0.34	-0.12	-0.09	0.23	0.24	0.15	-
10.	Station-ROHINI	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
		2019	-0.08	0.03	0.03	-0.64	0.05	0.32	0.17
		2020	0.14	-0.17	-0.32	-0.14	0.70	0.01	0.57
		2021	0.14	0.15	0.08	0.07	0.31	0.02	-
11.	Station-SHADIPUR	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.

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	2019	-0.24	0.63	-0.15	-0.53	0.45	0.55	0.40
	2020	-0.32	0.22	0.00	-0.38	-0.31	-0.25	-0.02
	2021	0.12	0.44	-0.26	-0.43	0.10	-0.06	-
12.	Station- SRI AUROBINDO MARG	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
	2019	-0.02	-0.45	-0.40	-0.55	-0.36	0.05	-0.11
	2020	-0.30	0.23	-0.65	0.24	0.30	0.26	0.18
	2021	-0.16	-0.64	-0.08	-0.46	-0.40	0.04	-
13.	Station- VIVEK VIHAR	1Jan.-24Mar.	25Mar.-14Apr.	15Apr.-3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
	2019	0.00	-0.13	0.34	-0.34	0.59	0.52	0.30
	2020	0.00	-0.27	-0.69	-0.50	-0.75	0.15	-0.38
	2021	0.19	0.17	-0.63	0.05	0.17	0.25	-
14.	Station- WAZIRPUR	1Jan.-24Mar.	25Mar.-14Apr.	15Apr. -3May	4May-17May	18May-31May	1Jun.-1Sep.	2Sep.-31Dec.
	2019	-0.08	0.49	0.31	-0.41	0.10	0.52	0.18
	2020	0.23	-0.42	0.18	-0.08	0.65	0.12	0.45
	2021	0.00	-0.00	-0.22	0.28	0.52	0.06	-

DKSSR- Dr. Karni Singh Shooting Range Station,   **JLNS-** Jawahar Lal Nehru Stadium Station, **DTU-** Delhi Technological University

Source- Data from www.app.cpcbccr.com; computations by Author, 2021
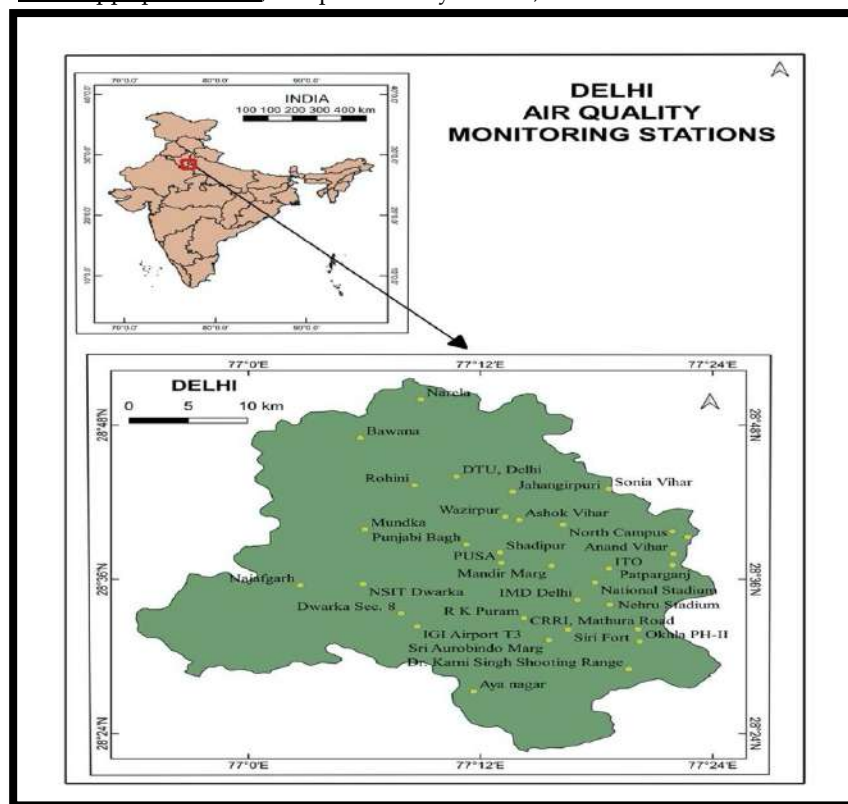
Fig. 1. Description of Study Area
Source- Author, 2021

RESEARCH ARTICLE

Integrated Contourlet Tetra Pattern and Improved Schmidt Decomposition based Pattern Mining from SRSI

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ABSTRACT

Mining of the Spatial Sequential Patterns (SSPs) from the collection of Serial Remote Sensing Images (SRSI) plays a significant role in the field of agricultural development, urbanization, climatic changes, etc. Conventional sequential pattern mining algorithms suffer from time consumption and computational complexity due to the need for scanning the large databases multiple times. To mitigate the drawbacks, hybridization of the Contourlet Tetra pattern and Improved Schmidt Decomposition based Run Length Coding (SD-RLC) for pixel grouping is proposed to enhance the mining efficiency of the SSPs from raster SRSI. The Contourlet Tetra pattern is used for enabling quad-tree based decomposition of the lower and higher-pass channels. The Contourlet Transform (CT) is applied for directional finding and effective representation of the images into multiple directional bands with ultimate precise directional data in comparison with the spatial directives. The images are compressed by using the improved SD-RLC that provides an elegant form for the entanglement of vectors. From the experimental analysis, it is observed that the proposed SD-RLC method could efficiently extract spatial sequential patterns from the SRSI, without requiring more computational time and cost. The performance of the proposed work is experimentally evaluated using Cropland data layer dataset. The proposed method requires less mining time and generates appropriate patterns with support values greater than the threshold values.

Keywords: Contourlet Tetra Pattern, Run Length Coding, Schmidt Decomposition, Spatial Sequential Pattern (SSP) Mining, Raster SRSI

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INTRODUCTION

Continuous accumulation of the geospatial data paves a way for the effective observation of the Earth Surface. Among the geospatial data, the SRSI provides better potential to enable tracking of the environmental changes, urban expansion, vegetation expansion, agricultural development [1]. Various researches regarding the mining of knowledge from the SRSI are conducted over the past .SSPs are the meaningful types of knowledge extracted from the SRSI [2]. Sequential Pattern Mining (SPM) being the methodical base of the Spatial SPM (SSPM) aims in the extraction of the frequent patterns from the transaction databases. Unlike the existing SSPM, SPM tries discover the spatio-temporal frequent patterns from the geospatial databases. However, high structural complexity and huge volume of the geospatial data prevent the application of the SPM algorithms in the effective mining of the SSPs [3]. In the previous work, Quantized Tetra pattern (QTrP) and Singular Value Decomposition (SVD) applied for efficient mining of the sequences in the SRSI images [4]. Overall time required for the mining of the sequences from the input image is reduced by considering the non-repeated pixels alone using the QTrP. Previously, Singular Value Decomposition (SVD) is used for encoding the pixels to reduce the computational complexity. In this work, pixel-grouping based method is applied to extract the SSPs from the SRSI. SRSI is a group of remote sensing images that aim for the similar area within different periods. SRSI reflects the frequently and periodically occurring events that are the potential sequential patterns.

In SRSI, these frequently occurring patterns are related to the pixels and denoted by their colors or attributes. Each pixel in the SRSI image represents certain acreage of the land. The computational overhead can be reduced by grouping the pixels sharing the same changing patterns. Then, mining can be performed on the basis of the pixel groups. Initially, RLC is applied for encoding the pixels of the SRSI and the pixels are grouped together for compressing the raw SRSI dataset. Based on the RLC representation, the pixels sharing the same changing patterns are grouped and the images of the SRSI are made to intersect together at the line level. Then, the SRSI is combined into a single file containing information about the pixel groups. Then, the same pixel groups are combined together for data compression. An algorithm for mining malicious SPs is formulated by constructing an All Nearest Neighbor (ANN) classifier. PrefixSpan-X algorithm is introduced for solving the time and space constraints in the PrefixSpan algorithm [5]. An e-cosmos miner framework is proposed for the mining, generation and visualization of the sequential patterns that are hidden within the multimodal streaming data. This enabled selection of different SPs that appear in the translation process and track the occurrences of the patterns within a special simulator [6]. The patterns are ranked using the support statistic. However, the SPM focuses only on the mining of the frequent patterns, transactional or text-oriented data, and avoids the location and inner spatial relationships of the events. It also suffers from the generation of huge number of interesting patterns. These could be dealt by the SSPM [7].   Trajectory mining and spatial event mining are the two classic applications for SSPM. For trajectory mining, the SSPM extracts the movement patterns from the massive constant trajectory data [8]. A Location-Time-Item (LIT) PrefixSpan mining algorithm is developed for the discovery of frequent LIT spatial patterns for the visitors in the theme park.

A route suggestion procedure retrieved the suitable patterns for the visitors. This helped the managers to understand the behavior of the visitors so as to provide better visiting experience to them. The Modified Extrema Pattern is applied to offering grey scale invariant transformation pixel intensity values in comparison to the earlier applied local ternary pattern[14]. Preethi and Anandharaj proposed a Quantized Ternary Pattern (QTP) based pixel grouping and SVD-RLC based pattern mining. The overall time consumed for mining the patterns is reduced significantly by considering only the non-repeated pixels using the QTP. This is achieved by preventing the need for encoding the repeating pixels. Most of the energy content of the matrix is localized into a fewer number of singular values due to the combination of the RLC along with SVD. This also reduced the overall operation time[4]. To overcome this limitation, this work proposes the combination of the Contourlet Ternary pattern and Improved Schmidt Decomposition RLC for pixel grouping to improve the mining efficiency of the SSPs from raster SRSI. Also, the local ternary pattern captures only the local information, but the contourlet ternary pattern captures both the native and global information, making it ideal for image classification.

MATERIALS AND METHODS

Contourlet Tetra Pattern

Local Tetra Pattern (LTrP) is highly effective in capturing only the native features contained in the image. But, LTrP is extremely vulnerable to the external aspects including noise and illumination settings. To mitigate this limitation, CT is applied for deriving the directions for the LTrP. The CT is less vulnerable to the external aspects, owing to its dependency on the transform domain instead of the spatial domain. Also, it effectively captures the most dominant visual features such as edges and curves in the image. The advantages of the local ContourletTetra (LCTrP) pattern over the LTrP [9] are shown in Table 1. Figure 1 shows the operational flow diagram of the proposed SD-RLC method. CT uses the Laplacian Pyramid (LP) and Directional Filter Bank (DFB) for the multiple-scale image decomposition and multi-directional image decomposition. With the application of Laplacian Pyramid (LP), input image is decomposed into different scales and DFB captures the directional information at each scale. Let 'I_i' represent the input remote sensing image, BP_j be the band-pass region of the LP decomposition at various scales (where j=1, 2,…,M which is the total value of scales) and L_M indicates the low-pass region at the Mth decomposition phase. $\mathcal{D}I_j(S) = DFB(BP_j)$, where 'S' is the direction S=0, 1, …, N-1 (where N denotes the total directions regarded per scale). With the independent selection of both direction and scale of the Discrete CT (DCT), the required directions could be selected in the contourlet domain. In this work, four directions (N=4) are selected. Figure 2 shows the directional partitioning for four directions. Four directions are selected as the LTrP uses four directions to derive the local pattern. Different number of contourlet directions could be used, but a novel algorithm is required for local pattern formation. Despite of changing the number of directions, the scales are changed in this work to include more directionality. LTrP uses the primary-order gradient in the X and Y directions for the directional representation above both the horizontal and vertical directions. It is described as

$$L_H(I_C) = L(I_H) - L(I_C) \tag{1}$$
$$L_V(I_C) = L(I_V) - L(I_C) \tag{2}$$

Here, I_C indicates center pixel, I_H denotes pixel located in right side to I_C (along horizontal direction) I_V represents pixel located above I_C (along vertical direction).

The direction numbers of I_C for the LTrP are obtained as

$$L_{Dir}(I_C) = \begin{cases} 1, L_H(I_C) \geq 0 \ and \ L_V(I_C) \geq 0 \\ 2, L_H(I_C) < 0 \ and \ L_V(I_C) \geq 0 \\ 3, L_H(I_C) < 0 \ and \ L_V(I_C) < 0 \\ 4, L_H(I_C) \geq 0 \ and \ L_V(I_C) < 0 \end{cases} \tag{3}$$

The four probable directions of the CT at each scale is represented as $DI_i(0), DI_i(1), DI_i(2) \ and \ DI_i(3)$. The number of directions of I_C for the LCTrP is formulated as

$$L^{\,j}_{Dir}(I_C) = \begin{cases} 1, |DI_i(0)| \geq |DI_i(1)| \ and \ |DI_i(0)| \geq |DI_i(2)| \ and \ |DI_i(0)| \geq |DI_i(3)| \\ 2, |DI_i(1)| > |DI_i(0)| \ and \ |DI_i(1)| \geq |DI_i(2)| \ and \ |DI_i(1)| \geq |DI_i(3)| \\ 3, |DI_i(2)| > |DI_i(1)| \ and \ |DI_i(2)| \geq |DI_i(3)| \ and \ |DI_i(2)| > |DI_i(0)| \\ 4, |DI_i(3)| > |DI_i(1)| \ and \ |DI_i(3)| > |DI_i(2)| \ and \ |DI_i(3)| > |DI_i(0)| \end{cases} \tag{4}$$

Where $|X|$ represents the absolute value of X and 'j' indicates the scales. As shown in the above equation, there are four possible directions for I_C. The image is ultimately converted into four directions. The LCTrP for I_C with eight-point neighbor is described as

$$LCTP^j(I_C) = \begin{cases} G\left(L^{\,j}_{Dir}(I_C), L^{\,j}_{Dir}(I_1)\right) \\ \cdots\cdots\cdots \\ G\left(L^{\,j}_{Dir}(I_C), L^{\,j}_{Dir}(I_8)\right) \end{cases} \tag{5}$$

$$G\left(L^{\,j}_{Dir}(I_C), L^{\,j}_{Dir}(I_P)\right) = \begin{cases} 0, L^{\,j}_{Dir}(I_C) == L^{\,j}_{Dir}(I_P) \\ L^{\,j}_{Dir}(I_P), Otherwise \end{cases} \tag{6}$$

Using the above equations, the input image is converted into 8-bit Tetra Pattern (TrP) image. The TrP is represented into a binary pattern as follows:

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a) The Tetra patterns are converted into four patterns for I_C, based on the direction number as given below.

i. $LCTP^j(I_C)\big|j_{L\ j_{Dir}(I_C)=1}$

ii. $LCTP^j(I_C)\big|j_{L\ j_{Dir}(I_C)=2}$

iii. $LCTP^j(I_C)\big|j_{L\ j_{Dir}(I_C)=3}$

iv. $LCTP^j(I_C)\big|j_{L\ j_{Dir}(I_C)=4}$

b) Each part is converted into three different binary patterns based on the number of directions I_C. If there is single direction, the LCTrP generated by separating into three different binary patterns as follows:

$$LCTP^j(I_C)\big|_{D_R} = \sum_{\mathcal{P}}^8 2^{\mathcal{P}-1} \times \mathcal{H}\big[LCTP^j(I_C)\big]\big|_{D_R} \qquad (7)$$

$$\mathcal{H}\big[LCTP^j(I_C)\big] = \begin{cases} 1, if\ LCTP^j(I_C) = Direction \\ 0, \qquad\qquad\qquad Otherwise \end{cases} \qquad (8)$$

Three different binary patterns are formed for each TrP. Thus, totally 12 binary patterns generated four directions. For the local patterns with eight-point neighbors, there will be $2^8 = 256$ bins. Ojala proposed uniform patterns to reduce the feature dimension. Same approach is utilized for the ContourletTetra Pattern (CTrP), for the effective reduction of the size of the bins[10]. After the LCTrPs are formed, extraction of the feature vectors is performed through histogram generation. Let $LCTP(\mathcal{X},\mathcal{Y})$ be the LCTrP of size $N \times M$, the histogram is computed as

$$L_{Hist}(S) = \sum_{j=0}^{N-1} \sum_{k=0}^{M-1} \emptyset(LCTP(j,k) - S) \qquad (9)$$

Where $\emptyset$ is the Dirac delta function defined as

$$\emptyset(S) = \begin{cases} 1; \mathcal{X} = 0 \\ 0; \mathcal{X} \neq 0 \end{cases} \qquad (10)$$

The Tetra pattern is derived using this direction. The query image $\mathcal{Q}_I$ is applied as input and CTrPs extracted from image. Accurate matching of features is found out by using chi-square distance. It is given as

$$\chi_i^2(R,T) = \sum_{b=1}^B \frac{(R_b - T_{ib})^2}{R_b + T_{ib}} \qquad (11)$$

Where 'R' denotes the CTrP feature of the $\mathcal{Q}_I$ and T_i represents the feature of the ith image contained in the database. The best matched images are retrieved from the database.

Algorithm 1: ContourletTetra Pattern
Input: $\mathcal{Q}_I$
Output: Image retrieval from database based on best matching
Step 1: Load the $\mathcal{Q}_I$
Step 2: Convert $\mathcal{Q}_I$ into gray scale if required
Step 3: Apply CT to $\mathcal{Q}_I$
Step 4: Compute the directions using the contourlet directional bands
Step 5: Form the TrP
Step 6: Evaluate the histograms of binary patterns
Step 7: Generate the feature vector
Step 8: Compare $\mathcal{Q}_I$ with the images in the database
Step 9: Retrieve the best matched images from database

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Schmidt Decomposition based Run Length Coding

The quantum state describes a two-particle system as follows

$$|\varphi\rangle = \sum_{j}^{\mathcal{S}_\mathcal{A}} \sum_{k}^{\mathcal{S}_\mathcal{B}} a_{jk}|j\rangle_\mathcal{A}|k\rangle_\mathcal{B} \tag{12}$$

Where $\mathcal{S}_\mathcal{A}$ and $\mathcal{S}_\mathcal{B}$ denote the Hilbert space dimensions of the subsystems '$\mathcal{A}$' and '$\mathcal{B}$' respectively. Then, the following Schmidt Decomposition [11] is valid for the orthonormal bases of the subsystem spaces.

$$|\varphi\rangle = \sum_{k=1}^{\mathcal{R}} \sqrt{\eta_k}|\varphi_k^\mathcal{A}\rangle |\varphi_k^\mathcal{B}\rangle \tag{13}$$

Where $\mathcal{R} \leq min(\mathcal{S}_\mathcal{A}, \mathcal{S}_\mathcal{B})$, η_k denote the non-negative numbers that are the Schmidt's coefficients (also known decomposition weights) that satisfy the normalization condition of the total probability $\sum_k \eta_k = 1$. $|\varphi_k^\mathcal{A}\rangle$ and $|\varphi_k^\mathcal{B}\rangle$ are the Schmidt modes of the respective subsystems. The Schmidt coefficient enables the estimation of the effective number of modes in a decomposition by computing the Schmidt number.

$$\mathcal{K} = \frac{1}{\sum_k \eta_k^2} \tag{14}$$

It describes the degree of the non-randomness of the matches. Higher the $\mathcal{K}$ value, least is the probability of the random match. At the minimum value $\mathcal{K} = 1$ there is an apriori coincidence that marks the absence of the correlation.Improved SD based run length encoding is applied for compressing the image. SD is the specific way of stating a tensor product of two inner product spaces. RLC is the simplest compression technique that achieves best result for the images with large regions of adjacent color, especially single color images.For example, the string AAAABBBCCCCDDD is represented as 4A3B4C3D and each character & length is compressed as a unit. This technique yields better result for the repeated characters. Each color image comprises three primary colors (R, G, B). The RLC algorithm represents the image consisting of 'N' pixels as shown in Table 2. The difference between the adjacent pixels for each color is computed, if the difference between the red pixels R_1 and R_2 smaller than or equivalent to the threshold value, if the difference between the green pixels G_1 and G_2 is smaller than or equal to the threshold value and if the difference between the blue pixels B_1 and B_2 smaller than or equivalent to the threshold value. 1 is added to C_1, if the difference is greater than 10. This process is performed between the next adjacent pixels until the last pixel in the image is reached.

Algorithm 2: Schmidt Decomposition

Input: BMP image
Output: Decomposed image
Step 1: Read the BMP image
Step 2: Obtain the height 'H' and width 'W' of the BMP image
Step 3: Create an array with height and width of image, such that there are three fields for R, G and B colors in each element of this array
Step 4: Convert the BMP image into the main array
Step 5: Let Main (0,0) be the first element in an array and threshold 'T' be 10
Step 6: For I=0 to H-1
Step 7: For J=0 to W-1
Step 8: If $X - Main(H, W) \leq T$, then Let C=C+1
Else
Let $X = Main(H, W)$ and $C = 0$
Step 9: End

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RLC-based pixel grouping method

RLC is a line-based encoding scheme that is highly optimum for compressing the SRSI from the time of existence of the pixel group. Multiple pixels have same values in a line of SRSI. After encoding using the RLC method, each SRSI image is converted into a dataset. The image is encoded by a line that comprises a series of items. The 'k' SRSI images are merged into a single file containing k-sequence items. The neighboring pixels located in the same line are only grouped together into a single pixel group. The items are merged with the similar sequence in neighboring lines, different lines are grouped into the similar pixel group. But, it is observed that the non-neighboring pixels could have same sequence. All the pixels of the 'k' images are grouped to preserve the information regarding the sequence and occurrence frequency of the sequence in the SRSI. Hence, huge data volume of the SRSI images is reduced significantly [12].

RESULTS AND DISCUSSION

The proposed method is evaluated using the Cropland data layer dataset ((NASS), [13]). The dataset comprises geo-spatial raster images covering the continental area of the Iowa State in United States. The raster images are captured by a satellite with moderate resolution. Entire image covers up to one lakh fifty thousand square kilometers and each pixel in the image covers about nine hundred square meters. Different colors used to identify the crops cultivated in the region. Four datasets represented as D1-D4 are segregated in accordance with the time period of capturing the image. Figure 3 shows the input image and ContourletTetra – Schmidt decomposed image test datasets D1-D4. Table 3 shows the comparative analysis of the mining time required for the existing algorithms namely, Prefix Span (PS), Group Prefix Span (GPS), SVD-GPS, GFS pattern, Group prefix scan-AC and proposed SD-RLC algorithm based on the threshold value [4]. Figure 4 presents the evaluation of mining time the four test datasets D1-D4. Figure 5 depicts the comparison of the mining time on the four test datasets D1-D4. Figure 6 present the support values of the SP mining methods for each pattern. The PS algorithm required high mining time due to the incapability for the vertical projection of the database, as it skipped more number of rows through scanning. Thus, PS algorithm failed to generate the sequential patterns with required support values. When compared to the PS and GPS algorithms, the SVD-GPS algorithm generated support values that are greater than the predetermined threshold value. The proposed method is highly efficient, as it compresses a set of the SRSI images by integration of CTrP and SD even for the huge datasets. The sequential patterns are generated without consuming more time. With the compression-based classification, there is a significant reduction in the computational overhead arise during processing of the SRSI images.

CONCLUSION

The experimental analysis demonstrates that the proposed SD-RLC method is highly efficient, due to the effective compression of the SRSI images by using the combination of the CTrP, Schmidt Decomposition and Pixels Group concept. All the pixels of the 'k' images are grouped into the pixels group that maintains the information about sequence and occurrence frequency of the sequence in the SRSI. Hence, the volume of the SRSI images is reduced effectively. The performance of proposed work using Cropland data layer dataset and also requires less mining time and generates appropriate patterns with support values greater than the threshold values. Thus, all sequential patterns can be generated within a reasonable time. Also, the computational overhead needed for processing the SRSI images can be reduced effectively using compression-based classification. As the image discontinuities are effectively captured by the Contourlet transform, directional information are provided more precisely than the spatial derivatives. With the Contourlet directions, the visual features in the image could easily capture the macro and micro variations. Also, the CT could efficiently capture the curves and edges in the image, this will facilitate in the improvement of the feature performance. The CTrP are sensitive to noise present in the uniform regions because it uses a fixed threshold value that is based on the value of center pixel. However, it did not work well for the non-linear data. Also, they are variable under the grey-scale transform of intensity values as the LTrPs are encoded based

on a fixed predefined thresholding. In future, Modified Extrema Pattern will be used for the effective mining of SSP from raster SRSI.

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Table1: Drawbacks of LTrP and Advantages of LCTrP

Drawback of LTrP	Advantages of LCTrP
Derives the directions using the gradients in the spatial domain.	Derives the contourlet directions
Fail to capture the smoothness over the edges or contours of the image.	Effectively captures the smoothness over the edges or contours
Less directional information	More directional information
Captures only the local information	Captures both the local and global information
Not ideal for image classification	More ideal for image classification
Feature representation at single level	Better feature representation at multiple level

Table 2: Pixel distribution in image

Red pixel 'R'	Green pixel 'G'	Blue pixel 'B'	Number of pixels 'C'
R_1	G_1	B_1	C_1
R_2	G_2	B_2	C_2
--	--	--	--
--	--	--	--
R_N	G_N	B_N	C_N

Table 3: Details of Dataset

ID of the dataset	Region	Count of pixel	Duration (time)	Data volume
D1 Dataset	Smaller portion of butler country	21* 132	From 2010 to 2016	1.7 MB
D2 Dataset	Regions of butler country	1323*1348	From 2010 to 2016	20 MB
D3 Dataset	Region of ASD 1910	5971*3534	From 2010 to 2016	141 MB
D4 Dataset	Region of IOWA state	17,795*11,671	From 2010 to 2016	594 MB
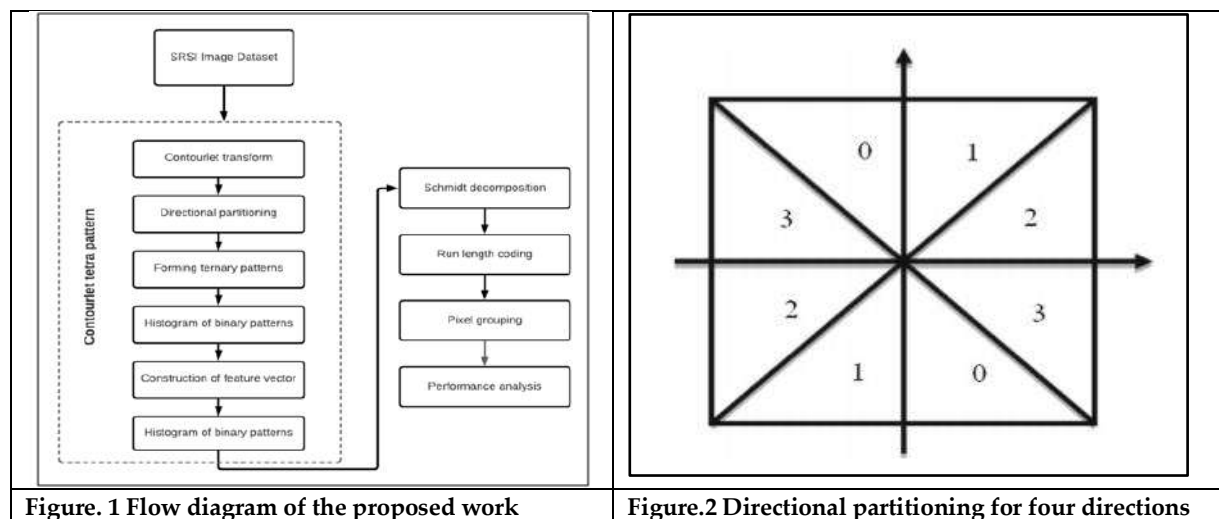
Figure. 1 Flow diagram of the proposed work	Figure.2 Directional partitioning for four directions

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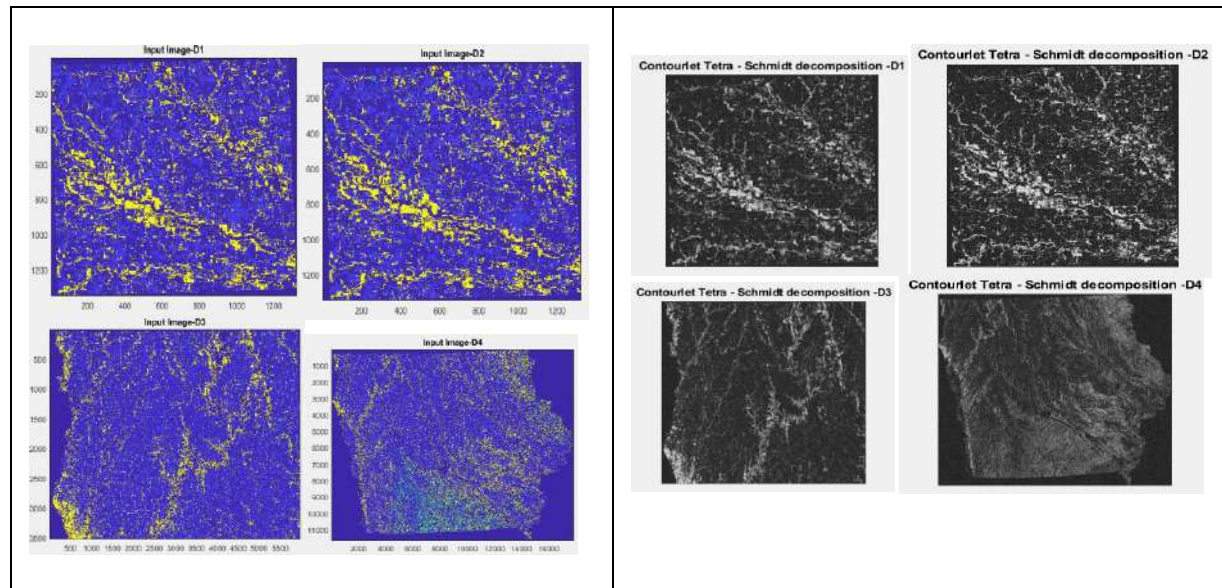
(a) Input Image of the datasetsD1-D4	(b) Contourlet Tetra based Schmidt decomposed images of four datasets

Figure 3 : (a) Input Image of the datasetsD1-D4 and (b) Schmidt Decomposed Image of the datasets D1-D4
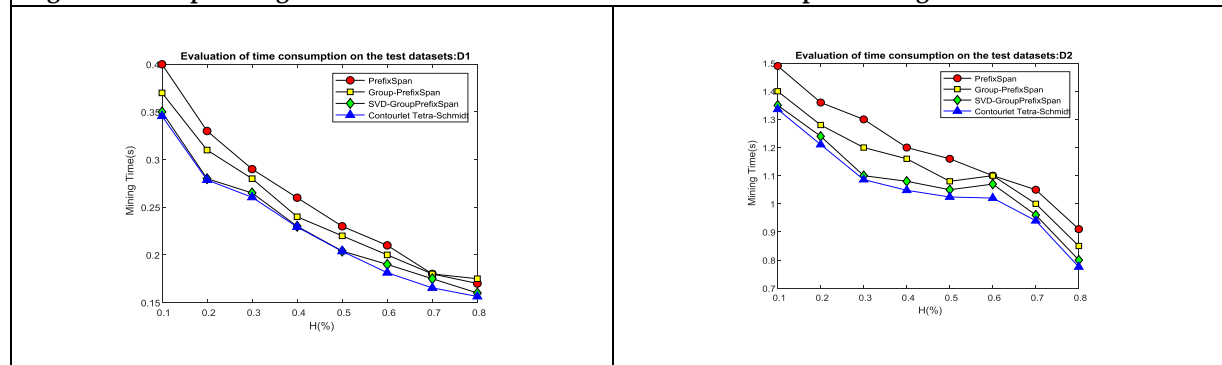
a)Assessment of mining time consumption of D1 (4.17% decreased)	b) Assessment of mining time consumption of D2 (10% decreased)
c)Assessment of mining time consumption of D3 (5.86% decreased)	d)Assessment of mining time consumption of D4 (16.92% decreased)
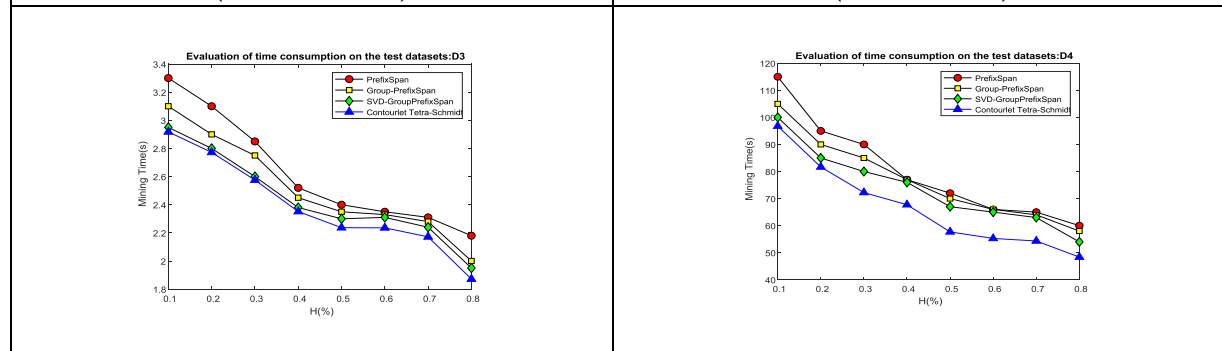
Figure.4: Comparative analysis of mining time consumption by proposed SD-RLC and existing PS, GPS and SVD-GPS algorithms

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(a). Comparison on mining time on the test dataset D1(54.55% decreased)

(b). Comparison on mining time on the test dataset D2 (40% decreased)

c) Comparison on mining time on the test dataset D3 (38.46% decreased)

d) Comparison on mining time on the test dataset D4 (36.36% decreased)
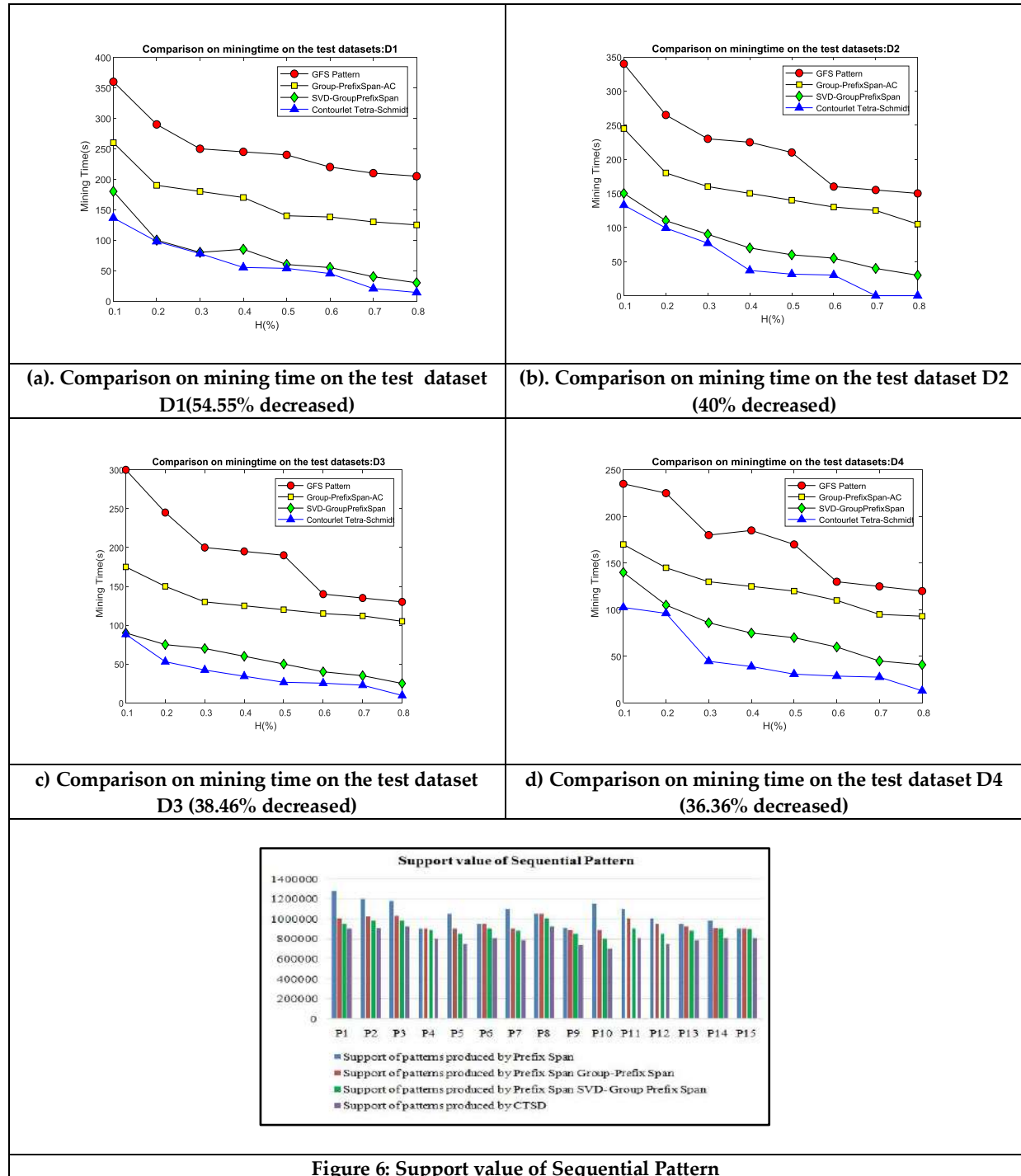
Figure 6: Support value of Sequential Pattern

RESEARCH ARTICLE

Bounds and Algorithm for the Domination number of Line Graph using Signless Laplacian Matrix

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ABSTRACT

If G is a connected simple undirected graph of vertices n. The smallest cardinality of a dominating set is the domination number. The Line graph is an edge to vertex dual graph $L(G)$ represents the adjacencies between the edges of G. In this paper we are discussing about the bounds for domination number of $L(G)$ using spectra of signless Laplacian Matrix $Q(L(G))$. We are also providing an algorithm for finding all the domination set associated with the line graph and the domination number of it, i.e. edge domination number of original graph using signless Laplacian Matrix $Q(L(G))$ and generating a generalized tool for it using Matlab.

Keywords: Complete Graph, bipartite Graph, regular Graph, Line graph, Signless Laplacian spectrum, Domination Number.

INTRODUCTION

In 1850's the problem for domination came from chess. The idea of domination was presented by chess master C.F.de Jaenisch in 1862 while concentrating on the issues of finding the minimum number of queens such that every square on the chess board either contains a queen or is attacked by a queen .The quickest development in investigation of domination set in graph theory started in 1960. The study of dominating sets in graphs was started by Ore and Berge [10] in 1962. Later the idea of domination set and domination number was utilized by Ore in 1962, domination number and the independence number were introduced by Cockayne and Hedetniemi [2]. A dominating set of G is a vertex subset S of G such that each vertex of $V(G)/S$ is adjacent to at least one vertex of S. The domination number of

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G, denoted by $\gamma(G)$, is the minimal cardinality of a dominating set of G. A dominating set S of G is said to be minimal if $|s| = \gamma(G)$. The concept of domination can be used in clustering and also in a cryptography, it plays an important role in power management. The concept of edge domination was introduced by Mitchell and Hedetniemi [11], a natural connection between the domination number and the edge domination number of a graph G becomes apparent when considering the line graph $L(G)$ of G. In this paper we are finding the bounds for the domination number of line graph on the basis of spectrum of signless Laplacian matrix of $L(G)$. The signless Laplacian matrix of a simple graph is defined as $Q(G) = D(G) + A(G)$, where D is a degree matrix and A is the adjacency matrix of a graph. We use the notation $Q(L(G))$ to represent the Signless Laplacian matrix of line graph $L(G)$ of G and $P_{Q(L(G))}(\lambda)$ for Characteristic polynomial of $Q(L(G))$ having roots $q_1 \leq q_2 \leq q_3 \leq \square \leq q_n$, known as eigen value or $Q-$ eigen values in this case. The largest eigen value q_n is Called the signless Laplacian spectral radius and the least $Q-$ eigen value is denoted by q_1.

The inequalities involving the domination number and Laplacian Eigen value of graphs given by given by J. Har [3]. Chang-Xiang He, Min Zhou present a sharp upper bound for the least signless Laplacian eigen value of a graph involving its domination number [5]. A Bounds of the signless Laplacian spectrum of a graph G involving the domination number by Huiqing Liu, Mie Lu [8]. The equality for signless Laplacian spectra, maximum degree, average degree is given by Rundan Xing, Bo Zhou [14]. Julien Baste *et.al.* proposed the conjecture that the domination number $\gamma(G)$ of a $k-$ regular graph G, with $k \geq 1$ is always at most its edge domination number $\gamma_e(G)$, which is the same as the domination number of its line graph [1]. We are also presenting an algorithm to find domination number using the signless Laplacian matrix . Ali Karci [6] computing the algorithms for solving NP-hard and NP-complete problems such as minimum dominating , he also used kmax tree and cut-sets matrix for computation of minimum dominating set. Jaishri B. veeragoudar *et.al.* [12] also present an algorithm domination number for a graph without isolated vertices or found the accurate domination number. A. J. Khan *et. al.* [7] proposed a adjacency matrix algorithm for finding a solution to the minimum dominating set and minimum dominating set problems for a graph. The algorithm proposed by Karci A. [6] used adjacency matrix while removing vertex one by one, according to the neighboring vertices until the minimum dominating set is found, keeping in mind all these algorithm we proposed a new algorithm with reduced time and space complexity with advantage that it gives us independent dominance set and dominance number, we focuses only on the line graph as they are claw free and so dominance number and independence dominance number are equal in that case.

Equalities For Signless Laplacian Spectral Radius, Maximum Degree And Average Degree For Line Graph
For the Line graph of a complete graph

Theorem 2.1. If q_n is the Signless Laplacian spectral radius of line graph of complete graph $L(K_n)$, $\Delta L(K_n)$ and

$\overline{d}L(K_n)$ is a maximum degree and average degree of $L(K_n)$, then the line graph of complete graph satisfies the equality, $2\overline{d}L(K_n) = q_n = 2\Delta L(K_n)$.   (2.1)

Proof. By the lemma 2.3 in [14], If G is a graph then $2\overline{d}(G) \leq q_n(G) \leq 2\Delta(G)$, Now the line graph of complete graph is a regular graph having a maximum degree $\Delta L(K_n)$ equals to $2n-4$ with the vertices and edges in

$L(K_n)$ equals to $\dfrac{n*(n-1)}{2}$ and $\dfrac{n(n-1)(n-2)}{2}$ respectively [9], where n is number of vertices in K_n. Now, the largest eigen value of q_n of $Q(L(K_n))$ is $4n-8$ with multiplicity one and the average degree $d(G) = \frac{2E(G)}{V(G)}$ of is $L(K_n)$ is $2n-4$. Thus for $L(K_n)$ we have the equality, $2\overline{d}L(K_n) = q_n L(K_n) = 2\Delta L(K_n)$.

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For the line graph of a regular complete bipartite graph
Theorem 2.2.

If q_n is the signless Laplacian spectral radius of line graph of regular complete bipartite graph $L(K_{m,m})$, $\Delta L(K_{m,m})$ and $d\overline{L}(K_{m,m})$ is a maximum degree and average degree of $L(K_{m,m})$, then the line graph of regular complete bipartite graph satisfies equality, $2\overline{d}L(K_{m,m}) = q_n \mathrm{L}(\mathrm{K}_{m,m}) = 2\Delta L(K_{m,m})$.　　　　　(2.2)

Proof. By the lemma 2.3 in [14], If G is a graph then $2\overline{d}(G) \le q_n(G) \le 2\Delta(G)$, Now the line graph of regular complete bipartite graph is a regular graph having a maximum degree $\Delta L(K_{m,m})$ equals to $2(m-1)$ with the vertices and edges in $L(K_{m,m})$ equals to m^2 and $m^2(m-1)$ respectively [13]. Now, the largest eigen value q_n of $Q(L(K_{m,m}))$ is $4(m-1)$ with multiplicity one and the average degree $\overline{d}(G) = \frac{2E(G)}{V(G)}$ of $L(K_{m,m})$ is $2(m-1)$. Thus for $L(K_{m,m})$ we have the equality, $2\overline{d}L(K_{m,m}) = q_n L(K_{m,m}) = 2\Delta L(K_{m,m})$.

For the line graph of a regular graph
Theorem 2.3.

If q_n is the signless Laplacian spectral radius of line graph of regular graph $L(G)$, $\Delta(G)$ and $\overline{d}(G)$ is a maximum degree and average degree of $L(G)$, then the line graph of regular graph satisfies the following equality,
$2\overline{dL}(G) = q_n L(\mathrm{G}) = 2\Delta L(\mathrm{G})$.　　　　　(2.3)

Proof. By the lemma 2.3 in [14], If G is a graph than $2\overline{d}(G) \le q_n(G) \le 2\Delta(G)$, Now the line graph of regular graph is a regular graph having a maximum degree $\Delta L(G)$ equals to $2k-2$ with the vertices and edges in $L(G)$ equals to $\frac{nk}{2}$ and $\frac{nk(k-1)}{2}$ respectively [4]. Now, the largest eigen value q_n of $Q(L(G))$ is $4(k-1)$ with multiplicity one and the average degree $\overline{d}(G) = \frac{2E(G)}{V(G)}$ of $L(G)$ is $2(k-1)$. thus for $L(K_{m,m})$ we have the equality, $2\overline{dL}(G) = q_n L(\mathrm{G}) = 2\Delta L(\mathrm{G})$.

Bounds For The Domination Number Using Signless Laplacian Spectra
Theorem 3.1.

If G is a connected regular graph of order $n \ge 2$, then for line graph $L(G)$ of G with the number of vertices $L(G) = e$, i.e. the number of edges of G having maximum degree of $\Delta L(G)$ with signless Laplacian spectral radius q_n $(L(G))$ we have, $q_n(L(G)) \ge 2\Delta L(G) - \frac{e}{\gamma L(G)}$

Proof. By the theorem (9) of reference [8], $q_n(G) \le 2\Delta - \frac{n}{\gamma(G)}$ where n is the number of vertices in G with dominance number $\gamma(G)$. Now for $L(K_n)$ as number of edegs e in K_n is $\frac{n(n-1)}{2}$ and also using theorem 2.1 with equation 2.1 we have q_n of $L(K_n) = 2\Delta L(K_n) = 4n-8$. Obviously we have $q_n(L(K_n)) > 2(2n-4) - \frac{n(n-1)}{2\gamma L(K_n)}$ thus the inequality hold for $L(K_n)$. The inequality hold for also line graph of a regular graph and $G \cong L(K_{m,m})$.

We observe the contradiction of [6] for the line graph of complete, regular bipartite and regular graph.

Example: For $q_n L(K_4) = 8$, $\Delta L(K_4) = 4$, $n = 4$, $\gamma L(K_4) = 2$ inequality hold (Figure 1).

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Theorem 3.2. If G is a connected graph with n vertices and e edges, then the line graph of complete, bipartite and k–regular graph satisfies $\gamma\left(L(G)\right) \geq e/(\Delta+1) \geq e/q_n$. Where Δ is maximum degree of $L(G)$ and q_n is largest eigen value of $Q(L(G))$.

Proof. If $G \cong L(K_n)$ then the number of vertices in a line graph of a complete graph is $\frac{n(n-1)}{2}$ and it is $(2n-4)$ regular the largest eigen value q_n of $Q(L(K_n))$ is $4n-8$. using inequality in theorem 2 in [4] We have

$$\gamma\left(L(K_n)\right) \geq \frac{n(n-1)}{2(2n-3)} \geq \frac{n(n-1)}{2q_n}. \tag{3.1}$$

The above inequality also follows for the line graph of regular complete bipartite $L(K_{m,m})$ regular graph,

$$\gamma\left(L(K_{m,m})\right) \geq \frac{m^2}{(2m-1)} \geq \frac{m^2}{q_n}. \tag{3.2}$$

And for line graph of $k-$ regular graph with n vertices, we have $\gamma\left(L(G)\right) \geq \frac{nk}{2(2k-1)} \geq \frac{nk}{2q_n}. \tag{3.3}$

ie $\gamma\left(L(G)\right) \geq e/(\Delta+1) \geq e/q_n$.

Theorem 3.3.

If G is connected graph with order $n,$ then for $\gamma(L(K_n))$ we have $\frac{2\upsilon}{q_n} \leq \gamma\left(L(K_n)\right) \leq \upsilon,$ where q_n is the largest eigen value of $Q(L(K_n))$ and $\upsilon = \frac{(q_n+8)(q_n+4)}{4^3}$ considered as bound parameter.

Proof. We know that the largest eigen value q_n of $Q(L(K_n))$ is $4n-8$, also number of vertices of $L(K_n)$ is $\frac{n(n-1)}{2}$ for any graph G we have $\gamma(G) \leq \frac{n}{2}$ where $n,$ is order of G thus we have, $\gamma(L(K_n)) \leq -\frac{n(n-1)}{4}$,

ie $\gamma(L(Kn)) = \frac{(q_n+8)(q_n+4)}{4^3} \tag{3.4}$

Using the equation (3.1) and (3.4), we get $\frac{n(n-1)}{2q_n} \leq \gamma(L(Kn)) \leq \frac{(q_n+8)(q_n+4)}{4^3}$,

ie $\frac{2(q_n+8)(q_n+4)}{4^3 q_n} \leq \gamma(L(Kn)) \leq \frac{(q_n+8)(q_n+4)}{4^3}$. If we consider $\upsilon = \frac{(q_n+8)(q_n+4)}{4^3}$, we get domination bounds

for $L(K_n), \frac{2\upsilon}{q_n} \leq \gamma(L(Kn)) \leq \upsilon.$

Theorem 3.4.

If G is connected graph with order $n,$ then for $\gamma(L(K_{m,m}))$ we have $\frac{2\upsilon}{q_n} \leq \gamma(L(K_{m,m})) \leq \upsilon,$ where q_n is the largest eigen value of $Q(L(K_{m,m}))$ and $\upsilon = \frac{(q_n+4)^2}{2^5},$ considered as bound parameter.

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Proof. We know that the largest eigen value q_n of $Q(L(K_{m,m}))$ is $4m - 4$, also number of vertices of $L(K_{m,m})$ is m^2.

for any graph G we have $\gamma(G) \leq \frac{n}{2}$, where n, is order of G thus we have

$$\gamma\left(L(K_{m,m})\right) \leq \frac{m^2}{2},$$

ie $\gamma(L(K_{m,m})) \leq \frac{(q_n+4)^2}{2^5}.$ (3.5)

using the equation (3.2) and (3.5) we get,

$$\frac{m^2}{q_n} \leq \gamma\left(L(K_{m,m})\right) \leq \frac{(q_n+4)^2}{2^5}, \quad \text{ie}$$

$$i.e. \frac{2(q_n+4)^2}{2^5 q_n} \leq \gamma\left(L(K_{m,m})\right) \leq \frac{(q_n+4)^2}{2^5}. \quad \text{if we consider}$$

$$\upsilon = \frac{(q_n+4)^2}{2^5}, \text{ we get domination bounds for } L(K_{m,m}),$$

$$\frac{2\upsilon}{q_n} \leq \gamma(L(K_{m,m})) \leq \upsilon$$

Theorem 3.5.

If G is k- regular graph, then for the domination number of line graph of $k -$ regular graph we have $\frac{2\upsilon}{q_n} \leq \gamma(L(G)) \leq \upsilon$,

Where q_n is the largest eigen value of $Q(L(G))$ and $\upsilon = \frac{n(q_n+4)}{8}$ considered as bound parameter.

Proof. We know that the largest eigen value q_n of $Q(L(G))$ is $2k - 4$, also number of vertices in line graph of $k-$ regular graph is $\frac{nk}{2}$ for any graph G we have $\gamma(G) \leq \frac{nk}{2}$, where n, is order of G thus we have

$$\gamma(G) \leq \frac{n}{2}, \quad \text{ie}$$

$$\gamma\left(L(G)\right) \leq \frac{nk}{4},$$ (3.6)

using the equation (3.3) and (3.6) we get,

$$\frac{nk}{2q_n} \leq \gamma\left(L(G)\right) \leq \frac{(q_n+4)^2}{2^5} \quad \text{ie}$$

$$\frac{2n(q_n+4)}{8q_n} \leq \quad i.e. \ \gamma\left(L(G)\right) \leq \frac{n(q_n+4)}{8}. \quad \text{If we consider} \quad \upsilon = \frac{n(q_n+4)}{8} \quad \text{we get domination bounds for } L(G),$$

$$\frac{2\upsilon}{q_n} \leq \gamma\left(L(G)\right) \leq \upsilon.$$

Algorithm For Finding The Domination Number In Line Graph Using Signless Laplacian Matrix

To generate this algorithm, we note the fact that there are graph families in which $\gamma(G) = i(G)$ that is, every minimum maximal independent set is dominating set, example if G is claw free graph: means a graph does not have a claw

$K_{1,3}$ as induced sub graph, then we have $\gamma(G) = i(G)$ also for any graph G its line graph $L(G)$ is claw-free, and hence a minimum maximal independent set in $L(G)$ is also a minimum dominating set in $L(G)$. Using above facts to find the domination number of line graph, we are generating algorithm to find independent dominating set, this will give us dominating number of $L(G)$ i.e. edge dominating number of graph G.

Step 1. Create the signless Laplacian matrix Q for a line graph $L(G)$. Find the largest eigen value and found the bounds lb and ub.

Step 2. Assign matrix Q to A. Assign $\gamma = 0$

Step 3. Start with the first row first vertex u, assign this vertex to domination set D. First row first column entry corresponding to this vertex a_{11} gives degree of the vertex i.e. number of vertex dominated by this vertex u. (All are in neighborhood of u: $N_{L(G)}(u)$) $\gamma = \gamma + 1$

Step 4. Now cross all rows and column of $N(u)$ having 1 in first row and the first column, delete these rows and column including the row and column for u, Update the matrix A. Repeat steps 3 to 4 till A is a null matrix.

Step 5. Display set D as domination set, assign γ to set S.

Step 6. Assign null set to D repeat step 2 to 5 for next vertex of the graph till all vertex get checked for domination.

Step 7. Find the minimum number from set S, it gives domination number for $L(G)$. and the domination set.

Example: (Figure 2).

Step 1. Signless Laplacian of $L(K_{2,3})$ will be,

$$Q(L(K_{2,3})) = \begin{array}{c} \\ ad \\ ac \\ ae \\ be \\ bc \\ bd \end{array} \begin{array}{cccccc} ad & ac & ae & be & bc & bd \\ 3 & 1 & 1 & 0 & 0 & 1 \\ 1 & 3 & 1 & 0 & 1 & 0 \\ 1 & 1 & 3 & 1 & 0 & 0 \\ 0 & 0 & 1 & 3 & 1 & 1 \\ 0 & 1 & 0 & 1 & 3 & 1 \\ 1 & 0 & 0 & 1 & 1 & 3 \end{array}$$

Step 2. Assign $A = Q$ $\gamma = 0$

Step 3. $D = \{ad\}$ $\gamma = 1$ $N_{L(K_2)}(ad) = \{ac, ae, bd\}$ Having 1 in first row and the first column.

Now deleting all crossed row and column we get

$$A = \begin{array}{c} \\ be \\ bc \end{array} \begin{array}{c} be \quad bc \\ \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix} \end{array}$$

Step 4. The remaining vertices are *be, bc* now select *be* and it's a dominated vertex. So $D = \{ad, be\}$, $\gamma = 2$.

now, A=[ ]

Step 5. As A=[ ] we get dominating set $D = \{ad, be\}$ and S = {2}.

Step 6. $D = \{ \}$ Repeating steps 2 to 5 for all remaining vertices we get all the domination set as {ad ,be},{*ac, be*}, {*ae,bc*} and $S = \{2, 2, 2\}$.

Step 7. The domination number will be $S_{\min} = 2$. (other combination of domination sets are also possible as:{*ad, bc*} , {*ac, be*} ,{*ae, bd*} and so on it will depends on selection of the vertex.)

Note

Annexure 1 and 2 is attached as Matlab code of the proposed algorithm and its output respectively.

CONCLUSION

In this paper, we obtained the bounds for the domination number of line graph of complete, regular bipartite and $k-$ regular graph on the basis of Signless Laplacian spectra of the line graph as $\frac{2\upsilon}{q_n} \leq \mathcal{K}(L(G)) \leq \upsilon$ where the value of bound parameter υ will depends on type of graph. We also provide an algorithm to find domination set and domination number on the basis of signless Laplacian matrix. We have implemented this algorithm using Matlab code and a tool is created for it. As we are going to update the matrix in each step of our algorithm it consumes less memory and gives answer for domination number and dominating set simultaneously with reduced time complexity. Using iterative formulae for the specified line graph we can extend this algorithm to find domination number of iterated line graph, for this we have to use the tool successively up to the specified number of iteration.

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Fig. 1. K₄ Graph and its L(K₄)

Fig. 2. K₂,₃ Graph and its L(L₂,₃)
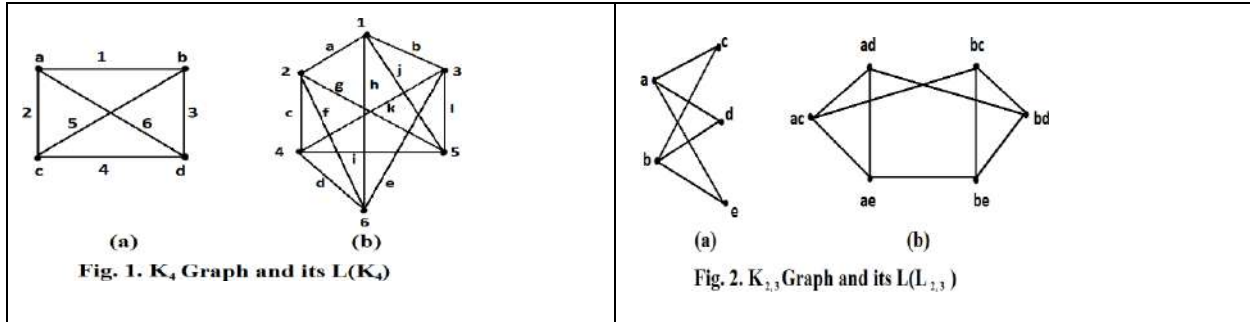
Annexure.1

```
% Matlab Program to find independent Dominant set and Dominance number in
% Line graph.
%*********************************************************% clear
clc
disp('Inp
ut')
disp ('Vertex Set ');
%V1=input(' Vertex Set');
%required to input data presently assigned
V1=[1 2 3 4 5 6];
disp(V1);
V2=V1;
% Q=input ('Singless Laplacian matrix');
%required to input data presently assigned
Q=[3 1 1 0 0 1; 1 3 1 0 1 0;1 1 3 1 0 0; 0 0 1 3 1 1; 0 1 0 1 3 1; 1 0 0 1 1 3];
disp('Singless  Laplacian  matrix  of  line
graph '); disp(Q);
[n1,m1]=size(Q);
c=[];
D=[];
s=[];
% Code  as  per  mentioned
Algorithm disp('OUTPUT');
disp('Dominating
set '); for i=1: n1
a=Q;
V1=V2;
gm=0; k=i;
while
(isempty(a)~=1)
[n,m]=size(a);
c=[];
D=[D,V1(k
)];
gm=gm+1;
for j=1:m
```

Pranjali Kekre and Kajal Mittal

```
if a(k,j)~=0
c=[c,j];
end
a(:,c)=[];
a(c,:)=[];
V1(:,c)=[];
k=1;
end
%disp   ('Domination
set'); disp(D);
D=[];
s=[s,  gm];
end
Gam=min
(s);
disp          ('domination
Number !') disp(Gam);
%***************************************************%
```

Annexure.2

Input
Vertex Set
1 2 3 4   5 6

Singless Laplacian matrix of line graph

```
3   1   1   0   0   1
1   3   1   0   1   0
1   1   3   1   0   0
0   0   1   3   1   1
0   1   0   1   3   1
1   0   0   1   1   3
```
Output

Dominating set

```
1        4
2        4
3        5
4        1
5        1
6        2
```
domination Number !
2
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RESEARCH ARTICLE

Saline Stress: Strategies Adopted by *Phaseolus vulgaris* for Survival

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ABSTRACT

Environmental stresses always limit plant growth and yield. These stresses are growing threats to agriculture. Salt stress is the most common among them. Salinity is mainly formed through natural processes and also via human activities. The high salt content in soil affects plants negatively. It causes ionic and osmotic stress to plants. Besides that, it brings morphological, anatomical, biochemical, and molecular changes in plants. These changes can be considered as adaptive mechanisms developed by plants to cope with the detrimental effects of salt. *Phaseolus vulgaris* comes under the family Leguminosae, generally known as common bean; a glycophyte. Under salt stress, common beans adopt several mechanisms for survival. It consists of an increase in osmoprotectants like glycine betaine, proline, etc., enhancing antioxidant systems, increasing stress hormones, etc. Changing gene expressions and micro-RNA expressions are some of the molecular mechanisms posses by common beans against stress. This review helps to understand the mechanisms developed by common bean plants against salt stress. Likewise, it provides new insight into crop improvement.

Keywords: *Phaseolus vulgaris*, Legume, Salt stress, Glycophytes, Common Beans.

INTRODUCTION

The agriculture system is mainly affected by abiotic and biotic stresses. They may cause significant yield loss. Most common stresses include water and salinity stress. Salt stress causes the accumulation of excessive salt contents, leading to inhibition of crop growth and crop death, and causes soil infertility. Salt stress unfavourably affects the morphological, physiological, biochemical, and molecular aspects of plants. Seedling and young plants are usually more sensitive to stress than adult plants. Salinity stress is also considered hyperosmotic stress, it may cause osmotic imbalance (Munns 2005). Soil salinity is high in arid and semi-arid regions. Heavily irrigated agricultural lands are highly saline and lead to an enormous reduction in crop production (Oprica and Marius 2014). Salinity is mainly

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caused by poor irrigation, irrigation water that contains salts, over-irrigation, and proximity to the sea, and the capillarity rise of salts from underground water into the root zone (Abdelhamid et al., 2013). Salinity can be classified into primary salinity and secondary salinity. Primary salinity occurs naturally, while secondary salinity occurs due to human activities. Plants adapt various mechanisms to cope with abiotic constraints. On the basis of adaptive evolution, plants are classified into two major types, Halophytes (can withstand salinity) and glycophytes (cannot withstand salinity). The majority of crops belong to glycophytes. Halophytes can tolerate salt concentrations over 0.5% at any stage of life (Stocker *et al.,* 1928). Major halophytes are *Anemopsis californica, Attalea speciosa, Panicum virgatum,Glycyrhiza glabra, Chenopodium album, portulaca oleraceae, Atriplex* spp., etc. Salt tolerant plants have various adaptations, including morphological, physiological, biochemical, and molecular changes (Acosta Motos et al., 2017), consisting of ion compartmentalization, osmolyte production, germination responses, osmotic adaptations, succulence, selective transport and uptake of ions, enzyme responses, salt excretion and genetic control (Koyro *et al.,*2011). Nearly all crop plants are glycophytes. Salinity stress adversely affects their morphology and physiology through osmotic and ionic stresses and also affects biochemical parameters (Khan *et al.,* 2013).

Initially, plant growth is repressed by osmotic stress and then followed by ion toxicity (James *et al.,* 2011; Rahnama *et al.,* 2010). Legumes are extremely sensitive to abiotic stresses. *Phaseolus vulgaris* is the most important among them. *P. vulgaris* is also known as common beans, French beans, runner beans, string beans, half-runners, snap beans, and haricot beans, and the seeds are known as pinto, kidney, navy beans etc. (Kelly, 2010). This plant is an herbaceous annual, self-pollinated crop that grows in tropical, subtropical, and temperate areas. Common bean is the most consumed legume, and it is a vital component of the diet. Common beans are cultivated for their green pods and leaves. Beans are rich in proteins, amino acids, carbohydrates, and fibers and also provide essential minerals and vitamins, so this crop is known as "poor man's meat." Beans are used as an alternative to meat in developing and under-developing countries. It can be consumed in raw or cooked forms. Bean pods and seeds have greater demand in the food industry. Several food dishes are prepared with beans like salads, pickles, curries, etc. It is also capable of fixing atmospheric nitrogen in the soil and increasing soil fertility. Common bean shows anti-cancerous, antidepressant, anti-leukemia, cardio-protective, estrogenic, hepatoprotective, chemopreventive, anti-diabetic, diuretic, diaphoretic, emmenagogue, antioxidant, fungicidal, hypoglycemic, antiviral, and antipyretic properties (Blumenthal *et al.,* 1998; Rafi and Vastano, 2002). Linoleic and linolenic fatty acids are dominant in the fat of the common bean (Salunkhe *et al.,* 1983); these fatty acids belong to the omega fatty acids group, provide protection against obesity, strengthen the immune system, and prevent cholesterol. Omega fatty acids are physiologically and biochemically essential for body functions (Candela *et al.,* 2011).

Bean consumption decreases the risk of ischemic heart and cardiovascular diseases, stomach and prostate cancer, weight control and obesity, stress attenuation, anxiety, and depression (Messina, 2014; Mudryj *et al.,* 2014).Common bean is a glycophyte sensitive to salt. Soil salinity causes a significant reduction in common bean growth, green pod, and dry seed yields (Al Hassan *et al.,* 2016). Bean suffers yield loss at soil salinity less than 2dsm-1(Lauchli 1984). At the salinity equivalent to 100mM, pod yield per plant decreased by 85 % (De Pascale *et al.,* 1996). Common beans are mainly cultivated on soil with little or no salinity (Maas and Hoffman 1977). And the genotype grown under different salinity conditions shows different responses. Increasing salinity causes more stress on young beans (Kaymakanova and Stoeva 2008; Ndakidemi and Makoi 2009). Some cultivars are more tolerant than others. *Phaseolus vulagris* and *Phaseolus coccineus* are closely related sps, but *P coccineus* is more tolerant than *P. vulgaris* (Subbaraoand Johansen, 1994). Basic salt stress responses involve the control of ion homeostasis and the maintenance of cellular osmotic balance involves water transport into the cell, compartmentalization of toxic ions in the vacuole, and synthesis and accumulation of compatible solutes or osmolytes in the cytoplasm etc. (Munns and Termaat 1986; Zhu 2001). Phaseolus species like wild *P. acutifolius* Gray var. latifolius Freem. and *P. vulgaris* L. can be classified as salt tolerant because they are able to restrict Na+ ions in roots and leaves (Bayuelo-Jimenez *et al.,* 2003).
A wide range of genetic adaptations was also observed in legumes under saline conditions. Several genes associated with salt tolerance include DREB, SOS genes, ATNHX1, and H+ ATPase, SAG HSP genes, Genes coding antioxidant enzymes include CAT, Mn- SOD, GPX Identification and understanding of such genes provide valuable information about tolerance mechanisms.

MORPHOLOGICAL AND ANATOMICAL CHANGES INDUCED BY SALINITY STRESS

Salt stress adversely affects plant growth and yield. The reduction in growth and yield is quantitatively related to salt concentration. Salinity always reduces plant morphological parameters, such as root and shoot length, root and shoot fresh weight, dry weight, and number of leaves, leaf area, and leaf thickness, number of branches, flowering, and number of pods, pod weight, pod size, and also the number of seeds. The most important symptoms of salt stress are a decrease in leaf area, increase in leaf thickness and succulence, abscission of leaves, necrosis of roots and shoots, and decrease of internodes length (Gucci and Tattini 1997; Kozlowski 1997; Parida and Das 2005), and also shows non-chlorotic wilting spots, and necrotic spots in the leaves (Assimakopoulou *et al.,* 2015). Salinity also enhances the senescence of old leaves (Shabala and Munns, 2017). Roots play a significant role in salt tolerance; they are the first organs that control the uptake and translocation of nutrients and salts throughout the plants (Rahneshan *et al.,* 2018). Accumulation of Na+ in the roots is an adaptive response used by some woody plants to avoid its toxicity in the shoots (Picchioni *et al.* 1990; Gucci and Tattini 1997). Toxic effects observed in leaves are generally necrosis and losing chlorophyll, reduction in leaf area, and fall of leaves. Pigment contents are also affected by salinity. In the case of salt-tolerant plants, the chlorophyll level is unchanged or increased under salinity, whereas chlorophyll content is decreased in salt-sensitive plants (Stepien and Johnson, 2009; Ashraf and Harris 2013). A decrease of these pigments under salt stress is considered to be a result of slow synthesis or fast breakdown of the pigment in cells (Ashraf 2003).

Shoot growth reduction occurs in two phases, the osmotic phase and the ion-specific phase (Munns 2002). The osmotic phase is the rapid response to salt stress, while the ion-specific phase is the slower response. The osmotic phase leads to growth reduction, and the ion-specific phase leads to necrosis and reduction in the photosynthetic area (Munns 2002; Hasegawa *et al.,* 2000). In all species, Na+ concentration increased almost homogeneously in shoots and roots, but Cl- concentration increased more in stem and leaves than roots (Bayuelo-Jimenez et al., 2012). Stress responses are dependent on the plant developmental stage (Läuchli and Epstein, 1990; Johnson et al., 1992; Vicente et al., 2004). Reductions in leaf characteristics such as leaf number and the leaf area were reported in a number of plants under saline conditions (Lycoskoufis *et al.,* 2005; Rodriguez *et al.,* 2005). Salinity affects shoot growth less than root growth (Assimakopoulou *et al.,* 2015). According to Wignarajah (1990), salinity affects shoot growth more than root growth in *Phaseolus vulgaris*. Salinity had adverse effects on plant morphologic features such as plant height, the number of leaves, root length, and shoot/root ratio in beans (*Phaseolus vulgaris*) (Wignarajah, 1990). In all *Phaseolus* taxa, salt stress inhibits the growth of hypocotyl more than radical (Ahmadian and Bayat 2016). According to previous works, salinity causes an increase in leaf lamina thickness through an increase in mesophyll cell size or the number of layers (Longstreth and Nobel 1979). Salinity also delayed the flower emergence; for example, NaCl salinity was found to delay the flower emergence in nearly all rice cultivars (Mercado *et al.,* 1974).

ANATOMICAL CHANGES

According to Waisel (1972) and Strogonov (1962) there are numerous structural changes occurring in response to salinity, it increases succulence, changes the number and size of stomata, thickens the cuticle, develops tylosis and lignification, and changes the diameter and number of xylem vessels. According to Tahri *et al.,* 2020 root and stem of *Phaseolus vulgaris* under saline stress possess variances like reduction in parenchyma cells size, change in xylem vessels diameter, and increase in their number. Under saline conditions, Epidermal thickness, Mesophyll thickness, and Palisade cell length were increased, and Palisade cell diameter was approximately constant in *Phaseolus vulgaris* (Longstreth and Nobel 1979). Bray and Reid (2002) reported that the numbers of epidermal and palisade cells per unit area and stomatal density of the abaxial epidermis were increased by salinity. Moreover, salt reduced the number of cells per leaf.

BIOCHEMICAL CHANGES ASSOCIATED WITH SALT STRESS

Salinity causes biochemical abnormalities in plants. Salinity is also considered hyper osmotic stress for the reason that, during the early phases of salinity stress, the water absorption capability of root systems decreases, and water loss from leaves increases because of osmotic stress of high salt accumulation in soil and plants. Salinity is also known as hyper ionic stress; in the initial stage, Osmotic stress causes a variety of physiological changes, such as

interruption of membranes, nutrient imbalance, impairs the capacity to detoxify reactive oxygen species (ROS), changes in the antioxidant enzymes, and diminished photosynthetic activity, and reduce the stomatal aperture (Munns and Tester, 2008; Rahnama *et al.*, 2010).

Plants build up a mixture of physiological and biochemical mechanisms against salt stress for their survival. These mechanisms mainly include ion homeostasis and compartmentalization, transport of ions and their uptake, biosynthesis of osmoprotectants, activation of the antioxidant system, hormone regulations. Maintaining ion homeostasis is crucial for growth under salt stress (Niu *et al.,* 1995; Serrano *et al.,* 1999; Hasegawa, 2013). Both glycophytes and halophytes can't resist high salt content in their cytoplasm. So, the excess salt may be transported to the vacuole or sequestered in older tissues, thereby protecting the plant from salinity stress (Reddy *et al.*, 1992; Zhu, 2003). According to Al Hassan *et al.,* 2016, salt tolerance in Phaseolus is mostly based on the mechanisms that restrict the transport of Na+ to the aerial part of the plants. Plants of the genus Phaseolus are able to exclude sodium from the shoots, even in the presence of relatively high NaCl concentrations in the soil (Seemann *et al.,* 1985). In common bean, osmotic potential declines as an effect of water deficit in the leaf tissue (Cabot *et al.,* 2005). Reduced water uptake is the common response of plants under salt stress (Munns, 2002; Habtamu, 2013). Phaseolus species have the capacity to regulate high salt concentrations via lowering tissue osmotic potential through an increase of inorganic ions, principally Cl–, Na+, and K+ in their leaves (Bayuelo-Jimenez *et al.*, 2003). Salinity affects photosynthesis both in the short and long term. Plants have developed various mechanisms for protecting their photosynthetic machinery. One of the mechanisms is the xanthophyll cycle, whose function is to dissipate excess excitation energy in the PSII antenna as heat by a process named non-photochemical quenching (NPQ). Photorespiration is an additional mechanism for the protection of photosynthetic machinery (Acosta-Motos *et al.,* 2017).

Under saline stress, chlorophyll (a, b) and carotenoids contents of leaves were increased. The maximum increase was recorded in 150mM treatment (Zayed *et al.,* 2017). Wang and Nil (2000) also observed an increase in pigment content in *Amaranthus tricolor* under salinity. During stressed conditions, plants synthesize osmotically active compounds, called osmoprotectants. They are uncharged, polar, and soluble in nature. Their functions are adjusting cellular osmosis, scavenging ROS, protecting cellular membranes, and stabilizing proteins, enzymes, and enzymatic functions. Osmolytes like proline, glycine betaine, polyamines, etc. are potent osmoprotectants (Gupta and Huang, 2014). Free amino acid concentration is affected by stress—especially proline. Proline concentration is highly influenced by salt stress. Various workers reported that proline application increases salt tolerance in plants (Ben Ahmed et al., 2010; Hoque et al., 2008; Deivanai *et al.*, 2011). Proline acts as molecular chaperons and protects protein integrity, thereby increasing the activity of enzymes (Rasool *et al.,* 2013). Proline seems to be a reliable marker of stress in Phaseolus (Al Hassan *et al.,* 2016). Proline content significantly increased with an increasing salt concentration in *Phaseolus vulgaris* (Zayed *et al.,* 2017). Under salt stress, common beans showed variations in total phenol content, proline content, and the activities of both peroxidase and polyphenol oxidase (Noreen and Ashrafa 2009). Glycine betaine is another osmoprotectant, which protects the cell through osmotic adjustment (Gadallah, 1999), stabilizes proteins (Makela *et al.,* 2000), and protects the photosynthetic apparatus from stress damages (Cha-Um and Kirdmanee, 2010) and reduction of ROS (Ashraf and Foolad, 2007; Saxena, 2013). Rahman *et al.,* (2002) reported that under stressed conditions (150 mM NaCl), the ultra structure of *Oryza sativa* seedling shows considerable damages, such as swelling of thylakoids, and the disintegration of grana and intergranal lamellae, and disruption of mitochondria. Though, these damages were largely prevented when seedlings were pretreated with glycine betaine. Stresses always lead to the accumulation of polyamines which plays an array of roles in normal growth and development. The level of polyamines is positively associated with stress tolerance in plants (Gupta *et al.,* 2013; Yang *et al.,* 2007; Groppa and Benavides, 2008; Kovacs *et al.,* 2010). Polyols, also known as sugar alcohols, which has high antioxidant activities, therefore providing protection against environmental stresses (Williamson., et al. 2002). Polyols also accumulated in response to salt stress (Gupta and Huang, 2014). Anthocyanin is a flavonoid and accumulates in plants under salt stress. It is a good indicator of stress, and increases under stress which enables protection against damages (Jeon *et al.*, 2020). Jeon *et al.*, (2020) states that the amount of anthocyanin pigment is beneficial for the prediction of stress tolerance intensity in *Sorghum bicolor L.* Salt stress induces an increase in carbohydrate content. Carbohydrate accumulation plays an important role in osmoprotection, osmotic adjustments,

carbon storage, and radical scavenging under stress (Gupta and Huang, 2014). Alamgir and Yousuf, (1999) reported that Sugar content increased and decreased in various rice genotypes under salinity stress. Sugars take part in a vital role in NaCl-tolerance, such as Na+ and Cl− translocation and compartmentation, solute synthesis for growth, osmotic adjustment and protein turnover (Arbona *et al.*, 2005).

Salt stress leads to the production of several proteins. Salt-induced proteins can be classified into two groups (Mansour, 2000), salt stress proteins and stress-associated proteins. Salt stress proteins accumulate only due to salt stress, while stress-associated proteins accumulate in response to various abiotic stresses like drought, heat, cold, water logging, and high and low mineral nutrients (Rasool *et al*, 2013). Protein accumulation provides a storage pool of nitrogen (Singh *et al.,* 1987), and also plays a crucial role in osmotic adjustment. In *Pisum sativum*, soluble protein content increase in response to salinity (Ahmad and Jhon, 2005). In *Vicia faba*, soluble protein content decreased in response to salt stress (Gadallah, 1999). Generation of ROS during salinity may cause oxidative stress. In chloroplasts and mitochondria; Abiotic and biotic stress can lead to overflow, deregulation, or even disruption of electron transport chains (ETC) (Gupta and Huang, 2014).OH•, O_2•−, O_2, H_2O_2 are the major free radicals that cause damage to the cell. As a defense strategy, plants can take action to stress conditions by the production of stress proteins and compatible osmolytes, which can scavenge ROS (Zhu *et al.,* 1997). The antioxidant system plays a central role in ROS detoxification. There are enzymatic and non-enzymatic antioxidants present. Superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), guaiacol peroxidase (GPX), glutathione reductase (GR) ascorbic acid (AA) etc. are chief antioxidants (Das and Roychoudhury 2014).

Abdi et al. (2015) suggested that the increase in antioxidant enzymes/molecules is a mechanism of salt tolerance in the Common bean. The author also reported that the changes in the activities of antioxidant enzymes and the levels of some non-enzymatic antioxidants could be used as markers of salt tolerance in common bean (*Phaseolus vulgaris* L.) inoculated by rhizobia strain (Ar02) that belong to the *Sinorhizobium genera.* Zayed *et al.,* (2017) reported that the activities of antioxidants such as PPO, CAT, and POD were significantly increased with an increasing salt concentration in *Phaseolus vulgaris*. Farhangi-Abriz and Shahram Torabian (2017), reported that the salinity increased the activity of catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD), polyphenol oxidase (PPO), and superoxide dismutase (SOD), and the content of malondialdehyde (MDA), oxygen radicals (O_2•−), and hydrogen peroxide (H_2O_2) in leaf and root of common bean, and also magnitudes of proline, glycine betaine, soluble sugar and soluble protein contents were increased with increasing salinity. Ascorbic acid is one of the significant non-enzymatic antioxidants. In French beans ascorbic acid contents were elevated under salt stress (Nagesh Babu and Devaraj, 2008). Lipid peroxidation is the major symptom of oxidative damage. Malondialdehyde (MDA) is an endogenous lipid peroxidation product toxic to genes. MDA level is an excellent indicator of ROS-induced damages (Hernández & Almansa, 2002). Koca *et al.,* (2007) found that MDA content was increased significantly with salinity in Sesame cultivars. Rasool *et al.,* 2013 also reported that the rate of lipid peroxidation was increased with increasing salinity. ABA is an important plant hormone that ameliorates the effects of stress in plants. ABA is an essential cellular signal; in plants, several stress-related gene expressions are modulated by ABA (Gupta and Huang, 2014). ABA accumulation diminishes the inhibitory effect of salinity on photosynthesis, growth, and translocation of assimilates (Popova *et al.,* 1995; Jeschke *et al.,* 1997). Accumulation of ABA is positively interrelated with salinity tolerance, and it attributes to the accumulation of K+, Ca+, Proline, and sugars in roots and vacuoles, which helps counteract the uptake of Na+ and Cl (Chen *et al.,* 2001; Gurmani *et al.,* 2011). Salicylic acid (SA) and Brassinosteroids (BR) have an imperative role in plant abiotic stress responses (Fragnire *et al.,* 2011; Clause and Sasse, 1998). The application of SA also promoted salinity tolerance in barley (El-Tayeb, 2005). The application of BR amplified the activity of antioxidant enzymes (SOD, POX, APX, and GPX) and non-enzymatic antioxidant accumulation (tocopherol, ascorbate, and reduced glutathione) (El-Mashad and Mohamed, 2012). Both BRs and SA are improving plant stress tolerance. Exogenous application of these hormones provides salt tolerance in plants. In common beans, the interactive effect of AsA and GA3 enhanced protein content and the activity of the antioxidant enzyme guaiacol peroxidase under salt stress. And the interactive effects also alleviate the adverse effects of salinity on *P. vulgaris* seedlings (Saeidi-Sar et al., 2013). Nitric oxide (NO) is a small volatile gaseous molecule. The positive effects of NO on salinity tolerance or stress mitigation have been attributed to antioxidant activities and modulation of the

ROS detoxification system (Mishra *et al.,* 2011). According to Zhang *et al.,* (2007), during salinity stress, NO acts as a signal molecule and promotes salt resistance by enhancing PM H+-ATPase activity. Exogenous application of NO improve plant growth under salinity stress and increases antioxidant enzymes such as SOD, CAT, GPX, APX, and GR (Zhao *et al.,* 2004).

MOLECULAR CHANGES ASSOCIATED WITH SALINITY

As a defense mechanism, numerous genes are induced by saline stress. Genes are up regulated or down regulated under stress. Under salinity stress, regulation of gene expression induces a broad range of mechanisms for up-regulattion or down-regulation of specific gene products. Transcriptome analysis provides comprehensive information about gene expression at the mRNA level; these mechanisms help to understand various genes and gene expressions involved in the stress responses. Several transcription factors and genes are affected by salt stress. Transcription factors are the most significant regulators that control gene expression. bZIP, WRKY, AP2, NAC, C2H2, Zinc finger gene and DREB families cover a great number of stress-responsive members (Gupta and Huang, 2014). Salt responsive genes consist of a different class of genes, including ion transport or homeostasis gene (e.g., SOS genes, ATNHX1, and H+ ATPase), senescence-related gene (e.g., SAG), molecular chaperones (e.g., HSP genes), and dehydration associated TF (e.g., DREB) (Gupta and Huang, 2014). SOS gene family plays a significant role in ion homeostasis, thereby; providing tolerance (Hasegawa *et al.,* 2000; Yen *et al.,* 2000; Liu *et al.,* 2000; Shi *et al.,* 2000). Evidence demonstrates the roles of a Salt Overly Sensitive (SOS) stress signaling pathway in ion homeostasis and salt tolerance (Hasegawa *et al.,* 2000; Sanders, 2000). The SOS signaling pathway has three main proteins, SOS1, SOS2, and SOS3. SOS1 encodes a plasma membrane Na+/H+ antiporter; it is crucial in regulating Na+ efflux at the cellular level and also aid long-distance transport of Na+ from root to shoot. This protein's over-expression provides salinity tolerance in plants (Shi *et al.,* 2000; Shi *et al.,* 2002). OsNAC5 and ZFP179 show an up-regulation under salt stress which controls the synthesis and accumulation of proline, sugar, and LEA proteins; these play a critical role in stress tolerance (Song *et al.,* 2011).

ROS scavenging and osmotic regulating genes are also up-regulated under salinity. Glutathione S-transferase and ascorbate peroxidase genes are up-regulated in salinity stressed rice plants (Kawasaki et al., 2001). Baisakh et al., (2006) reported that under salinity stress, *Spartina alterniflora,* a halophyte plant species exhibits up regulation of 10 genes related to osmotic regulation. In rice plants, SALT-RESPONSIVE ERF1 (SERF1), a rice (*Oryza sativa*) transcription factor gene, improves salinity tolerance (Schmidt *et al.,* 2013). *DREB* genes are regularly connected with abiotic stress tolerance. Konzen et al., (2019) systematically categorized 54 putative *PvDREB* genes distributed in the common bean genome. Four genes (*PvDREB1F*, *PvDREB2A*, *PvDREB5A*, and *PvDREB6B*) were cloned, and analyzed their expressions in abiotic stresses. *PvDREB1F* and *PvDREB5A* showed high relative inducibilities under stresses such as drought, salt, cold, and A.B.A. *PvDREB2A* inducibility were mostly localized to the stem under drought. *PvDREB6B* was found as a cold- and dehydration-responsive gene, mainly localized in leaves (Konzen et al., (2019). microRNAs (miRNAs) and endogenous small interfering RNAs (siRNAs) play a momentous role in plant stress responses. Shriram et al. (2016) reported that miRNAs are potential targets for abiotic stress tolerance in plants. Differential expression patterns of miRNAs were observed under different abiotic stresses, including salinity, drought, high temperature, cold, cadmium, and arsenic, in many plants (Xie *et al.,* 2014; Ferdous *et al.,* 2015; Giusti *et al.,* 2016; Shriram *et al.,* 2016; Wang *et al.,* 2016.) Molecular studies in Arabidopsis, rice, soybean, maize, and Populus have identified salt responsive miRNAs such as miR393, miR394, miR396, and miR156 (Sunkar and Zhu, 2004; Liu *et al.,* 2008; Ding *et al.,* 2009; Gao *et al.,* 2011; Li *et al.,* 2011). The expression profiles of nine different miRNAs were analyzed in *Phaseolus vulgaris* seedlings in response to salinity and drought stress. The miR395 was most sensitive to both stresses and was up-regulated under stresses (Nageshbabu and Jyothi, 2013). miR396 and miR172 were up-regulated after exposure to both the stresses. The miR396 is associated with leaf development (Liu *et al.,* 2009) and expression of miR396 induced by high salt, cold, and drought stresses (Liu *et al.,* 2008). Over-expression of miR396 leads to an increase in tolerance to drought stress (Feng-Xi and Di-Qiu, 2009). Researchers observed that individual miRNA expression profiles varied with different stresses; that is, salt and drought stresses differently affect miRNA expressions through various mechanisms, such as oxidative stress or inhibition of plant growth. They also reported that salt and drought conditions induced the expression of stress-related genes such as APX and ADH in *Phaseolus*

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vulgaris. Arenas-Huertero *et al.* (2009) found that miRS1 and miR159.2 accumulation increased in response to salinity in common beans. They also proposed that miR398 targets a superoxide dismutase in common beans and other plants (Arenas-Huertero *et al.,* 2009). miRNAs expressions vary with species; the changes are due to differences in the cultivation of plants, the level of treatment applied, differences in time points at which tissues were sampled, or even differences in tissues like roots, shoot, leaves, etc. analyzed (Mantri et al., 2013).

CONCLUSION

The common bean is the most important legume in the world. It is highly sensitive to saline stress. Salinity always adversely affects plant morphology, biochemistry, and molecular responses. And also decreases yield and productivity. Metabolic processes and gene expressions are also affected by salinity. Plants adapt various mechanisms to cope with salinity stress. A better understanding of such mechanisms provides valuable information about stress and tolerance mechanisms in plants, and this information is very advantageous in genetic engineering and helpful for crop improvement; it helps the farmers to produce tolerant varieties.

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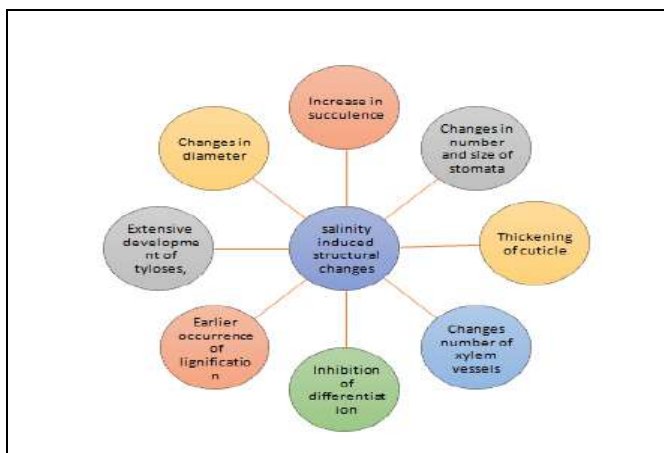
| Figure 1: Structural changes under salinity stress (Waisel (1972) and Strogonov (1962) | Figure 2: SOS gene pathway under salinity stress |
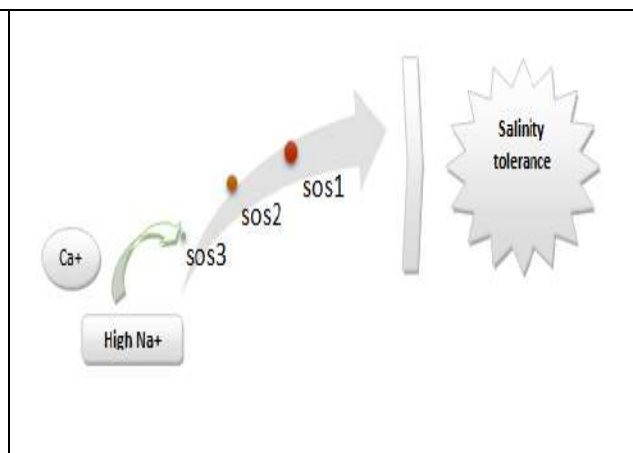
REVIEW ARTICLE

A Review of Current Practices in Aseptic Filtration

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ABSTRACT

Aseptic manufacturing is the most challenging process faced in pharmaceutical industries. During aseptic processing, the sterility of the components and the products should be assured. Sterile solutions which cannot be sterilized in the final container can be filtered through a sterile filter of nominal pore size 0.22µ. Due to the heat-induced degradation of thermo sensitive drugs, it becomes difficult to sterilize. Aseptic filtration is preferred when terminal sterilization is not feasible for drug products. When selecting and validating filters, there are several complex and interactive factors to be considered like filter material, membrane thickness, flow rate. Filtration developments include the production of continuous processes that substitute traditional offline filtration. This article describes the filtration process; the filter forms and the filter activity used in aseptic development and focus on sterile filter operation and filtration line design aspects.

