



Pharmaceutical Suspensions: A Review on another Approach for Poorly Soluble Novel Materials

Dinesh Kumar Sharma¹, Gurudutta Pattnaik¹, Amulyaratna Behera^{1*}, Prafulla Kumar Sahu¹, Biswajeet Acharya¹, Gayatri Behera¹, Suchismeeta Behera²

¹School of Pharmacy and Life Sciences, Centurion University of Technology and Management, Odisha, India.

²Post Graduate Department of Zoology, Utkal University, Vanivihar, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Amulyaratna Behera

School of Pharmacy and Life Sciences,
Centurion University of Technology and Management,
Bhubaneswar- 752050, Odisha, India.
Email: amulyaratna.behera@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Pharmaceutical suspensions are a type of solid-liquid dispersion that is defined as a heterogeneous biphasic liquid dosage form of drug in which the external or continuous phase is usually a liquid or semisolid, and the internal or dispersed phase is made up of particulate matter that is insoluble in the continuous phase but dispersed through it. The current study covers a variety of topics related to suspensions, including classification, theories, sedimentation behavior, and techniques for forming floccules, suspension formulations, stability. This article provides a straightforward and accurate exposition of essential topics in pharmaceutical suspension for students and young researchers.

Keywords: Pharmaceutical suspension; Solubility; Dissolution; Bioavailability

INTRODUCTION

Pharmaceutical suspensions are biphasic liquid dosage forms where the inner phase is distributed homogeneously in the outer phase (dispersion medium). The suspensions inner phase (dispersed phase) is made up of immiscible solid particles with a size range of 0.5 to 5.0 micron that is sustained consistently in the suspending vehicle by the use of a particular or mixture of the suspending agent. For non-oral usage, the dispersion medium is normally aqueous, although in some cases it may be an oily or organic liquid [1]. When the ideal suspension's container is gently shaken, it can settle slowly and disperse easily. The suspension must spill out of its container readily and uniformly. Chemically, it should be inert. It does not make a cake of the scattered particles. It should not contain large particles which, when applied externally, ruin its shape and give a gritty taste to oral preparations and also cause irritation to susceptible tissues. Preferred characteristics in suspensions such as dispersed solid particles should not be quickly



**Dinesh Kumar Sharma et al.**

sedimented and sediment formed, simply re-dispersed with moderate shaking. It must be simple to dispense, but not watery or gummy. It must have a good scent, color, and taste. It needs to be stable microbiologically, chemically, and physically. The sterilizable ophthalmic and parenteral suspension must be required. The advantages of pharmaceutical suspensions like chemical stability of certain drugs can improve by the suspension, example like Procaine Penicillin G. The rate of bioavailability of suspended drugs is higher than that of the bioavailability of other dosage types in the order mentioned: solutions > suspensions > capsules > compressed tablets > coated tablets. It is possible to regulate the onset and duration of action, eg. Protamine Zinc-Insulin suspensions. Bitter/unpleasant taste of drug can mask in suspension form. Eg. Chloramphenicol [2]. Disadvantages are problems may be caused by sedimentation, compaction, and physical stability. At the time of transport and handling, it is cumbersome, adequate care should be taken, it is not simple to prepare. The precise and uniform dose cannot be accomplished except suspension is packaged in unit dose [2].

Application of Suspension is generally appropriate for drugs that are poorly soluble or insoluble, example such as Prednisolone suspension. To avoid drug deterioration as well as to get better drug stability, example such as Oxytetracycline suspension. To coat the drug's bad taste, example such as suspension of Chloramphenicol palmitate. Suspension for topical application may be formulated example such as Calamine lotion. In regulate to monitor the drug absorption rate, Parenteral Suspension may be formulated. Suspension can be formulated in the form of Vaccines as an immunizing agent, example such as Cholera vaccine. Suspension can also be formulated as X-ray contrast agents, example such as Barium sulfate for examination of the alimentary tract [2]. In this article, authors covered all study related to pharmaceutical suspension like classification, theories, sedimentation behavior, and procedures for producing floccules, suspension formulations, stability that will be useful for all students and research scholars who wants to increase the solubility, dissolution and bioavailability of poorly soluble drugs and dosage forms can also be used as a sustainable release of drug for good health and well being.

Classification of Pharmaceutical Suspensions

Pharmaceutical suspensions are classified on the basis of universal classes like oral suspension, parenteral suspension, ophthalmic suspension, topically applied suspension. On the basis of the percentage of solid particles like concentrated suspension (50%w/v solid), dilute suspension (2 to 10%w/v solid). On the basis of the electro-kinetic character of solid particles like Non-flocculated suspension, flocculated suspension. On the basis of the size of solid particles like nanosuspensions (10 ng), coarse suspensions (>1 micron), colloidal suspensions (< 1 micron).

Oral Suspensions

These suspensions are administered orally by the patient. Suspensions used orally commonly consist of a sweetening agent and flavoring agent to mask the unpleasant taste of the drug. Nowadays suspensions are accessible in the sell-in dry powder form and these are reconstituted by the addition of the specific amount of recently boiled and cooled water before use e.g., for pediatric use antibiotics in suspension form.

Parenteral Suspensions

The suspensions which are consumed by the parenteral route are known as parenteral suspensions. These suspensions are essential to accomplish the following qualities: The drug particle size should be easily passed through the needle of the syringe. During storage, there should be no crystal growth in the suspension. In the suspension, solid particle concentration should be between 0.5 to 30%. The suspension viscosity should not interfere with its flow through the syringe needle. The suspensions must be sterilized.

Ophthalmic Suspensions

As compared to eye drops ophthalmic suspensions are not generally used. These are formed only in those cases when the drug is unstable in liquid form or immiscible in the desired solvent. These suspensions should complete the following conditions: The eye suspensions particle size should be fined sufficient so that it should be non-irritating to the eye. The suspensions must be sterilized. These suspensions must be isotonic. This must-have





Dinesh Kumar Sharma et al.

preferred viscosity. The suspension must be packed in an appropriate container so that it can be simply instilled into the eye.

Suspensions for External Use

These suspensions are used externally e.g. ear drops, inhalations, lotions, etc. These suspensions contain extremely minute particles to avoid grittiness. Lotion-containing suspended particles evaporate when applied to the skin leaving a light deposit of medicament on the surface. Its simpler to spread lotions and less sticky than other external semi-solid preparations. Calamine lotion is a suspension-type dosage form that is applied externally and provides a protective effect. Lotions which are used for the treatment of skin that is damaged or inflamed must be free of harmful microorganism.

Theory of Suspensions

Sedimentation behavior:

Sedimentation implies the settlement of floccules or particles in liquid dosage shape under gravitational force.

Sedimentation theory

Sedimentation velocity, represented by the Stokes equation,

$$V_{sed} = \frac{d^2(\rho_s - \rho_0)}{18 \eta_0} \dots\dots\dots (1)$$

$$= \frac{2r^2(\rho_s - \rho_0)g}{9 \eta_0}$$

Where, V_{sed} = rate of sedimentation (cm / sec), d = Particle diameter, r = Particle radius,

ρ_s = density of disperse phase, ρ_0 = density of continuous phase, g = increase of rate due to gravity, η_0 = viscosity of continuous phase (poise).

Stoke's Equation can be written as:

$$V' = V_{sed} \cdot \epsilon^n \dots\dots\dots (2)$$

V' = the velocity of fall at the interface (cm/sec), V_{sed} = sedimentation rate as per Stoke's law.

ϵ = Primary system's porosity is expressed by first fraction volume of the equally mixed suspension varying to unity,

n = a constant for any device that measures the system's "hindering"

Factors affecting sedimentation:

Diameter of particle size (D): ($V \propto d^2$)

The rate of sedimentation (v) and square particle diameter are directly proportional to each other.

The density difference between dispersed and continuous phase ($\rho_s - \rho_0$)

$$V \propto (\rho_s - \rho_0) \dots\dots\dots (3)$$

The density of the particle is typically higher than that of the continuous phase, but in some situations, it is lower than that of the dispersed phase, so suspended particles float and are not easy to disperse consistently in the medium.

The viscosity of continuous phase (η):

$$V \propto \frac{1}{\eta_0}$$

The sedimentation rate is inversely proportional to the continuous phase's viscosity. If the continuous phase viscosity increases, sedimentation decreases, allowing the particles to achieve a good dispersion method. But, as the viscosity increases, issues such as re-dispersibility, pouring, and syringibility of suspension arise. Merits owing to the viscosity of dispersion medium like higher viscosity prevent the transition of metastable crystals to stable crystals, and it increases the suspension's physical stability and demerits like re-dispersibility of settling particles is slowed by





Dinesh Kumar Sharma et al.

high viscosity; higher viscosity also slows down the drug absorption. At the time of production higher viscosity often causes issues in material handling [3].

Sedimentation parameters:

Three essential considerations for sedimentation are measured:

For flocculated suspensions sedimentation volume (F) or height (H)

The ratio between the final sediment volume (V_u) and the initial sediment volume (V_o) before settling is known as the volume of sedimentation.

$$F = \frac{V_u}{V_o} \quad \text{----- (4)}$$

Where,

V_u = ultimate or final sediment volume, V_o = initial suspension volume before settling.

Often 'F' is interpreted as 'Vs' and as a percentage expressed. Similarly, the volume is determined by a measuring cylinder.

$$F = \frac{H_u}{H_o} \quad \text{..... (5)}$$

Where,

H_u = ultimate or final sediment height, H_o = before settling initial suspension height

Settling of flocculated and deflocculated suspensions is depicted in figure (Figure 1) [4].

Sedimentation behavior of flocculated and non-flocculated suspensions:

Flocculated suspensions

Due to a rise in the dimension of the settling particles, produced loose aggregates (flocs) will source a rise in sedimentation velocity in flocculated suspension. As an effect, flocculated suspensions resolve more quickly. The sedimentation here is influenced by the dimension of the loose aggregates as well as by the flocs porosity. The free structures of the quickly sedimenting flocs continue to keep in the sediment in flocculated suspension, which includes a considerable quantity of trapped fluid. As a result, the final sediment volume is comparatively high and agitation will easily disperse it.

Non-Flocculated suspensions

Individual particles in a non-flocculated suspension settle slowly, preventing the liquid medium from being entrapped, making it complex to re-disperse by shaking. This occurrence is as well known as 'claying' or 'cracking'. Larger particles sediment rapidly in non-flocculated suspensions, while smaller particles remain in the supernatant liquid, resulting in cloudy supernatant, while in flocculated suspensions, even the least particles are included in flocks, resulting in cloudless supernatant. Sedimentation performance of non-flocculated and flocculated suspension is depicted in figure 2 [4] and a comparison between flocculated and non-flocculated suspension are described in table 1 [4].

Techniques of floccules formation:

The various techniques for forming floccules are listed below:

Electrolytes

Electrolytes reduce the electrical barrier among the particles as well as carry them simultaneously for floccules formation. They decrease the zeta potential to near zero, resulting in the creation of a bridge between neighboring particles, which outline them simultaneously in a freely ordered formation. Electrolytes work as flocculants by lowering the electric barrier among particles, as demonstrated through reducing in zeta potential and the creation of a link among closest particles, linking them simultaneously in a freely organized formation. As we dissolve bismuth subnitrate particles in water, the system is peptized or deflocculated based on electrophoretic mobility potential due to the strong repulsion force among closest particles. By making a sequence of bismuth subnitrate suspensions with rising concentrations of monobasic potassium phosphate, the relationship between sedimentation volume, apparent zeta potential, flocculation, and caking can be confirmed (Figure 3) [5,6].





Dinesh Kumar Sharma et al.

Surfactants

Surfactants, both non-ionic and ionic, are used for suspended particle flocculation. The optimal concentration is essential for the reason that these compounds as well work as wetting agents to reach dispersion. Surfactants reduce surface free energy by lowering the interfacial tension between the solid particles and liquid medium at optimum concentrations. This reaches to produce tightly packed agglomerates. The particles with the lowest surface free energy are drawn to each other by vanderwaals forces, forming flocs.

Polymers

Polymers' structures are made up of long chains. The long-chain is adsorbed on the particle surface, with the remainder projecting out into the continuous phase. The formation of loose aggregates is also caused by bridging between these later sections.

Liquids

When enough liquid is there to shape the connection, a dense agglomerate is produced, similar to the granulation of powders. The force performing to keep the particles together is determined by the interfacial tension in the link's segment. Hydrophobic liquids can be used to flocculate hydrophobic solids.

Formulation of Pharmaceutical Suspensions

Structured Vehicle:

The word "structured vehicle" is more essential for formulation as well as stability requirements when it comes to the need for a stable suspension. The key drawback of the suspension formulation is restricted its use in regular practice is its long-term stability. The word "structured vehicle" has become important in overcoming or reducing this problem to some degree. Under the static condition of very low shear on storage, the viscosity of the preparation approaches infinity in the structured vehicle. The vehicle functions as a 'false body,' allowing particles to remain suspended in a less or more stable state. It is understandable that the idea of a "structured vehicle" applies only in deflocculated suspensions, in which a hard cake forms owing to solid particle sedimentation and must be quickly and uniformly re-dispersed at the time of administration. Since settled floccules are easily re-dispersed when shaken, the Structured Vehicle definition does not apply to flocculated suspension. In general, the idea of a Structured Vehicle is not applicable for parenteral suspensions as the high viscosity can cause problems with syringe ability. Structured vehicle preparations Hydrocolloids are used to create structured vehicles. They first hydrolyzed and swelled to a large extent in a particular medium, enhancing viscosity at lower concentrations. It also can work as a 'Protective colloid' along with stabilizing charge. Glycerin, sugars, polyvinylpyrrolidone, and polyethylene glycols can all help to increase the density of structured vehicles.

Further Formulation Components:

Formulation Components are mentioned in table 2 [6].

Flocculating agent

The solid particles in suspensions are well distributed in the dispersion medium, which is the vehicle. A surfactant that serves as a flocculating agent may be added to increase the dispersion. The flocculating agent works by lowering surface tension, which improves solid dispersion and reduces flocculation e.g. Tweens, sodium lauryl sulfate, spans, and carbowaxes, etc. are commonly used as a flocculating agent.

Wetting agents

These are compounds that decrease the interfacial stress between the liquid medium and solid particles, resulting in a high-quality suspension. This can be accomplished by incorporating a suitable wetting agent that is adsorbed at the solid/liquid interface, increasing particle affinity for the surrounding medium while decreasing inter particular forces, for example, glycerin in sodium alginate or bentonite dispersion, alcohol in tragacanth mucilage, and polysorbate in oral and parenteral suspensions.

Thickening agents

These are hydrophilic colloids that form colloidal dispersions with water and increase the viscosity of the dispersion medium, allowing solid particles to stay suspended in it for long enough to calculate an accurate dose uniformly. The thickening agents used to stabilize suspects are classified into three major group polysaccharides, inorganic agents, and synthetic compounds. Two types of polysaccharides are used nowadays these are natural polysaccharide

42562



**Dinesh Kumar Sharma et al.**

like gum acacia, tragacanth, starch and sodium alginate another polysaccharides type is semi-synthetic example like methyl cellulose, sodium carboxymethyl cellulose and microcrystalline cellulose. Examples of inorganic agents are clay and aluminium hydroxide. Examples of synthetic compounds are carbomer and colloidal silicon dioxide.

Osmotic Agents

When a suspension is proposed for injectable or ophthalmic preparation, they are used to create osmotic pressure similar to biological fluids. Mannitol, dextrose, and sorbitol are the most widely used osmotic agents in ophthalmic suspensions. Sodium chloride, sodium sulfate, mannitol, dextrose, and glycerol are used in parenteral suspension as tonicity-adjusting agents [3,6].

Surfactants

Surfactants lower the interfacial stress between liquid and drug particles, allowing liquid to enter drug particle pores, displacing air, and ensuring wetting. Surfactants in the right concentration aid particle dispersion. Non-ionic surfactants are mainly used, but ionic surfactants can also be used in some situations. Surfactants have the disadvantage of having foaming properties. Furthermore, they have a bitter flavor. Surfactants like polysorbate 80 interfere with preservatives like methylparaben, lowering antimicrobial activity.

Hydrophilic Colloids

In one or more layers, hydrophobic drug particles are coated through hydrophilic colloids. This will give drug particles hydrophilicity and make them easier to wet. Since the force of attraction is reduced, they induce suspension deflocculation. Tragacanth, acacia, alginates, pectin, guar gum, wool fat, gelatin, egg yolk, Veegum, bentonite, Methylcellulose, and so on are some examples.

Solvents

Glycerin, alcohol, polypropylene glycol, and polyethylene glycol are the most commonly utilized solvents. They include wetting by being miscible with water and lowering the interfacial stress between liquid and air. Individual particles are penetrated by liquid, which promotes wetting.

Buffers

To run into issues of stability All liquid formulations should have a pH of 7.0 or higher. The pH of the system affects rheology, viscosity, and other properties. The pH range of 4-10 is stable for most liquid systems [3,4,6-8].

Flavoring and coloring agents

They're included to boost patient approval. There are several coloring and flavoring agents on the market. Color selection should be linked to the flavor used to enhance the patient's attractiveness. Since only sweetening agents are incapable of fully masking the taste of unpleasant drugs, flavoring agents are used. The product can be identified by its color [2,3,6,9].

Antioxidants**Appropriate antioxidants are used as follows:**

Ascorbic acid derivatives like sodium ascorbate, erythorbic acid, ascorbic acid. Thiol derivatives like cysteine, thioglycerol, acetylcysteine, dithioerythritol, cysteine, glutathione, dithiothreitol. Tocopherols, Butylated hydroxyl toluene (BHT). Butylated hydroxyl anisole (BHA). Sulfurous acid salts like sodium bisulfite, sodium sulfate, acetone sodium bisulfite, sodium sulfite, sodium metabisulfite [10].

Preservatives

Microbial contamination is a risk of naturally occurring suspending agents like xanthan gum, acacia, and tragacanth. If the suspension is not correctly maintained, then enhancement in microbial activity can lead to problems with stability, such as color loss, suspension activity loss, odor, and changes in beauty, tastes, and so on. Lower pH increases antimicrobial activity [3-7].

Stability of Suspensions

With mild shaking, a stable suspension can be homogeneously redispersed and easily poured during its shelf life. Pharmaceutical suspensions that are flocculated, or in which the suspended particles are physically bonded together



**Dinesh Kumar Sharma et al.**

to make a free, semi-rigid structure, are the most stable. The deflocculated suspension can be stabilized by reducing the suspended material's particle size or raising the vehicle's density and viscosity.