Keywords: Filtration, membrane filters, hydrophobic, hydrophilic, integrity test.

INTRODUCTION

Aseptic filtration mainly aims to create a sterile product by a cold process because it does not rely on temperature or other energy sources to eliminate microorganisms. Aseptic filtration usually eliminates or separates microbial life from the substance. Filtering by a 0.2µm eliminates the microorganisms and sterilizes the solutions to be filled into the final container. Membrane filters are used to sterilize solutions due to their non-shedding properties, non-reactivity, and particle-retention effectiveness. They consist of polyether sulfone (PES) and polyvinylidene difluoride (PVDF) filters [1]. Aseptic solutions filtered by using a sterilizing grade filter of pore size 0.22µfor aseptic filling, whereas 0.45µ shall be used for terminally sterilized products to reduce the final bioburden in the product before sterilization. The quality of the sterilized filter shall be checked and validated before the filtration process and after use, by methods such as bubble-point, diffusive flow or pressure hold test [2]. Various factors such as type of particle, filter material and membrane thickness, porosity, applied pressure, temperature, flow rate and time affect the filter efficiency [1].

STERILIZATION

Filtration can sterilize liquids that are affected by heat, irradiation or chemical sterilization. It is used for sterilization of liquids and gases and can prevent both viable and non-viable particles [3]. The fiber shedding features of filters should be negligible [4]. Filtration and/or aseptic processing are favoured in situations where terminal sterilization is not possible due to product volatility or package incompatibility. Before sterilization, microbial contamination should be negligible and its bioburden should be controlled [5].This can be achieved by following good aseptic practices. The sterilization by filtration is performed at the end of the filling point as far as possible [4].

Methods of sterilization

There are 2 methods for sterilization- Physical method, Chemical method

a) The physical methods include-
- Dry heat-Flaming, hot air oven, infrared rays, incineration
- Moist heat- a) At temperature below 100ºC- Pasteurization

At temperature above 100ºC- Autoclave, Radiation

- Filtration

b) The chemical methods include-
- Liquids- Alcohols
- Gaseous- formaldehyde, ethylene oxide [6].

FILTERS

Filters play a major role in the filtration process. Microorganisms are separated from the sterilizing fluids rather than being killed or inactivated [7]. The filter must be non-toxic and should not adsorb the components to the cycle, and eliminates the associated bioburden. The average porosity of the bacteria retentive filters is 0.22µm. Filters are composed of various materials such as cellulose esters, polytetrafluoroethylene, nylon, and other polymeric materials [7]. Filters can be either flat membranes (stacked disk filters such as Millipore's Millipak® system) or pleated into cylinders or cartridge filters. Capsule filters are cartridges encapsulated in a rigid shell and are disposable. The rigid shell composed of polycarbonate or polypropylene [8].

TYPES OF FILTERS

There are multiple filter designs used in the pharmaceutical industry. Filtration is facilitated by the use of vacuum pumps with either positive or negative pressure. Earthenware filters and asbestos filters are old types of filters are called depth filters. Based on the material of construction and capacity of particle size separation filters are categorized [9].

Based on the material of construction there are five types of filters they are earthenware filters, asbestos filters, sintered glass filters, capsule and membrane filters.

Earthenware filters
These are made of porcelain or diatomaceous earth. Different types are Pasteur- Chamberland filter, Berkefeld filter, Mandler filter.

Asbestos filters These are made of the chrysotile and composed of silicate magnesium. These are disc-type and used only once. Autoclaving sterilizes the disc. There are different grades HP/ PYR (to eliminate pyrogens), HP/ EKS (to provide utter sterility), HP/EK (to clarify).

Sintered glass filters These are available in the form of disc fused into glass funnel. These are made up of finely ground glass, which is fused enough to adhere to small particles, each other. These have a pore diameter between 1-1.5µm [10].

Capsule filters are designed for small volume filter applications in pharmaceuticals. They contain pleated, filter media which provides good retention of particles. These are made up of polypropylene which offers high chemical resistance and durability. It is used to filter tissue culture media, fermentation broth, large-volume media preparation, pilot-scale manufacturing and sterile filtration of buffer solutions. These are sterilized by gamma irradiation [11].

Membrane filters- These are made up of polymeric materials such as polycarbonate, cellulose diacetate, and polyester, polycarbonate, polyvinylidene fluoride or other synthetic material. The older membranes are gradocol composed of cellulose diacetate and ranges of pore diameter from 3-10µm. The newer ones are made of cellulose diacetate and pore diameter ranges of 0.015-12µm. These are used for sterility testing [9].The benefit of membrane filters is considered to be porosity, no fluid retention, after autoclaving reusable and compatible with many chemicals. For pilot and full-scale production three membrane choices are available in combinations which are commercially used in aseptic filtration technology they are:

1. Supor ® Membrane- This provides high flow rates. It is used to process solutions like serum, culture media supplemented with serum, and viscous solutions.
2. Fluorodyne ® 2 Membrane-It offers high flow rates, low adsorptive and extractable properties and applied to biopharmaceuticals.
3. Supor ® EKV Membrane filters- are0.2µ. It is used for the filtration of liquids like buffers, tissue culture media(11).

There are two types of membranes- Hydrophilic and Hydrophobic filters.

Hydrophilic filters- are used to filter aqueous liquids in a sterile way. These are available in two forms.
a. Disc filters (sheet or plate)
b. Cartridge filters

Disc filters The membrane is positioned between the metal inlet and the outlet plates. These are stacked serially and sealed together using elastomeric O-rings. These are hard to sterilize, and cannot tolerate differentials of high pressure. These are less commonly used.

Cartridge filters are the most widely used filters in pharmaceutical industries. These filters are placed inside cylindrical housings made of stainless steel or removable plastic housings. The operating component is a rectangular membrane layer, pleated and folded in a cylindrical shape. The membrane is fragile and sandwiched within two non-woven material support layers. The pleated cylinder is mounted all over one perforated plastic hollow tube and within another perforated plastic hollow tube. Two end caps hold the entire assembly together. Hydrophobic filters-

These are used in sterile filtration of gases, solvents or acidic or alkaline solutions. These are used as air vents on processing tanks. As gases pass in or out of the tank these filters remove microorganisms and particulate matter from the gas [12].

Based on the capacity of the particle size separation there are four types of filters: clarifying filters, microfilter, ultra, and Nano filters.

Clarifying filters
Are also used as Depth filters or Prefilters. This consists of a size range of 10 to 200 microns. The materials used in-depth filters are cellulose fibers, diatomaceous earth, glass fibers, and polypropylene. Prefilters or surface filters used to prevent the microfilter from clogging of the membrane. Cellulose ester and heat-bonded propylene fibers are the materials used as pre-filters. It is used for extracting contaminants, pollens, particles, and several bacteria.

Microfilters
Are sterilizing filters. The size range differs from 0.1 to 10μ. Due to controlled polymeric structures, these have narrow pore distribution. It is used to remove large bacteria, algae, colloids, and yeasts.

Ultrafilters
These are used in upstream processing for cell harvesting and buffer exchange. The size range differs from 0.001 to 0.1μ. Cellulose acetate, cellulose nitrate, regenerated cellulose; polyamide, polycarbonate, polyvinylidene difluoride, and polytetrafluoroethylene are the polymers used in both ultrafilter and microfilter. It is used to eliminate organic compounds that are growing.

Nano filters
These are used on devices with reverse osmosis. It has < 0.001 μ. These are used to remove small organic compounds and ionic forms [1].

ASEPTIC FILTRATION APPLICATIONS:
The principal challenge in aseptic processing is to maintain a high-level consistency of microbial control. Aseptic filtration is used to remove microbes from heat liable liquids such as antibiotic solutions, serum, heat sensitivity injections, ophthalmic, and biological products. Numerous applications of aseptic filtration include:
- Eliminating bacteria from ingredients of culture media.
- Toxins are separated from culture filtrates.
- Filtering the samples during storage to prevent microbial growth.
- Filtering of buffers to eliminate particulate and inhibit microbial growth during storage.
- Filtering of biological and environmental samples for analytical analysis.
- To sterilize solutions used in aseptic conditions like isopropyl alcohol, disinfectants.
- Post-fermentation filtering of broths for further purification or analysis [13].

IMPROVEMENTS IN FILTER TECHNOLOGY:
Over the past decade, there have been many improvements in filter technology to meet the needs of regulatory requirements and manufacturers. New technologies are evolved to improve efficiency and flexibility in the design. Risk analysis tools help to illustrate the bioburden reduction and help us to select the appropriate filter type and its process requirements. The advancements in filter technology are listed below.
- Improved materials of construction of filter cartridges.
- Instead of manually assembled disc sets pre-assembled cartridge filters are used to minimize error.
- Improved vent and gas filters with greater efficiency and strength.
- Enhanced automated systems for in situ filter integrity evaluation [14].

REGULATORY ASPECTS

The manufacturing of sterile products should meet the requirements of good manufacturing practices (GMP). Where sterility is asserted, regulatory agencies require integrity tests of filters to ensure the performance of the sterile filter and the filters should meet the standard requirements of regulatory bodies. Therefore, effective regulation is required to ensure the safety, efficacy, and quality of the products as well as accuracy [15].

- EU GMP – Before use, the quality of the sterilized filter should be verified and validated immediately after application by an adequate method such as destructive and non- destructive methods [16].
- US FDA- Filter integrity testing can be done in advance of the process and should be periodically post-use [17].
- Regulators are suggesting redundant filtration for critical filtration systems as a risk mitigation technique [18].

STERILIZING GRADE FILTERS

USFDA defined sterilizing filter as one that produces sterile effluent at a minimum concentration of 10^7 organisms per cm^2 of filter surface when challenged with the microorganisms *Brevundimonas diminuta*. They are also used as venting devices on fermenters, centrifuges, and autoclaves in manufacturing [17]. There are various factors involved in selection of filters which are depicted in Fig.1 [10].

ASEPTIC PROCESSING BY USING STERILE FILTERS

In aseptic areas, strict control measures should be adopted to avoid contamination of the preparations. Aseptic processing of the drug product, container, and closure that have been subjected to different sterilization methods separately, filtered and assembled in extremely high environments. By using sterilizing filter, the solution is filtered and then filled into sterile containers. Grade C environment is used for filtering sterile liquids.   Before manufacturing, all the raw materials and primary packaging materials are dispensed and glassware and accessories, transfer vessels are cleaned by clean-in-place (CIP) and steam sterilized by sterilization-in-place (SIP) or autoclave. The solutions are filtered by using a pre-filter followed by a 0.22μm filter and transferred into the sterile vessel. The fill units (eg vials, cartridges, and pre-filled syringes) are washed and silicone film is applied as required to them and passed through the annealing lehr. It minimizes the interaction between the product and the container. The container dehydrogenation is done by exposing them to high temperatures to remove the pyrogen from the containers. By using two 0.22μm sterilizing grade filters the solutions are once again filtered and filled into the containers and sealed and stored at 2-8ºC and these visually inspected. After the inspection is done these are ready for secondary packaging. The manufacturing process is depicted in fig 2 [19].

Precautions during Aseptic filtration:
- Pre and post integrity test should be performed for all the product filters which are used for filtration of the drug product.
- Pre and post integrity test should be performed for all the vent filters which are used for manufacturing and filling process.
- Before starting the pre-integrity test for product0.22μm capsule filters the particle counter is switched ON for the filtration area.
- Sterile filtration must begin immediately after the manufacture of the bulk solution.
- Ensure the solution filtration is carried out through the required pre-filter followed by one 0.22μm sterilizing grade filter.
- Pre-integrity test should be performed for the filters before proceeding for filtration and post integrity should be performed after completion of the filtration.
- Ensure that all the filtration laminar airflow units are switched ON and differential pressure as per set limits are maintained [20].

GENERAL PROCEDURE FOR STERILE FILTERS USAGE

Sterilization-The SIP, autoclaving or gamma-irradiation sterilize the filter system. If the SIP approach is chosen, then the low-point vent on the upstream side of the barrier filter is opened during the process. To drain filter outlet air

condensate and steam is passed through the filter and low-point vent is closed. With the application of compressed gas, the system cools down and retains the sterility infiltration mechanism.

Wetting
Ensures that the product filters are fully wetted for its integrity test with particle-free water. Initially, the vent on the product filter is left open and the insulation valve is closed to downstream equipment.

Testing
It can be performed by either diffusion or bubble-point test. Pressurized gas is pumped onto the upstream side of the product filter. Only the drain line remains open so that test gas can flow freely through a hydrophobic portion of its membranes

Drying
The product filter is dried to avoid dilution of the product stream before the product is inserted into the filtration process.

Testing for filter integrity
70/30 isopropyl alcohol used as a wetting medium and ≥1,280 bar (18.5psi) used for the test. The filters are wetted with dynamic flushing or static-soak methods. Before the filtration of the product, filter integrity is tested.

Process
The aseptic filtration process can commence when the integrity of the product filter is verified.

After Processing
After the filtration, the retrieval of the substance is achieved by air blown-down with the application of 5psi low differential pressure to the filter. These filters are tested for integrity with particle-free, water-based, alcohol (70/30IPA/water) or product-based parameters at the end of product recovery. For specifications on a particle-free, water-based or alcohol integrity check, a filter must be thoroughly flushed with the test liquid to eliminate excess product before testing. Specifications for product-based can be established from filter vendors [21].

FAILURE MODE TEST
To simulate this test, users should analyze how a fully wet barrier filter gas flow rate affects a product–filter integrity check. These filters can be fully wetted by flushing at 3 bars with WFI.

TROUBLESHOOTING DECISION TREE
It is applied when the product filter fails an integrity test. It consists of three steps

Step 1: system setup and test parameter checks are checked
System setup checks:
- Verify that the test setup is installed and operated properly.
- Verify that the test equipment has been properly calibrated.
- Make sure that there are no leaks in the test system and correct filters have been installed.
- During testing, verify that the temperature remained within the specified range.

Test parameter checks
- Verify that the appropriate integrity test has been selected.
- Verify that the test parameters are correct.
- Verify that the proper wetting fluid and wetting procedure are being used.

After checking the above parameters filter is rewetted and integrity test is performed.

Step 2: If the test passes the results are recorded and the filter is integral. If the test fails filter is wetted by increasing the flush volume and differential pressure. Backpressure is applied. If the test passes the results are recorded and the filter is said to be integral.

Step 3 If the test fails again filter is wetted by flushing the filter with low surface tension reference wetting liquid. If the test passes the results are recorded and the filter is said to be integral. If it fails the results are recorded and it is demonstrated that the filter fails the test [20].

FILTER INTEGRITY
In the pharmaceutical industry integrity test of the sterilizing filters is essential. While processing sterile solutions FDA requires integrity testing of filters to reduce the bioburden. Integrity testing is classified into two types-destructive and non-destructive testing[22]. In destructive testing sterilizing filters ability to retain the bacteria is determined. Non-destructive testing done before and after use on filters. The non-destructive test is of three types-bubble point test, diffusion test, and water intrusion test.

Bubble point test
A bubble point test is used to determine the pressure at which a continuous stream of bubbles initially seems downstream of a wetted filter under gas pressure. The filter is wetted by using water or IPA. On the upstream side of the filter, the pressure is increased slowly. By using flow meter, the gas flow is measured. Various instruments like Palltronic® Flowstar IV, Sartocheck® 4 (as mentioned in Fig 3) [233]. Nalgene ™ are used for checking the filter integrity [24].

Sartocheck® 4 Parameters:
Test parameters: Bubble point and Diffusion test
Pressure: in mbar
Stabilization time: in min
Time: in min
Max. Diffusion: in ml/min
BP Min: in mbar
BP Max: in mbar
Net volume: Enter or measure, if Enter: Volume in ml.

Test parameters: Water intrusion test
Pressure: in mbar
Stabilization time 1: in min
Stabilization time 2: in min
Time: in min
Max. Diffusion: in ml/min
Auto Filling: Yes/No
Net volume: Enter or measure, if Enter: Volume in ml (25).

CAPSULE FILTER
Capsule filter provides sterility assurance, narrow chemical compatibility, and high flow rates.   These can be sterilized by autoclave and gamma radiation and available with a variety of end fittings for easy connection in process lines.

Wetting procedure for capsule filter during pre and post integrity testing

- The upstream of the filter is connected to the mobile phase which contains water with silicon tubing. The downstream of the filter is connected with 50cm of silicon tubing.
- It is flushed with WFI at pressure with 1.0 bar, during the flush the vent in the upstream filter is opened until the air pockets are removed. The flush volume should not be less than 7.5 liters.
- Approximately5 minutes WFI flush is continued, followed by folding the silicon tubing in the downstream to create backpressure and vent in upstream are opened.
- The entire wetting procedure is performed for NLT 10 minutes at a pressure of 1 bar. (0.8 to1.2 bar) (26).

Pre-integrity test of capsule filter

- Before starting the test and filtration activity particle counter is switched ON.
- Check whether the pack is gamma sterilized or not.
- The filters are wetted with WFI or a suitable solvent, once the wetting is done filter is removed and the inlet of the capsule filter is connected to the integrity apparatus and integrity test of the filter is performed.
- In case the test fails, the flush time is increased to NLT 15 minutes and bubble point value is checked. If the test even fails after WFI wetting for the second time the filter is isolated and the deviation is raised.

Note

- Before starting the filtration, the capsule filter is purged with filtered nitrogen gas such that there is no residual water in it.
- Based on the WFI bubble point value, the minimum pre-bubble point value is fixed.
- If the pre-integrity test is failed with WFI bubble point value for the first time, then again, the test is repeated with WFI (II flush).

Filtration Assembly

- Once the pre-integrity test passes, one side of the sterilized silicon tubing is connected to the inlet of the capsule filter in filtration area and another side of the tubing is connected to the pre-filter in the formulation area (as mentioned in fig. 4) [27].. New sterilized silicon tubing is taken and one side is connected to the inlet of the pre-filter and another end to the outlet of the non- sterilized container.
- New sterilized silicon tubing is taken and connected to the outlet of the capsule filter and another end is connected to the inlet of the sterilizing container [27].

Aseptic filtration of the solution

- After the complete installation of the filter assembly, the non- sterilized containers are pressurized with 0.22μm filtered nitrogen gas.
- The air vent of the filter is opened to release the air and then the vent is closed to carry out the aseptic filtration.
- In the filtration room, the bulk solution is filtered into the pre-sterilized vessel under LAF using a gamma sterilized 0.22-micron capsule filter. If any air pockets are observed in tubing the filtration is stopped.
- After completion of the filtration, the outlet valve of the non- sterilized containers is closed and nitrogen gas is released.
- The silicon tubing from the inlet of the capsule filter and transfer vessel is removed.
- The filter is flushed with WFI, and the inlet of the capsule filter is connected to the integrity apparatus and the post integrity test of the filter is performed [28].

Post integrity test of capsule filter

After completion of the filtration process, the capsule filter assembly is removed and the filter is flushed with WFI and the inlet of the capsule filter is connected to the integrity apparatus and the test is conducted. If the test is not passed with the first flush of WFI, then the test is performed with the second flush of WFI, if not passed it is performed with 70% Isopropyl alcohol. Bubble point values for the wetting media like WFI- NLT 50 psi, IPA/Water- NLT 18.5 psi [27].

REDUNDANT FILTRATION

A redundant filtration is a form of serial filtration in which a second filter is used as a backup to protect the primary product filter against integrity failure. It reduces the risk of product loss due to sterilizing integrity failure. In the case of redundant filtration, a pre-integrity test has been performed to both filters. Post integrity is performed for the final filter. In case of integrity failure of the final filter, then the test is performed on the first filter. If the first filter passes the test, then the filtration is successful. In case both the filters fail, the deviation is to be raised[29].

Procedure for redundant filtration connection for the filtration activity

- The pre-integrity test for both filters is performed. The first pre-integrity is carried out for the filter which near to the filling zone.
- By using sterilized silicon tubing the two filters arranged in series.
- In the filtration area, the first and second filters along with the silicon tubing connections are placed under LAF.
- One side of the tubing is connected to the 0.22μm capsule filter-1 in the filtration area and another side is connected to the outlet of the pre-filter which is present in the formulation area.

Another piece of tubing is taken and one end of the tubing is connected to the inlet of the pre-filter and another end to the container (as mentioned in fig 5)[30].

- The outlet cap of capsule filter-1 is removed and one end of the tubing is connected to the outlet of capsule filter-1 and another end of the tubing is connected to the inlet of capsule filter-2.
- The outlet cap of capsule filter-2 is removed and one end of the tubing is connected to the outlet of capsule filter-2 and another end is connected to the receiving container.

Procedure for redundant filtration connection for filling activity

- In the filtration area, the two filters are connected in series and the filters are wetted and a pre-integrity test is performed.
- After completion of the filtration, the outlet of the transfer vessel is connected to the inlet of the first filter through silicon tubing.
- The outlet of the first filter is connected to the inlet of the second filter through the tubing and the second filter outlet is connected to the silicon tubing and another end of the tubing is wrapped with steri pouch and autoclavable indicator tape.
- The entire set of the filter connection is wrapped in the filtration area under LAF.
- By using sterilized forceps, steri pouch is removed from the tubing and it is connected to the inlet of the dosing vessel [30].

VENT FILTERS

Under dry or moist conditions, these enable high-efficiency removal of airborne bacteria and particulates. Hydrophobic membranes include polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF) which is used as a sterile venting barrier or protection of particulates. These should retain particulate material and droplets and bacteria effectively. Hydrophobic filters are used to allow air to flow in and out of storage tanks. To protect liquid contents from microbial or particulate contamination, these vent filters are mounted on the tank. Tank vent filters allow air to flow in both directions and prevent damage to the tank when air is compressed during tank filing or when tank emptying is made [31].

Wetting of the vent filters

- One end of the silicon tubing is connected to the can outlet and another end is connected to the filter via a peristaltic pump. One more piece of silicon tubing is connected to the filter outlet and another end to the can inlet.
- The wetting procedure is performed by switching ON the peristaltic pump by recirculating the 60% IPA.

- The peristaltic pump RPM is maintained between 100-150 rpm to ensure that no pressure is built at the inlet of the filter.
- The wetting procedure is continued for by recirculating the disinfectant for 5 minutes and ensures that there are no air bubbles.
- Once the wetting procedure is done peristaltic pump is switched OFF and the filter inlet and outlet are disconnected and connected to the integrity testing machine.

Drying of vent filters

The vent filters wetted with 60% IPA are dried by passing the compressed air for 5 minutes. Physical inspection is done to ensure that the filter is dried properly. Once the filters are dried the filter is labelled with integrity details and stored until further use [21].

Pre-Integrity Test

The filter is wetted using a peristaltic pump, using the required amount of 60 % IPA. Remove the filter after wetting, and connect it to the integrity tester and then the test is started by entering the required input data. After completion of the test, the filter is flushed using compressed air for 5 minutes and NMT 1 bar pressure. If the filters pass the test these are subjected to sterilization.

Post Integrity Test

The filter is removed and wetted and wetted with 60% IPA and connected to the integrity tester. If the test fails for the first time the filters are flushed with an additional quantity of 60% IPA. If it fails for the second time, then the deviation is raised. If the vent filters are used again on the same day of post integrity test of the earlier batch. A post integrity test is considered as a pre-integrity test for this batch. If it is not used on the same day, pre-integrity test for vent filters performed before using [2]. The below table (Table 1) describes the standard psi values for measuring the bubble point pressure in vent filters. So, this table helps us to record observations of filter whether the filter passes or fails the integrity test.

CONCLUSION

In aseptic processing, sterility plays a crucial role. It establishes that the process equipment and facilities are robust. The filter performance should be periodically checked and risk assessment should be performed before an existing filter is implemented for a new product manufacturing. There are several varieties of filters available in the market with compliance with regulatory guidelines. By implementing aseptic filtration to thermo liable drugs it improves product safety, quality, and flexibility. To achieve a robust process infiltration various improvement are done for filters. Even after these advancements in aseptic filtration still, there is a scope for innovation and advancement in the development of the filtration process.

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DECLARATIONS

CONFLICTS OF INTEREST

The Authors declare that they have no conflict of interest.

Statement of Human and Animal Rights: This article does not contain any studies with human and animal subjects performed by any of the authors.

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Authors Contributions
B. Rishitha Reddy (RR), Divya Talasila (DT), Hemanth Kumar S (HK) Gowrav M P (GP), Shailesh T (ST) conceptualized and designed the study. DT, RR, performed the literature analysis, and wrote the original manuscript draft. HK, GP and ST revised, edited, and extended the final draft. All authors have reviewed and approved the manuscript before submission.

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Table 1: Bubble point pressure monitoring for 0.22μm vent filters

Bubble point pressure (psi)		Observation	From - To (Hrs)	Remarks
Std	Actual			
≥20.0 psi	----- psi	Pass/ Fail		
≥20.0 psi	------ psi	Pass / Fail		
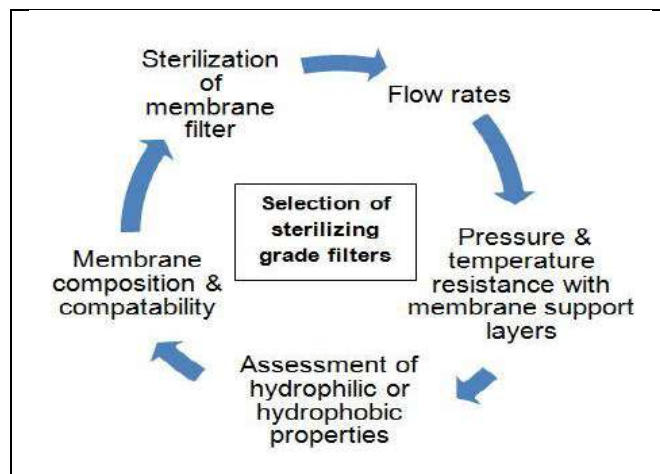
Fig. 1. [10] Selection of sterilizing grade filters
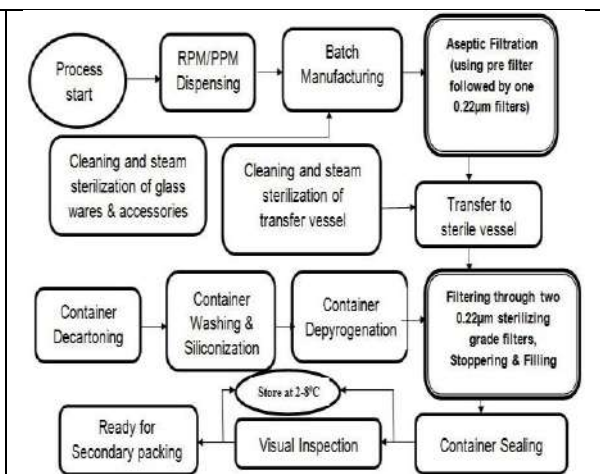
Fig. 2: [19] General Aseptic manufacturing Process of Parenterals

Fig. 3: [23] Sartocheck® 4 integrity apparatus
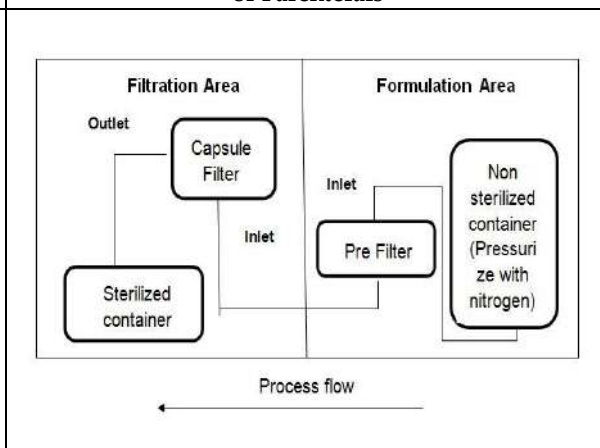
Fig. 4: [27] Filtration Assembly

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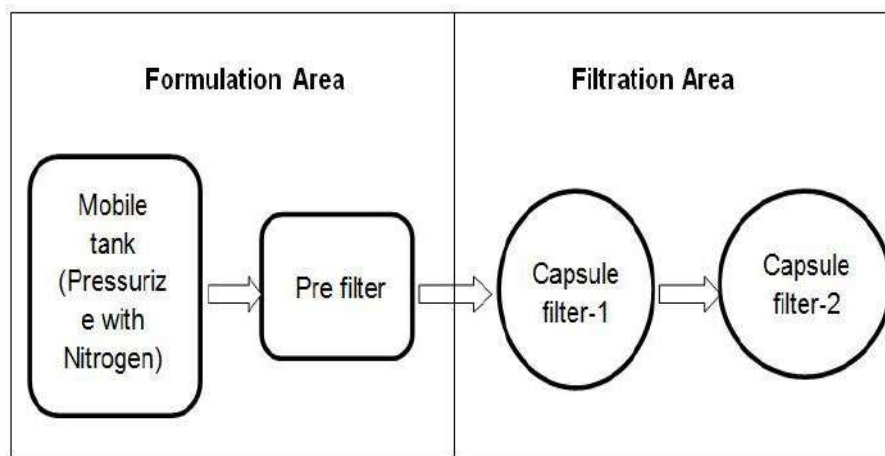
Fig. 5. [30] Redundant filtration Setup

RESEARCH ARTICLE

Comparision between Active and Sedentary Individual for Risk of fall by using Berg Balance Scale

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ABSTRACT

Aging is a dynamic, progressive and physiological process accompanied by functional, morphological, biochemical and psychological changes. As the age increases the fear of falling increases. Falls are one of the major causes of morbidity and mortality in geriatric population. This scale is two types of individual that is the active population and the sedentary group. The different studies says that the fall is more in the sedentary group because of less of the decrease physical activity. But the scores vary with every individual, so this study compares the risk of fall in both the groups. Comparative study was conducted between two groups, Active group and sedentary group. The total 30 individuals were taken and they were asked to perform the listed items given in the BBS scale The scores were given on the basis of the how the individual performs the given activity . Results were statistically analysed by the Levene's test for equality of variance between the two groups and the "t-Test" is applied . The study concludes that the risk of fall is more in the sedentary group compared to the active group. The risk of fall is more because of the decrease or no amount of the physical activity in the sedentary individual. The more the physical activity the less the risk of fall.

Keywords: Active group, t-Test, analysed by the Levene's , equality of variance

INTRODUCTION

Aging is a dynamic, progressive and physiological process accompanied by functional, morphological, biochemical and psychological changes. India having the second position in the world for population rise in elderly individual and there has been reported that it will rise to about 324 million by 2050[1].Postural control is important to do all the daily tasks. It is important in all the daily activities like standing to sitting, walking .The ability to maintain balance

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in various positions and when reacting to external perturbations presents the good postural control.[2]Falling is an event which leads to decrease in independence of geriatric population [2]. Falling leads to musculoskeletal injuries [2]. Falling is one of the reason for hospitalization in elderly population [2]. Active ageing is promoted by physical activity which in term helps in maintaining and developing functional capacity which helps in advance age [2]. In UK, Finland, New Zealand, United States and Sweden, the incidence of fall have been reported to fluctuate between 224 and 809 per 1000 person-years in the community based older population[3] .As the age increases the fear of falling increases. Varieties of factors can affect the risk of fall like decrease in the sharpness of eyesight, hearing and reflexes. Some diseases like diabetes mellitus, heart problems or problems with thyroid, nerve, blood vessels can affect balance. Some medicines have side effects such as dizziness and sleep which may cause risk to fall. Some bodily internal factors like muscle weakness, problems with gait, postural hypotension may cause fall. External factors affecting the balance such as low luminous light, slippery floor etc. Lack of physical activity can lead to great risk of developing high blood pressure, risk of type2 diabetes. It can also lead to anxiety and depression. Physical inactivity can cause overweight or obese .Bones may get weakened and demineralised.

It may also cause poor blood circulation and hormonal imbalance .Inactive lifecycle may cause certain cancers like colon, breast and uterine cancers .A sedentary lifecycle can raise your risk of premature death. The more sedentary you are, higher your health risk are. The 8th Cranial nerve which is called Vestibulo-Cochlear maintains the balance and equilibrium of the body .If the nerve is affected it leads to balance affection. In the elderly population the chances of vestibular dysfunction increases which results in affection of balance and gait [3]. Due to Dorsal Column Dysfunction, ataxic gait takes place .There are also chances of having stiff gait. The elderly population shows same characteristics as they walk slowly compared to normal individual and have more risk for fear of fall. Sedentary individual have significant unsteadiness during walking [4]. The two types of population are elderly individual, active and sedentary. The one who performs physical activity for 30 minutes regularly other than all the ADL's. Sedentary are those who do not perform any activity other than ADL's. Vestibular system helps in maintaining balance which is present in the inner ear. Balance is present when all the sensory activities like body's sense, eye, and inner ears. Balance may be affected if all the sensory mechanism is affected. Muscle strength plays important role in maintaining balance [2]. Falling leads to unfavourable outcomes which can also cause musculoskeletal injuries, decrease performance of functional activities of daily living [2]. Physical activity is the preventive measure for risk of fall. The advantages of increasing the physical activity are improvement in muscular strength, speed of task execution, coordination, maintenance of postural control, preservation of functional capacity Muscle strength and balance is used to assess the risk of dependence of the elderly population [2].

This assessment will help in developing the future interventions for good and effective treatment. Patients and society can get the benefit of this assessment and can also be made aware of the early identification and mapping the risk factors for the same. There is the percentage distribution of older adults of only 22% who are just involved in the physical activity .Lack of physical activity leads to the functional decline and also decreases exercise capacity and also leads to injury [3]. The Centre of Gravity and the Base of Support controls the posture in both static and dynamic situations. After the physical interventions the falls are reduced .In the gait disturbance there is decrease in stride length. The different systems which take part in changes in the gait are nervous system, Cardio respiratory, musculoskeletal changes [4]. In elderly population there is affection in gait cycle. The following changes takes place which are that the speed decreases, there is reduced hip and knee extension, decreased ankle dorsiflexion and angle at the heel strike. Decreased step and the stride length and altered step width. It also leads to increase double support time, stance time. Falls in older adults are a significant cause of morbidity and mortality. Fall can be defined as "sudden and unexpected change in position which usually results in landing on the floor" [4]. The cause of falling in old age is often multifactorial and may require a multidisciplinary approach both to treat any injuries sustained and to prevent future falls. Classification of fall: accidental versus non accidental, syncopal versus non syncopal, intrinsically versus extrinsically driven, falls with injury versus fall without injury and a single fall incident versus recurrent falling [4] .Pain, loss of confidence, functional decline, and institutionalization are associated with the fall [4]. Falls can lead to "fear of falling" and along with that there are chances of increasing levels of immobility and dependency with a deteriorating quality of life [1]. Patients demonstrate abnormal and inflexible postural responses

to decrease the chance to fall [1]. Patients also experience difficulty in dynamic motions such as initiating self-movements like functional reach, walking, and turning [1] .Many scales have been developed to assess balance and predict falls in the older adults. This include Berg balance scale (BBS), Functional reach test (FRT),the time up and go Adults. This include Berg balance scale (BBS), Functional reach test (FRT), the time up and go test (TUG),the cognitive timed up and go test (CTUG) and the Dynamic gait index(DGI) [1] .

Strategies to improve safety and reduce fall risk:
Prevention of fall in elderly is an important goal. Patient education and lifestyle counselling can help to reduce likelihood of falls. Patients should avoid activities like climbing on ladder, walking on slippery or icy floor. The education should address the harmful effect of sedentary lifestyle and physical activity should be encouraged; in form of regular exercise and walking. Medications should reviewed by physician if postural hypotension is there to the patient in patients with more risk of fall; compensatory strategies can be applied if normal strategies are lacking. Increasing friction between the floor surface and body can reduce the chances of fall can be instructed to wear rubber sole shoes for more grip. Assistive devices can be uses while locomotion to prevent fall. environmental changes can be done for decreasing chances of fall like ;adequate light in room ,carpets with loose edges ,chair or sofa with adequate height or firmness ,handrails on stairs if not present should be installed ,grab bars or rails in bathroom can installed to reduce the fall in watery surface, adequate height of toilet seat for independent use [1]. BBS should be used in conjunction with other balance measures because of the factors like its validity and reliability. Some author stated that there was a limitation during using the BBS scale because of the lack of items requiring postural response to external stimuli or uneven support surfaces. This concludes that BBS would be more appropriate for older adults rather then the community dwellers [10].

NEED OF THE STUDY
To check the risk of fall in the Geriatric population between the age group of 55-75 Years on the basis of BERG BALANCE SCALE. As the Geriatric population have more risk of fall so we took this population for our study. In this age group the bodily changes are more so this age group is taken. The aim of the study is to evaluate the balance in the Geriatric population between Active and Sedentary individuals.

MATERIALS AND METHODS

Study Design: Comparative Observational Study
Study Subject: Elderly Population between 55-75 Years
Sample Size: 30
Sample Design: Simple Random Sampling
Source of Data: Sainath Hospital, Opposite Kabir Enclave Bopal
Duration of Study: 2 week
Materials used in the study are: Stop watch, Measure Tape, Chairs, Step Stool, BBS Scale paper, Pencil, Rubber

INCULISION CRITERIA
Males and Females Both
Age: 55years -75 years
Able to follow command
Subjects who are able to walk without any assistive devices

EXCLUSIONCRITERIA
Subjects having neurological and psychological problems
Subjects having any acute illness or any kind of Injury
Incomprehension to subjects
Subjects having any type of Musculoskeletal Disorders.

OUTCOME MEASURE
Berg Balance Scale

PROCEDURE
Subjects at the Sainath Hospital will be briefed about the study and are selected on the basis of Inclusive and Exclusive criteria .The subjects who are selected will be given the written consent in their known language. They will be randomly selected according to the criteria. The patients are been given the knowledge about the study and they are explained about the activities which are listed in the scale .The patient are said to do this activity under the supervision of the therapist. An interpretation is done according to the patient completing the 14 items in the scale. The proper supervision is conducted during the patient performing any activity. According to the scores of the BBS, the further treatment protocol is done.

RESULTS

The total 30 Individuals were taken for the study. They were divided in 2 groups which are Active and Sedentary Population according to the inclusive and exclusive criteria. The data was analysed by using SPSS (statistical package for social sciences) software. Levene's test for equality of variance was used. And the two groups were compared using unpaired t test. TABLE 1 Mean values of the Active and Sedentary Population. The above given chart describes about different things like the Mean Value, Standard Deviation and the Standard Error Mean. The total number of active individual was 15 and the Mean BBS of this group was 48.1333 and the Standard Deviation was 2.8999. The Standard error mean of the sedentary is more in sedentary individual. TABLE 2: Results This table states that the mean BBS of the Active individual is more compared to the Sedentary individual .The error mean of the active is less than the sedentary error mean .Levene's test for equality of variances is used in this study. Unpaired t-Test is used for measuring the mean difference, standard deviation error. The lower and the upper values of the 95% confidence interval of the difference is measured. GRAPH 1. Mean BBS of the Active and Sedentary Population. The given chart shows two group of population. Active and Sedentary group .The mean for the active is 48.1333 and the sedentary is 41.4667. The difference between the groups is by 7 points. So it states that the risk of fall is more in sedentary group compared then active group. The result says that the physical activity of the passive group is less.

DISCUSSION

The Berg Balance Scale was developed to assess the risk of fall in the elderly individual and the patients with any neuromuscular disease. It is also used in evaluating the treatment protocol for the patients. BBS classifies the risk of fall in 3 categories which are low risk, medium risk and high risk[1]. The risk of fall in more common in the geriatric population because of the first and the foremost reason which is age[5]. The other reasons which may be the osteoporotic changes and osteoarthritis leading to more risk of fall. Falls also takes place because of the poor health and the decrease in the physical activity. The factors which take part in this include the increase in the age, increase use of medication, sensory loss[5]. The balance is evaluated in both the static and the dynamic group. In this research, the elderly individual have more balance affection in the dynamic group because the patient need to do the activity like sitting to standing, picking up the object from the floor[1] .Muscle strength plays an important role in this because less muscle strength will lead to more risk of fall. The amount of physical activity which an individual does also plays an important part. The less the activity the more the risk of fall. Increase in the ageing process leads to absence of stimulation[5]. In the static group, the patient needs to attain a functional position for a specific period. This is comparatively easy for the individual because maintaining stability is easier then performing the given task. Fatigue will lead to poor postural control. The above result states that the risk of fall is more in the sedentary group of individual then the active group. This is because of age and the amount of physical activity. As the age increases the changes in the body takes places like the neuromuscular changes, bony changes, cardiovascular changes and all the other physiological changes which leads to impaired balance[9]. If arthritic changes in the elderly population, commonly leads to the balance affection because of the joint overuse, increase in the friction between the joint,

osteophytic changes etc. This all changes leads to less physical activity which will affect the balance because of less range of motion and decrease muscle strength [7]. The female population have more risk of fall because arthritic changes are more common in them. They need treatment for improving their balance. This study can be useful in the further changes which can be made in the balance examination and setting the future goals. The Active group of population have low risk of fall because they have more muscular strength which is helpful in their postural control. The result says that the mean BBS of the active group is 47.1333 and the sedentary group have the mean of 41.4667 which states that the difference between these groups is more by 7 points. The risk of fall is more in sedentary. The lifestyle of the individual also affects the risk of fall. The elderly population have inadequate muscle contractions because of the muscle weakness because of the decrease in the tactile sensitivity which leads to the decrease CNS response for the body stability. It leads to gait changes and instabilities which lead to more falls. The regular physical activity which can be from mild to moderate provides less functional decline [2]. Exercises will help in less functional decline.

The lack of the physical activity give rise to decrease joint mobility, appearance of contractures, physical deconditioning and sarcopenia and this increase the risk of fall. As the age increases the thereis decrease sense position, slow nerve and sensory information conduction. It leads to imbalance of centre of mass of postural oscillation. In this study 30 subjects were taken and balance was assessed by berg balance scale. There are lot of study conducted on the balance assessment of the elderly people. There are so many studies also done on comparison of physically active and passive elderly individual [8]. Static postural control or stability: It refers to ability to maintain a posture with orientation of the centre of mass (COM) and the base of support (BOS) [Eg: holding in sitting, kneeling or standing] Dynamic postural control or stability: It is called as the controlled mobility. It is the ability to maintain postural stability while parts of the body are in motion. Eg: Includes weight shifting or maintaining posture with the addition of progressively more challenging movements [Eg: Lifting with upper trunk rotation and upper extremity reaching or standing with lower extremity [11]. In the study the static and dynamic balance was assessed by using BBS on the active and sedentary people. A.I.bellodid the study on the dynamic balance which states that considerable number of activities in daily life includes turning from on point to other in order to interact with environment turns included in the locomotion are necessary for functional mobility and have a common occurrence in daily activities. Thus rehabilitation is essential for the patient who have disturbance in their dynamic balance and they return to their highest functional level, prevents fall and their consequences.

Miguel Antonio Rahal says that the dynamic balance is a complex phenomenon that requires repetitive and coordinative movement of the limbs to move the body safely and effectively. Biological ageing manly causes structural changes and functional capacity loss which effects on maintaining dynamic balance [6]. Patricia Martinis Franiculli compared the risk of falls between active and sedentary individual and the finding of the study says that the muscle stretching, resistance exercise and the aerobic exercise promotes postural balance. He stated that the decrease in balance and gait disturbance is more in the sedentary group of individual. The study says that the more physical activity promotes effects on the risk of fall, because it slows down the inherent modifications and decrease risk which is important tool for prevention of ageing. The static and dynamic balance depends on the different systems like the somatosensory, visual somatosensory and signs involved in balance control[12]. Dynamic results says that patients have more instability because of the age criteria and the decrease muscular strength. Thus the study concludes that the comparison between the Active and Sedentary individual by using the BBS says that the risk of fall is more in sedentary individual, because of their lifestyle, age, any disease, or less amount of physical activity [8].

CONCLUSION

The result concludes that the chances of risk of fall are more in the sedentary group of individuals compared to the physically active group of individuals. Because of no physical activity in the group the strength and the range decreases which leads to more risk of fall.

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Table 1: Mean values of the Active and Sedentary Population

Group		N	Mean	Std. Deviation	Std. Error Mean
BBS_ Score	Active Individual	15	48.1333	2.89992	.74876
	Sedentary Individual	15	41.4667	3.97971	1.02756

Table 2: Results

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	T	Df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BBS Score	Equal variances assumed	.176	.678	5.243	28	.000	6.66667	1.27142	4.06228	9.27105
	Equal variances not assumed			5.243	25.597	.000	6.66667	1.27142	4.05122	9.28211

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Graph 1. Mean BBS of the Active and Sedentary Population

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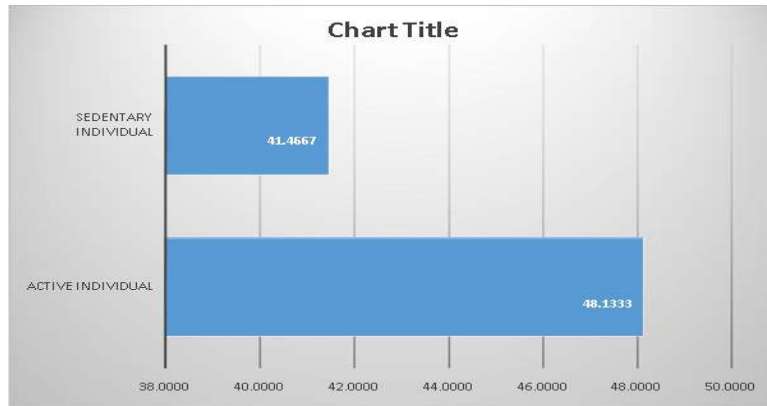
A Retrospective Study of Farmer's Admission and Disease Profile in Medical Critical Care Unit of Rural Tertiary Care Hospital

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ABSTRACT

Farmers play an important role in Indian society as they provide food and fiber ensuring nutrition and clothing for all. Though farming provides employment for most of the population, on the other hand farmers face various disease conditions most common being consumption of organ phosphorus compound poisoning which may be either intentional or accidental, followed by unknown species bite (most commonly snake and scorpion bite) other less common once are the alcoholic addiction, stress due to debt, poor yield and family responsibility ending with suicides. To study farmer's type of admission and disease profile in medical critical care unit of rural tertiary care hospital. A retrospective observational study done at rural tertiary care hospital. After approval of institutional ethical committee this retrospective observational study was conducted upon using the admission and discharge records of past 3years dated 01-01-2019 to 31-12-2021 from the hospital, data was collected and recorded. Total there were 770 patients identified in mentioned duration; male patients were 748(97.1%) while female patients were 22(2.9%). Maximum number of patients were aged less than 45years 423(54.9%) and most of the patient's reached to hospital between 8.00pm to 8.00am. Commonest problem observed was consumption of organophophorus and non-organophophorus compound poisoning followed by unknown species bite. July and October months witnessed highest number of admission. Out of 770

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patients a total of 577(74.9%) patients were shifted to general ward, 131(17%) of patients were declared dead, 49(6.4%) took discharge against medical advice and 13(1.7%) patients were referred to other higher center from critical care unit. The majority of farmers in and around our rural tertiary care hospital got admitted with history of consumption of pesticides which makes real concern. A proper action like education of the formers and involvement of government to prevent this is need of the hour.

Keywords: critical care, disease, farmer, poisoning, snake bite

INTRODUCTION

India is a developing country and farmers are the backbone of Indian society since ages as they are the main population for the food supply. Unfortunately farmers are exposed to various diseases which may lead to medical emergencies. The most common condition is pesticide poisoning [1,2]. Now a day it is not uncommon to see high amount of use of pesticides by farmers to get good yield. The lack of education, low socio-economic status and casual attitude for deadly pesticides may lead to exposing farmers to these chemicals leading to medical emergencies [3]. One of the common routes of exposure being the dermal followed by inhalation and via eyes. These chemicals are easily accessible, accidental or purposeful ingestion of these compounds seen among the farming individuals [4]. The objective of the study was to describe the characteristics of farmers getting admission in medical critical care unit, and to assesses' factors related to disease severity and hospital admission. We retrospectively analyzed all medical intensive care unit case records of farmers who got admitted from 1st January 2019 to 31st December 2021.

MATERIALS AND METHODS

After approval of institutional ethical committee [DR/RMC/UG-PG/2021/120], this retrospective study was conducted upon using the admission and discharge records of past 3years dated from 1st January 2019 to 31st December 2021. We collected demographic data, admission related data like time of arrival, disease profile data like diagnosis, duration of stay in medical intensive care unit and discharge details of the patients admitted in medical critical care unit of our tertiary care center. Inclusion criteria were patients of 18 years old and above getting admitted in medical critical care unit of both gender and farmer by occupation. Patients who were referred from other hospital were excluded.

RESULTS

770 patients were included in this study based on inclusion criteria. Out of this 729 (97.1%) patients were located in the rural area itself while 41 (5.3%) patients were located in urban area. Male patients 748 (97.1%) were most commonly suffered than women 22(2.9%). (Figure 1) .Majority of the patients were aged between 15 years to 45 years as depicted in figure no 2. Most of the patients' i.e 320 (41.6%) patients got admitted to the hospital between 8.00pm to 8.00am. In three years, the maximum number of patients got admitted in the month of July as shown in figure 3.Out of 770 patients 202(26.2%) patients had organophophorus compound poisoning which was commonest problem among all other disease pattern. A total of 47(7.5%) patients had unknown compound poisoning and 73 (11.8%) patients had snake bite and were admitted in (intensive care unit) ICU for monitoring and treatment which accounted to be the next commonest cause of ICU admission among farming population. Maximum number of patients i.e. 296(38.5%) had two days of ICU stay and once stabilized then they were discharged from ICU as shown in figure no 4.Out of 770 patients about 577 (74.9%) patients were shifted to general ward from the ICU, 49(6.4%) took discharge against medical advice, 131 (17%) patients died in ICU and 13 (1.7%) patients were referred to higher center based on the other associated clinical conditions (Figure 5).

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DISCUSSION

In this retrospective study we had a total of 770 patients who were farmer by occupation and admitted in the medical critical care unit. The study showed the male farmers are more in number and are indulged more in farming activities and so is the disease exposure is more in males than in females, the outcome matches with other study [5-7]. Agricultural workers suffer the broadest and most extensive exposure to injury and disease of any other occupation group. In this study, farmers of either gender are exposed to chemical hazards. Farming is one of the oldest of human occupation, in country like India. Farming provides 50% employment to the population and thus ensuring food and fiber to all the population [8]. Among the various health conditions, organophophorus compound poisoning (OPP) is of highest prevalence. OPP compounds are in regular use by farmers for crop protection and pest control [9]. These compounds are easily available and are of low cost leading to suicidal and accidental poisoning, suicidal being the most common followed by accidental poisoning[10,11].OPP compound poisoning is more common in developing countries as compared to developed countries[12]. Among the exposed 729(94.7%) belonged to rural area and 41(5.3) in urban area. The common age group, involved is less than 45years of about 423 (54.9%). Organophophorus compound poisoning has the highest incidence followed by unknown species bite (snake bite and scorpion bite being the most common). Low cost and easy availability of OPP compounds make them for consumption (accidental and suicidal) and route of OPP consumption is mainly through oral route, inhalation and less commonly through skin absorption [13]. Majority of the patients got admitted in the month of July and rainfall is expected during this and thus the farmers are getting more exposed to insect bites especially snake bite or heavy usage of OPP during these months causes increased incidences of OPP related issues. The clinical course of the disease of OPP last for 3 to 9 days this result is in accordance with similar studies conducted [5]. Among all the admitted patients in medical intensive care unit (MICU), majority of patients 577(74.9%) were shifted to general ward after stabilizing in MICU, 131(17%) were declared dead, 49 (6.4%) of patients took discharge against medical advices (DAMA) and 13(1.7%) of total 770 cases were referred to higher Centre indicating effective cure of patients under MICU admission with prompt and early treatment regimen. Of the total 770 case, commonest time of hospital presentation is at 8.00pm to 8.00am which numbered 320(41.6%) , between 8.00am to 2.00pm there were 196(25.4%) and 2.00pm to 8.00am there were 254(33%). These statistics indicate highest incidence of hazards (biological and health related) to farmers, also outcome of treatment in such emergencies depends upon the time of presentation of patients to the hospital. Earlier visit to hospital ensures better outcomes and earlier discharge from hospital and decreases mortality. This result coincidence with similar study conducted [14].

LIMITATION OF THE STUDY
The study is a retrospective therefore the possibilities of bias are more compared to prospective study WHERE the outcome is yet to occur.

CONCLUSION

The maximum farmers got ICU admission in the night hours, suggesting the transportation facility should be made optimum. The majority of farmers in and around our tertiary care hospital got admitted with history of consumption of pesticides which makes real concern. A proper action like education of the formers and involvement of government to prevent this is need of the hour.

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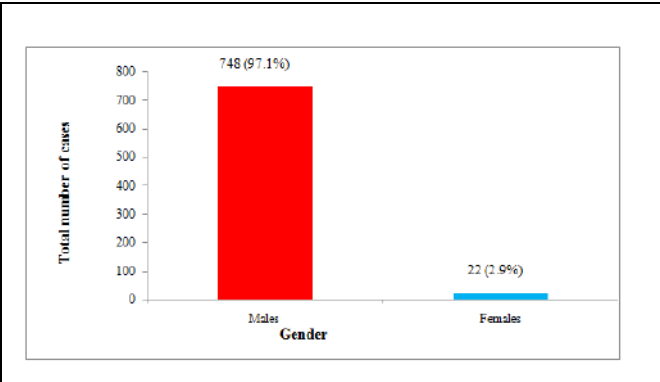
Fig. 1: Gender Distribution
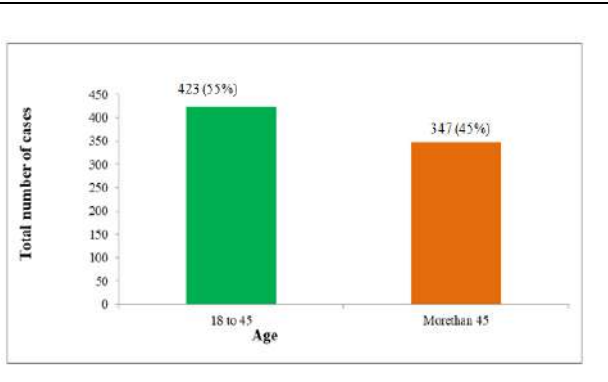
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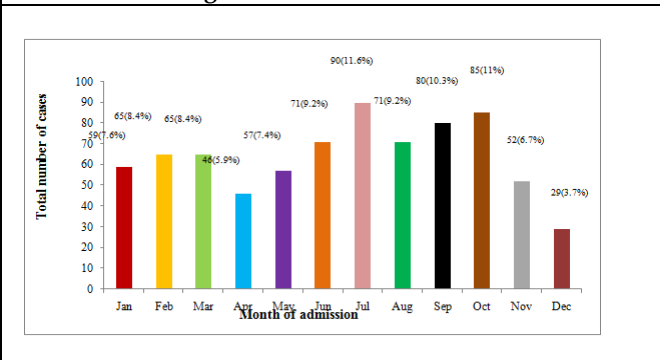
Fig. 3: Month wise admission of patients in 3 years of study period
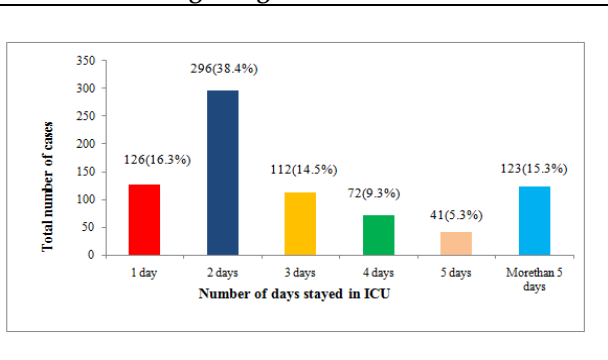
Fig. 4: Number of days stayed in ICU

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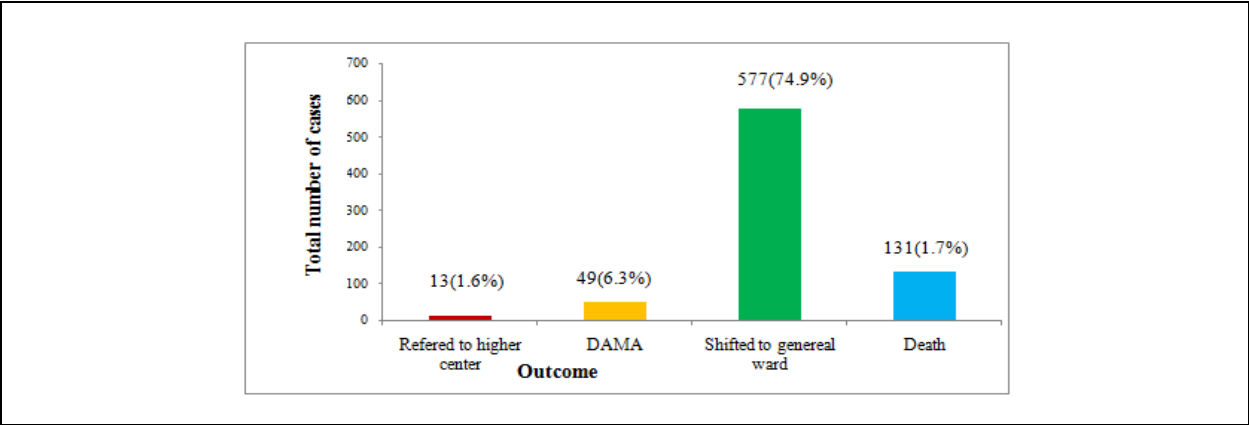
Fig. 5: Outcome of the Patients

RESEARCH ARTICLE

An Assessment of Urban Land use / Land Cover Analysis: A Case Study of Salem Corporation with help of GIS and Remote Sensing Approach, Tamil Nadu

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ABSTRACT

Anthropogenic activities of land use and land cover are being increasingly recognized as critical factors influencing the global change. The land use/cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. In the present study, to work out the land use/cover classification, supervised classification methods with maximum likelihood algorithm were utilized in the ENVI 4.7 software for the period of 1992, 2001, 2012 and 2018. To understand land encroachment for different land categories during the last three decades, a change detection was prepared which reveals that forest cover has been converted into agriculture, built-up area and fallow land area of agriculture has been converted into vegetation, fallow land and built-up area of fallow has been converted into agriculture, vegetation and built-up land and water body has been converted into vegetation. Over all, less vegetation cover was observed 2012. The results revealed that the environmental assessment sustainable development and continuous monitoring in and around the granite quarry is warranted in the mining district. The mining industry has evolved significantly and   allows   for   improved   mapping   and monitoring environmental impacts related to mining activities.

Keywords: Landsat data, land use and land cover changes, environmental impact, Salem City

INTRODUCTION

Urbanization has been an important social and economic phenomenon taking place at aunique scale and rate all over the world (Sun et al., 2013). Although, urban areas cover a very small fraction of the world's land surface, their rapid expansion has significantly altered the natural landscape and created enormous environmental, ecosystem, and social impacts (Berling-Wolff & Wu, 2004; Grimm et al., 2000; Mundia and Murayama, 2010; Pickett et al., 2001; Weber & Puissant, 2003). Due to the acceleration of the global urbanization in both intensity and area, there is a growing interest in understanding its implications with respect to a broad set of environmental factors including loss of arable land (Lopez et al., 2001), decline in natural vegetation cover and climate at local, regional, and globalscales (Grimm et al., 2000). The land use/ Land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space (Mir & Ahmed, 2014). Land use activity is a major issue and challenge for town and country planners as well as environmentalists to design an eco-friendly and sustainable economic growth. Research on Land-Use and Land-Cover Change (LUCC) using remote sensing technology has a long history and has made progress (Wei et al., 2015; Sun et al., 2016). LUCC is an important indicator in understanding the interactions between human activities and the environment (Dewan et al., 2012). The rapid changes of land cover are often characterized. Substantial impact on urban environmental conditions suchas biodiversity, climate change, and atmosphere particulate pollution at local and/or global scales as well as regional level. Despite, present technologies such as Geographical Information Systems (GIS) and Remote Sensing provide a cost effective and accurate alternative to understand the dynamics of landscape (Raziq et al., 2016) GIS and Remote Sensing are very useful in the formulation, implementation and monitoring urban land use and land cover for the sustainable development strategy. GIS is a systematic process of spatial data collection and processing. It can be used to study. the environment by observing and assessing the changes and forecasting the future based on the existing situation. Remote Sensing, on the other hand, is the process of data acquisition through space or air borne sensors, it allows the acquisition of multispectral, multi-resolution and multi-temporal data for the land use change analysis and an appropriate modelling.

Both Remote sensing and GIS tools have been applied in a number of urban studies to detect, monitor and simulate urban land use changes. Because of their cost effectiveness and temporal frequency, Remote sensing approaches are widely used for change detection analysis. It has also great potential for the acquisition of detailed and accurate surface information for managing and planning urban regions (Herold et al., 2002). However, computer assisted production of spatially detailed and thematically accurate LU/LC information from satellite image continues to be a challenge for the remote sensing research community. However, recent advances in GIS and RS tools and methods have enabled researchers to analyse and detect the dynamic nature of urban land use and land cover features in a more efficient way. The unplanned and uncontrolled rapid growth has resulted in serious negative effects on the urban dwellers and their environment. It is also associated with health risks including air pollution, occupational hazards and traffic injury, and risks caused by dietary and social changes (Li et al., 2012). Primary causes of urbanization are population eruption, migration from other places, industries, economy and proximity to resources and basic amenities. The built-up is generally considered as the parameter for quantifying urban sprawl. As population increases in an area or a city, the boundary of the city expands to accommodate the growth; this expansion is deemed as covert into other land uses.

Study Area

Salem Corporation is geographically located at 11.669437°N 78.140865°E, at an average elevation of 278 m in above mean sea level (Fig.1). Pre-monsoon thunderstorms occur during April and May. The Southwest monsoon season lasts from June to September. The northeast monsoon occurs from October to December. Salem is a major textile centre in Tamil Nadu, with more than 125 spinning mills, weaving units and garment units. Until the 1960s, it had less few spinning mills. Private handloom weaving began to increase in the region after the 1960s and during the 1980s, the textile industry expanded. The calculated annual average rain fall of the study area is 1019 mm, the annual mean varies from 667 mm to 1356 mm (Fig.2). The population in Salem has grown at a rate of 23 percent

per decade between 1951 and 1971, the rate has been lower for the decade 1971 – 1981 at 17 percent and 14 percent per decade between 1991 and 2011 (Fig.3).

METHODOLOGY

The study area boundary will be delineating the from topographical sheet with the scale of 1:50000 and will collected the basic information such as literatures of urban temperature and appropriate data from various Governmental and Non-Governmental Organisation (NGO).In the present study, varied data sets were employed to carry out the work including Survey of India (SOI)top sheets (scale, 1:50,000), also will be adopted Multi-Spectral of Land sat and8 OLI and sentinel 2 satellite data with the adequate spatial resolution of 30-meters and 10 meters for assessing recent urban sprawl in Salem corporation which freely offering from USGS (United States Geological Society) as well as European Space Agency (ESA). Dynamic phenomenon, such as urban sprawl/growth, requires land use change analyses. ArcGIS 10.6 software have been used to generate various thematic layers, like land use map, road map, railway line using the top sheets and other available maps. ENVI software will be assessed the land use / land covers in the Salem city.

Satellite data
In the present case, a FCC has been prepared for visual interpretation and to serve as a background image during sampling and subsequent image classification, taking three bands from the available four bands of the LISS III data. Following the standard procedure, the NIR band has been coded in red colour, the red band has been coded in green colour and the green band has been coded in blue colour to generate a standard FCC. False color composite using bands 4, 3, and 2 has been generated by Landsat TM and ETM+ 'Colour Composite' operation for three periods in ENVI 4.7 (Fig.5). With the help of FCC, several land cover classes were interpreted.

Land use / land cover
In the present study, to work out the land use/cover classification, supervised classification methods with maximum likelihood algorithm were utilized in the ENVI 4.7 software for the period of 1992, 2001, 2012 and 2018 (Figure 6 to 9). Maximum likelihood algorithm (MLC) is one of the most popular supervised classification methods used with remote sensing image data. This method is based on the probability that a pixel belongs to a particular class. The basic theory assumes that these probabilities are equal for all classes and that the input bands have normal distributions. Field verification was done for doubtful areas. Based on the field verification, the misclassified areas were corrected using recode option in ENVI. The error matrix and Kappa Khat methods were used to assess the mapping accuracy. Five land use/cover types are identified in the study area viz., (i) water bodies (ii) agricultural land (iii) fallow land (iv) built-up land and (v) forest cover.

RESULTS AND DISCUSSION

From an evaluation of Table 1, the attribute data of each pixel were derived from the supervised classification of satellite data captured on 1992, 2001, 2012 and 2018. It is seen that during 1992 to 2001, the major changes are in two classes i.e., agriculture and built-up area. The built-up area increased by 1.21% and the agriculture land increased by 0.34%. There are no significant changes in water bodies. The forest cover decreased by 0.51% and the fallow land decreased by 1.02%. In 2001 to 2012, The built-up area increased by 1.67% and the agriculture land decreased by 1.62%, water bodies decreased by 0.01%, the forest cover decreased by 1.21% and the fallow land increased by 3.5%. Figure 10 shows the comparison of land use and land cover changes of the years 1992, 2001, 2012 and 2018. The three decadal change detection pixels are give in Table 2. Figure 10 shows land use / land cover change detection mapping for study area. To understand land encroachment for different land categories during the last three decades, a change detection was prepared which reveals that forest cover has been converted into agriculture, built-up area and fallow land area of agriculture has been converted into vegetation, fallow land and built-up area of fallow has been converted into agriculture, vegetation and built-up land and water body has been converted into vegetation.

CONCLUSIONS

The current trend of urban land uses has the most obvious environmental impacts on the surrounding ecosystems, land resources, structure and pattern of the urban area and hence quality of life. The present study will be carried out urban land use / land cover change in Salem city. The Salem corporation area has suffered large urban land use changes in the last few years. It has also been supposed out that some kind of urbanization is also suffering in the protected areas of the region. Given these fundamental facts, the principal objective of this study will be to analyse the trend of urban land use changes. Both urban/built-up expansions led to dramatic changes in land use and land cover, the decreases in agriculture, fallow, and vacant. An excessively dense population, massive resource consumption, and very scarce land resource.

ACKNOWLEDGEMENT

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Table 1: Attribute data derived from the supervised classification of satellite data, captured on the year 1992, 200, 2012 and 2018

S.No.	LULC	1992	%	2001	%	2012	%	2012	%
1	Agricultural land	267216	26.82	270530	27.16	286746	28.78	286746	28.78
2	Built-up land	212159	21.30	224246	22.51	240867	24.18	240867	24.18
3	Fallow land	327368	32.86	317216	31.84	296475	29.76	296475	29.76
4	Forest covers	182510	18.32	177390	17.81	165423	16.60	165423	16.60
5	Water bodies	6987	0.70	6858	0.69	6729	0.68	6729	0.68
6	Mining area	112510	11.32	177390	17.81	165423	16.60	165423	16.60

Table 2 : Three decadal changes of land use / land cover in pixels

S.No.	LULC	1992-2001	2001-2012	2012-2018	1992-2012
1	Agricultural land	3314	16216	13216	19530
2	Built-up land	12087	16621	11621	28708
3	Fallow land	-10152	-20741	-10741	-30893
4	Forest cover	-5120	-11967	-01967	-17087
5	Water bodies	-129	-129	-29	-258
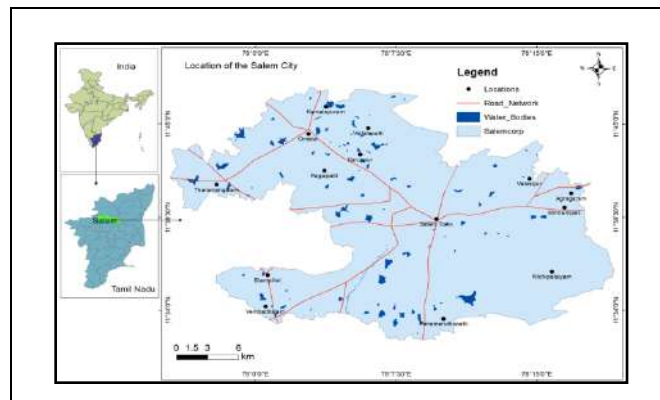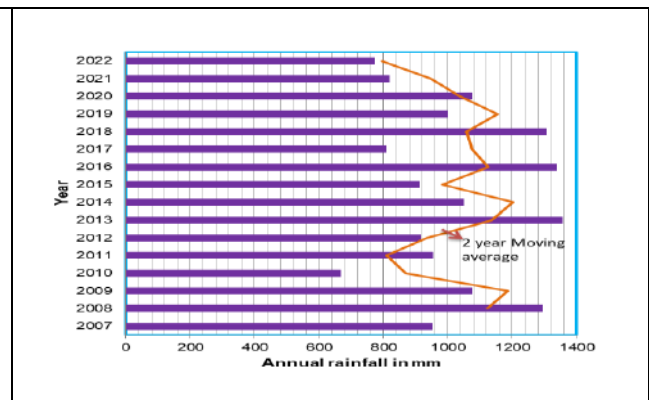
Figure 1 : Location map of the study area	Figure 2 :Annual Average rainfall in the study area
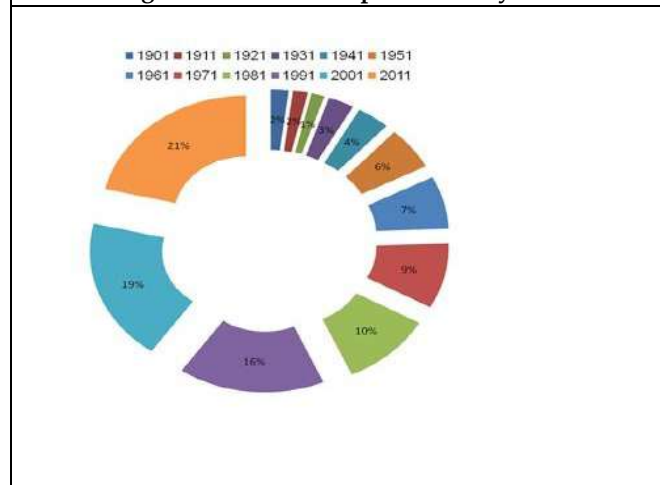
Figure 3: Decadal population growths in Salem city	Figure 4: Methodology Flowchart
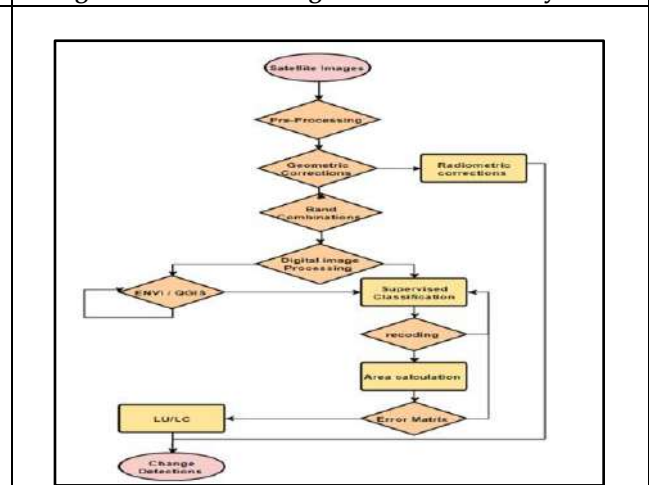
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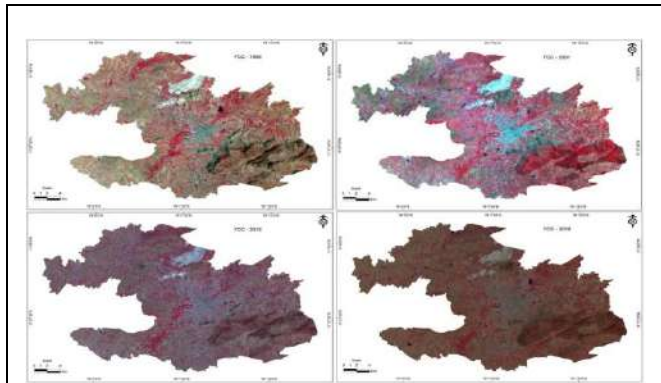
Figure 5: Satellite image used for the study
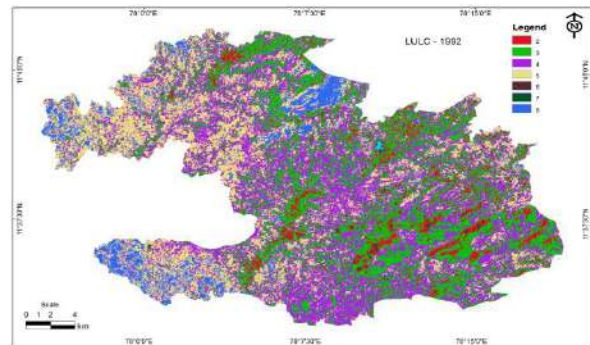
Figure 6 : Land use / land cover status of the study area for the period of 1992 (Legend: 2-Dence forest, 3-residues forest, 4-builtup-land, 5-agricultural land, 6 water bodies, 7-fallow land, 8-mining area)
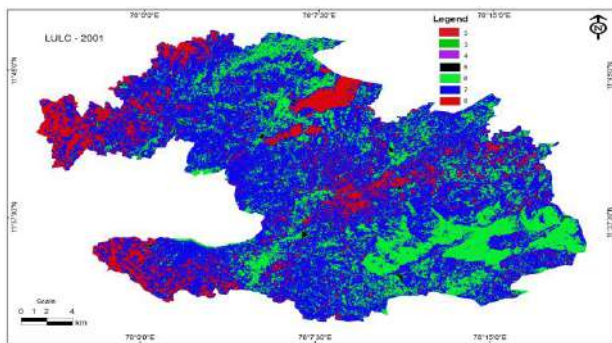
Figure 7: Land use / land cover status of the study area for the period of 2001 (Legend: 2-Dence forest, 3-residues forest, 4-builtup-land, 5-agricultural land, 6 water bodies, 7-fallow land, 8-mining area)
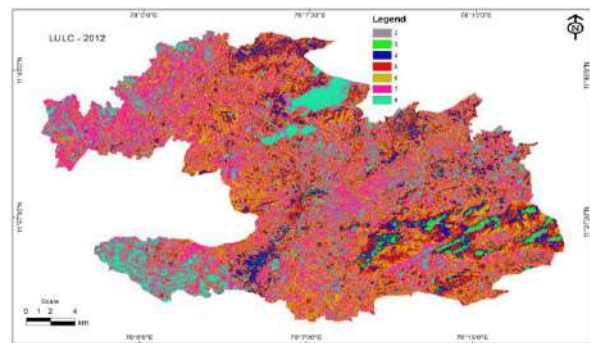
Figure 8 :Land use / land cover status of the study area for the period of 2012 (Legend: 2-Dence forest, 3-residues forest, 4-builtup-land, 5-agricultural land, 6 water bodies, 7-fallow land, 8-mining area)
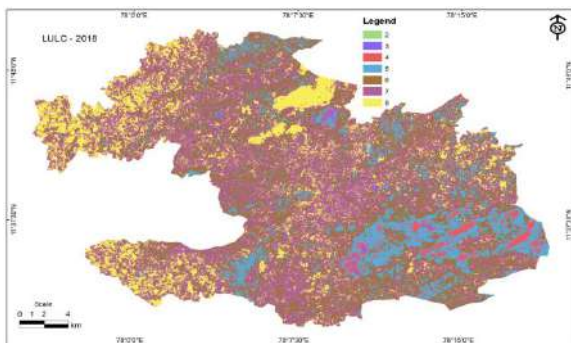
Figure 9: Land use / land cover status of the study area for the period of 2012 (Legend: 2-Dence forest, 3-residues forest, 4-builtup-land, 5-agricultural land, 6 water bodies, 7-fallow land, 8-mining area)
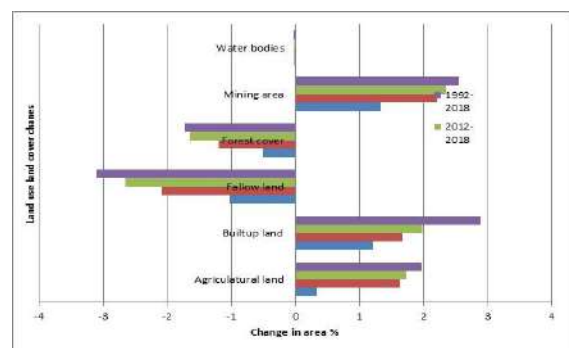
Figure 10 :Land use / land cover changes of three decades

RESEARCH ARTICLE

Detection of Forest Land Cover Changes using Geospatial Technology in Yadgir District, Karnataka, India

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ABSTRACT

The natural herbal may be visible normally inside the valleys and hill locks only. The forest vegetation generally falls below Southern tropical dry deciduous forest and Southern tropical thorn forests. Kalyana Karntataka location is one in of the biggest arid regions in India. The study was conducted in Yadgir districts between the years 2000-2020. The study area lies among is 16°20′ to 17°45′ North latitude and 76°4′ to 77°42′ East longitude with a place of 5275 km². The Indian satellite IRS P6 LISS-III-IV imageries were used to classify the land use/land cover (LU/LC) classes with ground truth data collected with GPS through supervised classification in ERDAS and ArcGis software. The LU/LC classes identified were forest, forest-scrub, and forest plantation. The forest covered a place in the year 2000 is 3024.8 hectare (15.29%), and in 2020 is 13525.7 hectare (57.00%). Scrub-forest in the year 2000 is 16527.4 (83.55%) and in 2020 is 9736.9 hectare (41.03%), and forest plantation in 2000 is 227.2 hectare (1.14%), in 2020 is 466.6 hectare (1.96%). The study indicated that the aspect and altitude influenced the forest types. The decrease in forest area in some locations turned into due to anthropogenic activities. The thematic map of LU/LC classes was prepared the use of ArcGIS Software.

Keywords: LU/LC Change detection, Forest, Yadgir District, GIS.

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INTRODUCTION

Detecting land use change over time has become increasingly important consideration for environmental management (Kiswanto and Mardiany 2018; Mensah et al. 2019). Therefore, studying the rate of LU/LC support a decision making processes. Due to world population boom and advancement in science and technology, the natural resources are overexploited with high severity for the sake of economic activities in developing countries. Agricultural expansion into the forest land, timber logging, charcoal production and firewood harvesting are the major drivers of deforestation in Africa (Declee et al. 2014; Muhati et al. 2018). The vegetation distribution is mainly depends on topographic and environmental factors. Vegetation cover affects local and regional climate. Among the topographic factors altitude, slope and element are effective parameters on spatial distribution of vegetation (Clerk, 1999, Solan, 2007, Stage, 2007). In a forest ecosystem, soil properties are also influenced by vegetation composition. The issue and slope can manage the movement of water and material in a hill slope and contribute to the spatial differences of soil properties (Chun, 2007). Land use is the human modification of the natural environment or wilderness into managed environment such as field, pasture, industrialization, settlement and agricultural practice. The major effect of land use on land cover has been deforestation. The extent and the type of land use directly affects wildlife habitat and thereby creating an impact on local and global biodiversity. Human alteration of landscape from natural vegetation to any other use typically results in habitat loss, degradation and fragmentation, all of which can have a devastating effect on biodiversity. Land conversion is the greatest cause of extinction of terrestrial species, of which particular concern is deforestation, where logging or burning is followed by the conversion of land to agriculture or other land uses and if forest is left standing, the resulting fragmented landscape typically fails to support many species that previously existed (Bierregaard *et al.*, 2000).

Forested ecosystems are being rapidly and directly transformed by the land uses of our expanding human populations and economies (Allen *et al.*, 2010). Various studies on deforestation and degradation have been conducted in tropical forests using coarse and high resolution remote sensing data (Kanga *et al.*, 2011). The temporal assessment of forest changes based on satellite imagery of various time series is becoming an important technique for assessing the degree of threat to ecosystem (Yadav *et al.*, 2015; Kanga *et al.*, 2013). Remote sensing and Geographic Information System (GIS) offers a powerful tool for LU/LC changes analysis; however studies of LU/LC changes based solely on remote sensing and GIS may not be relevant or dependable for specific environmental application at local level. Integrated research on LU/LC changes requires a combination of agent-based systems and narrative perspectives for an in-depth understanding of biophysical states (Fairhead J, Leach M 1995, Muloo *et al.,* 2019). The use of remote sensing and GIS integrated with the information from the local community can yield deeper insights into LU/LC changes and the drivers of changes. As a result, there is a growing need for the integration of scientifically proven knowledge with farmers' local knowledge of the state of land resources evaluation (Fairhead J, Leach M 1995, Okoba BO, Sterk G 2006).

STUDY AREA
The study was carried out in region of Yadgir district, Karnataka, located in north east of Karnataka state, India and it is bounded on the west through Bijapur district, at the north through Gulbarga district of Karnataka, at the east through Maheboobnagar district of Telangana and on the south with the aid of Raichur district of Karnataka (Figure 1). The region lies between 76^0 17'30''E to 77^0 28'30''E longitude and 16^0 11'30''N to 16^0 57'00''N latitude 0 16° 72' 58''N latitude and 76° 74'19''E longitude with an elevation of 1609 ft above the sea level. The district falls under the Krishna river basin with her tributary Bheema. Climatically the study region exhibits high temperature pattern with humidity and low rainfall; the lock of surface water may be very high. The maximum essential elements figuring out the conditions of plant life in this location are attributed to low or scanty rainfall with lengthy continuous drought period of six months except high temperatures, especially during the summer seasons. The vegetation diversity range in the study place is moderately distributed; the herbaceous species are almost dried during summer regenerating again during monsoon season.

MATERIALS AND METHODS

Data used for this study place is moderately dispensed; information used for this study is accumulated from field survey, literature review, satellite images and topographical maps. The field survey performed to give an overview of the physical condition of the study location, along with topography, vegetation and land use type. Global Positioning System (GPS) was used to collect ground control point from different LU/LC classes. Information measures happening were collected using some of research tools such as formal interviews, focus group discussions and field observations. The primary data used in this study have been topographical maps and satellite images. With the help of the topographical maps and satellite images, base maps had been prepared. Field surveys were conducted via GPS receiver. Digital photographs had been taken for different types of land use and land cover, in conjunction with many of GPS factor readings. Topographical maps of the region with scale 1:50,000 covering Yadgir district had been procured from Survey of India.

RESULT AND DISCUSSION

The land use/land cover classes in Yadgir district was demarcated based on ground truth data collected from GPS, and classification made using supervised classification in ERDAS software. Landsat TM, ETM+ (Enhanced thematic mapper) images of 2000, 2005, 2010, 2015 and 2020 were used to evaluate forest cover changes in the study area. The different LU/LC classes with their region protected within the district given in table 1. The LU/LC forest classes are also shown in the form of map in figures 3(a, b, c, d and e) shows a great variation of LU/LC over the study period. Both forest-scrub and forest plantation indicates declining trend while the remaining land use such as forest shows a slight increase over the study period. The supervised classification of the landsat images yielded the LU/LC forest classes shown in figure 3(a, b, c, d and e). These classes were calculates in hectares (ha) and also in percentages (%). Among the forest classes were covered, forest in the year 2000 is 3024.8 hectare (15.29%), and in 2020 is 13525.7 hectare (57.00%). Scrub-forest in the year 2000 is 16527.4 (83.55%) and in 2020 is 9736.9 hectare (41.03%), and forest plantation in 2000 is 227.2 hectare (1.14%), in 2020 is 466.6 hectare (1.96%) this includes teak and Acacia plantation also. The spatial distribution of plant life cover mainly relies upon on topographic and environmental elements (Wang et al., 2012). The factors inclusive of elements, soil, and climate are maximum essential which are determining the vegetation composition (Solan et al.,). The highest LU/LC type in hectares was forest-scrub land shown in table 2 and presented in figure 4. In 2000, maximum area was covered by forest followed by scrub-forest and forest plantation land. In 2020, maximum area was covered by forest followed by scrub-forest and forest plantation land. From 2000 to 2020, forest area decreased by 41.70% per. Forest-scrub increased by 42.52% followed by forest plantation with 0.81% decrease. The decrease forest area is mainly due to agriculture and settlement expansion. Also conversion of forest land from one class to another *i.e.,* forest to forest-scrub and forest plantation is the main reason behind the decrease of forest and increase of other forest classes. The ever growing human population is considered as a major threat to forests (Reddy *et al.,* 2016). Agricultural expansion, forest plantation development, logging, mining, industry, urbanization and construction of water harvesting structure are primarily responsible for deforestation (Geist and Lambin, 2002). The change in area is shown in Table 3 and presented in figure 5.

CONCLUSIONS

The relationship between the forest covers and various thematic maps were advanced. The developing human financial actions and the attention of human population into forest zones are being felt in the world of the sector in both growing and developed countries similar. Proof about various designs of land use and land cover through the time in forest areas is thus important, now not only for the organization and development of these areas, but also for a improved understanding of the association amongst landscape dynamics and forest ecology responses. Satellite remote sensing lets in a surveying, synoptic viewing of huge areas, for this reason supplying the capability for a geographically and temporally particular evaluation of land-use and land-cover mapping in forest areas. In this study has set up the helpfulness of satellite remote sensing, visual interpretation and GIS strategies for land-use and

land-cover mapping. The study has found out that a considerable growth in built-up occurred with increase in populace and housing growth. The decrease pattern of the spatial distribution of forest was found to be proportional to the growth in built-up. The deterioration of forest became evidently the consequence of the boom of human economic activities in combination with fast built-up improvement. Therefore the administration ought to manage the unplanned urban expansion by way of introducing new technologies for agriculture activities.

ACKNOWLEDGEMENTS

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Table 1: Forest Land Change Detection (2000-2020) Year

Description	2000	2005	2011	2015	2020
Forest	3024.8	3526.1	3526.0	2979.2	13525.7
Forest-Scrub	16527.4	16850.7	18497.2	18118.7	9736.9
Forest Plantation	227.2	386.4	302.5	234.1	466.6

Table 2: Forest Land Change Detection in Percentage (2000-2020) Year

Description	2000	%	2005	%	2011	%	2015	%	2020	%
Forest	3024.8	15.29285	3526.1	16.98258	3526.0	15.79357	2979.2	13.96583	13525.7	57.00035
Forest-Scrub	16527.4	83.55863	16850.7	81.15648	18497.2	82.85165	18118.7	84.93684	9736.9	41.03329
Forest Plantation	227.2	1.148523	386.4	1.860945	302.5	1.354782	234.1	1.097329	466.6	1.966358

Table 3: Decadal forest changes detection of Yadgir district (2000-2020)

Description	2005-2000	2011-2005	2015-2011	2020-2015	2000-2020
Forest	1.689733	-1.18901	-1.82774	43.03452	-41.7075
Forest-Scrub	-2.40215	1.695172	2.085191	-43.9035	42.52534
Forest Plantation	0.712422	-0.50616	-0.25745	0.869029	-0.81783

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Figure 1: Geographical location of the Study area	Figure 2: Flow chart of Methodology
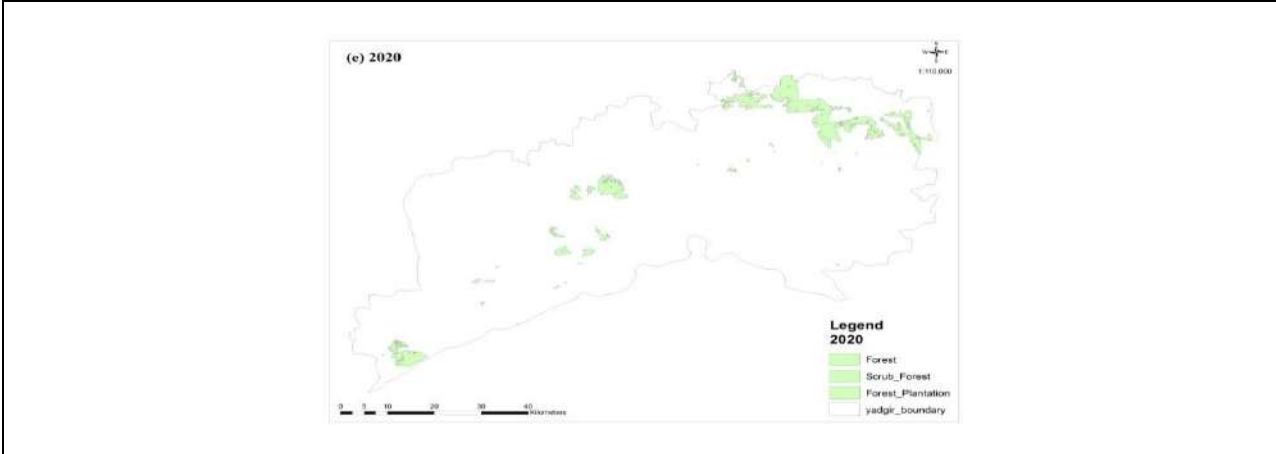
Figure 3: a, b, c, d, e is forest land cover changes detection (2000-2020)
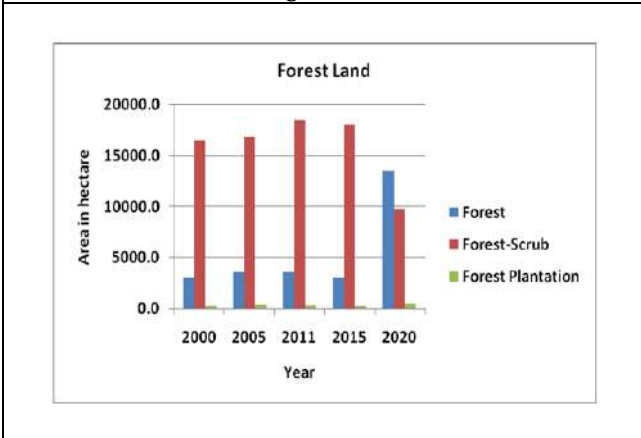
Figure 4: Forest Land Cover analysis of Study Area
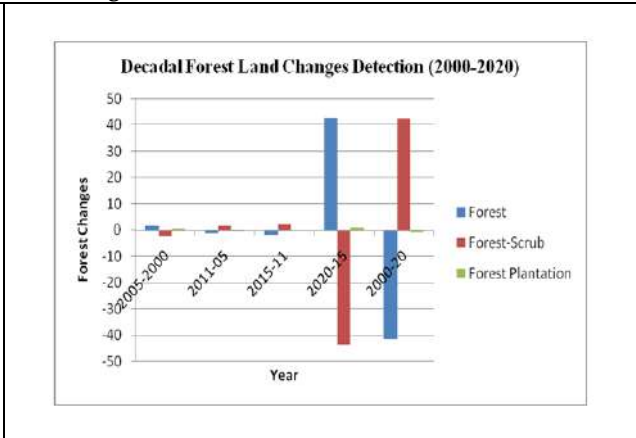
Figure 5: Decadal forest changes detection (2000-2020)

RESEARCH ARTICLE

Hybrid Backward Production Scheduling for Manufacturing Systems

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ABSTRACT

In this paper, a hybrid backward scheduling method, discusses very importantly the discrete manufacturing atmospheres. It operates according to a hierarchical discrete event simulation and shop floor modelling structure. Hybrid Backward Scheduling makes use of a collection of conversion relations to transfer a finite capacity forward scheduling method (FS) which will be used in various assignment rules to their backward equivalents. These policies comprise both conventional dispatching rules with a single criterion and an adaptable multiple-criteria for decision-making method which is expected to have a variety of conflicting criteria such as flow time, tardiness and manufacturing cost. Performance of the Hybrid Backward Scheduling method was studied through a set of simulation experiments and was estimated through many relevant performance indicators.