For evaluation of the stability of suspensions the methods mentioned below are widely used to assess suspension's physical stability.

Sedimentation method

Sedimentation means the settling of particles or floccules that occurs under gravitational force in the liquid dosage form. The measurement of sedimentation volume is the most important parameter in the evaluation of the stability of suspensions. It is determined by keeping a measured volume of the suspension in a graduated cylinder in an undisturbed position for a definite time and noted the ultimate height (hu) of the sediment and the initial height of the total suspension. The sedimentation volume F is the ratio of the ultimate height and initial height (hu/ho). The sedimentation volume can be plotted against time. The graph indicates the sedimentation pattern of suspension on storage. A stable suspension shows the horizontal or less steep curve. The evaluation of redispersibility can also be determined by shaking the suspension and again find out sedimentation volume (hu/ho).

Rheological method:

Using a high-quality viscometer, the suspension viscosity is measured at various time intervals. It provides valuable information about suspension stability.

Electrokinetic method:

Determination of electric charge on the surface or zeta potential of suspension is useful to find out the suspension's stability. Definite zeta potential produces more stable suspension as controlled flocculation. The zeta potential can be estimated using the electrophoretic method's particle migration velocities.

Micromeritic method:

The particle size of the dispersed phase determines the suspension's stability. The size of particles in a suspension can increase, eventually resulting in lumps or caking formation. As a result, the difference in particle size with respect to time will provide valuable information about a suspension's stability. Microscope and coulter counter methods can be used to investigate changes in particle size distribution and crystal habit [11].

CONCLUSION

After reading this article we can conclude that this article is helpful for updating the knowledge of the pharmaceutical suspension and this will be beneficial for the pharmacy students for getting complete information of the pharmaceutical suspension. This article will be also useful for the research scholar who wants to prepare suspension formulation as well as increase the solubility, dissolution rate, and bioavailability of low soluble drugs.

ACKNOWLEDGEMENTS

The author would like to express his gratitude to Centurion University of Technology and Management, Odisha, India, for providing the essential resources for the completion of this study.

REFERENCES

1. R. Santosh Kumar and T. Naga Satya Yagnesh. Pharmaceutical Suspensions: Patient Compliance Oral Dosage Forms. *World Journal of Pharmacy and Pharmaceutical Sciences* 2016;5(12):1471-1537.
2. Martin A. Fourth edition, "Coarse dispersion" *Physical Pharmacy*, Lippincott Williams and Wilkins, Philadelphia 2001;479-481.
3. Cooper & Gun. Sixth edition, "Dispersed system" *Tutorial Pharmacy*;75-78.





Dinesh Kumar Sharma et al.

4. Aulton M.E. Second edition, "Suspension" Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone, Edinburgh 2002;84-86.
5. Banker G.S. and Rhodes C.T. "Dispersed systems" Modern Pharmaceutics, Marcel Dekker, INC. New York 1979;72:345-346.
6. Subramanyam C.V.S. Second edition, "Suspensions" Text Book of Physical Pharmaceutics;374-387.
7. Ansel C., Allen L.V, Popovich N.G. Eighth edition "Disperse systems" Pharmaceutical Dosage Forms & Drug Delivery Systems, Lippincott Williams and Wilkins, Philadelphia 2005;387-389.
8. Remington. Twentieth edition, "Colloidal Dispersions" The Science and Practice of Pharmacy, Lippincott Williams and Wilkins, Philadelphia 2000;298-307.
9. Remington. Twentieth edition, "Pharmaceutical Necessities" The Science and Practice of Pharmacy, Lippincott Williams and Wilkins, Philadelphia 2000;1017-1021.
10. Lachman L. Third edition, "Pharmaceutical Suspension" The Theory and Practice of Industrial Pharmacy, Verghese Publishing House, Bombay 1996;488-489.
11. Mehta R.M. Pharmaceutics-II, M.K. Jain Vallabh Prakashan, second edition 2003;119-130.

Table 1. Comparison between Flocculated and Non-flocculated Suspension

| Flocculated Suspension | Non-Flocculated Suspension |
|--|--|
| Particles form flocs and make a structured network. | The particle exists as a separate entity. |
| High sedimentation rate. | |
| Sediment is quickly formed. | Slow sedimentation rate. |
| Re-dispersion of sediment is simple. | Sediment is slowly formed. |
| The sediment is loosely packed, thus, does not form a hard cake. | Re-dispersion of sediment is difficult. |
| Clear supernatant is obtained. | The sediment is closely packed, thus, forms a hard cake. |
| The floccule sticks to the side of the bottle. | Cloudy Supernatant is obtained. |
| Suspension is unpleasant in appearance. | The floccule does not stick to the side of the bottle. |
| | Suspension is pleasant in appearance. |

Table 2. The following are the different components used in a suspension formulation

| Components | Function |
|---------------------------------|---|
| API | Active drug substances |
| Flocculating agents | They are used to floc the drug particles |
| Wetting agents | They are used to spread solids in the continuous liquid phase. |
| Thickening agents | They are used to enhance the viscosity of the suspension. |
| Osmotic agents | They are used to adjust osmotic pressure comparable to biological fluid. |
| Buffers and pH adjusting agents | They are used to stabilize the suspension to a preferred pH range |
| Coloring agents | They are used to impart preferred color to suspension and develop elegance. |
| Preservatives | They are used to inhibit microbial growth. |
| External liquid vehicle | They are used to construct the structure of the final suspension. |





Dinesh Kumar Sharma et al.

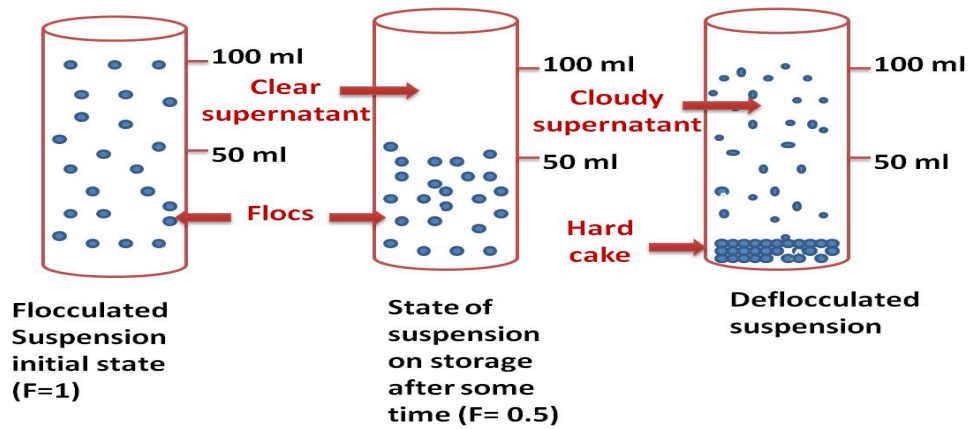


Fig. 1 Suspensions as measured by the volume of sedimentation (f)

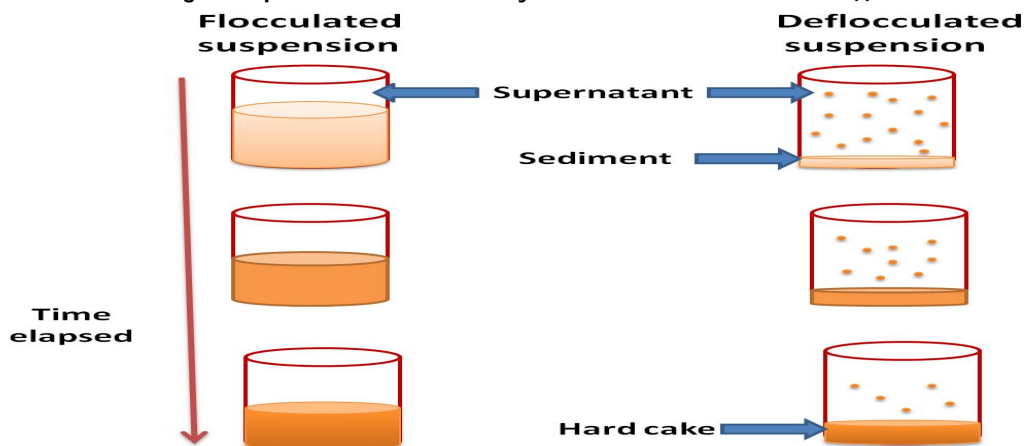


Fig. 2 Sedimentation performance of non-flocculated and flocculated suspensions

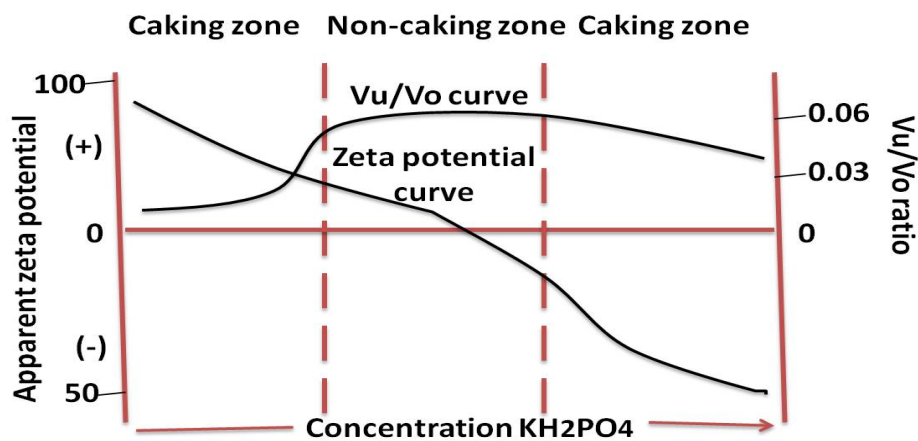


Fig. 3 Caking illustration, presenting the flocculation of bismuth subnitrate suspension using the flocculating agent





Formulation Development and Evaluation of Herbal Dispersible Triphala Tablet Containing Herbal Excipients

Gayatri Behera^{1*}, Basant Behera², Dinesh Kumar Sharma¹ and Chaitanya Prasad Meher¹

¹School of Pharmacy, Centurion University of Technology and Management, Odisha, India

²College of Pharmaceutical Sciences, Puri, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Gayatri Behera

School of Pharmacy,

Centurion University of Technology and Management,

Balangir-767001, Odisha, India.