Keywords: Finite capacity; Backward Production scheduling; discrete event simulation

INTRODUCTION

Operations are processes that are carried out on machines in manufacturing or production in order to produce the desired results. In scheduling, tasks are given to manufacturing units with precise time requirements. This also includes manufacturing sequence and continues till the final product is made and ready for delivery. Scheduling refines processing times to complete all the jobs or tasks on time so that the final product can be delivered to customers on time. Operations are actions taken by machines during manufacturing or production to get the intended outcomes. Tasks with specific strict deadlines are assigned to manufacturing units during scheduling. One approach to these problems or difficulties is operations scheduling. This comprises delegating operations or tasks to

the appropriate machinery and labour resources for processing. Therefore, operations scheduling can be defined as a method that specifies the timing of the completion of each operation in a manufacturing or production process. Scheduling involves estimating the time needed to complete each operation as well as the time required to carry out the entire series of operations in the stipulated order. Utilizing the resources at hand is essential if you want to guarantee that the production will be finished on schedule. If operations scheduling is properly carried out, it may help to boost an organization's revenue and cut down on overall production time. Planning entails the proper distribution of various resources and materials for every job, while scheduling adds the timing component of the production schedule. It ensures the formulation and implementation of the most effective production schedule by optimising the operation sequence on the resources allotted. To achieve trade-offs between competing goals, such as efficient personnel, equipment, and facility use, as well as the reduction of client wait times, inventory, and cycle times. Vertical and horizontal scheduling are further sub categories of finite capacity scheduling.

Vertical loading is the process of filling a work center one operation at a time. When a shop order is loaded horizontally, the maximum priority order is loaded initially out of all of its operations, followed by the order with the next highest priority, and so on. The goal of maximal capacity utilization may be at odds with the horizontal method. Even while a job is pending, using precise schedules with horizontal loading might produce idle times within a work center's capability because a more crucial order will come after. Forced idle time is another name for this side effect. In circumstances when determining the ideal timetable can be challenging, vertical loading is typically thought to offer effective scheduling solutions. Finite capacity scheduling techniques can be divided into vertical and horizontal directions, but there is also the question of forward and backward scheduling to consider . Beginning with the 1st operation in the work's routing sequence, forward scheduling will put all operations for the job from the date of beginning of the schedule to the actual finite capacity. It focuses at completing the job at the earliest. It can also be used to determine whether the customer's requirements will be met by the earliest practicable completion time. Backward From the final operation in the routing sequence, scheduling would take into account all operations for a job starting from the due date. Its goal is to finish the work by the deadline or as near to it as feasible. Hybrid backward scheduling (HBS), is the backward scheduling technique that could be categorized as a vertical loading-based toward optimality backward scheduling technique.

LITERATURE REVIEW

Enns (1996) employed simulator to compare the horizontal (also called as block time) and vertical (also called as non-delay) loading approaches as soon as applied to a scheduler with constrained capacity moving ahead. Presumptions for routing were made under the assumption of a normal flow shop. The rules relying on due dates only were taken into account. Watson et al. (1997) proposed a method in their study that creates order plans for releasing using a replication model of the manufacturing facility's queuing system. Future planned or predicted orders were scheduled forward, while open orders were scheduled backward to determine workload-dependent planned lead times. The definite loading approach towards task-oriented scheduling, that schedules single job at a time even when a job may contain numerous sequential operations, is another related idea in literature (Yeh 1997).The algorithm loads a job's activities either forward or backward on parallel computers with limited capacity to assign feasible start and finish times. Market-Driven Contract Net, a hierarchical multi-agent scheduling system that utilized first-come, first-served forward and backward cost-driven scheduling, was described by Baker (1998).Production planning at factories that produce large, complex components with cycle periods ranging from two months to two years was studied by Agrawal et al. (2000). With the specific aim of reducing cycle time, their method used a lead-time evaluation and scheduling algorithm to undertake intricate backward scheduling of processes. MRP-based system used the predicted lead times to release work orders to the shop floor after scaling them for capacity sharing impacts by numerous goods in general assets. However, capacity was still generally calculated considering projected prime time balances, a standard lot size of each end item, and an typical product mix drawn from historical data and projections. Numerical studies indicated that cycle time improved. Ho and Chang (2001) suggested an incorporated MRP and Just-In-Time (JIT) framework for discovering specific shop floor schedules with the aim of decreasing the

overall production cost. The backward heuristic carried out horizontal loading depending on the Least Unit Total Cost (LUTCT) criterion after a forward pass scheduled the final operation of the job with the earliest due date. Furthermore, they did not approach the scheduling issue utilizing a variety of criteria. With the aim of reducing the total count of late jobs fixed for a single due date scenario and the total count of early to late jobs for the due date case, Yoo and Martin-Vega (2001) presented a variety of heuristics for the single-machine scheduling problem. A backward scheduling technique was created for a general class of early to tardy jobs ratio concerns, which in turn generated excellent experimental results. Maheswaran and Ponnambalam (2003) dealt with in investigation on the total weighted tardiness of the single machine scheduling problem. The single- machine, single-criteria problem was resolved using a horizontal backward heuristic. The assumption of sequence independent setup time and the unavailability of alternative resources further restrict its use. In a later study of the same authors (Maheswaran and Ponnambalam (004) an intensive search evolutionary algorithm was proposed in order to be a meta- heuristic as soon as an initial schedule is formed by their horizontal backward scheduling method.

The approach suggested
Hybrid Backward Schedulingoperatesundertheframeworkofcategorizedshopfloorandworkloadmodellingand event-driven simulation. This operational structure is next explained.

Operational structure of Hybrid Backward Scheduling
Ability of production is detached into Job Shops, each of which has the capacity of producing a range of related semi-final and finished goods. Every Job Shop is further distributed into Work Centre's, which has many resources. The latter can be defined as individual production cells or parallel processors that can perform similar operations (Figure1). The hierarchy of the task is broken down in accordance with the facility order. Orders are divided into Jobs, which itself are made up of several Tasks (Figure 2). An Order is broken down into Jobs that, depending on their specifications, can only be processed by a suitable Job Shop. These Jobs are matched to the entire production facility. A job is made up of tasks that can only be assigned to one work center. Multiple simultaneous Resources in the work center may receive the same tasks simultaneously. The operational strategy guiding the assignment of a job to a particular resource can either be a straightforward dispatching rule or a multiple-criteria decision making technique (Chryssolouris and Lee 1994). Dispatching rules' benefits stem from their ease of use. They base their decisions on the now rather than trying to forecast the future. These guidelines are therefore especially helpful in highly unpredictable factories like workshops. Additionally, dispatching rules typically only need data that is present at the point where the decision will be implemented. Before allocating the available resources to the pending production tasks, various options are created and assessed when the multiple-criteria decision making technique is used. The optimal alternative is selected by weighing a number of factors in a decision matrix, including cost, flow time, quality, and tardiness. To rate the options and select the best one, a utility function is used. Without aggregation, released orders are scheduled immediately. Instead of combining the relevant criteria into one order, grouping is handled in order to maximize machine efficiency or create an economical lot size.

The algorithm of HBS is portrayed using the upcoming example. Let J_1 and J_2 be 2 jobs that are released to the shop floor with the similar arrival dates (AD_j), while their due dates(DD_j) differ by δ time units. The routing of each of them contains of three tasks Q_{ij}, where i isthe serial number of the task and j the job it belongs to, e.g. Q_{21} is the second task of job J_1:

J_1:Q $\Longrightarrow$ Q_{21} $\Longrightarrow$ Q_{31},   (AD_1, DD_1)
J_2: Q_{12} $\Longrightarrow$ Q_{22} $\Longrightarrow$ Q_{32},   (AD_2=AD_1,DD_2=DD_1+ δ)
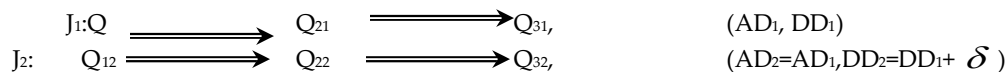
Sequence determines how long setup takes. The setup times for each source R_k's potential succession of tasks are kept in a special setup matrix $[R_k]$, where element (t_{mn}) stands for the setup time needed to switch production from job m to task n. For the sake of simplicity, it is assumed that all setup and processing times are almost equal and that all resources are available full-time in this case. The event-driven logic of the Hybrid Backward Scheduling framework, as implemented in this example, would result in a finite capacity forward scheduling (FS) method. The Gantt chart representation of the resulting shop floor schedule would resemble the one in figure 3. The operational policy chosen would determine the relative priorities of the tasks. For the time periods r_1 and r_2, respectively, it is assumed that resources R_1 and R_2 are receiving planned maintenance or repairs. This advance scheduling architecture may lead to relatively high job slack times by dispatching jobs as soon as possible (Figure 3), which indicates that the final products of an order may be completed much earlier than their due date if the workload is not heavy. Using the HBS framework to dispatch jobs may also result in increased holding costs and storage space requirements, a greater risk of product deterioration, and a reduction in the capacity's flexibility to handle new order arrivals with shorter due dates. It is however useful in finding out whether the earliest feasible completion time will meet customer's requirements

Relations of the Hybrid Backward Scheduling transformation

The Hybrid Backward Scheduling method will allocate all task sofa job from its due dates, starting from the last task(Vilma Roseline J and Saravanan D 2022).Its main goal is to finish each job on or before its due date, thus minimizing its slacktime. Operatingunderthehierarchicalmodellinganddiscreteeventsimulationframework presented in the previous section, HBS applies a set of transformation relations in order to apply various popular dispatching rules and a multiple-criteria decision making technique (Chryssolouris and Lee 1994), as the operational policy, backwards . Using the earlier example, the essential conversions of the Hybrid Backward Scheduling' algorithm include:

Level 1: In the development of each job's back routing, precedency relationships will be reversed, thus a task's prerequisites are now its prerequisites:

J_1: $Q_{31} \Longrightarrow Q_{21} \longrightarrow Q_{11}$, (AD_{1}, DD_{1})

J_2: $Q_{32} \longrightarrow Q_{22} \longrightarrow Q_{12}$, (AD_{2}, DD_{2})
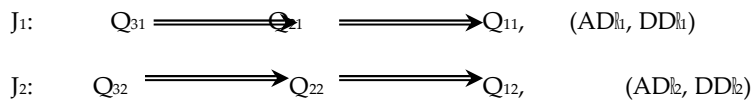
Level 2: Rearrangement of each resource's setup matrices R_k: $[R_k]^{trans}=[R_k]^P$ .....(1)

Level 3: A random reference time point (t_{ref}) is defined as any time that is larger than or equal to the latest due date for all jobs that have been unrestricted to the shop floor as of the schedule start time(t_s): $t_{ref}=S_{max}(DD_j)$ (2)
The time intervals between the work due date and the reference point t_{ref} are (Figure 3): J_1:$t_{ref}- DD_1=a_1$ time units and J_2:$t_{ref}- DD_2=a_2$ time units

Level 4: Definition of a time point in a imaginary time scale where the reverse workload willbe scheduled (t_s^l). The energizer accent in a variable will be used to denote its reference to the imaginary time scale. The time point t_s^l in the imaginary time scale (t^l) corresponds to time point t_{ref} in the real time scale (t). Since the resources work without any intervals the selection of point t_s in the imaginary time scale is arbitrary and independent from the selection of point t_{ref} in the real time scale. The real time decreases proportionately, when time in the imaginary scale increases. Therefore, if S time units pass after time point t_s^l in the imaginary time scale $(t^l = t_s^l + S)$, then in the real time scale the clock is turned S time units in the past before the reference point t_{ref} $(t = t_{ref} - S)$:

$t_s' = t_s + S$ ⊘ $t = t_{ref} - S$ ..... (3)

Hence, the connection between any point t in real time and its corresponding point t_l' in imaginary time is:
$t_l' = t_s' + (t_{ref} - t)$ ...... (4)

Level 5: In the real time scale, order arrival dates (AD_j) are transferred to the imaginary time scale using equation(4),where they constitute the order due dates (DD_{lj}'). Like wise, order due dates (DD_j) in real time are transferred to imaginary time using equation (4), where they constitute the order arrival dates (AD_{lj}'):

$AD_{lj}' = t_s' + (t_{ref} - DD_j)$ and $D_{lj}' = t_s' + (t_{ref} - AD_j)$ ..... (5)

Implementing equation (5)in the case of the two jobs of the example:
J_1: $AD_{l1}' = t_s' + (t_{ref} - DD_1) = t_s' + a_1$, $DD_{l1}' = t_s' + (t_{ref} - AD_1)$ J_1: $AD_{l2}' = t_s' + (t_{ref} - DD_2) = t_s' + a_2$, $DD_{l2}' = t_s' + (t_{ref} - AD_2)$
Above all, since $DD_1 = DD_2 - 0$ and $AD_1 = AD_2$ ⊘ $AD_{l1}' = AD_{l2}' + 0$ and $DD_{l1}' = DD_{l2}'$.

Level 6: Transformation of machine down time intervals (r_1 and r_2) to the imaginary time scale using equation (4).

Level 7: If a rule for dispatch is chosen as the operational strategy, its "opposite" to be applied in the phase; for example, on choosing STPT rule, LTPT should be used in the hypothetical scale of time. Transformation of forward scheduling workload with t_s' taken as the start time of schedule (Fig 4).

Level 8: Coming across the viability of the schedule. In order to prevent exceeding its actual due date DD_j, a work in the Gantt chart of Fig. 4 should have been released to the shop floor well before arrival date AD_j in real time if it finishes after its artificial due date DD_j'. Further more, $t_{lpast}' = t_s' + (t_{ref} - t_s)$ is the ability to apply equation (4) to determine the transition of the present time (t_s) to the fictitious time scale (t_{lpast}'). Hence, in hypothetical time, time points with $t_l' > t_{lpast}'$, or those with t_s, relate to the past. If a job completes after time point t_{lpast}' in fictitious time, it reveals that it should have been released to the shop floor in the past, prior to present time t_s, in order not to violate its due date DD_j.

Level 9:Mirroring the imaginary schedule in real time scale using the following transformation relations (Figure5):

$ST_{ij} = t_{ref} - (CT_{lij}' - t_s')$ and $CT_{ij} = t_{ref} - (ST_{lij}' - t_s')$ ....(6)

where: ST_{ij} is the start time of task T_{ij} in the real timescale, t_{ref} is the reference time point in the real time scale, CT_{lij}' is the time taken to complete task T_{ij} in fictional timescale, t_s' is the start time of the schedule in fictional time scale, CT_{ij} is the time taken to complete task T_{ij} in real time scale and ST_{lij}' is the start time of task T_{ij} in the fictional times cale. Now, we have formed the final schedule. A schedule with minimum job slack times usinge it her a single criterion dispatching rule, ora multiple-criteria decision making procedure as the assignment policy is created with the help of Hybrid Backward Scheduling method.

How is Hybrid Backward Scheduling applied in a textile industry
Through a series of simulation studies in a vertically organized Indian textile sector, the performance of HBS was investigated. The company under investigation is involved in the woolen textile industry and offers yarns for garments, carpeting, interweaving, and wool/synthetic carpets among its product offerings. The suggested technique has been used on the blend carpet manufacturing line. The chosen production line is divided into three independent departments: spinning, dying, and weaving. A Job Shop model has been created for each of them in accordance with the HBS operational framework. The following table lists the tasks related to each work center in the hierarchical facility model breakdown of the selected manufacturing line. The scheduling of production in spinning and weaving facilities is particularly important because there are several substitute resources available to them that can perform the same tasks. For the selected manufacturing region, the workload model offers about 190 different job types for

the weaving job shop and 55 different task types for the spinning job shop. Each job type in the weaving job shop represents a particular carpet type, which is distinguished by its color scheme, surface density, yarn types, weaving pattern, form, and measurements. Each work type in the spinning job shop corresponds to a specific yarn type, which is distinguished by its color, quality (the kind of fibers selected), composition, and name. An assembly manufacturing system can achieve its scheduling objective of minimizing the cumulative lead time for a group of assembled jobs by applying HBS to component jobs after either FS or HBS has identified the schedule start date of the final assembly activity. Component activities needed to manufacture a multi-stage product should be finished at the same time and assembled concurrently to achieve zero idle time, minimize work-in- process(WIP) inventory, and save cumulative lead time. Weaving, which is the main responsibility of a weaving job, can be through of as an assembly activity involving four different yarn system: the warp, weft, pile and selvage yarn system. All of these system must be present at the same time in order for an order to be carried out in the weaving work centre. Since they are needed in the weaving job shop first, the tasks required to produce them in the spinning job shop are scheduled last. Performance indicators like mean/maximum tardiness, earliness, reserve time, flow, queue time, mean manufacturing cost, mean capacity utilization, makespan and customer service level were all used for evaluating the found detailed shop floor schedules.

RESULTS AND DISCUSSION

The effectiveness of hybrid backward scheduling has been investigated through a series of simulation studies. Real data were gathered from the textile industry's sales department for a planning horizon of 55 days, plus 25 days' worth of data for initialization. The same workload of 115 spinning job orders and 155 weaving job orders was scheduled using the Hybrid Backward Scheduling method across all of the experimental settings. Chryssolouris (1994) proposed the multiple-criteria decision making approach (MCDTI) in four different configurations. The specific criteria for cost, flow time, and tardiness were all given, but their comparative significance in the decision-making process was changed by providing them the appropriate weight factors, w_c, w_f, and w_t. The values of the weight factors were MCDTI1: $(w_c, w_f, w_t) = (0.3, 0.5, 0.5)$, in the 2nd MCDTI2: $(w_c, w_f, w_t) = (0.2, 0.9, 0.2)$, in the 3rd MCDTI3: $(w_c, w_f, w_t) = (0.2, 0.2, 0.9)$ and inthe 4thMCDI4: $(w_c, w_f, w_t) = (0.9, 0.2, 0.2)$ in the first configuration. Due dates for orders can be determined by management decisions based on various due date establishing regulations, MRP processing, or delivery schedules guaranteed to customers (Enns 1996, Kuroda et al. 2002, Saad et al. 2004). The number of operations rule (NOP) was applied to determine due dates as follows:

$$DD_j = AD_j + k \cdot N_j \qquad .... (7)$$

Where N_j is the number of tasks for job j and k is the allowance factor in days. The quantity of tasks in a project could be used as a measure of the essential flow time since time in queue is typically the major contributor to lead time. Three components of the allowance component k values were chosen to illustrate various cases of due date tightness. According to the created schedule, the outcome of deviations among due dates anticipated completion timeframes can be evaluated due to variations in allowance factor values. K was given the values 0.8, 1.0, and 1.4. While the last option has a relatively generous stiffness level, the first two values produce a set of due dates that are fairly constrained. The first two tight circumstances were chosen on the basis of the presumption that the relative performance of the various operational approaches could be illustrated more visibly in tight due date scenarios. Above all, having short deadlines could give the company a competitive edge by enabling it to offer better customer service and reduce expenses by reducing WIP inventory. Therefore on the whole, there are 14 various operational policies, 3 various due date settings, totaling up to 42 investigational circumstances for the 1750 tasks job, causing into more than 1750 x 14 x 3 = 73500 task assignments. Six days a week, the production facility works in two shifts per day. In each experiment, the average capacity consumption level was maintained at 75%. The following two tables depicts the average/max lateness and average/max reserve time gives us the results.

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Average and maxlateness both diminish as the tightness level of due date decreases with increasing allowance factor k. (Table 2). The MOPNR, LIFS, and MWRK dispatching rules, in order of deficiency, underperformed with respect to both performance indicators, as was expected. Due to their high operation volume, late arrival rates, and residual work, respectively, these criteria aim to favor orders that is never expected to finish on time. By giving priority to orders that is expected to finish normally early at the expense of those that would otherwise finish before the due date, this logic can result in even more late orders. The STPT rule created the second-largest maximum tardiness while having a reasonable mean tardy performance. However, MCDTI3, EDD, FIFS, and FASFS delivered the best outcomes, in that order. The extra ordinary acts of MCDTI3 and EMDD could be given attributes to the fact that both policies directly speaks about due dates and takes efforts to minimize delayness. The time interval between the arrival time of an order and its actual commencement time is referred to as reserve time. Reserve time has a chance of being utilized as a pointer of the flexibility of any schedule's, or else its capacity reserve in the near future to be able to more effectively respond to fresh purchaser needs or urgency orders. Low WIP inventories are also correlated with high mean reserve times. The mean and maximum reserve times also grow as the allowance factor k increases (Table 3). Due to its attempt to reduce job idle times and resulting high reserve times, the Hybrid Backward Scheduling approach has this as one of its core advantages. Each work center's and operational policy's CQR distributions are particular to that manufacturing system. The multiple-criteria policies and the LWRK dispatching rule can lessen queues, which in turn can reduce WIP hoarding, according to this particular system's "signature." The BLEND and SPOOL work centers were the minimum busy, with nearly no listings noted there.

The responsibilities assigned to these labor centers started immediately they were made accessible to them. Since reduced slack periods typically coincide with just-in-time purchases, reductions in WIP and end product inventories, and inventory performance, the total earliness performance indicator and inventory performance are directly correlated. The ultimate aim was to evidently show the dominance of a backward finite capacity scheduling methodology like Hybrid Backward Scheduling upon a forward finite capacity scheduling method, in inventory routine. In the instance of Hybrid Backward Scheduling, operational rules that yielded low mean earliness also produced high mean earliness for Forward Scheduling, and vice versa. Hybrid Backward Scheduling affords a framework-methodology which converts forward assignment guidelines into the backward equivalents. This framework uses both hierarchical modelling and event-driven simulation to operate. To address the intricate scheduling problem in industrial systems, an integrated strategy is required. It is mandatory for the production management of each and every manufacturing structure to cautiously examine its unique conditions and important indicators of performance prior to actually choosing the most suitable alternate solution shop schedule. For the conversion of forward assignment policies into their backward counterparts, Hybrid Backward Scheduling offers a framework-methodology and it overcomes the application limitations of comparable studies identified in the literature by virtue of its characteristics, which enable the adoption of the proposed technique in complex problems.

CONCLUSIONS

The shop floor schedule should be created using client and expected orders as far in advance as feasible to retain consistent visibility within the planning horizon. It is crucial to reschedule and update the shop floor schedule each day because as the schedule's planning horizon gets longer, information validity decays faster. Future research should look into the employment of forward scheduling and Hybrid Backward Scheduling in arrangement during two sequential passes. Depending on its goal, a job can be separately planned either forward using the forward scheduling framework or backward using the Hybrid Backward Scheduling technique. It will be possible to plan in reverse from bottleneck resources using HBS. If FS is used, the terminal tasks can be scheduled as soon as possible by the initial forward scheduling run, then the processes prior to bottleneck resources can be rescheduled using HBS, lowering WIP inventory. The HBS process should be reversed in order to convert backward finite capacity scheduling techniques into their forward equivalents.

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Table 1: HBS operational framework

JobShops	Work center ID	Description of Task	Resources
Coloring	COLOR-WC	Coloring	1
	PRESS-WC	Hydro extraction	1
	AER-WC	Aeration	1
Spinning	PREP-WC	Opening	1
	COMBIN-WC	Combination	5
	CARD-WC	Carding	3
	REVOL-WC	Revolving	6
	EVAPO-WC	Evaporating	1
	WIND-WC	Cleaning	2
Weaving	SPOOL-WC	Spooling	4
	WEAV-WC	Weaving	25
3JobShops	**11Work centers**		**50Resources**

Table 2: Representation of due date setting combination and tardiness in every policy

	Mean Tardiness(hr:mn:ss)			Max Tardiness(hr:mn:ss)		
K	0.8	1.0	1.4	0.8	1.0	1.4
STPT	20:16:46	10:52:01	2:59:45	307:07:15	282:30:25	187:22:05
EDD	10:38:15	3:00:00	0:00:00	54:43:44	32:00:34	0:00:00
FIFS	8:55:56	2:49:59	0:00:00	65:22:23	42:01:33	0:00:00
LIFS	26:20:40	18:20:38	5:57:51	272:03:41	252:09:20	157:13:02
MOPNR	40:10:42	30:02:41	13:01:02	385:50:30	364:11:21	246:23:03
FASFS	10:2:30	3:02:11	0:00:00	64:03:20	40:00:02	0:00:00
LPT	12:59:50	6:25:55	0:00:00	100:10:20	78:21:24	0:00:00
FOPNR	10:49:10	3:22:04	0:00:00	111:20:00	88:41:56	0:00:00
LWRK	10:56:30	5:36:44	0:25:00	157:31:26	132:58:07	38:35:56
MWRK	26:20:50	17:11:02	3:39:49	282:20:39	259:33:42	164:18:39
MCDTI1	10:13:57	3:28:49	0:00:00	150:05:12	112:13:38	0:00:00
MCDTI2	14:12:48	7:00:01	1:02:06	210:40:04	177:30:22	84:48:48
MCDTI3	9:40:26	1:54:29	0:00:00	110:26:33	38:06:55	0:00:00
MCDTI4	15:01:00	8:08:04	0:15:13	151:33:40	183:08:49	50:00:19

Table3: Mean/maxre serve time in every policy and due date setting combination

	Mean Reserve time(hr:mn:ss)			Max Reserve time(hr:mn:ss)		
K	0.7	0.9	1.4	0.7	0.9	1.4
STPT	38:20:34	50:37:18	139:55:59	97:58:23	122:24:51	218:29:53
EDD	30:50:21	46:48:36	132:00:22	87:00:55	110:51:17	209:50:34
FIFS	36:14:13	45:31:50	138:48:56	87:59:03	112:50:23	218:00:34
LIFS	27:55:04	43:00:17	128:03:02	87:31:17	111:33:16	207:43:01
MOPNR	20:11:46	42:00:00	120:34:28	77:32:15	101:39:14	197:36:34
FASFS	25:53:32	41:05:24	127:32:55	88:35:42	112:33:11	208:38:56
LPT	30:33:43	44:11:03	124:57:44	84:48:46	108:40:26	204:38:14
FOPNR	26:55:25	45:07:31	130:11:04	88:39:53	112:36:55	205:09:30
LWRK	35:14:39	42:05:22	133:23:00	87:49:25	111:50:25	207:510:28
MWRK	21:05:39	42:10:00	122:21:34	81:54:47	105:55:37	197:39:14
MCDTI1	36:24:00	45:59:04	133:52:25	92:15:31	115:13:49	206:39:28

MCDTI2	35:50:55	44:17:55	132:39:39	89:01:35	112:00:57	210:31:26
MCDTI3	32:00:12	46:28:48	127:52:59	89:17:34	111:46:05	207:53:09
MCDTI4	24:34:38	41:44:21	124:34:51	91:54:23	99:27:02	206:46:09
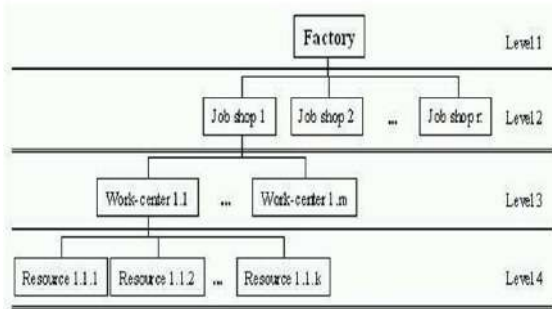
Figure 1: Gradable facility model of a discrete manufacturing system at 4 levels
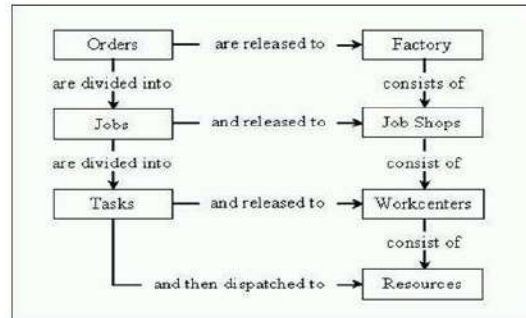
Figure 2: Orders are divided into Jobs, which itself are made up of several Tasks
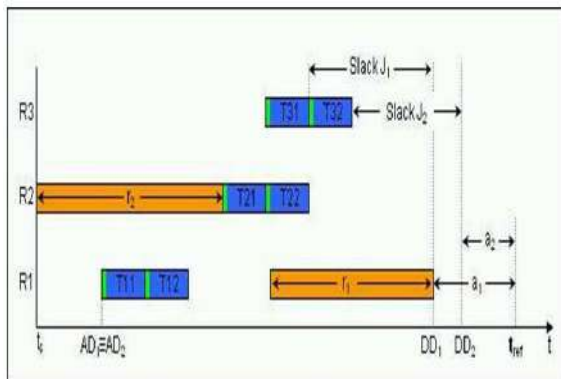
Figure 3: Hybrid Backward scheduling frame work applied infinite capacity forward scheduling
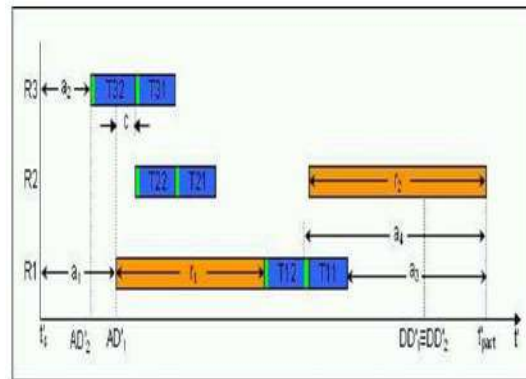
Figure 4: Forward finite capacity scheduling in fictitious time scale (HB Scheduling)- stage 1
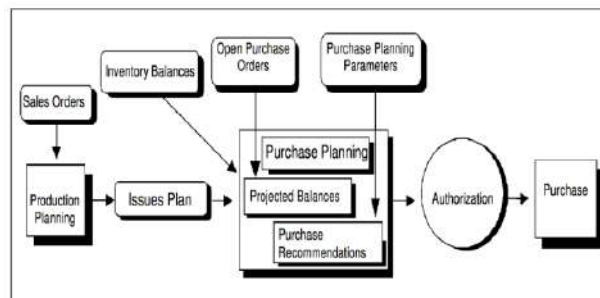
Figure 5: Date of the indicators of dependent performance indicators for policies under multiple criteria

RESEARCH ARTICLE

Solid State Fermentation for the Production of Ellagic Acid from Mango Pulp Industrial Waste using *Aspergillus niger* and Molecular Docking Against Targets of Covid-19

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ABSTRACT

Ellagic acid was considered as the potential bioactive compound with many therapeutical applications. Bioconversion of tannin present in the mango pulp processing waste in to ellagic acid using fungi would be better than the chemical extraction from plant sources. A total of three different fungi were isolated from the soil sample. Further the isolated strains of *Aspergillus niger* were identified to produce ellagic acid from ellagitannin. Quantification of ellagic acid production by solid state fermentation using 3% of mango waste as substrate. Ellagic acid enzyme activity was calculated and found to be 17.6 U/mL. The ellagic acid production was optimized to fix the various factors *viz.*, pH, temperature, nitrogen and carbon source. The maximum production (200 μg/g) of ellagic acid was achieved at pH 5.5, temperature 30 ºC, Sodium nitrate as nitrogen source, 0.2% and NaCl as carbon source (1% of sugar). Ellagic acid produced was characterized by UV-Visible spectrophotometer and by FTIR and GCMS analysis. They were docked against SARS-CoV-2 proteins (receptor), namely Mpro using Epic, LigPrep and Glide module of Schrödinger. Ellagic acid was found to have the ability to bind with the candidate receptor protein PDB ID 2BX4 for SARS-CoV-2. Ellagic acid exhibited potential applications and further research in product development is promising.

Keywords: Ellagic acid; *Aspergillus niger*; solid state fermentation; Mango pulp waste; SARS-CoV-2

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INTRODUCTION

Natural products are used widely to cure many human diseases. Ellagic acid (EA) is a phenolic compound with potent anti-oxidant, anti-carcinogenic, anti-viral, anti-mutagenic, anti-parasitic, anti-diabetics, anti-steatosic, anti-cholestic, anti-fibrogenic and anti-hepatocarcinogenic and also has been reported against SARS-CoV-2 properties [1-8]. However, ellagitannins inhibit the growth of a number of bacterial species and resist microbial attack. But certain molds, such as *Aspergillus* sp., *Penicillium* sp., *Trichoderma* sp., *Fusarium* sp., *Mucor* sp., *Rhizopus* sp., *Neurospora* sp., are able to hydrolyse tannin with the help of tannases [9-10]. Hydrolyse volania tannin to EA have been demonstrated with *Aspergillus niger*(*A. niger*)grown on waste husk [11]. The efficiency of EA as antioxidant compounds greatly depends on their chemical structure and several hydroxyl groups of ellagic acid found to enhance their activity [14]. Ellagic acid is a dilactone formed by the hydrolysable of hexahydroxy diphenic acid. EA is found in several plants, such as oak tree, eucalyptus, pomegranate, strawberry, raspberry, blueberry, blackberry, cranberry, gooseberry, grape, pecan, walnut, valonea and creosote bush at varying concentration [15]. These ellagic acids are being extracted from ellagitannin-rich plant sources using strong alkali and acids (H_2SO_4 or HCl) [16-17].It also involves treatment with higher concentrations of alkali or acid that leads to corrosionor damage of the process vessels and subsequently needs more safety precaution. Major disadvantage is the unforeseen toxic or hazardous with chemically produced [18]. Biotransformation of ellagitannin to ellagic acid is known for decades and found economic. Biosynthesis of ellagic acid achieved by the enzymatic catalysis of ellagitannin by the tannase.

Tannase acts on depside (C–O) and ester linkages present in hydrolysable tanninsresulting into a bio transformed products such as gallic acid, ellagic acid and glucose [19]. Microbial synthesis of ellagic acid using solid-state fermentation with mango waste by the *Aspergillus* sp., a GRAS organism (Generally Recognized as Safe) is planned in this study. Huge volume of waste generated in the mango pulp processing industries is harnessed for the production of ellagic acid. Depending on the varieties, the kernel represents 45–85% of the seed containing 17–22% of tannin being recycled for the production of valuable ellagic acid[20].Optimization of ellagic acid production through onsite fermentation would be great boon to the smaller industries. Agricultural residues are the main effective source of natural bioactive compounds [10].Many researchers have already been studied on potential sources of bioactive compounds from agricultural by-products. The food industry is facing a great challenge to handle large quantity of waste generated from product recovery. Billions of dollars are spent on the treatment of agricultural and food waste to recover from the risk caused by these wastes to the environment. Therefore, the risks can be reduced and the costs for treatment of waste can also be reduced. Value for agricultural and product development would be possible through this bioconversion. Mango peels, mango seeds and other wastes are discarded in the industrial process of pulp recovery [11]. The COVID-19 pandemic has emerged as a global public health concern due to the high mortality. In the ongoing COVID-19 pandemic, India is among the worst-hit countries, with over 458,000 deaths reported as of November 1, 2021, the second-highest number after the United States [12].

There are currently no vaccines available that have proven effective against COVID-19 in clinical trials. For designing and developing anti-Covid-19 medicines, several SARS-CoV-2 macromolecules have been selected, including 3-chymotrypsin-like protease (3CL pro), endoribonuclease, RNA-dependent RNA polymerase and 2-O methyltransferase. Viral entry, viral protein maturation and viral infection pathogenesis are affected by 3CLpro protein (3CLpro/Mpro) [13].The 3CLpro/Mpro or main proteases namely, $M^{Cov1}Pro$ (PDB ID 2BX4) from SARS-CoV-2 were used in this study. Mango peel can be used as a valuable, economic and cheaper source for the commercial production of the ellagic acid [14]. Ellagic acid can be obtained by the enzymatic hydrolyzes of ellagitannins. Microbial conversion of ellagic acid from pomegranate husk had shown 65.7 mg/g [8]. Earlier many reports had studied the role of ellagitannase on ellagitannins biodegradation. Therefore, the aim of this study was to elucidate thebio-conversion of ellagitannins into ellagic acid by submerged fermentation using *A. niger*. In addition, we also focused on structure-based computational modelling of ligand-receptor interactions that deals with the *in-silico* study of bio-converted EA metabolites as potential bioactive components against targets of COVID-19.

MATERIALS AND METHODS

Isolation and identification

Soil samples were collected from Periyar University campus, Salem, Tamil Nadu. The soil samples were collected in sterile sealed polythene bags using sterile spatula. One gram of soil sample was dispensed into 100 mL of sterile distilled water and shaken well for 20 minutes and serially diluted was carried out up to 10^{-7} mL. 1mL of each serially diluted sample was poured in the sterile petri plates containing PDA medium. Chloramphenicol (25ug/mL) was added in molten PDA medium in the petri plates and was incubated at 30 ± 1 ºC for 3-5 days. After incubation, different fungal colonies grow on the PDA medium. Preliminary identification of the fungi was done based on their morphological characteristics. Microscopic examination of fungal culture was done by placing one drop of LPCB on glass slide and culture was mounted cover slip on the slide. The slide was observed under light microscope (40 X objectives).

Screening for Ellagic acid producer

Czapek minimal media was prepared and sterilized separately by passing through a membrane filter (pore size 0.22 um, Millipore Corporation, Bedford, MA, U.S.A.). After sterilization, Czapek Dox's minimal medium a sterile ellagitannase was added final concentration of 1 %. Fungi were inoculated on czapek medium containing ellagitannin as sole carbon. Then the plates were incubated at room temperature for 4 to 5 days. After the incubation zone formation around the fungal growth was observed. The plate flooded with 0.5M $FeCL_2$ zone formation was not clearto enhance visibility of zones of ellagitannin degradation.

Preparation of fungal spore suspension

Spore suspension was prepared a by pouring 5–7 mL of sterile 0.9 % NaCl (w/v) + 0.01 % Tween 80 on a PDA plate containing culture as in subheading and scrape the spores into solution. After filter the spore solution into a sterile 10 mL test tube through a sterile funnel it containing a cotton wool plugs to remove hyphae. The number of spores can be counted using hemocytometer and diluted to 2×10^7 spores/mL.

Production of Ellagic acid

3 g of mango pulp wastes was taken in 250 mL conical flask and 7 mL of Czapek Dox medium in test tubes were autoclaved separately at 121ºC for 15 min at 15 lbs. After sterilization 7 mL medium was poured in to conical flask containing 37.07% mango pulp wastes with 1ml of inoculums (containing 2×10^7 spores per gram of support) was inoculated and flasks were incubated at 30 °C for 144 hours.

Extraction of Ellagic acid

After fermentation, the biomass was mixed with distilled water at (1:2) ratio and heated for 5 min. After cooling it was centrifuged at 10,000 rpm and the supernatant was measured. Diethyl ether (5X) was added to the supernatant and mixed thoroughly by swirling for 2 min. The solution was allowed to stand for 2 min at room temperature for the separation of the organic phase and aqueous phase. In the biphasic system, ellagic acid was extracted into the organic phase, which was then separated for further analysis(Fig 1).

Quantification UV Visible spectrophotometer

Stock solution of standard ellagic acid (50mg/50mL) was prepared by dissolving in methanol. Working standards were prepared by tenfold dilution from standard solution pipetting by out 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0 mL into the clean test tubes. The tubes were making up to 2 mL using phosphate buffer (0.05 M pH 7.4) and OD was read at 255 nm. A standard graph was prepared and floating concentration of standard ellagic acid with OD values. The amount of ellagic acid produced in the biomass was determined using standard graph.

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Determination of tannase activity
One milliliter of crude enzyme liquid was added to 1 mL of 23% (v/v) solution of gallotannin which replaced with wheat bran as substrate in a citrate buffer (0.1 M pH 5.0). After incubation at 40°C for 10 min, the reactions were brought to end by the adding of1 mL of ethanol (90%) and absorbance was measured at 270 nm. Control samples were prepared by adding 1 mL of crude enzyme to the same reaction mixture and these samples were withdrawn after incubation at 40°C for 3 min. The quantity of gallic acid released during hydrolysis of gallotannin represents the tannase activity. Here, one unit of tannase activity corresponds to a decrease of 0.001 units in the absorbance per milliliter of gallotannin solution per minute at 270 nm.

Characterization of Ellagic acid
FTIR analysis
The Crystallized sample was subjected to FTIR analysis. Infrared spectra were obtained in transmission mode using Perkin-Elmer Spectrum-FTIR instrument between 4000 and 400 cm-1 using Kbr (Potassium Bromide) pellets.

GCMS analysis
Extracted ellagic acid was diluted in methanol. The methanolic extract of EA was subjected for GC-MS analysis using Brucker Model- 45X GC 44 ga chromatography instrument with EVOQ triple quadrupole (TQ) detector, column 15m Brucker was used for the identification of ellagic acid. One microliter of sample was injected and oven temperature was programmed from 40°C with an increase of 8°C /min to 150°C, then 8°C /min to 250°C, ending with a 20 min at 280°C. The split ratio was 10:1, and helium was used as a carrier gas at a constant flow rate of 1.73 mL/min. The mass spectrometer was operated in the electron impact (EI) mode at 70 eV with a scan interval of 0.5 s.

Optimization of Ellagic acid production
Effect of Temperature
The solid-state fermentation was carried out at different temperature of 25, 30, 35 and 40 °C for 144 hrs.

Effect of pH
The solid-state fermentation was carried out at different pH (adjusted using 1N NaOH and 1N HCl) ranging from 5.0, 5.5, 6.0, and 6.5pH.

Effect of Nitrogen supplements
The effect of nitrogen sources was studied on production of ellagic acid. 0.2 % of various nitrogen sources like (Sodium nitrate, Sodium nitrite, Ammonium nitrate, Ammonium chloride, Ammonium sulfate, Potassium nitrate and Urea) were added to fermentation media.

Effect of Mango pulp supplements as carbon source
Acid hydrolyzed mango pulp waste containing 45 to 65 % of sugarwas used as a carbon source[24].

Mango pulp waste pretreatment
Acid hydrolysis of Mango pulp waste performed by 50 mL of 1 % hydrochloric acid heated with 5 grams of Mango pulp at 120 °C at 10 min. After heat treatment the suspension was centrifuged at 5000 rpm for 10 min and the supernatant was collected and analyses the amount of glucose content by DNS method.

Reducing sugar estimation in Mango pulp pretreated suspension
Standard solution was prepared by dissolve 100 mg of glucose in 50 mL of distilled water. From the standard solution 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0 mL was added into the clean test tubes and the tubes were appropriately labeled. 0.1 mL of mango pulp pretreated sample added into the test tubes. The tubes containing solutions were made up to 2 mL using distilled water and 2 mL of distilled water was added into the test tube that was considered as a blank. From each tube 2 mL of DNS reagent was added and the tubes were kept in water bath

for 5 min and the tubes were cooled in running tap water. The absorbance read at 520 nm and the standard graph was plotted to detect the glucose level in sample.

Mass production of Ellagic acid

Owing to produce large number of fungal spores was prepared by disposing 3g of mango waste in 250 mL and 7 mL of Czapek Dox medium in test tubes were separately autoclaved at 121 ℃ for 15 min at 15 lbs. After sterilization 7 mL medium (Optimized parameters pH, carbon sources, nitrogen sources were provided.) was poured into conical flask containing 3% of mango pulp wastes as a substrate. 1 mL of inoculum (containing $2×10^{-7}$ spores per gram of support) was inoculated and flasks were incubated at optimized temperature for 6 days.

Molecular docking

Ligand preparation

From the characterization analysis, ellagic acid structure was downloaded in SDF (Spatial DataFile) two-dimensional (2D) format from the PubChem database (https:/pubchem.ncbi.nlm.nih.gov/, accessed on March 2021). Ligand was prepared using LigPrep tool of Maestro v 11.1). The pH 7.0 ± 2.0 was used for the generation of ionization states of the compounds with Epik 2.2 (Force field: OPLS4) in Schrödinger ver.11.1. Up to 32 possible stereoisomers per ligand were retained.

Protein preparation

The three-dimensional (3D) structure of the $M^{Cov1Pro}$ (PDB ID 2BX4) from SARS-CoV were retrieved from the RCSB Protein Data Bank (https://www.rcsb.org/structure/, accessed on 12 March 2021) in PDB format. The Protein Preparation Wizard (Schrödinger ver.11.1) was used to prepare the 2BX4 structures using the following processes: optimization, removal of water molecules and minimization (Force field: OPLS4).

Receptor grid generation and glide molecular docking

The grid generation (Schrodinger Maestro ver.11.1) for the selected receptor was performed using the default parameters (Force field: OPLS4). Receptor grids were calculated for the prepared proteins for the observation of poses by various ligands bound within the active predicted site during the docking procedure. The Van der Waals radius scaling factor and the partial atomic charge parameters were set as 1.00 and 0.25, respectively. A cubic box of specific dimensions centered on the centroid of the active site residues was obtained for the receptor. The bounding box was set to 14 × 14 × 14 Å for docking experiments. Ligand docking was followed by the flexible standard precision (Schrödinger ver.11.1) and the docking score and the interactions of the ligand docking were recorded.

RESULTS AND DISCUSSION

Isolation and identification of *A. niger*

A total of three different fungal strains were isolated from the soil sample using PDA plates after 4 days of incubation. Yellow to white mycelia with black color sporulating fungus (Fig 2) was examined by using LPCB mount. Based on the microscopic (hyaline, septate hyphae, conidiophores were long and globose) and macroscopic morphology (presence of black, globose conidia with very dark to black spores) shown in Fig 3. The fungal strain has been as confirmed as *A. niger*. *A. niger* was included GRAS under 21 CFR act of U.S. Food and Drug Administration (1958) and it has been used for the Ellagic acid production from pomegranate husk[21-22].Conversely, group have also produced ellagic acid using solid-state fermentation from cranberry pomace with *Rhizopus oligosporus*[23].

Screening of Ellagic acid producer

Ellagic acid producer was identified by clear hollow zone around the fungal colonies which indicated the breakdown of ellagitannin supplemented in czapek dox minimal media (Fig 4). Then plates were flooded with ferric chloride

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which reacted with tannin to produce dark brown color and the zone was clearly visible. Ellagitannin acyl hydrolase was an enzyme responsible of the EA production Mycelium of potential tannase producers was scanty but clear zones were produced[30-31]*Aspergillus* sp. been recorded as best extracellular tannase producing fungi [9]. Ellagic acid and gallic acid production from ellagitannin and gallotannin by *A. niger*had been proved by some previous papers [21,26-28].

Spore count and inoculum preparation

Fungal spores were dissolved in sterile solution of 0.01% Tween-80, and counted in a Neubauer chamber [29]. Total number of spores counted in five squares was 1, 38,400 and the average number of spores were 27,680.

Number of spores/ml   = Average no of spores x dilution factor x 10^4

Number of spores/ml   = 27680 x 1x 10^4

Number of spores/ml   = 27.68 x 10^7

One milliliter of spore suspension contains 27.68 x 10^7 spores which were taken as stock culture. From the stock, 1 mL was pipette out and made up to 4.6 mL, to obtain 6 x 10^7 spores/ mL and used as inoculum.

Production and quantification of ellagic acid

Ellagic acid production by *A. niger* was carried out by solid state fermentation using mango waste as substrate. Similarly, pomegranate husk was used as a substrate for the EA production by *A. niger*[31]. Ellagic tannase enzyme activity was calculated and found to be 17.6 U/mL, as it is involved in the conversion of ellagic tannin for ellagic acid. The extracted sample containing ellagic acid was analyzed using UV-Visible spectrophotometer at 255 nm and compared with standard ellagic acid(Fig 5). It was found that, 100μg of EA produced from 3g of mango waste catalyses by tannases produced by *A. niger*. A prior study revealed that, optimum conditions for tannase production were solid to liquid ratio of 1:2, 35 °C, pH 5.5 and 72 hrs incubation time which resulted 0.256 mg/mL of an extract of EA.[32]Comparably, study by recorded the solid-state fermentation of pomegranate peel powder have also produced 8.48–132.62 mg/g of ellagic acid under optimized condition by *A. niger* GH1.[27]SSF of pomegranate seeds and husk by *A. niger* GH1 and PSH to yields 6.3 and 4.6 mg of EA per gram of dried pomegranate husk.[28]However, maximum EA (138.44 mg g-1) production was recorded at 8 hrs, using *A. niger* GH1 through submerged culture [34]. Degradation of creosote bush ellagitannin yielded 23.1 % of ellagic acid.[33]Cups extract of valonia acorns degrade by mixed culture (*Aspergillus oryzae* and *Trichoderma reesei*) to yields 23% of EA.[34]Biosynthesis of volania tannin hydrolase by *Aspergillus* SHL6 has yielded 5.0 g l-1 of ellagic acid.[30]*A.niger* co-culture with *Candida utilis* degrades volanea tannin to yield 12.1 %. Ellagic acid production from mango pulp wastes was lower than the previous report because tannin content of mango pulp wastes was much lower than the used substrate.

Characterization of ellagic acid

FTIR analysis

Confirmation of the ellagic acid was done by using FTIR by their functional groups. Test compound was analyzed by FTIR, then the results of the spectrogram represent the presence of glycosidic groups V (O-H) that is the presence of OH stretching with a broad peak at 3554cm-1. These bands are more or less similar to the standard ellagic acid (Fig6). Similarly, ellagic acid extracted from the fermentation medium also showed a peak at 28.223 min retention times when it was tested with GC-MS. Standard ellagic acid in the methanolic extract had the retention time of 29.269 mins[32].The above peak had been identified as 2- cumaranone. 7,8- dihydroxy coumarin known as urolithin [Metabocard for urolithin D (HMDB0029219)] which is known to be secondary metabolite of ellagic acid degradation[35].

GCMS analysis

Standard ellagic acid in the methanolic extract had the retention time of 11.37 mins (Rajak et al., 2017). Similarly test ellagic acid also showed a peak at 11.385 mins retention time when it was tested with GCMS. The above peak had been identified as 2- cumaranone. 7,8- dihydroxy coumarin known as urolithin [Metabocard for urolithin D (HMDB0029219)] which was a secondary metabolite of ellagic acid [41]. EA was found in first peak was confirmed by GCMS analysis(Fig 7).

Optimization of various factors for ellagic acid production

Effect of pH

Fungal growth and enzymes activity were highly sensitive to pH. Maximal fungal growth was observed at pH 5.5. Among various pH (3.0 to 8.0) provided for the production of EA. Maximum tannase activity (18.4 U ml^{-1}) was observed at pH 5.5 (Fig 8). Similarly, reported that, *Aspergillus flavus* needed an acidic environment for tannase production.[36-37]Suggested the tannase production from *A. niger* showed optimum activity at pH of 6.0 with a second peak at pH 4.5. Comparably, maximum tannase production in *Aspergillus* Sp. was observed at pH at 5.5.[18,32-38]Already reported that, strains of *A. niger* possess tannin protein complex degrading activity at a pH range of 6.0 and 5.0 respectively.[21-39]However, revealed the optimum pH for tannase production from *Rhizopus oryzae* was at pH 5.0[40].

Effect of Temperature

Ellagic acid production was higher at temperature 30 ºC which yielded tannases activity was 19.8 U mL^{-1} (Fig 9). Previous study has stated that, optimum temperature for production of tannase at 30 ºC where strains like *Aspergillus oryzae*, *Penicillium chrysogenum* and *A. niger* used.[18]Also studied the optimum temperature for production of tannases at 30 ºC using *A. niger.*[27-41]Some previous studies reported that 12.1 mg/g of ellagic acid produced with the temperature 28 ºC with *A. niger* from valonea tannins.[32-42] Have achieved 0.256 mg/L ellagic acid with the temperature 35 ºC using *Aspergillus awamori* frommauha bark. Contrarily, reported the 235.89 mg/g^{-1} of ellagic acid from pomegranate at 60 ºC.[43]Some researchers reported that the rising of temperature would affect the solubility of protein, so that enzyme activity increased. Higher temperature would denature the enzymes thus decreased activity.

Effect of Nitrogen source

Among various nitrogen sources used for EA production higher the enzyme production recorded with was (25.6 U mL^{-1}) 0.2% sodium nitrate (NaNO$_3$) than ammonium nitrate(21.2 U mL^{-1}), and ammonium chloride (18.1 U mL^{-1}). While other nitrogen sources like sodium nitrite, potassium nitrate, ammonium sulfate, urea found to affect the tannase production (Fig 10). Highest tannase production was obtained with *P. variotii* was grown in ammonium nitrate as nitrogen source.[41]Observed the lower production of tannase with ammonium sulphate compared with ammonium nitrate could be due to the toxicity of sulphate ion itself on fungal growth.

Effect of Carbon source

A concentration of 0.2% sugar from mango pulp favored both growth and enzyme production. Above 1% sugar provided, enzyme activity was decreased (Fig11). 0.2% of glucose favoured both growth and enzyme production. However, above 1% glucose, growth and enzyme production were drastically affected due the osmotic stress of the medium[11]. 1.0 % carbon source optimum for tannase production[40].

Production of ellagic acid and enzyme activity under optimized condition

The ellagic acid production was carried out under optimized conditions (pH, temperature, carbon, nitrogen) and using mango pulp waste. The enzyme activity optimized as follows (Table1).Already reported the enzyme activity of *Aspergillus oryzae* was co-cultured with *Trichoderma reesei* using acorn cups extract containing up to 62% ellagitannins as substrate to produce ellagic acid with comparatively high levels of ellagitannin acyl hydrolase, xylanase and cellulase[44].The results indicate that the mixed culture is an effective approach to produce an enzyme system of degrading ellagitannins for ellagic acid production.

Molecular docking analysis

SARS-CoV-2

In the present study, structure-based computational modelling of ligand-receptor interactions has been performed, focusing on the ligand molecule of ellagic acid. One of the best-characterized and distinguished drug targets among CoVs is 3CLpro also called Mpro, a viral 3C–like protease or main protease. 3CLpro along with PLpro (papain–like protease) cleaves the polyprotein pp1ab and pp1a to produce non-structural proteins (NSPs) such as RNA

dependent RNA polymerase and helicase [45-47]. They play an essential role in viral replication and hence its inhibition interrupts the viral life cycle. Mpro is highly conserved among CoVs, sharing over 90% sequence identity, differing only 12 residues between M[Cov1]Pro from SARS-CoV and M[Cov2]Pro from SARS-CoV-2 [48]. The crystal structure of SARS Coronavirus Main Proteinase (P21212) (PDB ID 2BX4) was considered as the receptors for the present study. Nelfinavir, a protease inhibitor (PI) [49]has been used as the control for molecular docking throughout our experiment. It is widely used in the treatment of HIV (human immunodeficiency virus) infection and AIDS (acquired immunodeficiency syndrome) [50]. Nelfinavir selectively binds to the HIV protease and inhibits it by interfering in its replication machinery [50]. Both experimental and computational evidences suggest the ability of nelfinavir in inhibiting the cytopathic effect caused by SARS-CoV-2 [49]. Molecular docking was carried out using ellagic acid against COVID-19 enzyme receptor, PDB ID 2BX4 with Nelfinavir as the control. Docking was done using Glide module (Maestro software) of Schrodinger ver.11.1. The strength of the receptor-ligand interactions was determined based on the Glide score. The higher the Glide score value in the negative scale, the better the interaction between the protein and the ligand [51]. In other words, the lower the Glide scores the better the affinity between the protein and the ligand. Potential ligands were shortlisted based on the ligand efficiency, Glide score and docking score. The receptors, PDB ID2BX4 was docked with ellagic acid, whose results are displayed in (Table 2) respectively. In the docking experiment, ellagic acid was shown to possess considerable docking score against PDB ID2BX4 (Table 2)which displayed the highest predicted binding affinity with a Glide score of -5.388kcal/mol. The docking interaction between the control and PDB ID2BX4 was appreciably high with a Glide score of -4.687kcal/mol.

Molecular docking revealed that ligand atoms of the control, interacted with various amino acid residues of the protein at position 8 (Phenyalanine), 104(Valine), 105 (Arginine), 106 (Isoleucine), 107(Glutamine), 108(Proline), 109 (Glycine), 110 (Glutamine), 111(Threonine), 151 (Asparagine), 158 (Serine), 202(Leucine), 203(Asparagine), 246(Histidine), 249(Isoleucine), 292(Threonine), 293 (Proline), 294(Phenyalanine) and 295(Aspartic Acid) respectively. Proline made a hydrophobic interaction with the 'OH' atom of nelfinavir, whereas glutamine made a polar hydrogen bond interaction with the functional group, 'NH' and phenylalanine made a hydrophobic interaction with 'N+H' group of the ligand (Fig12).Ellagic acid were docked against PDB ID2BX4 and the highest binding efficiency with a glide score of -5.388kcal/mol. Docking results revealed that ligand atoms of ellagic acid interacted with amino acid residues of the protein at positions 202 with leucine, 203 with asparagine and 240 with glutamic acid respectively. Leucine makes a hydrophobic hydrogen bond interaction with the 'O' atom of the ligand, whereas asparagine makes a polar hydrogen bond interaction with 'OH'. Glutamic acid makes a negatively charged hydrogen bond interaction with 'OH' (Fig12).Thus, in this study, the SARS-CoV-2 protein namely, PDB ID2BX4 was considered as targets to screen and identify potential drugs against SARS-CoV-2 that have appreciable binding affinity towards these receptor proteins which play essential role in viral replication. In the docking experiments, ellagic acid showed considerable docking score against PDB ID2BX4 (Table 2) with highest Glide score (-5.388kcal/mol), greater than even that of the control (nelfinavir) (Gscore: -4.687kcal/mol). Hence, ellagic acid is proposed to possess better inhibitory property towards PDB ID2BX4 than that of the control. Thus, ellagic acid is strongly recommended as a potential drug candidate for SARS-CoV-2 (M[CoV1]Pro). Hence, ellagic acid could be selected for further study and evaluation with respect to the targeted drug treatment approach for the noxious SARS-CoV-2.

CONCLUSION

Biological production of phenolic compounds has emerged recently due to the potent beneficial characteristics. Ellagic acid production has gained great attention in recent years due to their beneficial nature. Numerous studies had an attempt to production of ellagic acid from different sources, but still need more new strategies for the optimum production of EA in cost effective manner. Based on this approach, the present study was under taken for the EA production from the Mango pulp waste using *A. niger*. On the whole, EA yield of 200 µg was obtained from 3 g of mango pulp waste at the optimum conditions (0.2% glucose, 0.2 %sodium nitrate, 30 °C and pH 5.5). Hence forth, waste to value a technology developed would be soon for smaller industries. These ellagic acid compounds

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could be chosen for further research and assessment in the context of targeted medicinal therapy approach for the virulent SARS-CoV-2 virus.

ACKNOWLEDGEMENT

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Table 1:Optimized parameters for the Ellagic acid production

Optimized parameters for the maximum enzyme activity (0.2% sugar from Mango pulp waste, 0.2 %sodium nitrate,30 ºC, pH 5.5) with Mango pulp processing waste	
Enzyme activity (U/ml)	27.2

Table 2:Result of the docking experiment performed between the receptor (2BX4) and theligands (Ellagic acid)

S. No	Protein	Ligands	Glide Ligand Efficiency	Docking Score(kcal/mol)	Glide Score(kcal/mol)	Amino Acid Residue	Types of Interactions
1.	The 3CL pro/Mpro or mains proteases (PDB code 2BX4)	Nelfinavir (Control)	-0.117	-4.673	-4.687	Phe8	Hydrophobic
						Val104	Hydrophobic
						Arg105	Positively charged
						Ile106	Hydrophobic
						Gln107	Polar

	from SARS-CoV					Pro108	Hydrophobic Hydrogen Bond with "OH"
						Gly109	Glycine
						Gln110	Polar
						Thr111	Polar
						Asn151	Polar
						Ser158	Polar
						Leu202	Hydrophobic
						Asn203	Polar
						Hie246	Polar
						Ile249	Hydrophobic
						Thr292	Polar
						Pro293	Hydrophobic
						Phe294	Hydrophobic Pi cation with N^+H
						Asp295	Negatively charged
2.		Ellagic Acid	-0.242	-5.317	-5.388	Leu202	Hydrophobic Hydrogen Bond with "O"
						Asn203	Polar interaction Hydrogen Bond with "OH"
						Glu240	Negatively charged Hydrogen Bond with "OH"

Fig 1: Diethyl ether extraction of ellagic acid using separating funnel

Fig 2: Sporulation of A. nigeron PDA plate

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Fig 3: Microscopic observation of *A. niger*

Fig 4:Plate showing Clear zone around ellagic acid producer on Czapek Dox Minimal Media
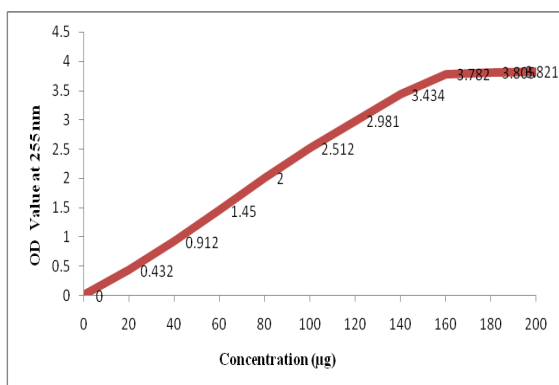
Fig 5: Quantification of ellagic acid
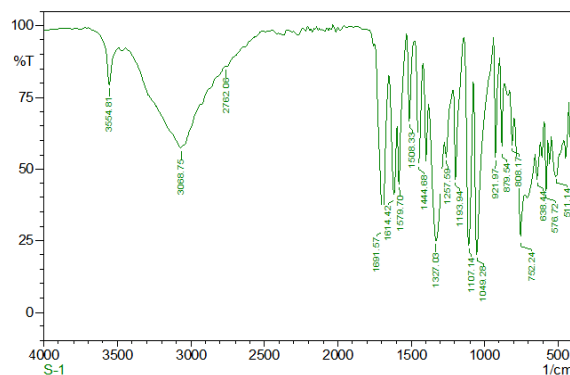
Fig 6: FTIR spectrum of sample
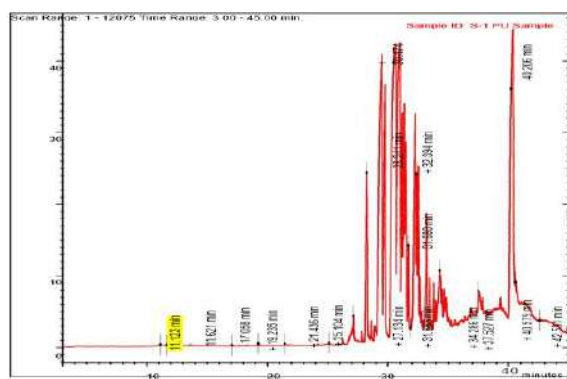
Fig 7:GCMS spectrum of sample
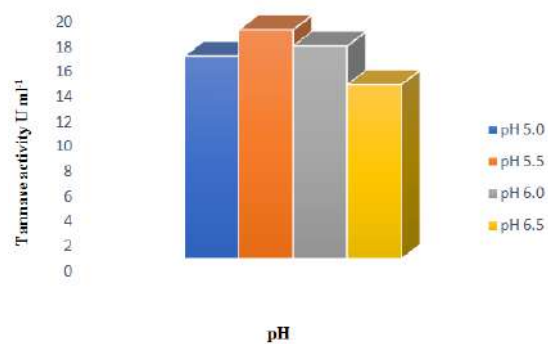
Fig 8: Effect on pH on tannase activity

Fig 9: Effect of temperature on tannase activity

Fig10: Effect of nitrogen sources on tannase activity

Fig 11: Effect of different concentration of carbon sources on tannase activity

Fig12: Interaction diagram with H-bonds and other interactions of a 2BX4 with (a) Nelfinavir, with (b) Ellagic acid

RESEARCH ARTICLE

A Dynamic Hand Gesture-based Human Computer Interaction using Deep Learning Methods

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ABSTRACT

Dynamic hand gesture recognition is a very challenging area, especially in the field of human-computer interaction because of the motion information. In this paper, a dynamic hand gesture recognition system is created to classify and recognize the hand gestures under varying lighting conditions and complex background. The major objective of this work is to help vocally impaired and aged people to interact with machines in a natural way. The proposed work is built using two deep learning representation methods: convolutional neural network (CNN) method and recurrent neural network (RNN) method. In CNN method, 3D CNN model is used to capture the motion information from many contiguous frames. In RNN method, long short-term memory model is employed that is capable of remembering long-term information in case of lengthy videos. This proposed system is tested using dynamic hand gestures in RGB modality from Ego Gesture dataset. The data is preprocessed before it is fed into the deep learning model. The proposed work achieved accuracy of 89% for 3D CNN model and 94% for 3D CNN-LSTM model. This shows that combining 3D CNN and LSTM model yields better performance in recognizing the dynamic hand gestures.

Keywords: Dynamic hand gestures, Convolutional neural network, Recurrent neural network, Ego Gesture dataset.

INTRODUCTION

Gesture recognition is one of the current and vital research areas that is extensively used in the fields of man-machine interaction, robotics [1] multimedia understanding, analysis of shopping behavior, etc. Gestures, particularly using hand and face, provides a simple, easy and a faster way for communication. Amongst gesture recognition techniques, gesture recognition using hand is the effective technique which is even used by vocally impaired and aged people, and also, it replaces the use of devices like mouse, keyboard, etc. Hand gestures can be static or dynamic which are recognized using two methods: vision-based approaches and non-vision-based approaches [1]. Vision-based approach captures hand gestures using video cameras that can be a single camera, stereo camera or multiple cameras. Non-vision-based approach make use of wearable devices, instruments or sensors attached to human hand in order to get information. Though non- vision based method attains higher recognition rate, it is necessary to carry or wear the device all the time, which is not possible at all situations. So, vision-based approach is mostly used in hand gesture recognition (HGR) and thus, it is employed in our proposed work. HGR can be performed by hand-crafted features-based methods and deep learning representation methods. Gesture recognition can be carried out using statistical models like Hidden Markov Model (HMM), Conditional Random Field (CRF) [2], etc. and gesture classification using classifiers such as support vector machine (SVM) [3].

 Bayes classifier[4], etc. These above models are hand-crafted features-based methods which failed to extract many important gesture features that affects the recognition performance. Thus, deep learning representation method[5]. is employed in most of the recent studies of HGR that builds high-level features for automating feature extraction process which helps in achieving good performance on problematic learning tasks. There are many deep learning representation methods[5]. such as convolutional neural networks method, auto-encoder method, deep belief networks method, recurrent neural networks (RNN) method, etc. Midst these methods, convolutional neural networks method and recurrent neural networks method are employed for the proposed HGR. Convolutional neural networks (CNN)are the most extensively used deep learning model in image domain like object detection, image segmentation and classification[6] and attained great success. This success extended to 3-dimensional convolutional neural network (3D CNN or C3D) -based action recognition where motion information from videos is extracted. 3DCNN-based dynamic hand gesture recognition is the emerging research area which performs well even in bad lighting conditions. In this paper, we proposed a dynamic hand gesture recognition system using 3DCNN method. Then, a combination of 3DCNN and RNN method is employed those extracts both spatial and temporal features. Long Short-Term Memory (LSTM) is the RNN method used along with 3D CNN. The experiment is evaluated using large, versatile Ego Gesture dataset that has multiple static and dynamic gestures. The remaining sections of the paper are: section 2 briefly describes the related work, proposed method and its architecture is given in section 3, results and comparative analysis in section 4, and conclusion and future work in section 5.

RELATED WORKS

CNN is the popular deep learning network that achieved a great success in image field and also in video. As our work is based on video-based hand gesture recognition, this section brings out a brief introduction about the works that implemented gesture or action recognition using convolutional neural networks method. The work [7]. Proposed a 3DCNN model for action recognition that extracts both spatial-temporal features which helps in extracting motion information. This model was evaluated using the the TREC Video Retrieval Evaluation (TRECVID) data and tested on airport surveillance videos in real-time. The work in [8] utilized depth and intensity data of VIVA challenge dataset and built a HGR system for drivers. The system achieved accuracy of 77.5%. The work of [2] included 3DCNN and LSTM networks as a combination for gesture recognition. This work showed how to create a simple and small model in deep learning for a small dataset and to run the model in real-time condition, and achieved accuracy of 97.8% by using both RGB and depth data, and in real-time, improved accuracy rate from 89% to 91%. The work [9] Presented a "3DCNN-ConvLSTM-2DCNN" recognition network for continuous gesture recognition and experiments were done by means of three datatsets namely: Montalbano, CongoGD, Jester dataset. HGR model was built in [10] reached 90% performance using 3DCNN and implemented using a web application.

The work of [11] provided a home appliance control using CNN architectures, AlexNet and VGGNet. The primary goal in this paper was to detect only the hand region through background subtraction and recognize it and thus achieved accuracy of 95.61%.The concept built in [4] was also a dynamic gesture recognition system by combining 2DCNN and DenseNet deep learning models to extract spatiotemporal features. Prediction was done on RGB videos from VIVA and UTD-MHAD datasets. A framework for violence detection was proposed in [12] using triple-staged model. Initially persons were detected using CNN, then person detected frames (16 frames) fed to 3DCNN and neural network optimization was performed. Human activities like horse riding, biking, cycling, etc. were classified from videos using 3DCNN in work [13] that returned good performance. The model developed in [6] used CNN based sliding window approach where 2DCNN for detecting gestures and 3DCNN for classifying one or more gestures and indicate missing detections. This work evaluated on NVIDIA and Egogesture dynamic datasets [14]. Showed a combined network with CNN and LSTM for gesture or activity recognition. The work proposed in [15] also used 3DCNN to detect fingertips and recognize hand gestures which achieved good accuracy in terms of complex background, longer distance, etc. Static hand gestures were classified using transfer learning based deep neural network in[16]. For transfer learning, AlexNet model was used and hyperparameters were tuned using Artificial Bee Colony (ABC) optimization algorithm. A 3DCNN based human action recognition model was developed in paper [17] where both RGB and depth videos were used. The input videos were transformed into 32-frames and features were extracted. Then, feature fusion and classification were performed. These literatures showed that video-based or dynamic gesture or activity recognition can be accomplished through 3D CNN deep learning network. 3D CNN model produces high performance and recognition rate that will be very helpful in real-world environment. Thus, the main idea of our proposed work is inspired from these literature works.

Proposed Method

This section shows the proposed system with two methods, one with 3D convolutional neural network model and the other with the combination of 3D CNN and LSTM. This idea is stimulatedto capture both the motion information and long-term features for better recognition.

Dataset

The proposed system is evaluated using EgoGesture dataset [18], [19]which is a large, versatile one for training a deep neural network model. This dataset contains 83 diverse static and dynamic hand gestures which is captured using a wearable device placed on the subject's head shown in Figure 1. These gestures are collected from 50 subjects on 6 different outdoor and indoor scenarios. Sample frames of scroll hand towards right action is shown in 3 different scenarios in Figure 2. This is a novel standard dataset as the gestures are done in different background, lighting conditions, speed difference in performing gestures. Hand gestures of all the subjects are performed using both hands. The gesture samples are available in RGB and depth modalities. There are about 24,161 video samples and 2,953,224 frames.

Preprocessing

From EgoGesture dataset, 6 dynamic gestures, scroll hand towards right, scroll hand towards left, scroll hand upward, scroll hand downward, zoom in with two fingers, zoom out with two fingers whose label numbers are 1, 2, 3, 4, 12 and13 respectively as shown in Figure 1 are chosen. The dataset has videos of all the gestures together. Videos of above 6 gestures are trimmed where each video length is between 3 to 6 seconds. These videos are converted into 30 frames per second. Hand region extraction is not necessary because the dataset has only the hand portion. As 3DCNN model is employed in this work, the input (videos of hand gestures) should contain equal number of frames, and height and width of all the frames should be similar. So, the height and width are set as 112 x 112. To make unification of frames, 16 frames are chosen for each video. Thus, total number of videos (for 6 actions) will be 1800.

C3D Neural Network

Convolutional neural network-based methods are proven to be successful in many fields such as image or scene classification, object detection [5], etc. which involves 2D images. This success motivated many researchers to use

CNN based approach for computer vision problems such as action recognition. They made several changes on the CNN based method to recognize dynamic actions and produced good results. Thus, this proposed work utilized CNN based method for dynamic hand gesture recognition. As our work is video-based, both spatial and temporal information are needed. In general, CNN extracts only spatial features. In order to extract temporal information for videos, 3D CNN is employed. 3D CNN helps in extracting motion information from numerous contiguous frames. It performs 3D convolutions [12], [5] by convolving a 3D kernel to a sequence of frames(video). Thus, feature maps are obtained from the convolutional layers that are connected with numerous sequences of frames in the previous layer, gets the motion information. In the *ith* layer, the operation performed at point (x,y,z) of *jth* feature map is given by,

$$v_{il}^{xy} = \varphi(b_{i,j} + \Sigma_m \Sigma_{p=0}^{P_i-1} \Sigma_{q=0}^{Q_i-1} w_{i,j,m}^{p,q} v_{(i-1),m}^{(x+p),(y+q)}) \tag{1}$$

In Eq. (1), φ is a non-linear activation function that can be Tanh, Sigmoid or ReLu, w is the 3D weight matrix, P,Q,R are the height, width and length of the kernel, respectively.

Proposed C3D Architecture

The 3DCNN architecture built in this work achieves good performance in recognizing dynamic hand gestures. C3D architecture of this work is slightly modified based on trial-and-error method according to the input data. The input layer of the network dimension is 16x112x112x3 which represents image depth, image width, image height and number of channels respectively. The network consists of 5 convolutional layers that performs 3D convolutions on the input video frames using Conv3D. The size of the filters used in each convolutional layers are 16, 32, 64, 128, 256 which is in increasing order and the size of the kernels in each convolutional layer is 3x3x3. 3 dimensional maxpooling is performed using Maxpooling3D, which is present after each convolutional layer in order to down sample the feature maps obtained through convolution operation without any information loss. The activation function used in all the layers is 'ReLu' and the output layer has 'softmax' function. Then, a flatten layer is used in order to convert the multidimensional features into one dimensional array. The above conversion is necessary because densely connected layers can handle only 1D array. Two fully connected layers are present with 512 and 256 neurons respectively. The output layers finally help in classifying the gestures (0 to 6).

C3D and LSTM Network

3DCNN can learn short-term temporal features from the sequence of frames which in turn make it difficult for the model to memorize lengthier sequences. As many gestures show the motion differences in longer frames, learning process for the model is not easy. So, long short-term memory (LSTM) model is employed along with 3DCNN for better hand gesture recognition from both short and long videos. A distinct type of recurrent neural network (RNN) is the LSTM network [lstm ref] which has the ability to memorize lengthier sequences over a longer period of time and learning is easy in LSTM. LSTM model is also similar to CNN model, that has input and output layers, and hidden layer that acts a memory block. Four distinct neurons present in this memory block are input gate, output gate, forget gate and a memory cell. These neurons help in avoiding vanishing gradient problem. LSTM can preserve and utilize past information as it has control through these gates and memory cell. LSTM is defined by these below equations.

Input gate, $i_t = \sigma(W_{xi}x_t + W_{hi} h_{t-1} + b_i)$ (2)

Forget gate, $f_t = \sigma(W_{xf}x_t + W_{hf} h_{t-1} + b_f)$ (3)

Output gate, $o_t = \sigma(W_{xo}x_t + W_{ho} h_{t-1} + b_o)$ (4)

Input transform c_in$_t$ = $tanh (W_{xc}x_t + W_{hc} h_{t-1} + b_{c\_in})$ (5)

Cell state update $c_t = f_t . c_{t-1} + i_t .c\_in_t$ (6)

Output $h_t = o_t . tanh(c_t)$ (7)

where, input vector is x_t, output vector is h_t, cell state is c_t, sigmoid activation function is σ, weight vector from m to n is W_{mn} and bias associated with n is b_n.

Proposed C3D and Stacked LSTM Architecture

The proposed C3D and LSTM combined network initially consists of six convolutional layers along with pooling layers, then two LSTM layers and at last, an output layer. The input layer specifies the sequence length as 16, image width as 112, image height as 112 and number of channels to be 3. Convolutional layer 1 and 2 has same number of filters and kernel size. Both these layers have 2 filters and kernel size to be 3x3x3. The third and fourth layer consists of 64 filters each and the kernel size is as same as first and second convolutional layers. Convolutional layer 5 has 128 filters and sixth layer has 256 filters. After each convolutional layer, maxpooling layer is present where the pool size is 3 x 3 x 3. Once all the convolutions are done, the feature maps obtained from the last convolutional layer is reshaped according to the next layer, which is a LSTM layer. There are two LSTM layers with 200 and 100 memory units respectively. Many dropout layers with the value of 0.5 are added in between. Then, a flatten layer is used in order to convert the feature maps into one-dimensional array. Finally, three fully connected layers are used where the first two are hidden layers and the last one is the output layer. Two hidden layers consist of 256 and 128 neurons respectively. The last dense layer consists of 6 neurons that represents the dynamic hand gesture classes.

EXPERIMENTAL RESULTS

The experiments were accomplished using Python 3.1 on a processor of Intel (R) Core (TM) i5-8300H CPU @ 2.30GHz with 8.00 GB RAM on Windows 10 platform. The proposed system is assessed with the help of EgoGetsure dataset [18]. There are about 83 classes of static and dynamic gestures in this dataset from which six dynamic gestures are used in this work. The data used for training and testing is 80% and 20% respectively. The proposed work has two models, one with 3D CNN and other with the combination of 3D CNN and LSTM deep leaning networks. The architecture of these models is discussed in section 3. The architecture is modified based on the input data. Hyperparameters such as batch size, number of epochs, optimizer, learning rate, etc. are selected based on performing various experiments in order to attain high performance. Thus, batch size is chosen to be 16, number of epochs is 35, optimizer is Adam and learning rate is 0.001 for our proposed work.

Proposed Method - Performance Evaluation

The proposed system has two models built with 3D CNN, and combination of 3D CNN and LSTM networks. Performance of these two models is given in table 1. From these two proposed models, 3D CNN + LSTM model attains higher performance than 3D CNN model. Thus, combination of 3D CNN and LSTM model achieves 94.3% accuracy that helps in extracting the motion information from contiguous frames and capable of remembering long-term information from lengthy videos. Figure 5 shows 3D CNN-LSTM model accuracy and loss during training and validation. In figure 5, (a) represents how accuracy increased during each epoch in case of training and validation. The accuracy increases rapidly during first 5 epochs, then gradually increases till 15 epochs. Again, the accuracy curve maintains a slow pace but in increasing order. The accuracy achieved during training is 93.01 % and validation is 94.3%. Figure 5(b) represents how loss values decreased during each epoch while training and validation. In early epochs, the loss decreases rapidly from 0.9 to 0.2. Then, decreasing pace gets slower and it reaches the value 0.06.

Comparative Analysis with Existing Methods

This comparative analysis is about the performance of proposed methods and existing methods. Table 2 provides the details of dataset, modality, classifiers used and their accuracy. The first row refers to the work [2] that created a gesture recognition system using multiple static ad dynamic gestures. They used the combination of 3D CNN and LSTM on RGB data (own dataset) and achieved accuracy of 73%. The next work in [13], utilized UCF YouTube Action dataset for recognizing static, dynamic and hybrid features. They proposed a 3D CNN architecture to recognize these features from the RGB data and attained 85.2% accuracy. Another work [3] provided a hand gesture recognition system in order to categorize multiple gestures in different lighting environments. The experiments of

this work are carried out using both 3D CNN and 3D CNN+LSTM and attained 82.04% and 94.07% accuracy. Lastly, our proposed method employed 3D CNN and 3D CNN+LSTM networks on RGB data of EgoGesture dataset. The architecture is constructed based on the input that achieves performance of 94.3%. Thus, table 2 illustrates that our proposed work yields better performance when compared to the existing methods. Hand gestures are recognized using the proposed method with 3D CNN and LSTM models and sample result is shown in figure 6 (a) and (b) for the actions scroll hand towards right and zoom in with fingers respectively.

CONCLUSION AND FUTURE WORK

In this paper, a dynamic hand gesture recognition system is built using two deep learning models, 3D CNN and LSTM. The system is assessed using EgoGesture dataset, which is a large, versatile dataset that has many static and dynamic gestures which are performed using 50 subjects in different environments, in varying lighting conditions and with varying timings. The input for the deep learning model is RGB videos of six classes, scroll hand towards right, scroll hand towards left, scroll hand upward, scroll hand downward, zoom in with fingers and zoom out with fingers. In this proposed work, two models are built, one with 3D CNN only, and the other by combining 3D CNN and LSTM. As this work is video-based hand gesture recognition, 3D CNN is employed that acquires the motion information from numerous contiguous frames. Since 3D CNN is used, number of frames, and its height and width should be same. But, the sequence of frames of each subject varies in number as they perform in different speed. So, frame selection is performed and reshaping of all the frames are done in order to make the input suitable for 3D CNN. Combination of 3D CNN and LSTM is used to get the motion information from both short and long videos as LSTM is capable of remembering long-term dependencies. The proposed work achieved accuracy of 89% for 3D CNN model and 94% for 3D CNN-LSTM model. The proposed system overcome few challenges (lighting condition, complex background, any of the hands can be used for performing action) and can be used mainly for deaf and dumb people in order to interact with machines. There are certain limitations in this work which are given below. Videos with RGB modality is considered and number of classes is only six. The system is tested with hand region alone. Occlusion is not taken into account. The system won't be able to handle multiple subjects or hands. These limitations must be considered in future work to create a more robust and user-friendly system.

ACKNOWLEDGEMENTS

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Table 1: Performance evaluation of proposed work

Method	3D CNN	3D CNN + LSTM
Accuracy (%)	**89.04**	**94.3**

Table 2: Comparison of proposed and existing methods

Reference No.	Dataset used	Modality	Methods used	Accuracy (%)
[2]	Own dataset	RGB data	3D CNN+LSTM	73.0
[13]	UCF YouTube Action dataset	RGB data	3D CNN	85.2
[3]	VIVA dataset		3D CNN 3D CNN+LSTM	82.04 94.07
Proposed method	EgoGesture dataset	RGB	3D CNN 3D CNN+LSTM	89.04 94.3

Figure 1: Gestures of EgoGesture dataset

Figure 2: Scroll hand towards right action frames are shown in 3 different scenarios
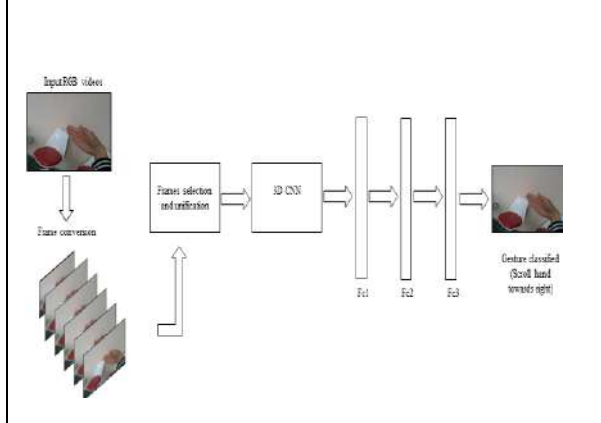
Figure 3: Proposed framework of C3D neural network
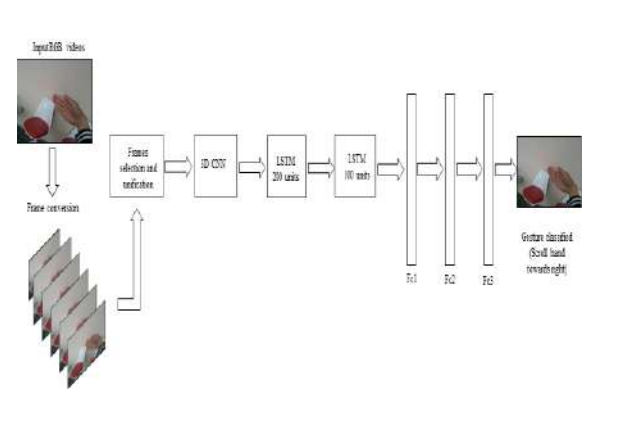
Figure 4: Proposed framework of C3D and LSTM neural network
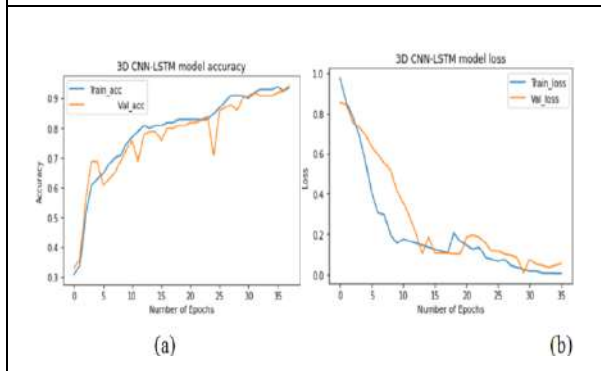
Figure 5: (a) Accuracy during training and validation of 3D CNN-LSTM model (b) loss during training and validation of 3D CNN-LSTM model
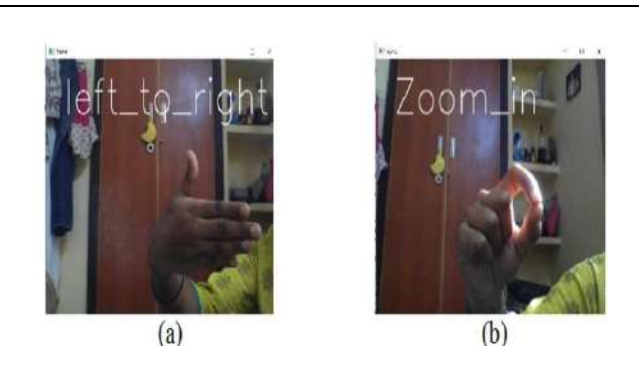
Figure 6: Gesture recognition using 3D CNN+LSTM model- (a) scroll hand towards right, (b) Zoom in with fingers.

RESEARCH ARTICLE

Induced Mutagenic Studies on Foxtail Millet *Setaria italica* (L.)

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ABSTRACT

The present study was under taken to observe the mutagenic effect of ethyl methane sulphonate on M_1 generation of an important foxtail millet variety Co-7 *Setaria italica* (L.) with special emphasis on electrophoretic (SDS-PAGE) analysis of foxtail millet seeds after mutagenic treatment with concentration of EMS. The seeds of foxtail millet variety Co-7 was treated with different concentrations of ethyl methane sulphonate (10 to 50 mM) for six hours after pre –soaking period of twelve hours. Then the mutagen treated seeds were sown in the field to observe M_1 characteristics. The ethyl methane sulphonate treated seeds were subjected to SDS-PAGE analysis. Based on ethyl methane sulphonate treatments the protein content and protein banding pattern were varied. The M_1 parameters such as germination and survival percentage, height of plant, number of productive tillers/plants, number of non productive tillers/plants, total number of tillers, root length, number of roots, 500 seeds weight, number of leaves and length of internodes were decreased with increasing concentrations ethyl methane sulphonate. All the growth parameters showed negative trend when compared to control. Protein content was estimated from seeds treated with different concentrations of EMS such as 10 mM, 20 mM, 30 mM, 40 mM and 50 mM. There was a gradual increase in protein content in all the treatments of EMS compared with control.
there was a study increase in protein content in all the treatments of EMS

Keywords: Mutation, *Setaria italica* (L.), Growth and Yield parameters, EMS, SDS-PAGE analysis

INTRODUCTION

Foxtail millet and other millet species (namely, kodo-, finger- proso- little- and pearl- millet) were shown to have an anti-proliferative property and might have a potential in the prevention of cancer initiation (Chandrasekara and Shahidi, 2011), due to the presence and quantity of phenolic extracts (Rao *et al.,* 2011). Foxtail millet protein improves insulin sensitivity and cholesterol metabolism through an increase in 8 adiponectin concentration thereby making it beneficial food component in obesity-related disease such as type 2 diabetes and cardiovascular diseases (Choi *et al.,* 2005). Mutation induction can be done on the plants by mutagenic treatment of certain materials of plant reproductive organs such as seeds, stem cuttings, pollen, root rhizome, tissue culture and others. Involving gamma illumination caused distinctive chromosomal variations in various plants (Jayabalan and Rao, 1987). One of the important alkylating agents like EMS has recently received much attention as the most effective mutagenic agents in higher plants known today. Concentrates on uncovered that EMS is a successful mutagen and has been utilized to prompt hereditary fluctuation in various yield plants (Jabeen and Mirza, 2002; Kumar and Rai, 2005). Induced mutation may broaden genetic variants and provide materials for plant improvement. Ethyl methane sulfonate (EMS) is typically used to induced mutations, because it causes mispairing between complementary bases by formation of adducts with nucleotides, leading to base changes after replication (Ashburner, 1990); (Greene *et al.,* 2003); (Haughn and Somerville, 1987).

MATERIALS AND METHODS

Seed material / Experimental material

Mature, healthy and uniform seeds of *Setaria italica* (L.)   var CO-7 was obtained from Tamil Nadu Agricultural University, Coimbatore ,Tamil Nadu and used as an experimental material to carry out the mutagenic studies using ethyl methane sulphonate as a chemical mutagen. The field experimentation was conducted during October-December of 2018 for M_1 generation.

Preparation of phosphate buffer

Take 0.31g of NaH_2PO_4 and add 100ml of distilled water to make makeup the solution- 1. Then take 1.09g of Na_2HPO_4 and add 100ml of distilled water to makeup the solution -2. Keep the solution in refrigerator for 30min. After that both the solution were kept for 30 min in room temperature. Then take 99ml of solution-1 and 1ml of solution-2, makeup to 1000ml using dH_2O. Finally the solution was set into 6 pH range.

Determination of imbibition period

For the purpose of chemical mutagen treatment, the total imbibitions period was calculated before ethyl methane sulphonate treatment. The imbibition period was divided in to (i) pre- soaking period-12 hrs and (ii) mutagen treatment period 6hrs.

Treatment with Ethyl methane sulphonate

Seeds of foxtail millet were treated different concentration of (10,20,30,40 and 50mM) of ethyl methane sulphonate for induced mutagenesis .Before treatment, seeds were pre-soaked in distilled water for 6hrs at room temperature. Finally these seeds were dried on filter paper. All seeds are uniformly exposed to ethyl methane sulphonate solution by stirring with a glass rod and kept in rotary shaker. After treatment seeds were rinsed thoroughly with distilled water, air-dried and stored for electrophoretic analysis. Then the pre-soaked seeds were immersed in various concentrations of EMS for 6 hrs. After mutagenic treatment the seeds were carefully washed with distilled water to remove the traces of EMS present on the surface of the seeds. After treatment with EMS the seeds were immediately sown in the field.

M1 Characteristics

The following M_1 characteristics were studied in the field

1. Germination percentage
2. Survival percentage
3. Root length
4. Number of roots
5. Height of plant
6. Length of internodes
7. Number of leaves
8. Total number of tillers
9. Number of productive tillers
10. Number of non productive tillers
11. 500 seeds weight

Calculation

1. Germination percentage $=\dfrac{\text{Total number of germinated seeds} \times 100}{\text{Total number of seeds planted}}$

2. Survival percentage $=\dfrac{\text{Total number of plants survived} \times 100}{\text{Total number of plants germinated}}$

3. Number of roots and their length were calculated separately and taken the average.
4. Height of the plant, and internodal length were measured and taken as average.
5. Number of leaves and Length of leaves were measured and taken as average.
6. Total number of tillers , Number of productive tillers and number of non-productive tillers were measured and taken as average.
7. The weight of 500 seeds were measured

Statistical analysis

Each experiment/treatment was repeated thrice. A complete randomized design was used in all the experiments and wherever appropriate mean and standard deviation also carried out.

RESULTS AND DISCUSSION

During this study, the effects of ethyl methane sulphonate radiation on various characters such as seed germination, survival of seedlings, root length, number of roots, height of plants, length of internodes, number of leaves, number of productive tillers, number of non productive tillers, total number of tillers, 500 seeds weight of M_1 generation were recorded. The direct effect of the mutagen is seen in the first generation of mutagenesis. The details of various characters are presented separately.

Seed germination

The data on germination of seeds sown after treatment are presented in table 1. The germination percentage ranged from 78.01 % in control and it was 28.06 % in 60 mM exposure. Treated seeds showed a tendency for decrease in percentage of germination with an increasing concentration such as 10 mM (70.02%), 20 mM (64.12%), 30 mM (56.20%), 40 mM (46.02%), and 50 mM (38.05%). (Table : 1)

Survival of plants
Percentage of survival of plants reaching to maturity ranged from 84.03 % in control and it was 42.02 % in 50 mM exposure it have also reported that increased concentration of ethyl methane sulphonate decreased the percentage of germination and survival of seedlings in *Setaria italica* (L.)

Root length
The root length was showed higher at control (4.88±0.12) and lower length of roots was showed at 50 mM (4.09±0.09) values in M_1 generation.

Number of roots
The number of roots was showed higher at control (11.08±1.01) and lower number of roots was showed at 50 mM (8.70±0.09) values in M_1 generation.

Height of plants
Height of the plants at harvest ranged from 49.09±0.92 cm in control and it was 16.09±0.01 cm in 50 mM exposure. This showed the effect of mutagen on the height of the plant where plant height decreased from lower to higher concentration.

Length of internodes
Length of internodes ranged 9.09±0.01 cm in control and it was 4.30±0.31 cm in 50 mM in generation. Internode length of based on the observations on internode length and plant height reported that the growth rate was reduced by the mutagen. It have also reported that length of internodes was decreased while increasing the concentration of ethyl methane sulphonate in *Setaria italica.* (L.)

Number of leaves
Highest number of leaves (31.04±1.02) were seen in plants of control exposure and lower in 50 mM exposure (10.60±1.14). The same trend of decrease in number of leaves was also noticed in 30, 60 and 90 days after planting.

Total number of tillers
The total number of tillers was showed higher at control (5.01±0.08) and lower number of tillers was showed at 50 mM (3.06±0.15) values in M_1 generation.

Number of productive tillers
The number of productive tillers was showed higher at control (2.50±0.01) and lower number of productive tillers at 50 mM (1.07±0.02) values in M_1 generation.

Number of non-productive tillers
The number of non-productive tillers was showed higher at control (2.25±0.07) and lower number of non-productive tillers at 50 mM (1.05±0.02) values in M_1 generation.

Weight of 500 seeds
500 seeds each from every treatment were collected at random and weighed. Higher seed weight is (1.67 g) was seen in control exposure and lowest (1.25 g) in 50 mM exposure values in M_1 generation.

Effect of EMS on protein content and banding pattern
Protein content was estimated from seeds treated with different concentrations of EMS such as 10 mM, 20 mM, 30 mM, 40 mM, 50 mM. When compared to control there was a study increase in protein content in all the treatments of EMS. The protein content in control was 3.04mg/g fw. whereas it was 3.15,3.24, 3.29, 3.34, 3.18 mg/g/fw in respectively in 10,20,30,40,and 50mM concentrations of EMS. (Fig :1 and Table : 2). Similar type mutants were achieved by gamma ray induced mutagenesis on exposed sunflower (Ratnam and Madhava rao, 1994).Like that of

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our study, induced mutations were carried out in (*Setaria italica* L.) The frequency of mutation, lethality and efficiency of ethyl methane sulphonate and sodium azide on foxtail millet *Setaria italica* (L.) by (Esson 2018).
Several authors reported that induced mutagenic studies in (*Setaria italica* L.). (Gupta and Yashvir, 1976) noticed that induced mutations in foxtail millet (*Setaria italica* L.) viable mutations in ear characters induced by gamma rays, EMS and DES. (Anitha and Mullainathan, 2018) reported that mutagenic effect of EMS and DES on thenai (*Setaria italica* L.) in M₁ generation. Two cultivars of *Ipomoea purpurea* treated with EMS, N-methyl-N-nitro-N-nitrosoguanidine and NaN3, showed corolla whorl-explicit attributes (Bhate, 2001). (Rodrigo et al., 2004) got Chrysanthemum freaks with different petal tones (i.e., pink-salmon, light pink, bronze, white, yellow and salmon) through EMS treatment.(Afify and Shousha, 1988) reported that, radiation may dissociate these protein fractions to small subunits and rearrangement to form a complex protein even high or small molecular weight compounds. (Englard and Seifter, 1990) hydrophobic interactions lead to aggregation, followed by coagulation and precipitation. (Chiou *et al*., (1990, 1988).

CONCLUTION

The present study was under taken to know the mutagenic effect of ethyl methane sulphonate on M1 generation of an important foxtail millet variety Co-7 (*Setaria italica* (L.)   with special emphasis on electrophoretic (SDS-PAGE) analysis of foxtail millet seeds after mutagenic treatment with concentration of EMS. The seeds of foxtail millet variety Co-7 was treated with different concentrations of ethyl methane sulphonate (10 to 50 mM) for six hours after pre –soaking period of twelve hours. Then the mutagen treated seeds were sown in the field to observe M1characteristics.The ethyl methane sulphonate treated seeds were subjected to SDS-PAGE analysis. Based ethyl methane sulphonte treatments the protein content and protein banding pattern were varied. The M1 parameters such as germination and survival percentage, plant height, number of productive tillers/plants, number of non productive tillers/plants, total number of tillers, root length, number of roots, 500 seeds weight, total number of leaf area, number of leaves were decreased with increasing concentrations ethyl methane sulphonate. All the growth parameters showed negative trend when compared to control. The present study, is a basis for production new mutant varieties with improved characteristics in foxtail millet through mutation breeding technology.

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Table 1: Effect of EMS on growth and yield parameters of *Setaria italica* (L.) in M₁ -generation.

S.N	Concentration	Germination %	Survival of plants %	Root length (cm)	No. of roots	Height of plants (cm)	Length of internodes (cm)	No. of leaves	Total no.of tillers	No.of productive tillers	No.of non-productive tillers	500 seeds weight (g)
1	Con	78.01± 2.02	84.03±4.02	4.88±0.12	11.08±1.01	49.09±0.92	9.91±0.01	31.4±1.02	5.01±0.08	2.50±0.01	2.25±0.07	1.67±0.25
2	10	70.02±2.11	78.12±2.10	4.47±0.41	10.09±0.01	31.02±0.63	8.71±0.51	20.05±0.03	4.05±0.03	2.45±0.05	2.08±0.04	1.61±0.02
3	20	64.12±4.12	64.05±4.08	4.36±0.02	9.80±0.07	29.60±5.60	6.91±1.51	17.06±1.02	4.04±0.05	2.10±0.02	2.03±0.03	1.48±0.01
4	30	56.20±8.20	54.04±6.04	4.25±0.13	9.50±0.08	20.01±0.07	6.80±0.51	11.60±0.81	4.03±0.03	1.91±0.01	1.18±0.02	1.45±0.11
5	40	46.02±6.14	50.03±2.06	4.14±0.03	9.09±1.03	18.80±3.21	6.21±0.08	10.70±0.09	3.08±0.02	1.19±0.03	1.10±0.01	1.28±0.03
6	50	38.05±2.13	42.06±2.02	4.09±0.09	8.70±0.09	16.09±0.01	4.30±0.31	10.60±1.41	3.06±0.15	1.07±0.02	1.05±0.02	1.25±0.05

Table : 2 Effect of EMS on presence and absence of different protein banding pattern of foxtail millet *Setaria italica* (L.)

S .No.	kDa value	Control	10 mM	20 mM	30 mM	40 mM	50 mM
1	24.8	_	_	+	+	+	_
2	35.2	+	-	-	-	-	-
3	41.1	_	_	+	+	+	_
4	48.7	+	-	-	-	-	-
5	59.3	+	+	+	+	+	_
6	62.5	+	+	+	+	+	_
7	88.5	_	_	_	+	_	_
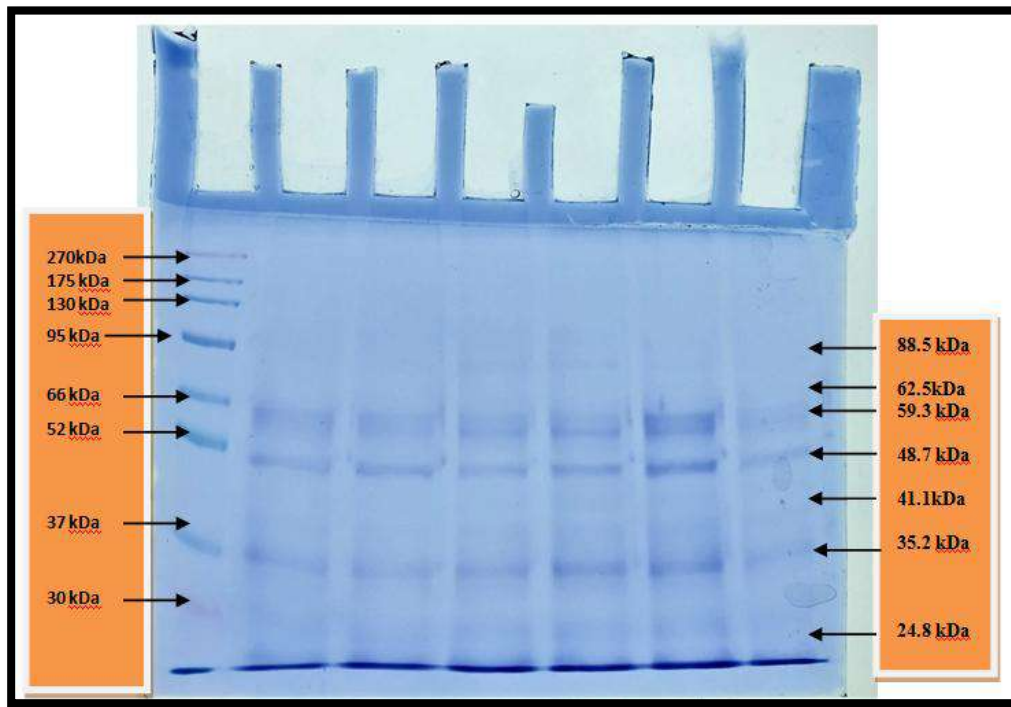
Fig. 1. SDS-PAGE analysis of foxtail millet *Setaria italica* **(L.) seeds treated with different concentration of EMS.**

RESEARCH ARTICLE

A Comparative Study to Determine Effectiveness of Neural Tissue Mobilization and Cervical Stability Exercise for Pain, Handgrip Strength and Functional Limitation in Cervical Radiculopathy

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ABSTRACT

Cervical radiculopathy is a clinical disorder that may present as neck pain, tingling, numbness in the upper limb, and overall weakness of the upper limb due to inflamed or damaged nerve root in the cervical region. Neural tissue mobilization is a technique that restores normal movement and elasticity of neural structures and promotes normal functioning. Cervical stability training is applied as an exercise strategy to improve the cervical spine's stability, reduce pain, and enhance functionality. This study intends to evaluate and compare the effect of neural tissue mobilization and cervical stability exercise for pain, handgrip strength and functional limitations for people suffering from cervical radiculopathy. 52 subjects were randomly allocated into two groups that met inclusion criteria. For four weeks, Group A received neural tissue mobilization and Group B received cervical stability exercise. The data were evaluated using paired and unpaired t-tests. According to the findings of this study, there is a significant difference in NPRS, NDI, and grip strength in both groups. However, group A improved significantly more in terms of NPRS, NDI, and grip strength. Therefore, this study concludes that while both techniques are effective for reducing symptoms associated with cervical radiculopathy, neural tissue mobilization may be more effective.

Keywords: Cervical radiculopathy, neural tissue mobilization, cervical stability exercise, NPRS, grip strength.

INTRODUCTION

Cervical radiculopathy is a disorder that affects the nerve roots of the cervical region. It occurs because of inflammation and compression of cervical nerve roots at neural foramina. Cervical disc herniation [1] and cervical spondylosis [2]seem to be the most likely reasons for radiculopathy. Cervical radiculopathy can however occur for no apparent reason. Cervical radiculopathies occur as a result of subsequent factors: Mechanical deformation of the nerve root by either the hypertrophied joints between vertebrae or uncovertebral joints, spondylotic spurring and projection of the disc between vertebral bodies, or a mixture of those factors [9]. Pain can occur as a result of physical restriction at the spinal level and inflammation. Various symptoms like sensory deficit, motor weakness, or radiating pain might appear because of pressure on the nerve root [1]. The prevalence of cervical radiculopathy is 83 per 100,000 people [3]. The reported annual occurrence for men is 107, 3 per 100.000 and 63,5 per 100.000 for women[4]. Neural mobilization procedures are passive or active manoeuvres associated with restoring the nervous system's ability to tolerate the normal compressive, tension generating pressure and abrasions associated with daily activities and sports [5,6].

It is assumed that these therapeutic movements can improve blood flow within neural tissue, transport through axoplasm, and the elasticity of viscous neural connective tissue. Along with this, it reduces the sensitivity of AIGS [7]. Gliders or sliders are neurodynamic manoeuvres that attempt to produce flossing movement between neural network and adjacent non-neural tissue and are performed in a non-provocative manner [7]. Tensile loading techniques are oscillating neural tissue manoeuvres. It is more vigorous than sliding techniques. The purpose of the neurodynamic tensile loading methods is to restore nerve tissue's physical ability to tolerate movements that put pressure on the corresponding nerve bed [7]. Cervical stability exercise is used as a training strategy to improve cervical stability, reduce pain, and improve functionality [8]. Superficial muscles of the neck are over-activated to compensate for the deep flexor muscles in people with neck discomfort [9]. This over activation of the superficial muscles causes fatigue and muscle spasms. Therefore, cervical stability training emphasizes reducing undue activation of these muscles and reducing fatigue [10].

Numeric pain rating scale
The NPRS is a self-reported questionnaire for pain. The person is asked to indicate the intensity of their pain which they are perceiving currently. This scale has 11- point numeric scale, which ranges from 0 (no pain) to 10 (worst pain imaginable) [11,12].

Handgrip strength
Cervical radiculopathy has an impact on handgrip strength and related functions. A person with cervical radiculopathy may have reduced grip strength. Which can be assessed with the hand dynamometer. Excellent test-retest reliability for grip strength measurement was measured in patients with cervical radiculopathy, suggesting that a hydraulic hand dynamometer could be used as an outcome measure for these patients [13].

Neck disability index
The NDI is the most often used outcome measure for self-reported disability in individuals with neck discomfort [14]. The Neck disability index comprises seven items related to activities of daily living, two items related to pain, and a concentration-related element (reading ability). Every item is scaled from 0 to 5 points and the total score is stated as a percentage. Higher scores represent a greater degree of disability. The maximum total score is 50 points and the minimum of 0 means no disability [14].

MATERIALS AND METHODS

The study was carried out after receiving ethical approval from the university's ethical committee. A total of 52 individuals were evaluated for cervical radiculopathy and included in the study if they met the inclusion criteria. Individuals willing to participate in the study, those aged between 30-60 years, those with unilateral radicular symptoms, and participants of both genders were included. Participants with cervical spine instability, cervical vertebral fractures, recent cervical or thoracic spine surgery, inflammatory arthritis of the cervical spine, and vertebrobasilar artery insufficiency were excluded. Before receiving therapy, all participants were examined in form of chief complaint, history of present illness, and the Spurling and upper limb tension tests. Individuals were randomly divided into 2 groups. There were 26 people in Group A and 26 people in Group B. Before commencing the treatment, participants were evaluated for pain with NPRS, handgrip strength with handheld dynamometer and functional disability with neck disability index.

The procedure of assessment
Numeric pain rating scale
This scale is used to assess the severity of pain. It is a scale that is self-reported. Patients were asked to rate the severity of their current pain on a scale ranging from 0 to 10. Handgrip strength: A hydraulic hand dynamometer was used to assess handgrip strength. Patients were asked to sit up straight in a chair with back support. Feet are supported on the floor.

The upper limb should be in the following positions
Shoulder 0 degrees of flexion, abduction, and rotation, elbow flexed to 90 degrees, forearm resting in a neutral position, and wrist in minimum extension. The patient is requested to hold a dynamometer and make three maximal grasping attempts after obtaining a standard posture. The average of three tries was measured and used to estimate handgrip strength. The strength was measured in kilograms of force (kgf). To avoid fatigue, a 10-second rest time was given between each exertion.

Neck disability index
It is a self-reported questionnaire designed to assess how neck discomfort has impacted the patient's functional level. It is divided into ten segments. Each section is graded from 0 to 5. 0 represents no discomfort and 5 represents the worst pain imaginable. For each part, the patient was asked to mark their present pain level. The overall score was then computed. The cumulative score was given as a percentage.

Treatment procedure
Group A
Participants in group A were treated with neural tissue mobilization along with conventional physiotherapy for cervical radiculopathy. Out of 26 patients, 13 patients were treated with median nerve mobilization,10 were treated with ulnar nerve mobilization and 3 were treated with radial nerve mobilization.

Neural tissue mobilization for the median nerve was performed in the following manner
Abduction of an arm, an extension of the wrist, supination of the forearm, shoulder lateral rotation, an extension of the elbow, opposite side neck lateral bending. Neural mobilization for the ulnar nerve was performed in the following manner: Extension of the wrist, forearm pronation, elbow flexion, arm external rotation, shoulder depression, and shoulder abduction.

Neural mobilization for radial nerve was performed in the following manner
Shoulder depression, internal rotation, an extension of elbow and flexion of the wrist. Three sets of neural tissue mobilization were conducted in total. Each set consisted of ten repetitions. In the end position, a 5-second hold with stretch was provided.

Group B

Participants in Group B were treated with cervical stabilization exercises in addition to traditional physiotherapy. In group B, a total of 26 patients were assigned. Patients were trained to activate deep cervical flexor muscles before undergoing the cervical stability exercise. The following activities were introduced when patients learned to contract their muscles. For the neck, all movements were done while holding a contraction of the deep cervical flexor muscles. The activities include, isometric cervical flexion, isometric cervical extension, shrugging of the shoulder, unilateral arm raises while maintaining the neck muscles contracted. Moved to reciprocal arm raises. The exercises began with 10 repetitions of holding the contraction for 10 seconds. It was eventually increased to 15 repetitions. Thera band was used for these activities. Activities of the upper limb include shoulder flexion and abduction, bicep curl, seated shoulder press. A 1 kg dumbbell was used to do upper-limb exercises. Initially, 10 repetitions were completed, then progressed to 15. A traditional physiotherapy programme implies Both groups A and B received a traditional physiotherapy.

programme that included

Cervical traction for 15 minutes at 7% of total body weight with 7 seconds hold and 5 seconds rest, moist heat pack at the neck region, isometric neck exercise in each direction. Total 25 repetitions were performed while holding each contraction for 7 seconds.

Statistical analysis

SPSS version 20.0 was used as a data analyser. The data was analysed by using the descriptive statistic in form of mean and standard deviation. Paired and independent t-tests were performed with a $p<0.05$ level of significance. For both, groups A and B mean and standard deviation were performed as descriptive statistics. Paired t-test was performed to analyse the data within groups A and B. It was performed to analyse pre NPRS with post NPRS, pre handgrip strength with post handgrip strength and pre NDI score with a post-NDI score, in both the groups. An independent t-test was performed to compare the values of NPRS, handgrip strength, and NDI scores between groups A and B.

RESULT

Table.1.shows mean values and standard deviation with a $p<0.05$ level of significance. Group A (neural tissue mobilization) shows mean values and standard deviation with a $p<0.05$ level of significance of NPRS, handgrip strength and NDI at 4 weeks post treatment. Group B (cervical stability exercise) shows mean values and standard deviation with $p<0.05$ level of significance of NPRS, handgrip strength and NDI at 4 weeks post treatment. Table.2 shows the mean and standard deviation for post-NPRS, post handgrip strength and post NDI. Comparison of post-NPRS, handgrip strength and NDI in both groups shows that there is a significant reduction in these symptoms in both groups but group A shows a more significant effect for reducing pain and disability and improving handgrip strength.

DISCUSSION

The study found that Group A had more considerable improvement in symptoms of pain, handgrip strength, and functional impairments following cervical radiculopathy. The findings of this study are similar to those of author Heba Mohammad *et al*, who studied the influence of neural dynamic mobilization on pain and handgrip strength in cervical radiculopathy patients. They got some favourable effects from the median and ulnar nerve mobilization, as well as radial nerve mobilization, in their study. Patients who got neural dynamic mobilization showed better results in terms of reduced pain and enhanced grip strength [15]. Cleland claims that when the nerve root is compressed, the microcirculation surrounding the nerve is damaged. Short oscillating methods are used in neural tissue mobilization. This manoeuvre is responsible for reducing oedema and hypoxemia. As a result, it helps to alleviate compression symptoms. In this study, there was a statistically significant difference in pain, handgrip strength, and functional

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impairment in group B. This finding was similar to the research done by Nihal Gelecek and colleagues. They analysed the impact of neck stabilization exercise on pain and functional ability in individuals with cervical radiculopathy[16]. In their research, one group was given cervical stability exercise while the other was given the standard therapy procedure. The VAS, NDI, SF 36, Corbin postural assessment scale, and handgrip strength were used to examine the patients. According to their finding, cervical stabilization exercise can effectively reduce pain, functional impairment, poor posture, and other symptoms associated with cervical radiculopathy [16]. Following cervical radiculopathy, weakness of the neck and shoulder girdle muscles is particularly prevalent. According to Michael W. Wolff et al, cervical stability exercise is a key component of rehabilitation for reducing pain, maximising function, and avoiding injury progression or re-injury. The anterior and posterior cervical musculature and the shoulder girdle musculature must be coordinated and trained to prevent further damage. The patient can balance strength and forces around the cervical spine as a result of improved muscle strength and greater proprioceptive awareness. The capacity to divert forces away from the cervical spine is improved by strengthening the shoulder girdle and upper limb.

There is a lack of research that compares the effects of neural tissue mobilization with cervical stability exercise. The result of the present study has gained positive results from neural tissue mobilization as well as cervical core stability exercise. However, neural tissue mobilization showed better results compared to cervical stability exercise in terms of pain reduction, handgrip strength improvement, and functional status. Deep cervical muscles maintain mechanical stability of the cervical spine, which is disrupted in cervical radiculopathy. These activities can also help with mobility, spinal alignment, and sensorimotor function. As a result, it aids in the alleviation of symptoms associated with cervical radiculopathy. The potential of neural tissue mobility to generate various alterations in the physiological function of the nervous system might explain the positive results. When a stretch is given to a nerve, actin polymerization, rate of force generation, neurotransmitter release, and intra-neural blood flow all increase. As a result, the rate of motor unit recruitment enhances. When combined with adequate neurobiology training, these strategies can help to reduce undesired anxiety of movement, perhaps lowering the pain neuromatrix responsiveness.

CONCLUSION

For cervical radiculopathy, neural tissue mobilization and cervical stability training appear to be useful in reducing pain, functional limitations, and enhancing handgrip strength. As a result, both can be used effectively to decrease symptoms associated with cervical radiculopathy. When compared to cervical stabilization exercise, the results of the study demonstrated that neural tissue mobilization can be more beneficial in alleviating symptoms.

Further Recommendations
The study can be done to evaluate the effect of both treatments for a longer period. A more reliable outcome to check and evaluate cervical and upper limb muscles strength in the cervical stability training group should be used in further study. The effect of both techniques should be evaluated on other clinical outcomes as well.

Conflict of Interest
Nil

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Table 1.Shows pre and post mean difference and SD at p<0.05 level of significance of NPRS, handgrip strength and NDI

Group	Outcome	Mean difference	Std deviation	sig(2-tail)
Neural tissue mobilization	Pre NPRS- Post NPRS	4.222	1.050	0.000
	Pre Handgrip strength- Post Handgrip strength	-5.309	1.807	0.001
	Pre NDI score- Post NDI score	13.62963%	4.64218%	0.000
Cervical stability exercise	Pre NPRS- Post NPRS	3.840	0.943	0.000
	Pre Handgrip strength - Post Handgrip strength	-4.180	1.879	0.004
	Pre NDI score- Post NDI score	8.48000%	3.17700%	0.000

Table 2. Mean and Standard deviation of post NPRS, handgrip strength and NDI of both groups

Outcome measure	Group A		Group B	
	Mean	SD	Mean	SD
Post NPRS	1.19	1.111	1.36	0.995
Post handgrip strength	24.84	8.307	23.03	6.197
Post NDI	9.1111%	5.66591%	12.2400%	7.21849%
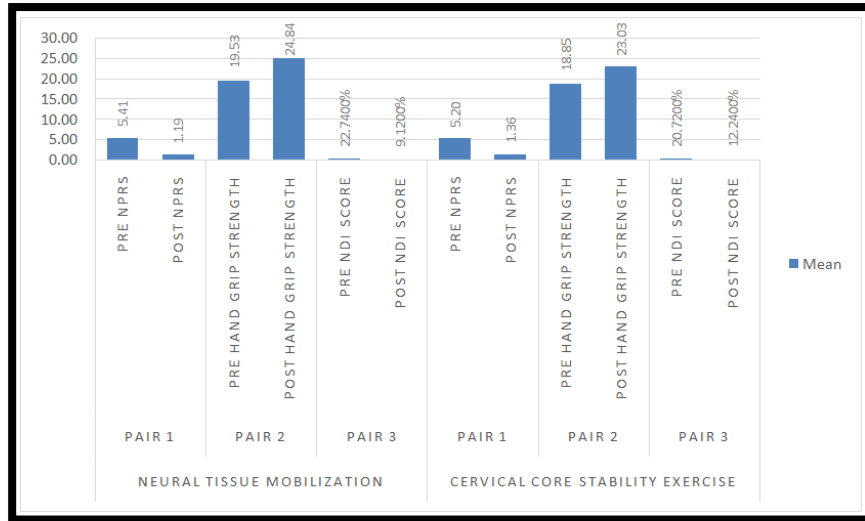
Graph 1. Shows pre and post mean values of NPRS, Handgrip strength and NDI in both groups.

RESEARCH ARTICLE

LCMS / MS Method Development and Validation for Solriamfetol Estimation in Rat Plasma

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ABSTRACT

The bioanalytical method for solriamfetol has been established using D6-solriamfetol as the internal standard in pharmaceutical dose form. It is quick, precise, sensitive, and repeatable. Solriamfetol was separated chromatographically on the Waters Alliance-e2695 using a 150x4.6mm, 3.5m Waters X-Bridge column and a mobile phase made up of 10mM ammonium formate buffer and ACN in a 30:70% v/v ratio. There was a flow of 1 ml/min; The method was validated over a concentration range of 2.00ng/ml to 40.00ng/ml of Solriamfetol with detection of Solriamfetol m/z-456.20 and354.20 and m/z-231.10 and 194.10 in positive ion mode. According to USFDA requirements, the suggested approach underwent bio-analytical validation. For the pharmacokinetics investigation of solriamfetol and the examination of its stability, the method was found to be straightforward, affordable, suitable, exact, accurate, and stable.

Keywords: LCMS/MS, Biological research, Rat plasma, Validation, Solriamfetol

INTRODUCTION

Numerous sleep disorders, such as narcolepsy and obstructive sleep apnea, are accompanied by excessive sleepiness (ES)(OSA). According to Mergenthaler et al.,(2007); available at http://www.fda.gov/downloads/ForIndustry/ User Fees/Prescription Drug User Fee /UCM377107.pdf, ES is the clinical hallmark symptom of narcolepsy and is the symptom that is reported to have the most impact on patients' lives. A decrease in ES is also advised by the

American Academy of Sleep Medicine as one of the most important parts of managing narcolepsy (Krahn et al., 2015). In spite of good therapy with positive airway pressure, ES in OSA is a notable symptom that may not go away (Veasey et al., 2006; Weaver and Chasens, 2007; Pépin et al., 2009; Gasa et al., 2013; Chapman et al., 2016). In narcolepsy patients or The quality of life of individuals with OSA, ES is frequently significantly impacted and can be a burdensome condition (Aldrich, 1989; George, 2007; Ozaki et al., 2008). Serotonin (5-HT), norepinephrine (NE), and dopamine (DA) monoaminergic systems are known to regulate sleep-wake cycles among other physiologic processes (Jouvet, 1972; Steriade and McCarley, 1990; Jones, 2000; Siegel, 2000; Wisor et al., 2001). Several lines of evidence link ES, in part, with dysregulation of DA systems, despite the fact that the underlying pathophysiology of ES may vary among sleep disorders [for a review, see Slater and Steier (2012)].

MATERIALS AND METHODS

Chemicals and solvents: Solriamfetol and Solriamfetol-D6 were purchased from SS Pharma lab, hyd lcms grade acetonitrile was purchased from Rankem; buffer and methanol were purchased from Merck; and hplc grade water was obtained from the Milli-Q water system. The remaining compounds were all of analytic quality.

LC-MS/MS Instrument conditions
Alc-10ADvp pump and an auto sampler made up the chromatographic apparatus from alliance-e2695. A water Xbridge C-18 column of 150 x 4.6 mm and 3.5 um was employed for the chromatographic analysis. With a split ratio of 1:1, the separation of the analyte and IS was carried out under isocratic conditions, and the isocratic mobile phase was made up of 30:70 v/v of 10 mints. Buffer with ammonium formate and acetonitrile. The temperature of the auto sampler was fixed at 4C, and the injection volume was held constant at 20 g/ml. The LC ran for a total of 10 minutes. The electro spray ionization (ESI) interface of a triple quadrupole mass spectrometer API 4000 operating in the positive ion mode was used to ionise the analyte and detect the IS. Utilizing MRM, which was created to monitor protonated precursor, quantization was decreased.

Preparation of standard solutions& (QC) samples
When creating the stock solution of Solriamfetol for use in the LC-MS method development stage, the precisely weighed standard substance was dissolved in acetonitrile. The working standard solutions for method development, calibration curves, and quality control samples were generated by appropriately diluting the Solriamfetol standard solution with mobile phase from the stock solution. The working and stock standard solutions were kept in polypropylene tubes and kept in a freezer set to -20°C.

Sample Extraction Procedure
Extraction of Solriamfetol from plasma sample by LLE

200μl of blank plasma

↓

300μl of Acetonitrile

↓

Add 500μl of Solriamfetol (20ng/ml)

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Add 500μl of Internal standard

↓

Add 500μl of Diluent

↓

Vertex for 5mints

↓

Centrifuge for 20mins at 5000rpm

↓

2ml supernatant was separated

↓

Inject the sample on the LCMS
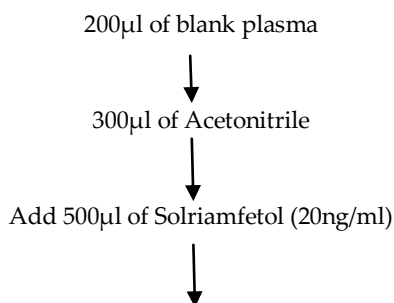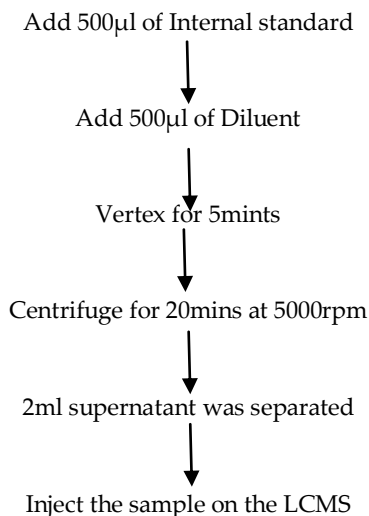
Bioanlytical method validation: According to US-FDA industry guidance, the suggested procedure was validated. Validating bioanalytical techniques Comparing the chromatogram of spiked plasma samples at the lower limit of quantification (LLOQ) concentration with plasma from six different people allowed researchers to determine the selectivity of the assay. The assay of three separate analytical curves on three distinct days by linear regrassion of analyte/IS peak area ratios was used to evaluate a calibration curve in the range of 2.0 to 40.0 ng/ml. LLOQ was defined as the lowest analyte concentration at which a quantitative determination could be made with a precision of 20% and an assay of 98-120%. By analysing low, medium, and high quality control samples on several days, the accuracy and precision were assessed. Except at LLOQ, where it should not exceed 20%, the accuracy was required to be within +-15% and the intraday and interday precision to be lower than 15%.

RESULTS AND DISCUSSION

Specificity and selectivity
It was tested by looking for any chromatographic interference at the retention periods of the Solriamfetol and IS in blank plasma samples from six different sources.

Calibration curve
In order to get final concentrations of 2, 5, 10, 15, 20, 25, and 40ng/ml for the Solriamfetol, the working solution was injected into the blank plasma in the proper volumes to create an 8-point calibration curve. The calibration curve was created by graphing the peak area ratio of the Solriamfetol to IS transition pair against the nominal calibration standard concentration. Analyses of linear regression were used to fit the results. Except at LLOQ, where the acceptance threshold was set at 20%, each back-calculated standard concentration had a tolerance of 15% SD from the nominal value. The American Food and Drug Administration, 2001

Precision and accuracy
By examining six duplicates of LLOQ, LQC, MQC, and HQC samples, intraday precision was ascertained. On three different days, six sets of LLOQ, LQC, MQC, and HQC samples were used to confirm the method's repeatability (day-to-day variation, or interday precision).The ratios of standard deviation (SD) to the mean, which are expressed as percentages, were used to calculate the intraday and interday assay precision.

$$\text{Precision (CV \%)} = \frac{\text{Standard deviation (SD)}}{\text{Mean}} \times 100$$

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Six replicates at four QC levels (LQC, MQC, HQC, including LLOQ) were analysed on the same day and three different days, respectively, to assess the intra- and inter-assay accuracy. By multiplying the ratio of the determined concentration and the actual concentration by 100%, accuracy was calculated.

$$\text{Accuracy (\%)} = \frac{\text{Found concentration}}{\text{Theoretical concentration}} \times 100$$

Except for LLOQ, where it could not exceed 20% of SD, the data had to be accurate to within 15% deviation (SD) from the nominal values and precise to within 15% relative standard deviation (RSD) (Food and Drug Administration of the United States, 2001).

Stability Experiments
As part of the method validation, the stability study was assessed. The following stability test was created to gauge how easily Solriamfetol might decompose under certain conditions.

Freeze-thaw stability
LQC, MQC, and HQC each had six duplicates that were held at - 20 oC, totally thawed at ambient temperature, and then were immediately refrozen at -20 oC. The samples were removed for injection into the LCMS after this cycle had been completed twice.

Bench top stability
Solriamfetol stability for benchtop stability experiment. in three concentrations (LQC, MQC, and HQC) in six repetitions in the rat plasma after an 8-hour benchtop exposure.

Wet Extract stability
Solriamfetol freezer stability in plasma was evaluated by examining LQC, MQC, and HQC samples in six replicates that were kept at -20 °C for 24 hours as part of a stability study. Six replicas were used to compare each sample to freshly prepared samples from three distinct QCs. According to the Food and Drug Administration of the United States (2001), samples were regarded as stable if assay results were within the permitted ranges of precision (i.e. 15% RSD) and accuracy (i.e. 15% SD).

Auto sampler Stability
Analyzing LQC, MQC, and HQC samples that were injected every hour for up to 24 hours allowed researchers to evaluate Solriamfetol samples in plasma. Six repetitions of each sample were used to compare them to newly prepared samples of 0Hr from various QC. According to the Food and Drug Administration of the United States (2001), samples were regarded as stable if the assay results were within the permissible ranges for precision (i.e., 15% RSD) and accuracy (i.e., 15% SD).

Recovery
The analytical data for extracted samples at three different concentrations (LQC, MQC, and HQC) in six repetitions were compared with extracted standards (unprocessed), which indicate 100% recovery, to assess the extraction recovery of the analytes. In contrast, an experiment involving the recovery of IS was conducted at a single dose of 20ng/mL. The following formula was used to determine the extraction recovery:

$$\text{Recovery (\%)} = \frac{\text{Response of processed spike plasma}}{\text{Response of standard solution (unprocessed}} \times 100$$

CONCLUSION

Solriamfetol was the subject of the experiments in the current study. These studies make use of an LCMS/MS combined with PDA detector as the apparatus. Although solid and protein precipitation extraction techniques were used in the published literature, we created liquid-liquid extraction for sample preparation that has higher sensitivity and longer column life than protein precipitation. Due to its high economic rate, the solid phase extraction method was not used. These strategies' many parameters are chosen after careful rationale and numerous trials and errors. Solriamfetol in plasma can be detected using an extremely sensitive and specific HPLC technique. The techniques we've created in our lab are quite straightforward and use a liquid-liquid extraction process, giving them great analysis throughput. Each and every set of validation data satisfied the USFDA's range approval requirements.

ABBREVIATIONS

5-HT, serotonin; DA, dopamine; DAT, dopamine transporter; ES, excessive sleepiness; hDAT, human DAT; hSERT, human SERT; HEK, human embryonic kidney; IC50, inhibitor concentration resulting in half inhibition; Ki , inhibitory constant; NE, nor epinephrine; NET, or epinephrine transporter; OSA, obstructive sleep apnea; SERT, serotonin transporter.

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Table 1: Preparation of Solriamfetol working stock solution for standard curve

Linearity	Plasma (µl)	ACN (µl)	Std Stock (µl)	IS (µl)	MP added (µl)	Solriamfetol Conc. (ng/ml)	Solr response	Area res ratio
Linearity-1	200	300	50	500	1450	2.00	0.364	0.116
Linearity-2	200	300	125	500	1375	5.00	0.742	0.235
Linearity-3	200	300	250	500	1250	10.00	1.533	0.491
Linearity-4	200	300	375	500	1125	15.00	2.186	0.699
Linearity-5	200	300	500	500	1000	20.00	3.064	0.979
Linearity-6	200	300	625	500	875	25.00	3.774	1.204
Linearity-7	200	300	750	500	750	30.00	4.456	1.425
Linearity-8	200	300	1000	500	500	40.00	6.057	1.940
SLOPE						0.0466		
INTERCEPT						0.02055		
r square						0.99942		

Table 2: LOD and LOQ data for Solriamfetol

Name	LOD		LOQ	
	Concentration (ng/ml)	s/n	Concentration (ng/ml)	s/n
Solriamfetol	0.27	4	2.7	24

Fig. 1: Structure of Solriamfetol

Fig. 2: MS Spectra of Solriamfetol
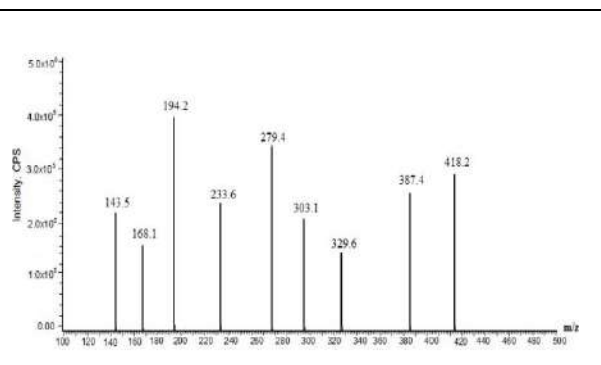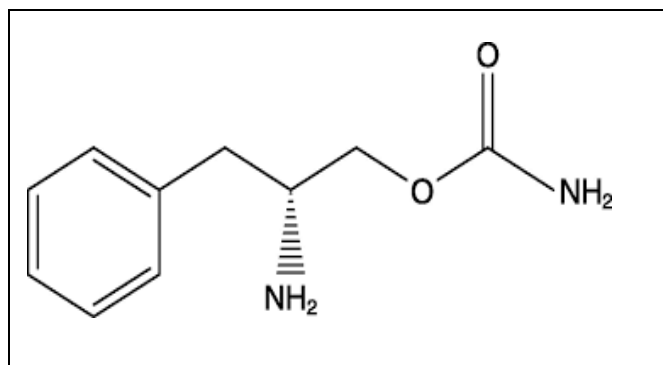
Gurumurthy and Suresh
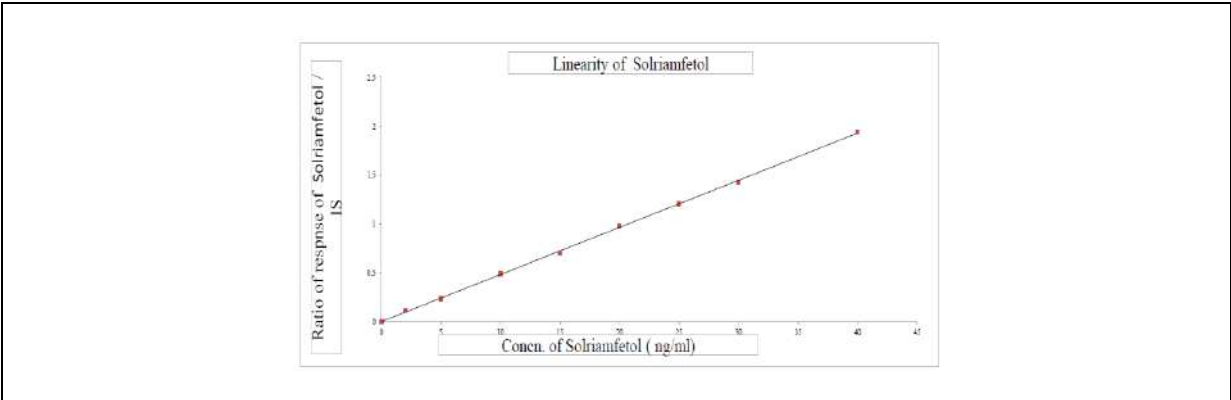
Fig. 3. Calibration plot for concentration v/s Area ratio of Solriamfetol

RESEARCH ARTICLE

Smart Home Security System and Liveness Detection using Convolutional Neural Networks

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ABSTRACT

This project's main aim is to create a smart security system for enhancing home security using the Internet of Things and Deep Learning that can safeguard and monitor a home from a mobile phone. The DL-based face recognition system, which is triggered whenever any motion is detected, identifies the visitor's face using the Viola Jones Haar Cascade algorithm and unlocks specific rooms based on the person's category. Live persons are differentiated from still images of the person using the liveliness detection deep learning model making the system fool-proof. SMTP is used in the system and the mobile app to customize the numerous profiles and the persons linked with each profile and also to alert the owner whenever a stranger visits the place. MQTT is used to unlock each and every lock remotely using the mobile app.

Keywords: Deep Learning, IoT, Home Security System, Haar Cascade algorithm

INTRODUCTION

With the country's fast economic expansion and rising urban population, security has become a top priority. As a result, theft, burglary, robbery, and other occurrences involving personal security have been on the rise. These incidences have a significant impact on people's daily lives, particularly those who spend the majority of their time outside the house. The issue is with the traditional lock and key method of security, which may be easily picked without leaving any traces. We envision to create an intelligent home security system that overcomes the overheads

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due to the traditional security measures. This project makes advantage of technical breakthroughs such as IoT and Deep Learning to greatly improve home security. The faces of the owner and his family members are registered and saved in the database. Along with that, the owner may establish profiles such as family, non-family and customize the doors that must be unlocked for each profile. When someone enters the house, the camera positioned at the front entrance records an image of them and recognizes their face. If their face matches a profile in the database, the doors corresponding to that profile are opened. If no match is identified, the image is sent to the owner, who can choose whether or not to unlock the door. Section II addresses some of the relevant studies and existing systems in the same field. Section III introduces the proposed system, and Section IV evaluates the system's performance. Finally, the project is concluded in section V. To identify research needs, a survey of existing systems was conducted. CCTV Cameras, Video Door Phones, Traditional Alarm Solutions, and other security systems have become popular in recent years. CCTV Cameras records videos 24x7 usually in a low quality also wastes a lot of storage space. They do not immediately notify the residents. When no one is at home or at the office, the Video Door Phone is worthless. Traditional alarm systems just notify the neighbors in the event of a burglary and do not offer any type of surveillance. The main issue with present systems is that they can only detect the intruder after the theft has occurred, which is inefficient. Furthermore, the system does not always distinguish between human and non-human objects. Wireless Sensor Networks is the most sophisticated existing system (WSNs). It is combined with the usage of the Internet of Things (IoT) and the Cognitive Internet of Things, which broadens the scope of smart home concepts and solutions, as well as their applications. The present study provides a revolutionary smart home anti-theft system that can identify an intruder even if their face is partially or completely disguised by clothes, leather or plastic materials. The fundamental idea was to create a cost-effective and efficient method allowing an individual to detect any type of theft in real-time and provide the house owner with immediate warning of the crime. The technology also claims to provide home security with real-time video data processing. The recognition results verify the suggested system's success. The accuracy of the system is determined by the many scenarios that occur.

MATERIALS AND METHODS

Using MQTT, the proposed approach is deployed in near real-time to an IoT-based smart home monitoring system. To analyze unauthorized access, a smart home model is established and constructed based on an integrated framework of sensors, cameras, and specialized hardware. The architecture of the system as mentioned in Fig.1. The system functions on two levels: through a hardware interface and a software interface. A sensing node (PIR motion sensor, Pi camera), solenoid locks, and relay modules are deployed at the hardware interface level, and are linked to a processing unit (Raspberry Pi 4B) that recognizes the face-data captured by the camera. The main objective of the software is to detect and report unsupervised human activity.

The software interface level is divided into 3 parts, as follows
- Face recognition
    - Face detection
    - Identification
    - Liveness detection
- Processing unit
- Mobile App

Face Recognition
A pi camera is installed in front of the door and is activated when the PIR motion sensor detects motion as shown in Fig.2.The pi camera's live video is transferred to the processing unit for face detection, identification, and liveness detection, as stated below.

Face detection

The Viola–Jones object detection framework [3], also known as Haar Cascades, is used for face detection. It was intended to recognize frontal faces the best, rather than those looking sideways, upwards, or downwards. Prior to detecting a face, the image is transformed to grey scale since it is easier to work with and has less data to process [1-7]. The algorithm recognizes the face on the grey scale picture first, and then locates it on the colored picture. Viola-Jones draws a box and looks for a face within it. It is essentially looking for Haar-like characteristics including edge features, line features, and four-sided features some of which are shown in Fig.3. These features assist the system in interpreting what the image is. We use this model to detect the face in the live feed and then process it for face recognition [8].

Calculation of Haar like features with Integral Image

Using integral images, we can achieve constant time evaluation of Haar features.
1.Edge Features or 2 Rectangular Features requires only 6 memory lookups
2.Line Features or 3 Rectangular Features requires only 8 memory lookups.
3.Diagonal Features or 4 Rectangular Features requires only 9 memory lookups.
2 Rectangle = A-2B+C-D+2E-F
3 Rectangle = A-B-2C+2D+2E-2F-G+H
4 Rectangle = A-2B+C-2D+4E-2F+H-2I+J

Identification

We utilized Adam Geitgey's face-recognition package [2] to recognize faces. It is developed with Dlib's cutting-edge face recognition model using deep learning. On the Labelled Faces in the Wild benchmark, the model has an accuracy of 99.38 percent. It creates a 128-dimensional encoding vector. Based on this encoding, we can calculate the similarity of two facial photographs to determine if they belong to the same individual. To recognize a person, we must encode the detected face and store the 128-dimensional encoded vector in a Python dictionary with the encoded vector as the key and the person's name as the value. The tolerance value for checking similarity (i.e. Euclidean distance between the encoding vectors) is set at 0.6 by default. If the Euclidean distance between two face encoded vectors is less than 0.6, they are from the same person; otherwise, they are from different persons. To make face comparisons more stringent, a lower tolerance value is required.

Liveness detection

Face recognition technology has advanced quickly in recent years, and it is now more direct, user-friendly, and convenient than any other previous approaches. Face recognition systems are subject to spoof attacks by fake/non-real faces [6]. Facial images, such as portrait shots, are a simple approach to fool face recognition algorithms. To make face recognition systems more reliable, we need to recognize such fake/non-real faces – liveness detection is the word for such techniques. Some of the approaches are the following:

- Texture analysis
- Frequency analysis
- Variable focusing analysis
- Heuristic-based algorithms
- Optical flow algorithms
- 3D face shape
- Binary classification-based analysis

We are employing the binary classification-based analysis, which is described below.

Binary classification using CNN

The technique of anti-spoof problem was introduced by Tan et al [1]. The authors' primary concept is that a real human face differs from a face in a photograph. A genuine face is a 3D item, but a photograph is only 2D. The objective is formulated as a binary classification issue, however the distributions of positive and negative are

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substantially overlapping in the input space, hence an appropriate representation space is determined to be important. The collection of actual and fake facial photos is fed into the CNN, which extracts characteristics from the photographs [9]. This CNN, also known as Liveness Net, consists of a series of convolutional layers linked sequentially with a SoftMax layer at the end for classification. We utilize the dataset to train the Liveness Net model, which is used to determine if a face in a live feed is real or false. Because we are doing this in real-time, we must confirm by checking a number of times and taking the maximum as the result. A basic Binary classification using CNN is shown in Fig.4.

RESULTS AND DISCUSSION

The user will be able to control the whole system using the mobile application. A nice and interactive GUI-based interface and icons lets the user know about its working easily. The user can also keep track of all the entries added as shown in the figure 1. The main functionalities of the application. Add, Modify or Delete entries: The user details can be added, modified or deleted in the android app and the data will be automatically sent to the raspberry pi through SMTP which is also stored in the local database. The user details consist of their name, phone number, gender, type (Family or Non-Family) and the photo of the user as Shown in figure 6. The users of the system will be displayed in the first page of the application as shown in Fig.5. Opening door using MQTT: The Message Queuing Telemetry Transport is a lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP; however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT. The doors can be opened with a single button click as shown in Fig.6.

Performance Evaluation:
Our proposed model is built using Dlib's state-of-the-art face recognition which uses deep learning. The model has an accuracy of 99.38% on the labelled Faces in the Wild benchmark.

CONCLUSION

This paper implements a smart home security system to be able to monitor the home with the help of Raspberry pi, Camera sensor, Motion detection sensor and a Mobile app. The DL-based face recognition system, which is triggered whenever any motion is detected, identifies the visitor's face using the Viola Jones Haar Cascade algorithm and unlocks specific rooms based on the person's category. Live persons are differentiated from still images of the person using the liveliness detection deep learning model making the system fool-proof. SMTP is used in the system and the mobile app to customize the numerous profiles and the persons linked with each profile and to alert the owner whenever a stranger visits the place. MQTT is used to unlock each lock remotely using the mobile app.

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Table 1: Overall time taken for the process

Parameters	Time duration in seconds
Time taken to detect motion	0.57s
Time taken to detect face	0.87s
Time taken to recognize face	1.46s
Time taken to send mail	16.7s
Time taken to open locks after face recognition	0.24s
Time taken to open locks using mobile app	0.15s
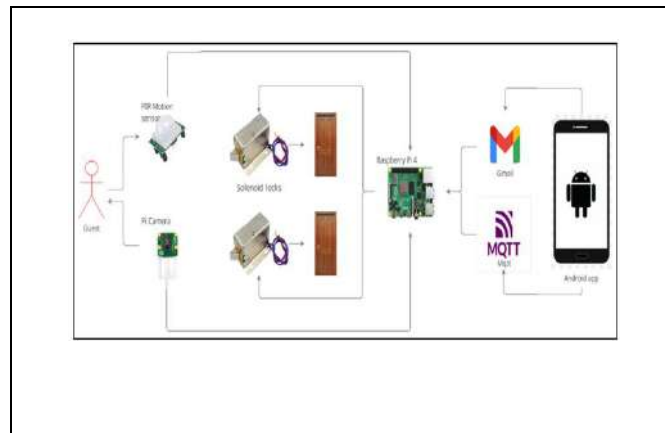
Fig. 1: Overall architecture diagram of the proposed system	**Fig. 2: Snapshot of the Model**
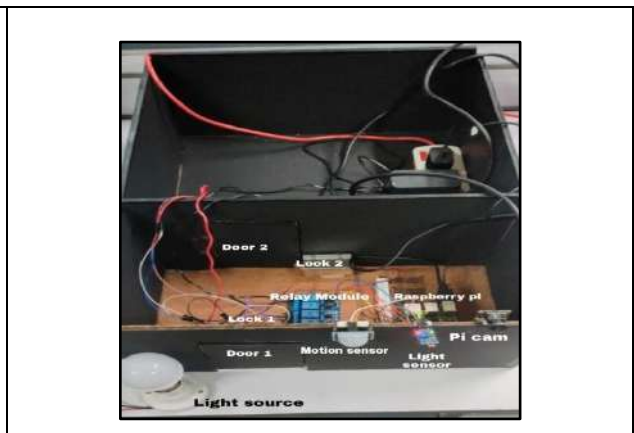
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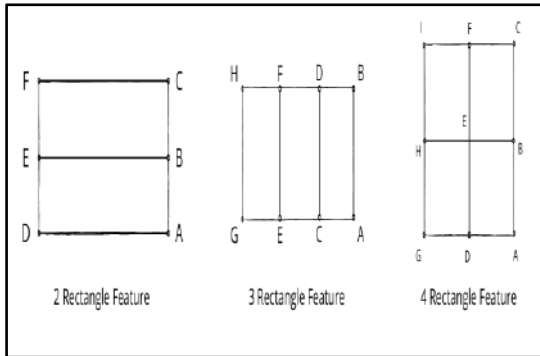
Fig. 3: Rectangle features-Haar
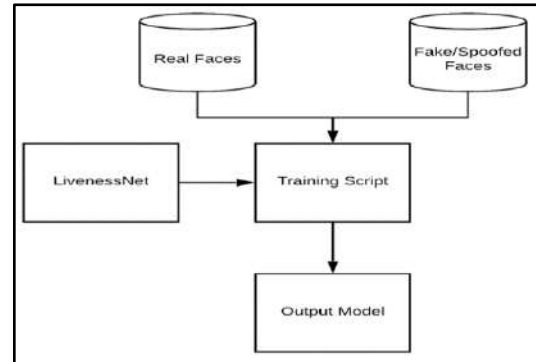
Fig. 4: Binary classification using CNN

Fig. 5: Application result 1

Fig. 6: Application result 2

Fig. 7: Application result 3

RESEARCH ARTICLE

Purification and Characterization of Bacteriocin Produced by *Lactobacillus plantarum* LBF1 Strain from Fish

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ABSTRACT

Bacteriocin producing *Lactobacillus plantarum*LBF1strain was isolated from the fish samples. It was identified by morphological and biochemical characterization which showed broad range of antibacterial activity against certain food borne pathogens. The purification of bacteriocin was done with ammonium sulphate precipitate and Gel filtration chromatography methods. Biochemically it was pure protein moiety, and the molecular weight was 14 kDa. On the addition of enzymes, "α-amylase, lipase showed slightly positive effect on the bacteriocin production whereas, proteinase K and trypsin strongly inhibited the production of bacteriocin and the highest residual activity was observed at pH 6.0. The purified bacteriocin of *Lactobacillus plantarum* was heat stable, as the inhibition activity remained constant even after heating at 80°C for 15 min and partial loss of its activity at 121°Cfor 15 min was observed. The present study revealed the possibility of using bacteriocin as a potential food preservative against food borne pathogens and *Lactobacillus plantarum* LBF1strain as an effective probiotic.

Keywords: Bacteriocin, *Lactobacillus plantarum* LBF1, food preservatives and Probiotics.

INTRODUCTION

Bacteriocins are natural peptides secreted by various bacterial species for the purpose of killing other bacteria. This provides them to have the competitive advantage in their environment, eliminating competitors to gain resources. These peptides are ribosomally synthesized and some are extensively post-translationally modified. Lactic acid bacteria (LAB) are a diverse group of microorganisms that produce lactic acid as the primary end-product of the

fermentation of carbohydrates[Kumari *et al.,*2012, Carr *et al.,*2002; Pringsulaka 2012]. LAB plays a critical role in food processing and spontaneous fermentation and is used in a wide range of fermented food. LAB exerts a strong antagonistic activity against many food contaminating microorganisms as a result by the production of organic acids, hydrogen peroxide, diacetyl, inhibitory enzymes and bacteriocins (Maurya and Thakur, 2012, Wilson et *al.,*2011). LAB species belonging to the genera *Lactobacillus, Lactococcus, Streptococcus, Pediococcus, Oenococcus, Enterococcus, Leuconostoc* and *Carnobacterium* produce a variety of bacteriocins, most of which can be grouped into several classes (Klaenhammer, 1993). These bacteriocin producing bacteria are probably the most promising natural food bio preservatives(Sankar *et al.,* 2012,Atanassova *et al.,* 2001, Leroy and De Vuyst(2003). Bacteriocin have been widely applied in many countries for natural food preservation and safety (Cotter *et al.,* 2013; Yang *et al.,* 2014). For example, the bacteriocin nisin, which was found in 1933 in New Zealand, has been allowed in 48 countries since as food preservative introduction into the market in England in 1953 (Tagg *et al.,* 1995). Based on their primary structure, molecular mass, thermal stability, mode of action, and genetic properties, the bacteriocins produced by LAB have been divided into four classes *viz.,* class I (30 kDa), heat sensitive, protein-like bacteriocins; Class-II is represented by small heat stable, non-lanthionine containing membrane active peptides Class-III bacteriocins, include heat labile proteins of large molecular mass and class IV, complex bacteriocins containing lipid or carbohydrate moieties (Klaenhammer,1993).

From these classes, class II has been divided into four sub classes among the substances class IIa bacteriocins have a conserved YGNGV motif and a disulfide bond linkage in the N-terminal region that is essential for strong inhibitory effect on *L. monocytogenes* as well as other food spoilage and pathogenic bacteria (Perez *et al.,* 2014). Moreover, these class IIa bacteriocins could be degraded by gastrointestinal proteases (Abbasiliasi *et al.,* 2017). Therefore, class IIa bacteriocins are promising candidates as bio-preservatives and are considered as a good candidate to replace chemical preservatives (Gao *et al.,* 2010).It is well documented that bacteriocin producers exist widely in fermented food, and LAB are considered as the dominant microorganism in fermented fish products (Paludan-Muller *et al.,* 2002a; Liu *et al.,* 2011). A variety of bacteriocin producers isolated from fermented fish have been reported that includes *Lactobacillus plantarum* PMU 33 (Paludan-Muller *et al.,* 2002b), *E. faecium* NKR-5-3 (Ishibashi *et al.,* 2012),*Enterococcus faecium* CN-25 (Sonsa-Ard *et al.,* 2015), *Pediococcus pentosaceus* CFF4 (Peng *et al.,* 2017). Although previous studies have identified the bacteriocin producers were valuable to the food industry, the reports concerning practical application in the food industry are relatively rare (Hata*et al.,* 2010). Therefore, more novel bacteriocins that have potential use as natural and safe food preservatives in the food industry remain to be explored. Hence, this investigation report focused on the purification and characterization of the bacteriocin produced by *Lactobacillus plantarum* isolated from fish.

MATERIALS AND METHODS

Isolation and screening for lactic acid bacteria
The collected fish samples were suspended and 1g of sample was serially diluted in saline solution up to 10^{-4} concentration. About 1 ml of appropriate dilution of the sample was pipette into sterile Petri dishes. MRS agar media (pH 5.2) was poured and incubate at room temperature for 48 h. The LAB was identified based on cell morphology, gram staining, catalase activity and biochemical identification. Further, identification of the species of this LAB was performed according to carbohydrate fermentation patterns and growth on MRS broth (HI Media) as described in Bergey's manual of systematic bacteriology.

Preparation of culture supernatants
The bacteriocin producing strain was grown in MRS broth (pH 5.5) at 37 °C for 24-30 h. After the incubation period, cultured broths were centrifuged at 5000 rpm for 15 min at 4°C. The supernatants were filtered through 0.22 μm cellulose acetate filters (M/s. Himedia, India) and neutralized to pH 6.0 with 1 N NaOH to eliminate the inhibitory effect caused by the decrease of pH. This is followed by treatment with catalase to remove the inhibitory action of

hydrogen peroxide and dissolved in phosphate buffer at pH 7.0 at 1 mg ml^{-1} final concentration, supernatant was concentrated by evaporation (Lyophilization) and crude bacteriocin is prepared and used for further studies.

Test microorganisms

The food borne bacterial pathogens *viz. Listeria monocytogenes MTCC* 657, *Bacillus cereus* MTCC 1272, *Staphylococcus aureus* MTCC 740, were obtained from the Institute of Microbial Technology, Chandigarh, India. They were maintained as pure cultures in TS agar slants. The periodic sub-culturing was carried out every 4-8 days.

Screening of isolates for antagonistic activity

Antimicrobial activity of the bacterial isolates against all the pathogenic microorganisms was determined by well diffusion method where in the MRS agar plates were inoculated with 100 mL of each target microorganism after growing them in a broth and diluting appropriately. In the well diffusion method wells of 7 mm diameter were cut out of agar plates containing growth of food borne pathogens. 100 μl cultures of each isolated bacteria was poured in the wells of each indicator lawned petri plate. The plates were then incubated at 37 ºC for 24 h and zones of inhibition against maximum number of inhibitors were observed. The isolates which showed the maximum zone of inhibition against indicator microorganisms were selected for further studies.

Partial purification with ammonium sulphate:

The bacterial isolate that showed the maximum zone of inhibition was grown in MRS broth at 37 °C for 48 h. After incubation, the broth was centrifuged at 5000 rpm for 10 min and the cells were separated out. The supernatant obtained was used as a crude bacteriocin. The crude bacteriocin sample produced was treated with solid ammonium sulphate to 0, 30, 40, 50, 60, 70 and 80 per cent saturation. The mixtures were stirred for 2 h at 4 ºC and later centrifuged at 20,000 rpm for 1 h (4ºC) and the precipitates were re-suspended in 25 ml of 0.05 M potassium phosphate buffer (pH 7.0). The inhibitionzones of different fractions were recorded in comparison with the crude bacteriocin.

Complete purification with Gel filtration chromatography:

3 gm of sephadex G-75 was suspended in 500 ml of buffer (0.5 M phosphate buffer) for 48 h. When sephadex G-75 swelled it was packed in the column having dimensions of (31x2.5 cm). To avoid the air bubbling in column continuous flow of buffer was maintained and 3 ml of Partially purified bacteriocin was loaded on the sephadex G-75 column. Elution of the column was done with help of 0.5 M phosphate buffer and 3 ml fractions were collected. A flow rate of 3 ml in 7 min was maintained throughout the process. The protein content of the collected fractions was measured at 280 nm. Further, these fractions were observed for the bacteriocin activity. The active fractions having maximum bacteriocin activity were pooled together and stored at 4º C.

Characterization of bacteriocin thermostability

5 ml of bacteriocin was taken in test tubes overlaid with paraffin oil to prevent evaporation and then treated at different temperature at 30,40,60, 80,100 and 121°C for 15 min. The heat-treated samples were then be assayed for antagonistic activity.

Effect of pH

5 ml bacteriocin was taken in test tubes and the sample in the test tubes were adjusted at 2-9 pH range, with dilute NaOH or HCl (1 N NaOH or 1 per cent HCl solution) and allowed to stand at room temperature for 2 h. Further, the treated bacteriocin was assayed using well diffusion method.

Effect of proteolytic enzyme

The enzymes and respective buffers employed were trypsin and proteinase K in 0.01 mol l^{-1} sodium phosphate buffer (pH 7.0), *α*-amylase and lipase in 0.01 mol l^{-1} potassium phosphate buffer (pH 6.0). The purified bacteriocin was mixed with equal volumes of the enzymatic solutions and incubated at 30°C for 2 h where in the untreated

bacteriocin, served as control. The samples were removed after 2 h and assayed for inhibitory activity against foodborne bacterial pathogens by agar well diffusion method.

RESULT AND DISCUSSION

Isolation and identification of lactic acid bacteria

 In the present study, bacteriocin producing lactic acid bacterial strain LBF1 isolated from fish was characterized as gram positive, non-spore forming, rod shaped, 1.0 µm x 3.0 µm and non-motile. In biochemical tests, LBF1 strain was negative to catalase and oxidase tests, NH_3 from arginine, gas production from glucose and in carbohydrate fermentation tests positive to cellobiose, esculin, fructose, galactose, glucose, lactose, maltose, mannitol, mannose, melibiose, raffinose, ribose, salicin, sorbitol, sucrose, trehalose, delayed reaction to arabinose, melezitose, xylose and negative to rhamnose. Further, the isolate was identified as *Lactobacillus plantarum* based on the morphological and biochemical characters and carbohydrate fermentation as in Bergey's manual of systematic bacteriology (Kandler and Weiss, 1986). As several studies have reported that lactic acid bacteria isolated from various samples of fresh and frozen fish and prawn. The isolates found were gram positive cocci and gram positive rods, non-motile, nonspore forming, catalase negative. Based on the morphological, physiological and biochemical characters the lactic acid bacterial isolates were belong to the genus *Lactobacillus*. Each strain was identified by species level by sugar fermentation patterns. The species identified were *Lactobacillus plantarum, Lactobacillus gasseri, Lactobacillus rhamnosus, Lactobacillus fermentum, Lactobacillus viridescens, Lactobacillus farciminis, Lactobacillus buchneri, Lactobacillus acidophilus, Lactobacillus alimentarius* and *Lactobacillus animalis*. This results are in accordance with the above findings, of Seema Nair and Surendran (2005).

Inhibitory Activity of Crude Bacteriocin of Lactic acid Bacteria against Foodborne Bacterial Pathogens:

The crude bacteriocin of LBF1 isolated from fish samples produced the highest inhibition against *Listeria monocytogenes* MTCC657(Table - I) followed by*Bacillus cereus* MTCC1272 and the lowest inhibition zone was recorded in *Staphylococcus aureus* MTCC 740.These results are in agreement with the results of   Morales *et al.,* 2020 who studied and reported that the bacteriocin produced by *Leuconostoc mesenteroides, Enterococcus mundtii* and *Enterococcus faecium strongly* inhibited the growth of *Listeria monocytogenes*. Further, the bacteriocin produced by *Lactobacillus casie* and *Streptococcus* species inhibited the growth of *Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Klebsiella species* was reported by Mondal and Aruna (2014).

Purification of bacteriocin

There was increase in the antagonistic activity of bacteriocin from partial purification to complete purification (Table - II).During each purification procedure, each step resulted in considerable loss of protein and with increase in specific activity. The protein content of bacteriocin *Lactobacillus plantarum*(LBF1) was reduced from 400 µg/ml) in crude bacteriocin to75 µg/ml) in purified bacteriocin. The purification fold of bacteriocin by complete purification was increased up to 18.75 from 1.0. The bacteriocin activity increased from 1600AU/ml to 6400 AU/ml after complete purification of bacteriocin against *Listeria monocytogenes MTCC657*. This indicates that the protein purified by gel filtration chromatography showed best results. The antagonistic activity of purified protein ascertained the genuine status of bacteriocin.

Molecular weight determination in SDS-PAGE

In the present study, purified bacteriocin from *Lactobacillus plantarum* LBF1 revealed homogeneity of a single protein band on SDS-PAGE. Its molecular weight was calculated as 14KDa (Fig-I). Similar results were recorded by Todorov and Dicks (2007) who isolated *Lactobacillus pentosus* ST712BZ from Boza and the molecular weight of bacteriocin ST712BZ was estimated at 14 kDa by SDS-PAGE.

Physio - chemical characterization of bacteriocin

Effect of Enzymes, pH and Heat Treatment on Inhibitory Activity of purified Bacteriocin of *Lactobacillus plantarum* LBF1 Isolate was given in the table-3. The purified bacteriocin preparations of *Lactobacillus plantarum*(LBF1) lost its inhibitory activity when treated with trypsin and proteinase K but its inhibition zone (24.80 mm) remained unaffected in α-amylase and lipase, compared to untreated purified bacteriocin (24.80 mm). In the present study, bacteriocin produced by *Lactobacillus plantarum*(LBF1) exhibited inhibitory activity at pH values between 2 to 9. Highest inhibitory activity was recorded at pH 6.0. These results surely support the view expressed by Ivanova,*et al.,*(2000). The inhibitory activity of purified bacteriocin of *Lactobacillus plantarum* (LBF1) withstand high temperature up to 121°C, although a partial loss in the activity was observed with a continuous increase in temperature. The thermostability of bacteriocin at high temperature makes it possible to sterilize the food products even at room temperature, thus avoiding their storage at low temperature. Earlier studies revealed that bacteriocins produced by*L. plantarum* remained active after heating till 121°C for 20 min(Ravisankar *et al.,*2012).The purified bacteriocin of *Lactobacillus plantarum* (LBF1) may be used as bio-preservative in fish products.

CONCLUSION

The bacteriocin LBF1 produced by *L. plantarum* LBF1 strain had a molecular weight of 14KDa and possessed bactericidal activity against foodborne spoilage and pathogenic bacteria, wide pH stability, high thermostability, and easily degraded by proteases. Therefore, bacteriocin LBF1 is a promising natural and could be a safe biological preservative for the food industry.

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Table 1. Inhibitory Activity of Crude Bacteriocin of Lactic acid Bacteria against Foodborne Bacterial Pathogens

Foodborne bacterial pathogens	Diameter of inhibition zone (mm)
Bacillus cereus MTCC1272	14.30
*Listeria monocytogenes*MTCC 657	16.40
*Staphylococcus aureus*MTCC 740	13.53

Table 2. Purification and Recovery of Bacteriocin Produced by LBF1 Isolate

Purification steps	Volume (ml)	Activity unit (AU/ml)	Total activity (AU)	Protein (µg/ml)	Specific activity (AU/mg)	Purification fold	Recovery percentage
Crude Bacteriocin	1000	1600	1600000	400	4.0	1.00	100
Partial purification (Ammonium sulphate precipitation)	25	3200	80000	333	9.61	2.4	82.50
Complete purification (Gel filtration chromatography)	2	6400	12800	75	85.33	8.88	18.75

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Table 3. Effect of Enzymes, pH and Heat Treatment on Inhibitory Activity of purified Bacteriocin of *Lactobacillus plantarum* **LBF1 Isolate**

S.No	Treatment	Inhibition Zone(in mm)
1.	Purified bacteriocin (control)	24.80
2.	Trypsin	-
3.	Proteinase K	-
4.	α-amylase	24.78
5.	Lipase	24.80
	pH	
6.	2.00	10.50
7.	3.00	12.80
8.	4.00	13.90
9.	5.00	23.06
10.	6.00	24.80
11.	7.00	23.56
12.	8.00	16.13
13.	9.00	13.40
	Temperature	
14.	30° C	24.80
15.	40° C	22.60
16.	60° C	19.73
17.	80° C	17.50
19.	100° C	13.23
20.	121° C	07.50
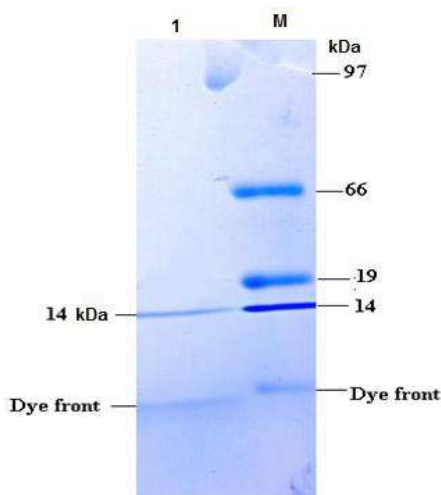
Figure 1. Molecular weight determination in SDS-PAGE
SDS-PAGE Profile
Lane 1: Sample Protein
Lane M: Standard Protein Molecular Weight Marker

REVIEW ARTICLE

A Review on Impacts of Covid-19: Blessings or Curses to the Environmental Quality and Human Life Style in Indian Context

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ABSTRACT

The Novel Corona Virus (COVID-19) has created a worldwide biological disaster. As a result of sudden lockdown industries, market, transport system, educational institutions, etc. all became shutdown. At this time, people do not go out of the house which leads to a drastic reduction in the number of vehicles on the roads; the closure of industrial plants also alters the amount of all types of pollution. Lockdown create a difference in pollution level. Many studies shows that in lockdown period air quality improve, water pollution decrease and noise pollution lessen. Many polluted rivers restore themselves. Covid-19 helps to lessen pollution but it also create a huge amount of biomedical waste, plastic waste, and municipal waste. It also creates economical loss and effected education system. In this paper, it has been mainly discussed with the help of secondary data, the effects of Covid-19 pandemic situation and in consequence of that the long period of lockdown and restrictions on environment in India.

Keywords: COVID-19, lockdown, pandemic situation, pollution, economical loss, education system.

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INTRODUCTION

The entire world is experiencing the despondency and desolation of COVID-19, affecting with discouraging morbidity and mortality figures. As COVID-19 is highly infected with a high mortality rate countries around the world have taken numerous precautions to manage the spread of COVID-19 viruses. Looking at the escalating rates of corona cases honourable Prime Minister of India declared "Janta curfew" on 22nd March 2020. He has declared lockdown of 21 days for entire country on March 24, 2020 and further extended for 19 days on 14th April, 2020 in 2nd phase followed by 14 days till 17th May in 3rd phase, and more 14 days in 4th phase (Lokhandwala and Gautam, 2020). Lockdown results into the slowdown of economic performance that affects the life style also. Beside of several negative points, it has few positive impacts on environment. In lockdown period many industries, markets, transportation systems, tourist spots etc. are now closed which helps to improve air quality, water quality, lowering noise pollution, less production of industrial hazardous waste, and decrease the pressure on the tourist destination. Air pollutants like carbon monoxide (CO), sulfur dioxide, nitrogen oxides, and particulate matters (PM) are decreased in air during these phases; the amount of waste generation has reduced. In this time, we saw scores of range clearly which can't see in normal time due to pollution. The current study is not to highlight the curses of COVID-19, but also to fall lime light on positive changes in our affectionate environment.

Pandemic era and air quality improvement
India is the second populous country in the world. The quality of life of the Indians has improved due to industrial development but it also severally damaged our environment. As a result of excessive industrialization the amount of air pollution is gradually increasing. A study on three mega cities (Delhi, Mumbai, and Kolkata) in India, air quality during lockdown period shows that air quality has improved as compared to pre-lockdown period. According to CPCB, $PM_{2.5}$, PM_{10}, and CO are the major pollutants in India. In lockdown phase $PM_{2.5}$, PM_{10} and CO have reduced by 47%, 41% and 27% in Mumbai; 52%, 39% and 13% in Delhi; and 49%, 37% and 21% in kolkata. This report shows that a short period of lockdown can reduce the air pollution (Mandal *et al.,* 2021*)*. The nationwide pollution level has decreased by 69%. $PM_{2.5}$, SO_2 and NO_2 level also lowered by 32%, 43% and 41% respectively during lockdown as compared to pre-lockdown and the ground level O_3 has increased by 7% as compared to pre lockdown (Khan *et al*., 2021).

Pandemic Episode and Water Quality Improvement
Water which is the most essential natural resources to survive, in a greater challenge due to industrialization, rapid growth of human population. Many industries and cities are situated at the river bank and the waste water or effluents are mainly discharged into the river without appropriate treatment and causes water pollution. Due to Covid-19 many changes are happened in our daily life and also our society. To prevent the rapid spread chain of corona lockdown started and industries, hotels, tourist spots are shutdown which helps to recover water bodies. After the declaration of lockdown within 10 days people starts to notice the improvement of water quality. The real time water monitoring data of the CPCB say that around 27 out of 36 monitoring units of the Ganga River found suitable for bathing and fisheries (Singhal *et al*., 2020). Not only river Ganga but also her sister Yamuna River was decreased their pollution burden in this time period. Indian Institute of Technology, Roorkie, indicated that the water of Ganga and Yamuna River was fit for drinking. In this time all transport are closed like commercial, so the oil spill was reduced. This are all the positive impact on marine life and for this reason all water parameters like BOD, COD were reduced, Dissolved oxygen level was increased, as a result of that, marine animals, plants were back to normal life from suffocated life in lockdown period.

Impact on Education System
Only good education can bring future generations to a new level and create a better society. According to UNSECO in India nearly 320 million students are affected in this pandemic situation (Rawal, 2021). Indian education system is mainly classroom dependent which is transformed into online mode in this period. Teacher and students are facing difficulties as they are not accustomed to this new online education system and lack technical knowledge and

training. Online classes create a huge communication gap between teacher and student. Covid-19 mainly affected poor and rural students (Rawal, 2021). Government survey conducted on the year of 2019 says that only 24% household have internet access. In rural areas it is much lower, only 4% house having internet connection. So technology based education is out of reach for many students. It creates huge obstacles for Indian education system (Deka and Anand, 2021).

Biomedical Waste Generation during this Pandemic Period

Due to the sudden onset of corona virus, the amount of biomedical waste is greatly increased. The national daily waste generation is extended around 850 tonnes per day (Chand *et al.*, 2021). A lot of biomedical waste like face masks, PPE kits are generating from household are not properly managed that can also spread corona virus and polluting the environment. To prevent Covid–19 India started vaccine administration on 16th January, 2021 and as of June 21289 million doses are administered. By the end of the vaccination process over 1.3 billion used syringes, needle and more than 100 million discarded glass would be produced which need careful disposal as per the rule. But there is a huge gap in the process that prevents successful management of biomedical waste (Singh, 2021).

Ecological Restoration and Covid-19

Tourism industry has improved tremendously in the last few years. The number of travellers to travel destinations has been drastically reduced since the onset of Corona virus and lockdown, resulting in a reduction in environmental pollution (Rume and Islam, 2020).

Covid Affected Indian Economy

Lockdown in first and second waves of Covid hit and damage Indian economy. In this time period industries, market, transport systems all are shutdown which less economy to nearly stopped position. On May 31, the Indian government released GDP of the financial year 2020-2021 data, GDP decreased by 7.3 percent. After independence it is the most severe loss in India (Kumar, 2021). In India a large number of daily workers such as drivers, carpenters, domestic labours', vegetable vendors, waiters are losses their work (Sarkar and Das, 2020). The tourism industry and aviation sector are shutdown due to Covid-19 and faces economic losses. Covid-19 and lockdown break down the supply chain of raw materials for the industry that effected the production.

CONCLUSION

The impact of Covid-19 pandemic on different sectors of India has been discussed in the present review paper. Every incident has both sides, one is positive and another one is negative. Covid-19 has taken the lives of many people, yet many people are hospitalized. Due to this situation the Indian economy has been overwhelmed. It also broken down the health system, affected education system, generates a huge amount of biomedical wastes. Slow down of economy led to unemployment and job lost. In this bad phase one positive incident is that environment is recovering itself. Lockdown lessen the pollution that is a positive sign for nature. In this time water and air quality improve, noise pollution decreases. Wildlife gets a chance to recover their land without any disturbance (Arora *et al.*, 2020). In this time period people have opportunities to spent times with family members. We don't know when we will be able to get out of this situation and return to normal life. But we are hopeful that we will be soon able to return our former healthy lifestyle.

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REVIEW ARTICLE

A Review: Ethanopharmacological Activity of *Koelreuteria paniculata* Laxm.

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ABSTRACT

Koelreuteria paniculata Laxm. established as invasive species used as traditional medicine and showing various biological activities. Traditional medicine depends on knowledge, skills, practices to maintain and improve physical health. These traditional medicine is used for *in-vivo* and *in-vitro* studies. Plants, animals, and varieties of technique used in traditional medicine. *Koelreuteria paniculata* native to the China, Korea as well as East Asia. The phytochemical constituents present in the plant is responsible for its biological activity which identified the pharmacological and ethanomedicinal uses. The purpose of this study is based on literature review of *koelreuteria paniculata* plant and identification of its phytoconstituent mainly responsible for various pharmacological activities. This article also focused on prevention of the various diseases using the plant of *Koelreuteria paniculata* Laxm. Traditionally the plant is used as in Ophthalmic preparation. The main Pharmacological characterstics of *Koelreuteria paniculata* reported as antigout, antioxidant, anti malarial, antibacterial, hypercholestremia, hypertension. In the study of this plant a number of journals representing its pharmacological activities for the management of health benefits against various risk factor or diseases.

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Keywords: Antitumor activity, Antimicrobial activity, Anti-Alzheimer, Antioxidant activity, Antineoplastic, Genoprotective, Antimalarial, Anti-gout, Neuroprotective, Ophthalmic effect, Hypercholesterolemia , Hypertension

INTRODUCTION

Koelreuteria paniculata also called Golden rain tree or varnish tree or pride of India that belongs to the genus of the *Koelreuteria Paniculata* comes under the family *Sapindaceae* or soap berry. The Origin of the tree is found in Northern China, Korea. The Golden rain tree is short –lived species which grows as fast and tolerant a moisture conditions and numerous soil. In 2014 *Koelreuteria paniculata* was observed for the first time in a riparian habitat , i.e. between the basal blocks of river rupel in boom . By 2017 a second individual recorded in an identical habitat along river Scheldt in Kruibeke. *Koelreuteria paniculata* is a deciduous tree or sometimes be a multi-trunked shrub whose bark that is thick and grayish-brown to grayish-black. The leaves of *koelreuteria paniculata* are oval in shape and divided into 7-15 leaf segments which is approx 7-10cm long The leaves of the *koelreuteria paniculata* appears bronze color in the spring season which turns yellow to orange in the autumn season. The nuts that grow on branches are in the form of chymes. The flowers of the tree are yellowish in color bloom in June and July. After the flowering, the fruit appears like bladder which is 4cm approx. The color of the fruit changes from green to bronze and contains a black seed. The fruit on a tree remains is long lasting. Fruits of the *koelreuteria paniculata* appears oval-shaped that have petals with acuminate apexes and the exterior is reticulated. The characteristics of cultivation of *koelreuteria paniculata* becomes easy, light-loving, cold-tolerant and drought-tolerant. For their growth limestone-weathered calcium-based soil is needed. The adaptability of the plant is strong. In China, sprouts of *koelreuteria paniculata* late in spring season and falls in early season in autumn. In the lower reaches of the Yellow River and Yangtze River basins, it grows slower. In the early phase of summer or the first week of the July the tree contains panicles which is covered the yellow flowers, some appears in the ring form of corolla which is red in color. Until the leaves fall the large pinnately leaves turn a rich yellow color in autumn. The seed containing fruit enclosed within lantern like bracts strung as beads. It is used as greening and courtyard ornamentation.

The woody part of the *koelreuteria paniculata* is used to makes small utensils and its seed used to extract out essential oil. The leaves of the tree is used as black dye for the culture in its range. The phytochemistry and the medicinal values of the *Koelreuteria paniculata* is quite diverse that includes antioxidant, anti-tumor activities. The seeds containing the flavonoids and galloyl derivatives that suggests use as insecticidal agents. The flowers decoction is beneficial for ophthalmic rinse for the eyes. The varieties of *Koelreuteria paniculata* depends on their distribution and appearance such as In Northern China and Korea the leaves arranged in single pinnate while In Western China the variety *of Koelreuteria apiculata* the leaves arranged in bipinnate. The species of this plant has been used for landscaping of parks, roadsides and industrial areas and distributed around the world including Bulgaria. It has been remarkable to overcome the heavy metal pollution. *Koelreuteria paniculata* called invasive species of Bulgaria. A number of biologically active substances isolated from the various part of *Koelreuteria paniculata* such as phenolic compounds, terpenes and terpenoids, saponins and steroids. Phytochemical screening of plant using various extract responsible for its pharmacological activities. A new variety of the *koelreuteria paniculata* 'Jinluan 2'were identified from the seedling of *Koelreuteria paniculata*. At the time of spring the leaves color, petioles, and tender branches appears orange red. On maturity color turns yellow green in summer. The method of propagation based on grafting technique and suitable for growing in China (Northern & Central Region).

Nomenclature
Synonymn: *Koelreuteria apiculata*
Common Name: Golden Rain Tree or Pride Of India

Taxonomical Classification

Kingdom	*Plantae*
Sub kingdom	*Viridiplantae*
Infra kingdom	*Streptophyta*
Super division	*Embryophyta*
Division	*Tracheophyta*
Subdivision	*Spermatophytina*
Class	*Magnoliopsida*
Order	*Sapindales*
Family	*Sapindaceae / Soapberries*
Genus	*Koelreuteria*
Species	*Koelreuteria paniculata* Laxm

Pharmacological activity of *Koelreuteria paniculata*

Antitumor activity

The ethanolic extract of the different part of the *koelreuteria paniculata* possess antiproliferative activity was examined on two tumor cell lines-HT29 and PC3. HT29 cell line is present in human colon adenocarcinoma and widely used for the study of colon cancer and shows many intestinal cells which becomes mature. PC3 is a prostate cancer cell lines also responsible for carcinogenesis. Prostate cancer is primary malignancy in men leads to death as secondary cause. The antiproliferative activity of the flower extract beneficial effect on HT-29 was observed(IC_{50}-23.63microgram/ml) and less pronounced activity in the PC3 case (IC_{50}-58.76 micro gram/ml). The leaf extract shows the similar effect on HT29 (IC_{50}-23.63 micro gram/ml)cell lines but less sensitive in PC3(80.56 micro gram/ml). The bark extract of *koelreuteria paniculata* was found as weak sensitive which shows weak inhibition effect on HT29 cancerous cell lines (IC_{50}-339.4 micro gram/mL) and in PC3 cell lines (IC_{50}-182.8 micro gram/mL) respectively. It seen clear the antiproliferative activity of bark extract of *Koelreuteria paniculata* was dose-dependent for HT_{29} and PC_3 cell lines. At low concentration of flower and leaves extract affected the cell growth and same value obtained over the higher concentration at 60mg/mL. Antitumor mechanism of pyrogallol in cytotoxixity and reduced the number of colonies in Hep3B and Huh7 cell lines. The flower extract of *Koelreuteria paniculata* contain carotenoid which has seen low cytotoxicity in human hepatocarcinoma and breast cancer cells. In *vitro* cytotoxicity assay analysis; two phenolic compounds present in the *koelreuteria paniculata* such as methyl gallate and austrobailignan reduced the cell proliferation activity.

Antimicrobial activity

Bark extract of *Koelreuteria paniculata* against Gram-positive bacteria (Bacillus subtilis and Bacillus cereus) are more effective for its antimicrobial action. At higher concentration of bark extract was used against Gram-negative bacteria include Pseudomonas aeruginosa and Proteus vulgaris was seen most effective respectively. Flower extract of *Koelreuteria paniculata* similar effective as compare to bark extract on Gram-positive and Gram-negative Bacteria include P.vulgaris (10 mm IZ), B.subtilis (14mm IZ), B.cereus (14mm IZ). The leaf extract of the plant did not shown zone of inhibition against the Gram-negative bacteria. Ghahari *et al*. reported the antibacterial activity of *K.paniculata* using methanolic extract of leaf against the B.subtilis and S.aureus. Zazharskyi *et al.* investigated the ethanolic extract of leaf of *K.paniculata* against pathogens includes E.Ham *et.al* reported that the bark extract of *Koelreuteria paniculata* contain neryl acetate in its composition responsible for antimicrobial potential.