Email: gayatri.behera@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present research deals with the formulation and evaluation of 100 mg Herbal Dispersible Triphala Tablet containing 60 mg of Triphala (Harida, Bahada, Amla 20 mg each) containing herbal excipients. The method of selection of various herbal excipients, Drug excipient compatibility studies are done and 10 formulations of Herbal Dispersible Triphala Tablet are made. After preparing, in vitro evaluation, release kinetic studies, and stability studies are done. Results declared that the F7 (Formulation 7) is selected as the best formulation which produces a better drug content capacity of 99.98 % and disintegration time of 2.06 ± 0.34 minutes. So it is confirmed that the best formulation F7 (Formulation 7) can produce anti-oxidant, anti-inflammatory, antibacterial, and anti-viral activities. It can develop the immunity power of the body and can prevent gastric, pneumonia, cancer, AIDS, and protect Corona Virus also.

Keywords: Herbal, dispersible, Triphala tablet, Immunity, AIDS, Corona Virus.

INTRODUCTION

Ayurvedic medicine is the World's oldest medicinal system that was started in India by Acharya Chanaka 3,000 years ago who is called the Father of Medicine [1]. WHO has recognized the importance of traditional medicine to provide essential care in 1989 [2]. It generated the concept that traditional medicines can be implemented for diagnosis, cure, treatment, and prevention of diseases and maintenance of health. Herbal medicines are conventional medicines that are easier to dispense, easily available, stabilize hormones secretion and metabolism in the body, provide strength to the immune system, having fewer side effects, and are cost-effective. Triphala is called polyherbal medicine containing Harida, Bahada, and Amla in proper ratio [3], [4]. It can provide anti-oxidant, anti-inflammatory, antibacterial, and anti-viral activities. It can develop the immunity power of the body and can prevent



**Gayatri Behera et al.**

gastric, pneumonia, cancer, AIDS, and protect Corona Virus also. The oral dispersible tablet is the novel approach of drug delivery system which led a new path in the formulation world [5]. It is cost-effective, a better onset of action provides better therapeutic effects, reduces drug loss, and produces patient compliance. The natural bioactive agents are used in place of synthetic excipients because they are non-toxic, and easily available, and do not hamper the therapeutic effects of the drugs [6]. The objective of the study is to formulate and evaluate 100 mg Herbal Dispersible Triphala Tablet containing 60 mg of (Triphala Harida, Bahada, Amla 20 mg each.) by using herbal excipients. This herbal tablets are sustainable for good health and well being.

MATERIALS AND METHODS**Survey upon Drugs and Their Adequate Excipients**

Various literature surveys have done about proper herbal ingredients for preparing the Triphala dispersible tablet. [7-16]

Collection of Materials

The 100% genuine Ayurvedic herbal drugs and excipients without any colors, preservatives, or chemicals are collected from the company "Indian jadibooti" Sales and Marketing Office, 60, C-58/4, SVC, Sector-62, Noida, Uttar Pradesh, India, 201301. <https://indianjadibooti.in>.

Methods of Research Work

Different properties and uses of various excipients are taken in different ratios to formulate and evaluate Herbal Dispersible Triphala Tablet are given in Table I [16].

Composition of Herbal Dispersible Triphala formulations:

10 formulations of dispersible Herbal Triphala Tablets are prepared that is represented in Table II.

Drug-excipient compatibility studies:

Drug-Excipient compatibility study is done at 45°C and 75% RH for 90 Days (Table III). Drug – excipients 1:1 ratio were packed in 85mm HDPE bottles with an oxygen adsorbent, a molecular sieve, and a desiccant containing silica gel with cotton as filler and made the compatible study.

Recovery of less compatible formulations:

In F2 by increasing the quantizes of Guggule (Binding agent) and decreasing the quantities of Corn starch (Glidant). In F4 by increasing the quantizes of Corn starch(Glidant). and decreasing the quantities of Mangifera Indica Gum(Super disintegrant).

In F8 by increasing the quantities of Corn starch and decreasing the quantities of Lactose (Diluents).

Final formulation of Herbal Dispersible Triphala Tablets:

Finally, 10 formulations of Herbal Dispersible Triphala Tablets are confirmed (Table IV).

Preformulation study:

The preformulation studies like flow properties, solubility were determined shown in Table 5.

Flow properties are studied of Herbal Dispersible Triphala formulations:

The following flow properties of the lubricated granules were evaluated (Table V).

Angle of Repose (Θ):

It was determined by using a funnel whose tip was fixed at a constant height (H) of 2.5cm from the horizontal surface. The conical pile is generated by passing granules through the funnel. The radius of the conical pile is measured as R (cm). It is determined with the formula;

The angle of repose (θ) = \tan^{-1} (height of pile /radius of the pile).





Gayatri Behera et al.

Bulk density and Tapped density (g/ml):

The previously weighed granules (W) were placed separately into a graduated measuring cylinder and the initial (bulk) volume (V_B) was noted. Then it is placed into Bulk density testing apparatus. The tapping rate is 200/minute. It was recorded as the final (tapped) volume (V_T) and various flow properties were calculated with the following formulae.

$$\text{Bulk density, } \rho_B = \frac{W}{V_B} \qquad \text{Tapped density, } \rho_T = \frac{W}{V_T}$$

Compressibility Index:

It was calculated by using the following formula

$$\text{Carr's Index or Compressibility Index (CI)} = 1 - \frac{\rho_B}{\rho_T} * 100$$

The CI value below 15% indicates the good flow of the powder and above 30% indicates poor flow property of the powder.

Hausner's Ratio:

It is calculated by the following formula;

$$\text{Hausner's Ratio} = \frac{\rho_T}{\rho_B}$$

Less than 1.25 indicates good flow property and above 1.25 indicates poor flow property of the powder.

Preparation of Herbal Dispersible Triphala Tablets granules:

Preparation of granules:

The 10 formulations of Herbal Dispersible Triphala Tablets were prepared by the wet granulation method. The composition of the tablet is mentioned in T-2. The required ingredients were weighed accurately and passed through 40 mesh. The sieved materials were then mixed well in a polybag for about 30 minutes. The distilled water is mixed slowly. The wet mass was granulated in the RMG granulator. The granules were then dried in a Retsch rapid dryer at 60°C for about 60 minutes until the % LOD becomes less than 3%. The dried granules were then passed through 40 mesh and then lubricated by mixing with the lubricant (which was previously passed through 60 mesh) in a polybag for about 15 minutes. The flow properties of the lubricated granules were determined.

Preparation of Herbal Dispersible Triphala Tablets

The lubricated granules were then compressed by using 16 station tablet compression machine (CADMACH) with 7 mm plane round-shaped punches. 10 formulations of Dispersible Triphala tablets are made of different compositions.

The Post comprisal parameters of formulations of Herbal Dispersible Triphala Tablets:

The Post comprisal parameters like weight variation, hardness, thickness, % friability, disintegration time were evaluated for all the prepared tablets. The drug content was determined for all the batches. Dissolution studies were conducted for all formulations (Table VI).

Weight variation

Twenty tablets were collected randomly and the average weight and individual weight were calculated. The % weight variation was calculated with the following formula.

$$\% \text{Weight variation} = \frac{\text{Average weight} - \text{individual weight}}{\text{individual weight}} * 100$$

Thickness

The thickness of the ten tablets was measured in mm by using Vernier calipers.

Hardness:

The hardness of the ten tablets was measured by using Varian V K200 Tablet Hardness Tested and is given in the units of KP.





Gayatri Behera et al.

Friability:

Ten tablets were carefully dedusted before testing and weighed accurately (W_0). The tablets were placed in the drum of Roche Friabilator (USP). The drum was rotated 100 times at a speed of 25rpm. The tablets were collected, re-dedusted, and accurately weighed (W_1). It is calculated to form the following formula:

$$\% \text{ Friability} = 1 - \frac{W_1}{W_0} * 100$$

Disintegration Test:

The disintegration study was performed for Dispersible Triphala Tablets by using disintegration apparatus Thermonik DT Tester (USP). For this water was used as the disintegration medium. 6 tablets were placed in 6 tubes of the disintegration apparatus. The time (min) taken for the tablets to disintegrate was noted.