Anti-Alzheimer's activity

The seed of koelreuteria paniculata and its ethanolic extract obtained the five new barrigenol triterpenoids 1-5. Compound 1 was found to be 16-O-2-methylbutanoyl-A2 barrigenol. Compound 2 was found to be 3-O-[alpha-L-arabinofuranosyl (1-3)-beta galactopyranosyl(1-2)-(6-O-methyl)-beta D-glucuronopy-ranosyl-28-O-2-methyl butanoyl –A2 barrigenol. Compound 3 was found to be 3-O-[beta galactopyranosyl(1-2)]-(6-O-methyl)-beta D-glucuronopy-ranosyl-28-O-2-methyl butanoyl –A2 barrigenol. Compound 4 was found to be 3-O-[alpha-L-arabinofuranosyl(1-3)-

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beta galactopyranosyl (1-2)-(6-O-methyl)-beta D-glucuronopyranosyl-22-O-2-methyl butanoyl –A2 barrigenol. Compound 5 was found to be 3-O-[beta-D-galactopyranosyl (1-2)] 6-O-methyl)-beta D-glucuronopyranosyl-22-O-2-methyl butanoyl –A2 barrigenol. Ethanolic extract of seed of K.paniculata contain five new barrigenol triterpenoids decrease the treated mice ability to swim and helps to reduce the amyloid plaques by reduced the hyperphosphorylation of tau protein induced by okadaic acid treated mice and also regulates the glycogen synthase kinase beneficial for its anti-alzheimer action.

Anti-oxidant activity

The Flowers extract of *Koelreuteria paniculata* was identified three Carotenoid named as beta-carotene, lycopene and lutein . Thiapong *et al.* described the ABTS (azinobis-(3)-ethylbenzthiazone-6-sulfonic acid) assay was performed *In vitro* study of antioxidant in the flower extract of *K.paniculata* and DPPH(1,1-diphenyl-2-picrylhydrazyl) scavenging assay was used to isolate the fraction of carotenoid. The estimated value of carotenoid extract from *K.paniculata* present in amount of 1.41g was 2.82%. The flower extract of *Koelreuteria paniculata* contain carotenoid such as beta-carotene (2899.95), lycopene (569.87), lutein (538.34). Finding of the study was that the *in-vitro*; a good anti-oxidant activity of *Koelreuteria paniculata* using flower extract followed by ABTS assay (368.86 mMTE / g) as compared to DPPH method which was found to be ten times lower activity 37.06 =1.54 mMTE /g.

Anti-neoplastic activity

The abnormal growth of cancer cells divides without control and invade or destroy the other tissues. These abnormal cells called cancer cells and widely spread through the blood and lymphs. Neo-adjuvent therapy eliminated the cancer causing cells by reducing their size without affecting the other normal tissue. In present study of isolated carotenoids from the extract of flower of plant *koelreuteria paniculata* laxm were tested in BJ, HepG2 and MDA-MB-231 cell lines for antineoplastic activity and its fraction has DNA protective activity investigated in calf thymus DNA. MTT assay method was used to performed cell viability testing procedure. The most sensitive cell lines was observed HepG2 with IC_{50}=459.9 micro gram/ml. The weak inhibition effects on cell line growth was observed MDA-MB-231 with IC_{50}=522.2 micro gram/ml.

Genoprotective activity

Genotoxicity interpreted the harmful changes in the sequences of genes due to presence of genotoxins. The action of these harmful genotoxins impair the sequence of gene and interfere on chromosomal abbreviations, genetic mutations, recombination. The *Koelreuteria paniculata* Laxm extract and its fraction was used to investigate the Genoprotective potential. The leaves of the *K.paniculata* extract out and its fraction (KPE & KPF) both showed the DNA protective effect in the thymus part of calf / pUC18 DNA protection studies. In the case of the calf thymus DNA plasmid undergoes fragmentation of DNA and disappears their band on the other hand pUC18 DNA plasmid exposed to reagents (Fenton's) conversion of double strand DNA into single band. This was clear showed the protective effect of DNA on addition of KPE & KPF at the concentration of 50 and 250 (micro gram/mL) in pUC18 and scavenging the *OH radical in study of calf thymus DNA protection studies.

Anti-malarial activity

The ethanolic extract of *Koelreuteria paniculata* leaves ten compounds was isolated and the structure of these ten compounds identified through NMR spectroscopy. The present of compounds in the leaves of *K.paniculata* such as 5-methoxy luteolin, kaempferol-7-O-rhamnoside, loliolide, kaempferol-3-O-rhamnoside, methyl-myo-inositol, beta-sitosterol, beta-sitosterol-3-O-glucoside, ethyl gallate, methyl gallate, and gallic acid. These isolated compounds are used in various pharmacological activities like antibacterial, antifungal, antileishmanial. From these isolated compounds ethyl gallate and methyl gallate was elucidated for antimalarial activity. The antimalarial activity showed against the chloroquine-sensitive (D6) and chloroquine-resistant (W2). A protozoa Plasmodium falciparum acts on chloroquine-sensitive (D6) with the same value of IC_{50} of 1.28 micro gram/mL , In case of chloroquine resistant (W2) the IC_{50} value observed for protozoan was 0.77 and 1.85 micro gram/ mL respectively. The IC_{50} value indicated that the leaves extract of *Koelreuteria paniculata* has antimalarial potential against the Plasmodium falciparum protozoan respectively.

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Anti-gout effect

Oxidative stress in living tissue due to the Xanthine Oxidase (XOD). This Xanthine Oxidase (XOD) also responsible for to initiate gout (a common form of arthritis) an enzyme required to produce uric acid by the breakdown of purine nucleotides. The tannins inhibited this enzyme has been reported in similar way of tannins several galloylated flavonoids examined the inhibitory action on XOD and act as XOD inhibitors. Quercitin is a galloylated flavonoids was reported in *koelreuteria paniculata* Laxm leaf extract which plays an important role in reduction of synthesis of Xanthine Oxidase and shows prevented action on gout formation. The IC_{50} value of these galloyalated flavonoids showed inhibitory action as 1.9-3.5*10M .These findings suggest the spatial arrangement and its correlation between aglycon and galloyl group and their differences shows the inhibitory activity.

Neuroprotective Activity

Isolation of essential oils from the aerial part of *Koelreuteria paniculata* has been investigate for the neuroprotective activities..The ethanolic extract of leaves of *Koelreuteria paniculata* seven components were identified in which the sesquiterpenes were the dominant group (70.5%), Hydrocarbons (50.29%), Oxygenated compounds (20.21%). The components of sesquiterepenes farnesene possess the neuroprotective effects. Other components responsible for the activity were identified alpha-copaen-11-ol and diterpene isophytol.

Ophthalmic Activity

The root of *Koelreuteria paniculata* contains active constituent. These active constituents found in the root of Koelreuteria paniculata analyzed. The Isolated active constituents present in the root of the plant revealed through data analysis contains oleic acid, linoleic acid, Lupinol, retinal, and other active constituent also present that have great role and importance on medical, chemical, & food industries. These constituents Identified through GC-MS techniques, FTIR. The ethanolic, methanolic benzene/ethanol extract of roots of *Koelreuteria paniculata* from these solvents contains the main components such as linoleic acid, lupinol, and retinal aldehyde. Retinal aldehyde act as transduction molecule and giving signal to the cells present in the retinal called retinal sensory cells. This active constituent effect on retina and relief on the myopia as well as conjunctivitis.

Hypercholesterolemia and Hypertension

Koelreuteria paniculata ethanolic and methanolic extract of roots contains linoleic acid . The unsaturated form of free fatty acid is termed as linoleic acid. The value of linoleic acid within the blood serum becomes high leads to the formation of CHS and CVS. This active constituent of plant reduce the level of lipids and also downstream the level of high blood pressure (hypertension) through the narrowing of blood vessels and enhance the microcirculation within the blood. The deposition of the cholesterol in the blood reduce by linoleic acid through narrowing the vessels and acts as a scavengers of blood vessels to prevent from the hypercholesterolemia and hypertension.

CONCLUSION

From the above study concluded that the flower extract of *Koelreuteria paniculata* beneficial for antiproliferative activities which reduced the cytotoxicity. Bark stem extract of *K.paniculata* showed the antimicrobial activities against the gram positive and negative bacteria. The memory and mentalillness in alzeheimer disease treated using the seed extract of *K.paniculata*. Ethanolic extract of leaves of *K.paniculata* enhance the genoprotective potential and also beneficial effect on DNA protection studies. It also helpful to fight against the malaria causing protozoan shows the antimalarial action. Retinal aldehyde found in root extract of *K.paniculata* to prevent ophthalmic disorder and also its extraction enhance the blood cholesterol level and blood pressure.

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Figure.1. Habitat: Grows in the height of 30-40 feet tall and reached at maturity the plant spread around 35 feet	**Figure.2. Leaves: 7-15 toothed leaflets green in color that are 1-4 inches long.**
Figure.3. Twigs and bark: Arranged in zig-zagged having scars along with lenticels.	

Figure.4. Flowers & Fruits: Flowers are gold in color shinny appearance Papery fruit develops containing black seeds and 12-18 inches long.

RESEARCH ARTICLE

Few Algebraic Structures on Q-Rung Orthopair Fuzzy Matrices

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ABSTRACT

A q-rung orthopair fuzzy matrices (q-ROFM), an extension of the Pythagorean fuzzy matrix (PFM) and intuitionistic fuzzy matrix (IFM), is especially helpful in tending to indistinct information that occurs in evident circumstances. In this paper we portray a couple of numerical assignments, for instance, max-min, min-max, supplement, We moreover inspect the numerical properties of these exercises. Also, look at a piece of their fundamental arithmetical properties. Furthermore analyze distributive guidelines for the circumstance where the exercises of $\boxplus_q$, $\boxtimes_q$, $\wedge q$ and $\vee q$ are combined each other on q-ROFMs .

Keywords: q-rung orthopair fuzzy matrices(q-ROFM), algeraic sum, algebraic product

INTRODUCTION

An idea of an intuitionistic fuzzy matrix was launched by Pal *et.al* and Im.*et.al* [1,2]. The concept of fuzzy matrix was deduced by Thomason[9]. Some of the analysts have upgraded the fuzzy matrix. One of the upgraded idea was Pythagorean fuzzy matrix [7,8] and it sis entrenched in 2020. PFM sets the membership degree $\lambda_{s_{ij}}$, along with membership say $\eta_{s_{ij}}$ and sum of square of the membership values lies between zero and one. Intuitionistic fuzzy matrices[2,3,4,5,6] and the application of its were developed. Later the development of PFM, Generalized orthopair, Fermatean fuzzy matrix, we have extended picture fuzzy set [3,4]. Picture fuzzy sets describe the mentality of human being in various fields. Some of them accept the reality, someone will not accept. Picture fuzzy set expresses the degree of positive, negative and neutral membership. In some stage addition of their membership value exceeds one. In that case, to attain the expected result PFM fails. So, the thought of q-rung picture was described by Li. *et al* [10] in 2018. q-rung fuzzy matrix deals with the degree of neutral membership and also free the constraint of picture and spherical fuzzy matrix. Whenever q raises the representation space of acceptable triplets raises. Therefore q-RPFMs gives more flexibility to understand the concept.

Definition: q-rung orthopair fuzzy matrix

A Matrix of pairs $S = \left\{ \lambda_{s_{ij}}, \eta_{s_{ij}} \right\}$ where $\lambda_{s_{ij}}, \eta_{s_{ij}} \in [0,1]$addresses the level of the enrollment and the level of the non-participation for all i , j respectively and $0 \leq \lambda_{s_{ij}}{}^q + \eta_{s_{ij}}{}^q \leq 1$.

Definition

Let $\mathcal{F}_{mn}$ be the family of all q-ROFMs n for all i ,j.

Let $T = \left[< \lambda_{t_{ij}}, \eta_{t_{ij}} > \right]$, $S = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right]$ be two q-rung orthopair fuzzy matrices of same order.Then

(i)$S \vee_q T = \left[< max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, min\{\eta_{s_{ij}}, \eta_{t_{ij}}\} > \right]$

(ii) $S \wedge_q T = \left[< min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, max\{\eta_{s_{ij}}, \eta_{t_{ij}}\} > \right]$

(iii) $R^c = \left(< \eta_{s_{ij}}, \lambda_{s_{ij}} > \right)$

(iv) $S \boxplus_q T = \left(\left(< \lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} > \right)$

(v) $S \boxtimes_q T = \left(\left(< \lambda_{s_{ij}} \lambda_{t_{ij}}, (\eta_{s_{ij}}{}^q + \eta_{t_{ij}}{}^q - \eta_{s_{ij}}{}^q \eta_{t_{ij}}{}^q \right)^{1/q} > \right)$

(vi) $kS = \left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q \right)^k \right)^{1/q}, \left(\eta_{s_{ij}} \right)^k > \right)$

Theorem 3.1: For any $S, T \in \mathcal{F}_{mn}$ then

(i) $S \vee_q T = T \vee_q S$

(ii)$S \wedge_q T = T \wedge_q S$

(iii) $S \boxplus_q T = T \boxplus_q S$

(iv) $S \boxtimes_q T = T \boxtimes_q S$

Proof:

To Prove (i)

By the definition

$S \vee_q T = \left[< max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, min\{\eta_{s_{ij}}, \eta_{t_{ij}}\} > \right]$

$\qquad = \left[< max\{\lambda_{t_{ij}}, \lambda_{s_{ij}}\}, min\{\eta_{t_{ij}}, \eta_{s_{ij}}\} > \right]$

$\qquad = T \vee_q S$

To Prove(ii)

$S \wedge_q T = \left[< min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, max\{\eta_{s_{ij}}, \eta_{t_{ij}}\} > \right]$

$\qquad = \left[< min\{\lambda_{t_{ij}}, \lambda_{s_{ij}}\}, max\{\eta_{t_{ij}}, \eta_{s_{ij}}\} > \right]$

$\qquad = T \wedge_q S$

To Prove (iii): By the definition

$S \boxplus_q T = \left(\left(< \lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} > \right)$

$\qquad = \left(\left(< \lambda_{t_{ij}}{}^q + \lambda_{s_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{s_{ij}}{}^q \right)^{1/q}, \eta_{t_{ij}} \eta_{s_{ij}} > \right)$

$\qquad = T \boxplus_q S$

To Prove (iv):

$S \boxtimes_q T = \left(\left(< \lambda_{s_{ij}} \lambda_{t_{ij}}, (\eta_{s_{ij}}{}^q + \eta_{t_{ij}}{}^q - \eta_{s_{ij}}{}^q \eta_{t_{ij}}{}^q \right)^{1/q} > \right)$

$\qquad = \left(\left(< \lambda_{t_{ij}} \lambda_{s_{ij}}, (\eta_{t_{ij}}{}^q + \eta_{s_{ij}}{}^q - \eta_{t_{ij}}{}^q \eta_{s_{ij}}{}^q \right)^{1/q} > \right)$

$\qquad = T \boxtimes_q S$

Theorem 3.2: For any $S \in \mathcal{F}_{mn}$ be a q-rung OFM then

(i)) $S \vee_q J = J \vee_q S = J$

(ii) $S \wedge_q O = O \wedge_q S = O$

(iii) $S \vee_q O = O \vee_q S = S$

(iv) $S \wedge_q J = J \wedge_q S = S$

(v) $S \boxplus_q J = J \boxplus_q S = J$

(vi) $S \boxtimes_q J = J \boxtimes_q S = S$

(vii) $S \boxplus_q O = O \boxplus_q S = S$

(viii) $S \boxtimes_q O = O \boxtimes_q S = O$

Proof:

To Prove (i):

$$S \vee_q J = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right] \vee_q [< 1, 0 >]$$
$$= \left[< max\{\lambda_{s_{ij}}, 1\}, min\{\eta_{s_{ij}}, 0\} > \right]$$
$$= [<1,0>] = J$$

$J \vee_q S = J$ (using 3.1)

To Prove (iv)

$$S \wedge_q J = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right] \wedge_q [< 1, 0 >]$$
$$= \left[< min\{\lambda_{s_{ij}}, 1\}, max\{\eta_{s_{ij}}, 0\} > \right]$$
$$= \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right] = S$$

$J \wedge_q S = S$ (using 3.1)

In a similar manner we can prove (iii)

To Prove (v):

Consider,

$$S \boxplus_q J = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right] \boxplus_q [< 1, 0 >]$$
$$= \left(\left(< \lambda_{s_{ij}}{}^q + 1^q - \lambda_{s_{ij}}{}^q 1 \right)^{1/q}, \eta_{s_{ij}} 0 > \right)$$
$$= [<1,0>] = J$$

$J \boxplus_q S = J$ (using 3.1)

To Prove (vii):

Consider

$$S \boxtimes_q O = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right] \boxtimes_q [< 1, 0 >]$$
$$= \left(< \lambda_{s_{ij}} 0, (\eta_{s_{ij}}{}^q + 1^q - \eta_{s_{ij}}{}^q)^{1/q} > \right)$$
$$= [<0,1>] = O$$

$O \boxtimes_q S = O$ (using 3.1)

Similarly, we can prove (vi), (vii).

Theorem 3.3:

For any q ROFMs

$$T = \left[< \lambda_{t_{ij}}, \eta_{t_{ij}} > \right],$$
$$S = \left[< \lambda_{s_{ij}}, \eta_{s_{ij}} > \right],$$
$$V = \left[< \lambda_{v_{ij}}, \eta_{v_{ij}} > \right] \text{ of same size.}$$

(i) $S \vee_q (T \vee_q V) = (S \vee_q T) \vee_q V$
(ii) $S \wedge_q (T \wedge_q V) = (S \wedge_q T) \wedge_q V$
(iii) $S \boxplus_q (T \boxplus_q V) = (S \boxplus_q T) \boxplus_q V$
(iv) $S \boxtimes_q (T \boxtimes_q V) = (S \boxtimes_q T) \boxtimes_q V$

Proof:
To Prove (i)
Consider,
$$S \vee_q (T \vee_q V) = S \vee_q \left[< max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\} > \right]$$
$$= \left[< \max\{\lambda_{s_{ij}}, \max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}\}, \min\{\eta_{s_{ij}}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\}\} > \right]$$
$$= \left[< \max\{\max(\lambda_{s_{ij}}, \lambda_{t_{ij}}), \lambda_{v_{ij}}\}, \min\{\min(\eta_{s_{ij}}, \eta_{t_{ij}}), \eta_{v_{ij}}\} > \right]$$
$$= \left[< \max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \min\{\eta_{s_{ij}}, \eta_{t_{ij}}\} > \right] \vee_q [< \lambda_{v_{ij}}, \eta_{v_{ij}} >]$$
$$= (S \vee_q T) \vee_q V$$

In a similar manner we can prove $S \wedge_q (T \wedge_q V) = (S \wedge_q T) \wedge_q V$

To Prove (iii) :
Let $\boxplus_q V = A = \left[< \lambda_{a_{ij}}, \eta_{a_{ij}} > \right]$,
$S \boxplus_q T = B = \left[< \lambda_{b_{ij}}, \eta_{b_{ij}} > \right]$
By the definition
$$A = \left[< \lambda_{a_{ij}}, \eta_{a_{ij}} > \right] = \left(\left(< \left(\lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q \right)^{1/q}, \eta_{t_{ij}} \eta_{v_{ij}} > \right) \right) \ldots\ldots\ldots\ldots\ldots(1)$$
$$B = \left[< \lambda_{b_{ij}}, \eta_{b_{ij}} > \right] = \left(\left(< \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} > \right) \right) \ldots\ldots\ldots\ldots(2)$$
Consider, $S \boxplus_q (T \boxplus_q V) = S \boxplus_q X$
$$S \boxplus_q A = \left(\left(< \lambda_{t_{ij}}{}^q + \lambda_{a_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{a_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{a_{ij}} > \right)$$
$$= \left(< \lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q - \lambda_{s_{ij}}{}^q \left(\lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q \right) > \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} \eta_{v_{ij}} >] \quad \text{(Using 1)}$$
$$\left[= < \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q + \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} \eta_{v_{ij}} > \right] \ldots\ldots\ldots\ldots(3)$$
Consider, $(S \boxplus_q T) \boxplus_q U = B \boxplus_q U$
$$B \boxplus_q V = \left(\left(< \lambda_{b_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{b_{ij}}{}^q \lambda_{v_{ij}}{}^q \right)^{1/q}, \eta_{b_{ij}} \eta_{v_{ij}} > \right)$$
$$= \left(< \lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q - \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q \right) > \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} \eta_{v_{ij}} >]$$
$$= \left(< \lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q + \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q > \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} \eta_{v_{ij}} >] \ldots\ldots\ldots\ldots(4)$$
From (3) & (4) RHS are equal
Which Implies LHS must be same
$S \boxplus_q A = B \boxplus_q V$
$S \boxplus_q (T \boxplus_q V) = (S \boxplus_q T) \boxplus_q V$
In a similar manner, we can prove(iv) $S \boxtimes_q (T \boxtimes_q V) = (S \boxtimes_q T) \boxtimes_q V$

Theorem 3.4:
Let $T = [< \lambda_{t_{ij}}, \eta_{t_{ij}} >]$,
$S = [< \lambda_{s_{ij}}, \eta_{s_{ij}} >]$,
$V = [< \lambda_{v_{ij}}, \eta_{v_{ij}} >]$
be any three QROFMs of same size then

(i) $(S \vee_q T) \wedge_q V = (S \wedge_q V) \vee_q (T \wedge_q V)$

(ii) $S \wedge_q (T \vee_q V) = (S \wedge_q T) \vee_q (S \wedge_q V)$

(iii) $S \vee_q (T \wedge_q V) = (S \wedge_q T) \wedge_q (S \wedge_q V)$

(iv) $(S \wedge_q T) \vee_q V = (S \vee_q V) \wedge_q (T \vee_q V)$

Proof:

To Prove (i):

Let A $= S \vee_q T = \left[\max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\}, \min\ \{\eta_{s_{ij}}, \eta_{t_{ij}}\}\right]$

$\quad$ A $= \left[< \lambda_{a_{ij}}, \eta_{a_{ij}} >\right]$

Consider, $(S \vee_q T) \wedge_q V = A \wedge_q V$

By definition,

$A \wedge_q V = \left[< \min\left\{\lambda_{a_{ij}}, \lambda_{v_{ij}}\right\}, \max\ \left\{\eta_{a_{ij}}, \eta_{v_{ij}}\right\} >\right]$

$\quad = \left[< \min\left\{\max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \lambda_{v_{ij}}\right\}, \max\ (\min\{\eta_{s_{ij}}, \eta_{t_{ij}}\}, \eta_{v_{ij}}) >\right]$

$\quad = \{< \max\left\{\min\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \min\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}\right\} \min\left\{\max\{\eta_{s_{ij}}, \eta_{v_{ij}}\}, \max\{\eta_{t_{ij}}, \eta_{v_{ij}}\}\right\} >\}$

$\quad = [\min\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \max\{\eta_{s_{ij}}, \eta_{v_{ij}}\}] \vee_q [\min\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \max\{\eta_{t_{ij}}, \eta_{v_{ij}}\}]$

$\quad = (S \wedge_q V) \vee_q (T \wedge_q V)$

$(S \vee_q T) \wedge_q V = (S \wedge_q V) \vee_q (T \wedge_q V)$

To prove (ii)

$\left[< \lambda_{b_{ij}}, \eta_{b_{ij}} >\right] = B = T \vee_q V = \{<\max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\}>\}$

Consider, $S \wedge_q (T \vee_q V) = S \wedge_q B$

By definition $S \wedge_q B = \left[< \min\{\lambda_{s_{ij}}, \lambda_{b_{ij}}\}, \max\{\eta_{s_{ij}}, \eta_{b_{ij}}\} >\right]$

$\quad = \left[< \min(\lambda_{s_{ij}}, \max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}), \max(\eta_{s_{ij}}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\}) >\right]$

$\quad = \left[< \max(\min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \min\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}), \min(\max\{\eta_{s_{ij}}, \eta_{t_{ij}}\}, \max\{\eta_{s_{ij}}, \eta_{v_{ij}}\}) >\right]$

$\quad = \left[< (\min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \max\{\eta_{s_{ij}}, \eta_{t_{ij}}\}], \vee_q [< \min\left\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\right\}, \max\{\eta_{s_{ij}}, \eta_{v_{ij}}\}) >\right]$

$\quad = (S \wedge_q T) \vee_q (S \wedge_q V)$

$\quad S \wedge_q (T \vee_q V) = (S \wedge_q T) \vee_q (S \wedge_q V)$

To prove (iii)

Consider $S \vee_q (T \wedge_q V)$

Let $\quad D = (<\lambda_{d_{ij}}, \eta_{d_{ij}} >) = (T \wedge_q V)$

$\quad = \left[< \min\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}, \max\left\{\eta_{t_{ij}}, \eta_{v_{ij}}\right\} >\right]$

$S \vee_q (T \wedge_q V) = S \vee_q D$

$\quad = \left[< \max\{\lambda_{s_{ij}}, \lambda_{d_{ij}}\}, \min\left\{\eta_{s_{ij}}, \eta_{d_{ij}}\right\} >\right]$

$\quad = \left[< (\max\{\lambda_{s_{ij}}, \min\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}), \min(\eta_{s_{ij}}, \max\{\eta_{t_{ij}}, \eta_{v_{ij}}\}) >\right]$

$\quad = \left[< \min(\max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \max\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}), \max(\min\{\eta_{s_{ij}}, \eta_{t_{ij}}\}, \min\{\eta_{s_{ij}}, \eta_{v_{ij}}\}) >\right]$

$\quad = [(< \max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \min\{\eta_{s_{ij}}, \eta_{t_{ij}}\} >] \wedge_q [< \max\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{s_{ij}}, \eta_{v_{ij}}\} >)]$

$\quad = (S \vee_q T) \wedge_q (S \vee_q V)$

Hence proved

$S \vee_q (T \wedge_q V) = (S \vee_q T) \wedge_q (S \vee_q V)$

To prove (iv)

Let $G = S \wedge_q T = (<\lambda_{g_{ij}}, \eta_{g_{ij}}>)$

$\quad = \left[< \min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \max\{\eta_{s_{ij}}, \eta_{t_{ij}}\}, >\right] (S \wedge_q T) \vee_q V = G \vee_q V$

$\quad = \left[< \max\{\lambda_{g_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{g_{ij}}, \eta_{v_{ij}}\}, >\right]$

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$$= \left[< \max\,(\,\min\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \lambda_{v_{ij}}\,), \min(\max\{\eta_{s_{ij}}, \eta_{t_{ij}}\}, \eta_{v_{ij}}) >\right]$$

$$= \left[< \min(\max\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}), \max(\min\{\eta_{s_{ij}}, \eta_{v_{ij}}\}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\}) >\right]$$

$$= \left[< \max\{\lambda_{s_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{s_{ij}}, \eta_{v_{ij}}\} >\right] \wedge_q \left[< max\{\lambda_{t_{ij}}, \lambda_{v_{ij}}\}, \min\{\eta_{t_{ij}}, \eta_{v_{ij}}\} >\right]$$

$$= (S \vee_q V) \wedge_q (T \vee_q V)$$

$(S \wedge_q T) \vee_q V = (S \vee_q V) \wedge_q (T \vee_q V)$

Theorem 3.5:

Let $S = (< \lambda_{s_{ij}}, \eta_{s_{ij}} >)$, $T = (< \lambda_{t_{ij}}, \eta_{t_{ij}} >)$

$V = \left(< \lambda_{v_{ij}}, \eta_{v_{ij}} >\right)$ be any three q ROFM belongs to $\mathcal{F}_{mn}$ then

(i) $(S \vee_q T) \boxplus_q V = (S \boxplus_q V) \vee_q (T \boxplus_q V)$

(ii) $(S \wedge_q T) \boxplus_q V = (S \boxplus_q V) \wedge_q (T \boxplus_q V)$

(iii)$(S \vee_q T) \boxtimes_q V = (S \boxtimes_q V) \vee_q (T \boxtimes_q V)$

(iv)$(S \wedge_q T) \boxtimes_q V = (S \boxtimes_q V) \wedge_q (T \boxtimes_q V)$

Proof:

To prove (i):

Consider,

$$(S \vee_q T) \boxplus_q V = \left(\max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}, \min\left\{\eta_{s_{ij}}, \eta_{t_{ij}}\right\}\right) \boxplus_q \left(< \lambda_{v_{ij}}, \eta_{v_{ij}} >\right)$$

$$= \left[< (\max\{\lambda_{s_{ij}}{}^q, \lambda_{t_{ij}}{}^q\} + \lambda_{v_{ij}}{}^q - \max\{\lambda_{s_{ij}}{}^q, \lambda_{t_{ij}}{}^q\} \cdot \{\lambda_{v_{ij}}{}^q\})^{\frac{1}{q}}, \min\left\{\eta_{s_{ij}}, \eta_{t_{ij}}\right\} \cdot \eta_{v_{ij}} >\right]$$

$$= \left[< \left((1 - \lambda_{v_{ij}}{}^q)\max\{\lambda_{s_{ij}}{}^q, \lambda_{t_{ij}}{}^q\} + \lambda_{v_{ij}}{}^q\right)^{1/q}, \min\{\eta_{s_{ij}}\eta_{u_{ij}}, \eta_{t_{ij}}\eta_{v_{ij}}\} >\right] \text{----------------------(5)}$$

Consider, $(S \boxplus_q V) \vee_q (T \boxplus_q V)$

$$= \left[< \left(\lambda_{s_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{v_{ij}}{}^q\right)^{1/q}, \eta_{s_{ij}}\eta_{v_{ij}} >\right] \vee_q \left[< \left(\lambda_{t_{ij}}{}^q + \lambda_{v_{ij}}{}^q - \lambda_{t_{ij}}{}^q \lambda_{v_{ij}}{}^q\right)^{1/q}, \eta_{t_{ij}}\eta_{v_{ij}} >\right]$$

$$= \left[< \left(\lambda_{s_{ij}}{}^q(1 - \lambda_{v_{ij}}{}^q) + \lambda_{v_{ij}}{}^q\right)^{1/q}, \eta_{s_{ij}}\eta_{v_{ij}} >\right] \vee_q \left[\left(\lambda_{t_{ij}}{}^q(1 - \lambda_{v_{ij}}{}^q) + \lambda_{v_{ij}}{}^q\right)^{1/q}, \eta_{t_{ij}}\eta_{v_{ij}}\right]$$

$$= \left[< \max\left\{\left((1 - \mu_{v_{ij}}{}^q)\mu_{v_{ij}}{}^q + \mu_{s_{ij}}{}^q\right)^{1/q}, \left((1 - \mu_{v_{ij}}{}^q)\mu_{t_{ij}}{}^q + \mu_{v_{ij}}{}^q\right)^{1/q}\right\}, \max\left\{\eta_{s_{ij}}\eta_{v_{ij}}, \eta_{t_{ij}}\eta_{v_{ij}}\right\} >\right]$$

$$= \left[< \left((1 - \mu_{v_{ij}}{}^q)\max\{\mu_{t_{ij}}{}^q\} + \mu_{v_{ij}}{}^q\right)^{1/q}, \min\left\{\eta_{s_{ij}}\eta_{v_{ij}}, \eta_{t_{ij}}\eta_{v_{ij}}\right\} >\right] \text{---(6)}$$

From (5) +(6) $\mu_{s_{ij}}{}^q$

$(S \vee_q T) \boxplus_q V = (S \boxplus_q V) \vee_q (T \boxplus_q V)$

In a similar manner we can prove (ii),

To prove (iii):

$$(S \vee_q T) \boxtimes_q V = \left[< \max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}\min\{\eta_{s_{ij}}\eta_{t_{ij}}\} > \boxtimes_q < \lambda_{v_{ij}}, \eta_{v_{ij}} >\right]$$

$$= \left[\max\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\}\lambda_{u_{ij}}\left(\min\left\{\eta_{s_{ij}}{}^q, \eta_{t_{ij}}{}^q\right\} + \eta_{u_{ij}}{}^q - \eta_{u_{ij}}{}^q \min\{\eta_{s_{ij}}{}^q, \eta_{t_{ij}}{}^q\}\right)^{1/q}\right]$$

$$= \left[< max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\}\lambda_{v_{ij}}, \left((1 - \eta_{v_{ij}}{}^q)\min\{\eta_{s_{ij}}{}^q, \eta_{t_{ij}}{}^q\} + \eta_{v_{ij}}{}^q\right)^{1/q} >\right] \text{----------------------------(7)}$$

$(S \boxtimes_q V) \vee_q (T \boxtimes_q V)$

$$= \left[< \left(\lambda_{s_{ij}}\lambda_{v_{ij}}, (\eta_{s_{ij}}{}^q + \eta_{v_{ij}}{}^q - \eta_{s_{ij}}{}^q + \eta_{v_{ij}}{}^q)^{1/q}\right) \vee_q \left(\lambda_{t_{ij}}\lambda_{v_{ij}}, (\eta_{t_{ij}}{}^q + \eta_{v_{ij}}{}^q - \eta_{t_{ij}}{}^q + \eta_{v_{ij}}{}^q)^{1/q}\right) >\right]$$

$$= \left[< \left(\lambda_{s_{ij}}\lambda_{v_{ij}}, \left((1 - \eta_{v_{ij}}{}^q)\eta_{s_{ij}}{}^q + \eta_{v_{ij}}{}^q\right)^{1/q}\right) \vee_q \left(\lambda_{t_{ij}}\lambda_{v_{ij}}, \left((1 - \eta_{v_{ij}}{}^q)\eta_{t_{ij}}{}^q + \eta_{v_{ij}}{}^q\right)^{1/q}\right) >\right]$$

$$= \left[\max\left\{\lambda_{s_{ij}}\lambda_{v_{ij}}, \lambda_{t_{ij}}, \lambda_{v_{ij}}\right\}, \min\left\{\left((1 - \eta_{v_{ij}}{}^q)\eta_{s_{ij}}{}^q + \eta_{v_{ij}}{}^q\right)^{1/q}, \left((1 - \eta_{v_{ij}}{}^q)\eta_{t_{ij}}{}^q + \eta_{v_{ij}}{}^q\right)^{1/q}\right\}\right]$$

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$$= \left[\max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\} \lambda_{v_{ij}}, \left(\left(1 - \eta_{v_{ij}}{}^q \right) \min\left\{\eta_{s_{ij}}{}^q, \eta_{t_{ij}}{}^q\right\} + \eta_{v_{ij}}{}^q \right)^{1/q} \right] \text{----------------------(8)}$$

$= (S \vee_q T) \boxtimes_q V$

From (7) + (8)

$(S \vee_q T) \boxtimes_q V = (S \boxtimes_q V) \vee_q (T \boxtimes_q V)$

In a similar manner we can prove (iv)

Theorem 3.6:

For any S, T ϵ $\mathcal{F}_{mn}$ be any two q ROFMs of same size then

(i) $(S \vee_q T)^c = S^c \wedge_q T^c$

(ii) $(S \wedge_q T)^c = S^c \vee_q T^c$

(iii)$(S \boxplus_q T)^c = S^c \boxplus_q T^c$

(iv)$\left(S \boxplus_q T\right)^c = S^c \boxplus_q T^c$

Proof:

To prove (i)

$$(S \vee_q T)^c = \left(\max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\}, \min\left\{\eta_{s_{ij}}, \eta_{t_{ij}}\right\} \right)^c$$

$$= \left(\min\left\{\eta_{s_{ij}}, \eta_{t_{ij}}\right\}, \max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\} \right)$$

$$= \left(\eta_{s_{ij}}, \lambda_{s_{ij}} \right) \wedge_q \left(\eta_{t_{ij}}, \lambda_{t_{ij}} \right)$$

$$= S^c \wedge_q T^c$$

To prove (iii)

$$\left(S \boxplus_q T\right)^c = \left[< \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} > \right]^c$$

$$= \left[< \eta_{s_{ij}} \eta_{t_{ij}}, \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q} > \right]$$

$$= \left(\eta_{s_{ij}}, \lambda_{s_{ij}} \right) \boxplus_q \left(\eta_{t_{ij}}, \lambda_{t_{ij}} \right)$$

$$= S^c \boxtimes_q T^c$$

In a similar way we can prove (iv)

Theorem 3.7:

Let $S, T \in \mathcal{F}_{mn}$ be any two q ROFMs of then

(i) $K(S \vee_q T) = (K S) \vee_q (K T)$

(ii) $K(S \wedge_q T) = (K S) \wedge_q (K T)$

(iii)$K(S \boxplus_q T) = (K S) \boxplus_q (K T)$

(iv)$K(S \boxtimes_q T) \boxplus_q = (K S) \boxtimes_q (K T)$

(v) $(K_1 \boxplus_q K_2) S = K_1 S \boxplus_q K_2 S$

Proof:

To Prove (i):

$$K(S \vee_q T) = K \left(\max\left\{\lambda_{s_{ij}}, \lambda_{t_{ij}}\right\}, \min\left\{\eta_{s_{ij}}, \eta_{t_{ij}}\right\} \right)$$

$$= \left[\left(1 - (1 - \max\{\lambda_{s_{ij}}{}^q, \lambda_{t_{ij}}{}^q\})^k\right)^{1/q}, \min\left\{(\eta_{s_{ij}})^k, (\eta_{t_{ij}})^k\right\} \right]$$

$$(K S) \vee_q (K T) = \left(\left(1 - (1 - \lambda_{s_{ij}}{}^q)^k\right)^{1/q}, \eta_{s_{ij}}{}^k \right) \vee_q \left(\left(1 - (1 - \lambda_{t_{ij}}{}^q)^k\right)^{1/q}, \eta_{t_{ij}}{}^k \right)$$

$$= \left[< \max\left\{ \left(1 - (1 - \lambda_{s_{ij}}{}^q)^k\right)^{1/q}, \left(1 - (1 - \lambda_{t_{ij}}{}^q)^k\right)^{1/q} \right\}, \min\left\{(\eta_{s_{ij}})^k, (\eta_{t_{ij}})^k\right\} > \right]$$

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$$= \left(\left(1 - (1 - \max\{\lambda_{s_{ij}}{}^q , \lambda_{t_{ij}}{}^q\})^k\right)^{1/q} , \min\left\{ (\eta_{s_{ij}})^k , (\eta_{t_{ij}})^k \right\} \right)$$

$$= K \, (S \vee_q T)$$

To Prove (iii):

$$K \, (S \boxplus_q T) = K\left[< \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q \right)^{1/q} , \eta_{s_{ij}} \eta_{t_{ij}} > \right]$$

$$= \left(\left(1 - (1 - (\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q)^k \right)^{1/q} , (\eta_{s_{ij}})^k , (\eta_{t_{ij}})^k) \right)$$

$$= \left(\left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^k \left(1 - \lambda_{t_{ij}}{}^q\right)^k > \right)^{1/q} , (\eta_{s_{ij}} \eta_{t_{ij}})^k >) \right)$$

Consider,

$$(K \, S) \boxplus_q (K \, T) = \left(1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^k \right)^{1/q} , \eta_{s_{ij}}) \boxplus_q \left(1 - \left(1 - \lambda_{t_{ij}}{}^q\right)^k \right)^{1/q} , \eta_{t_{ij}})$$

$$= \left(\left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^k \left(1 - \lambda_{t_{ij}}{}^q\right)^k > \right)^{1/q} , (\eta_{s_{ij}} \eta_{t_{ij}})^k >) \right)$$

$$= K \, (S \boxplus_q T)$$

In a similar manner we can prove (iv)

To Prove (v):

$(K_1 \boxplus_q K_2) \, S = K_1 S \boxplus_q K_2 S$

$$(K_1 \boxplus_q K_2) \, S = \left(\left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^{k_1 + k_2} > \right)^{1/q} , \left(\eta_{s_{ij}}\right)^{k_1 + k_2} >) \right)$$

$$= \left(\left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^{k_1} \left(1 - \lambda_{s_{ij}}{}^q\right)^{k_2} > \right)^{1/q} , \eta_{s_{ij}}{}^{k_1} \eta_{s_{ij}}{}^{k_2} >) \right)$$

$$= \left(< 1 - \left(1 - \lambda_{s_{ij}}{}^q\right)^{k_1} , \eta_{s_{ij}}{}^{k_1} \right) \boxplus_q \left(\left(1 - (1 - \lambda_{s_{ij}}{}^q)^{k_2} , \eta_{s_{ij}}{}^{k_2} \right) \right)$$

$$= K_1 S \boxplus_q K_2 S.$$

Theorem 3.8:

The set $\mathcal{F}_{mn}$ is an q-rung fuzzy algebra under $\vee$ and $\wedge$.

Proof:

$0 \vee_q S = S \vee_q 0 = S$

$J \wedge_q S = S \wedge_q J = S$ for all $S \in \mathcal{F}_{mn}$

Which Implies the zero matrix (0)is the additive identity and the universal matrix Jis the multiplicative identity.

Hence the identity elements with respect to $\vee_q$ and $\wedge_q$ exists.

Also, $S \vee_q J = J = J \vee_q S$

$S \wedge_q 0 = 0 = 0 \wedge_q S$

Which shows that Universal bound exists for all $S \in \mathcal{F}_{mn}$

Theorem 3.9:

The set $\mathcal{F}_{mn}$ is a q rung or the pair fuzzy vector space under $\vee_q$ and $\wedge_q$.

Proof:

Using the theorem 3.1,3.2,3.3 and theorem 3.7 , $\mathcal{F}_{mn}$ is a q rung or the pair fuzzy vector space over F.

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Theorem 3.10:
The set $\mathcal{F}_{mn}$ is a commutative monoid under $\boxplus_q$ and $\boxplus_q$.

Proof:
Using theorem 3.2,
S $\boxplus_q$ O = O $\boxplus_q$ S = S
S $\boxplus_q$ J = J $\boxplus_q$ S = S
Shows that the zero matrix is the additive identity and the universal matrix is the multiplicative identity. The associative law under $\boxplus_q$, $\boxtimes_q$ are proved using 3.3. And the commutative property is satisfied using theorem 3.1.
Hence under the operations $\boxplus_q$ and $\boxtimes_q$, F_{mn} is a commutative monoid.
Hence (F_{mn} , $\boxplus_q$, O) and (F_{mn} , $\boxtimes_q$, J) are commutative monoids.

Corollary:
For any two monoids (F_{mn} , $\vee_q$, O) and (F_{mn} , $\wedge_q$, O) and
$\Psi: F_{mn} \rightarrow F_{mn}$ such that $\Psi(S) = S^c$, then there exists a monoid homomorphism under $\boxplus_q$ and $\boxtimes_q$.

Proof:
Let $S , T \in \mathcal{F}_{mn}$
$$\Psi(S \vee_q T) = \Psi(\max\{\lambda_{s_{ij}} , \lambda_{t_{ij}}\}, \min\{\eta_{s_{ij}} , \eta_{t_{ij}}\})$$
$$= (\min\{\eta_{s_{ij}} , \eta_{t_{ij}}\}, \max\{\lambda_{s_{ij}} , \lambda_{t_{ij}}\})$$
$$= (\eta_{s_{ij}} , \lambda_{s_{ij}}) \wedge_q (\eta_{t_{ij}} , \lambda_{t_{ij}})$$
$$= S^c \wedge_q T^c$$
$$= \Psi(S) \wedge_q \Psi(T)$$
$$\Psi(S \vee_q T) = \Psi(S) \wedge_q \Psi(T)$$
$$\Psi(O) = O^c = J , \Psi(J) = J^c = O$$
Let $S , T \in \mathcal{F}_{mn}$
$$\Psi(S \boxplus_q T) = \Psi\left(\left[< \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q\right)^{1/q}, \eta_{s_{ij}} \eta_{t_{ij}} >\right]\right)$$
$$= \left(\left[< \eta_{s_{ij}} \eta_{t_{ij}}, \left(\lambda_{s_{ij}}{}^q + \lambda_{t_{ij}}{}^q - \lambda_{s_{ij}}{}^q \lambda_{t_{ij}}{}^q\right)^{1/q} >\right]\right)$$
$$= (\eta_{s_{ij}} , \lambda_{s_{ij}}) \boxtimes_q (\eta_{t_{ij}} , \lambda_{t_{ij}})$$
$$= S^c \boxtimes_q T^c$$
$$= \Psi(S) \boxtimes_q \Psi(T)$$
$$\Psi(S \vee_q T) = \Psi(S) \boxtimes_q \Psi(T)$$
$$\Psi(O) = O^c = J , \Psi(J) = J^c = O$$
Hence Ψ is a monoid homomorphism.

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RESEARCH ARTICLE

Ergonomics and its Application in Architectural Design: Studio Design Exercise of A Residence for A Physically Challenged Couple

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ABSTRACT

Ergonomics, the study of human factors, is a multidisciplinary field that aims to create a comfortable environment surrounding human beings for their health and well-being. Humans spend most of their time in the built environment or surrounding areas and this interaction between the two is ergonomics. Ergonomics is majorly used and discussed in relation to product and object design. Not much study or data is available as far as its relationship with architecture is concerned. The aim of this paper is to analyze the role of ergonomics in architecture and design and its application in the design of a residence for a physically handicapped couple. The study therefore highlights the importance and challenges of human centered design in architecture by implementing the same in a studio design exercise.

Keywords: Ergonomics, Architecture, Design, physically challenged, studio exercise

INTRODUCTION

International Ergonomics Association (IEA) (2018) defines Ergonomics as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance". It focuses on the interaction between humans and the system/ environment for better efficiency, health and comfort and applies to the design of everything and anything that is concerned with humans like places of work, leisure, play, health, etc. The workplaces, systems and products are designed using ergonomics in such a way that they fit the people who use them. Ergonomics is a Greek word composed of two parts: 'ergo' meaning 'work' and 'nomos' meaning 'law'. Thus it simply means a 'study of the work'. In North America, it is referred to as 'human factors'. It involves learning about human limitations and abilities to apply in the design of systems/

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environment. Ergonomics focuses on 'Human centered design' and is therefore associated with products, tasks, jobs, organizations and the environment. Designing with respect to ergonomics reduces fatigue, inefficiency, difficulties faced by users, injuries, accidents, chronic problems like lower back pain, etc. and musculoskeletal disorders.

Ergonomics can be classified into three domains

physical ergonomics, cognitive ergonomics and organizational ergonomics as shown in Figure 1 (Woodcock, 2011). Physical ergonomics is related to human body measurements and their physical features. Since it is concerned with human activity, it relates to human anatomy, anthropometry, physiology and biomechanics. Human anatomy, the branch of science that deals with the human body structure, is related to ergonomics since the physical work of a person involves various body parts and to improve the work efficiency, the study of anatomy is needed. Anthropometry, the study of human body dimensions and proportions, is effectively used by designers and architects to design products and environments. Physiology, concerned with the vital processes of living organisms and how their constituent tissues and cells function, is used to design systems so as to reduce/ avoid physiological problems. Biomechanics, is concerned with the movement or structure of living organisms and hence is related to ergonomics by calculating ways to minimize work done.

Cognitive ergonomics involves mental processes that are associated with "interactions between humans and their artificial products" (Eilouti, 2020). They involve processes such as reasoning, perception and interpretation and takes into account as to" how the human mind perceives its environment and processes information" (Eilouti, 2020). The five senses of the human sensory system; vision, hearing, tactile sense, olfactory sense and taste are involved in cognitive processes. Cognitive ergonomics plays a vital role due to various newer trends in the industries and technology. The third category of ergonomics is organizational ergonomics that is predominantly concerned with the optimization of sociotechnical systems, including their organizational structures, policies, and processes. It mainly deals with the "side of products and their internal and external systems" (Eilouti, 2020). It is related to managing everything in an organization to provide a better place to work.

Ergonomics and Architecture

The application of Ergonomics is relevant to the design of things and environment that is related to the people, be it their work places, homes, sports, recreation, health, leisure and safety. Humans, building and environment are the three vertices of a triangle. The interaction between humans and buildings is what we call ergonomics, between building and environment is a green building and that between environment and humans is sustainability (Eilouti, 2021).Ergonomics also considers the wellbeing of nature and the natural environment (Charytonowicz, 2020). Since architects are concerned with the design of spaces and environment, ergonomics becomes important for the design of optimum and comfortable spaces. All the domains of ergonomics are significant in architectural design. Physical ergonomics helps in creating user-centric design. Anthropometry (physical ergonomics), the study of body dimensions and proportions, thus plays a major role in the design of almost anything and everything associated with humans. According to Eilouti (2020), "While anthropometrics affects mainly the static settings of product designs, ergonomics adds time and motion considerations". Cognitive ergonomics augments sense of place and place making characteristics and develop a sense of belonging and connectedness to the place thereby fostering social sustainability. Organizational ergonomics helps in the optimization of building performance and efficiency to fit the user's needs. The emphasis is therefore on the user interaction with space which forms a basis for the spatial design and form. The principles that are driven by human factors or ergonomics play a pivotal role in the architectural design process and include user's involvement, human variability and diversity, overcoming stereotypes and standards and system oriented approach as shown in Table 1 (Attaianese&Guca, 2012). According to Attaianese&Guca (2012), user centered design of built environment discourses a holistic approach that is structured in three macro-activities: context of use specification, user identification and tasks performed by the users using the products (Attaianese, 2016). Users need to be analyzed in terms of the physical aspects like age, gender, height and other physical characteristics etc., cognitive aspects like their skills, intellectual capabilities, interests, etc. and behavioral aspects (Attaianese, 2016). The use of ergonomics and human factor approach in architectural design can lead to a sustainable built environment from environmental, social and economic perspectives (Attaianese, 2017) and

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can also be used for energy efficiency, for functionality and serviceability, for improving operation and maintenance and for protecting occupants comfort (Attaianese, 2012).Onay (2021) in his research emphasized on the "well-being framework for interiors and its application to design process". Since it is the built environment in which the human beings perform various activities, not much has been studied in context to architecture and design based on ergonomics approach (Biswas, Kundu, Imam, 2021; Attaianese & Duca 2012). This paper is thus an attempt to understand the application of ergonomics in architectural design to create spaces that fulfill the needs of the different inhabitants.

MATERIALS AND METHODS

The 4th year students of architecture were assigned the work of designing a residence in their subject Applied Ergonomics. The aim of design exercise was to make them understand the integration of ergonomics and anthropometry in architectural design and to make them aware about the importance of user-based and human centric design. The students sensitively focused on the needs of the users before they started working on their design. The design exercise incorporated the principles driven by human factors or ergonomics in the architectural design process like human variability and diversity, user's involvement and system oriented approach.

Residential Design Project
The residence was to be designed for a family with special needs according to the guidelines and principles of ergonomics. The family consisted of a physically challenged couple with two children. The man of the house was physically challenged and was on wheel chair while the female of the house used crutches. The couple had two children, a daughter and a son aged 16 years and 14 years respectively. The students were given the freedom to add any other layer to the design requirements in terms of engagements, hobbies and interest of the family members, their heights, etc. This added another level of complexity to the design and human variability and diversity.

Design Process
The design evolved after going through various different stages of the design process that included (Table 2):
1. Design Brief: As an initial step, the students were required to prepare a design brief of the exercise based on the complexity incorporated by them for the users of the residence. The design brief helped students to focus on the requirements of each user. They framed the detailed requirements based on the different needs of the users and their circulation patterns. The various spaces and their interactions were analyzed by studying the behavior tendencies of the users.
2. Study of Anthropometry and Standards: Anthropometric studies were done to arrive at the area requirements of the different spaces as per the specific needs of the users. Various standards were also analyzed to arrive at the area requirements. This stage was presented through handmade sketches on the sheets with human figures.
3. Study of behavior pattern of the users: The next stage of the exercise was to study the movement patterns and behavior tendencies of the users. The various spaces and their interactions were analyzed by studying the behavior tendencies of the users. The students were encouraged to interact and do a survey of the different users to get an in-depth understanding of the same. This step also helped the students to understand the problems faced by them and their perception of the kind of spaces they desired in their house.
4. Concept design and study models: Based on the background study of the users of the residence, the students made conceptual sketches and flow diagrams. Detailed discussions with the course instructors on the conceptual sketches were regularly held to improvise the design. The students also incorporated the technological advancements in their design.
5. Final design: After various rounds of discussions and changes, student's designs were finalized. The students also made models of the house they designed for better understanding of spaces and their interactions.
6. Furniture design: In addition to the residence design, the students were also required to design a furniture used in the residence based on ergonomics with the details. This helped them to understand the application of ergonomics in furniture design also.

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Design Solutions

The students very enthusiastically and interestingly came forward with the design brief by adding another layer of human variability and diversity in addition to the ones assigned to them. In order to enhance the well-being of the residents, each user was identified based on physical, cognitive and behavioral factors. Their needs and expectations were studied in detail to come up with the design solutions. The study of residents with special needs was done thoroughly and sensitively so as to make the living conditions comfortable, safe and enjoyable for them without any obstructions. The interaction of each user, be it emotional, social or psychological, with one another and the built environment in different situations and scenarios were configured and understood. This tri-fold study as stated by Eilouti (2020) is the study of interaction between humans and buildings, humans and indoor and outdoor environment, and between buildings and environment. The study was followed by conceptual design and schematic models. After series of discussions with the course faculty, revisions were carried out in the design to arrive at the best possible solution keeping in mind the various study parameters. The different design solutions were arrived at with an aim to maximize the efficiency of the built environment and satisfy the diverse residents of the house. The students also worked on the furniture design for the differently baled people.

RESULTS AND DISCUSSION

The design exercise opened new avenues for the students where they understood the importance of human centered design from the very conception of the project. The active involvement of the users, the way the users performed various tasks and their interaction with the surroundings enhanced their understanding of the role of users in the design process. The surveys conducted by them in the form of interviews and small questionnaire helped them to get a clear knowledge about the specific requirements and problems faced by them in the current scenario. This further motivated them to work towards the betterment of their design solutions. The students required various skills in the design process at different design stages: analytical thinking and research aptitude for understanding the needs and behavior of the different users for whom they were required to design, anthropometrics to study the space requirement, interior design to satisfy the needs of the users in different spaces, spatial organization to understand the relationship and flow of each space with one another, landscape design for outdoor and indoor spaces, visualization as how the built form will be visible with its massing, furniture design to satisfy the functional requirements of varied users (Eilouti, 2020). The students based on their study also identified the following keywords for their ergonomics based design: Comfort (physiological, psychological, environmental comfort), health, safety, user satisfaction, functional, accessible, flexible, wellbeing, security, sense of attachment, design for all, etc.

CONCLUSION

The aim of this paper was to analyze the role of ergonomics in architecture and design and its application in the design of a residence for a physically handicapped couple. Ergonomics/ human centered design plays a pivotal role in the design of buildings and built forms. All the domains of ergonomics are relevant to building design: physical, cognitive and organizational. The design solutions achieved using ergonomics and anthropometry were more functional and satisfied the needs of each user both psychologically and physiologically. They further proved to be more beneficial for the social interaction between the different users with varied interests and hobbies. Therefore, the architects and designers should incorporate ergonomics in their design from the very conception of the project and thereby provide a human centered design for all. The implementation of human-centered methodology in the design of a building/ built form proved to be a challenge as well as a learning experience for the students of architecture to create spaces that are usable for all with human diversity. At the same time, this approach also ascertained to enrich the quality of life of the residents by providing safe, comfortable, healthy spaces thereby enhancing a sense of place, attachment, belongingness, satisfaction and well-being of the users.

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Table 1: Principles driven by Human factors or Ergonomics (Source: Attaianese & Guca, 2012)

Principles	Detail
Human Variability and Diversity	In terms of physical aspects like age, gender, height and other physical characteristics etc., cognitive aspects like their skills, intellectual capabilities, interests, etc. and behavioral aspects (emphasis on physical, social and cultural differences of users)
User's involvement	Participation of users and their feedback
Overcoming standards and stereotypes	Focusing on human–systems interactions considering the effect of the environment on real people
System Oriented Approach	Focuses on Built environment: interaction between people and all the elements within the system from micro to macro level

Table 2: Incorporation of Principles driven by Human factors or Ergonomics in the Design Project / Brief

Principles	Design brief
Human Variability and Diversity	Physically challenged couple and family having diverse interests and hobbies to be pursued
User's involvement	Questionnaire survey and interview of the users
Overcoming standards and stereotypes	Application of anthropometry and feedback of users to identify their varied requirements
System Oriented Approach	Inferences from the studies incorporated in different stages of the design process from designing of individual spaces for every user to designing of interactive and shared spaces and their relationship thereof

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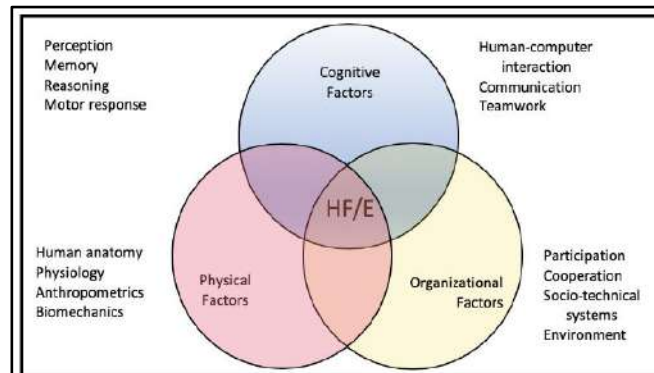
**Figure 1: Domains of Ergonomics/ Human Factors/ Human Engineering
(Source: International Ergonomics Association)**

RESEARCH ARTICLE

An Exploratory Data Analysis to Determine Autism Spectrum Disorder in Young Children using Machine Learning Approaches

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ABSTRACT

The scope of Machine Learning techniques has enhanced the performance of machines and deepens the research across all fields. The primary work of the Machine Learning algorithm is to improve the prediction accuracy with less intervention from human beings. The prediction model highly depends on the quality of data to achieve greater accuracy of results. The data preprocessing takes a significant time in proper analysis and replacement of irrelevant or noisy data. This paper provides a comprehensive report on a detailed examination of the AATT (Autism Assessment Test for Toddler) dataset. An in-depth analysis to explore/interpret the AATT dataset with an evaluation of Machine Learning algorithms is carried out. The preprocessed and balanced data generates an acceptable performance by implementing classification algorithms such as Logistic Regression, Decision Tree and Support Vector Machine. The results obtained using Logistic Regression give higher predictive accuracy than those of the other two models.

Keywords: preprocessing, autism assessment, logistic regression, decision tree, support vector machine.

INTRODUCTION

The pervasiveness of the developmental disorder among children causes various intellectual and progressive disabilities. Symptoms of autism spectrum disorder are noticeable in the early developmental period of 2-3 years. But in most cases, the particular condition is not appropriately addressed at the precise time due to a lack of knowledge of parents and caretakers. It remains as a lack of observance until the child reaches pre-school. Early identification of

developmental disorder is necessary to suppress it at an initial stage and assist the child through therapy to live an independent life. When this statement fails, the child ardently needs to depend on others for daily-life activities. In certain exceptional cases, it might also end up with no options for treatment. Detecting disorders at an early developmental stage is essential to optimize the treatment outcomes. Autism is a kind of neurodevelopmental disability that severely influences the speaking ability and correspondence of a person. Poor eye contact, delayed speech, and repetitive/stereotyped behaviors are the most commonly identified symptoms in autistic children. Autism spectrum disorder (ASD) causes a lifelong effect on a child's development. To alleviate this illness at the earliest many researchers have contributed diagnosing methods and screening tools for assessment. The evaluation process using these methods is time-consuming and to be carried out only by a trained professional. Therefore machine learning techniques provide a high level of automation and make an accurate prediction of outcomes due to the recent improvements in the big data era.

Machine Learning (ML) takes the existing data as input and discovers patterns to perform predictions in the new dataset. ML algorithms are adapted to explore more complex patterns and relationships among the attributes to obtain meaningful business solutions. Researchers derive meaningful inferences from new data objects to build an intelligent system. In this paper, an Autism Assessment Test for Toddlers (AATT) checklist is prepared to overcome the difficulties faced during the autism evaluation process. AATT is an automated autism assessment testing tool validated clinically by professionals in assessing autistic traits of young children within 2-5 years of age. AATT is translated into both English and Tamil (a regional language in India), providing an opportunity for the commoners to use it without technical assistance from clinicians. Detailed descriptive analysis of the collected dataset is presented and formulated for further improvements. The contents of this paper are outlined as follows: Section 1 - presents the introduction. Section 2 - is a review of the literature survey. Section 3 - explores the dataset used for the analysis. Section 4 - discusses the preprocessing techniques. Section 5 – includes data interpretation and class imbalance methods applied to resolve. Section 6 – list the algorithms implied. Section 7 – illustrates the results obtained using Machine Learning algorithms. Section 8 – holds the conclusion and future study for improvements.

Related Work

Tava *et al.* [1] reported a significant contribution in providing a complete insight view of the autism dataset for adolescents. The author provides an analytical view of the adolescent autism dataset that covers an age group of people between 12 and 16. The study highlights meaningful insights and interesting fact findings of the dataset values. Albright [2] presents the All-Pairs technique, a novel preprocessing method using neural networks to forecast the evolution of Alzheimer's disease. The initial approach was to drop the missing values and convert categorical variables into numeric values is performed. Later All-Pairs technique is applied to compare all possible combinations of data points for every patient. Finally, it transforms the dataset into a feature array to train the machine learning model. The author concludes that applying this technique helps to identify Alzheimer's at an early stage.   Zelaya [3] focuses on an innovative approach to determining the sensitive data that deviates from the outcome. An extensive analysis of preprocessed data identifies the differences in prediction. The existing dataset includes a new metric called volatility for experimenting with the returned results. The author concludes that the purpose of understanding the inference of data preprocessing is essential to making a better prediction. Alshdaifat *et al.* [4] did a prominent analysis of the effects of combining nine different preprocessing techniques on eighteen datasets. The author states that the adopted preprocessing techniques vary from one classifier to another. Pradhan *et al.* [5] predict the model accuracy, which improved after applying effective preprocessing methods.

Correlation-based Feature selector (CFS) is applied to determine the dominant features that forecast the target variable. The study results in an efficient binary classifier for diabetes prediction by implementing a Support Vector Machine (SVM). Benjamin *et al.* [6] presented a similar analysis of AATT using the pictorial representation of an autism screening tool that incorporates 21 attributes to measure the autistic traits among children in Sri Lanka. The author demonstrated quality analysis with reports of evidence and multiple metrics of assessment using Machine Learning techniques. Finally, the author declares that random forest has outperformed the accuracy of all other algorithms. As the dataset holds essential information, removing missing or noisy values in a dataset cannot be done

abruptly. The improper handling of missing data may result in partial or inaccurate results. Algorithms also produce a biased result when the class is imbalanced. This partial result is because the algorithm concentrates only on the majority class data and eliminates the minority class data considering it noisy. Therefore, final results occur as misclassification of data values [7] [8] [9] [10]. The severity of the syndrome differs from one child to another. Therefore, autism is known as spectrum disorder. Similarly, in measuring the outcome of the intervention, some exhibit slow progress and few others show signs of rapid improvement [11].

Data Collection and Description
The autism datasets [12] [13] [14] [15] accumulated are from Kaggle and UCI Machine Learning Repository, which is publically available for access. An introductory exploration is carried out by studying and analyzing the data values intensively. The entire collection of autism datasets obtained was using a mobile application [16] that assesses autism symptoms. Data is formulated based on the age group of people such as toddlers, children, adolescents and adults. It measures the behavioral characteristics of an individual to predict whether an individual possesses autistic traits or not. A set of 10 autism questionnaires (AQ) is used to measure the behavioral characteristics of an individual and is commonly referred to as (Quantitative Checklist for Autism in Toddlers) Q-CHAT-10. The main objective of this study is to primarily focus on the early identification of ASD in the age gap of 2-3 years (12-36 months). After careful evaluation and information collected from various sources, a new set of assessment plans called AATT – Autism Assessment Test for Toddlers is proposed. AATT consists of 15 attributes that measure the behavioral traits of a toddler shown in Table 1. The principal spotlight of AATT is to evaluate the key characteristics of autism such as communication, attention, social interaction, repetitive behavior and sensory attributes of an individual. The entire list of items comprised in AATT is dichotomous questions with two possible responses Yes/No. The assessor is allowed to effortlessly answer in either English or Tamil without any clinical assistance from professionals. The first three attributes of AATT are age, gender and family member with autistic traits to determine basic information provided by an individual for further analysis. The remaining 12 attributes AT4-15 are to identify the behavioral attributes of autistic kids. Positive response for the questionnaire AT13-15 and negative response for the remaining indicates the presence of autism. Participants of AATT were children receiving therapy sessions from academies that treat special children with disorders. We collected 152 records from these centers, which provide conclusive evidence of autistic traits in kids from licensed clinicians apart from the result obtained in AATT. A count of 23 control variables was included in the dataset.

Data Preprocessing
Data preprocessing and cleaning are commonly applied to the dataset to reduce noise and missing values. The essence of data is improved and prepared for further analysis [17] [18] to obtain an optimized solution. The new AATT dataset contains missing values in two attributes, age and family member with ASD Traits. Considering that age is a numeric attribute, the missing values are imputed using a mean calculation that is the most commonly used method of replacing numeric values. Another feature is to measure the family history of autistic symptoms. Parents and the caretakers are unaware of the exact detail to respond to the question. The information provided at this juncture is unreliable because people completely do not know about the specific disorder in their family. This type of situation is quite common in low or middle-income countries because people do not have enough knowledge of autism disorder. Instead, all inappropriate behavior in children was commonly considered a mental illness. There was no perfect classification of developmental disorders in earlier days. Reasonably the missing value of a family member with ASD traits is valued as it is, and therefore no replacement is imputed. The dataset moved to the next phase of evaluation called data interpretation, as the remaining values are intact.

AATT Dataset Interpretation
Data interpretation is to derive meaningful insights and relevant conclusions from the dataset. It is a salient process to determine the hidden correlation between dataset values. The prime task is to structure and order the collected raw data to derive significant conclusions. The conclusion derived from interpreted results helps to focus the observations of the researchers in numerous ways. A few interpretations of the AATT dataset are justified below.

Age distribution of Toddlers in AATT

The AATT dataset contains a group of children between 2-5 years of age. Fig. 1 depicts the age distribution of 152 autistic children at various intervals. The visualization of the histogram is slightly right-skewed. Interpretation of the graph clearly states that autistic traits are identified after the children enter preschool, which is during 42-50 months of age (approximately four years). Very few entries below 24 months of age indicate that parents or caretakers are unidentified with the symptom until the kids enter the preschool. One of the objectives of this study is to address this issue at an early stage using the AATT assessment.

Gender classification of Toddlers in AATT

Autism disorder in females is considerably lower in number compared to males. The substantial decrease in the female count is still unclear [22]. The male-female ratio in autism is 4:1 [23], which is getting closer now to 3:1 [24]. Accordingly, the AATT dataset also replicates the same proportion of gender differences in ASD classification between male and female children. Fig. 2 depicts the ratio of male and female count as close to 4:1. The total number of male children with autistic traits is 121 and females are 31.

Family member with autistic traits in AATT

Autism is a hereditary disorder that affects siblings in a high ratio [25]. Fig. 3 present the AATT dataset count of family members with autistic traits. Out of 152 samples of autism, 33 people answered YES, 85 answered NO, and the remaining entries are indefinite. Total uncertainty arises among the respondents to provide an exact answer. People are not proficient in classifying the illness among family members in the early days due to a lack of knowledge or evidence.

Data Imbalance

The Machine Learning algorithm produces inaccurate results when the class proportion is not balanced, resulting in poor prediction and less accuracy [26] [27]. SMOTE (Synthetic Minority Oversampling Technique) significantly help to cover the prime issue of class imbalance in datasets. One pioneering technique contributed its essential role in preprocessing a dataset and improving the performance of the classifier [28]. Table 2. presents the effect of SMOTE in the AATT dataset, where the class variable that denotes the autistic traits is of equal measure.

Algorithm Analysis

Logistic Regression

The logistic regression model is a powerful technique in Machine Learning to analyze and predict the outcome of a dichotomous variable [29]. When the outcome variable is continuous, linear regression is preferred, and for a categorical output, logistic regression is well suited to predict the accurate outcome of results [30]. In the AATT dataset, the autistic behavioral characteristics of children expect an answer of yes or no. The assessment measure acts as independent variables $x_1, x_2, \ldots x_n$, $b_0, b_1 \ldots b_n$ represents the binary coefficients where the dependent variable y determines the outcome after the evaluating (1). The logistic form of representation is [31].

$$\log\left[\frac{y}{1-y}\right] = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots + b_n x_n \qquad (1)$$

Decision Tree

A Decision Tree is a classification algorithm that constructs a tree in a top-down hierarchical structure that begins with a root node and ends with a leaf node. A Decision Tree classifier is an effective method that classifies discrete and continuous outcome variables [32]. The advantage of using a decision tree is easy to understand and interpret. Additionally, it has highly robust to outliers. The algorithm performance depends on entropy, the metric used to measure the uncertainty of data and acts as a splitting parameter to fragment the values into branches [33]. Entropy is the measure in the Decision Tree to determine the uncertainty of observations [34]. The value is a measure between 0 and 1 using (2), where S is the total instances, N denotes the distinct values in a class and pi is the event probability,

$$E(S) = -\sum_{i=1}^{N} p_i \, log_2 \, p_i \qquad (2)$$

Support Vector Machine

A Support Vector Machine is a powerful Machine Learning algorithm that results in robust performance for multi-classification problems. Many applications and real-world problems use SVM to optimize the accurate solution. SVM builds a model to minimize the classification errors and maximizes the performance and generalization ability of the training data [35]. SVM is a supervised learning algorithm to solve both classification and regression problems. The kernel function in SVM transforms the data to a higher dimensional space to achieve the separation of data at certain limits [36].

RESULTS AND DISCUSSION

This paper aims to present a detailed interpretation of AATT dataset values. In the first phase, a comprehensive description provides the data collection of 152 actual and 23 control instances. The main characteristics considered for assessment are communication, attention, social interaction, repetitive behavior and sensory attributes of individuals. The second phase is to explore the available information in various dimensions. Next, we balanced the dataset using SMOTE technique by generating synthetic samples to overcome the over fitting problem. SMOTE balances the actual and control instances and, therefore dataset moves to the next phase of implementation. During the final phase, the Machine Learning algorithms like Logistic Regression, Decision Tree and Support Vector Machine are concentrated. In the execution performed, Logistic Regression exhibits more accuracy of 99.1%, Decision Tree classification scored 94.5 % and Support Vector Machine with 98.7% of accuracy. Table. 3 displays the accuracy, precision and recall results of all three algorithms used in the evaluation. Fig. 4 visualizes the outcome of classifier results obtained. The investigation and execution of ML calculations utilizing Python 3.9 and the design of the figuring framework is Windows 10 64bit, Intel Center i5-2450M Processor 2.50 GHz, 4GB RAM and 500GB Hard Disk.

CONCLUSION

This paper conducts an extensive experiment analysis to detect autistic traits in children between 2-5 years. Logistic regression obtains promising results of 99% accuracy in examining the behavioral attributes. Therefore, we suggest the AATT for toddlers between 2-3 years of age to analyze the disorder at earliness. The parents and caretakers can assess on their own without any clinical help. When there is a positive symptom, we recommend obtaining clinical confirmation and starting therapy sessions so that child is back to normal life as early as possible. In future, the aim is to focus on feature selection techniques and much more complex algorithms for evaluation.

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Table.1. AATT Dataset Description

Attribute	Attribute Description	Type of Response	Behavioral Assessment
AT1	Age	Numeric	-
AT2	Gender	M/F	-
AT3	Family Member with Autistic Traits	Yes/No	-
AT4	Does your child look at you when you call his/her name? [19]	Yes/No	Attention
AT5	Does your child follow where you are relooking? [19]	Yes/No	
AT6	How easy is it for you to get eye contact with your child? [19]	Yes/No	Communication
AT7	Does your child point to indicate that s/he wants something? (e.g. a toy that is out of reach) [19]	Yes/No	
AT8	Does your child pretend? (e.g care for dolls, talk on a toy phone) [19]	Yes/No	
AT9	Would you describe your child's first words as: [19]	Yes/No	
AT10	If you or someone else in the family is visibly upset, does your child show signs of wanting to comfort them? (e.g. stroking hair, hugging them) [19]	Yes/No	Social Interaction
AT11	Does your child use simple gestures? (e.g. wave goodbye) [19]	Yes/No	
AT12	Does your child show interest in playing with another child like sharing toys etc? [19]	Yes/No	
AT13	Does your child show unusually strong reactions to one or more of their five senses. (e.g. reaction to bright sunlight, bothered by tags on	Yes/No	

	their clothing or by loud noises) [20]		
AT14	Does they often exhibit difficulty with the colour, smell, or texture of certain foods? [21]	Yes/No	Sensory Attributes
AT15	Does your children do same thing over and over again? (For example, flapping their hands, jump, or walk on tiptoes.) [19]	Yes/No	Repetitive Behavior

Table.2.Dataset Effect Before and After Smote

Dataset	Before SMOTE	After SMOTE
Number of Instances	175	304
Class Variable – YES	152	152
Class Variable – No	23	152

Table.3. Implementation Results

Machine Learning Algorithms	Logistic Regression	Decision Tree	Support Vector Machine
Accuracy	99.1	94.5	98.7
Precision	100	92.5	97.9
Recall	98.7	98.0	100
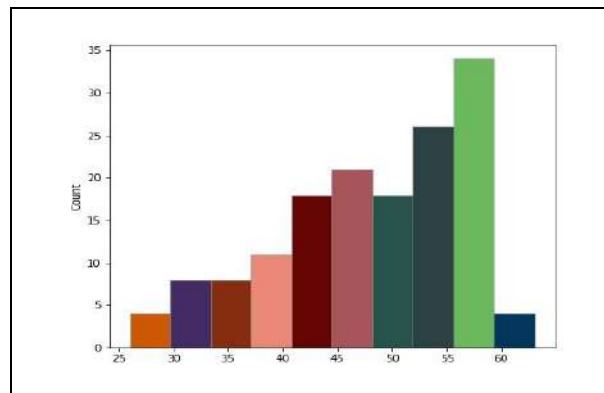
Figure 1. Age distribution in months

Figure 2. Autism Gender Classification
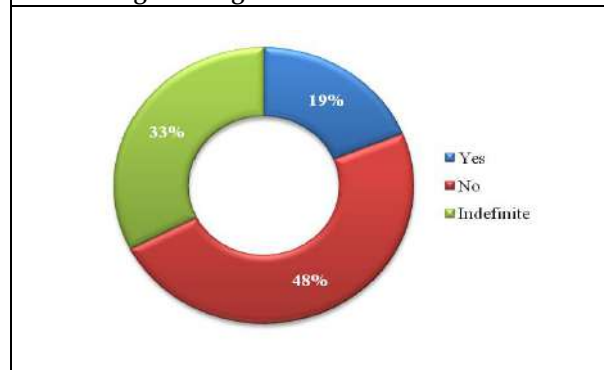
Figure 3. Family member with autistic traits
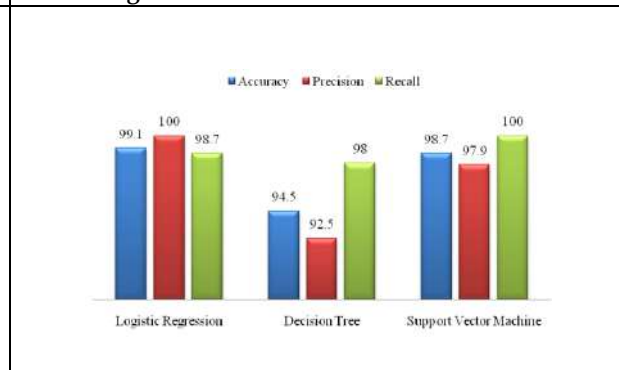
Figure 4. Accuracy measure

RESEARCH ARTICLE

Suitability of Groundwater for Irrigation in Beedanahalli Watershed T.Narasipura Taluk, Mysuru District, Southern Karnataka, India using Geographic Information Science and Remote Sensing

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ABSTRACT

The Present study aims to evaluate groundwater suitability for irrigation purposes in the Beedanahalli watershed. Thirty-one samples were collected during the Pre/Post Monsoon period of 2022. The samples collected were analyzed for major cations like Ca^{2+}, and Mg^{2+} by titrimetry Na^+ and K^+ by flame photometer, anions Cl and HCO_3 titrimetry SO_4^2 by spectrophotometer. In addition, Ec and pH were determined in the field using electrodes. Based on this analysis, irrigation quality parameter like S.A.R., percentage Na, R.S.C. P.I. was calculated. These parameters were compared with WHO standard limits. Most samples were within the safe limits suitable for irrigation purposes. The U.S.S.L. plot indicates that most samples are suitable for irrigation. The S.A.R. values indicate that they fall in the excellent category. Based on the permeability index, most of the samples belong to class 1 suggesting the suitability of groundwater is good for irrigation.

Keywords: Irrigation, Water quality Suitability, Agriculture parameter, Permeability Index, Residual Sodium Carbonate, Kelly's Ratio.

INTRODUCTION

Groundwater is a large natural supply of freshwater used extensively by the world's population for domestic, agricultural, manufacturing, and industrial purposes. (Treidel *et al.,* 2011).Therefore, managing and conserving freshwater resources is necessary (Russell, Sally and Kelly, 2010). On the other hand, the world economy still heavily depends on agriculture. (Alston *et al.,* 2014) Farming is the greatest consumer of water and a substantial factor in the depletion of surface and groundwater, so farming is remarkable for these reasons (Coleman *et al.,* 2004). Assets and excellence Groundwater supplies are essential for economic growth, particularly in arid regions. The natural, physical, chemical, and anthropogenic activity-related changes to the water's characteristics are all considered to be a component of the water quality. The processes and actions that follow the water from the time it is first collected until it is stored in a well, as well as several physio-chemical traits, define groundwater quality (Asadi *et al.*, 2020).Numerous groundwater assets have been exhausted and corrupted due to the combined effects of population growth and unsustainable groundwater use (Werner *et al.,* 2013). It is also evident that the quality of agricultural water influences the condition of the soil and, consequently, the yields. Interest in farming areas and the goods generated by these farms has raised significantly. During the past century, due to population growth (Orsini *et al.,* 2013). Many problems, including growing urbanization, more industrialized areas, inadequate land management, and environmental contamination, experts claim, have put further pressure on agricultural production (*Bouma et al.*, 1998). The purpose of the current study is to assess the irrigation quality of groundwater in the study area.

Study Area
The study area is Beedanahalli watershed. It belongs to the Cauvery basin of the river T.Narasipura Taluk, Mysore District of Karnataka. It is bound between 12° 12ˈ 40" - 12°24ˈ36" North latitudes and 76°48ˈ10" - 76°09ˈ14" East longitudes shown in Fig.1.The Beedanahalli watershed spread into and Mysore district in the southern part of Karnataka. The spatial extent of the study area is 235sq.km. The area is covered in the Survey of India toposheet numbers 57D/15 and 57D/16. The area is well connected to a year-round movable road, the physiographically, the Beedanahalli watershed forms the' Southern Maidan' region of Karnataka. The direction of the Cauvery Riveris towards the North and chamarajanagar towards the south. Topographically the study area is undulating terrain with elevations varying from 1079 m to 759 m above Mean Sea Level(M.S.L.).,The major portion of the study area is covered by basement gneisses of the 'Peninsular gneissic complex'overlain by basic, intermediate acid lavas (Metavolcanics), Schistose Rocks of Chikanayakanahalli schist belt. The Central Ground Water Board reports that the annual Report (2017-2018) average rainfall of the study area is 722mm (C.G.W.B. 2017-18). The three soil types in the study area are: red sand soils, red loamy soils, and deep black soils. The north-Eastern part of T. Narasipur taluk comprises red loamy soil. It is characterized by clayey content mixed with sand. Deep Black soils occur in the south-western part of T. Narasipur taluk in a small area.

METHODOLOGY

Thirty-one samples of the groundwater were taken during the Pre-monsoon & Post-monsoon season from the various bore wells in the study region. The locations of the water samples were indicated. The samples were taken after pumping for5 minutes and kept at 4° C in thoroughly cleaned containers made of polythene until the start of the chemical analysis. Volumetric titration techniques were used in the laboratory to measure the concentrations of calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), and sulfate (SO₄), whilst chloride concentrations were measured using an auto titrate (Metrohm Titrandi, 2020).A spectrophotometer (Model No. 119) was used to evaluate sulfate content, while a flame-photometer (Model No. 128) was used to evaluate sodium and potassium concentrations. Blanks and standards were frequently run to verify the accuracy of the analyses. The ion balance error was also calculated to ensure that the results were accurate to within 5%.After the analysis was complete, WATCHIT. It was used to analyze the data, and ARC GIS version (10.8) was used to create thematic maps.

RESULT AND DISCUSSION

Groundwater Chemistry

The findings of a statistical analysis of the physicochemical properties of samples of groundwater are displayed in Table.1.The pH of the research area's groundwater ranges between 6.93 and 8.41, with an average of 7.94, indicating that it is alkaline. Groundwater's electrical conductivity ranges from 254 to 2690 S/cm. The TDS. ranges from 165 to 1748 mg/l. It is mostly composed of inorganic salts, with trace amounts of organic matter dissolved in water. Calcium, magnesium, sodium, potassium, bicarbonate, chloride, and sulfate cat ions are the most common minerals used to calculate T.D.S. Potassium concentrations range from 0.3 to 46.8 mg/l. Major ions control the general hydrochemical properties of groundwater (Li *et al.,* 2016). Ca^{2+}, Mg^{2+}, and Na^+ concentrations range from 32 to 176 mg/l, 4.86 to 68.04 mg/l, and 19.7 to 317 mg/l, respectively. Cl concentrations vary between 18.4 to 691 mg/l, SO_4^{2-} from 4.9 to 81.79 mg/l, and HCO_3^- from 34 to 523 mg/l.

Irrigation Water Quality Parameter

The irrigation of plain land is heavily reliant on groundwater. A variety of factors influence the suitability of the water. For example, comprising soil texture and Composition, regional geology, and agricultural activities. Some characteristics that determine irrigation water quality are SSP., Salinity, SAR, RSC, KR, CR, PS, RSB, MAR, PI, and SR. (Abou El- Defan *et al.,* 2016; Singh *et al.,* 2020).

Salinity Hazard Classification

Due to salty soils brought on by increased irrigation with saline water, plants were less able to absorb water. Therefore, crop yield will be significantly reduced due to long-term saline water use. Overtime, the soil will become less fertile. Richards (1954) Irrigation water salinity was divided into four groups and given a letter grade (Table 2 &3).Each class was introduced with a statement of the maximum Salinity allowed, its suitability for growing crops and soil, the necessary safety measures, and the characteristics of the crops that must be cultivated. In the research area, more than 67% of the groundwater is found suitable for irrigation while just 33% is deemed unsuitable.

Sodium ratio (Sr)

The ratio of dissolved sodium cations to total calcium and magnesium in irrigation water was indicated as (S.R.), and a computer was used to evaluate the irrigation water's quality.(Abou El-Defan *et al.,* 2016). In good water, this ratio should not be higher than one. Meq/l is the unit of measurement for all ion concentrations..

$$SR = \frac{(Na^+)}{(Ca^{2+} + Mg^{2+})}$$

The rest of the analyzed samples in the study area were suitable for agricultural use; however, 4 of the samples are in the inappropriate group and cannot be irrigated. Therefore, the spatial distribution of the sodium ratio is slightly variable Fig (3).

Soluble Sodium Percentage (Ssp)

The Soluble Sodium Percentage (SSP) is a key factor in determining sodium hazard. It is used to categorize irrigation water into two groups: soft and hard, with a high value denoting soft water and a low value denoting hard water. Because of the high sodium level, soils become less permeable and have poor internal drainage (Subramani *et al.,* 2005).Na% categorizes groundwater into four categories: excellent (<20%), reasonable(20-40), and permissible.(40-60), doubtful (60- 80), and unsafe (>80%).The equation shown below is used to calculate the Soluble Sodium Percentage (S.S.P.).

$$Na\% = \frac{(Na^+ + K^+)}{(Ca^{2+} + Mg^{2+} Na^+ + K^+)}$$

Thirty different groundwater samples from the study area have all been deemed acceptable and suitable for irrigation—table (5). Greater concentrations of soluble sodium are visible on the spatial distribution map in the area of So sale.

Sodium Adsorption Ratio (Sar)

When deciding whether or not water is suitable for agriculture, the Sodium Adsorption Ratio, a crucial water quality criterion, must be considered. It is also to blame for the risk of salt poisoning. Based on the Sodium Adsorption Ratio value ranges, the water was classified for irrigation. The SAR is the ratio of sodium to calculate magnesium in the water extract. It's one-half divided by the Na concentration divided by the square root (Uma Mohan and Krishnakumar, 2021). The following formula is used to calculate it, with all ions being given in meq/l

$$SAR = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$$

As shown in the Fig (6) of spatial distribution of Sodium Adsorption Ratio (SAR) and Table (7&8) shows Sodium Hazard classification (Richards, 1954),the groundwater samples used for agriculture in the study area are in excellent condition.

Magnesium Adsorption Ratio(Mar)

Magnesium content is a crucial factor in determining the quality of irrigation water. Ca and Mg keep a balance in the majority of water. As soils grow increasingly salty, an excess of magnesium in irrigation water will have a negative impact on agricultural production (Joshi *et al.*, 2015). The MAR. was calculated by the equation.

$$MAR = \frac{MgX100}{Ca + Mg}$$

The water sample ranges from 8.81% to 45.70%, according to the spatial distribution of the study area for the magnesium adsorption ratio (MAR). Fig. (7) Table (8).All groundwater samples in the research area are within 50% of MAR, making them all appropriate for irrigation.

Permeability Index (Pi)

Irrigation techniques may have a negative impact on soil permeability. The permeability of the soil is affected by several components, such as sodium, calcium, magnesium, and bicarbonate. Therefore, the permeability Index is classified into two categories one is <60% is suitable for irrigation, and another one is >60% is not suitable for irrigation. Based on this category Permeability Index is classified Table (9). The ion concentrations are all expressed in meq/L Table 9. The equation below was used to calculate P.I.

$$PI = \frac{(Na + \sqrt{HCO3X100})}{Ca + Mg + Na}$$

Permeability is often measured in a saturated state; Permeability refers to the ability of soil to transfer water. Long-term soil permeability will be affected by more significant levels of ions such as sodium, calcium, and magnesium. Out of Thirty-one groundwater samples, Twenty-five groundwater samples show less than 60% of the permeability index, which is suitable for agriculture purposes, and the remaining 6 groundwater samples show more than 60% of the permeability index, which is not suitable for agriculture. The 6 groundwater sample locations show the highest soil permeability index, and the remaining locations show the lowest Permeability Index (PI) Fig 8.

Kelly's Ratio (K.R.)

Kelly considered the proportions of sodium, calcium, and magnesium. (Pophare and Sadawarti, 2019). The water's salt content is too high if the Kelly's index is greater than one. When Kelly's ratio exceeds one, indicating that the water is too sodium-rich. Anything with a Kelly's ratio of less than one is suitable for irrigation, while anything greater than one is unsuitable for irrigation. Except for three places, the regional Kelly's Ratio shows that the other 28 locations in the research area fall within his permitted limit, and almost 90% of the groundwater samples are suitable for irrigation Fig 9.

Corrositivity Ratio (C.R.)

The corrositivity ratio measures groundwater's susceptibility to corrosion and has been used the ratio to evaluate the corrosive tendency of groundwater. The qualities of groundwater delivered through metallic or P.V.C. pipes, such as corrosion, must be examined to preserve the water supply systems. Corrosion is a type of electrolysis in which metal surfaces are attacked and corroded away. Numerous chemical equilibrium reactions and physical variables like temperature and flow rate influence corrosion rates. (Malpe *et al*., 2021). Groundwater with less than one corrosivity ratio is safe to transport in any pipe, while groundwater with a corrosivity ratio greater than one is corrosive and should not be conveyed in metal pipes. The C.R. was calculated using the equation below.

$$CR = \frac{\left(\frac{Cl}{35} + \frac{SO_4^-}{96}\right)}{\frac{CO_3^- + HCO_3^-}{100}}$$

Most groundwater samples in the study area have lower corrosivity ratios (Fig 10) Table (11), meaning that water can pass through metallic pipes without corroding them. However, only 10% of groundwater samples havea high corrosivity ratio, and water cannot be transported through copper pipes.

Residual Sodium Carbonate (Rsc)

The presence of carbonate and bicarbonate ions impacts water suitability for irrigation. One of the empirical techniques assumes that all Ca2+ and Mg2+ precipitate as carbonate mineral species. Therefore, residual sodium carbonate (R.S.C.) was developed for evaluating high-carbonate waters. Due to sodium carbonate chemical deposition, water with a high R.S.C. has a high pH, and land irrigated with it becomes unproductive. Therefore, the effects of bicarbonate (HCO3-) and carbonates (CO3-) are calculated using R.S.C. formula (Eaton, 1950). The following formula calculates it, with all ions being given in meq/l.

$$RSC = (CO_{3+}^- + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

The range of the RSC in groundwater is -0.01 to 2.16 meq/l**.** Negative R.S.C. indicates that Na⁺build-up is unlikely since sufficient $Ca^{2+}$and $Mg^{2+}$are over what can be precipitated as CO_3^{2-}.However, 93.54%ofsamples are within the safe quality categories for irrigation. Fig (11) Table (12).

Residual Sodium Bicarbonate (Rsbc)

Water's appropriateness for irrigation is influenced by bicarbonate and carbonate concentrations. A high pH is seen in the water with high RSBC. As a result of the deposition of Sodium Carbonate, land irrigated with such water has become unproductive (Eaton, 1950). Water from the study area has residual sodium bicarbonate levels of -0.41 to 4.50 meq/L (Table 13). Irrigation is considered safe if the R.S.B.C. levels are fewer than 5meq/L.(Gupta and Gupta, 1087; Oladeji *et al.,* 2012). Using the following formula, the values of residual sodium bicarbonate are calculated.

$$RSBC = HCO_3^- - Ca^{2+}$$

It can classify the alkalinity risk of irrigation water into six groups based on Residual Sodium Carbonate (RSBC) values in Table (13). For example, 51% of the study area showed non-alkaline water, 13% of water samples were ordinary water, and 29% of water samples showed low alkalinity water in the study area Fig (12).

CONCLUSIONS

In the study area, to assess the groundwater for irrigation, a number of indices were used.. Groundwater samples from the study area were alkaline in more than 90% of the cases. The values of the groundwater samples were grouped as C1S1 and C3S1 on values that may suggest low sodium to medium salinity threat.According to a recent investigation, the study area's groundwater samples showed 67% of medium Salinity. A substantial amount of salt in groundwater samples, which leads to the production of scale in pipelines, is indicated by a negative R.S.C. value. Water is treated with lime or soda ash to eliminate the hardness and prevent scaling in heat exchangers cooled by water. Most groundwater samples were determined to be suitable for irrigation after being analyzed with SAR, RSC, SSP, PI, MAR, and KR even though anthropogenic groundwater pollution was not found in the current investigation,

extra care should be taken to prevent other human activities, anthropological and agricultural fertilizers, from contaminating this valuable resource.

ACKNOWLEDGMENT

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Table 1: Statistical analysis of Physio-chemical parameters of groundwater

Parameter	Unit	Max	Min	Mean
pH	-	8.41	6.93	7.94
TDS	Mg/L	1748	165	598
EC	µS/cm	2690	254	921
SO$_4$	Mg/L	76.17	4.99	40.81
F	Mg/L	1.2	0.08	0.59
Fe	Mg/L	2.15	0.02	0.47
Mg	Mg/L	68.04	4.86	34.96
Cl	Mg/L	248.8	23	95.51
NO$_3$	Mg/L	147.94	2.11	53.84
HCO$_3$	Mg/L	523	187	312.82
K	Mg/L	3.7	0.3	4.00
Ca	Mg/L	176	32	104
Na	Mg/L	317	19.7	93.97

Table 2: Classes of irrigation water salinity (Richards, 1954).

Class	Description	Salinity	T.D.S.	Remarks
C1	Low Salinity	< 0.25	< 200	Well used for irrigation of most crops on most soil. Some leaching is needed under normal irrigation condition, but excessive irrigation is required in extremely poor soil or porous soils.
C2	Medium Salinity	0.25-0.75	200-500	Can be used when the majority of leeching stays stable. Plants that withstand moderate salt concentrations. Can be grown in most regions without special salinity control methods.
C3	High Salinity	0.75-2.25	500-1500	Not effective in areas with restricted drainage. Even with adequate drainage, special salinity control management is required and plants with good salt tolerance may grow in this area.
C4	Very high Salinity	> 2.25	> 1500	Under normal circumstances, it is not suitable for irrigation but can be used in special cases. The soil must be permeable, sufficient drainage must be provided, water from the irrigation system must be used in excess and crops tolerant of high salt levels should be

Table3. Salinity Hazard (after Davis and De Weiest, 1966; Wilcox, 1955)

Salinity Hazard Classification	Remarks on quality	Number. of Samples	Percentage
C1	Excellent	1	3.2
C2	Good	20	64.5
C3	Doubtful	10	32.2
C4	Unsuitable	0	0

Table 4: Sodium ratio (SR) classification (after Abou- El-Defan *et al.,* 2016)

Sl No	Values meq/l	Remarks on quality	Numbers of Samples
1	<1	Suitable for agriculture	27
2	>1	Unsuitable for agriculture	4

Table 5.Soluble Sodium Percentage (SSP) classification (after Wilcox, 1954).

Category	S.S.P. Range (%)	No. of samples	%
Excellent	<20	7	23
Good	20 – 40	21	68
Permissible	40 – 60	2	6
Doubtful	60 – 80	1	3
Unsafe	>80	0	0

Table 6: Irrigation water classes and description as SAR values (after Abou-El-Defan *et al.,* 2016)

Class	Description	S.A.R. Value (meq/l)	Remarks
S1	Low sodium water	<10	Irrigation can be used on almost any soil with little risk of exchangeable sodium development. Sodium-sensitive crops, on the other hand, may accumulate harmful sodium levels.
S2	Medium sodium water	10 – 18	Unless gypsum is present in the soil, there is a significant sodium hazard in fine-textured soil with C.E.C., especially under low leaching conditions. However, it can be used on soil with a coarse texture or that is organic and has good permeability.
S3	High sodium water	18 – 26	Most crops consider it unsatisfactory, and exchangeable sodium concentrations could be dangerous as a result. Most soils will require unique soil management, such as adequate drainage, high leaching and organic matter additions. Such water may not cause harmful levels of exchangeable sodium in gypsiferous soils. Replacement exchangeable sodium may require chemical amendments.
S4	Very high sodium water	>26	Is generally unsuitable for irrigation of most crops, except for low and likely medium Salinity where calcium from the soil or the use of gypsum may make the use of this water possible

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Table.7:Sodium Hazard classification (Richards, 1954)

Sodium Hazard Class	S.A.R. range meq/l	Remark	No. of Samples
S1	< 10	Excellent	30
S2	10 – 18	Good	1
S3	18 – 26	Doubtful	0
S4	> 26	Unsuitable	0

Table 8: MAR Classification of the groundwater samples in the study area (after Gupta and Gupta, 1987)

MAR (%)	Water Quality	No. of samples
<50	Suitable for agriculture	31
>50	Unsuitable for agriculture	0

Table 9: Permeability Index

P.I.	Remarks	No. of samples	%
< 60 %	Suitable for irrigation	25	80.64
> 60%	Unsuitable for irrigation	6	19.36

Table 10: Kelly's Ratio (Kelly, 1940) of the groundwater samples in the study area

Kr	Remarks	No. of samples
<1	Suitable	28
>1	Unsuitable	3

Table 11. Corrosivity Ratio of the Groundwater samples in the study area (after Balasubramanian and Nagaraju, 2019)

Sl. No	Values meq/l	Remarks on quality	No. of samples
1	<1	Water transport in any type of pipe is entirely safe.	28
2	>1	Corrosive and should not be transported in metal pipes	3

Table 12: Residual Sodium Carbonate of the groundwater samples in the study area (after Abou-El-Defan *et al.,* 2016)

Category	R.S.C. range (meq/l)	Water Quality	No. of samples
Good	< 1.25	Water probably safe for irrigation	29
Medium	1.25-2.50	Water is marginally suitable for irrigation and can be used with certain conducts.	2
Bad	>2.50	Water is unsuitable for irrigation purposes.	0

Table 13: RSBC Classification of the groundwater samples in the study area (after Abou –El- Defan *et al.,* 2016)

Sl.No	Category	R.S.B.C. range (meq/l)	No. of samples
1	Non-alkaline water	-value	16
2	Normal water	0-1	4
3	Low alkalinity water	1-2.5	9
4	Medium alkalinity water	2.5-5.0	2
5	High alkalinity water	5.0-10.0	0
6	Very high alkalinity water	>10.0	0

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Table 14: Irrigation water quality parameters of the study area

Sl. No	Location	X	Y	MAR (%)	RSC meg/l	RSBC meg/l	CR meq/l	SSP meq/l	KR meq/l
1	Megadahalli	12.2254	76.9335	45.70	-1.10	4.50	0.31	58.71	1.43
2	Doddabbagalu	12.2527	76.9631	22.06	-0.30	2.42	0.39	35.76	0.56
3	Kolatur	12.2826	76.9799	16.05	1.28	2.48	0.29	40.00	1.63
4	Mudukanapura	12.2811	76.9613	27.07	-4.07	0.33	0.27	36.12	0.57
5	Kallipura	12.3131	76.9349	12.29	-0.54	0.66	0.42	47.98	0.93
6	Ukkalagere	12.3015	76.9155	31.72	-1.12	1.49	0.43	36.56	0.58
7	Kannayakanahalli	12.2674	76.9208	11.28	-6.32	-4.4	1.03	27.26	0.38
8	Somanthapura	12.2758	76.8818	41.29	-2.48	1.92	0.26	20.23	0.25
9	Atthalli	12.3216	76.8801	32.70	-6.32	-0.72	0.98	34.22	0.52
10	Kethupura	12.3006	76.8838	18.10	-6.69	-3.49	1.31	37.47	0.60
11	Sosale	12.2398	76.9120	34.70	2.16	3.55	0.28	71.94	2.58
12	Bannur	12.3308	76.8612	37.79	-1.81	1.19	0.40	35.92	0.58
13	Sennapathihalli	12.3090	76.8645	20.99	-4.87	-2.07	0.61	22.34	0.29
14	Gadijogihundi	12.3651	76.8398	8.81	-2.94	-1.54	0.32	31.44	0.46
15	Kodagahalli	12.3768	76.8239	25.51	-1.95	0.25	0.15	16.50	0.20
16	Hunasaganahalli	12.3963	76.8594	17.99	-4.63	-2.04	0.56	28.83	0.41
17	Goravanahalli	12.3914	76.7715	27.88	-3.57	-0.77	0.33	17.01	0.21
18	Turaganur	12.3842	76.8990	37.79	-1.29	1.31	0.30	18.85	0.23
19	Maragaudahalli	12.3806	76.8685	35.67	-4.61	-0.41	0.51	31.14	0.47
20	Hanumanahalu	12.3669	76.8683	34.70	-3.97	0.31	0.43	18.82	0.23
21	Yedahalli	12.3615	76.8863	28.82	-6.55	-1.76	0.71	20.85	0.26
22	Dasagaudanakoppal	12.3560	76.9193	20.36	-2.19	-0.59	0.36	17.16	0.21
23	Banagavadi	12.3744	76.8937	10.46	-3.12	-2.13	0.48	15.90	0.19
24	Hegguru	12.3701	76.9278	23.29	-0.01	2	0.20	30.35	0.52
25	Nugahallikopal	12.3927	76.9344	30.26	-6.69	-1.7	0.58	17.10	0.21
26	Guddadakopal	12.4040	76.9283	9.94	-2.04	-1.64	1.49	24.88	0.34
27	Menasikyatanahalli	14.4136	76.9156	37.79	-2.22	2.37	0.46	39.34	0.68
28	Doddamalagudu	12.4371	76.9127	31.30	-1.94	1.11	0.44	31.55	0.47
29	Megalakoppal	12.3166	76.8980	14.99	-3.25	-1.45	0.62	35.51	0.56
30	Bommanahalli	12.3473	76.8713	13.55	-3.47	-1.87	0.59	28.15	0.40
31	Beedanahalli	12.3206	76.9400	26.26	-4.59	-1.19	0.40	21.20	0.27

Cont ......Table 14: Irrigation water quality parameters of the study area

Sl. No	Location	X	Y	SR meq/l	SAR meq/l	PI %	USSL Salinity	Na Hazard	Pot. Salinity meq/l
1	Megadahalli	12.2254	76.9335	2.118	6.27	71.25	C3	S2	2.61
2	Doddabbagalu	12.2527	76.9631	0.733	2.34	57.03	C3	S1	3.62
3	Kolatur	12.2826	76.9799	2.064	5.15	81.04	C2	S1	1.75
4	Mudukanapura	12.2811	76.9613	0.769	2.75	51.37	C3	S1	1.89
5	Kallipura	12.3131	76.9349	1.155	3.33	67.84	C2	S1	2.49
6	Ukkalagere	12.3015	76.9155	0.883	2.01	60.04	C2	S1	2.05
7	Kannayakanahalli	12.2674	76.9208	0.464	1.72	41.67	C3	S1	4.83
8	Somanthapura	12.2758	76.8818	0.370	1.03	43.56	C2	S1	1.56
9	Atthalli	12.3216	76.8801	0.725	2.62	47.36	C3	S1	6.87

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10	Kethupura	12.3006	76.8838	0.772	2.95	49.58	C3	S1	7.74
11	Sosale	12.2398	76.9120	3.631	6.33	93.23	C2	S1	1.40
12	Bannur	12.3308	76.8612	0.829	2.01	57.31	C2	S1	1.86
13	Sennapathihalli	12.3090	76.8645	0.376	1.24	39.96	C2	S1	2.99
14	Gadijogihundi	12.3651	76.8398	0.559	2.08	49.65	C3	S1	2.57
15	Kodagahalli	12.3768	76.8239	0.272	0.70	44.76	C2	S1	0.70
16	Hunasaganahalli	12.3963	76.8594	0.523	1.81	45.49	C2	S1	3.00
17	Goravanahalli	12.3914	76.7715	0.278	0.78	39.01	C2	S1	1.26
18	Turaganur	12.3842	76.8990	0.334	0.76	49.79	C2	S1	1.30
19	Maragaudahalli	12.3806	76.8685	0.664	1.97	47.79	C2	S1	2.15
20	Hanumanahalu	12.3669	76.8683	0.326	0.98	39.06	C2	S1	2.35
21	Yedahalli	12.3615	76.8863	0.360	1.30	36.32	C3	S1	3.84
22	Dasagaudanakoppal	12.3560	76.9193	0.272	0.69	44.77	C2	S1	1.15
23	Banagavadi	12.3744	76.8937	0.232	0.67	39.72	C2	S1	1.41
24	Hegguru	12.3701	76.9278	0.690	1.81	61.15	C2	S1	1.00
25	Nugahallikopal	12.3927	76.9344	0.283	1.01	33.04	C3	S1	3.30
26	Guddadakopal	12.4040	76.9283	0.409	0.76	46.64	C1	S1	0.90
27	Menasikyatanahalli	14.4136	76.9156	0.966	2.90	57.49	C3	S1	3.13
28	Doddamalagudu	12.4371	76.9127	0.646	1.74	53.65	C2	S1	2.21
29	Megalakoppal	12.3166	76.8980	0.699	2.22	53.22	C2	S1	2.83
30	Bommanahalli	12.3473	76.8713	0.494	1.57	47.50	C2	S1	2.67
31	Beedanahalli	12.3206	76.9400	0.362	1.16	39.62	C2	S1	1.84

Fig.1: Location map of the study area	**Fig.2: U.S.S.L. diagram demonstrating irrigation water quality of the groundwater samples in the study area (U.S.S.L.S., 1954)**

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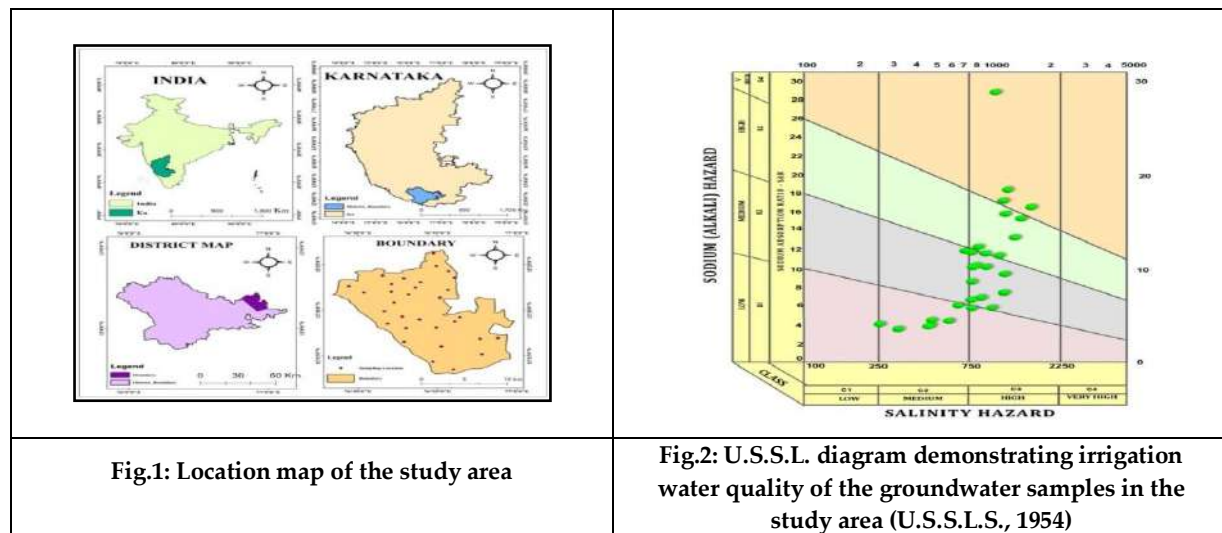
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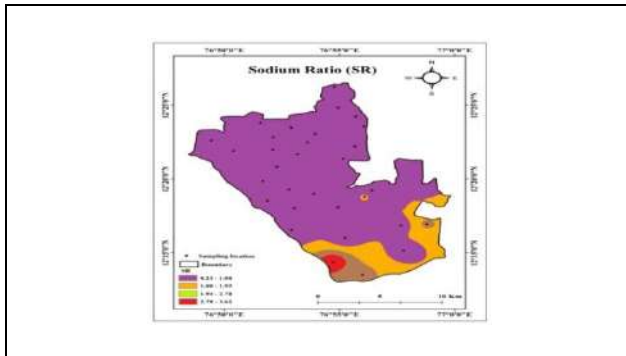
Fig.3: Spatial distribution of Sodium Ratio (SR)
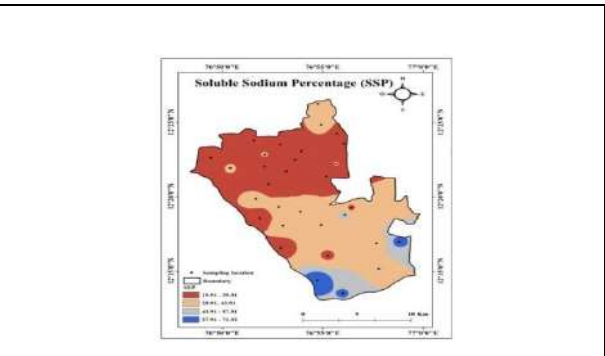
Fig .4: Spatial distribution of Soluble Sodium Percentage (SSP)
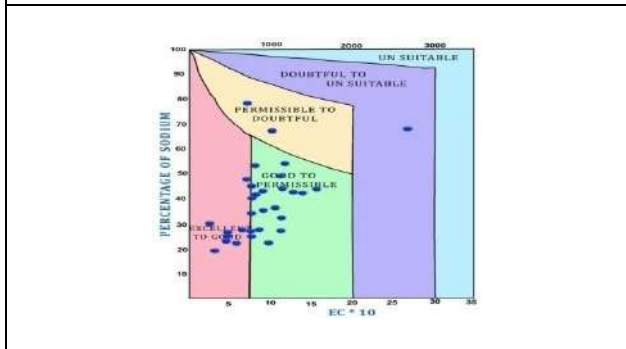
Fig.5: Wilcox diagram demonstrating irrigation water quality (after Wilcox, 1955)
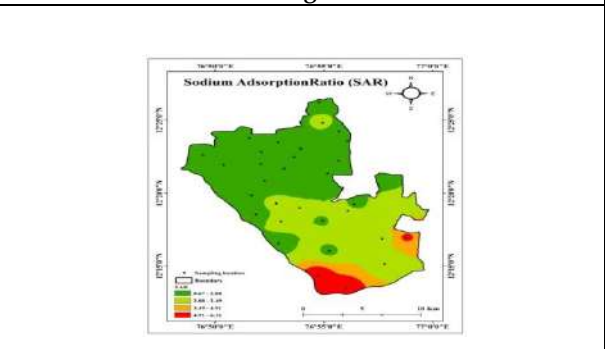
Fig.6: Spatial distribution of Sodium Adsorption Ratio (SAR)
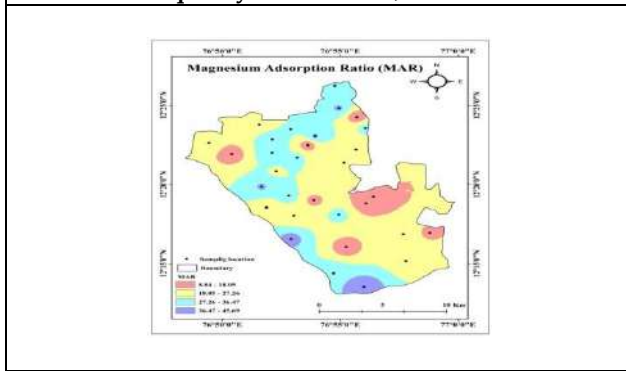
Fig .7: Spatial distribution of Magnesium Adsorption Ratio (MAR)
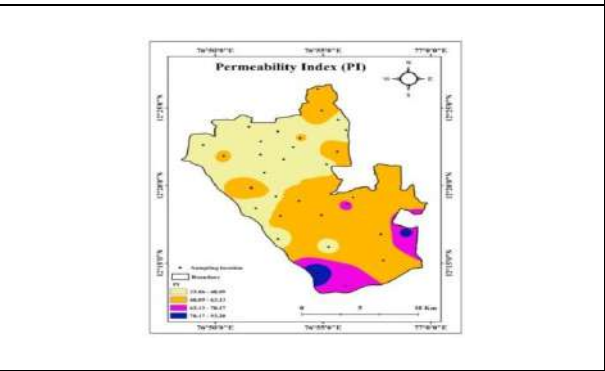
Fig .8: Spatial distribution of Permeability Index (PI)

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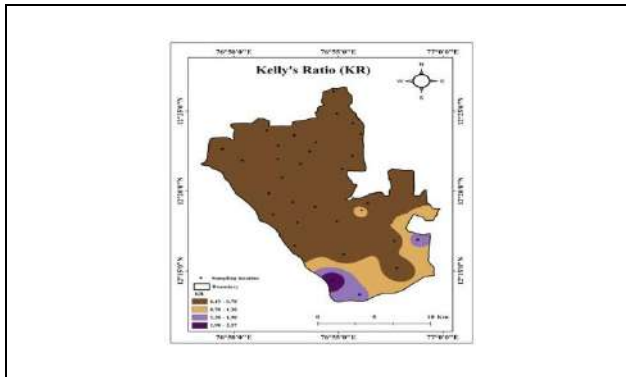
Fig .9: Spatial distribution of Kelly's Ratio (KR)
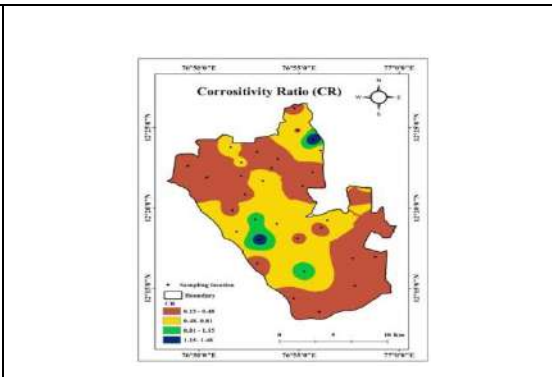
Fig .10: Spatial distribution of Corrositivity Ratio (CR)
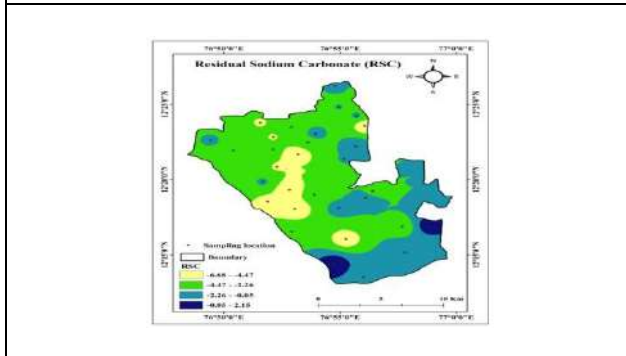
Fig.11: Spatial distribution of Residual Sodium Carbonate (RSC)
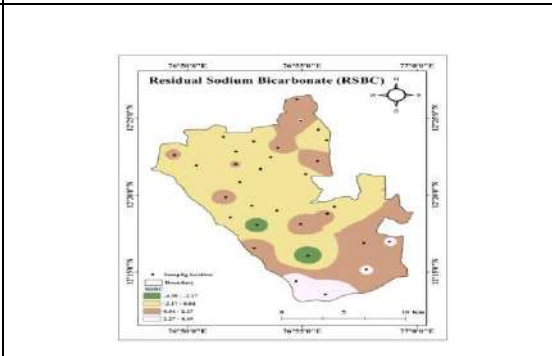
Fig.12: Spatial distribution of Residual Sodium Bicarbonate (RSBC)

RESEARCH ARTICLE

Impact on Knee Muscles Strength and Speed Performance with Specific Strength Exercises in Tennis Players - A Randomized Control Trial

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ABSTRACT

Tennis is a great form of exercise and amazing sport. As tennis being a sprinting game, the player has to have strong legs and great speed. Speed being the other important component for playing tennis along with that the leg strength is also important. To study the impact on knee muscles strength and speed performance with specific strength exercises in tennis players. 60 players were taken based on selection criteria and were randomly divided into 2 groups by chit draw method. Players of group A had undergone specific strength training of knee along with their regular regime. Players of group B undergone regular regime only. Baseline data both pre and post test were taken of 20 meter speed test and modified sphygmomanometer strength test. Result of intergroup analysis between the control and experimental group in which experimental group showed significant improvement in knee flexors and knee extensor strength as well as in speed performance. Present study concluded that individual specific knee muscles strength exercises are effective to improve knee flexor and knee extensor muscles strength as well as on speed performance in tennis players.

Keywords: Tennis, Knee Muscles, Strengthening, Speed, Modified Sypgmonometer Strength Exercises, 20-meter Speed Test, Repetition Maximum.

INTRODUCTION

Strength and Speed is often considered the basic element of tennis. As tennis being a sprinting game, the player has to have strong legs and great speed. Speed being the other important component for playing tennis along with that the leg strength is also important [1]. Tennis ability is composed of complex motions. Tennis is a game which requires technical as well as tactical skills along with muscular strength, flexibility and speed of both lower body and upper body [2-3]. The aim of the talent advancement program is to maintain and encourage the youth to make progress in the sports field. Although muscular strength refers to the external that can be initiated by muscle group or specific muscle, it is commonly expressed in terms of resistance lifted. Strength can be assessed either statically (no overt muscular movement or limb movement) or dynamically (movement of an external load or body part, in which the muscle changes length). Static or isometric strength can be measured conveniently using a variety of devices, including cable tensiometers and dynamometers. Unfortunately, measures of static strength are specific to both the muscle group and joint angle involved in testing; therefore, their utility in describing overall muscular strength is limited. Peak force development in such tests is commonly referred to as the maximum voluntary contraction (MVC). Traditionally, the one-repetition maximum (1-RM), the most considerable resistance that can be moved through the entire ROM in a sustained manner with good posture, has been the standard for dynamic strength assessment [4-6].

Speed is defined as rate of change of distance to time. The entire body speed and acceleration of the participants is not available to be measured readily and is difficult which hampers the tennis analysis. 5 meter and 10 meter sprint speed in straight line helps in the analysis of the entire body acceleration from the start point [7-8]. For assessment, the MSST with fixed stabilization is used. The positioning of the sphygmomanometer was parallel to the section to resist the motion of the muscle groups and the pressure was inflated to 100mmHg. The pressure was declined by 20mmHg and while testing it was kept in the range of 20-30mmHg. The reading was taken by the exerted force by the manometer. For the stabilization of the extremity mulligan belt was used [9]. Many studies have been performed on the specific tennis strength training for the serve performance. But strength of both upper and lower body is essential for the players to improve their performance. In this study, the impact of the specific knee strengthening program for tennis players has been implemented to improve strength and speed.

Need of the Study

Tennis needs the bio-motor skills such as strength and speed. Tennis player requires to move speedy according to the opponents shot. To move quickly and speedily the players needs to have good strength in the lower leg. The need of the study is to find the impact on knee muscles strength and speed performance with specific strength exercises in tennis players

AIMS AND OBJECTIVES

Aims

To study the impact on knee muscles strength and speed performance with specific strength exercises in tennis players.

Objectives

To evaluate the impact on knee muscles strength with specific strength exercises in tennis players.
To evaluate the impact on speed performance with specific strength exercises in tennis players.

METHODOLOGY

❑ **Study Design:** Randomized controlled trial
❑ **Study Setting:** SAI Gandhi Nagar

❑ **Sampling Technique:** simple random sample
❑ **Study Population:** Male/female
❑ **Sample Size:** 60
❑ **Study Duration:** 8 Week/ 3 Session per week

Selection Criteria

Inclusion Criteria
Tennis players
• Age between 10 to 14 years
• Both male and female
• At least 2 years of tennis playing experience

Exclusion Criteria
• Other than tennis players
• Uncooperative subjects
• Recent injuries

Procedure
Tennis players satisfying the selection criteria were selected for the study. All the participants were explained about the need of study and test procedures before their enrollment in the study. The written informed consent was taken prior to the enrollment of all participants in the study. Participants were randomly and equally distributed into two groups: Group A- experimental group (n-30) and Group B- control group (n-30). Group A were given specific strengthening exercises for knee muscles along with the regular regime and Group B were given only their regular regime. Training protocol was given for 3 days/weeks for 8 weeks. Post data was assessed after the completion of 8 weeks training. Pre data and post data were evaluated by SPSS version 21 for both inter and intra group analysis for MSST of knee muscles and 20-meter speed test.

Intervention
Knee muscles strength training was given for 3 days/week for 8 weeks. The exercise regime for the group A included knee exercises along with it 1-RM was performed for all the participants individuals and the weight was given to perform exercises according to their 1-RM. Free weights were used for performing strength training. Training regime includes the training protocol in which the repetition decreases as the load increases. Total 7 exercises were performed by the participants. The exercises are standing leg abduction, standing calf raises, single leg extension, standing single leg curl, seated single leg press, seated single leg curl and standing leg adduction.

RESULT

Group A- Experimental
Group B- Experimental

DISCUSSION

The objective of this study is to evaluate the impact on knee muscles strength and speed performance with specific strength exercises in tennis players. Hence, the participants of the experimental group (Group B) were given 8 weeks of specific strength exercises along with their regular regime. Baseline outcome measures for MSST and 20-meter speed were performed on 1st day and after 8 weeks of intervention. The results showed statistically significant improvement (p=0.001) in the group A after 8 weeks of intervention for MSST and 20-meter speed test by intra group comparison by using paired t-test. In the within group comparison, the MSST of left knee flexion in group B did not

showed significant improvement. The intergroup comparison was performed using independent t-test between the groups for MSST and 20-meter speed test also states that there was statistically significant improvement and the p value proves it. Hence, the result of the present study rejects the null hypothesis and supports the experimental hypothesis by its various analysis in the form of intergroup and intergroup. In group B, there was no significant improvement in MSST of knee flexion seen it can be due to dominancy of the limb. According to the Alex Vaisman *et al*. compared maximal power between the dominant and non-dominant legs among healthy adults and concluded that symmetrical power performance is expected between the lower body independent of the existence of dominance assessed by vertical single-leg jump tests [10]. Also, no significant improvement was seen in the knee extensor strength of both sides in group B. Muscle strength can be improved by the specific knee exercises strength training based on the specificity principle. No significant improvement seen in the 20-meter speed test in group B.

It shows there is a correlation between strength and speed performance. The study performed by Delecluse C. *et al*. analyzed the effect of High Resistance and High Velocity training on the different phases of 100-meter speed sprint performance concluded that HR protocol resulted in an improved early acceleration phase [11]. There was significant improvement in group A of intra group analysis of knee flexion and knee extension muscle strength and also there was improvement in 20-m speed test after the intervention. So, strengthening exercises is responsible for improving the speed performance. For a better performance, Individual specific knee muscles strength required for increasing knee flexor and extensor muscles strength. Knee Muscles strength significantly improved speed performance in speed skaters. The knee is the most frequent joint injured during speed skating, so stability and strength are required to prevent the injuries.2 Individual specific knee strength muscle Exercise could be improved the strength of the muscle, which leads to improvements in power generation by them during the movement.

CONCLUSION

Present study concluded that specific knee muscles strength exercises are effective to improve knee flexor and knee extensor muscles strength as well as on speed performance in tennis players.

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Table .1 Intra Group Analysis of Modified Sphygmomanometer Strength Test of Knee Flexion for Group A

Knee Flexion	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Pre	61.2	8.2	0.817	0.420
	Post	60.8	7.8		
Left Side	Pre	59.8	8.1	1.12	0.269
	Post	60.2	8.1		

Table .2 Intra Group Analysis of Modified Sphygmomanometer Strength Test of Knee Extension for Group A

Knee extension	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Pre	61.2	8.2	0.817	0.420
	Post	60.8	7.8		
Left Side	Pre	59.8	8.1	1.12	0.269
	Post	60.2	8.1		

Table .3 Intra Group Analysis of 20-meter Speed Test for Group A

20-meter speed	Mean	Standard Deviation	t-Value	p-Value
Pre	2.30	0.21	-5.04	0.00
Post	2.73	0.13		

Table .4 Intra Group Analysis of Modified Sphygmomanometer Strength Test Knee Flexion for Group B

Knee flexion	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Pre	50.2	7.5	3.22	0.003
	Post	51.4	8.22		
Left Side	Pre	49.3	7.6	2.09	0.450
	Post	50.2	7.7		

Table .5 Intra Group Analysis of Modified Sphygmomanometer Strength Test Knee Extension for Group B

Knee extension	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Pre	61.2	8.2	0.817	0.420
	Post	60.8	7.8		
Left Side	Pre	59.8	8.1	1.12	0.269
	Post	60.2	8.1		

Table .6 Intra Group Analysis of 20-meter speed test for Group B.

20-meter speed	Mean	Standard Deviation	t-Value	p-Value
Pre	2.40	0.13	-9.07	0.000
Post	2.9	0.32		

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Table .7 Inter Group Analysis of MSST of Knee Flexion

Knee extension	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Control	51.4	1.91	9.94	0.000
	Experiment	57.7	2.17		
Left Side	Control	50.2	2.2	10.16	0.000
	Experiment	57.2	2.5		

Table .8 Inter Group Analysis of MSST of Knee Extension

Knee extension	MSST	Mean	Standard Deviation	t-Value	p-Value
Right Side	Control	60.8	2.2	11.99	0.000
	Experiment	66.2	2.1		
Left Side	Control	60.2	2.2	8.9	0.000
	Experiment	65.4	2.6		

Table .9 Inter Group Analysis of 20-meter Speed Test

20-meter speed	Mean	Standard Deviation	t-Value	p-Value
Control	2.7	0.36	-2.42	0.067
Experiment	2.9	0.32		

RESEARCH ARTICLE

A Study on the Physicochemical Characteristics and Heavy Metal Analysis of Tannery Effluent on Dindigul District

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ABSTRACT

The tannery industry, one of the oldest and most crucial industries, uses an enormous amount of freshwater for leather processing and releases a huge amount of toxic effluent every day. The rapid growth of industries in par with the threatening population continue to the high discharge of industrial wastewater impair the groundwater quality, soil and flora in that area. The productive management of tannery effluent is the need of the hour. In the present study, the tannery effluent collected from a tannery industry in Dindigul was characterized for basic parameters. The effluent was greenish colored with a disagreeable odor, acidic in pH, with high organic and inorganic load indicating high Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total hardness, chlorides and Heavy metal like Copper, Chromium, Iron, Lead and Zink, were analyzed using standard protocols. The physicochemical parameters were, determined as per the standards prescribed by Bureau of Indian Standards (BIS).

Keywords: Pollution, Tannery effluent, Physical parameters, Chemical parameters, Heavy metal.

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INTRODUCTION

Industrial effluents is the major social problem throughout the world. The rate of the pollutants are increasing at an alarming rate due to urbanization and industrialization. Tanning industry is one of the conventional form of industries in the world evolved from the ancient times and they are organized to meet the local demands of leather footwear, drums and musical instruments. With the increase in population, the demand for the requirement of leather and its products led to the establishment of large commercial tanneries. In today scenario the environment is facing acute pollution problem due to the discharge of various industrial effluents, containing substances that differ in their characteristics from nutrients to highly toxic substances. Pollution leads to wide spread denaturation of the environment, threatening the existence of every living being in a given habitat. Tannery industry is a reputed global industry and contribute a major role in environmental pollution (UNIDO, 2005). The current pattern of industrial activity alters the natural flow of materials and introduces novel toxic chemicals into the environment (Faisal and Hasnann, 2004). Heavy metal from industrial activities released to the environment pose a significant threat to the environment and has been a significant threat to the environment, soil and public health. Tannery effluent is one of the most toxic industrial wastes. Leather production requires large amount of water. Around 35 liters is required to produce per kilogram of leather processed. The effluent generated from this process is estimated about 75,000m3/day (Sahasranaman. A. and Buljan J, 2000). The processing of 7,00,000 tons of hides and skins per annum require about 4,00,000 tons of chemicals. Not more than 20% of the chemicals are absorbed by leather; the remainder flows out with the effluent.

Environmental pollution by industrial waste has been increased tremendously with the rapid industrialization in the country. The quantities and characteristics of discharged effluent vary from industry to industry depending on the water consumption and chemicals utilized in the processing unit (Jothi and Santani, 2012). The effluents from this type of industry are the great potent hazards to the natural sources like soil, water, flora, fauna and human population (Jaishree and Khan, 2014). A enormous volume of mostly untreated tannery effluent is released into surface water and contaminate the ground water which inturn spoils the drinking water bodies. Effluent from tannery has high concentration of proteins, chlorides, trivalent chromium, nitrogen, sulphate, sulphides, COD, BOD and suspended solids (Kadam, R.V, 1990). The volume and characteristics of wastewater discharged vary from the process used, type of tannery and duration. The operations in a tannery are done in batches and discharge of wastewater is intermittent. Wastewater from beam house operations like soaking, liming, deliming, bathing etc., is alkaline and contains decomposable organic matter, hair, lime, TSS, TDS, sulphides and BOD. This is mainly due to the poor quality of calcium hydroxide and other chemicals used in excess without proper control. The major public concern over tannery industry has traditionally been about strong odours and water pollution from untreated discharges. Other issues have arisen more recently from the increasing use of synthetic chemicals such as pesticides, solvents, dyes, finishing agents and new processing chemicals, which can cause severe problems of toxicity and persistence.

One of the major emerging environmental problems in the tanning industry is the disposal of chromium contaminated sludge discharge into the water bodies, as a by-product of waste water treatment. The data reveals that India produces around, 2000 to 3000 tons of chromium and it is released into the environment annually from tanneries, and the concentrations ranges between 2000 and 5000 mg/L in the aqueous effluent and their level is very high to the recommended permissible discharge limits of 2 mg/L (Altaf *et al.,* 2008). Industrial effluent contains dyes, aniline, caustic soda, acids, heavy metals ions etc. and most of the heavy metals are essential for the growth of the organisms as a micronutrient (Jaishree and Khan, 2014). The increasing concentration of heavy metals leads to bioaccumulation of metals in fauna andflora. As heavy metals are not biodegradable, they accumulate in primary organ in the body and lead to various diseases. Partially treated or untreated tannery effluent can be harmful to both aquatic and terrestrial life by adversely affecting on the natural ecosystem and long term health effects (Jaishree and Khan, 2014). The present study was designed to study the tannery effluents in Dindigul District and characterize the effluent.

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MATERIALS AND METHODS

Study area

The area chosen for the present study is Dindigul located in the southern part of Tamil Nadu in India. Dindigul is one of the major trading towns of Tamil Nadu and is the head quarters of Dindigul district. This is popularly known for its leather industries and some of them were established as early as 1939. Since then tanneries are multiplying and at present more than 80 industries are well established. Most of these are located in the centre of Dindigul town and along Madurai, Batlagundu and Ponnamaravathi roads. Tannery waste is characterized by strong color (greenish) and odour. The growing of industrialization has been encroached even to small townships and villages along with all ills of contamination.

Collection of Tannery Effluent

The effluent sample was collected from egress of tannery effluent located in Dindigul District. Samples were collected in wide mouthed plastic bottles. The plastic bottles were clearly washed with detergent and distilled water prior to water collection and were carefully rinsed with sample effluent, filled up to the brim and tightly closed to ensure bubble-free sample storage.

Determination of Physicochemical Parameters

The Tannery effluent samples were analyzed for their physicochemical characteristics such as appearance, odour, turbidity, total dissolved solids, electrical conductivity, pH, total hardness, calcium, magnesium, nitrate, chloride, fluoride, sulphate, were also analyzed (Clesceri *et al.,* 1998).

Analysis of Heavy Metal by Atomic Absorption Spectroscopy (AAS)
Preparation of Standard Ion for AAS

The calibration plot method described in the British pharmacopoeia (2005) was adopted for the preparation of metal ion and Atomic Absorption Spectroscopy analysis.

Sample Preparation for AAS Analysis

The tannery effluent was filtered in a micro filter and it was used for analyzing the heavy metals by AAS.

The Analytical Technique

The analytical technique used to determine heavy metal level in all samples was thermo element Sys-813 Atomic Absorption Spectroscopy (International Equipment trading Ltd, USA). At each step of digestion processes, acid blanks (laboratory blank)were prepared in order to ensure that the sample and chemical used were not contaminated. They were analyzed by Atomic Absorption Spectrophotometer before the sample and their values were subtracted to ensure that equipment read only the exact values of heavy metal. Each set of digestion had its own acid blank and was corrected by using its blank.

RESULTS AND DISCUSSION

Physical parameters of effluent from tannery industry

The water quality parameters such as appearance, odour, turbidity, electrical conductivity and total dissolved solids were analyzed in the sample collected from tannery effluent. The tannery effluent sample showed Greenish color with an objectionable odour. Odour of water is due to the chemical agents like hydrogen sulphide, free chlorine, ammonia, phenols, alcohols, esters, hydrocarbons and biological agents such as algae, fungi and other microorganisms (Sharma, 2000). Turbidity it was estimated that value of the tannery effluent was 30 NTU . The colloidal and suspended impurities cause turbidity in the receiving effluent and reduce the light penetration into water and ultimately decrease the photosynthesis (Aisien *et al.,* 2010). It causes high turbulence and mixing of water leads to an increase in concentration of suspended particulate matter. Turbidity normally increases after heavy rain.

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The rain runs along the ground picking up small particles of dirt before reaching water source, hence increasing turbidity. Another study had pointed out that the surface water rich in turbidity suspends impurities of decaying organic matter, clay, microorganism like bacteria and small amount of minerals salts (Frada, 2001).

The study also proves the electrical conductivity of tannery effluent was very high (8070). It is defined a measure of water's ability to conduct an electric current, and related to the amount of dissolved minerals in water, but it does not give an indication of the type of element present; but high value of EC is a good indicator to check the presence of contaminants such as sodium, potassium, chloride or sulphate (Nazir *et al.,* 2015). The study also proves that the Total Dissolved Solids (TDS) The total dissolved solid of Tannery effluent was high of about80 (mg/l). TDS in water originates from natural sources, sewage, urban and agriculture run off, municipal waste and chemical weathering of rocks (Hussain, 1989). Water containing extremely low concentration of TDS may also be impermissible because of its flat and inadequate taste (WHO, 1994). TDS content in water is a measure for salinity. A high content of dissolved solid elements affects the density of water, influences osmoregulation of fresh water organisms and reduces solubility of gases and utility of water for drinking, irrigation and industrial purposes. Waters can be classified based on the concentration of TDS as, desirable for drinking and permissible for drinking (Wilcox, 1955).

Chemical examination of effluent from tannery industry
The hydrogen ion concentration of the tannery effluent was alkaline 8.8. pH is most important in determining the corrosive nature of water. Lower is the pH value; higher is the corrosive nature of water. pH is positively correlated with electrical conductance and total alkalinity (Gupta *et al.,* 2009). The reduced rate of photosynthetic activity, the assimilation of carbon dioxide and bicarbonates are ultimately responsible for increase in pH. Various factors bring about changes in the pH of water. Alkalinity was high in tannery effluent due to high pH. The higher pH values suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected due to changes in physico-chemical condition (Karanth, 1987).Hardness is defined as the concentration of multivalent metallic cations in a solution. The hardness of water varies from place to place. Total hardness of the tannery effluent was estimated to 788 mg/l. The hardness of water reflects the nature of geological formation with which it has been in contract (Garg *et al.,* 2007). Calcium is an important element that is associated with different cations like carbonates, bicarbonates and fluorides. Calcium (Ca) concentration was higher in the sample and it is of 650 mg/l. Calcium is responsible for hardness of water.

Chloride inhibits the growth of plants, bacteria and fish in surface waters;high levels can lead to breakdown in cell structure. If the water is used for irrigation purposes, surface salinity increases through evaporation and crop yields fall. When flushed from the soil by rain, chlorides reenter the ecosystem and may ultimately end up in the ground water (Bosnic *et al.,* 2000). The observed chloride value in the present study was about (6500 mg/l). Fluoride content (1.0 mg/l) in the effluent samples were within the permissible limits(2 mg/l), whereas the sulphate content (1300mg/l) of the tannery effluents was exceeding the limit. Sulphate is a component of tannery effluent, emanating from the use of sulphuric acid or products with a high (sodium) sulphate content (Bosnic *et al.,* 2000). Calcium, magnesium, carbonates, bicarbonates, sulphates, chlorides, nitrates, organic matter together associate and form hardness of water (Salim *et al.,* 2013). Magnesium content (370 mg/l) was found to be maximum in the Tannery effluent . Nitrate (NO_3) (Electrode Method) The amount of nitrate present in the tannery effluent was 70 mg/l . Nitrate esters are capable of migrating over great distances and pose a threat (Rifler and Medina, 2006).

Heavy metal analysis of Tannery effluent
The physicochemical properties and heavy metals concentration of the effluent varies depending on the process of tanning adopted in various industries (Vidya and Usha, 2007). The tannery waste water is being contaminated with higher levels of metals (iron, nickel, chromium, zinc, cadmium, manganese and copper) and these metals contaminate the agricultural soil. The crops and vegetables, when consumed by human can cause serious health hazards to the consumer (Mohanta *et al.,* 2010). Higher value of chromium (9.5 mg/l),copper (0.8 mg/l) was found in the Tannery effluent. Maximum level of lead (6.5 mg/l) in Tannery effluent was reported in the present study (Fig 1).

CONCLUSION

The present investigation concludes that the physical parameters of the tannery effluent such as Color, Odor, Turbidity , Electrical conductivity, Total dissolved solids and chemical parameters such as pH , Alkalinity, Total hardness, Calcium, Magnesium, Chloride, and Nitrate are above the permissible limit in tannery effluent. The presence of heavy metal such as Chromium, Lead, Iron are high in the Tannery effluent., so this contaminated effluent is highly toxic and can cause serious negative impacts to the human population and also to the community. Discharge of untreated tannery effluents into the sewer system causes deposition of calcium carbonate and choking of the sewer. Hence, a better approach is necessary to treat the effluent before being discharged or at least to transform them to innocuous substances is necessary. Bioremediation is an option that offers the possibility to destroy or render harmless various contaminants of tannery effluent using natural biological activity, and therefore, further study is under progress using greener biomethod.

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Table 1: Physical Parameters of Tannery Effluent in Dindigul District

Parameters	Permissible Value In Normal Water	Tannery Effluent
Colour	-	Greenish
Odour	-	Objectionable
Turbidity(NTU)	10	30
Electrical conductivity	-	8070
Total dissolved solids (mg/l)	20	80

Table:2 Chemical Parameters of Tannery Effluent in Dindigul District.

Parameters	Permissible Value In Normal Water	Tannery Effluent
pH	6.5	8.8
Total hardness (mg/l)	200	788
Calcium	-	650
Magnesium	30-100	370
Chloride	-	6500
Fluoride	2.0	1.0
Sulphate	1000	1300
Nitrate	45	70
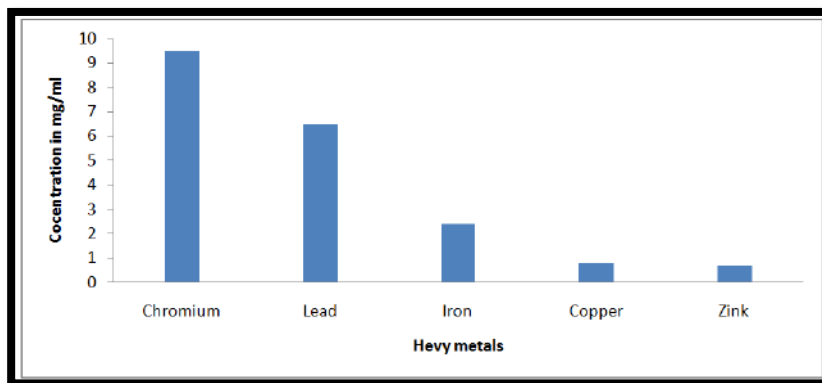
Figure : 1 Heavy Metals in Tannery Effluent

RESEARCH ARTICLE

Phytochemical Analysis, Antioxidant and Antimicrobial Screening of Leaves Extract of *Tetrastigma thomsonianum* Planch

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ABSTRACT

Tetrastigma thomsonianum Planch. is a rare indigenous plant of north-east Indian used mostly as leafy vegetable. The qualitative estimations showed that presence of various phytochemical. Quantitative analysis showed that the high amount of phenol and flavonoids are present in methanol extract with 33.07±0.01 mgGAE/g and 83.50±0.02 mgQE/g respectively. DPPH and ABTS assay illustrated that the highest antioxidant activity was showed by methanol extract with IC_{50} 8.76 μg/ml and 2.54 μg/ml respectively and the total antioxidant potential was also found to be highest; 61.65± 0.46 μMFe(II)/g in methanol extract. The analysis for antibacterial activity suggested that the ZOI for chloroform and n-hexane extract ranging from 7.00±0.00 to 14.00±1.73 mm. highest inhibition in DD and AWD (11.00±1.73 mm) and (14.00±1.73 mm) respectively was showed in acetone extract against *S. mutans.* Similarly in MIC and MBC also was ranging from 1.25 mg/ml to >5 mg/ml for methanol, acetone, chloroform and n-hexane extract.

Keywords: Phytochemical, antimicrobial, antioxidant, plant extract, human pathogen.

INTRODUCTION

Tetrastigma thomsonianum Planch., also known as 'Nol-Tenga', 'Dhemsri' belongs to the family Vitaceae and grows spontaneously in Eastern Himalayan and indigenous to North East India ranging from Sikkim, Darjeeling, Arunachal Pradesh, Assam, Nagaland. It is a herbaceous climber; the colour of the stem is dark and generally flattened. Leaves, 3-foliate. The climber is found near the river banks, river islands and in evergreen tracts (Fig-1)[15]. The phytochemical constituent for other *Tetrastigma sp.* depicted the presence of high amount of Alkaloid in the plant, which is an important component for various pharmacological application and it is high in antioxidant activity [2]. It is an economically important plant and a non-wood forest product (NWFP) used by many ethnic groups of North-East India and grow wildly all over the area [17, 33]. This climber has been considered threatened at a sacred groove of Devi Satkanya in Darjeeling Hills[30]. In Assam, the tender leaves and stem of *T. thomsonianum* are used as an herbal recipe because of its tangy taste and high vitamin C content, it is included in many dishes during festive season to fight against diseases [8, 16]. Similarly in Arunachal Pradesh, the Khampti tribe grows it in their homestead garden and use it as a leafy vegetable for many traditional dishes [19]. Not much documents are available regarding *T. thomsonianum,* so the potential of this plant against various diseases has been widely explored during the study.

MATERIALS AND METHODS

Collection of Plant Sample.
Collection of *T. thomsonianum* was form Nanam Khamti Village(Lat 27° 44' 35.2644'' N,Long95° 54' 0.504'' E), Namsai District of Arunachal Pradesh. in April 2021. The plant was deposited and identified at Botanical Survey of India, Shillong (Meghalaya).

Preparation of Plant Extract
The freshly collected root of clean and air dried at room temperature and finely powdered using a grinder. The powdered root was subjected to extraction with water, methanol, acetone, chloroform and n-hexane. All the extracts were obtained by macerating of 5g of dry matter powder with 50ml of each solvent for 48hr with interminant shaking. The extracts were filtered using Whatman filter paper No.1 and concentrated under reduced pressure and temperature using rotary evaporator at 40°C to total dryness. The dried crude extracts were stored in the freezer at 4° C for future use after percentage yield calculation [2,3,11].

Phytochemical Screening
The preliminary phytochemical screening for each extract were tested for the presence of Alkaloid, Carbohydrates, Saponin, Phenols, Flavanoids, Tanin, Terpenoids, Cardiac glycosides, Protein, Coumarin, Starch, Quinone, Phlobatanin, Steroids. The tests were carried out to identify the useful constituents by standard methods[25].

Determination of Total phenolic contents
To determine total phenolic content the folin Ciocalteu method with minor modifications [5,24]. Briefly, 250µl of crude extract(1mg/ml) were made upto 3ml with distilled water and was mixed with 1ml of Folin-Ciocalteu reagent and allowed to stand for 3 min. After that 2ml of 20% (w/v) Sodium Carbonate was added and incubated in the dark for 60 min at room temperature. The absorbance was measured at 735nm. Gallic acid was used as standard. The Phenolic content was determined by constructing a calibration curve against the standard and results were expressed as gallic acid (GAE) equivalent per gram of dry weight.

Determination of Total Flavanoid contents
The aluminium chloride (AlCl₃**)** colorimetric assay method was used to determine total flavonoid contents, using quercetin as a standard[39]. 500 µl of crude extract was mixed with 1.5ml methanol, 0.1ml of 10% aluminium chloride, and 0.1ml of 1 M Sodium acetate and added to 2.8 ml of Distilled water. The solution was allowed to stand for 30 min and absorbance was recorded at 428 nm using UV Vis- spectrophotometer. Flavonoid content was

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determined by constructing a calibration curve against the standard different concentrations and were expressed as quercetin equivalent per gram of dry weight.

Antioxidant activity
DPPH radical scavenging assay
Free radical scavenging ability of the extracts was tested by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay as described by Blois and Eruygur with slight modification[10,18]. 0.1mM of DPPH was prepared in methanol and 1ml of this solution was mixed with 3ml of various concentration of the sample and standard solution (50- 500μg/ml) and shook vigorously, then it was allowed to stand in the dark for 30 min at room temperature and absorbance was taken at 517nm and ascorbic acid as a reference. The optical desnsity was recorded and % inhibition was calculated by the formula %RSA= [(Abs$_{control}$- Abs $_{sample}$)/Abs$_{control}$] x100 where Abs$_{control}$is the absorbance of DPPH solution without any sample and Abs$_{sample}$is the absorbance of sample extract.

ABTS radical scavenging assay
For the ABTS assay, the procedure was followed according to Cano and co-worker with some modifications**[12]**. Stock solution ABTS$^+$ radical cation was produced using 7mM of ABTS and 2.4mM of potassium persulphate solution. The solution was then diluted to obtain the absorbance of 0.70± 0.01 unit at 734 nm using spectrophotometer before beginning the assay. Various concentrations of sample/ standard was taken (50-500 μg/ml) to the 4 ml of ABTS solution and mixed. The sample was incubated at room temperature for 30 min and optical density was noted at 734 nm. The ABTS scavenging capacity was compared with Ascorbic acid and calculated as ABTS RSA (%)= [(Abs$_{control}$- Abs $_{sample}$)/Abs$_{control}$] x100.

Ferric reducing antioxidant power (FRAP) assay
FRAP assay was determined according to Benzie and Strain, Babu et al., with slight modification [6,9]. 150μl of the extract was adjusted to the volume of 3 ml of methanol and was allowed to react with 1ml of FRAP solution and was incubated for 30min in dark at room temperature. The optical density was taken at 593nm. was taken was standard curve Ferrous sulphate (FeSO4) with different concentrations and results are expressed in μMFe(II)/g dry mass and compared with ascorbic acid.

Antibacterial Activity
Bacterial strains
Antibacterial activity was tested against 5 human pathogenic bacteria, two gram positive *Streptococcus mutans* (MTCC 890), *Streptococcus pyogenes* (MTCC 1926) and three gram negative bacteria *Vibrio cholerae* (MTCC 3906), *Shigella flexneri* (MTCC 1457) and *Salmonella typhi* (MTCC 3224).

Disc Diffusion assay
Disc diffusion assay was performed according to Bakht et al. [7].Mueller Hinton Agar (MHA) plates was prepared and the bacterial cultures (0.5 McFarland standard) were seeded over the plate evenly. A 6mm diameter discs were dispensed with the plant extracts of different concentrations 400μg/ml, 800 μg/ml and 1.6mg/ml and placed on the surface of the agar plate. Antibiotic disc (Streptomycin 10μg) and 5% DMSO were used as positive and negative control respectively. The plates were incubated for 12 hrs at 37°C and Zone of Inhibition (ZOI) was recorded.

Agar well diffusion assay
Agar well diffusion method was done following Allen and Kirby- Bauer technique to determine the antibacterial activity of the plant extracts [4]. 100μl of bacterial cultures spread on MHA plates and dry it. A 6mm diameter well was punched on the plate aseptically and 100μl of each plant extracts in DMSO, were dispensed on the well at concentrations of 400μg/ml, 800 μg/ml and 1.6mg/ml and5% DMSO used as negative and streptomycin as positive control and incubated for 12hr at 37°C. The ZOI were recorded for each extract and pathogens.

Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC)

MIC determined by broth dilution method as per standard methods[32,34]. 0.1 ml of the bacterial suspension adjusted to 0.5 McFarland standard (10^8 CFU/ml) was inoculated into the tubes containing different concentration of two-fold serial dilution extracts ranging from 5mg/ml to 0.156mg/ml in Mueller Hinton Broth.   The broth was incubated for 8hrs at 37°C until there was visible growth. The visual turbidity of the broth was noted down to confirm the MIC. After MIC determination of the different extracts of the plant, aliquot of 50µl of the broth from MIC which showed no visible bacterial growth was spread over fresh prepared Mueller Hinton Agar plates and incubated for 24 hrs at 37 °C. When 99.9% of the bacterial population are killed at the lowest concentration of the extract, the MBC was read and recorded [28].

Statistical analysis

The data were expressed as the triplicate (n=3) with mean ±standard deviation (SD) and analysed using Chi square test and using one way analysis of variance (ANOVA). $P<0.05$ was considered to be statistically significant.

RESULTS AND DISCUSSION

Plant collected and identified at Botanical Survey of India, Shillong (Meghalaya), and deposited the Voucher specimen at the Herbarium of BSI, Shillong with Accession number 98456.

Percentage yield and Phytochemical screening

The percentage yield was found to be highest in methanol extract with 20.18% followed by Acetone extract with 12.22%, chloroform extract 12.00%, water extract 11.92% and lowest was in n-hexane extract with 6.20%. The phytochemical Characteristics of *T. thomsonianum* for various solvents were summarized in Table-1. The quantitative screening revealed the presence of various phytoconstituents.

Total Phenolic content

The TPC in terms of (GAE) gallic acid equivalent (Fig.2a), the standard curve equation y=0.0038x+0.0442, R^2= 0.9944. The TPC evaluated showed maximum value in methanol extract with concentration 33.07 ± 0.00mgGAE/g followed by acetone and water extracts with 25.61 ± 0.04mgGAE/g and 24.39 ±0.00mgGAE/g respectively. Lowest TPC was shown by chloroform extract 3.12 ± 0.00mgGAE/g and n- hexane extract 1.10 ±0.00mgGAE/g (Fig.2c) (Table-2).

Total Flavanoid content

Total flavonoid (Standard curve equation: Y=0.0064x+0.0062, R^2=0.9915) in terms of quecetin (QE) (Fig.2b),Determination of TFC for *T. thomsonianum* showed that methanol extract contains highest amount of flavonoid content with 83.50 ± 0.01mgQE/g, then acetone extract with value of 63.38± 0.02mgQE/g followed by chloroform extract 22.47 ± 0.00mgQE/g and lowest concentration was found in n-hexane and water extract with the value of 8.39 ± 0.01mgQE/g and 6.72 ± 0.00 mgQE/g respectively as shown in (Fig.2d) (Table-2)

Antioxidant activity

DPPH test

Evaluation of DPPH assay for *T. thomsonianum* determined that the highest scavenging activity was found in methanol and acetone extract and the least activity was found in water, chloroform and n-hexane extracts as shown in (Fig 3a) . In methanol extract %RSA at the concentration of 50 µg/ml and 500 µg/ml was 20% and52.03% respectively followed by acetone extract with the value of 3.81% RSA at 50 µg/ml to 3.92%RSA at 500 µg/ml. In chloroform extract %RSA was ranging from 1.3 % at 50 µg/ml to 7.6% at 500 µg/ml. In n-hexane extract %RSA was ranging from 1.47% to 4.84% at 50 µg/ml to 500 µg/ml respectively. While in water extract %RSA at the concentration of 50 µg/ml to 500 µg/ml was 0.28% to 2.64% respectively. The IC_{50} for water, methanol, acetone, chloroform and n-hexane extract was 279.27 µg/ml, 8.76 µg/ml, 16.64 µg/ml, 74.06 µg/ml and 125.48 µg/ml respectively and for ascorbic acid 3.530 µg/ml. It was found that IC_{50} value of water followed by n-hexane and

chloroform were very high as compared to the standard ascorbic acid and the other extracts. Therefore the antioxidant activity was in the order: ascorbic acid > methanol> acetone> chloroform> n-hexane> water as shown in (Fig. 3b).

ABTS

In *T. thomsonianum* evaluation of antioxidant activity by ABTS assay revealed the potency of the scavenging property of the plant. The %RSA determined for all the PEs found that the, with increase in concentration methanol extract had higher percentage of scavenging activity than the standard ascorbic acid whereas for others it was moderately high but less than the standard ascorbic acid (Fig. 3c). The %RSA for all the PEs at the concentration ranging from 50-500 µg/ml are as follows: for methanol extract %RSA was 48.58% - 99.97%, for water extract it was 8.72% - 100%, for chloroform extract 6.17 %- 40.38% and in n-Hexane extract %RSA was 2.92%- 33.18%. For the standard ascorbic acid, it was 43.21% - 99.13%. The IC_{50} calculated from the %RSA of *T. thomsonianum* is shown in (Fig.3d). IC_{50} for all the PEs; water, methanol, acetone extract, chloroform, and n-hexane extracts were 6.43 µg/ml, 2.54 µg/ml, 6.52 µg/ml, 12.98 µg/ml, 15.55 µg/ml respectively. The inhibition activity for methanol at IC_{50} found to be lower than that of the standard ascorbic acid with 2.73 µg/ml of IC_{50} value while for chlororform and n-hexane it was moderately high. Therefore, order of antioxidant activity is: Methanol> Ascorbic acid> Water> Acetone> Chloroform> n-Hexane.

Total antioxidant activity (Ferric Reducing Antioxidant Power FRAP)

In the FRAP assay the total antioxidant activity the standard curve equation was Y=0.0141x+0.7424, R^2 = 0.9742 for $FeSO_4$ (Fig.4e). In *T. thomsonianum* highest concentration was found in methanol extract with the value of 61.65 ± 0.46 µM Fe(II)/g, followed by acetone extract with the concentration of 20.02 ± 0.01 µM Fe(II)/g. The lowest concentration of antioxidant potential was found in water, chloroform and n –hexane with 0.19 ± 0.10 µM Fe(II)/g, 0.92 ±0.02 µM Fe(II)/g and 0.53 ± 0.03 µM Fe(II)/g respectively. The concentrations of all the extracts were lower than the standard ascorbic acid with 90.25 ± 0.01 µM Fe(II)/g (Fig. 3f).

Correlation between TPC, TFC and Antioxidant potentials

From Table-3 it is evident that the two variables i.e TPC/TFC and the antioxidant potential IC_{50} of DPPH/ ABTS are negatively correlated to each other, which apparently denotes that the plant extracts contain high phenolic and flavonoid content which makes a very low IC_{50} value representing all the extractives a very good antioxidant potential. For all the extractives of the selected plant species, the two variables TPC and TFC are positively correlated to each other.

Antibacterial Activity
Disk Diffusion

ZOI observed for different extracts of *T. thomsonianum* against the selected bacterial strains are given in (Table-4). At the highest concentration of 1.6 mg/ml, ZOI in water extract was recorded only for *S. typhi* (8.17±0.29 mm). Similarly for methanol extract found to be effective against the only *S. mutans*(7.00±0.00 mm). In acetone extract highest ZOI was observed in *S. mutans* (11.00±1.73 mm) and lowest was by *S. typhi* (7.67±0.58mm). For Chloroform extract ZOI was not much of a difference among strains however highest ZOI was shown by *S. pyogenes* (8.83±1.04 mm) and lowest was in *S. typhi* (7.00±1.00 mm). For n- hexane extract also highest ZOI was observed by *S. mutans* (10.33±0.58 mm) and *S. flexneri*(7.83±0.29 mm)lowest. For positive control Streptomycin it could be seen that highest ZOI was obtained by *S. mutans* and the lowest by *V. cholerae* (9.83±0.76 mm) while the negative control DMSO, all the selected strain for the study didn't show any response.

Well Diffusion

The evaluation of well diffusion at the different concentrations for different bacterial strains in stdy, ZOI (in mm) are given in [Table-5]. At 1.6mg/ml in *T. thomsonianum* water extract none of selected bacterial strains showed any visible inhibition. Methanol extract showed highest ZOI against *S. typhi* (12.67±0.58 mm)followed by *S. mutans* (11.00±1.73 mm), *S. flexneri* (10.00±0.00 mm), lowest was in *S pyogenes* (8.67±1.15 mm). In acetone extract highest ZOI was found in *S. mutans* (14.00±1.73 mm) followed by *S. pyogenes* (11.33±1.15 mm), *S. flexneri* (10.67±2.31 mm), *S. typhi* (10.00±0.00

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mm) and lowest was in *V. cholerae* (9.67±0.58 mm). In chloroform extract also the *S. mutans* (10.00±1.73 mm) had the highest ZOI followed by *S. pyogenes* (9.33±0.58 mm), *S. typhi* (8.33±1.15 mm) and lowest was in *S. flexneri* (7.33±1.15mm) while *V. cholerae* did not have any response. Similarly, in n-Hexane extract also except for *V. cholerae*, other strains showed ZOI where *S. mutans* had the highest ZOI with (11.33±1.15 mm) followed by *S. pyogenes* (9.17±0.29 mm), *S. flexneri* (8.33±0.58mm) and lowest was in *S. typhi* (8.27±0.25mm). Observation for the positive control showed that the highest ZOI was found in *S. mutans* (23.33±2.89 mm) and lowest was in *V. cholerae* (10.00±0.00 mm).

Minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC)
The determination of MIC and MBC for the extractives of *T. thomsonianum* are given in (Table-6) The MIC and MBC for water extract in all the selected strains *S. mutans, S. pyogenes, S. flexneri, V. cholerae* and *S. typhi* were (> 5mg/ml). For methanol extract only in *S. mutans* MIC and MBC was observed at the concentration of (5 mg/ml) whereas for the other selected bacterias it was (>5mg/ml). For acetone extract MIC was attained only by *S. mutans* at the concentration of (2.5mg/ml), *S. pyogenes* and *S. typhi* at (5 mg/ml) while the rest were (>5mg/ml). The MBC was only obtained by *S. mutans* (5mg/ml) but the other strains were (>5mg/ml). The MIC at (5mg/ml) in chloroform extract was obtained by *S. mutans* and *V. cholerae* while the others were at (>5mg/ml) and the MBC was only obtained by *S. mutans* at (5mg/ml) and for the other strain it was (>5mg/ml). For the n-Hexane extract only *S. mutans* obatined the MIC and MBC at a lower concentration (1.25mg/ml) while for *S. pyogenes, S. flrxneri, V. cholerae* and *S. typhi* MIC and MBC was (>5mg/ml). In both disk and well diffusion higher ZOI was observed in n-hexane extract for *S. mutans* while the other strains were moderately susceptible while water and methanol extracts were less susceptible. In Well diffusion it could be seen that; except for *S. mutans*, all the selected strains did not showed any ZOI at lower concentrations i.e. 400µg/ml and 800 µg/ml, whereas at the higher concentration of 1.6mg/ml it was observed that ZOI was obtained by all the strains but *V. cholerae* was less susceptible to the PEs as compared to the other. For MIC and MBC also, results were observed against *S. mutans* which showed response at the given concentrations for all the extracts but n-hexane extract were highly susceptible. The phytochemical analysis conducted on the various solvents of *T. thomsonianum* plant extracts revealed the presence of the major constituent which are known to exhibit medicinal properties. Medicinal herbs and many modern medicines rely on the secondary metabolites for their action.

The preliminary qualitative analysis revealed the presence of secondary metabolites such as alkaloid, carbohydrates, saponin, phenols, flavonoids, tannin, terpenoids, cardiac glycoside, coumarin, starch, quinone, phlobatannin and steroids[41]. Similar results were also shown in *T. leucostaphylum, T. hemsleyanum*[1,35,36]. The findings demonstrated that different solvents had variable extraction or percentage yield and the highest percentage yield was obtained by methanol extract. This suggest that majority of the extractable compounds was polar in nature [27]. The highest content of TPC and TFC value was also reported by [15,38]. Plant polyohenols are group of large hetereogenous, ubiquitous secondary metabolite and are generally involve in defence against ultraviolet radiation or invasion of pathogen, they can perform as hydrogen atom donator, reducing agent and singlet oxygen scavenger [31]. Thus the determination of total phenol content and total flavonoid content of *T. thomsonianum* extacts were correlated to the radical scavenging assays (DPPH , ABTS and FRAP).It is evident that the ROS or the free radicals are produced in the oxidation reaction which are responsible for inflammatory and angiogenic process involving in tumor growth, cell damage and in damaging food[21, 23].When different extract of *T. thomsonianum* was evaluated for antioxidant activity, methanol extract contains the highest %RSA followed by acetone extract, chloroform extract, n-hexane and water extract simultaneously and $IC_{50}$was lowest for methanol. Similar to our observation many other researchers have also reported high antioxidant activity in *Tetrastigma* species like *T. hemsleyanum*, *T. sulcatum; T. augustifolia* in ethanol, methanol extract and essential oil[20,22,35,36,37,40]. The high antioxidant activity of methanol, water and acetone extracts were due to the high phenolic and flavonoid content of the extracts [14].The Antibacterial analysis reveals that the polar solvents i.e. methanol and acetone extracts were susceptible towards all the five selected bacteria as reports suggested that polar solvents exhibit more antibacterial activity [29]. Antibacterial potential of this plant *T. hemsleyanum* have reported by the previous researchers[13,26,42].

CONCLUSION

The present data would certainly help to ascertain the potency of the tested part of the plant for medicinal use and functional food and nutraceutical applications. Plant extract showed the antimicrobial activity against the human pathogenic bacteria which could be potentially used for synthetic drug discovery from the active compounds present in it. Therefore, further investigations are needed for the isolation and identification of the active components and to elucidate its mechanisms of action, as well as their potential role in the biological activity, and antioxidant activities as well.

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CONFLICT OF INTEREST
The authors declare that there are no conflicts of interest relevant to this article.

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Table 1- Phytochemical Screening for *T. thomsonianum*

Chemical Groups	Various Solvent Extracts				
	Water	Methanol	Acetone	Chloroform	n-Hexane
Alkaloid	-	-	+	-	-
Carbohydrates	+	+	+	+	+
Saponin	+	-	-	-	-
Phenols	+	+	+	-	-
Flavonoids	+	+	-	-	-
Tannin	+	+	-	-	-
Terpenoids	+	-	-	-	+
Cardiac glycoside	+	+	+	-	-
Protein	-	-	-	-	-
Coumarin	+	+	+	-	-
Starch	-	-	+	-	-
Quinone	+	-	+	-	-
Phlobatannin	-	+	-	-	-
Steroids	+	+	+	-	+

Table. 2- Estimation of Various contents of *T. thomsonianum*

Extractives	*Total Phenolic content* (mgGAE/g)	*Total Flavanoid content* (mgQE/g)
Water	24.39±0.00	6.72±0.00
Methanol	33.07±0.01	83.50±0.02
Acetone	25.61±0.05	63.38±0.03
Chloroform	3.12±0.00	22.47±0.00
n-Hexane	1.10±0.00	8.39±0.01

Table-3. Correlation between TPC, TFC and Antioxidant potentials

Correlation factor	Correlation coefficient
TPC &TFC	0.70
TPC & FRAP	0.72
TFC & FRAP	0.92
TPC & IC$_{50}$ DPPH	-0.14
TPC & IC$_{50}$ ABTS	-0.99
TFC & IC$_{50}$ DPPH	-0.80
TFC & IC$_{50}$ ABTS	-0.72

Table-4: Antimicrobial activities of *T. thomsonianum* extractives against some bacterial strain tested by Disk Diffusion, ZOI in (mm) at various concentrations

Extractives/ Controls	400 µg/ml					800 µg/ml					1.6 mg/ml				
	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST
Water	0.00	0.00	0.00	0.00	7.33±0.58	0.00	0.00	0.00	0.00	8.00±0.00	0.00	0.00	0.00	0.00	8.17±0.29
Methanol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00±0.00	0.00	0.00	0.00	0.00
Acetone	10.17±0.29	0.00	0.00	0.00	6.50±0.50	10.33±1.53	0.00	7.33±1.15	7.17±0.29	7.50±1.32	11.00±1.73	8.00±0.00	8.00±0.00	8.50±0.50	7.67±0.58
Chloroform	8.00±0.00	7.00±0.00	0.00	0.00	6.67±0.58	8.17±0.29	7.67±0.58	7.33±0.58	6.17±0.29	6.83±0.76	8.77±0.68	8.83±1.04	7.67±0.58	7.73±0.64	7.00±1.00
n-Hexane	7.00±0.00	7.67±0.29	0.00	0.00	7.40±0.53	9.43±1.25	8.00±0.00	7.33±0.58	8.00±0.00	8.33±0.58	10.33±0.58	9.33±0.58	7.83±0.29	8.67±0.29	8.67±0.58
Streptomycin (+)	21.67±1.53	15.00±0.00	16.67±2.89	11.33±1.15	14.00±0.00	18.33±2.89	15.00±0.00	20.00±0.00	10.00±0.00	15.00±0.00	20.67±1.15	17.00±1.73	16.00±1.00	9.83±0.76	12.67±2.52
DMSO (-)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*SM= *Streptococcus mutans*, SP= *Streptococcus pyogenes*, SF= *Shigella flexneri*, VC= *Vibrio cholerae*, ST= *Salmonella typhi*. Computed mean and standard deviation obtained for the analysis out in triplicate (p<0.05)

Table-5: Antimicrobial activities of *T. thomsonianum* extractives against some bacterial strain tested by Well Diffusion, ZOI in (mm) at various concentrations

Extractives/ Controls	400 µg/ml					800 µg/ml					1.6 mg/ml				
	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST
Water	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methanol	9.67±0.58	0.00	0.00	0.00	0.00	10.33±1.53	0.00	0.00	0.00	0.00	11.00±1.73	8.67±1.15	10.00±0.00	0.00	12.67±0.58
Acetone	12.33±2.89	0.00	0.00	0.00	0.00	12.33±2.08	0.00	0.00	0.00	0.00	14.00±1.73	11.33±1.15	10.67±2.31	9.67±0.58	10.00±0.00
Chloroform	9.17±0.76	0.00	0.00	0.00	0.00	9.33±2.52	0.00	0.00	0.00	0.00	10.00±1.73	9.33±0.58	7.33±1.15	0.00	8.33±1.15
n-Hexane	5.33±4.62	0.00	0.00	0.00	0.00	6.83±1.44	0.00	0.00	0.00	0.00	11.33±1.15	9.17±0.29	8.33±0.58	0.00	8.27±0.25
Streptomycin (+)	23.00±0.00	17.00±0.00	18.33±2.89	10.00±0.00	18.33±2.89	23.67±1.15	20.00±0.00	15.00±0.00	10.00±0.00	15.00±0.00	23.33±2.89	21.33±1.15	20.00±0.00	10.00±0.00	15.00±0.00
DMSO (-)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*SM= *Streptococcus mutans*, SP= *Streptococcus pyogenes*, SF= *Shigella flexneri*, VC= *Vibrio cholerae*, ST= *Salmonella typhi*.
*Computed mean and standard deviation obtained for the analysis out in triplicate ($p<0.05$)

Table-6: Antimicrobial activities of *C. teeta* extractives against some bacterial strain tested by Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC), + = No Growth/ Inhibition, – =Growth/ No inhibition

Minimum Inhibitory Concentration (MIC)																									
Conc. (mg/ml)/ Control	Water					Methanol					Acetone					Chloroform					n-Hexane				
	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST
5	>5	>5	>5	>5	>5	+	>5	>5	>5	>5	+	+	>5	>5	+	+	>5	>5	+	>5	+	>5	>5	>5	>5
2.5						-					+	-		-		-			-		+				
1.25						-					-	-		-		-			-		+				
0.625						-					-	-		-		-			-		-				
0.312						-					-	-		-		-			-		-				
0.156						-					-	-		-		-			-		-				
(+)C	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(-) C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Minimum Bactericidal Concentration (MBC)																									
Conc. (mg/ml)/ Control	Water					Methanol					Acetone					Chloroform					n-Hexane				
	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST	SM	SP	SF	VC	ST
5	>5	>5	>5	>5	>5	+	>5	>5	>5	>5	+	>5	>5	>5	>5	+	>5	>5	>5	>5	+	>5	>5	>5	>5
2.5						-					-					-					+				
1.25						-					-					-					+				
0.625						-					-					-					-				
0.312						-					-					-					-				
0.156						-					-					-					-				
(+)C	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
(-) C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*SM= *Streptococcus mutans*, SP= *Streptococcus pyogenes*, SF= *Shigella flexneri*, VC= *Vibrio cholerae*, ST= *Salmonella typhi*.

Fig1:The Standard curve of (a) Gallic acid for total phenol (b) Quercetin for total flavonoid(c) total phenolic content (d) total flavonoid content.
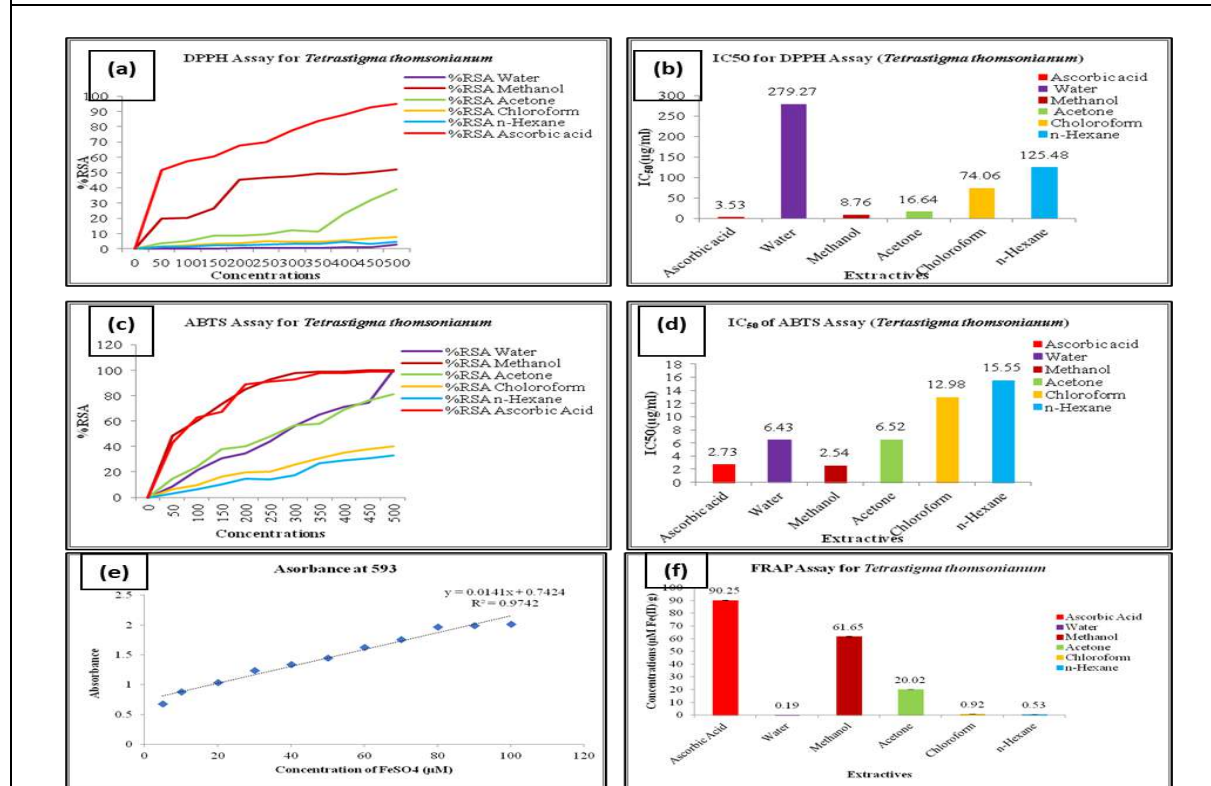
Fig 2: Antioxidant activities in different test: DPPH assay (a) % Radical scavenging activity (b) IC_{50} of DPPH;ABTS assay (c) % Radical scavenging activity (d) IC_{50} of ABTS;FRAP Assay (e) Standard curve for $FeSO_4$ (f) concentrations for total antioxidant present in different solvent

RESEARCH ARTICLE

Reducing the Power Oscillations in Transmission System by using Hybrid Power Flow Controller (HPFC)

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ABSTRACT

An innovative control method to improve the system stability by most favorable proposed technique is distributed power flow controller (HPFC) based stabilizer is mentioned in this paper. The paper demonstrates the fundamental module, current injection method, mathematical modelling of HPFC. The function of the effort is to design an power oscillation damping (POD) controller for HPFC to damp out low frequency oscillations and to reduce the oscillations in active power and reactive power and also to improve the transmission voltage and transmission efficiency. The HPFC device is eliminates the common dc link between the shunt and series converters, and uses the transmission line to exchange active power and reactive power between converters at the third-harmonic frequency. Instead of using a large three-phase converter, the HPFC employs multiple single-phase converters (D-FACTS concept). This system was analyzed by using MATLAB/Simulink software.

Keywords: FACTS, Distribute Power Flow Controller, Power Oscillation Damping.

INTRODUCTION

Generally power demand grows radically, and expansion in transmission and generation is constrained with severe ecological constrains and restricted accessibility of recourse. on the other hand, the ability of long, inter-regional power transmission is frequently restricted, and the main reason is caused by low-frequency power oscillations. In addition, interconnection between power systems ; rise to low frequency oscillations in the range of 0.3–3 Hz. This type of oscillations may results in possibly keep rising in magnitude in anticipation of loss of synchronism, if not healthy damped [1]. And also dangerous oscillation, known as 'Inter-area oscillation', is observed when a mob of

generates in a region swings and aligned with group in another region [2]. The conventional result is to use power system stabilizers (PSSs) on generator excitation control systems [3]. On the other hand, PSSs are frequently planned for local oscillation damping, and in large multi-area power systems it capacity be hard to adjust all the PSSs' parameters. FACTS controllers can be engaged for inter-area power oscillation damping (POD), and they are proved to be efficient [4],5],[6].The Distributed Power Flow Controller (HPFC) newly offered in transmission line[7], is a dominant device contained by the FACTS component, in this device is greatly lower cost and high reliability than usual FACTS devices. It is consequential from the UPFC [8] and has similar capability of at the same time adjusting all the parameters, like line impedance, transmission angle, and bus voltage magnitude. The HPFC device is eliminate the common dc link between the series and shunt converters, and also Exchange of active and reactive power takes place in transmission line at third-harmonic frequency. As an alternative of one large three-phase converter, the HPFC device employs multiple single-phase converters (Distributed-FACTS model [9]). In this paper also investigate the power oscillations in transmission system by using power oscillation damping.

HPFC PRINCIPLE
The Distributed Power Flow Controller consists of one shunt converter and a number of series converters. The shunt converter like as a STATCOM, the series converters acts like D-FACTS model. Transformation diagram for HPFC as shown in fig.1 every converter surrounded by the HPFC is autonomous and has a separate DC link capacitor to provide the essential DC voltage. Several individual converters cooperate together and create the HPFC as shown in Fig.2.all series converters connected in transmission lines. They can inject a convenient voltage at the fundamental frequency and also control the power flow all the way through the line. The shunt converter connected between the line and ground, series converters are Connected between the any two buses. While there is no common dc link between the series and shunt converters, the exchange of active power takes place through harmonics and ac network. The active power in transmission system is given by integrals of all the cross-product of terms with different frequencies are zero:

$$P = \sum V_n I_n \cos \emptyset_n \qquad (1)$$

Where $\emptyset_n$ is phase the angle between the current and voltage of the nth harmonic. The third- harmonic is preferred here to exchange the active power in the HPFC, because third harmonic can be easily eliminated by star-delta transformer.

MODELLING OF HPFC
A . HPFC control structure
In this shunt converter supplies active power in support of the series converters by injecting a constant third-harmonic current into the transmission line. In this; controller is used to control the dc voltage by the d-component of the fundamental current, and the q-component is utilized for reactive power compensation. The series converters produce a 360^0 rotatable voltage at fundamental frequency; to retain the dc voltages in active power we take help of a voltage at the third harmonic frequency. The control structure of HPFC as shown in Fig.3. Given that the third-harmonic frequency components will not control the power system at the fundamental frequency, they can be treated as an inner issue. The MATLAB tool box detailed model in[11].

B. HPFC current injection model
Generally HPFC structure is analyzed using nodal analysis method with an equivalent circuit and other way by using admittance matrix method. In this case above two methods are very difficult to analyze. In this schoolwork, we suggest current injection model of HPFC to study the effects of it on low frequency oscillations. The proposal of current injected models current source are shunt connected in line replaced by voltage source in series with line. as shown in Fig.4.
Series current $I_{se} = V_{se} / Z$
$I_r = -I_{sh} - I_{se}$ $I_s = I_{se}$
While the currents injected to buses be able to be like as loads.

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C. HPFC-POD Controller

The arrangement of the HPFC POD controller, as shown in Fig.5, is like as the PSS controller [4]. It contributes an amplification block, a wash out block and two lead-lag blocks [12].The washout is proposed to remove the dc component of POD controller input signal and has a huge time constant, regularly from 5sec to 10sec, even as the oscillation is at low frequency (less than 2 Hz normally). The time constants of lead-lag blocks T_{lead},T_{lag} and amplification gain K is the POD design parameters. In this case POD controllers are enhancement at the power flow control and ac voltage control blocks in Fig.3.from the time when the HPFC has three control teqniques ,They are $I_{sh,q}$,$V_{se,d}$ and $V_{se,q}$, the q-component of shunt current and dq-components of the series voltage, correspondingly. The control structure of the possible POD controller location in the HPFC control is as shown in Fig.6.

DESIGN of HPFC-POD CONTROLLER

A.System linearization

If design of a POD controller, is analyze to oscillations and to classify the system with HPFC can be represented by the state-space representation:

$$\Delta \dot{x} = A\Delta x + B\Delta u$$
$$\Delta y = C\Delta x + D\Delta u \qquad (4)$$

Let $\lambda_i = \sigma_i + j\omega_i$, $\lambda_i = \sigma_i - j\omega_i$ be the ith of the eigen value of the state matrix A. The real part of term consisting is eigen value gives damping, and the complex part gives angular velocity of the oscillation. The relative damping ratio is given by:

$$\zeta_i = - \sigma/(\sigma^2 +\omega^2) \qquad (5)$$

In this case eigen value damping ratio less than 3% are considered for critical oscillatory damping[13].To propose the POD controller, the system without the POD controller can be considered as a single input single output (SISO) system, with the open loop transfer function:

$$G(s) =\Delta y/\Delta u= C(SI – A)^{-1}B \qquad (6)$$

G(s) can also represent in partial fraction

B. Controller design of HPFC- POD using residue method

In this case using POD controller as the feedback to the SISO system, as shown in Fig.7, eigen values are entire systems are changed. If transfer function of the POD controller is KH(s), the change of the eigen value for the reason that of the POD controller is given by [10]: From equation (8) it can be change of the eigen value reason by the POD controller is proportional to the magnitude of the residue. Consequently if input signal of the POD controller is chosen according to magnitude of residue. By increasing the value of residue R_i to damp the oscillation λ_i, for the POD controller. In case by using HPFC-POD to reduces the oscillation of active and reactive power flow through the line, the current, or the bus voltage magnitude. To reduces the oscillation, to move the eigen value towards the left half s- plane, as shown in Fig.8.if angle between the information of the residue and the POD is the reparation angle $\emptyset_{comp}$, which is achieved by the lead-lag blocks. If the two lead-lag blocks in the POD controller equal, after that the parameters T_{lead} and T_{lag} are resolute by [10]:

$$\emptyset_{comp} = 180^0 –ang(R_i)$$
$$\alpha_c=T_{lead}/T_{lag}=(1-sin\phi_{comp}/m_c)/(1-sin\phi_{comp}/m_c) \qquad (9)$$
$$T_{lag} = 1/\omega_i\alpha_c$$
$$T_{lead} = \alpha_c T_{lag}$$

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Here m_c is the no. of lead-lag blocks and ω_i is the frequency in rad/sec of the oscillation. The amplification gain K can be considered as a function of preferred eigen value location $\lambda_{i,des}$ according to equation (8):

K=modules of $(\lambda_{i,des}-\lambda)_i/(R_i H(\lambda_i))$ (10)

In case POD is added three locations in the HPFC. given that the POD controllers contain manipulate on each other, in this case to calculate very complicate all three sets of POD parameters at one time by using the residue method. The procedure for manipulative POD controller parameters for a HPFC is described in the subsequent steps:

1. Determine the most significant eigen value of the system as the damping aim of the first POD controller;
2. Evaluate the residue designed for executable of POD locations, and the first POD controller is placed at the location where there is a biggest residue;
3. Evaluate the first POD controller parameters;
4. Evaluate the new eigen values of the system with the first POD controller, and find out the most critical eigen values one as the second POD controller damping objects;
5. Repeat the above procedure for calculating the rest POD controller parameters.