Determination of drug content of Herbal Dispersible Triphala Tablets:

Ten Dispersible Triphala Tablets were weighed accurately and then crushed well in a clean mortar and pestle. 25mg of the drug was weighed (W_s) and then transferred to a 100ml volumetric flask. 50ml methanol was added and sonicated for 5 minutes at 27°C. Then the volume was made up to 100ml using methanol (V_4). From this 4ml (V_5) was transferred to a 100ml volumetric flask and the volume was made up to 100ml (V_6) with 0.1N HCl (pH 1.2). The flask was agitated for 5 minutes and then the sample was analyzed for drug content at 281nm using UV Spectrophotometer. The drug content was calculated using the following formula (Table VI).

$$\% \text{ Drug Content} = \frac{AS}{AS} * \frac{W}{V_1} * \frac{V_2}{V_3} * \frac{V_4}{W_s} * \frac{V_6}{V_5} * \frac{AW}{L} * P$$

Where,

AS= Test absorbance

AS= Standard Absorbance

W= Weight of standard drug

V1= Volume of solvent added to the standard stock solution (100ml)

V2, V3= Dilution of the standard stock solution (4ml of stock solution diluted to 100ml with solvent)

AW= Average weight of the tablet (mg)

L= Label claim of the drug (100mg)

P = Purity of drugs.

Accelerated stability study of Herbal Dispersible Triphala Tablets

10 Dispersible Triphala Tablets were subjected to accelerated stability studies at 45°C and 75% RH for 90 Days. The tablets of SFMS were packed in 85mm HDPE bottles with an oxygen adsorbent, a molecular sieve, and a desiccant containing silica gel with cotton as filler. The tablets were withdrawn after the stability period and evaluated for physical and chemical changes (Table VII).

Release kinetic profile of Herbal Dispersible Triphala Tablets

The best fit with the highest determination R^2 coefficients was shown by both zero-order models and the Higuchi model followed by Korsmeyerpeppas which indicate the drug release via a diffusion mechanism (Table VIII). Zero-order rate equations, which describe the system where the release rate is independent of the concentration of the dissolved species. The Korsmeyerpeppas equation is used to analyze the release of pharmaceutical polymeric dosage forms,

From the result, it was confirmed that all the formulations are following the Higuchi model which indicates the drug release via a diffusion mechanism. The slope value from the Korsmeyer plots confirmed that the formulations are following Fickian diffusion.

Selection of best formulation of Herbal Dispersible Triphala Tablets

According to the Accelerated stability study of lubricated granules and Post compressional parameters and Accelerated stability study of compressed tablets, one formulation of Dispersible Triphala Tablets (F7) is selected (Table IX).



**Gayatri Behera et al.****Accelerated stability study of best formulation of Herbal Dispersible Triphala Tablets**

10 Herbal Dispersible Triphala Tablets were subjected to accelerated stability studies at 45°C and 75% RH for 90 Days (Table X). The tablets of SFMS were packed in 85mm HDPE bottles with an oxygen adsorbent, a molecular sieve, and a desiccant containing silica gel with cotton as filler. The tablets were withdrawn after the stability period and evaluated for physical and chemical changes.

In- vitro evaluation of formulations F7 as best formulation of Herbal Dispersible Triphala Tablets

The parameters like weight variation, hardness, thickness, % friability, disintegration time were evaluated for all the prepared tablets. The drug content was determined for all the batches. Dissolution studies were conducted for all formulations (Table XI).

Release kinetic profile of Herbal Dispersible Triphala Tablets

The cumulative drug release study of Dispersible Triphala Tablets in pH 6.8 phosphate buffer at 281 nm is done and the graph is plotted. The cumulative drug release study of Dispersible Triphala Tablets in 0.1 N HCl at 281 nm is done and the graph is plotted (Table XII).

RESULT AND DISCUSSION**Composition of Herbal Dispersible Triphala Tablet formulations:**

10 formulations of Herbal Dispersible Triphala Tablet formulations are prepared by considering the properties of various excipients (Table II).

Drug-excipient compatibility studies:

Drug-Excipient compatibility study shows F2, F4, F8 shows less compatibility by producing less flow ability (Table III).

Recovery of less compatible formulations:

Better compatibility is produced in F2 by increasing the quantizes of Guggule (Binding agent) and decreasing the quantities of Corn starch (Glidant).

Better compatibility is produced in F4 by increasing the quantizes of Corn starch (Glidant) and decreasing the quantities of Mangifera Indica Gum (Super disintegrant).

Better compatibility is produced in F8 by increasing the quantizes of Corn starch and decreasing the quantities of Lactose (Diluents).

Final formulation of Herbal Dispersible Triphala Tablets

Finally, 10 formulations of Herbal Dispersible Triphala Tablets are prepared (Table IV).

Preparation of Herbal Dispersible Triphala Tablets granules

The granulation of 10 formulations of Herbal Dispersible Triphala tablets was prepared by the wet granulation method.

Preformulation study

The Preformulation studies like flow properties, solubility produce better results (Table V).

Preparation of Herbal Dispersible Triphala Tablets

The lubricated granules were then compressed by using 16 station tablet compression machine (CADMACH) with 7 mm plane round-shaped punches. 10 formulations of Dispersible Triphala tablets are made of different compositions.

The Post comprisal parameters of formulations of Herbal Dispersible Triphala Tablets

Post comprisal parameters like weight variation, hardness, thickness, % friability, disintegration time produce a better result (Table VI).



**Gayatri Behera et al.**

Accelerated stability study of Herbal Dispersible Triphala Tablets
Accelerated stability shows better compatibility of all the 10 formulations (Tablet VII).

Release kinetic profile of Herbal Dispersible Triphala Tablets
The best fit with the highest determination R^2 coefficients was shown in Table VIII.

The zero order plot shows $R^2 = 0.842$ (Fig 1), The first order plot shows $R^2 = 0.986$ (Fig 2), The Higuchi plot shows $R^2 = 0.982$ (Fig 3)

The Korsmeyer - Pappas plot shows $R^2 = 0.988$ (Fig 4).

From the result, it was confirmed that all the formulations are following the Higuchi model which indicates the drug release via a diffusion mechanism. The slope value from Korsmeyer Pappas plots confirmed that the formulations are following Fickian diffusion

Selection of best formulation of Dispersible Triphala Tablets

According to Accelerated stability study of lubricated granules and Post compressional parameters and Accelerated stability study of compressed tablets one formulation of Dispersible Triphala Tablets. (F7) produce better drug release and is selected as the best formulation (Table IX).

Accelerated stability study of the best formulation of Herbal Dispersible Triphala Tablets
Accelerated stability shows better compatibility (Tablet X).

The In-Vitro evaluation of the best formulation of Herbal Dispersible Triphala Tablets

The In-vitro evaluation like weight variation, hardness, thickness, % friability, disintegration time produces the better result in regular intervals of time (Tablet XI).

Release kinetic profile of Dispersible Triphala Tablets:

The cumulative drug release study of Dispersible Triphala Tablets produces the highest determination R^2 coefficients (Tablet XII).

The zero-order model shows $R^2 = 0.9394$ (Fig 5), The first order plot shows $R^2 = 0.790$ (Fig 6), The Higuchi plot shows $R^2 = 0.9918$ (Fig 7) and The Korsmeyer Pappas plot shows $R^2 = 0.984$ (Fig 8).

Future Aspects

Further development of the formulation can be done by clinical studies and can be implemented for the service of society.

CONCLUSION

After in vitro evaluation, release kinetic study, and stability studies of various formulations the result of the present study indicate that the formulation F7 having Triphala with other herbal excipients is the best formulation of Herbal Dispersible Triphala Tablet which produce better release as well as better stability study. So it is confirmed that the best formulation F7 can produce antioxidant, anti-inflammatory, antibacterial, and antiviral activities. It can develop the immunity power of the body and can prevent gastric, pneumonia, cancer, AIDS, and Corona also.

REFERENCES

1. Benzie IFF, Wachtel GS, Herbal Medicine: Biomolecular and Clinical aspect, 2nd edition, Taylor and Francis 2011: 119. <https://www.ncbi.nlm.nih.gov/books/NBK92771>.
2. 2nd International Conference on Herbal and Traditional medicine, Dubai, UAE, June-20-21, 2016. <https://www.greenjournal.co.uk/event/2nd-international-conference-on-herbal-traditional-medicine/>.





Gayatri Behera et al.

3. Parasuraman S, Thing GS, Dhanaraj SA, Polyherbal Formulation: Concept of Ayurveda, *Pharmacogn Rev*, 2014, 8(16), P-73-80. DOI: 10.4103/0973-7847.134229.
4. Christine Tara Peterson, Kate Denniston, and Deepak Chopra, Therapeutic Uses of Triphala in Ayurvedic Medicine, 2017, 23(8), 607–614. doi: 10.1089/acm.2017.0083.
5. Hannan PA, Khan JA, Khan A, Safiullah S, Oral Dispersible System, A new approach in Drug Delivery System, *Ind Journal of Ph Sciences*, 2016, 78(1), 2-7. DOI: 10.4103/0250-474X.180244
6. Md Tausif Alam, Nayyar Parvez, and Pramod Kumar Sharma, FDA-Approved Natural Polymers for Fast Dissolving Tablets, *Journal of Pharmaceutics*, 2014, 1-6. Doi:10.1125/2014/952970.
7. Anwesa Bag, Subir Kumar Bhattacharyya, and Rabi Ranjan Chattopadhyay, The development of Terminalia chebula Retz. (Combretaceae) in clinical research, 2013, 3(3), 244–252. DOI: 10.1016/S2221-1691(13)60059-3.
8. Panshul Sharma, Kapil Kumar Verma, Hans Raj, Nutan Thakur, A review on ethnobotany, phytochemistry, and pharmacology on Terminalia bellerica (Bibhitaki) , *Journal of Drug Delivery & Therapeutics*. 2021, 11(1-s), 173-181. doi: <http://dx.doi.org/10.22270/jddt.v11i1-s.4739>
9. Prasan R. Bhandari, Mohammad Ameeruddin Kamdod, Emblica officinalis (Amla): A review of potential therapeutic applications, *International Journal of Green Pharmacy*, 2012, (2), 257-269. DOI: 10.4103/0973-8258.108204.
10. Navneet Nagpal, Kaur.P, Kumar. R, Rahar.S, Pharmaceutical diluents and their unwanted effects: a review, *Bulletin of Pharmaceutical Research Institute*, 2018, 6(2), 45-49 doi:10.21276/bpr.2016.6.2.2
11. Kishore Banik, Devivasha Bordoloi, Choudhary Harsha, Bethsebie L. Sailo, Ganesan Padmavathi, Nand K. Roy, Subash C. Gupta, and Bharat B. Aggarwal, Googling the Guggul (Commiphora and Boswellia) for Prevention of Chronic Diseases, *Front Pharmacol*, 2018, (9), 686. DOI: 10.3389/fphar.2018.00686
12. K. A. Shah, M. B. Patel, R. J. Patel, and P. K. Parmar, Mangifera Indica (Mango): *Pharmacogn Rev*. 2010, 4(7), 42–48. doi: 10.4103/0973-7847.65325.
13. Qian-Qian Mao, Xiao-Yu Xu, Shi-Yu Cao, Ren-You Gan, Harold Corke, Trust Beta, and Hua-Bin Li Bioactive Compounds and Bioactivities of Ginger (Zingiber officinale Roscoe) Foods, 2019, 8(6), 185. DOI: 10.3390/foods8060185.
14. Philip F. Builders and Mathew I. Arhewoh, Pharmaceutical applications of native starch in conventional drug delivery Starch/Stärke, 2016, 6(8), 1–10. doi:10.1002/star.201500337.
15. Satish Kumar Sharma, and Dr. Y. S. Tanwar, an overview on natural super disintegrants used in fast-dissolving tablet and their effect, 2020, 9(7), 2657-2668. DOI: 10.20959/wjpr20207-18059.
16. Vibhushree Kumar TV, Kopparam Manjunath, Anantha Narayana DB, Dry granulation technique for converting Triphala churna as granules, tablets, and organoleptic evaluation, 2015, 6(6), 321. DOI: 10.7897/2230-8407.06669.

Table 1. List of excipients used for the preparation of herbal dispersible triphala tablets

| Name of ingredients | Properties |
|--|--------------------|
| Harida (<i>Terminalia chebula</i>) | Medicament |
| Bahada (<i>Terminalia bellirica</i>) | Medicament |
| Amla (<i>Phyllanthus Emblica</i>) | Medicament |
| Lactose (Milk sugar) | Diluents |
| Guggule (<i>Commiphora wightii</i>) | Binder |
| Mango gum (<i>Mangifera indica gum</i>) | Super Disintegrant |
| Ginger (<i>Zingiber officinale</i>) | Bio- enhancer |
| Corn Starch | Glidant |
| Gurugum (<i>Cyamopsis tetragonoloba</i>) | Super disintegrant |
| Distilled water | Solvent |





Gayatri Behera et al.

Table 2. Composition of herbal dispersible triphala tablets

| Ingredients | F1 (mg) | F2 (mg) | F3 (mg) | F4 (mg) | F5 (mg) | F6 (mg) | F7 (mg) | F8 (mg) | F9 (mg) | F10 (mg) |
|----------------------|----------|----------|-----------|----------|----------|----------|----------|----------|----------|----------|
| Harida | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Bahada | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Amla | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Lactose | 15 | 10 | 10 | 5 | 10 | 10 | 15 | 15 | 10 | 10 |
| Guggle | 10 | 10 | 5 | 5 | 10 | 10 | 10 | 5 | 15 | 5 |
| Magnefira indica gum | 3 | 5 | 10 | 10 | 10 | - | 5 | 5 | 5 | 5 |
| Ginger | 2 | 5 | 5 | 10 | 10 | - | 5 | 5 | 5 | 5 |
| Corn Starch | 5 | 5 | 5 | 5 | | 10 | 5 | 5 | 5 | 10 |
| Guragum | 5 | 5 | 5 | 5 | - | 10 | - | 5 | - | - |
| Distilled water | qs up to | qs up to | q.s up to | qs up to | qs up to | qs up to | qs up to | qs up to | qs up to | qs up to |
| Total weight (mg) | 100mg | 100mg | 100mg | 100mg | 100mg | 100mg | 100mg | 100mg | 100mg | 100mg |

Table 3. Drug excipient compatibility study of herbal dispersible triphala tablet

| Granules | After 7 days | After 15 days | After 30 days | After 45 Days | After 60 Days | After 90 Days | Compatibility |
|----------|--------------|---------------|---------------|---------------|---------------|------------------|-----------------|
| F1 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F2 | No Change | No Change | No Change | No Change | No Change | Less flowability | Less compatible |
| F3 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F4 | No Change | No Change | No Change | No Change | No Change | Less flowability | Less compatible |
| F5 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F6 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F7 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F8 | No Change | No Change | No Change | No Change | No Change | Less flowability | Less compatible |
| F9 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F10 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |

Table 4. Final composition of herbal dispersible triphala tablets

| Ingredients | F1 (mg) | F2 (mg) | F3 (mg) | F4 (mg) | F5 (mg) | F6 (mg) | F7 (mg) | F8 (mg) | F9 (mg) | F10 (mg) |
|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| Harida | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |





Gayatri Behera et al.

| | | | | | | | | | | |
|----------------------|----------|----------|-----------|----------|----------|----------|----------|----------|----------|----------|
| Bahada | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Amla | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Lactose | 15 | 10 | 10 | 5 | 10 | 10 | 15 | 10 | 10 | 10 |
| Guggule | 10 | 15 | 5 | 5 | 10 | 10 | 10 | 5 | 15 | 5 |
| Magnifira indica gum | 3 | 5 | 10 | 5 | 10 | - | 5 | 5 | 5 | 5 |
| Ginger | 2 | 5 | 5 | 10 | 10 | - | 5 | 5 | 5 | 5 |
| Corn Starch | 5 | 5 | 5 | 10 | - | 10 | 5 | 10 | 5 | 10 |
| Guragum | 5 | 5 | 5 | 5 | - | 10 | - | 5 | - | - |
| Distilled water | qs up to | qs up to | q.s up to | qs up to | qs up to | qs up to | qs up to | qs up to | qs up to | qs up to |

Table 5. Flow properties of lubricated granules of herbal dispersible triphala tablets

| Formulation Code | The angle of Repose (Θ) | Bulk Density (g/ml) | Tapped Density (g/ml) | Compressibility Index (%) | Hausner's Ratio | %LOD |
|------------------|----------------------------------|---------------------|-----------------------|---------------------------|-----------------|------|
| F1 | 23.64 | 0.410 | 0.519 | 25.19 | 1.212 | 2.02 |
| F2 | 22.71 | 0.428 | 0.555 | 20.31 | 1.120 | 2.75 |
| F3 | 25.92 | 0.446 | 0.594 | 21.32 | 1.142 | 2.04 |
| F4 | 25.43 | 0.454 | 0.447 | 16.15 | 1.185 | 2.14 |
| F5 | 24.13 | 0.403 | 0.529 | 19.01 | 1.163 | 2.17 |
| F6 | 21.52 | 0.406 | 0.534 | 19.18 | 1.154 | 2.63 |
| F7 | 26.33 | 0.402 | 0.502 | 15.53 | 1.128 | 2.66 |
| F8 | 25.33 | 0.426 | 0.575 | 20.24 | 1.128 | 2.81 |
| F9 | 26.23 | 0.401 | 0.514 | 17.53 | 1.197 | 2.61 |
| F10 | 25.28 | 0.482 | 0.522 | 19.23 | 1.161 | 2.64 |

Table 6. Post compressional parameters of the herbal dispersible triphala tablets

| Formulation Code | Average weight (mg) | Thickness (mm) | Hardness (KP) | % Friability | Disintegration Time (min) | % Drug Content |
|------------------|---------------------|----------------|---------------|--------------|---------------------------|----------------|
| F1 | 107.1±0.451 | 3.14±0.002 | 5.75±0.088 | 0.167 | 3.56±0.468 | 88.98 |
| F2 | 106.6±0.541 | 3.53±0.008 | 5.87±0.214 | 0.159 | 4.34±0.081 | 96.63 |
| F3 | 104.8±0.699 | 3.18±0.021 | 5.62±0.370 | 0.159 | 4.35±0.315 | 99.23 |
| F4 | 105.2±0.441 | 3.18±0.024 | 5.51±0.228 | 0.398 | 5.39±0.460 | 98.57 |
| F5 | 106.4±0.401 | 3.00±0.045 | 5.39±0.220 | 0.081 | 5.39±0.329 | 95.12 |
| F6 | 107.3±0.410 | 3.10±0.045 | 5.11±0.109 | 0.198 | 5.56±0.034 | 98.45 |
| F7 | 105.8±0.543 | 3.41±0.07 | 5.79±0.155 | 0.298 | 2.98±0.056 | 99.83 |
| F8 | 106.6±0.321 | 3.51±0.006 | 5.43±0.279 | 0.299 | 4.43±0.039 | 97.54 |
| F9 | 105.2±0.500 | 3.20±0.010 | 5.45±0.109 | 0.292 | 4.98±0.075 | 98.23 |
| F10 | 106.5±0.327 | 3.01±0.001 | 5.49±0.056 | 0.299 | 4.31±0.125 | 98.49 |





Gayatri Behera et al.