CASE study of HPFC-POD

If POD ability of the HPFC is simulated in a simple two-area system [2]as shown in Fig.9. In this system consists of two areas which are associated by a weak tie, and each area consisting of two coupled generators. These generators are self-excited by dc exciters, and PSSs is not included in them. later than the linearization of the system without HPFC, a pair of eigen values are present in the positive plane with an oscillation frequency of approximately 0.4Hz.The HPFC is present in between the buses 8 and 9 used to monitor the power flow during the tie, and also to damp out the oscillations at the same time. Bus 8 is a perfect location for placing the shunt converter, because voltage swings are very high at bus 8. As mentioned earlier, the drawback with a set of fixed controller parameters i.e.tuned by conventional method, arises when the topology of the system is changed. In such cases, the re-tuning of POD parameters is required. To overcome this problem; based on a complete set of the model parameters, we have to re-tune the controller parameters for every new operating condition . In following Figures, dynamic responses obtained by this approach are denoted as ''re-tuned POD'', i.e. POD is re-tuned for appropriate operating condition, e.g. with the line out of service, whereas ''fixed POD'' means POD controller which is tuned well by residue based method, but for nominal condition. By placing HPFC without POD controller causes the unstable eigen values; these values will be shifted a little bit towards left side ; however the eigen values are still present at the right half plane and the system is unstable. By enhancing the control dynamic of HPFC, the eigen value can be further shifted to left, but the shifting is not very large. The critical oscillatory mode is characterized by eigen value $\lambda_1 = 0.0216 + j2.021$ and $\lambda_1^1 = 0.0216 - j2.021$ with the damping ratio $\zeta_1 = -0.044\%$. It is found that the HPFC control parameter Vse,d has the largest residue $R = 11.2058$ and therefore the most efficient to apply the POD controller to that variable. The input signal given to the POD controller is the active power and reactive power flow from bus 8 to bus 9. Using above method, the transfer function of the first POD controller is obtained as:

$H_1(s)= 0.2505*5s/(1+5s)*(1+0.1456s/1+0.2589s)^2$

By using single POD controller, the critical eigen values are shifted from right to left ,it is nothing but a stable location. However, as a side effect, the controller also brings a stable eigen value on the way to the critical damping, as shown in Fig.9.In fig.9 illustrates the eigen values of the system, where only the eigen values are close to the critical damping is shown. Three cases are mentioned below: without POD, with single and double POD controllers. To eliminate this side-effect, the second POD controller is employed to damp out the oscillatory mode $\lambda_2 = -0.1090+j0.4590$ and $\lambda_2^1 = -0.1090+j0.4590$ with the damping ratio $\zeta_2 = -0.190\%$. The HPFC control parameter Vse,q is

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selected to apply the second POD controller and using input signal as reactive power flow . The second POD controller transfer function are obtained as:

$$H_2(s) = 0.2001*5s/(1+5s)*(1+0.1245s/1+0.0519s)^2$$

After applying two POD controllers, all the Eigen values are away from the critical damping line; therefore it is not necessary to use the third POD controller in this case. when a fault occurs, the power oscillation phenomenon can be observed . To test the capacity HPFC POD , a fault is created in between the lines 7-8 at t =1s, and it is cleared after 0.1s. Fig. 11 shows the active power and reactive power flow from bus 8 to bus 9 in the three cases. When POD controller is not included, There is no such a huge difference between with one POD and two POD controllers, for the reason that the damping aim of the second POD controller is at a standstill under the critical damping line. In this simple 2-area system, only two POD controllers can achieve necessary stability. In case use of three possible POD controllers are in use, the HPFC can further stabilize a complex system ,because of to calculate the multiple critical eigen values are difficult.

SIMULATION RESULTS

The simulation is done by using MATLAB/ SIMULINK software to analyze the active power and reactive power flow, bus voltages without HPFC-POD controller as shown in fig.11. It can be seen that the proposed model based optimized HPFC-POD damping controller has good performance in damping low frequency oscillations and active power and reactive power flow, bus voltages as shown in fig 12.

CONCLUSION

HPFC is a new control technique in transmission system; it can control the active power and reactive power flow in transmission line. Here in this paper Power Oscillations Damping Controller is provided to damp low-frequency and multiple frequency power oscillations at the same time. Here POD control parameters are calculated by using residue method.

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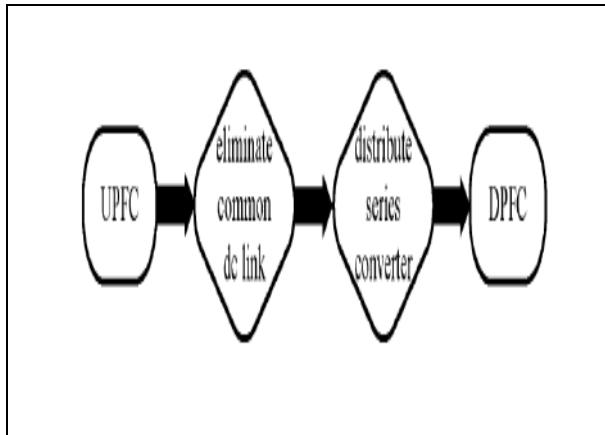
Fig. 1.Transformation diagram for HPFC	**Fig. 2.Basic structure of Distributed power flow controller**
Fig.3. control structure of HPFC	**Fig.4.current injection model of HPFC**
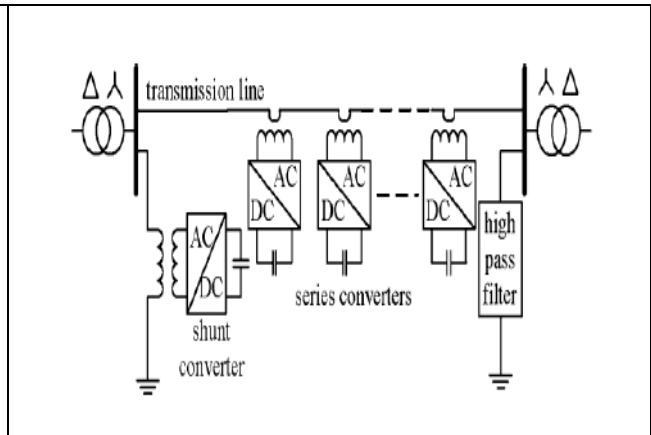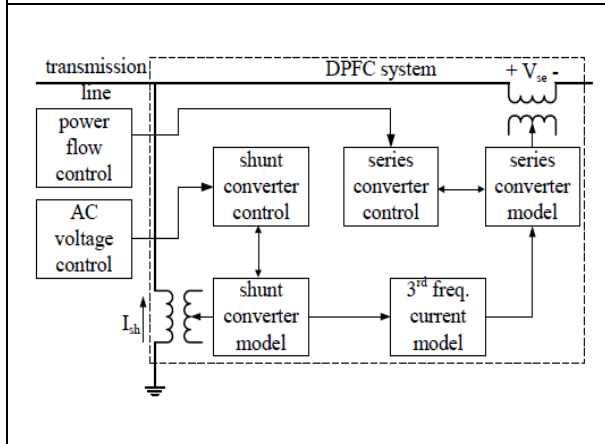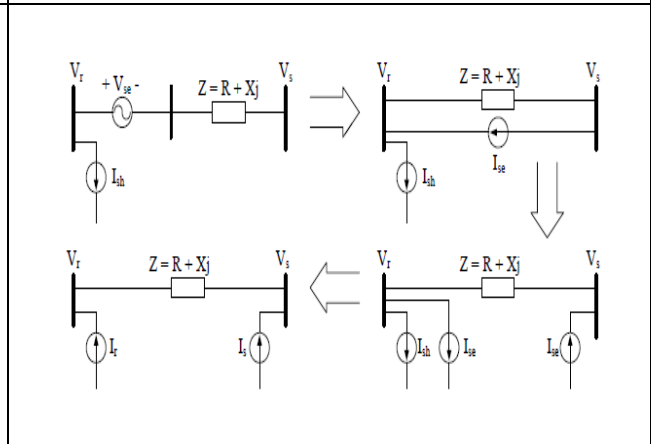
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Fig.5.HPFC-POD Controller	**Fig.6. (a) ac voltage controller (b) active power flow controller (c) reactive power flow controller**
Fig.7.closed loop system with POD	**Fig.8.shift of eigen values with POD controller**
Fig.9.Two-Area system with HPFC	**Fig.10.Location of eigen value in two-area system**

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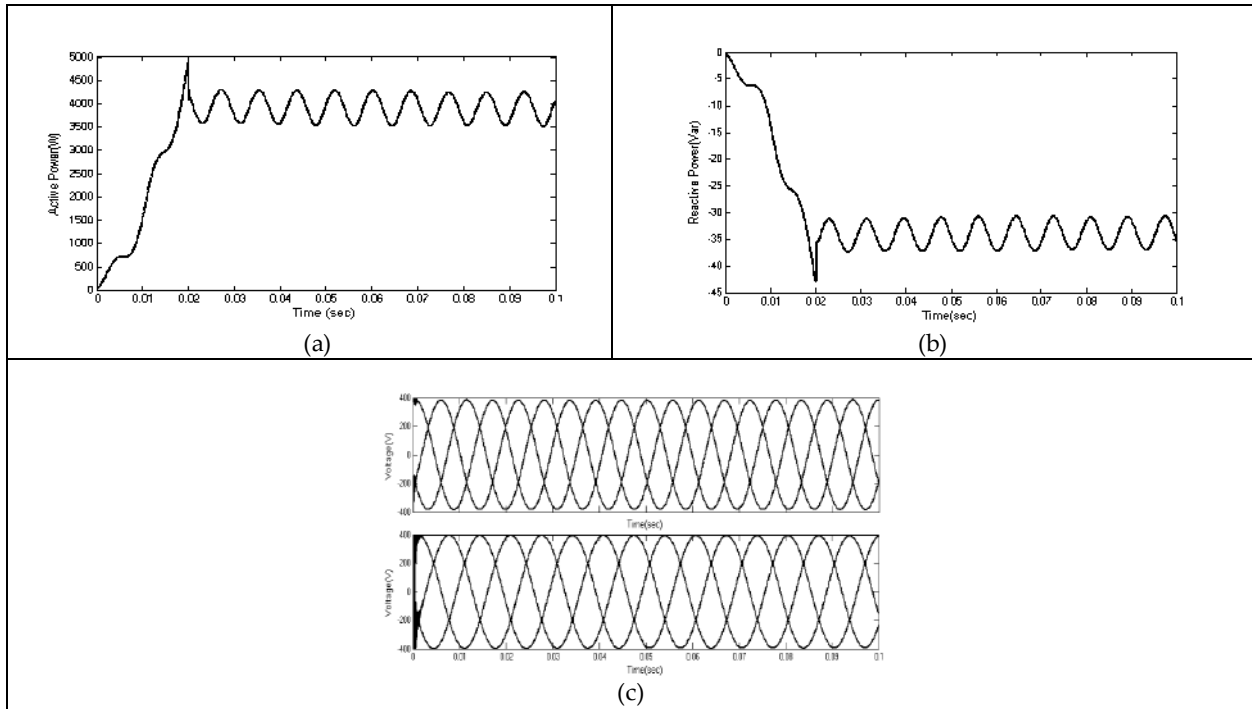
Fig.11.without HPFC-POD (a)Active power
(b) Reactive power (c)Bus voltage
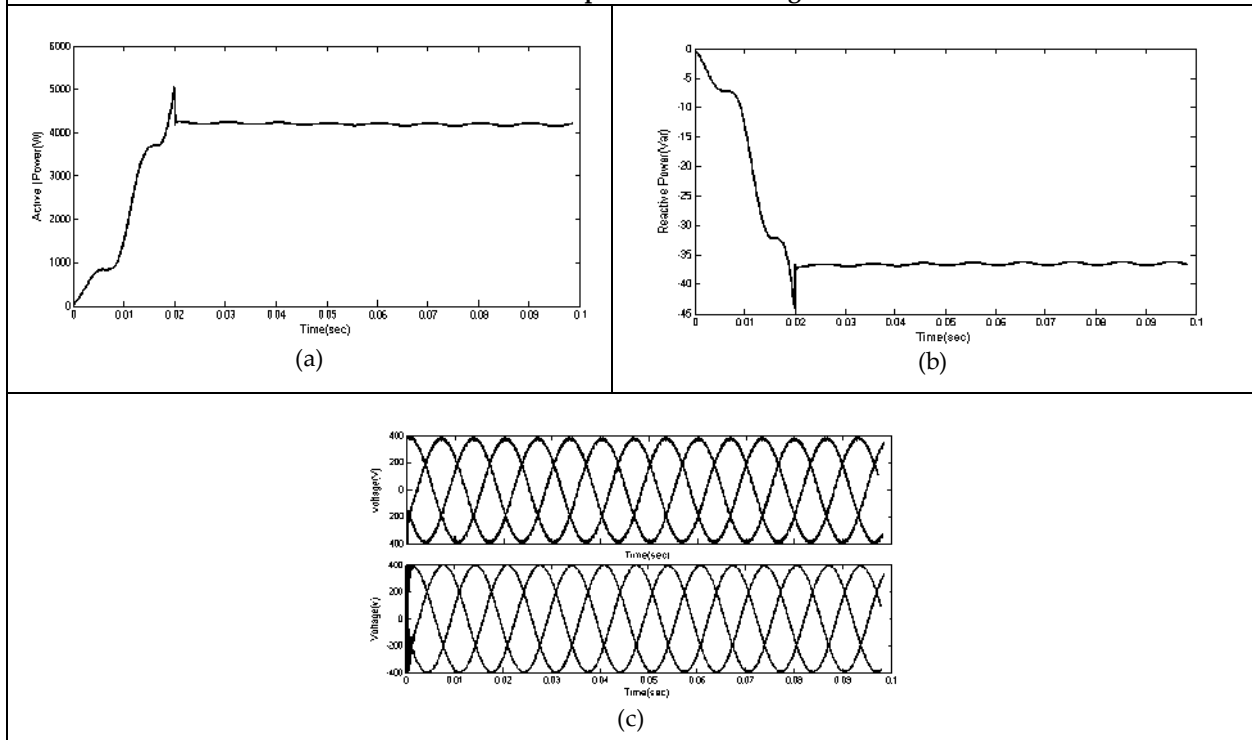
Fig.12.With HPFC-POD (a)Active power
(b) Reactive power (c)Bus voltage

RESEARCH ARTICLE

Covid-19 Pandemic: A Case Study of its Impact and Consequences on Different Sectors

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ABSTRACT

A transferable respiratory illness recently emanated in Wuhan city of Hubei zone in China. The World Health Organization has named it as corona virus disease 2019 (COVID-19), and the virus give rise to this ailment as SARS-Cov-2. This is severely distracting the global economy. The disease spread by the corona virus, starts with droplets in range of one meter from an infected person's cough, sneeze. All communities of the world are facing social, economic and livelihood challenges due to spread of COVID-19 epidemic. This paper targets on analyzing the impact of pandemic on different sectors for determining how it is causing various troubles to the world. All communities of different continents are undergoing global trade and industrial crisis. The research highlights the impact of corona on the world. Attention is drawn on approach that diminishes the epidemic influence on the business and the socio-economic pursuit. The research opens the way for future study on how to run specialized programs for future lockdowns. It has rapidly increase around the globe and has rigorously impacted the education, health, economic, emotions, food, environmental and social sectors and the entire human population. This research paper narrates the impact of COVID-19 on different fields of civilization and environment. The eruption of COVID-19 has pretentious over 2164111 citizens in the world as reported by the World Health Organization. This has been the greatest challenge of spread of COVID 19 pandemic.

Keywords: COVID-19; Social-economic; Epidemic.

INTRODUCTION

Corona virus illness 2019 (COVID-19) is a communicable respiratory illness also known as 2019 CoV. It attacks on respiratory system causing illness such as respiratory diseases or gastrointestinal diseases. It was first acknowledged in Wuhan in December 2019, China and after that it has outspread globally. It has globally affected more than a million of people across 188 countries and territories. It is highly affecting the social and economic status. It is more treacherous for children and mature people.COVID-19 poses a greater risk for those people already having health issues: heart disease, lung disease such as asthma, diabetes, weak immune system. Corona-virus is not only a serious community healthiness apprehension, it also triggers catastrophic socio-economic and policymaking disaster in the contaminated countries and it is the furthermost hazard to worldwide public health. It has also led to discrimination in infected countries and proved as a threat to social progression. The scourge COVID-19 was accounted for in December 2019, in Wuhan, Hubei territory, China, and most at first tainted cases were connected from seafood wholesale after that this malady quickly spread out everywhere throughout the world. Aside from COVID-19, the human progress has seen at any rate five pandemics in the current century, for example H1N1 in 2009, polio in 2014, Ebola (out broke in West Africa in 2014), Zika (2016) and Ebola (Democratic Republic of Congo in 2019). In this manner, the COVID-19 episode has been proclaimed as the 6th general wellbeing crisis of global worry on 30 Jan 2020 by the WHO.

These overall episodes set off an enormous number of fatalities, morbidities, and drifted billions of dollars [1] Compared to different ailments and their separate repercussions, COVID-19 is probably going to cause so a lot or more prominent human enduring than different infectious illnesses in the entire world. Other than its upsetting impacts on human life, the novel corona virus illness (COVID-19) can possibly fundamentally hinder the economy of China, the USA, or India yet additionally of the world all in all. Thusly, medicinal services staff, governments and people in general, all in all, need to show solidarity and battle side by side for counteraction and regulation of the pandemic [2]. In the current paper, our primary centre is to feature the effects of COVID-19 on the earth, society and economy. This template, modified in MS Word 2007 and saved as a "Word 97-2003 Document" for the PC, provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) Ease of use when formatting individual papers, (2) Automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) Conformity of style throughout conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

Symptom
Fever, exhaustion, cough, windedness, loss of smell, sore throat, runny or stodgy nose, body throbs, migraine , chills, sickness; Sometimes no manifestations by any stretch of the imagination.

How it spread?
The infection essentially spread among the individuals through close contact or interacting with beads delivered by sniffling, coughing and talking. The drops created for the most part fall on the ground or onto surface and doesn't go through air over significant distance. It sticks on the surfaces of materials like garments, shoes, polybag, railings and so forth by contacting these kinds of defiled surfaces and afterward their eyes, nose or mouth individuals can get contaminated or by interacting with a tainted individual. Individuals can transmit the infection without indicating the manifestations.

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Preventions
COVID-19 symptoms can be seen in 2-14 days after exposure. Therefore, it is better to take precautions. Follow the given steps:
• Remain at home.
• Avoid stuffed out spots.
• Keep up good ways from others.
• Washing hands with cleanser and water every day commonly in a day.
• Avoid contacting the eyes, nose, or mouth.
• Use alcohol based sanitizers.
• Clean and sterilize habitually touched objects and surfaces such as cell phones.

To reduce the chances of infection
If infected make sure to cover up nose and mouth with mask, avoid talking to people until you recover and maintain proper hygiene. After recovery also make a safe distance from people to avoid getting infected again or transmitting the infection to other people.

Treatment and Vaccines
There is no booster developed to put off COVID-19 as of now. Treatment is supportive. People who are at initial stage of COVID-19 with no or mild symptoms should isolate themselves at home during their illness. The best medicine for COVID-19 is awareness and proper hygiene. "PROTECT YOURSELF FIRST, THEN THE REST WILL SURVIVE"

Literature Survey
Mohamed Buheji, Katiane da Costa Cunha et al [12], calls attention to how it is difficult for the poor to hold fast to the prohibitive proportions of social segregation or the lockdown. Quick techniques that limit the pandemic effect on the business and the financial exercises of the poor are recommended. The exploration opens future examination about progressively particular projects for the poor during any future lockdowns. Indranil Chakra borty a, PrasenjitMaity [13], portrays the impact of COVID-19 on society and overall condition, and the expected habits by which the contamination can be controlled and expectation. It has immediately spread the world over, introducing enormous prosperity, monetary, environmental and social challenges to the entire human people. The crown contamination scene is genuinely upsetting the overall economy. For all intents and purposes all the nations are engaging to impede the transmission of the affliction by testing and compensating patients, confining hypothesized individuals through contact following, constraining huge parties, keeping up absolute or fragmentary lock down, etc. Backer, J.A *et al* [14], the clinical range for people with COVID-19 contamination ranges from mellow or vague signs and side effects of intense respiratory ailment, for example, fever, weariness, cough, windedness, to serious pneumonia and septic stun, which are fundamentally the same as other crown infection maladies. Rawat *et al*, In USA [15], in excess of 30,000 individuals kicked the bucket of this illness. As per the report of the Chinese government and the WHO, the current episode has tainted some84,180 individuals in China out of which more than 4642 individuals have passed on so far as of April 18.

The first instance of crown infection flare-up in quite a while was accounted for on 30 January 2020 in Kerala's Thrissur area when an understudy had get back from Wuhan University in China. Bremer, S *et al* [16], from the earliest starting point of progress, individuals step by step began controlling the nature for its own advantage. So as to fulfil the interest of expanding populace industrialization and urbanization got unavoidable, and the conspicuous hugeness was end up being inconvenient on the worldwide condition. Further, natural concerns incorporate air contamination, water contamination, environmental change, ozone layer exhaustion, a worldwide temperature alteration, consumption of ground water level, difference in biodiversity and biological system, arsenic defilement and some more. Saadat S. *et al* [17], before the lockdown caused due to the pandemic environment degradation, global warming is increasing rapidly. But due to the lockdown with industries closed at a large scale and less traffic on the streets air quality has been increased drastically. It has been seen 40% reduction in Nitrogen-dioxide. Unlike

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educational and economic sectors COVID-19 has a positive effect on the environment. Due to the pandemic many countries are forced to impose complete nationwide lockdown thus the industries are shutting down on a large scale. Therefore dumping of industrial waste into rivers has been stopped leading to a massive improvement in the water quality of Ganga and Yamuna. Chakraborty I. *et al* [18], Not only the air and water quality has increased COVID-19 lockdown also has a positive impact on wildlife. The wildlife animals' even sea turtles are moving freely where they would not dare to go.

Covid-19 Impact areas

The effect of covid-19 on the environment and water resources
Overall environment had changed a lot due to this epidemic like soil conservation; ozone layer is healing, pollution decreased and reduction in urbanization. Changing condition makes an undeniable effect on our planet and human wellbeing. Mechanical improvement is the primary driver of Global warming, discharging over the top measure of CO2 during the modern upheaval and hindering the nursery impact. To some extent COVID-19 outbreak may be painstaking as a roundabout outcome of global environmental changes. Transportation bunged, events cancelled, factories locked: the COVID-19 weighs on the world economy. But these good changes for the environment could only be fleeting. [2]

The impact of covid-19 on employment sector
The quickly developing monetary impacts of COVID-19 on the world are ending up being far more regrettable than the 2008-2009 money related emergencies, with expected occupation slices proportional to about 200 million all day labourers in the following three months alone. The admonition comes just about three weeks after the International Labour Organization (ILO) anticipated that 25 million employments are undermined by the new crown infection. Worldwide joblessness as of now remained at 190 million. The universe of work is enduring a completely surprising dive as a result of the impacts of the plague.

There are four worst sectors that's drastic effect of disease are
(i) Administration and business services
(ii) Housing and food
(iii) Manufacturing and retail
(iv)Wholesale

Beside this, health and social professionals are fighting against this syndrome on the front foot. All areas of the world and all the workers are affected severely. The crisis had brought a drastic impact on every sector of the world's workforce. Different policies are required to provide instant relief to the workers and enterprises to protect sustenance. Strategies for organizations monetary are for all intents and purposes for the most part in developing countries. An extra concern is that in low and centre pay nations, the most noticeably terrible hit enterprises and administrations have a high extent of low-wage labourers in casual work, with constrained access to wellbeing and State government assistance security nets. Precise plans are should have been taken as the labourers are confronting high danger of falling into neediness and would encounter more prominent difficulties in recapturing their jobs during the recuperation time frame as expressed by ILO in its most recent report. As indicated by late reviews a large number of labourers have just been influenced by COVID-19.In numerous urban territories, these labourers likewise work in financial areas that convey a high danger of infection contamination and are straightforwardly affected by lockdown measures: squander recyclers, merchants and food dealers, development, transport and household labourers and those in the powerless division are confronting declining more noteworthy breakdown. Although change in agriculture sector has worst affected the economy.

COVID resurgence priorities are:
1. Invigorating the employment and economy.
2. Sustaining jobs, enterprises and incomes.
3. Safeguarding labourers in the work environment.

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The impact of covid-19 on Social and economic issues

The economic and social crisis are posing huge challenges imposing wrenching trade-offs. Both crises require global harmony and togetherness. A Governments need to put resources into general wellbeing, credit offices, social and security measures, to assist nations with recouping quicker from the COVID-19 epidemic. The monetary report cautions that an insane blanket of prior arrangements won't work and brings up that administration must facilitate with one another to quicken the recuperation. The accompanying figure delineates immediate and roundabout expenses of the COVID-19 pandemic which may profoundly affect the worldwide economy. The roundabout effects have been broken to gracefully and request; nonetheless, Different territories of the economy are related and will effect sly affect each other. Direct cost will carry a spray to lost salary and destruction in resources which will prompt long haul impacts.

The impact of COVID-19 on space

The impact of covid-19 on space concerning the short lived end, deferment and reduction in the whole of its activities as creation and creation of the Space Launch System and related activities by specific spaces association as NASA's James Webb Space Telescope are typical that won't dispatch in walk 2021[11].The Japan Aerospace Exploration Agency (JAXA) errands and their different field networks have been suspended to lessen polluting. Bigelow Aerospace declared on 23 March 2020, that it was lying off the entirety of the 88 of its workers. It has said it would enlist labourers back when limitations forced by the pandemic are loose. Space agencies want to quarantine space centres, employee and visitors. Space offices require all non-critical personnel to work from home if conceivable. European Space Agency has requested numerous science and innovation office workforces to telecommuting however much as could be expected. Space agencies want the space station operations to remain unaffected from not only local virus but also corona-virus pandemic with additional security precautionary measures and measures for their representatives to constrain the spread of the infection in their working environments. New undertaking space explorers face longer and stricter isolates before trip with constrained faculty required for strategic work and to mind take and keep up the wellbeing and security of the office so killing their science instruments and setting them into a to a great extent unattended safe setup for a specific period will negligibly affect their general crucial.

The impact of covid-19 on Domestic violence

There are so many reasons behind domestic violence during covid-19 pandemic. Financial related frailty, stress and vulnerability have prompted expanded animosity at home accompanied with isolation from social activities that are part of human life. Full time home isolation without any work, a long duration of quarantine time, no proper counseling during this pandemic on how to manage stress and to calm the aggression, huge amount of time in front of TV and another media of news and entertainment has led to increase in domestic violence as well as incidents of street harassment.

The impact of covid-19 on education

The COVID-19 epidemic has pretentious learning systems in front of the world, inciting the for all intents and purposes total terminations of schools, universities and colleges.

Most governments around the world have quickly closed educational establishments attempting to contain the spread of COVID-19. According to UNICEF checking, 153 countries are starting at now completing the nation over terminations and 24 are executing close by terminations, influencing about 98.6 percent of the world's understudy people. 10 countries' schools are as of now unlocked. [2] Education framework terminations influence understudies, teachers, and families yet additionally have financial and cultural results. Education system closures in response to the epidemic have uncovered understanding into various social and monetary issues, along with student arrears, digital erudition, food timidity, and vagrancy.

During Covid19 a culture of telecommuting, ephemeral joblessness, self-teaching of youngsters, and absence of physical contact with the sum total of what relative has been taken note. All are adjusting to way of life changes, and dealing with the dread of getting the infection. Due to impact of covid19 on studies community wellbeing crises can have numerous psychosomatic impacts on undergrads, such as nervousness, panic, and be anxious. This cram was

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walk around factors of epidemic on college students influencing their anxiety. It has been noted that the devastating and breathtaking news features and wrong news reports have additionally added to nervousness and frenzy. The consequences of this examination demonstrated undergrad's tension with respect to the scourge. [6]

The impact of covid-19 on Emotions of population
Infectious sickness outbreaks, for example, COVID-19 can cause powerful misery and nervousness. These sentiments of misery and tension can happen even in individuals not at high danger of wiped out, notwithstanding an infection. Announced how much individuals and clinical staff experience the ill effects of stunning injury and how this vicarious injury of non-forefront clinical staff is more authentic than that of front line clinical staff [8]. Likewise, some slight sort of inclination is appeared against human administrations specialists who perhaps have a higher peril of being defiled and between non-striking clinical staff towards outstanding clinical staff. Due to COVID-19 contamination, the numerous specialists and attendants were tainted and a considerable lot of them kicked the bucket. All individuals on the planet additionally have elevated levels of worry because of pandemic disease. New insane person manifestations in individuals without mental disorder can happen or worsen the state of those with previous psychological sickness and cause trouble. Most medico experts working in remoteness units and they need preparing for giving emotional well-being care. A few people self-destruction in a time of the pandemic because of dread of spreading COVID-19. Because of that dread and apprehension of falling wiped out or passing on, lack of protection will drive an expansion in the 2020 self-immolation rates.

The impact of covid-19 on Food Security and supply Chain.
During the COVID-19 pandemic individuals confronting serious food instability worldwide and to the kept working of food flexibly chains were urgent in forestalling a food emergency and incapable to lift them out of destitution and food weakness. The COVID-19 is intensifying the danger of food system legitimately and in a roundabout way through effects on food flexibly and request, diminishes in buying power, lessens the ability to create and convey food, and the strengthening of care errands overall food-prize spike, which would trigger emergencies in numerous nations. Effect of COVID-19 on food supply and the request will have straightforwardly and in a roundabout way influenced by accessibility, get to, confronting serious work challenge, usage, and solidness. On the natural way of life side, interruptions to food supplies, creations, and appropriation have followed flare-ups because of an ascent in alarm purchasing by individuals during expected lockdowns, in this way, decay request because of a decrease in buying power. Social separating arrangements and sicknesses cause a drop in the general interest and in the interest of food-related administrations (for example eateries, inns, dairy, and other foodservice outlets) with repercussions on the loss of occupations, earnings, and employment. Beginning with the control and social separating arrangements, the pandemic makes initial a spike popular because of frenzy purchasing and accumulating of food by shoppers which will build food request for the time being, principally among the individuals who have the way to over-purchase nourishment for capacity in their homes as far as physical capacity to buy food because of development limitations and conclusion of eateries or other providing food offices, and regarding the loss of pay and buying power connected the loss of occupations and the freezing of monetary segments.

The impact of covid-19 on fisheries and sardine (aquatic food) systems
As the COVID-19 epidemic continues to spread internationally, are having noteworthy effects on other domains of human activity, including food and nutrition security, employments, vocations, sex equity, and expected social choppiness. Community perceptions were drawn out on how the progressions felt and how they influenced oceanic food framework and little scope fisheries and discovered dispiriting effect. Unexpected ailment, marked down salary, confusion to begin creation and information assortment, work emergency, transportation deliberation, intricacy in food flexibly, powerless worth chain, low purchaser request, rising item costs, loan boss' weight were recognized as the essential influencing drivers.[10]
The capture will be cruel and generally repulsive for the denied and weak living in mounting countries. It is obvious that the financial result of the COVID-19 pandemic could wound the larger section a billion people into shortage. The impacts of this general prosperity crisis at long last the monetary crisis will fantastically impact ladies and youngsters and speak progression on sexual direction consistency on various levels. But in the event that sound and

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fundamental measures rush to keep overall food deftly ties going and to make sure about poor and uncovered systems, an upsetting food crisis - with authentic money related results - will get imagined.

The impact of covid-19 on digestive health
Everybody faces an uncommon test as the flare-up of COVID-19 spots on the world in a highly sensitive situation. Medicinal services frameworks face bleak issues while the enormous interest for basic consideration for persistent periods and the inadequacy of emotional treatment are significant impediments, alongside a be lacking in antibodies. Acceptable help must be given to the overall population, patients, and human services experts all through the emergency to help lessen the drawn out weight incurred from this disease. COVID-19 has different ramifications on digestive health in COVID-19 positive patients. Studies have indicated that gastrointestinal manifestations can happen in positive patient's stomach relate COVID-19 side effects incorporate squeamishness, loose bowels, and spasms. Sometimes, stomach related indications can show up before respiratory side effects have worse result. Other than ceaseless stomach related conditions, the incendiary bowel disease (IBD), stomach related tumours, (for example, colorectal, gastric, pancreatic, oesophageal, and liver malignancy) and liver sicknesses (counting insusceptible stifled liver transplanted patients) could be especially helpless to COVID-19. Patients with such conditions ought to require broad general wellbeing suggestions like physical and social removing and viable hand sanitation. A significant thought identifying with this pandemic is mortality caused in light of the virus infection, for example, passing because of postponements in diagnosing and rewarding individuals with malignant growth could even prompt a larger number of long periods of lost life than through the virus itself.

RESULT AND DISCUSSION

There are millions of people affected with Covid-19, so immediate measures are requiring lessening the effect of the pandemic on different areas like unemployment, economy, social, Health. Domestic -violence and education etc. Government should also support all areas to strengthen their resources to run smoothly economy and social activities as well as public should be aware to use all guidelines to prevent corona infection until corona vaccine came in market. Presently the mask is only the vaccine to prevent from COVID 19 and the best way to save us from COVID, Public shouldn't ignore that most of the Indian companies' pharmacy, chemicals, and electronics businesses may countenance supply-chain issues. There are three key channels of effect for Indian businesses according to the report namely linkages, supply chain and macroeconomic factors. We research approaches actualized not just focused on relieving the passing and the morbidities identified with COVID-19, for example, the immediate wellbeing and general wellbeing related issues, yet additionally those measures giving a pad as short-run pay support and appropriations to business. We likewise cover mediations focused on tending to the more diligent scarring financial impacts that are required to show themselves in the more drawn outrun.

CONCLUSION

This paper conclude that the impact of Covid-19 on Indian economy and supply chain along with its effect on global manufacturing and supply chain. It is observed that the recent pandemic results in drastically affecting manufacturing units and their worldwide supply chain on a daily basis and hence forcing hundreds and thousands of industries to shut down their production and assembly lines majorly in all over the world. Not only on economic sector has COVID-19 drastically affected the education sector all across the globe. Due to COVID-19 school and universities are closed. Another problem arises when many universities and school has started taking classes online thus the students who does not have to internet, are facing a huge problem, this also indirectly widens the hole between the rich and the poor as it is self-explanatory that only the less privileged section of the society are deprived of internet and this is also affecting the health of the students as they are spending hours in front of their laptop's, which is severely affecting the eyes of the students, and also they are unable to practice any type of outdoor physical activities thus affecting their physical conditions. Beside this the paper impacted the health, economic, emotions, food, environment and social areas and the whole human population due to covid-19, But on a positive side COVID-

19 may have positive impact on decreasing the environmental pollution. Due to COVID-19 many countries have imposed nationwide lockdown, which results in shutting down factories and significantly reducing the traffic on the streets hence improving. In accumulation to patients, we likewise need to guarantee backing and insurance is given to bleeding edge human services suppliers, including gastroenterologists. Specialists must guarantee that gastroenterology offices are satisfactorily outfitted with personal protective equipment (PPE) and conventions are followed so experts, and their patients, are secured in medical clinic and careful settings.

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Saroj Agrawal and Yogesh Kumar Gupta
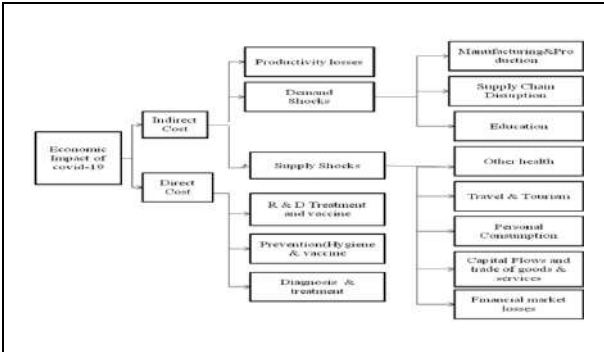
Figure 1Economy Impact of COVID-19 on different fields.
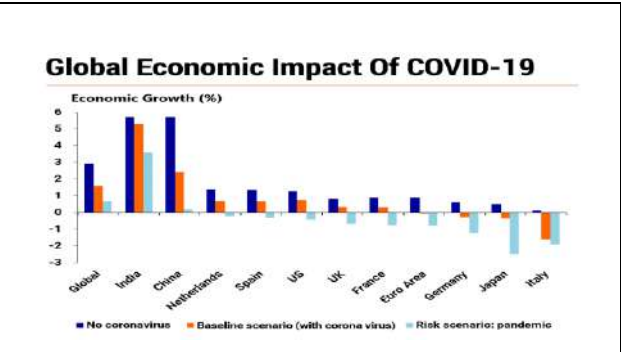
Figure 2 Global Economy Impact of COVID-19 [5].
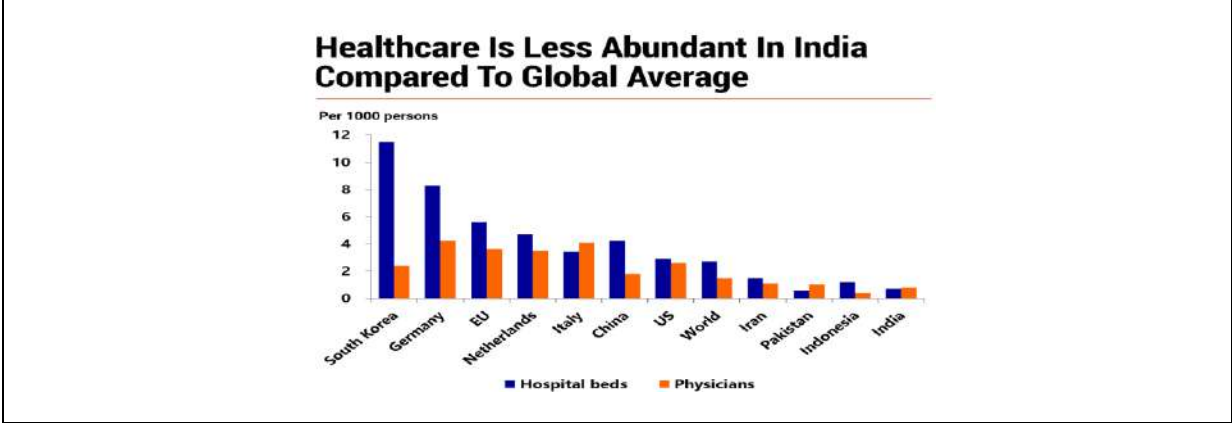
Figure 3 Example of an image with acceptable resolution

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RESEARCH ARTICLE

Awareness of School based Physical Therapy among School Teachers – A Multicentred Study

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ABSTRACT

To screen the level of awareness about School Based Physiotherapy using a self-administered questionnaire. To acquire information on the level of awareness about School Based Physiotherapy among school teachers .A multi-centred cross-sectional study was conducted in schools in and around Chennai. 126 teachers participated in this study which included 112 females and 20 males. A self-administered questionnaire was prepared and circulated to teachers in and around Chennai and the responses which came in within a period of 3-5 months were analysed and described. A self-administered questionnaire78(62%) school teachers of the 126 participants were unaware of SBPT. Among 126 participants 98 (78%) teachers had more than five years of experience. Science teachers made up 41.3% of the total. There were 92 high school instructors (61%), 52 primary school teachers (34%), and 8 nursery school teachers in all (5%). Awareness about School Based Physiotherapy among the primary school teachers who participated in the study was poor. Adequate awareness programs among the primary school teachers with regard to SBPT, through the various means of information transfer, can be beneficial in helping them to direct the parents who are in need of such services**.**

Keywords: school based physical therapist, service provider, school therapist, paediatric therapist

INTRODUCTION

School Based Physical Therapy is one of a group of connected service providers who help a student access his or her educational environment. They help students receive special education services. Physical therapy services help students achieve their academic and functional goals, as determined by the individualized education programme team, which includes school personnel, related service providers, parents, and, in some cases, the student. To the greatest extent possible, services should be based on peer-reviewed research [1]. They assist a student's physical involvement in a number of situations throughout the school day as movement specialists. The SBPT's main goal is to assist students in getting the most out of their educational programme while still remaining in school. SBPT is not the same as medical-based physical therapy, and determining the necessity for each service is also not the same. These services focus on both movement quality and functionality. Its main goal is to improve the child's skill level and movement quality. Medically-based therapies are often delivered in an outpatient therapy clinic or hospital to address a student's physical impairments and clinical weaknesses. In a school setting, physical therapy encourages participation of children in various activities. Physical therapy in a school context might include a variety of activities depending on a student's specific needs. Changing the environment in order to increase involvement (i.e. adaptive seating).Changing expectations in order to achieve more success and freedom. Educating employees on how to boost physical activity. Physical therapists and physical therapist assistants are essential members of school-based teams that ensure that students with disabilities receive an additional and relevant education and, in many circumstances, are prepared for further education, employment, and independent living [2].

Individuals with Disabilities Education Improvement Act of 2004 (IDEA) requires that students receive special education and related services in regular education settings (e.g., classrooms, hallways, and playgrounds) unless they are unsuccessful in those settings with supports and services. Physical therapists, as providers of related services in the educational setting, should integrate their services into students' regular routines and activities, such as moving through classroom centres or climbing on playground equipment during recess. School-based physical therapists (SBPTs) recognise that they do not always provide therapy services in traditional or natural education settings [3]. Physiotherapy plays a significant role in health care system. The pursuit of career in physiotherapy depends largely on the information available to the students about the practice of Physiotherapy [4].Physical therapy services are provided to students with disabilities in their schools as part of their Individualized Education Program in the United States. Reliable data on the characteristics of the range of physical therapy services provided to and on behalf of students are required to evaluate school-based physical therapy [5]. Unlike curriculum-based health education interventions in schools, the school environment approach promotes health by changing the physical/social environment of the school. Theories, intervention outcome and process evaluations, quantitative and qualitative studies are all part of it[6]. Because traditional health education curriculum in schools are ineffective, there is growing interest in interventions aimed at promoting young people's health by modifying the school environment. Existing systematic reviews cannot determine the effectiveness of environmental interventions because they look at interventions that combine environmental changes and traditional health education.

This is a significant gap because school-environment interventions are difficult to implement and may be overlooked in underfunded and achievement-focused school systems due to a lack of evidence to support such an approach. The impact of school-environment interventions that did not include health education on student health and inequalities. Interventions in the school environment have the potential to improve young people's health, particularly in terms of violence, aggression, and physical activity [7]. Strength, balance, coordination, and/or mobility are the primary goals of school-based physical therapy. Among the activities that a physical therapist strives to improve are: 1) Keeping one's balance while sitting in a classroom chair, on the floor during circle time, in the cafeteria, on the school bus, and/or swinging on the playground. 2) Walking from class to class and throughout the school, using a walker or wheelchair (if unable to walk unassisted), and walking up and down stairs (in school and on/off bus) 3) Navigating playground equipment, riding a tricycle/bike, maneuvering on a balance beam, jumping, skipping, throwing / catching a ball, and other recess or gym class-related activities. Physiotherapists are only appointed in special schools

in India, and only a small number of regular schools have physiotherapists. Regular school kids also require a Physiotherapist to help them get involved in their educational environment. This helps them to access their education easily. As school-based physical therapists, we frequently work in multiple schools (possibly districts) and do not usually have our own dedicated workspace. It is beneficial to have ideas for small spaces. It is also critical to have ideas that are simple to implement in collaboration with staff. In school-based physical therapy, the emphasis is primarily on core strength and balance. Physical therapists in schools ensure that all students can fully participate in school activities. SBPT is underappreciated by teachers and parents alike. The purpose of this study is to use a self-administered questionnaire to assess people's knowledge of SBPT. Based on the findings, awareness workshops in schools can be held.

METHODOLOGY

A multi-centred cross-sectional study of school teachers in and around Chennai was conducted to assess their knowledge of School Based Physical Therapy. The study included 126 teachers, 20 of whom were male and 112 of whom were female. A self-administered questionnaire was distributed to teachers in and around Chennai. Several schools in and around Chennai were personally approached. Permission letters from higher authorities were distributed to the schools in order for the survey to be conducted. Teachers who participated in the study where between the age group 22-64.The years of experience of teachers varied from 10 days to 35 years. Teachers handling different levels of education like Secondary, Primary and Nursery were participated in this study. The teachers included in the study were from various teaching specialties like Science, Maths, Language, Computer Science, Social Science, Abacus, Art, Entrepreneurship and Physical Education. Since Science teachers should be more aware of SBPT to guide the students, the subjects handled by the teachers were analysed. Questions included in the self-administered questionnaire were about their awareness on Paediatric Physiotherapy and it's significance. General questions about Physiotherapy and where physiotherapy can be studied were included. The teachers filled the forms which were given to them. The responses were updated and scored to conclude that there were more teachers who are not aware of SBPT. Awareness workshops on this will be conducted to create awareness.

RESULTS

The data was entered and analysed in Microsoft Excel. The frequency of the responses was analysed and calculated by means of percentage. School teachers must be aware of SBPT because they are the ones who are with the children during their growth. First, when the level of awareness was analysed, it was found that 78(62%) school teachers of the 126 participants were unaware of SBPT (Figure.1).Years of experience was one of the major components in the questionnaire to determine their years of experience in order to assess how well they know SBPT. Among 126 participants 98 (78%) teachers had more than five years of experience (Figure.2). Science teachers are expected to be more knowledgeable about physiotherapy and SBPT. They should be well-versed in this field in order to guide the children. Science teachers made up 41.3% of the total. There were 92 high school teachers (61%), 52 primary school teachers (34%), and 8 nursery school teachers in all (5%) (Figure.3).

DISCUSSION

The purpose of the study was to determine the level of awareness of School Based Physical Therapy among school teachers in and around Chennai. The open-ended nature of the questions assessing awareness allowed respondents to freely express their opinions, which was a key feature of this study. Erin Kinsey et all., (2022) stated that in the school setting, an intensive intervention model appears to be effective and feasible. When a student could benefit from evidence-based intervention strategies, they should be considered. He had stated about the Importance of School Based Physical Therapy in disabled kids. Vandana Rathod et al., (2018)stated about the general awareness of Physiotherapy in Primary School Teachers in which she stated that the study's primary school teachers had a low

level of knowledge about physiotherapy. Adequate physiotherapy awareness programmes among primary school teachers, via various means of information transfer, can be beneficial in assisting them to direct parents in need of such services.

CONCLUSION

Awareness about School Based Physiotherapy among the primary school teachers who participated in the study was poor. Adequate awareness programs among the primary school teachers with regard to SBPT, through the various means of information transfer, can be beneficial in helping them to direct the parents who are in need of such services. The study should be conducted on a larger sample size. More awareness sessions in schools should be conducted in the near future.

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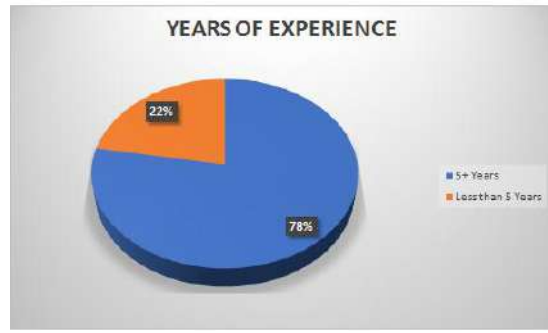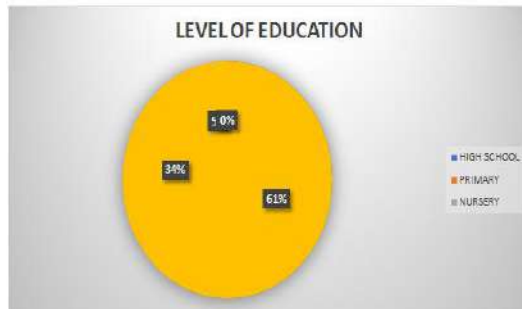
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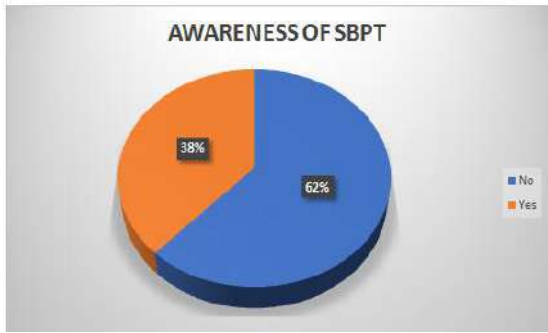
Figure 1: Awareness of SBPT

Figure 2: Year of Experience

Figure 3: Level of Education

RESEARCH ARTICLE

Current Physiotherapy Practice for Future Directions in Knee Osteoarthritis amongst Postmenopausal Women

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ABSTRACT

Osteoarthritis are common disease in postmenopausal women. It is the result of damage to articular cartilage caused by complex interaction of genetic, metabolic, biochemical and mechanical factors with secondary components of inflammation. Physiotherapy practice helps in reduction of pain and inflammation, by using cryotherapy, rest and electrotherapeutic modalities. The progressive muscle strength training, Aquatic exercises, aerobic exercises, isokinetic exercises, resistance exercises and weight management is effective in increasing the muscle strength in the quadriceps, improvement of the static and dynamic balance, increasing the speed of the motor responses, therefore improving the performance of daily activities and reducing the frequency of fall in women with postmenopausal women osteoarthritis. The purpose of this review is to find the current Physiotherapy for OA in Postmenopausal women. Articles were selected based on the basis of relevant topic and underwent the selection process. The reviewed studies provided evidence that physiotherapy interventions are beneficial for improving OA symptoms, functional capacity and Quality of Life in Postmenopausal women with OA.

Keywords: menopause. Osteoarthritis, Post-menopaual women, Physiotherapy.

INTRODUCTION

In postmenopausal women, osteoporosis and osteoarthritis are frequent ailments. Low bone mineral density (BMD) and micro architectural disruption of bone tissue are symptoms of osteoporosis, a systemic skeletal disease that raises the risk of fracture and increases bone fragility [3,4,8,9]. Contrarily, osteoarthritis results from articular cartilage destruction brought on by a complex interplay of genetic, metabolic, physiological, and mechanical variables along with ancillary inflammation-related components [10,11]. The physiological homeostasis of the entire joint is disrupted as a result of the osteoarthritis pathological alterations. The discomfort, functional capacity, and

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physical fitness of the elderly are all impacted by these diseases, which are significant public health issues[1,2,8,5]. Osteoarthritis, which accounts for 3.0% of all YLDs worldwide, is the fourth most common cause of Year Lived with Disability (YLDs). It explains the decline in daily living activities (ADL) among the elderly population who are dependent in the community[4,3]. Although osteoarthritis can affect both men and women, it is reported that females are more likely than males to develop the condition during perimenopause and to continue having it during menopause. The decrease of oestrogen during menopause may raise a woman's risk of developing osteoarthritis, according to a number of experimental, clinical, and epidemiological studies[9,8]. Compared to western nations, where the average menopausal age is 51 years, Indian women are 46.3 years old. As a result, Indian women are more likely than western women to experience osteoarthritis at a younger age [11,15]. The most prevalent kind of OA is knee OA. Because the knee joint is larger than the hand joint, knee OA is more painful and causes more physical impairment. However, the primary medical management of knee OA is restricted to symptom control, and arthroplasty surgery may be required if the condition worsens. Management of knee OA is crucial [16,18,13,6]. Since analgesics, such as nonsteroidal anti-inflammatory medications, have adverse effects such gastrointestinal problems and surgery is dangerous when performed at an older age [22,25].

Corelation between menopause and osteoarthritis
Age, gender, a person's genetic susceptibility, mechanical stress, trauma, and obesity are the key risk factors for osteoarthritis. Estrogen might contribute to the emergence of OA. Both men and women have the hormone oestrogen, albeit women have larger levels of it. Women who are going through menopause see a drop in oestrogen levels [11,18,13]. The majority of postmenopausal women suffer with OA. Because joint tissues include oestrogen receptors, it is possible that oestrogen protects the biomechanical integrity and function of these tissues. Acute oestrogen deficiency results in elevated levels of reactive oxygen species, nuclear factor-B activation, and generation of pro-inflammatory cytokines, demonstrating estrogens' predominate anti-inflammatory properties [8,9]. Numerous studies have demonstrated that joint discomfort increases as the menopause transition progresses and that preserving. It seems that progesterone and oestrogen reproductive hormone levels in women appear to lessen joint pain. This suggests that oestrogen supplementation during menopause may prevent cartilage degeneration and slow knee degeneration [18,17,9]. The prevalence of OA is higher in women than in men, and it is clearly associated with the peak age of menopause. Moreover, numerous clinical studies have revealed that 64% of women with knee OA experienced the onset of symptoms during perimenopause, within 5 years of naturally occurring menopause, or after hysterectomy. In fact, compared to only 20% of men, 58% of females had knee OA symptoms when they were under 50 years old [5,9,10]. Rather than hormonal changes, OA is brought on by degenerative changes in the joints. Degenerative "wear and tear" alterations are caused by cartilage degradation, which can cause pain, edoema, and difficulty moving the affected joint [6,7,8]. However, because high oestrogen levels are known to have an anti-inflammatory impact, it has been hypothesised that midlife hormonal changes, namely declining oestrogen levels, may increase the risk of osteoarthritis following menopause. Menopausal joint pain is frequently accompanied by aches, stiffness, edoema around the joint, and even warmth [2,4]. These could be worse in the morning, getting better as the day goes on. Larger joints, such the hips and knees, take a greater beating and are more vulnerable to arthritis in menopausal women [18]. The pain from osteoarthritis in the knees might be made worse by OA symptoms like sleep disturbances and mood abnormalities. One of the most common issues during menopause is weight gain. Knee pain reduces mobility, which leads to weight gain, which puts additional strain on the affected joints [10,12,22,23,25].

Effect of Exercises in Osteoarthritis
The primary pathological alterations linked to knee osteoarthritis are cartilage and subchondral bone degradation, as well as synovitis. Knee osteoarthritis is aggravated by mechanical strain, inflammation, metabolic variables, hormonal changes, and ageing, among other factors [21,26]. The three major forms of treatment for osteoarthritis of the knee are medication, physical therapy, and surgery. However, medication has several negative effects, and surgery is only appropriate for people with advanced osteoarthritis of the knee. Exercise is a key technique to increase and maintain bone mass at any stage of life because bone responds to variations in habitual mechanical loading [28,29,30]. Exercise training, used in conjunction with physiotherapy, can delay the deterioration of cartilage, reduce inflammation, and stop the loss of subchondral and metaphyseal bone trabeculae [17,18,20]. In patients with

knee osteoarthritis, exercise training appears to reduce pain, stiffness, joint dysfunction, and muscle weakness. For the treatment of knee osteoarthritis, there are a number of exercise training choices, such as aerobic exercise, strength training, neuromuscular exercise, balance training, proprioception training, aquatic exercise, and traditional exercise [26,27,28,30,31]. The current care of OA concentrates on minimising the symptoms and decreased function linked to the illness because there is no known cure or treatment that prevents or reverses the biochemical changes in the cartilage[32,36,37]. Additionally, it has been demonstrated that an active lifestyle that includes exercise is good for maintaining the biochemical characteristics of cartilage. Additionally, research has shown that exercise can stop the course of OA and reverse the cartilage shrinkage that results from inactivity and immobility. Because of this, PT may be a useful strategy for maintaining cartilage health [27,28,29].

METHODOLOGY

Search Strategy
We performed A systematic review for current physiotherapy practice for knee osteoarthritis in postmenopausal women. For the purpose of this review, an electronic search for relevant articles was done using Google Scholar, PUBMED, MEDLINE, Pedro, Research Gate and CINHAL database from 2019 to March 2022 was done where in MeSH search terms such as osteoarthritis in Postmenopausal women, function assessment tools, assessment index, quality of life, recent advances and free words were used. In addition to this, relevant books were also searched manually. Articles were chosen based on the expertise, self-awareness, and reflective practice.

Study Selection
The selection criteria of review were:
- Knee Osteoarthritis in Post-Menopausal Women
- Effect of exercises on knee osteoarthritis in postmenopausal women
- Comorbities in postmenopausal OA knee patients
- Study with mild knee osteoarthritis.

Data Extraction
All steps in selection of studies were assessed for the inclusion criteria. The titles and abstract of the studies were reviewed by reviewers. Full text of related articles were reviewed and included if they met inclusion criteria. The following data were extracted from related articles: study design, study population, physiotherapy interventions, physical impact, selected outcome measures, and key findings (Table 1).

REVIEW OF LITERATURE (Fig.1)

RESULT

The searches identified eight relevant studies; met the inclusion criteria for further analysis. These studies showed beneficial results of physiotherapy interventions in postmenopausal women having knee osteoarthritis. Studies showed physiotherapy interventions reduces pain and inflammation, also prevents further progression. It helps to restore normal movement pattern, muscle strength and gait pattern. Effects of high intensity resistance water training on body composition and walking speed in women with mild knee OA were discussed by Benjamin Waller, Matti Munukka, and others. In this study, two study arms were divided up into 87 volunteer postmenopausal women. While the control group (n = 44) continued their daily physical activities, the intervention group (n = 43) underwent 48 hours of closely supervised, intense water resistance training. 84 participants remained for the full 12-month follow-up period. With the help of dual-energy X-ray absorptiometry, body composition was determined (DXA). The knee injury and osteoarthritis outcome score (KOOS) and walking speed over a 2-kilometer distance were measured. Self-reported diaries were used to capture LTPA. In post-menopausal women with mild symptoms,

high intensity water resistance training reduces fat mass and increases walking speeding. knee OA. At a 12-month follow-up, only walking speed improvements remained. Loss of fat mass was linked to higher LTPA levels [4]. A Daskpan, F. Kilic, et al. looked into how aerobic exercise training affected postmenopausal women's OA knee pain and disability. 50 women (aged 48 to 78) with grade 2-3 knee OA on the Kellgren-Lawrence radiographic scale were included in the study. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the six-minute walk test (6MWT), the stair climb test (9-step SCT), and the visual analogue scale (VAS) were used to assess physical performance in relation to OA. Randomization was used to assign 50 patients to the treatment or control groups. For six weeks, the treatment group had a combination physiotherapy and extra aerobic exercise programme. For six weeks, the same physiotherapist performed the aerobic exercise programme five days a week. Only six weeks of a combined physiotherapy programme were given to the control group. In contrast, VAS ratings, the outcomes of all performance tests, WOMAC scores, and the distance covered in the 6MWT were substantially higher in the therapy group (p 0.05) in the post-treatment comparisons of the two groups [13]. A randomised controlled trial by Jesus Casilda-Lopez, Marie Carmen Valenza, et al. examined the effects of a dance-based aquatic fitness programme in obese postmenopausal women with knee osteoarthritis. An experimental group of women (n = 17) and a control group of women (n = 17) were assigned randomly. An 8-week aquatic workout programme based on dance was offered to participants in the experimental group in public swimming pools. The control group engaged in a comprehensive aquatic exercise regimen. Functionality was the main performance indicator. using the Osteoarthritis Index from Western Ontario and McMaster Universities (WOMAC). The 6-minute walk test was used to evaluate cardiorespiratory capacity, and a visual analogue scale was used to measure post-exercise heart rate and exhaustion.

A three-month follow-up was conducted after the baseline and intervention measurements. According to the study's findings, a dance-based exercise programme lasting eight weeks dramatically increased function and cardiorespiratory capacity while lowering post-exercise heart rate and fatigue [10]. The effectiveness of progressive aquatic resistance training for tibiofemoral cartilage in postmenopausal women with mild knee OA: a randomised control experiment was discussed by M. Mnukka, B. Waller, et al. Eighty seven postmenopausal volunteers, ages 60 to 68, with mild knee OA (Kellgren-Lawrence grades I/II and knee discomfort), were enlisted. They were then randomly divided into an intervention (n = 43) and control (n = 44) group. While the control group continued their usual level of physical activity, the intervention group engaged in 48 sessions of supervised water resistance training over a period of 16 weeks. Using single-slice transverse relaxation time (T2) mapping and delayed gadolinium-enhanced magnetic resonance imaging of cartilage, it was possible to determine the biochemical makeup of the medial and lateral tibiofemoral cartilage (dGEMRIC index). Cardiorespiratory fitness, isometric knee extension and flexion force, knee injury, and OA outcome (KOOS) questionnaire were secondary outcomes. T2 -1.2 ms (95% confidence interval (CI): -2.3 to -0.1, P = 0.021) and dGEMRIC index -23 ms (-43 to -3, P = 0.016) in the training group compared to controls in the full thickness posterior region of interest (ROI) of the medial femoral cartilage showed a significant decrease after four months of aquatic training. The intervention group's cardiorespiratory fitness increased by 9.8%7, which was highly significant[7]. A study was conducted by K Martin, K R Fontaine, B J Nicklas, K E Dennis, A P Goldberg, M C Hochberg, et al. to ascertain the effects of a weight loss and walking programme on knee pain and physical function in overweight and obese (BMI [kg/m2] 25-29.9 and BMI $ 30) postmenopausal women with knee osteoarthritis (OA). Forty-eight of these women participated in a 6-month intervention that comprised weekly nutrition classes and an exercise-walking programme.

They also completed self-report tests (Western Ontario and McMaster University Osteoarthritis Index [WOMAC]) and performance-based assessments of physical function. According to study results, postmenopausal overweight and obese women with knee OA benefit from a 6-month weight loss and walking programme in terms of physical functioning and pain management. The correlation between functional improvement and weight loss in obese individuals encourages sustained attention on weight loss for treating knee OA[16]. The effects of aerobic exercise training on postmenopausal patients with knee osteoarthritis were investigated by FilizKlç, ArzuDemirgüç, SaniyeAydoanArslan, EsraDilekKeskin, and others. 50 women (aged 48 to 78) with grade 2-3 knee OA on the Kellgren-Lawrence radiographic scale were included in the study. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the six-minute walk test (6MWT), the stair climb test (9-step SCT), and the visual

analogue scale (VAS) were used to assess physical performance in relation to OA. Randomization was used to assign 50 patients to the treatment or control groups. For six weeks, the treatment group had a combination physiotherapy and extra aerobic exercise programme. For six weeks, the same physiotherapist performed the aerobic exercise programme five days a week. Only six weeks of a combined physiotherapy programme were given to the control group. In contrast, VAS ratings, the outcomes of all performance tests, WOMAC scores, and the distance covered in the 6MWT were substantially higher in the therapy group (p 0.05) in the post-treatment comparisons of the two groups[13]. In a 12-month randomised controlled trial (RCT), J Multanen, T Rantalainen, H Kautiainen, R Ahola, T Jämsä, M T Nieminen, E Lammentausta, A Häkkinen, I Kiviranta, A Heinonen, et al. looked at the impact of progressive high-impact exercise on the structural strength of the femoral neck in postmenopausal women with mild knee Eighty postmenopausal women with mild radiographic osteoarthritis of the knee were divided into two groups at random: the exercise group (n = 40) and the control group (n = 40). Dual-energy X-ray absorptiometry was used to gauge the structural strength of the femoral neck. T2 mapping and delayed gadolinium-enhanced MRI of cartilage are quantitative MRI techniques that were used to determine the amount of knee cartilage that was exposed to exercise loading (dGEMRIC). Additionally, an accelerometer-based body movement monitor was utilised to assess the effects of the individuals' total physical activity loading on changes in femoral neck strength. The bootstrap analysis of covariance was used to estimate the training effects on the outcome variables. In women with mild knee osteoarthritis, the high-impact training boosted femoral neck strength without negatively impacting knee cartilage.

These results suggest that a potential strategy to prevent hip fractures in postmenopausal women with possibly fragile articular cartilage is gradual high-impact exercise[9]. The impact of isokinetic and aerobic exercise on serum levels of interleukin-6 and tumour necrosis factor alpha, pain and functional activity in individuals with knee osteoarthritis was examined by GülbüzSamut, FitnatDinçer, Oyazdemir et al. According to the diagnostic criteria of the American College of Rheumatology, 42 postmenopausal women and men with knee OA were included. Patients were divided into isokinetic, aerobic, and control groups using randomization. Patients in the intervention groups participated in pre-planned exercise regimens three times per week for six weeks. At baseline and at the end of the sixth week, the severity of pain, functional activity status, muscle strength, functional capacity, and serum cytokine levels were assessed. Although CRP levels showed a strong trend toward significance at the conclusion of the sixth week, there was no statistically meaningful drop in serum pro-inflammatory cytokine levels in either exercise group. The VAS and WOMAC ratings significantly decreased in both exercise groups compared to the control group, while functional ability and muscle strength significantly increased. Therefore, this study comes to the conclusion that exercise is useful for lowering discomfort, enhancing function, and increasing muscle strength [14].

DISCUSSION

The current analysis found 10 years' worth of published material on knee osteoarthritis in postmenopausal women that discussed physiotherapy treatment. In this study, the randomised control trials provided the majority of the evidence for management. However, there were some discrepancies between the studies' recommendations and results. These variations may be partially explained by variations in the methodology used to examine the reviewed research, the kind of studies chosen, the varied character of the clinical trials under assessment, and/or the emphasis or objective of these studies. As a result, high calibre study is required to assess the efficacy of physiotherapy treatment for knee osteoarthritis in postmenopausal women [2,4,9,19,17,22,24].The fact that so few databases were searched may represent a limitation of the current review. To widen the review and avoid excluding more recommendations and references for physiotherapy treatment of knee osteoarthritis in postmenopausal women, other databases may have been explored. However, Pubmed was chosen because it offers information on how to treat illnesses in a way that supports the current review's objectives, particularly when it comes to finding randomised control trials [4,8]. High-intensity water resistance training reduces fat mass and enhances walking speed in post-menopausal women with mild knee OA, according to a study by Benjamin Waller, MattiMunukka, et al. A Daskpan, F. Kilic, et al. study examined the effects of aerobic exercise on postmenopausal women with knee OA to see how it affected functional limits, exercise tolerance, and performance tests. The findings revealed that aerobic

exercise considerably reduced functional limitations. Thus, aerobic exercise and aquatic exercise were useful for enhancing functional capacity in postmenopausal women with knee OA, according to the research mentioned above [4,13]. The effects of an 8-week dance-based exercise programme dramatically increased function and cardiorespiratory capacity, as well as lowered post-exercise heart rate and fatigue in obese postmenopausal women with knee osteoarthritis, according to Jesus Casilda-Lopez, Marie Carmen Valenza, et al[10]. The integrity of the collagen-interstitial water environment (T2) of the tibiofemoral cartilage may be responsive to low shear and compressive stresses during aquatic resistance training, according to M. Mnukka, B. Waller, et al., [7]. A 6-month weight reduction and walking programme, according to K Martin, K R Fontaine, B J Nicklas, K E Dennis, A P Goldberg, M C Hochberg, et al., improves measures of physical functioning and pain in overweight and obese postmenopausal women with knee OA. Thus, the study mentioned above found that functional improvement among obese women was connected with weight loss, supporting sustained attention on weight loss for treating knee OA[16].T. Rantalainen, J. Multanen, et al. Effect of progressive high-impact exercise on the structural strength of the femoral neck in postmenopausal women with mild knee osteoarthritis was examined. According to the study's findings, high-impact training increased femoral neck strength in these women without negatively affecting their knee cartilage. In order to avoid hip fractures in postmenopausal women whose articular cartilage may also be fragile, the study suggests that progressive high-impact training is a workable method [9].

The effects of isokinetic and aerobic exercise training programmes on serum pro-inflammatory cytokine levels, pain, and functional activity in patients with knee osteoarthritis (OA) were examined by Gülbüz Samut, Fitnat Dinçer, Oyazdemir, et al. Results indicate that isokinetic and aerobic exercise is effective in reducing pain, improving function, and building muscle strength, but there was no statistically significant decrease in serum pro-inflammatory cytokine levels [14]. Maintaining a regular exercise routine is crucial for enhancing physical function and performance as well as decreasing discomfort, especially in postmenopausal patients. According to a study, older persons with knee OA who exercise more frequently have better physical performance and self-reported disability. The adverse events that occurred throughout the therapy period were rarely documented in research. Although they were noted in a small number of patients, the most frequent side effects were muscle soreness, increased foot and knee discomfort, and low back pain after activity. Another drawback of this review was the heterogeneity of the included studies, which had different scores with various primary and secondary outcomes, different protocols with distinct types of exercise (especially for aquatic and land-based exercise), different follow-up times, and studies that varied in both the length of individual sessions and the entire programme. As a result, it was impossible to compare the findings of the various study groups properly, even though it was obvious that all forms of physical activity were more effective than the control groups.

CONCLUSION

The articles that were previously examined gave a summary of the most recent research on physiotherapy therapies for OA in post-menopausal women. The evaluated studies provided proof that the physiotherapy methods described are helpful for enhancing post-menopausal OA patients' symptoms, functional capacity, and quality of life. If the physical therapy incorporates quadriceps activation, balance training and fall prevention, patient-centered treatment strategy, at-home exercises, and appropriate recreational activities, it may be successful.

CONFLICT OF INTEREST: None

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Table 1: Data extraction

study	Author	Intervention	Outcome measurement
Effects of high intensity resistance aquatic training on body composition and wallking speed in women with mild knee OA	Benjamin Waller, MattiMunukka	Aquatic resistance training 6 sessions lasting 1 hour, 3 times a week for 16 weeks	dexa, walking speed over 2km, koos, leisure time physical activity (LTPA)
Effect of a dance based aquatic exercise program in obese postmenopausal women with knee osteoarthritis: a randomized controlled trial	Jesus Casilda-Lopez, Marie Carmen Valenza	The dance-based training sequence was 5 minutes of slow rhythm music, 3 minutes of fast rhythm music, 5 minutes slow, 3 minutes fast, and 5 minutes slow (total 21 minutes). A cool-down period after the last rhythm was allowed for all participants.	6 MWT, VAS, Borg scale
Efficacy of progressive aquatic resistance training for tibiofemoral cartilage in	M. Mnukka, B waller.	one hour of supervised lower limb aquatic 21 resistance training	T2 relaxation time mapping and dGEMRIC INDEX

postmenopausal women with mild knee OA : a randomized control trial		three times a week for 16 weeks, for a total of 48 training sessions. Resistance of exercises was progressed with three different levels: barefoot, small fins and large resistance boots	
Weight loss and exercise walking reduce pain and improve physical functioning in overweight postmenopausal women with knee osteoarthritis	K Martin, K R Fontaine, B J Nicklas, K E Dennis, A P Goldberg, M C Hochberg	6-month weight loss and walking program of weekly classes that presented information on nutrition and healthy eating. walking session, was held after each nutrition class; the remaining two sessions per week were performed independently at home.	WOMAC, Up and Go test, 6-min walk test
The effect of aerobic exercise training on postmenopausal patients with knee osteoarthritis	FilizKılıç, ArzuDemirgüç, SaniyeAydoğanArslan, EsraDilekKeskin, Müyesser Aras	walking on the Voit treadmill five days for six weeks. Intensity-50%–70% of the maximum heart rate.	40 m Fast-Paced Walk Test (40mFPWT), 30 s Chair Stand Test (30sCST), Stair Climb Test (9-step SCT)), six-minute walk test (6MWT), (WOMAC), and Visual Analogue Scale (VAS)
Effect of progressive high-impact exercise on femoral neck structural strength in postmenopausal women with mild knee osteoarthritis: a 12-month RCT	J Multanen, T Rantalainen, H Kautiainen, R Ahola, T Jämsä, M T Nieminen, E Lammentausta, A Häkkinen, I Kiviranta, A Heinonen	Three weekly 55-min sessions of supervised high-impact aerobic and stepaerobic exercise for 12 months	DEXA, T2 mapping and (dGEMRIC)
The effect of isokinetic and aerobic exercise on serum interleukin-6 and tumor necrosis factor alpha levels, pain and functional activity in patients with knee osteoarthritis	Gülbüz Samut, Fitnat Dinçer, OyaÖzdemir	3days/week for 6weeks Isokinetic exercise- 5 min warm up on treadmill, 5 consentric flexion and extension at angular velocities of 60^0 /s, 90^0 /s, 120^0 /s and 180^0 /s. Aerobic exercise-5 minutes of warm-up on treadmill, exercise intensity was adjusted for 65 %-70%	BMI, Body composition analyser, AROM, PROM, Knee X-ray, VAS, WOMAC, 6 MWT, 30 Sec Sit to Stand test, Serum Inflammatory markers measurement, Biodex System 3 Pro Multijoint System Isokinetic Dynamometer.

		of age related heart rate for the first 4 weeks and 70%-75% for the next 2 weeks	
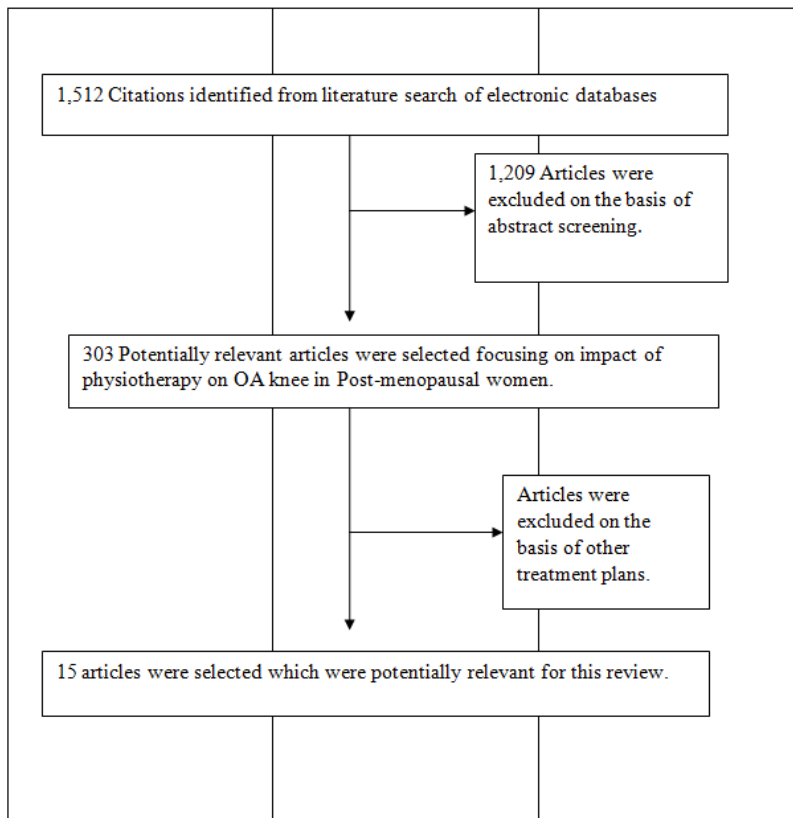
Fig.1. Flowchart summarising the selection of the articles for the review:

RESEARCH ARTICLE

Analysis of Recent Trends in the Collection of Specified and Non-Specified Non Timber Forest Produce in the State of Chhattisgarh

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ABSTRACT

The research work analyses the trend present in the collection of specified and non-specified NTFP. Recently the government of Chhattisgarh increased the MSP of NTFP. The declining trend obtained in this research work indicates that increased MSP of NTFP will not result improving the SES of the tribals as diminishing collections makes the income stagnant.

Keywords: Government, Chattisgargh, NTFP, tribals

INTRODUCTION

Chhattisgarh is a state that is suitable for enriched biodiversity. The subtropical climate of the state makes it suitable for green forests, diverse agricultural practices and thriving wildlife. The state from the imperial era is known for its forest produce that surpasses all the international standards. The wood originating from the sal and the sagaun tree is known for its anti-termite property and ability to used in industrial applications that have highly humid environment. Apart from the timber produce Chhattisgarh is also known for its high quality non timber forest produce such as –:
Specified NTFP
1. Tendu leaves
2. Gum
Non-Specified NTFP
Lac
1. Sal seeds
2. Gum Khullo
3. Harra

Satya Kishan and Kavita Silwal

While the gum, sal seeds, and Harra have vivid industrial usages such as ayurvedic proprietary medicine manufacturing, bakery fat manufacturing, feed manufacturing, and cosmetic fat manufacturing tendu leaves are used only for rolling poor man's cigarette also known as bidi. The tribal population of Chhattisgarh especially those who live nearby forest rely heavily on collection and selling of these NTFPs for earning livelihood. Recently, the government increased the minimum support price of the forest produce. For example, the MSP of tendu leaves increased from 2000 INR to 4000 INR per standard bag. The aim of increasing the MSP for the forest produce was to increase the income of NTFP gatherers. However, the effect of increasing the MSP is not reflecting from the socioeconomic conditions of NTFP gatherers. The objective of this research work is examining the trend present in the collection of NTFP in state of Chhattisgarh. The objective was set because the benefit of increased MSP for countering poor SES would be visible only when the collection of NTFP is increasing after increase in MSP.

LITERATURE REVIEW

NTFPs faces numerous challenges right from the collection to being converted as a finished goods. Biecher et.al, 2005, stated that around the world a large portion of the tribal's depend heavily on the collection of NTFPs for income and therefore stability in collection is necessary for a sustained income. Bhat et.al, 2018 stated that NTFPs suffer from production of finished goods difficulties because market states that raw materials of these goods i.e. NTFPs suffers from production stability and consistency and hence, market sizing is not possible. The research work indicated that NTFPs are not facing production issues rather they are undergo cyclic production cycle thus sometimes the production booms while sometimes it undershoots. Hence, the market sizing should be treated as optimization problem. Tikkanen, 2020 stated that collection bottleneck is one of the major issue behind the conversion of NTFPs into finished goods hence, its collection needs to be optimized.

DATA AND METHODS

To meet the set objective of this research-work the following data and methods were used. Data – Ancillary data obtained from the Chhattisgarh state minor forest produce trading and development co-operative federation ltd. Related to collection of specified NTFPs and non-specified NTFPs. Method – The trend in the collection of NTFP was determined using a linear regression model. In the model the collection of NTFP was considered as the dependent variable while time was considered as the independent variable. The coefficient associated with the time was considered as the one indicative of the trend present in the collection of NTFPs.

Analysis

The analysis of the ancillary data related to the research work has been presented below. From the table 1 presented above it is evident that for the year 2010 the collection of tendu leaf bags was 15.45 lakh standard bags (LSB). For the year 2011 the data was recorded as 13.57 LSB for the year 2012, 2013 and 2014 the collection was stagnant and 17.15 LSB was recorded for each year for the year 2015 the collection was recorded as 14.27 LSB while for the year 2016 the collection was recorded as 13 LSB while for the year 2017 it was recorded as 13.61 LSB. For the year 2018 the collection was recorded as 17.1 LSB while for the year 2019 the collection was recorded as 14.85 LSB. For the year 2020 the collection was recorded as 15.05 LSB. From the figure 1 shown above it is evident that the collection of tendu bags is exhibiting a declining trend. The trend noticed for the same was, -0.075 LSB. The determined trend shows a significant declining trend in the collection of the tendu leaves which is an important NTFP. From the table 2 presented above the collection of sal seeds was 1.34 Lakh quintals (LQ) in the year 2010. For the year 2011 it was recorded as 0.39 LQ. For the year 2012 the collection was recorded as 7.14. The collection remained stagnant for the year 2012, 2013, and 2014. For the year 2017 lowest sal seeds collection was recorded. The value was recorded as 0.028. From the figure 2 shown above it is evident that the collection of sal seeds is decreasing. The trend obtained for the same is -0.34 LQ per annum. Sal seeds is an important NTFP. Hence, a decline in the collection of sal seeds is alarming for the part of the economy which is dependent on the forest produce. For other important forest produce

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similar declining trend was noticed. Other important forest produce includes Harra, Gum, Gum Kullo, and Lac. Table 3 presents the detail of the same. From the table shown above it is evident that the collection of all the important forest produces is declining. The decline in the collection of these important forest produce is alarming as a major population of the state is dependent on the incoming arising from the collection of these forest produce.
The following conclusions can be drawn from the analysis presented above:

1. Tendu leaves are used for making poor man's cigarette that is wrap bidi. The bidi is an essential part of the culture of the Chhattisgarh state. It is one of the oldest forms of intoxication and tobacco consumption in Chhattisgarh. Tribals smoke wrap bidi in number of their cultural ceremonies as a customary part of the ritual associated with it. Other than cultural linkages there exists numerous tribal families that are involved in the collection of tendu leaves from centuries. Family members do not indulge themselves in any work apart from tendu leaf collection. A decline in the number of tendu bags collected suggests that these families are getting less chances of earning livelihood. The government of Chhattisgarh provides a support price of Rs 4000 per Standard bag. However, the declining trend in the collection of tendu bags diminishes the hope of alleviating the socioeconomic conditions of NTFP gatherers. The increase in minimum support price offers minimal benefit if the collection is decreasing. Thus, the income remains stagnant.
2. Sal seeds offer numerous industrial manufacturing options. They are ideal source of fat that can replace the costly coco butter. The cakes obtained after oil extraction are fit for production of fodder for poultry and pigs. However, the collection of sal seeds is also decreasing in the state. The decline in the collection of sal seeds hinders the hopes of economic upliftment of tribals who rely heavily on sale of forest produce for livelihood.

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Table 1: Collection of Tendu Leaves Bags (LSB) in Chhattisgarh

Year	Collection in Lakh Standard Bags (LSB)	Comment
2010	15.45	As compared to 2010 the collection of tendu bags decreased in the year 2020 by almost 0.40 LSB. Decrease in the collection was also noticed for years 2011, 2016, and
2011	13.57	
2012	17.15	
2013	17.15	
2014	17.15	

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2015	14.27	2019
2016	13	
2017	13.61	
2018	17.1	
2019	14.85	
2020	15.05	

Source: Data as furnished by Cgmfpfed

Table 2 :Collection of Sal Seeds (in Lakh Quintals) in Chhattisgarh

Year	Collection in Lakh Quintals	Comment
2010	1.34	The collection of the sal seeds is also decreasing.
2011	0.39	
2012	7.14	
2013	7.14	
2014	7.14	
2015	1.26	
2016	1.12	
2017	0.028	
2018	1.231	
2019	1.22	
2020	0.616	

Source: Data as furnished by Cgmfpfed

Table 3 : Collection of other important NTFPs in Chhattisgarh

Year	Harra (Quintals)	Gum (Quintals)	Gum Kullo (Quintals)	Lac (Tons)
2010	15710	955	0.76	-
2011	-	-	9.62	-
2012	7003.5	64.5	138.5	325
2013	7003.5	64.5	138.5	325
2014	7003.5	64.5	138.5	325
2015	34188.51	-	40.27	-
2016	57120	-	40.27	-
2017	3087.76	27.5	4	135
2018	125.87	28	3	2693
2019	1802.77	-	-	2252
2020	4072	-	0.69	357.5

Source: Data as furnished by Cgmfpfed

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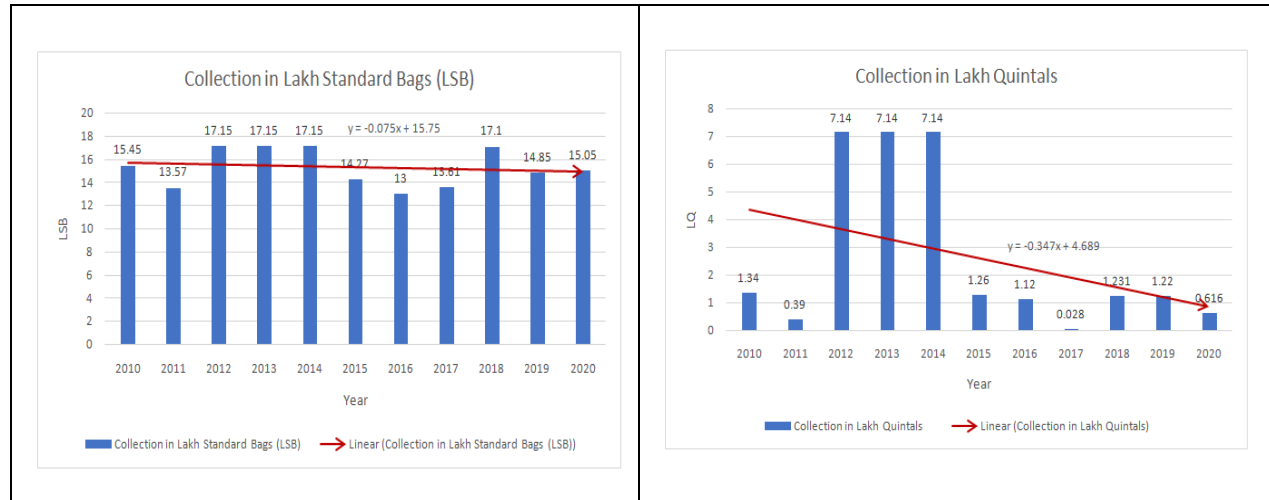
Figure 1: Trend in the collection of Tendu LSB	Figure 2: Trend in the collection of Tendu LSB

REVIEW ARTICLE

A Review of Cloud Based Augmented Reality / Virtual Reality

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ABSTRACT

AR/VR is the trending technology which can provide user experience the unseen within their comfort zones. If these technologies are merged with the cloud, then the outcomes would be satisfactory. This paper discusses a detailed explanation of AR/VR, the technologies used to develop and their history.

Keywords: AR/VR is the trending technology, user experience, outcomes

INTRODUCTION

Technology has made a greater impact on our lives. From booking tickets to shopping online, everything has come over our fingertips. And these technologies become boon when humans can venture out without physically venturing out. Augmented Reality and Virtual Reality have made this possible. We can run on a treadmill but feel as if we are jogging in a beautiful green park. Students can practice flying an airplane without actually flying it using a simulator. All of this is made possible using AR/VR. This paper details how these technologies work and how it can be improved using Cloud.

Augmented Reality and Its Future

Everyone has probably heard of the Pokémon Go game, it is the best example anyone can give when explaining Augment Reality (AR). Augmented Reality is a technology that makes use of existing reality and objects to bring in computer generated reality on top of it. This technology is used to lay computer generated images on top of the user's view and creates 3D shaped models, information and media. So, AR is not just an independent technology, rather it uses image processing, data analytics and other technologies to its success [1]. AR uses a physical device to overlay real world objects on top of the existing reality. Google Glasses, introduced in 2014 was a device that made users experience such technology for the first time. This brings us to the history of Augmented Reality. 1968 was the year when Augmented Reality made a debut and Ivan Sytherland, a professor and computer scientist at Harvard

created the first head-mounted display called 'The Sword Of Damocles'. Later in the year 1990, Tom Caudell, a Boeing researcher coined it the term 'Augmented Reality'. Later in the year 1992, Louis Rosenburg, working at USAF Armstrong's Research Lab as a researcher created a fully functional AR system and name it 'virtual fixtures'. The year 1998 was a massive outbreak in the success of the technology as the "sports vision" broadcasted the first NFL game with the yellow yard marker[2]. In 1999 NASA created a hybrid synthetic vision system of their X-38 spacecraft. This system leveraged AR technology to assist the pilot in an enhanced navigation system. In the early 20s the Esquire Magazine printed the concept of augmented reality to make the pages come live. Then came the first wearable experience of Augmented Reality by Google when it introduced Google Glass. Then Microsoft jumped into the business to deliver its version of wearable glasses called HoloLens. The technologies used are SLAM (simultaneous location and mapping), depth tracking and Image processing. All these technologies put together makes Augmented Reality possible. Camera devices such as smartphones and wearable's first capture the image of the surrounding place and analyze the objects present there. It then downloads data from the server about that object using image processing techniques and displays information relating to it [3]. Other applications of AR also provide users with 3D experience of digital objects that are not real or present there. It does this by downloading data about the object to be placed in that reality from the cloud and adjusts its size and position accordingly, when the user displaces himself the size and position of the digital object is adjusted automatically. The best use of the technology is put by Snapchat.

Types of Augmented Reality
There are over 6 types of Augmented Reality. We shall discuss all of them in brief.

- Marker-based AR: This type of AR uses the back camera of the mobile or any other device such as headset to analyze the environment and objects called markers in them. AR then allows users to view the marker in a much detailed view and in every angle.
- Mark less AR: In mark less AR, the technology allows users to insert objects that are not present in reality in that location.
- Location-Based AR: It is one of the most useful AR technologies today. It allows the users to navigate through places and get guidance on the surrounding places. Google maps allows users to see through the places on the mobile and get directions on the screen as if arrows are marked on the roads.
- Superimposition AR: This type of augmented reality creates an alternate view of a specific object and is partially or fully replaced by the original view of the object. In simpler sense, the superimposition AR creates an object and replaces either partially or completely by the original copy of the object on the device
- Projection-based AR: This type of augmented reality is not used by the user, instead the projection technique can extend or deliver data of object and its image on the surface of actually existing object.
- Outlining AR: This type of AR identifies the boundary lines with an updated augmented view which human eyes are incapable of recognizing it. It uses special cameras to identify such boundaries in certain situations [4].

Applications of Augmented Reality
There are many applications of AR such as in medicine, education, industry, tourism, search and rescue and still counting. Some of them are discussed below. Augmented Reality has already found its way into the medical field. It can help in preliminary care and operating rooms. One such example is AccuVein. AccuVein has designed a device that can help doctors see through veins and blood to get an idea from where to draw the blood or insert an IV. Augmented Reality can help doctors in operating rooms to plan complex surgeries before performing it. During June 2020, a neurosurgeons at Johns Hopkins University in Baltimore performed world's first Augmented Reality Surgery. The surgery was performed on the patient to help him with his back pain. The doctors used it to place six screws on the spine of the patient. Another field in which AR has got its place is education. This also includes medical education, where AR helps students understand complex organs such as heart and brain in a detailed and hands-on experience. For engineering students, it is a boon. Students can study complicated parts of a machine such as airplanes with 3D experience and in depth. The objects can be placed in an open ground and students can roam around the object and zoom in to get a detailed preview and engineering of the machine [5]. Tourism is a fun way of

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explaining AR. Nowadays, tourists can take a look at hotel rooms, places they want to visit before they actually travel. AR can enhance this experience by allowing the users to see these places in their comfort zone. This can even help businesses and Hotel management to gain early user feedback and improve user satisfactions. An example of such a hotel is The Hub Hotel from Premier Inn. It is a British resort, which designed an Augmented Reality system that made the rooms compatible with the wall maps. When the walls are viewed through the mobile phones, the wall maps show extra information about the popular attractions in the vicinity and some other information.

Drawbacks of Augmented Reality

Every new or old technology has limitations in itself. So, does Augmented reality. Some of the demerits are discussed below.

- **Affordability**: AR is an expensive technology depending upon how complex the use of the app or device actually is. The price of AR can reach up to $100k. Take a device which can present the complex engines in a rocket for example. Research involved in this can take a lot of time and man-power. Such devices will automatically increase the price.
- **Privacy and security:** People have already started to feel a little discomfort when it comes to privacy while using Augmented Reality. But AR is not possible without collecting user data and its environment, as the whole purpose of AR is collecting data. So, companies have to ensure how they use the data collected and inform the users about the same.
- **Healthcare:** Everybody is familiar with the chaos created when accidents became very frequent while people engaged in playing Pokémon game. People got addicted to such things. This is the major drawback of such technology when its users start using it very often. This must be dealt with utmost attention [6].