Table 7. Accelerated stability study of herbal dispersible triphala tablets

| Granules | After 7 Days | After 15 days | After 30 Days | After 45 Days | After 60 Days | After 90 Days | COMPATIBILITY |
|----------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| F1 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F2 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F3 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F4 | No Change | No Change | No Change | No Change | No Change | No change | compatible |
| F5 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F6 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F7 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F8 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F9 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |
| F10 | No Change | No Change | No Change | No Change | No Change | No change | Compatible |

Table 8. Release kinetic profiles of formulations of herbal dispersible triphala tablets

| Release kinetic profiles | Result-R ² |
|--------------------------|-----------------------|
| Zero-order plot | 0.842 |
| First-order plot | 0.986 |
| Higuchi plot | 0.982 |
| Korsemeyer- Pappas plot | 0.988 |

Table 9. Composition of best formulation of herbal dispersible triphala tablets

| Ingredients | F7(mg) |
|----------------------|----------|
| Harida | 20 |
| Bahada | 20 |
| Amla | 20 |
| Lactose | 15 |
| Guggule | 10 |
| Magnefira indica gum | 5 |
| Ginger | 5 |
| Corn Starch | 5 |
| Guragum | - |
| Distilled water | qs up to |
| Total weight(mg) | 100 |





Gayatri Behera et al.

Table 10. Accelerated stability study of best formulation of herbal dispersible triphala tablets

| Granules | After 7 days | After 15 days | After 30 days | After 45 Days | After 60 Days | After 90 days |
|----------|--------------|---------------|---------------|---------------|---------------|---------------|
| F7 | No Change | No Change | No Change | No Change | No Change | No Change |

Table 11. In vitro evaluation of best formulation of herbal dispersible triphala tablets at different times

| Parameters | Observed value | After 15 Days | After 30 Days | After 60 Days | After 90 Days |
|---------------------|----------------|---------------|---------------|---------------|---------------|
| Average Weight(mg) | 100.7±0.26 | 101.1±0.21 | 100.7±0.12 | 101.7.7±0.15 | 109.5±0.13 |
| Thickness(mm) | 3.14±0.07 | 3.40.±0.007 | 3.40.±0.06 | 3.40±0.07 | 3.40±0.06 |
| Hardness (KP) | 5.1±0.124 | 5.2±0.111 | 5.0±0.321 | 5.4±0.453 | 5.3±0.145 |
| % Friability | 0.599 | 0.657 | 0.768 | 0.923 | 0.884 |
| Disintegration Test | 2.04±0.56 | 2.03±0.19 | 2.03±0.32 | 2.07±0.32 | 2.06±0.34 |
| Drug Content in % | 99.85 | 99.87 | 98.89 | 99.92 | 99.98 |

Table 12. Release kinetic profiles of the best formulation (f7) as herbal dispersible triphala tablet

| Release kinetic profiles | Result-R ² |
|--------------------------|-----------------------|
| Zero-order plot | 0.9394 |
| First-order plot | 0.790 |
| Higuchi plot | 0.9918 |
| Korsemeyer- Pappas plot | 0.984 |

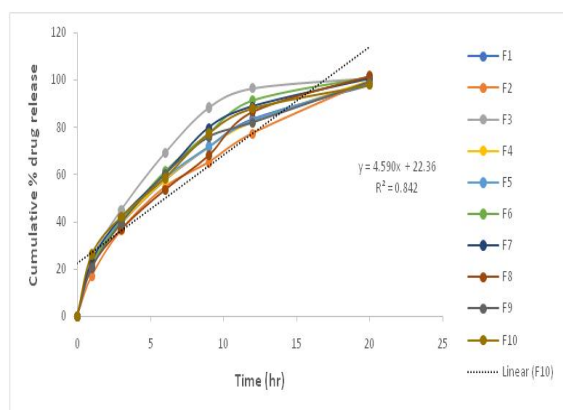


Fig. 1 Zero-order plots of Dispersible Triphala formulations

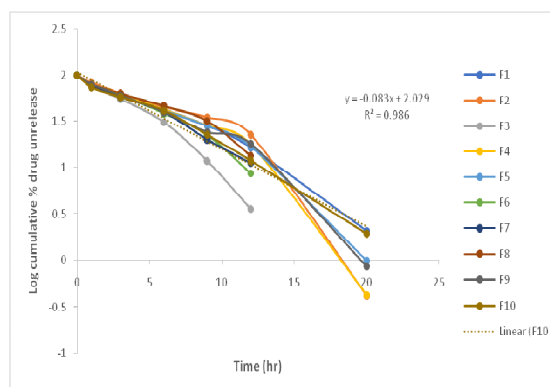


Fig. 2 First order plots of Dispersible Triphala formulation





Gayatri Behera et al.

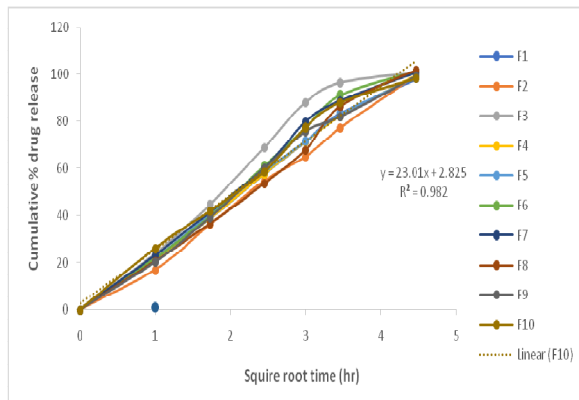


Fig. 3 Higuchi plots of Herbal Dispersible Triphala formulations

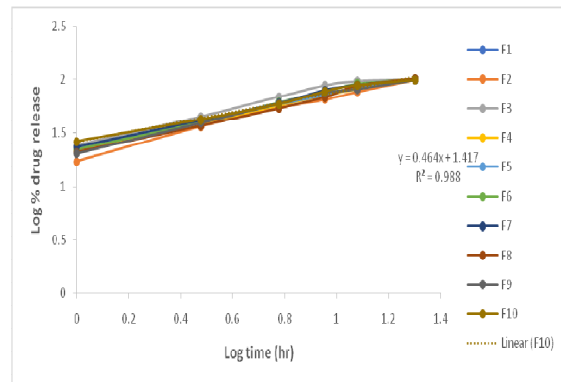


Fig. 4- Pappas plots of Dispersible Triphala formulations

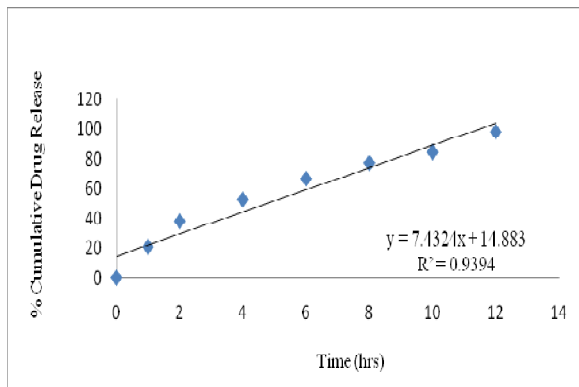


Fig. 5 Zero Order Graph of the best formulation (F7)

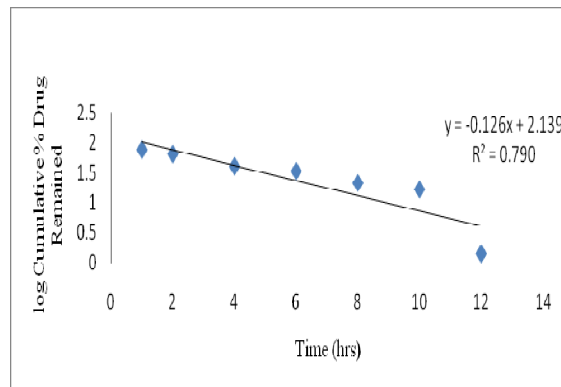


Fig. 6 First Order Graph of the best formulation (F7)

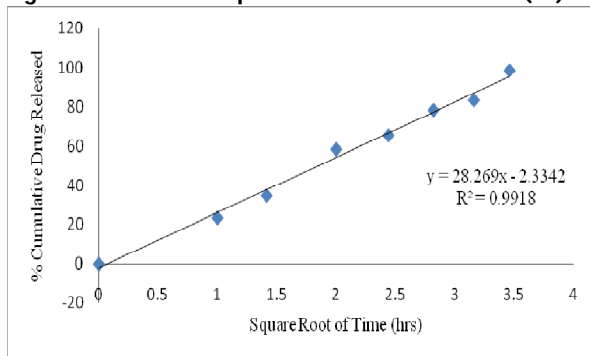


Fig. 7 Higuchi plot of the best formulation (F7)