Virtual Reality and Augmented Reality

As the name suggests, it's virtual. There are no physical objects in reality, the user is fully submerged into a digital world. It's one step beyond Augmented Reality. In this case, there are no smartphones or glasses used, specially designed headsets are used that completely blocks the user's sight and make him experience the virtual world with all digital objects in front of him. This concept is called Virtual Reality. It is used to create a simulated environment and is easily recognizable from its head mounted device. The user experiences a three-dimensional view of surroundings in front of his eyes instead of on the screen. Sam Trudgian, a VR developer at Napster, says, "VR and AR are in a state of innovation now. Headsets are getting smaller, faster and wireless" [7].

There are mainly three types of Virtual Reality

1. Non-Immersive: This is a category which is the simplest just because it's very common. In this the user is immersed into a digital environment where he's in control of their physical environment. Examples of such types are video games.
2. Semi-Immersive: As the name suggests, this type of virtual reality provides users with a partial virtual environment. It still makes the users feel that they are in a different reality where the technology is used to focus not only on digital image, but also allows users to remain connected to the actual reality [8]. The semi-immersive virtual reality provides environment with 3D graphics, also known as virtual depth. More detailed graphics results in a better and more realistic environment. Such types of VRs are used in the field like education and for training purposes which rely on displays such as projectors and other simulating displays.
3. Fully-immersive: Fully-immersive virtual reality offers the users the most realistic virtual environment and makes the user fully immersed into the reality. Here the user is fully immersed into a completely different virtual environment. The VR head mounted displays(HMD) or glasses are a must to experience and interact with the fully-immersive virtual reality. The VR headsets high resolution content to the user. Such devices split between the user's eyes which helps in creating a stereoscopic 3D effect which is combined with the input tracking to establish an immersive experience. As discussed above, in Augmented Reality the users experience digital objects

called 'Markers' immersed into their reality, whereas in Virtual Reality the users are fully immersed into the digital world. So here are some of the points discussed to differentiate between AR and VR.

- AR uses both physical and digital worlds to make users experience it, while VR makes users feel completely the digital world.
- In AR the user's physical form is in control, while in VR it's difficult to act with the user's form, however there are enhancements being done into the field.
- VR uses a headset, while AR can be experienced even with the help of a smartphone.
- AR enhances both physical and virtual reality, while VR enhances only the fictional reality.

Future of AR/VR

The concept of Augmented and Virtual Reality was discussed in a fiction book back in 1902, today it has become a reality. The advancements in science and technology is leading humanity to serve itself and nature in a better and effective manner. The future is expected to be driven by such technologies. Already remote surgeries have begun and becoming successful. The future can be very exciting using these technologies [9]. From space exploration to education and deep sea exploration, everything will be possible with such technologies, at the same time competition in such markets will also be at its peak.

Cloud Computing

The definition of cloud goes like this "On demand availability of computer system resources like storage without direct management by the user". This has contributed towards the growth of the cloud market a lot. Cloud is not just about storage, it's about lending resources and hardware remotely to the user on a rental basis. There are many companies that charter these services, some of them are Google Cloud, Amazon Web Services, Microsoft Azure. Among these AWS is the most popular one with a lot of inbuilt services which include storage, analysis, ease of access, and most importantly security. So, cloud is simply put into "Pay for what you use".

AWS Sumerian

Today cloud providing means in development of AR/VR have emerged. One such platform is Amazon Sumerian. Launched in Nov 2017, the Amazon Sumerian aims to provide developers set of tools to help create them virtual environment and chat bots. It is used to create Augmented and Virtual Reality and also 3D applications easily and publish those application on a website. Sumerian is merged with an AWS tool known as Amplify that is used to build full-stack web application. Depending on the usage of AWS Amplify Amazon charges the user [10].

Proposed methodology

We have many services as a part of cloud but what if we had another one called "AR/VR as a Service". Merging cloud with AR/VR can boost its capabilities. The main challenge that the current AR/VR face is the network, due to which there is high latency and poor visual display. Cloud AR/VR can help overcome these challenges. In Cloud VR, the standalone headset has to download the data from the cloud and make sure that the display visuals are of good quality. On the other hand, Cloud base AR has to send the data captured from sensors and camera to the cloud then the data processing will be done on the cloud using ML algorithms. This can reduce the GPU utilization of the headset in itself. All that the headset and devices need to do is connect to the cloud , then the external computations and resource processing can be done on the cloud. This will improve the headset efficiency, reduce latency and time.

CONCLUSION

Improvements in technologies like AR/VR are leading humanity into a new digital era where people need not travel to get something done. They will be able to do their job within their comfort zones, still making them feel like they are into some other work environment. Achieving such a thing is not possible without utilizing cloud and its services. Cloud can help boost these services and improve the quality of the same.

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RESEARCH ARTICLE

Diabetes Mellitus Prediction using a Suite of Machine Learning Algorithms

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ABSTRACT

Hyperglycemia is the word used to describe the chronic state of diabetes mellitus. As a result, individuals have a tremendous lot of hardship in their daily lives. It is anticipated that the number of diabetes patients would approach 642 million by the year 2040, indicating that one in ten people will have the illness by then. Consequently, this troubling issue requires further investigation. Because identification is such a lengthy process, it always concludes with the patient visiting a diagnostic centre and consulting with a doctor. However, the development of machine learning-based technologies has given a solution to this critical problem. Implementing Machine Learning Techniques such as K-neighbors classifier, Decision Tree classifier, Random Forest classifier, Naive Bayes classifier, and neural network classifier to predict diabetes mellitus in humans is one of the primary areas of this research.

Keywords: Machine Learning, Diabetes, Prediction, Learning Algorithms.

INTRODUCTION

Diabetes is a potentially lifelong condition that poses a significant threat to the health of humans. The abnormally high amount of glucose in the blood is the root cause of diabetes. This abnormality may be traced back to either an impaired insulin secretion or an impaired natural mechanism in the human body. The process of diagnosing and analysing diabetes might be a topic worthy of praise for its ability to concentrate quickly and accurately. The diagnosis of diabetes may be made with reasonable certainty by the use of fasting glucose levels, glucose resistance, and irregular glucose levels.

This aberration may have its origin in either a faulty insulin secretion or a faulty natural process inside the human body. Both of these possibilities are possible. It's possible that the process of diagnosing and analysing diabetes should be a subject worthy of recognition due to its capacity to focus swiftly and precisely. With the use of fasting glucose levels, glucose resistance, and irregular glucose levels, a diagnosis of diabetes may be established with a degree of confidence that is considered to be acceptable. The early detection is the only treatment that may prevent more issues from occurring. The use of machine learning strategies in diabetes prediction has been given extensive testing, and the results have been encouraging. Due to their capacity to manage massive amounts of data, aggregate data from several sources, and integrate contextual information, Data Mining and Machine Learning algorithms are becoming more powerful. We analyse the experimental performance of the three algorithms over a number of metrics, finding that all three are very accurate. Here, we use machine learning methods for diabetes mellitus prediction; specifically, the K-neighbors classifier, Decision Tree classifier, Random Forest classifier, Naive Bayes classifier, and neural network classifier. In this study, we evaluate a variety of algorithms and compare the evaluation results of this algorithm.

Literature Review

Classifying Diabetes Mellitus patients as diabetic or non-diabetic based on risk variables is discussed by Sajida *et al.* in [11]. The authors use the J48 decision tree as the foundation for their discussion of the roles of Adaboost and Bagging ensemble machine learning algorithms. The experimental results demonstrate that the Adaboost machine learning ensemble approach is superior than bagging and a J48 decision tree[5]. A non-parametric managed learning approach, k-NN was developed in 1951 by Evelyn Fix and Joseph Hodges and is used here[10]. If there is little to no historical data on how the information was disseminated, K-closest-neighbor (KNN) clustering should be one of the first choices made in the investigation [1]. The necessity for discriminant analysis led to the development of K-closest neighbour grouping, which is used in cases when a clear and concise parametric evaluation of the probability density is unavailable or difficult to determine. Random forests, also known as random choice timberlands, are a kind of ensemble learning approach used for task such as characterising, relapsing, and others via the development of a large number of decision trees during the preprocessing stage [2][3]. The outcome of the random forest for order tasks is the category selected by most trees. The result of a relapse assignment is the same as the solitary tree's mean or normal expectation. The Bayes classifiers are a kind of simple probabilistic classifier that uses Bayes Theorem to make inferences about the relationships between features [4][7]. When paired with component thickness evaluation, however, this Bayesian Network model becomes one of the most accurate available. A neural network's operational mechanism is similar to that of the human brain's cerebrum [8][9]. When a large number of "neurons" come together, they form a network that can collect and sort information in accordance with predetermined rules. Similar structures are used in quantifiable methods, and it seems to be the inspiration for this layout.

Dataset

This dataset was obtained from https://www.kaggle.com. It is titled "diabetic 012 BRFSS2015.csv," and it contains 253,680 review responses to the Centre of Diabetes's council BRFSS2015. It has classifications 0, 1, and 2 respectively. The number 0 indicates that the individual does not have diabetes, whereas the number 1 indicates that the individual does have prediabetes and the number 2 indicates that the individual does have diabetes. This particular dataset, which is linked below, has a total of 21 highlighting factors.

Classification Models

The Machine Learning models KNN, Decision Trees, Random Forests, Naive Bayes, and Neural Network classifiers are utilised in this proposed study to predict diabetes.

K Neighbours Classifier

The K-Nearest Neighbor classifier retains every single piece of available information and organises additional pieces of information based on their degree of similarity.

During the phase of the process known as "preparation," KNN only saves the dataset. After obtaining new information, however, it then characterises that information into a classification that is comparable to the new information.

Decision Tree Classifier

The Decision Tree classifier is a kind of supervised learning that may be used to classification and regression issues. While it can be used for both types of issues, its primary usage is for dealing with classification issues. It's possible that it's a tree-organized classifier, in which case the nodes within the tree represent the items of a dataset, the branches represent the decision rules, and the leaf nodes represent the results. The decisions or the test are carried out based on the rationale of the components of the dataset that is provided. The main function of a decision tree is to pose a question, decide whether the answer should be yes or no, and then further divide the tree into subtrees.

Random Forest Classifier

A random forest classifier compares the results of several decision tree classifiers applied to various subtests of the dataset. It then uses an average to improve the predictive accuracy and command over-fitting. In the event that bootstrap=True is used (which is the default), the size of the sub-test is limited by the max samples boundary; nevertheless, in most cases, the whole datasets are utilised to construct each and every tree.

Naïve Bayes Classifier

The Naive Bayes classifier is a probabilistic classifier that uses Bayes' Theorem as its guiding principle. It's a collection of computations, all of which adhere to the same standard; more specifically, the results of each calculation are isolated from one another based on the sequence in which the highlights are presented. Its primary use is in text characterisation, which also incorporates the process of producing a high-layered dataset.

Neural Network Classifier

A neural network is made up of a large number of neurons that are arranged in layers and are responsible for transforming an information vector into yield. Every neuron receives some information, applies some capability to it, and then passes on the outcome to the neuron below it in the hierarchy. The majority of the organisations are classified as feed-forward, which means that each unit is responsible for communicating its output to all of the other units on the subsequent layer, but there is no input to the layer that came before it. Weightings are applied to the indications that are travelling from one unit to different, and it is these weightings that are adjusted throughout the preparation stage in order to adapt a brain organisation to the front and centre problem. Calculations and examinations of the correctness are performed in accordance with these secret instances. The performance of each particular algorithm is analysed based on the percentage of cases that are properly classified in comparison to the percentage that are incorrectly classified out of the total number of instances. Compairsion of all the algorithm with their model accuracy. As shown in Figure 4, an AUC (Area under the ROC curve) score of 0.746, which falls somewhere in the range of 0.7 to 0.8, indicates that it may be deemed to be fair.

CONCLUSION

One of the clinical issues that we are confronted with in this day and age is the early detection of diabetes while it is still in its early stages. Within the scope of this investigation, rigorous attempts are undertaken toward organising a framework that is capable of diabetes forecasting. Throughout the course of this study, a number of different machine learning classifiers will be studied and analysed based on a number of different criteria. The use of KNN resulted in an increase in accuracy that was 82% higher during the training phase and 68% higher during the testing phase. The accuracy of the decision tree during training was 99%, which was much greater than the accuracy achieved by the KNN algorithm. However, the accuracy of the test, which was calculated at 65%, was much lower than that of the decision tree. In a manner similar to this, the Random Forest algorithm achieved a level of accuracy of 99% during the training phase but only 74% during the testing phase. While the Naive Bayes algorithm obtained

an accuracy rate of 70% during its training phase, it achieved an accuracy rate of 71% during its testing phase. And finally, the accuracy of the Neural Network during testing was 74%, which is the same as the accuracy it had during training, which was also 74%. As a consequence of this, and in light of the findings of the study that was carried out on the many Machine Learning Algorithms, we are in a position to claim that Random Forest is better to every other algorithm that is now being used.

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Table.1 .Results of K Neighbour Classifier

Result set of K neighbour Classifier			
	F1-Score	**Accuracy Score**	**MCC**
Training Set	82.70	82.70	64.99
Testing Set	68.67	68.66	36.59

Table.2. Result Set of Decision Tree Classifier

Result set of Decision tree Classifier			
	F1-Score	**Accuracy Score**	**MCC**
Training Set	99.37	99.37	98.73
Testing Set	65.60	65.61	30.32

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Table.3. Result Set of Random Forest Classifier

Result set of Random Forest Classifier			
	F1-Score	**Accuracy Score**	**MCC**
Training Set	99.37	99.37	98.73
Testing Set	73.31	73.28	46.05

Table.4. Result Set of Naïve Bayes Classifier

Result set of Naïve Bayes Classifier			
	F1-Score	**Accuracy Score**	**MCC**
Training Set	70.91	70.93	41.07
Testing Set	71.56	71.56	48.38

Table.5. Result Set of Neural Network Classifier

Result set of Neural Network Classifier			
	F1-Score	**Accuracy Score**	**MCC**
Training Set	74.41	74.39	48.22
Testing Set	74.92	74.89	49.28

Figure 1. Attributes in the Dataset	Figure 2. Heat map for the date set used.
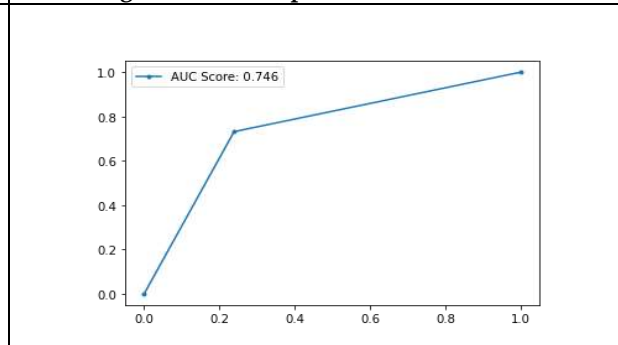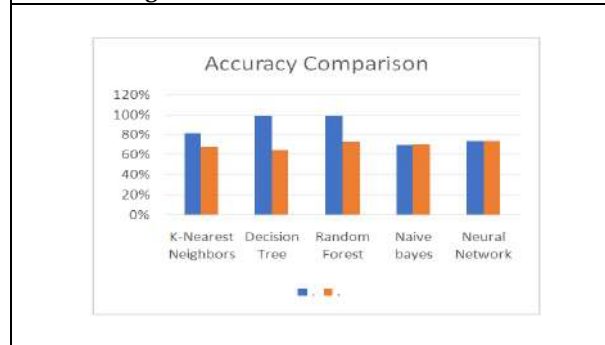
Figure 3. Shows Accuracy comparison between all the classifier	Figure 4. AUC score

RESEARCH ARTICLE

Comparative Study on Public, Private and Consortium Blockchain

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ABSTRACT

Blockchain technology has recently grown quickly, mainly because of launching Bitcoin. Consensus protocol is monitored by block chain and data structures concepts or blocks that are scattered across nodes and designed for cryptographically storing ordered data to facilitate different operations may be performed on it. Beyond crypto currencies, blockchain now offers user-specified decentralized independent requests or smart contracts with Ethereum. Blockchain was initially developed to store digital currency as system states. New blockchain platforms have been created in response to the industry's growing interest and the vast range of applications they can support. Without first having a greater understanding of what the key technological platforms have to offer, it is crucial and challenging to regulate the type of blockchain application can be used for specific use given how quickly technology is growing. As a result, we are able to examine the basics of blockchain and compare and contrast the architecture, consensus protocols of blockchain and its performance based on different types of Blockchain. By using the assessment, the emphasis onexisting experiments and performance issues by embracing of blockchain. We then suggest decision tree for the approach for applications based on the blockchain platform as solutions and a single blockchain framework for public, private and consortium blockchain.

Keywords: Blockchain, Distributed ledger, Consortium, Consensus Algorithm, Decentralized.

INTRODUCTION

Enterprise businesses are unsure about both public and private blockchain solutions. Since the invention of blockchain technology, there has been debate over public vs. private blockchains. It's crucial to understand the main distinctions between these two in an industrial context. In conclusion, companies must take into account both public and private blockchain examples when choosing the right blockchain type for their applications. Public Blockchain:

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Public blockchains are completely open, permissionless, and decentralised. All nodes have equal access to the blockchain thanks to public blockchains, which also allow for the addition of new blocks of data and the validation of already-existing blocks of data. The majority of today's bitcoin mining and trading takes place on public blockchains. You may be familiar with well-known public blockchains like Bitcoin, Ethereum, and Litecoin. On these open blockchains, the nodes "mine" for bitcoin by building blocks for the network-requested transactions and solving cryptographic challenges. A small amount of cryptocurrency is given to the miner nodes as compensation for their diligent work.In essence, the miners play the part of contemporary bank tellers who initiate a transaction and obtain (or "mine") cash in return.

Private Blockchain

Private blockchain network are referred as Permissioned blockchains. This kind of blockchain requires permission to entire in the network that are controlled or manged by a single organisation. The single owner will decide to allow nodes to be part of private blockchain network, the central authority may not always accord each node an equal right to execute certain responsibilities. Private blockchains are not exactly decentralized, Hyperledger are examples of private blockchains.

Consortium Blockchain

Blockchain technology has a variant known as consortium blockchain. A kind of blockchain technology is consortium blockchain. In contrast to public block chain, it has less number of nodes but ascendable and protected. Furthermore, it lessens load of the network and also increases better safety. It still has some difficulties regardless of being non translucent compared to public chain. In this type of network only less members are familiar. To ensure fewer latency and more speed, a voting-based method is applicable. The operation can be inscribed with any node, but a node cannot add a block by itself. Conversely, prior to being added to the network, each block added by a different node must first be confirmed. Greater exposure and innovation are made possible. Unlike other semi-decentralized networks, consortium blockchains do not provide membership to a single entity. Instead, a collection of people, or "node," receives it. Network security is provided, which public chains lack. Additionally, it offers a high degree of control, quick processing, and many other improvements that enhance its effectiveness and security.

Related Work

The writing survey conducted prior to this examination provides insight into the concept of blockchain technology as well as the distribution of productions within designated points. Therefore, the spread of productions among known points. The assessment reveals that the areas mentioned in more detail—blockchain as a management innovation, clever contracts, plans of action, creative probability and obstacles, and blockchain as an innovation that benefits everyone—lack in-depth coverage. Stuart Haber and W. Scott Stornettain 1991 published the first description of a chain of (records) blocks that were encrypted and linked. They planned a feasible structure for time-stamping ordinal papers for fully securing the confidentiality of the records also to do away with the necessity for saving the records by the using time stamp service. This was attained by utilizing digital signatures and cryptographically safe hash functions to overcome the confidentiality problems, frequency, deposit, ineptitude, and trust[1]. Merkle Trees, which allowed several documents to be inserted into one block, were introduced into the design by Bayer, Haber, and Stornetta in 1992, considerably increasing efficiency[2]. [3] Developed the concept of Bitcoin and created a workable method for sending money between entities linked in a peer-to-peer fashion. In [4] its identified that (1) Recognize common consensus protocol for public blockchains and (2) handle the assets with a continuous method, whereby we address the three domains of sustainability. This is because there aren't many evaluations that cover consensus algorithms holistically. The authors contribution is of two way: Method1, offering a proper summary of consensus algorithms for public blockchains that are taken from academic research as well as practical applications, and organize them in accordance with their research focus; Method2, Evaluating the usage of consensus algorithms expending a deterministic example and thereby analyse the gaps in the literature to address the comprehensive feasibility of consensus algorithms. Numerous advantages of blockchain include decentralization, persistence, anonymity, and auditability. Numerous businesses use blockchain technology, including finance management, risk controlling, the internet of things (IoT), public and social facilities, and crypto currency. [5]. A

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survey of the literature on crypto currencies is provided, however it is not concentrated on BCT structures[6]. Additionally, we investigate blockchain use cases outside of crypto currencies in this work, rather than just concentrating on the crypto currency market. Other reviews have the same problem concentrated on the literature surrounding smart contracts, or software that can be installed and run on applications for a blockchain. The consortium blockchain is a combination system with elements of both public and private blockchains [7]. Because technology is developing rapidly, it is important and difficult to decide which blockchain implementation should be used for a certain application without first a better understanding of what the core technology platforms have to offer. We recognize the current difficulties and glitches with the adoption of blockchain based on the comparison, and we then propose potential solutions and future implementations to optimize blockchain performance and provide further research areas [8].

Analysis of Blockchain:We would like to analyse different blockchain features
Public Blockchain

- Maximum Security: They may quickly halt all of the hacking issues they encounter by utilising the security standards of a public blockchain. Depending on the platform, security protocols may differ, although public blockchains are generally more reliable.
- Open Environment: Anyone can join this type of network since public blockchains are open to anyone. Therefore, you can access these sites from wherever you live. All you would require is a computer and a strong internet connection. But not all open platforms include mining features.
- The Nature of Anonymity: Actually, the majority of users adore this as one of the nicest aspects of public blockchains. In essence, nobody is identified here. Actually, you won't be revealing your identity or name here. Everything would remain secret, making it impossible for anyone to locate you. Given that it is a public space, the main purpose of this function is to protect one's personal property. However, it was also utilised illegally by some. Bitcoin is frequently used by criminals to finance illicit operations on the dark web. This is another drawback of the open blockchain.
- No restrictions: In fact, there are no rules that nodes must adhere to in public blockchain. As a result, there are no limitations for the individual for growing personally. Though, the main disadvantage can be firming cannot function in an unregulated environment. But without laws, it's challenging to adhere to all the requirements a project might have. The public blockchain has several drawbacks, including this.
- Actual Decentralization: True decentralisation is possible with a public blockchain. Private blockchain networks are noticeably devoid of this. It also has a distributed aspect because everyone has a copy of the ledger.
- Complete Transparency: In essence, public block chain companies favours in constructing the stages so that they are completely translucent to everyone using the record. It means that you have unlimited access to the ledger. Therefore, there is no room for corruption or inconsistencies. In any case, everyone is required to maintain the books and participate in decision-making.
- Immutability: The open blockchain network is completely unchangeable. It basically means that once a block is added to the chain, it cannot be changed or removed. Therefore, it ensures that no one can just change a certain block to gain from others. The fact that hash functions perform as a security protocol is the finest feature. The attempt to modify the blocks will therefore result in the creation of a new chain that diverges from the original chain. reversing their alterations in the process.
- Complete User Control: The user often has to adhere to several guidelines and restrictions in any network. Many times, the laws may not even be just ones. nevertheless, not in open blockchain networks. Since there is no overarching authority to oversee all of the users' actions, everyone is empowered under this system. Once the stages of platform are public then no other administration can avoid from using the nodes and participating in consensus.

Private Blockchain

- **High Performance**: Despite being the first, public blockchains have a reputation for being efficient. because they make the network accessible to everyone. As a result, the platforms become unable to provide enough resources due to lot of people take advantage of the features. It quickly slows down as a result. Contrarily, private blockchain only permits a small number of users to join the network. They frequently even have specific responsibilities to accomplish. Therefore, they cannot use up additional resources and cause the platform to lag.

- **Totally private**: Private blockchain solutions, as opposed to public blockchain systems, typically prioritise privacy issues. This technology is ideal for your business if you're seeking for a way to provide the highest level of anonymity.

- **Advancing Business**: Private blockchain solutions purposeis to authorise the organisation as a whole rather than just single employee. In practise, businesses do require excellent technology to support their operations. Furthermore, these keys are mostly for an organization's internal systems. This is among the top uses for the private blockchain.

- **Stability**: Private blockchain solutions can give you the comfort you require and are dependable. To perform a transaction, you must essentially pay a predetermined price on each blockchain network. However, the pressure from nodes requesting transactions on public platforms can cause the cost to rise significantly. The processing of transaction requests takes time when there are too many of them. Furthermore, the cost significantly rises as the amount of time passes. However, private blockchain networks do not. There are no delays because only a small number of people can request transactions.

- **Low Cost**: The transaction costs on private blockchain networks are incredibly low. In contrast to open blockchain systems, the transaction fee is not affected by the volume of requests. Therefore, the rates will always remain reasonable and correct regardless of how many individuals request a transaction. As a result, there are no hidden fees at all.

- **Reduces costs**: Private blockchain actually results in significant cost savings. This type of blockachains are easy to maintain in comparison to other blockchains. Private blockchain frameworks utilise a little amount of resources. In contrast, public blockchain consumes a more of space to sustain the massive user base of the platforms. This results in significant financial savings over time.

- **No Unlawful Activity**: Before you may use a private blockchain platform, there are authentication procedures. This procedure filters any unauthorised users attempting to access the system. As a result, all illicit activities are eliminated because only certified users are allowed access to the system.

- **Regulations**: Private blockchain can be the best option if you're seeking for the ideal technology for your business. Why? You must adhere to several rules and regulations in businesses. And there are repercussions if you don't follow them correctly.

- **Authority**: With a public blockchain, genuine decentralization is possible. Private blockchain networks are noticeably devoid of this. The ledger is shared by all users, hence it also has a distributed nature. As opposed to public blockchain systems, private blockchains are not entirely decentralised. More accurately, the situation is partially decentralized.

- **Access**: In a private blockchain, the network is governed by just one company. This implies that participation by the general public is not permitted. In practise, all private blockchain solutions will have an authorization system to identify platform users. As a result, the network is only accessible to a small group of users.

- **Cost of Transaction**: Comparing public and private blockchain networks, the cost of transactions on the former is typically higher. In practise, the platforms' vast number of nodes causes the performance to suffer. And as a result, processing the requests takes a long time. As a result, prices sharply increase. On the other hand, transaction costs on private blockchain networks are incredibly low. In contrast to open blockchain systems, the transaction fee is not affected by the volume of requests. As a result, the fees will always be reasonable and correct, regardless of how many individuals request a transaction.

- **Consensus:** Nodes on a public blockchain are not restricted from participating in the consensus procedure. Everyone is therefore free to engage and benefit from the platform. Private blockchain, on the other hand,

predetermines who can and cannot participate in the consensus. By this, several nodes cannot be used in the many nodes won't actually participate in the method.

- **Transaction Rate**: The transaction speeds of blockchain which are private and public can be compared. In actuality, both platforms can function almost identically up until a certain point. However, the transaction speed substantially differs after that point. Usually, anyone can request a transaction on a public blockchain. As a result, the network's transaction performance tends to slow down when there are too many requests on it. The time it takes to just process a transaction can be very long. Here, the transaction process is limited to a small number of nodes. Speed therefore never changes.
- **Data Management**: To compare private blockchain and public blockchain, let's look at how these two platforms handle data. Anyone can read and write on a public blockchain's ledger. However, once it appears on the ledger, it cannot be changed. However, in a private blockchain, the ledger can only be read and written to by a single company. And even fewer nodes can write to the ledger than that. And even fewer nodes than that are capable of writing to the ledger. Similar circumstances apply to both public and private blockchain examples.
- **Efficiency**: In actuality, private blockchain networks are more effective than public blockchain. Public blockchain networks struggle with scalability and experience a performance hit when there are too many nodes using them. On the other hand, there are very few nodes on private blockchain. As a result, they always remain effective.
- **Immutability**: The open blockchain network is completely unchangeable. It basically means that once a block is verified and added to the network, it cannot be erased. Therefore, it is assured that block chain cannot be altered for gaining from others. Private blockchains, however, are only partially mutable. Authorities may remove a particular block in some circumstances if they deem it appropriate.

Consortium Blockchain

- **Decentralized in some ways** : Unlike public blockchain networks, consortium blockchain are controlled by and accessible to only members of the consortium. As there are far fewer nodes in the consortium chain, it is simpler to come to an agreement. It functions as a somewhat decentralized system that aids in protecting data privacy.
- **More manageable:** Because of the enormous number of nodes in public blockchain, once data has been added, it cannot be altered or updated under the public blockchain systems. For instance, because there are so many Bitcoin nodes, it is virtually hard to alter the blocked data. In contrast, on a consortium blockchain, data can be changed as long as the majority of institutions agree.
- **Security of data**: Because only users in the consortium have access, consortium blockchain maintains the privacy of the data. This helps to safeguard the privacy of the data by ensuring that it is stored securely, without tampering, and with just a small known number of persons having access.
- **Greater transactional speed**: In comparison to public and private blockchain networks, transactions are completed much more quickly because there are fewer nodes involved. As a result, consensus can be reached quickly, and transactions proceed significantly more quickly.

Decision Tree and Framework for Different types of Blockchain
Figure 2: A Decision tree to determine which blockchain type is the appropriate to provide technical solution to solve a problem. Based on Consensus algorithm that is provided by respective blockchain network user can select the required platform.

Blockchain common Framework
The common framework for public, private and consortium is given above in the figure 3. Based on the functionalities required for an application one can use the framework accordingly. Public blockchain Network can be accessed by everyone in the network. joining and leaving this kind of network is very easy. It is not controlled by any one. We have unknown miners to validate transaction based on the consensus protocols.

Private Blockchain Network: This type of network cannot be accessed by everyone in the network. It is controlled by single owner node. Smaller compared to public network as everyone cannot join and leave. There are rules to join this kind of network.

Consortium Network: This type of network cannot be accessed by everyone in the network. It is controlled by set of participant nodes. It maintains the privacy of the data.

It can be classified as Blockchain Network, Consensus Protocols, Services required, and type of blockchain to be adopted for a particular application.

a) Blockchain Network:
b) Services and functions required:
c) Type of Blockchain network:

CONCLUSION

The research was carried to understand and analyse the concepts of blockchain, the data structure involved and its unique way of creating blocks and storing transactions that are verified and stay immutable. We have classified as permissioned and permission less blockchain and later categorized as public, private, and consortium blockchain and based characteristics we have deduced a decision tree which helps researchers and organizations to clearly follow and make decisions based on the type they are looking for their applications. Based on the features we have developed a common framework for all types of blockchain. The Decision tree and framework can assist in resolving the existing issues and provide guidance for the future.

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Table 1: Blockchain and Characteristics

Features	Public Blockchain	Private Blockchain	Consortium Blockchain
Access	Everyone	Restricted access	Restricted access
Authority	No	Single owner	Set of participants
Transaction Speed	Low	High	high
Consensus Protocol	No approval required	Approval required by single authority	Approval required by Group of authority
Efficiency	Less efficient	efficient	effiecient
Data handling	Open to everyone	Writing is restricted.	Writing is restricted.
Immutability	Yes	Yes but can be rollback	Yes but can be rollback

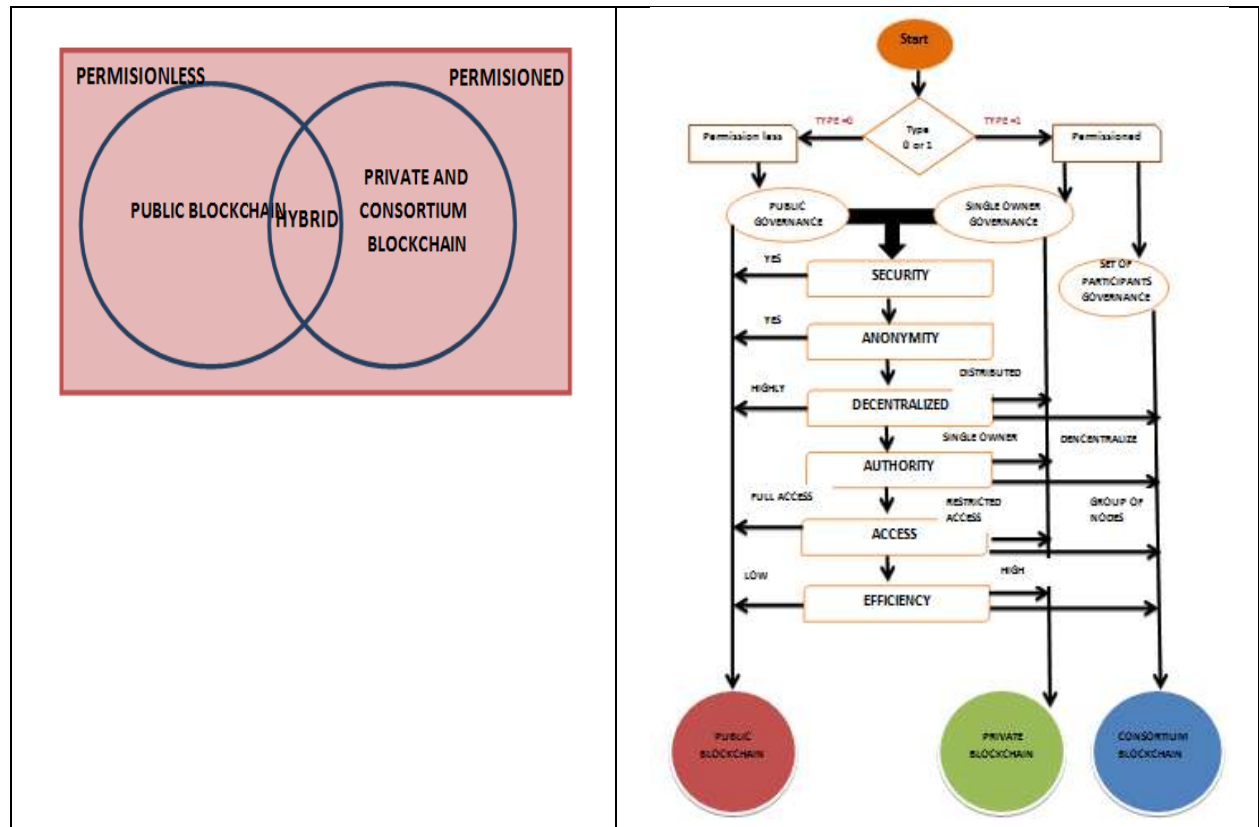**Sheetal and Vasantha kumari N**

Fig 1: Classification of Blockchain

Figure 2: A Decision tree to determine which blockchain type is the appropriate to provide technical solution to solve a problem. Based on Consensus algorithm that is provided by respective blockchain network user can select the required platform.
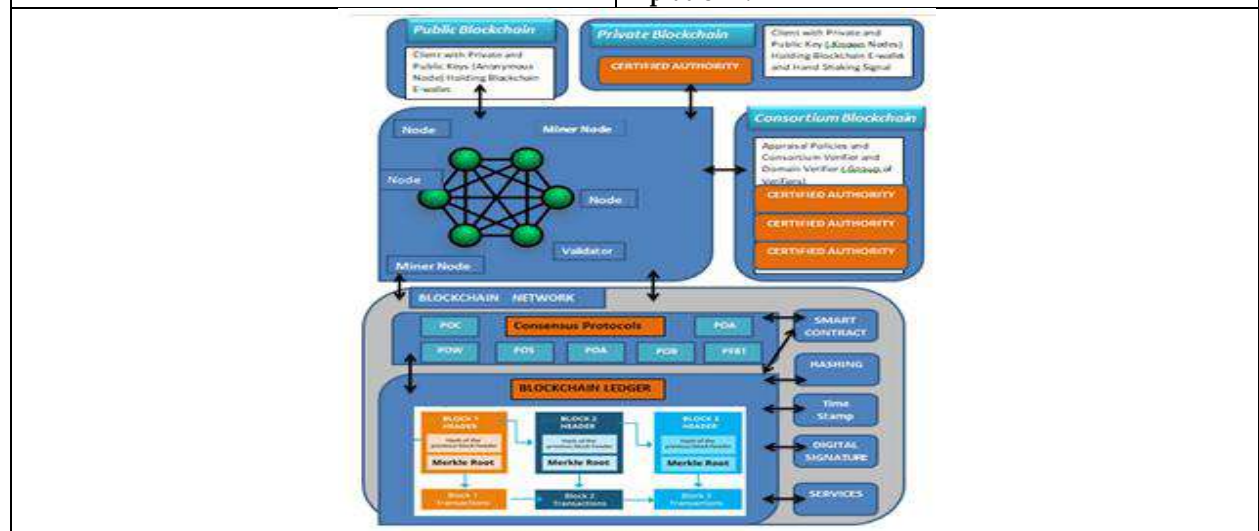

Figure 3: Common framework that supports all three types of blockchain

RESEARCH ARTICLE

Role of Global Cloud Security in Various Fields

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ABSTRACT

In the sphere of digital enterprises, online transactions, online recording conferencing platforms, communication applications, virtual private networks (VPNs), and cloud storages, cloud computing has today become one of the key structural components. The global tech infrastructure now includes the cloud and information security. Security of these sensitive data is crucial in this rapid development and expansion of the technological industry. Many other organisations and businesses continue to be unaware of the numerous security protocols and the importance of adequate cloud security measures, although the majority of organizations and businesses were quick to recognize and make the move.

INTRODUCTION

The concept of cloud computing is not new. Looking back at its past, server architecture was widely employed, with the client's control and all data being stored on the server. Since this technology had many limitations, people were so reliant on this one-sided communication that they began to explore for other improvements in the industry. Cloud Computing is a critical domain in the field of technology. Cloud computing is referred to as a system for better network which is available to a common network which consists some valuable resources. The new characteristics are such as resource sharing and multi - tenancy have not only called into question the effectiveness of the ongoing security framework but have created more efficient and updated security preventions. In today's IT environment, handling sensitive data in web domain computing is a crucial problem. Clouds stores almost every data, which clients can access anytime they need it. For the benefit of the consumer, privacy should be offered while obtaining databases and applications from such an environment. Applications, platforms, and infrastructure parts make up cloud computing. For businesses and people around the world, each segment offers a variety of services and goods. Data privacy and user proof are related in cloud computing. Taking charge of gaining entry to applications present in cloud is a broader issue, and protecting a user's account from exploitation is a crucial component of that challenge.

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Solutions for cryptographic authentication can aid in enabling safe resource use. Key management (assignment, distribution, and revocation) must be effective and highly scalable, depending on the cloud deployment architecture. This paper presents the security problems encountered by various public and private organizations and to get rid of such problems.

LITERATURE REVIEW

This paper presents the security problems encountered by various public and private organizations and to get rid of such problems.(access paper) with the recent developments revolving around cloud computing, there occur to be certain limitations that happen to any kind of software [3]. There came an approach called as Software Defined Cloud Computing also called as SDCC in which the various computer networks and cloud computing work simultaneously. The below figure 1 illustrates the structure of SDCC. SDN, also called as software defined network, is a concept where the network services can be managed by the network administrators. This process allows distant entry to the servers and changes for the traffic analysis in the networks. On the application, platform, and infrastructure levels, cloud computing offers a range of services [1]. Services can be broken down into three vital divisions which are Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and also Software as a Service (SaaS).

1.   **IaaS**: IaaS offers blocks and virtual machines along side distinct IP addresses based on the requirement for storage. Customers can gain the databases and applications from an interface where they are allowed to make changes in their servers. Considering that consumers are able to purchase only how much service they consume, such as electricity or utility computing is another name for this service.
IaaS includes the following components:
1.   Computer hardware
2.   Platform virtualization
3.   Internet
4.   Computer network
5.   Services
6.   Utility computing
7.   Agreement levels.

2. **PaaS:** In Paas, a definite group of various application, programs and developmental tools are included. They are hosted on the servers of the provider. Developers can create applications using the APIs of the provider. One of the most well-known Platform-as-a-Service vendors is Google Apps. It offers services for developing, testing, and deploying software in the same integrated environment that hosts them. It also provides an environment for growth and the support staff and collaboration growth.

3. **SaaS**: The biggest market is SaaS. Specifically, the customer is permitted to utilize provider's applications only. The user and the software communicate via an interface for such use. Any kind of software may be used, from internet-based email to software like Twitter and so on.

The technology that will be ideal for the infrastructure of their on-demand application should be chosen by the developer. In order to maximize resource usage and guarantee scalability, they should also resolve the application infrastructure that will be used. Additional load balancing and application delivery techniques also should be taken into consideration. Aside from that, it offers visibility into resource management as well as application capacity and performance. It should enable task automation and visibility for management. An on-demand infrastructure needs visibility. The infrastructure and related management systems must be aware of what is operating, when, and where in order to assess the resources that are available. Integrate everything at last so that the infrastructure benefits from resource sharing, automation, and abstraction. For cost savings, cloud computing leverages virtualization for optimal utilisation of connected computers' resources. Co-locating the network and those virtual machines is required on the

identical server. A software tool is a virtual machine and implementation of a program-executing computer as a true machine would. This software tool is employed to develop a different virtual environment called virtualization. The usage of virtualization makes it possible to access many running systems simultaneously and comprehend the method of constructing the network's infrastructure aggregation. The only environment used here is virtual for programs rather than operating system kernels. In the cloud, virtualization is the first stage of the whole infrastructure. It is crucial to reevaluate the appropriateness of each essential architectural layer for inclusion a fresh infrastructural design. From primary to higher education, the entire nation invests a lot of money, either directly or indirectly. Today, the majority of the communication happens through the Internet. Particularly, the Internet has grown to be a crucial part of modern civilization. It is utilised for everyday tasks like a resource to find up information, a way to contact with family and friends, as well as a destination, information on practically anything you can think of a majority of the Internet is frequently used for amusement and education.

Cloud Computing and IoT integration in the field of healthcare
In the recent years, the IoT technology has advanced rapidly and has enabled and developed interconnection of various smart devices, sensors as well as developed smooth data interchange between them, there is now a strict necessity for data analysis and data management [3]. Cloud computing and fog computing are instances of storage platforms. One application is in the medical profession. IoT sectors receive a significant amount of attention from business, academia, and the general public sector. Patient safety and staff satisfaction are improving as a result of combination of various IoT devices and cloud computing technologies together and operational effectiveness in the healthcare industry. The paper we have referred to has done the evaluation of the most recent IoT elements, software's and research on current cloud computing and IoT developments in healthcare applications. The most important component of IoT in healthcare is thought to be the IoTHeF (Internet of Things Healthcare Framework), because it enables the incorporation of both IoT and cloud computing concepts for software's related to healthcare. Additionally, the framework offers guidelines for the transmission of unprocessed medical data. Every element of the IoT healthcare system performs a certain role. Data about patient health can be gathered via the systems.

METHODOLOGY

As there is an advancement in this field of study, there are many drawbacks that come along with this too. There is not much of securitty available in this field. Once the data has been uploaded on the cloud, if there is no security available, many types of attacks can be done in no matter of time. The fact that users have no control over where or how data is stored is one of their main worries. Different users are much more dependent on the services that are cloudy to them and server function details are kept secret. Although it can increase security through obscurity, it also erodes user confidence. Clients might not understand the server-side data security measures in place. They are concerned about data retention as well. The cloud service provider may continue to store erased data in backups or for another unstated purpose. They may have to keep the records, but it also their duty to keep the users informed about the data they have stored without the users knowledge. For this , security measures should be boosted at the server's end, since any attacker can hack into the cloud, access the data, and use it for their own benefit. There was a recent data leak at Facebook, about 533 million user's data was compromised and was avaiable at a low access forum, where anyone can access the data for free. The data consisted of, for instance, maintained erased data but hidden it from view of the user. When a service is terminated, the same issues arise. This can be prevented by disposing the data that was deleted and was intended to be in the first place. Secondly, if we wannamatain any record of the same, we must keep it in a highly protected environment and eventually be deleted after some time, cause sooner or later there maybe a shortage of the space available. We can take google photos for instance. When we delete something it stays in the recycle bin for some fixed days, and then later gets disposed automatically. Similarly we can implement the same on cloud, where the data meets the same fate as explained in the above example. Insiders who are malicious pose as one of the biggest risks to cloud computing. An employee of the victim organisation who takes advantage of security flaws to gain illegal access, a rogue administrator working for a cloud service provider, or an attacker using social engineering techniques could all be considered insiders who aim
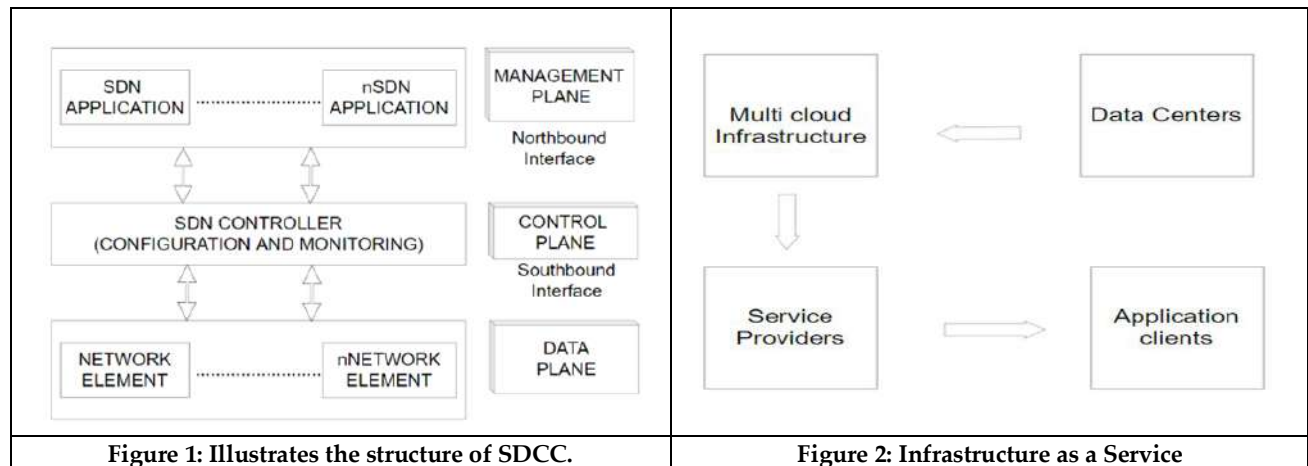
to launch assaults using cloud resources. Multi-tenant characteristics of the cloud computing environment make it challenging for the insider attacks to identify and stop.

CONCLUSION

Modern technology innovation is highly essential in today's modern environment in order to meet customer demands. The firm must monitor global collaboration, innovation, and productivity to meet the expectations of the customer. These are necessary for a business to compete with other businesses. As a result, the idea of cloud computing develops. The infrastructure and services of cloud computing are examined in this paper. Virtual cloud computing and security challenges are covered. The development of cloud computing for educational institutions.

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| Figure 1: Illustrates the structure of SDCC. | Figure 2: Infrastructure as a Service |

RESEARCH ARTICLE

Strong Domination Number of New Graphs

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ABSTRACT

A set of vertices R in a graph $W = (V(W), E(W))$is strong dominating set of W if each vertex $s \in V(W) - R$ is strongly dominated by some t in R. If $ts \in E(W)$ and $deg(t) \geq deg(s)$ then t strongly dominates s (or s weekly dominated by t). The minimum cardinality of a strong dominating set of graph W is strong domination number of graph W. We investigate strong domination of cycle in context of corona neighborhood and double graph of cycle (path).

Keywords: domination, strong domination number, corona neighborhood, double graph of path, double graph of cycle

INTRODUCTION

Sampthkumar and Pushpa Latha [2] first coined an idea of strong and weak domination number. Some results on bounds of strong and weak domination number studied by the same authors. The strong domination in paths and cycles related graphs were discussed by Vaidya and Karkar [4]. They explored many results on strong domination of some corona graphs [5]. The concept of strong domination and graph operations were introduced by Vaidya and Mehta[6]. Here, we consider $W = (V(W), E(W))$as finite, simple, undirected and connected graph. We follow Haynes et al.,[1] for domination related terminology. We represent the degree of a vertex in W by $degW(t)$.

Terminology and Notation
Definition: The dominating set $R$of vertices of graph $W=(V(W), E(W))$ satisfies that, every vertex $t \in V(W)- R$ is adjacent to atleast one vertex in R. The domination number of graph W is cardinality of minimal dominating set of graph W. We shall denote it as $\gamma(W)$.

Definition: If $ts \in E(W)$ and $deg(t) \geq deg(s)$ then t strongly dominates s (or s weekly dominated by t). A set of vertices R of W is called as strong dominating set of W if every vertex $s \in V(G) - R$ is strongly dominated by some t in R. A strong domination number is defined as the minimum cardinality of strong dominating set.

Definition: Consider W' as a copy of simple graph W, we shall represent vertices of W and W' as t_i and $s_i$respectively. A new graph $D(W)$ is named as double graph of W if $V(D(W)) = (V(W) \cup V(W'))$ and $E(D(W) = E(W) \cup E(W') \cup \{t_i s_j : t_i \in V(W), s_j \in V(W')$ and $t_i s_j \in E(W) \in V(W)$.

Definition: Consider W and T are two graphs on r_1 and r_2 vertices, l_1 and l_2 edges respectively. The corona neighborhood, $W \star T$ is graph formed with adding one copy of W and r_1 copies of T further joining every neighbour of ith vertex of graph W to the every vertex in the ith copy of T. Gopalapillai[3] first coined the concept of neighborhood corona$W$ ★ T.

RESULTS

Theorem 3.1. For r ≥ 4,

$$\gamma_{st}(C_r \bigstar W)) = \begin{cases} \frac{r}{2}, & if\ r \equiv 0\ (mod 4) \\ \frac{r+1}{2}, & if\ r \equiv 1\ or\ 3\ (mod 4) \\ \frac{r}{2} + 1, & if\ r \equiv 2\ (mod 4) \end{cases}$$

Proof: Consider the vertex set $V(C_r) = \{t_1, t_2, \ldots t_r\}$and vertex set $V(G) = \{s_1, s_2, \ldots, s_m\}$. In the graph $C_r \bigstar W$, we shall represent distinct vertices of p^{th}copy of the graph G by $s_1^p, s_2^p \ldots, s_m^p$, where$1 \le p \le r$. Let $K_p = \{s_1^p, s_2^p \ldots, s_m^p\}$, where$1 \le p \le r$. The deg$(C_r \bigstar G(t_p)) = (m+1)$ degC_r (t_p) where $1 \le p \le r$. Further, deg$(C_r \bigstar W(s_q^p)) =$ deg $C_r(t_p) +$ deg $W(s_q)$ for $1 \le p \le r$. We can say that deg$[C_r \bigstar W(t_p)] \ge$deg$[C_r \bigstar W(s_q^p)]$.

Case I For r ≡ 0 (mod4)
Let us consider the partition of $V(C_r \bigstar W) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup \{t_{n-3}, t_{n-2}, t_{n-1}, t_n\} \cup K_1 \cup K_2 \ldots, \cup K_r$. the m+1 vertices are strongly dominated by t_1 and t_r while the $2m+3$vertices are strongly dominated by $t_2, t_3, \ldots, t_{r-1}$. If t_2 belongs to strong dominating set R then t_2 strongly dominates the vertices t_1, t_2, t_3 and the all vertices of K_1 and K_3. If t_3 belongs to strong dominating set R then $t_3$strongly dominates the vertices t_2, t_3, t_4 and the all vertices of K_2 and K_4. The sets $\{t_1, t_2, t_3, t_4\}$and K_1, K_2, K_3, K_4 are strongly dominated by t_2 and t_3. In generalised manner all the vertices of the sets $\{t_{n-3}, t_{n-2}, t_{n-1}, t_n\}$ and $K_{r-3}, K_{r-2}, K_{r-1}, K_r$ are strongly dominated by the vertices t_{r-2} and t_{r-1}. Therefore all the vertices of $C_r \bigstar W$ are strongly dominated by the vertices of the set $\{t_2, t_3, t_6, t_7, \ldots, t_{r-2}, t_{r-1}\}$. We consider$\frac{r}{2}$ vertices of $V(C_r)$ strongly dominates all vertices of $C_r \bigstar G$. Hence, $\gamma_{st}(C_r \bigstar W) = \frac{r}{2}$.

Case II For r ≡ 1 (mod4)
Consider the partition of $V(C_r \bigstar W) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup \ldots \cup \{t_{r-4}, t_{r-3}, t_{r-2}, t_{r-1}\} \cup \{t_r\} \cup K_1 \cup K_2 \ldots, \cup K_r$. In the initial step of case I, we observe that $\frac{r-1}{2}$ number of vertices from vertex set of $V(C_r) = \{t_2, t_3, t_6, t_7, \ldots, t_{r-2}, t_{r-1}\}$ can strongly dominates the vertices $t_1, t_2, \ldots, t_{r-1}$ and all the vertices of the K_1, $K_2, \ldots, K_{r-1}$. Now the remaining vertices of set K_r and the vertex $t_r$are not strongly dominated. So we add a vertex t_{r-1} in strongly dominated set R. So that $\frac{r-1}{2} + 1 = \frac{r+1}{2}$. vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $C_r \bigstar W$.
$\gamma_{st}(C_r \bigstar W) = \frac{r+1}{2}$.

Case III For r ≡ 2 (mod4)
Consider the partition of $V(C_r \bigstar W) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup \ldots \cup \{t_{r-5}, t_{r-4}, t_{r-3}, t_{r-2}\} \cup \{t_{r-1}, t_r\} \cup K_1 \cup K_2 \ldots, \cup K_r$.
In the initial step of case I, we observe that r-2/2 number of vertices from vertex set of $V(C_r) = \{t_2, t_3, t_6, t_7, \ldots, t_{r-4}, t_{r-3}\}$ can strongly dominates the vertices $t_1, t_2, \ldots, t_{r-2}$ and all the vertices of the K_1, $K_2, \ldots, K_{r-2}$. Now the remaining vertices of the sets K_{r-1}, K_r and the vertices t_{r-1}, t_r are not strongly dominated. So we add vertices $t_{r-1}$and t_{r-2} in strongly dominated set R. So that$\frac{r-2}{2} + 2 = \frac{r}{2}+1$ vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $C_r \bigstar W$.$\gamma_{st}(C_r \bigstar W) = \frac{r}{2}+1$

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Case IV For r ≡ 3 (mod4)

Consider the partition of $V(C_r \bigstar W) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup ... \cup \{t_{r-6}, t_{r-5}, t_{r-4}, t_{r-3}\} \cup \{t_{r-2}, t_{r-1}, t_r\} \cup K_1 \cup K_2 . . ., \cup K_r$. In the initial step of case I, we observe that r-3/2 number of vertices from vertex set of $V(C_r) = \{t_2, t_3, t_6, t_7,…, t_{r-5}, t_{r-4}\}$ can strongly dominates the vertices $t_1,t_2, …, t_{r-3}$ and all the vertices of the $K_1, K_2,…, K_{r-3}$. Now the remaining vertices of the sets K_{r-2}, K_{r-1}, K_r and the vertices t_{r-2}, t_{r-1}, t_r are not strongly dominated. Therefore, we add vertices t_{r-1} and t_{r-2} in strongly dominated set R. So that $\frac{r-3}{2}+2 = \frac{r+1}{2}$ vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $C_r \bigstar W$. $\gamma_{st}(C_r \bigstar W) = \frac{r+1}{2}$

Illustration 1. In figure 1, the strong dominating set D = $\{t_2, t_3, t_4, t_5\}$ of the graph $C_6 \bigstar K_4$ is shown with blue coloured vertices. $\gamma_{st}(C_6 \bigstar K_4) = 4$.

Corollary 1. For r ≥ 4, m ≥ 3, K_m is complete graph on m vertices

$$\gamma_{st}(C_r \bigstar K_m)) = \begin{cases} \frac{r}{2} , & if\ r \equiv 0\ (mod4) \\ \frac{r+1}{2} , & if\ r \equiv 1\ or\ 3\ (mod4) \\ \frac{r}{2}+1 , & if\ r \equiv 2\ (mod4) \end{cases}$$

Corollary 2. For r ≥ 4, m ≥ 4, W_m is wheel graph on m vertices

$$\gamma_{st}(C_r \bigstar W_m)) = \begin{cases} \frac{r}{2} , & if\ r \equiv 0\ (mod4) \\ \frac{r+1}{2} , & if\ r \equiv 1\ or\ 3\ (mod4) \\ \frac{r}{2}+1 , & if\ r \equiv 2\ (mod4) \end{cases}$$

Theorem 3.2. For r ≥ 4,

$$\gamma_{st}(D(P_r)) = \begin{cases} \frac{r}{2} , & if\ r \equiv 0\ (mod4) \\ \frac{r+1}{2} , & if\ r \equiv 1\ or\ 3\ (mod4) \\ \frac{r}{2}+1 , & if\ r \equiv 2\ (mod4) \end{cases}$$

Proof: Consider the vertex $V(P_r) = \{t_1, t_2, . . . t_r\}$ and vertex set $V(P'_r) = \{s_1, s_2, . . ., s_r\}$. $D(P_r) = V(P_r) \cup V(P'_r)$. The $\deg(P_r(t_P)) = \deg(P'_r (s_P))$ for $1 \le p \le r$.

Case I For r ≡ 0 (mod4)

Let us consider the partition of $V(D(P_r) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup \{t_{n-3}, t_{n-2}, t_{n-1}, t_n\} \cup V(P'_r)$. The degree of t_1 is less than degree of t_2. Therefore if t_2 belongs to strong dominating set R then t_2 strongly dominates the vertices t_1, t_2, t_3 and the vertices of s_1, s_3 of $V(P'_r)$. If t_3 belongs to strong dominating set R then t_3 strongly dominates the vertices t_2, t_3, t_4 and the all the remaining vertices of vertices of $V(P'_r)$. The sets $\{t_1, t_2, t_3, t_4\}$ and $V(P'_r)$ are strongly dominated by t_2 and t_3. In generalised manner $\{t_{r-3}, t_{r-2}, t_{r-1}, t_r\}$ and $V(P'_r)$ are strongly dominated by the vertices t_{r-2} and t_{r-1}. Therefore all the vertices of $D(P_r)$ are strongly dominated by the vertices of the set $\{t_2, t_3, t_6, t_7,…, t_{r-2}, t_{r-1}\}$. We consider $\frac{r}{2}$ vertices of $V(P_r)$ strongly dominates all vertices of $D(P_r)$. Hence, $\gamma_{st}(D(P_r)) = \frac{r}{2}$.

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Case II For r ≡ 1 (mod4)

Consider the partition of $V(D(P_r)) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup ... \cup \{t_{r-4}, t_{r-3}, t_{r-2}, t_{r-1}\} \cup \{t_r\} \cup V(Pr')$. We observe that $\frac{r-1}{2}$ number of vertices from vertex set of $V(P_r) = \{t_2, t_3, t_6, t_7, ..., t_{r-2}, t_{r-1}\}$ can strongly dominates the vertices $t_1, t_2, ..., t_{r-1}$ and the vertices of the $V(P'_r)$. Now the remaining vertices of set $V(P'_r)$ and the vertex t_r are not strongly dominated. So we add a vertex t_{r-1} in strongly dominated set R. So that $\frac{r-1}{2} + 1 = \frac{r+1}{2}$. vertices of $V(P_r)$ are sufficient to strongly dominates all vertices of $D(P_r)$.

$\gamma_{st}(D(P_r)) = \frac{r+1}{2}$

Case III For r ≡ 2 (mod4)

Consider the partition of $V(D(P_r)) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup ... \cup \{t_{r-5}, t_{r-4}, t_{r-3}, t_{r-2}\} \cup \{t_{r-1}, t_r\} \cup V(Pr')$. we observe that $\frac{r-2}{2}$ number of vertices from vertex set of $V(P_r) = \{t_2, t_3, t_6, t_7, ..., t_{r-4}, t_{r-3}\}$ can strongly dominates the vertices $t_1, t_2, ..., t_{r-2}$ and the vertices of the $V(P_r)$. Now the remaining vertices of the sets $V(P'_r)$ and the vertices t_{r-1}, t_r are not strongly dominated. So we add vertices t_{r-1} and t_{r-2} in strongly dominated set D. So that $\frac{r-2}{2} + 2 = \frac{r}{2} + 1$ vertices of $V(P_r)$ are sufficient to strongly dominates all vertices of $D(P_r)$. So that $\gamma_{st}(D(P_r)) = \frac{r}{2} + 1$

Case IV For r ≡ 3 (mod4)

Consider the partition of $V(D(P_r)) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup ... \cup \{t_{r-6}, t_{r-5}, t_{r-4}, t_{r-3}\} \cup \{t_{r-2}, t_{r-1}, t_r\} \cup V(P'r)$. We observe that r-3/2 number of vertices from vertex set of $V(P_r) = \{t_2, t_3, t_6, t_7, ..., t_{r-5}, t_{r-4}\}$ can strongly dominates the vertices $t_1, t_2, ..., t_{r-3}$ and all the vertices of the $V(P'_r)$. Now the remaining vertices of the set $V(P'_r)$ and the vertices t_{r-2}, t_{r-1}, t_r are not strongly dominated. Therefore, we add vertices t_{r-1} and t_{r-2} in the strongly dominated set R. So that $\frac{r-3}{2} + 2 = \frac{r+1}{2}$ vertices of $V(P_r)$ are sufficient to strongly dominates all vertices of $D(P_r)$. Hence $\gamma_{st}(D(P_r)) = \frac{r+1}{2}$.

Illustration 2. In figure 2, the strong dominating set D = $\{t_2, t_3, t_4\}$ of the graph $D(P_5)$ is shown with blue coloured vertices. $\gamma_{st}(D(P_5)) = 3$.

Theorem 3.3. For r ≥ 4,

$$\gamma_{st}(D(C_r)) = \begin{cases} \frac{r}{2}, & if\ r \equiv 0\ (mod4) \\ \frac{r+1}{2}, & if\ r \equiv 1\ or\ 3\ (mod4) \\ \frac{r}{2} + 1, & if\ r \equiv 2\ (mod4) \end{cases}$$

Proof: Consider the vertex $V(C_r) = \{t_1, t_2, ... t_r\}$ and vertex set $V(C'_r) = \{s_1, s_2, ..., s_r\}$. $V(D(C_r)) = V(C_r) \cup V(C'_r)$. The deg($C_r(t_p)$) = deg($C'_r(s_p)$) for $1 \le p \le r$.

Case I For r ≡ 0 (mod4)

Let us consider the partition of $V(D(Cr) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup \{t_{n-3}, t_{n-2}, t_{n-1}, t_n\} \cup V(C'_r)$. If t_2 belongs to strong dominating set R then t_2 strongly dominates the vertices t_1, t_2, t_3 and vertices of s_1 and s_3 of $V(C'_r)$. If t_3 belongs to strong dominating set R then t_3 strongly dominates the vertices t_2, t_3, t_4 and the all the remaining vertices of vertices of $V(C'_r)$. The sets $\{t_1, t_2, t_3, t_4\}$ and $V(C'_r)$ are strongly dominated by t_2 and t_3. In generalised manner $\{t_{r-3}, t_{r-2}, t_{r-1}, t_r\}$ and $V(C'_r)$ are strongly dominated by the vertices t_{r-2} and t_{r-1}. Therefore all the vertices of $D(C_r)$ are strongly dominated by the vertices of the set $\{t_2, t_3, t_6, t_7, ..., t_{r-2}, t_{r-1}\}$. We consider $\frac{r}{2}$ vertices of $V(C_r)$ strongly dominates all vertices of $D(C_r)$. Hence, $\gamma_{st}(D(C_r)) = \frac{r}{2}$.

Case II For r ≡ 1 (mod4)

Consider the partition of $V(D(C_r)) = \{t_1, t_2, t_3, t_4\} \cup \{t_5, t_6, t_7, t_8\} \cup ... \cup \{t_{r-4}, t_{r-3}, t_{r-2}, t_{r-1}\} \cup \{t_r\} \cup V(C'_r)$. We observe that $\frac{r-1}{2}$ number of vertices from vertex set of $V(C_r) = \{t_2, t_3, t_6, t_7, ..., t_{r-2}, t_{r-1}\}$ can strongly dominates the vertices $t_1, t_2, ..., t_{r-1}$ and all the vertices of the $V(C'_r)$. Now the remaining vertices of set $V(C'_r)$ and the vertex t_r are not strongly dominated. So

we add a vertex t_{r-1} in strongly dominated set R. So that $\frac{r-1}{2}$ +1 = $\frac{r+1}{2}$. Vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $D(C_r)$.

Hence $\gamma_{st}(D(C_r)) = \frac{r+1}{2}$

Case III For r ≡ 2 (mod4)
Consider the partition of $V(D(C_r))$ = {t_1, t_2, t_3, t_4} ∪ {t_5 ,t_6 ,t_7, t_8} ∪... ∪ {t_{r-5} ,t_{r-4} ,t_{r-3} ,t_{r-2}} ∪ { t_{r-1}, t_r} ∪ V(C'_r). We observe that $\frac{r-1}{2}$ number of vertices from vertex set of $V(C_r)$ = {t_2, t_3, t_6, t_7,…, t_{r-4}, t_{r-3}}can strongly dominates the vertices t_1, t_2, …,t_{r-2} and the vertices of the $V(C_r)$. Now the remaining vertices of the sets $V(C'_r)$ and the vertices t_{r-1}, t_r are not strongly dominated. So we add vertices t_{r-1} and t_{r-2} in the strongly dominated set R. So that $\frac{r-2}{2}$ + 2 = $\frac{r}{2}$+1 vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $D(C_r)$ .Hence $\gamma_{st}(D(C_r)$) = $\frac{r}{2}$+1
Case IV For r ≡ 3 (mod4)
Consider the partition of $V(D(C_r)$ = {t_1, t_2, t_3, t_4} ∪ {t_5 ,t_6 ,t_7, t_8} ∪... ∪ {t_{r-6} ,t_{r-5} ,t_{r-4} ,t_{r-3}} ∪ { t_{r-2},t_{r-1}, t_r} ∪ V(C'_r). We observe that $\frac{r-3}{2}$ number of vertices from vertex set of $V(C_r)$ = {t_2,t_3,t_6,t_7,…, t_{r-5},t_{r-4}} can strongly dominates the vertices t_1,t_2, …,t_{r-3} and the vertices of the $V(C'_r)$. Now the remaining vertices of the set $V(C'_r)$ and the verticest_{r-2}, t_{r-1}, t_r are not strongly dominated. Therefore, we add vertices $t_{r-1}$and t_{r-2}in the strongly dominated set R. So that $\frac{r-3}{2}$+2 = $\frac{r+1}{2}$ vertices of $V(C_r)$ are sufficient to strongly dominates all vertices of $D(C_r)$. Hence $\gamma_{st}(D(C_r))$= $\frac{r+1}{2}$.

Illustration 3. In figure 2, the strong dominating set D = *{t_2 ,t_3,t_6, t_7}* of the graph $D(C_8)$ is shown with blue coloured vertices.$\gamma_{st}(D(C_8))$ = 4.

CONCLUSION

In this paper we investigated the strong domination number of corona related graphs and double graph of paths (cycles). To elaborate and investigate several families of graph which establishes similar results is an open problem for research. The domination has ample of applications in network security, communication network and defence surveillance.

ACKNOWLEDGEMENT

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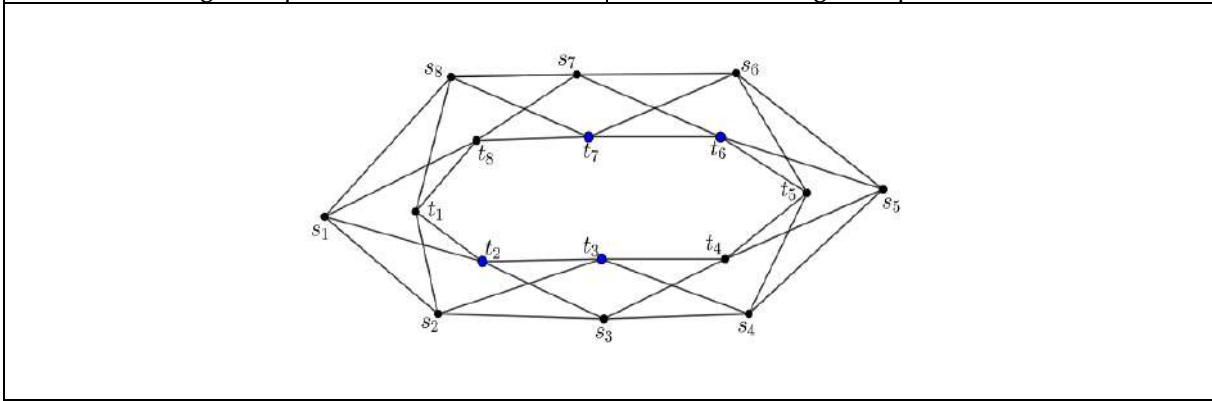
Sarang Sadawarte and Sweta Srivastav
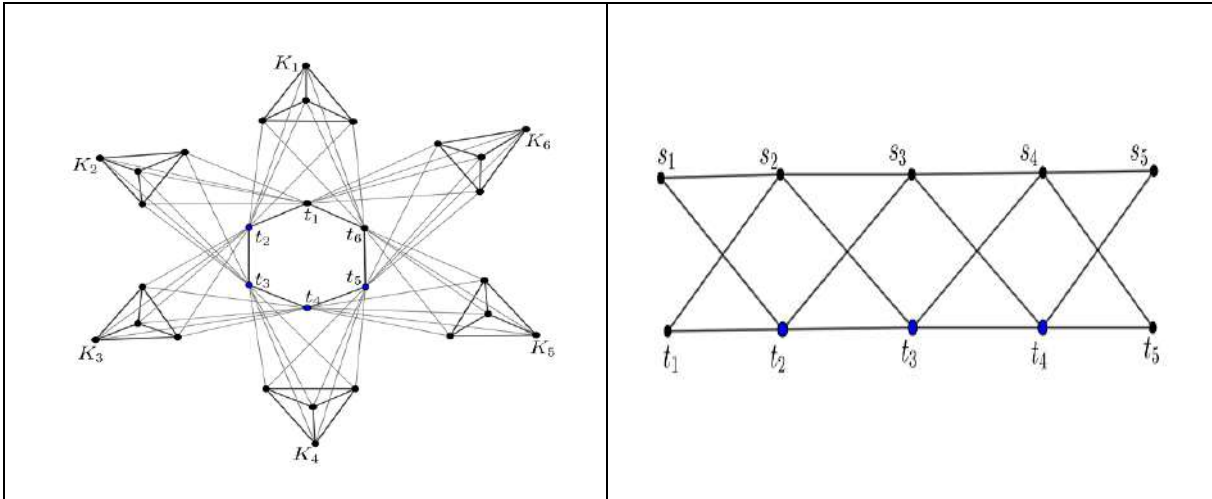
Figure 1. $\gamma_{st}(C_6 \bigstar K_4) = 4$

Figure 2 : $\gamma_{st}(D(P_5)) = 3$

Figure 3 : $\gamma_{st}(D(C_8)) = 4$

RESEARCH ARTICLE

Exploring Consumers' Behaviour towards Organic Food in India

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ABSTRACT

This study aims to reveal consumer behaviour towards organic food, particularly emphasizing the confusion and vagueness in the public eye. A structured questionnaire method was used to collect data from 534 consumers, and the data was collected by using a convenient sampling method. To find out the impact of consumer willingness to consume such foods, using regression analysis to find out the consumers' behaviour towards organic foods. Behaviour of a consumer can be used to find out some variables like belief, emotion (Positive& Negative), and store atmosphere is used. Nowadays consumers preferred store ambiance that will make a quick attraction to purchase a portion of organic food. The present study attempts to find out the consumers' behaviour towards organic food.

Keywords: Organic Food, Consumer Behaviour, Consumption, Price perception, Belief, Emotion, Store atmosphere.

INTRODUCTION

Consumer behavior types are determined by the product that need for consumers, the level of involvement, and the differences that exist between brands. The researcher predicts the behavioural intention of the consumers. There are three main determinants to predict an intention of consumer behaviour based on belief, positive and negative emotion and store atmosphere. The consumers have greater intention to engage in behavior, they are more likely to perform it. They can take a rational decision based on product attributes, to study emotions evoked by marketing stimuli, products and brands. The figure (1) below, related to the concept of organic food (i.e., consumer expectations about organic food), outlines the costs and benefits of organic produce. Consumers who benefit from organic food

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are considered to become more likely to develop positive buying intentions for such products. Natural food, on the other hand, could be perceived as having more costs than benefits by customers (Ozcelik A. O & Ucar A. 2008)

REVIEW OF LITERATURE

Khayyam, M., (2021) study on "Food Consumption Behavior of Pakistani Students Living in China: The Role of Food Safety and Health Consciousness in the Wake of Coronavirus Disease 2019 Pandemic". The emergence of coronavirus disease 2019 (COVID-19) has considerably changed global food production, processing, and consumption at different levels. Food safety and health consciousness, on the other hand, were only indirectly linked to behavioural intention via ATT and SN. Food safety and health consciousness were found to be important antecedents of classical TPB components that affect intentions and behaviours to avoid unfamiliar local food in a migrated context. The current study enlightens people who want to investigate sojourners' consuming behavioural intentions in the aftermath of a pandemic based on food safety and health consciousness. The findings of the current study are also applicable to typical food consumption patterns. Sumathy, D., and Rathna, G. A. (2018) Study focused On "A Study on Marketing Strategies and awareness about Organic Products in Coimbatore". This study aims to demonstrate the significance of marketing campaigns and organic product knowledge. Healthy foods are now widely regarded as being better than traditional foods. As a result, organic agriculture's expansion is seen as part of new marketing trends. Food protection, human wellbeing, and environmental effects are some of the reasons people shop. Multiple regression analysis has been used to find out the relationship between the dependent as ethical reasoning to buy the products, by comparing independent variable as a socio-economic status to find out the reasons for consuming organic foods and also create a creates awareness among them.

Research Objective
To identify the factor which influence the behavior of consumers towards organic products

RESEARCH METHODOLOGY

Area of the Study
Coimbatore is primarily an agrarian base of the district common man's interest for organic food products are well established and functioning of more than 70 organic retail stores across cities. These factors motivated the researcher to select this region for the field research. The empirical study is primarily focused on consumer's inhabitants in Coimbatore city.

Data Collection Method
Survey method is used for collecting data. The data collection covered the period from June 2019 to December 2019. After a detailed analysis of data, it was observed that more than one lakh retail stores of the differed category are functioning around the Coimbatore district, of which 70 stores were observed to organic product retail stores. These seventy organic food retailers are considered as the population of the study. A sample of 25 percent of these organic stores was chosen as the sample, i.e., is summed to 18 retail outlets. While the selection of these 18 retail outlets, certain criteria like nature and size of the store, store assortments, nature of organic products sold, long existence of the store, store popularity among the consumers were considered

Sampling Design

Sample design is a framework the portion of data is gathered from a large population to conclude the sample to the entire group (Teddle & Yu, 2007). The scope of the study defined the geographical location (Coimbatore) ie., Targeted population. The sample is selected from a sampling frame, the non-probability sampling methods are used, from that determine the appropriate sample size.

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Analysis and Interpretation

Multiple Regression Analysis- Consumer Behaviour and Reasons for Choosing Organic Products

The multiple regression model was performed to evaluate the association between consumer behavior towards organic products and reasons stated by them for choosing organic products.

Framed Hypotheses

H_02: There is no significant relationship between consumer behaviour and the reasons stated by them for choosing organic products.

There is no significant relationship between

H_02a:Price perception and the reasons stated by them for choosing organic products.

H_02b:Belief and the reasons stated by them for choosing organic products.

H_02c:Emotion(Positive & Negative)and the reasons stated by them for choosing organic products.

H_02d:Store atmosphere and the reasons stated by them for choosing organic products.

The dependent variable considered was consumer behaviour (price perception, belief, emotion (positive &negative), store atmosphere and the independent variable: X_1= Consumers gathered buying recommendations from mixed sources, X_2= Consumers don't often know why they like something, X_3= The crowd leads the way to buyer preferences, X_4= Influence on buying decision bed on social media, X_5= Previously positive experience for consumer, X_6= Review matter for deciding on product and companies, X_7= Retail stores, including flooring influence purchasing decisions, X_8= Consumers make emotional decisions and rational decision and, X_9= Consumer's subconscious drive purchase decision

Reasons stated by them for choosing organic products= f (Consumers gathered buying recommendations from mixed sources, Consumers don't often know why they like something, The crowd leads the way to buyer preferences, Influence on buying decisions depend on social media, Previously positive experience for the consumer, Review matter for deciding on product and companies, Retail stores, including flooring influence purchasing decisions, Consumers make emotional decisions and rational decision and, Consumer's subconscious drive purchase decision).

Measured reasons stated by the consumer as a dummy variable and run the following regression model to identify whether there exists an association between consumer behavior towards organic products and reasons stated by them for organic food products. Specifically,

(i) Price perception and reasons stated by the consumers for choosing anorganic products = $\alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e$

(ii) Belief and reasons stated by the consumers for choosing anorganic products = $\alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e$

(iii)Emotion (positive &negative) and reasons stated by the consumers for choosing anorganic products = $\alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e$

(iv)Store atmosphere and reasons stated by the consumers for choosing an organic products = $\alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e$

where,

Y_1 = Reasons stated by them for choosing organic products.

β_0 = Intercept

β_1-β_{11}= Slopes (estimates of coefficients)

X_1= Consumers gathered buying recommendations from mixed sources

X_2= Consumers do not often know why they like something

X_3= The crowd leads the way to buyer preferences

X_4= Influence on buying decision depend on social media

X_5= Previous positive experience for the consumer

X_6= Review matter for deciding on product and companies

X_7= Retail stores, including flooring influence purchasing decisions

X_8= Consumers make emotional decisions and rational decision

X_9= Consumer's subconscious drives purchase decision

e = Random error, which the authors assumed as NID for this research.

i)Price Perception : $Y_1 = 1.662 + .265 X_1 - .109 X_2 + .047 X_3 + .161 X_4 - .074 X_5 + .120 X_6 + .011 X_7 + .060 X_8 + .116 X_9$

It has been revealed from the above econometric analysis that the F ratio (52.024) is statistically significant at 5 percent level. This indicates the entire regression is significant, it establishes 68.7 percent relationship between the variables tested. From the above table, it is seen that the coefficient of correlation (R) value is 0.687 which describes the good relationship between variables. The coefficient of the determinant (R^2) 0.472 value describe that there exists a close association between price perception and reasons stated by the consumer for choosing organic products.

ii) **Belief: $Y_2 = 1.914 + 0.082 X_1 + 0.177 X_2 + 0.082 X_3 - 0.108 X_4 - 0.125 X_5 + 0.055 X_6 + 0.002 X_7 + 0.164 X_8 + 0.198 X_9$**

It has been revealed from the above econometric analysis that the F ratio (47.701) is statistically significant at 5 percent level. This indicates the entire regression is significant, it establishes 67.1 percent relationship between the variables tested. From the above table, it is seen that the coefficient of correlation (R) value 0.671 which describe the good relationship between variables and the coefficient of the determinant (R^2) 0.450 value describe that there exists a close association between consumers belief and reasons stated by the consumers for choosing organic products.

iii. Emotion (Positive & Negative): $Y_3 = 2.839 + 0.059 X_{10} - .103 X_2 - 0.035 X_3 + 0.132 X_4 + 0.069 X_5 - 0.027 X_6 + 0.055 X_7 + 0.068 X_8 + 0.055 X_9$

It has been revealed from the above econometric analysis that the F ratio (27.457) is statistically significant at 5 percent level. This indicates the entire regression is significant, it establishes 62.6 percent relationship between the variables tested. From the above table, it is seen that the coefficient of correlation (R) value is 0.626 which describes a good relationship between variables, and the coefficient of the determinant (R^2) 0.392 value describe that there exists a close association between level of emotion means for different types of foods. Researcher, find out basic emotions provides more information about the feelings of the consumer over and above positive and negative affect and the reason stated by them for choosing organic products.

iv) Store Atmosphere: $Y_3 = 0.056 + 0.359 X_1 + 0.125 X_2 - 0.106 X_3 + 0.016 X_4 + 0.048 X_5 + 0.126 X_6 - 0.036 X_7 + 0.243 X_8 + 0.249 X_9$

It has been revealed from the above econometric analysis that the F ratio (114.552) is statistically significant at 5 percent level. This indicates the entire regression is significant, it establishes an 81.4percent relationship between the variables tested. From the above table, it is seen that the coefficient of correlation (R) value .814 which describe the good relationship between variables and the coefficient of the determinant (R^2) 0.663 value describe that there exists a close association between consumers belief and reasons stated by the consumers for choosing organic products. To determine if one or more of the independent variables are significant with the predictors and to analyse whether their association between consumer behaviour towards organic products and reasons stated by them for choosing particular organic products, with the information provided above the co-efficient table is examined. Out of nine parameters statements considered nine were statistically significant. The standardized coefficient beta column reveals that consumer behaviour met have beta standard co-efficient 1.662, 1.914, 2.839, and .056 which are statistically significant at 0.000. Therefore the hypotheses framed stands accepted and it has been concluded that there exists a close association between (i) Price Perception, (ii) Belief, (iii) Emotion and (iv) Store atmosphere and reasons stated by the consumers for choosing organic products.

Findings

- Price perception
  It has been clearly identified that the majority of the sample consumers have expressed a high degree of behavior towards the price, they refrain intended to buyorganic foods because it is expensive which got 74.8 percent of respondents.
- Belief
  It has been found that the majority i.e 77.4 percent of the consumer find focused and believed organic food are too expensive to purchase.
- Emotion

This study classifies all emotion words has both positive and negative impact which is connected to consumer buying behavior. This study concluded that consumer behaviour towards organic products shows 82.6 percent of the respondents are willing to purchase the organic products with contentment. The study confirmed that Negative emotion has different behavioral consequences; it is important for failure in products or services causes a feeling of anger and sad ness got 79.4 percent.

- Store Atmosphere
  It has been found that majority i.e 77.2 percent of respondents focused on external variable that makes a first set cue in consumer views that makes a quick impression.

Practical Implications

This study provides several practical implications for the retail food industry. The retail managers should plan to execute various marketing strategies that influence the consumer to purchase organic food. They have to conduct advertisement campaigns to link organic food with environmental issues and also encourage the consumer to emphasize that organic food is an environmentally friendly product without any harmful elements to human health and also for the environment. In addition, a designed different product with different combinations may attract or satisfy the various consumer. For price-conscious customers, sufficient quality with an affordable price of organic food should be offered. By contrast, the quality of organic food is high with a high premium price provided to the consumer those who are not concerned about the price. A good marketing strategy will change consumers' perceptions and behaviourtoward organic food products.

CONCLUSION

Over time, market forces will favor an increase in the availability of organic prepared foods and a decline in the prevailing price of organics. Confusion about the meaning and value of organics is likely to mediate the rate of growth within this sector of the food industry. Non-buyers' lack of familiarity will make judgments about the relative value of organic foods more difficult. Conversely, the credibility and marketing power of familiar brand names will encourage product trials. Market dynamics will reflect the interaction of these two opposing forces. This study does not indicate that prices are irrelevant to either current or prospective buyers of organic products. Instead, it demonstrates a complex interaction of consumption values that shapes individuals' buying decisions. Social, functional, conditional, and emotional values (including pricing) are incorporated into these decisions relative to their importance to each individual. It is this relatively complex weighing of competing for alternative consumption values, within a broader context of economic decision-making, that results in the tradeoffs illustrated in this research.

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Table.1. Association between Consumer Behaviour Towards Organic Products and Reasons Stated by them for Choosing Organic Products

Reasons	β	t	sig	Tolerance	VIF
BELIEF					
(Constant)	1.914	15.666	.000		
Consumers gathered buying recommendation from mixed sources	.082	3.198	.001	.411	2.435
Consumers do not often know why they like something	.177	5.457	.000	.248	4.038
The crowd leads the way to buyer preferences	.082	2.166	.031	.220	4.547
Influence on buying decision depend on social medias	-.108	-3.345	.001	.357	2.798
Previous positive experience for consumer	-.125	-3.821	.000	.305	3.277
Review matter for deciding on product and companies	.055	2.658	.008	.835	1.198
Retail stores, including flooring influence purchasing decisions	**.002**	**.110**	**.912**	**.628**	**1.592**
Consumers make emotional decisions and rational decision	.164	6.436	.000	.558	1.793
Consumer's subconscious drives purchase decision	.198	9.359	.000	.774	1.292
PRICE PERCEPTION					
(Constant)	1.662	9.728	.000		
Consumers gathered buying recommendation from mixed sources	.265	8.890	.000	.431	2.319
Consumers do not often know why they like something	-.109	-3.121	.002	.301	3.323
The crowd leads the way to buyer preferences	**.047**	**1.530**	**.127**	**.543**	**1.841**
Influence on buying decision depend on social medias	.161	4.324	.000	.321	3.114
Previous positive experience for consumer	-.074	-3.243	.001	.701	1.426
Review matter for deciding on product and companies	.120	4.848	.000	.721	1.387
Retail stores, including flooring influence purchasing decisions	**.011**	**.456**	**.649**	**.724**	**1.381**
Consumers make emotional decisions and rational decision	.060	2.477	.014	.800	1.251
Consumer's subconscious drive purchase decision	.116	4.919	.000	.892	1.121
EMOTION(POSITIVE & NEGATIVE)					
	2.839	12.314	.000		

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| Reasons	β	t	sig	Tolerance	VIF
Consumers gathered buying recommendation from mixed sources	**.059**	**1.465**	**.144**	**.431**	**2.319**
Consumers do not often know why they like something	-.103	-2.178	.030	.301	3.323
The crowd leads the way to buyer preferences	**-.035**	**-.705**	**.481**	**.321**	**3.114**
Influence on buying decision depend on social medias	.132	3.214	.001	.543	1.841
Previous positive experience for consumer	.069	2.224	.027	.701	1.426
Review matter for deciding on product and companies	**-.027**	**-.796**	**.427**	**.721**	**1.387**
Retail stores, including flooring influence purchasing decisions	**.055**	**1.651**	**.099**	**.724**	**1.381**
Consumers make emotional decisions and rational decision	.068	2.093	.037	.800	1.251
Consumer's subconscious drive purchase decision	**.055**	**1.740**	**.082**	**.892**	**1.121**
STORE ATMOSPHERE					
	.056	.344	.731		
Consumers gathered buying recommendation from mixed sources	.359	13.175	.000	.528	1.893
Consumers do not often know why they like something	.125	3.862	.000	.322	3.106
The crowd leads the way to buyer preferences	-.106	-2.981	.003	.322	3.104
Influence on buying decision depend on social medias	**.016**	**.585**	**.559**	**.605**	**1.654**
Previous positive experience for consumer	.048	2.223	.027	.713	1.402
Review matter for deciding on product and companies	.126	5.319	.000	.718	1.392
Retail stores, including flooring influence purchasing decisions	**-.036**	**-1.541**	**.124**	**.737**	**1.357**
Consumers make emotional decisions and rational decision	.243	10.641	.000	.817	1.224
Consumer's subconscious drive purchase decision	.249	9.557	.000	.660	1.515
R		.687	.671	.626	.814
R2		.472	.450	.392	.663
F		52.024	47.701	27.457	114.552
Sig		.000	.000	.000	.000

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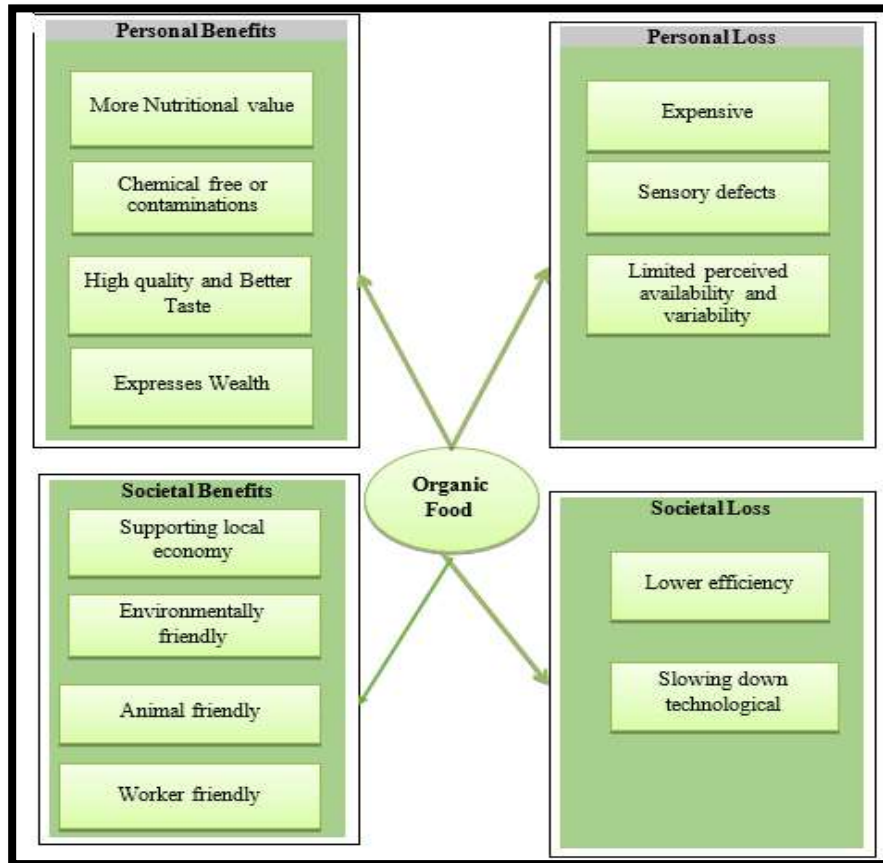
Figure.1.The Likely Benefits or Costs of Organic Food
Source. Kl ckner (2012)