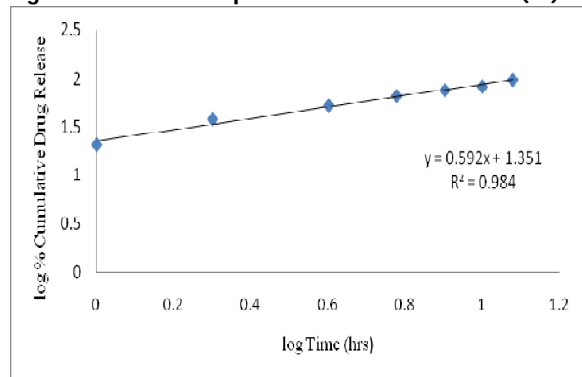


Fig. 8- Korsmeyer-Pappas plot of the best formulation (T F7)





A Review on Usefulness and Nutritional Benefits of Black Wheat on Health System

Suryakamal Biswal, B Jyotirmayee and Gyanranjan Mahalik*

Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar, Odisha

Received: 06 Mar 2022

Revised: 10 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Gyanranjan Mahalik

Department of Botany,
School of Applied Sciences,
Centurion University of Technology and Management,
Bhubaneswar, Odisha
Email: gyanranjan.mahalik@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

This study explains how black wheat, a nutrient-dense food, came to be. For its seed, wheat is a staple food in many countries around the world. In temperate regions, it is the primary source of food for both humans and livestock. Carbohydrates are a vital part of the diet. When purple and blue wheat are crossed, the result is black wheat. Due to its numerous health benefits, one of them is becoming increasingly popular among health-conscious individuals. Except for its grain colour and nutritional composition, it resembles white wheat in all respects. Anthocyanins, protein, dietary fibre, iron, and zinc abound in the Nabi MG variety. You can use it as a food supplement because it has a lot of biological value. Malnutrition can be combated and addressed on a national and international scale with its help. Wheat, black sesame seeds, flour, and cornflour were used to make it as a local characteristic of nutrient-dense food. After that, it was sterilised before being packaged in an inflated or vacuum-sealed quantity for immediate consumption. Many adverse reactions in humans have been linked to wheat products, including intolerances (including coeliac disease) and allergies (respiratory and food). Current and future concerns include sustaining wheat production and quality while reducing agrochemical inputs and developing lines for specific end uses, such as biofuels and human nutrition, with an increased rate of growth. As a result, our research focused on the nutritional, flavour, and compositional aspects of a food product and how it can be made healthier, more sustainable, or more appealing to the consumer.

Keywords: Black Wheat, Cereal Grain, Nutritional Composition, Disease.





INTRODUCTION

Wheat (*Triticum aestivum*) is the second most stable crop, covering an area of 29.8mha in India and is one of the oldest cereals cultivated and consumed for centuries. As one of the "big three" cereal crops, wheat is harvested at a rate of around 600 million tonnes per year. Rice and maize each produced 652 million tonnes and 785 million tonnes of harvest in 2007, respectively. Wheat reaches more than 67 degrees north Latitude in Scandinavia and Russia and 45 degrees South latitude in Argentina. It also occurs in the tropical and subtropical regions; it also possesses unsurpassed diversity and has been fully integrated into cultures and even religions of numerous societies(1).

In terms of production and area, it is superseded by rice. Fortified coloured wheat with zinc can go a long way to addressing one of the most serious issues in India; malnutrition affects both adults and children equally. A lack of protein, vitamins, energy and micronutrients are the causes, which results in poor health, impairing the quality-of-life improvements in the nutritional value of common wheat grains is one way to address the maturation Problem. The term black wheat refers to a hybridized purple and blue wheat. Black Wheat displays a black colour and contains anthocyanin, and it includes a higher Protein content, phenolic content, and dietary fibre compared to yellow wheat. In terms of antioxidant activities. However, it has a higher phenolic content higher than yellow wheat. The results demonstrated that fractionation significantly influenced the antioxidant properties and the anthocyanin and carotenoid contents in white wheat(2).

In order to assess the potential applications for black grained wheat Comparing the properties of these carefully selected wheat controls (Tai fen 1, classic, Yacare Rojo, Glen lea and Anza) to the properties of these carefully selected wheat controls (3). While white wheat is more common, black wheat has many more health benefits. An added benefit of eating black wheat is that it contains many essential nutrients and boosts the body's immune system. Because of its high concentration of antioxidants, vitamins B and folic acid as well as minerals and amino acids such as selenium and manganese as well as calcium and iron, black wheat is a nutrient powerhouse (4). For the same purpose, NABI was consulted, and it was discovered that not only was there black wheat, but also samples of blue and purple wheat. Why does it have such a wide range of anthocyanin levels? There are a number of pigments in fruits and vegetables known as anthocyanins, which give them their colour. The more concentrated these pigments are, the darker the food item will appear. Compared to standard wheat, black grain has anthocyanin concentrations of between 100 and 200ppm. According to science, black wheat is better for you than white wheat. In addition to anthocyanin, regular and black wheat have different nutritional values. There are also differences in the amount of zinc and iron found in each. The iron content of black wheat is said to be 60% higher than that of regular wheat. Protein, nutrients, and starch amounts, on the other hand, are unchanged (5). Cereals are essential to a healthy diet because they are one of the most important food items. Wheat is the most popular grain, and it is used in a wide variety of foods, including bread, noodles, and biscuits. Starch, proteins, minerals, and dietary fibre are all found in wheat, which contributes significantly to the daily caloric intake of wheat-eaters. Further nutritional value enhancement is expected to increase consumer demands in terms of health, nutrition, and ease of use (ease of use for consumers). Many countries around the world use nutraceutical crops for commercial purposes, such as high-quality protein maize with high levels of lysine and tryptophan (6).

Xinjiang characteristics of miscellaneous grains and nuts were taken into consideration in the development of a healthy nutritional product that includes black wheat granules (BWGP). Foods like black sesame seeds, flour, cornflour, chickpeas and walnuts were selected because of their nutritional value as well as their appearance in the BWGP. After that, it was sterilised before being packaged in an inflated or vacuum-sealed quantity for immediate consumption. Black wheat 30 percent, corn flour 20 percent, flour 15 percent, chickpeas 15 percent, black beans 2 percent, melon seeds 3 percent, walnut 3 percent, black sesame seeds 4 percent, and sunflower oil 20 percent was found to be the best formula. Simple methods of production and diverse flavours are just some of the benefits of BWGP. To sum up the findings, our research was focused on how a food product can be made healthier, more environmentally friendly or more appealing to the consumer (7). Consumers who are aware of the effects of specific



**Suryakamal Biswal et al.**

food ingredients on health and physiological functions have grown increasingly knowledgeable about the connection between food ingredients, diet, and health. Powdered foods like black sesame paste, walnut powder, and lily powder are readily available. Despite this, the majority of these instant granules only use a very small amount of the primary ingredients. Healthy nutritional supplements can be made from local ingredients in China's Xinjiang Uygur Autonomous Region (8). Black wheat (triticale), which is high in protein and antioxidants, is one of the food ingredients used in the creation of Xinjiang's distinctive granulated development. In addition to high-quality proteins and essential amino acids, black wheat has a 30-50% higher concentration of linoleic and linolenic acids than regular wheat. Endothelial cell protection, cardiovascular disease prevention, and anti-cancer agents are some of the health benefits associated with its consumption. Anthocyanins and procyanidins are also present. It has been shown that these bioactive compounds reduce the development of chronic diseases like diabetes, obesity and cancer as well as heart disease (9, 10).

Wheat is the most widely grown food crop in the world (220.4 million hectares or 545 million acres, 2014). In comparison to all other crops, wheat trade is the most significant in the world. After maize, the second most-produced cereal is wheat, which produced 772 million tonnes (1.7 trillion pounds) in 2017 and is expected to produce 766 million tonnes (1.7 trillion pounds) in 2019. There has been a dramatic increase in wheat and other grain crop production around the world since 1960. Gluten proteins' unique viscoelastic and adhesive properties are driving up global wheat demand because they make it easier to manufacture the processed foods whose consumption is rising as a result of global industrialization and the westernisation of diet (11). Carbohydrates like those found in wheat are vital for human survival. It is the most common plant protein source in human diets all over the world. In comparison to other significant cereals, it has a protein content of about 13%; however, this is a relatively high percentage but a low quality protein for supplying essential amino acids. Wheat, when consumed as a whole grain, provides a wide range of nutrients and fibre. Coeliac disease, non-celiac gluten sensitivity, gluten ataxia, and dermatitis herpetiformis can all be caused by gluten in a small percentage of the general population (12).

Common name - 'Nabi MG'

After seven years of research, the National Agri-Food Biotechnology Institute (NABI) Mohali has patented black wheat. Known as 'Nabi MG,' this variety of wheat is available in three distinct hues: black, blue, and purple (13). When purple and blue wheat are crossed, the result is black wheat. Wheat grain is black because of the anthocyanin in the outer layer (14).

Health Benefits

Black Wheat Flour is a non-GMO product and an excellent choice for having a high amount of antioxidants, fibres, protein, and fewer carbohydrates(15).

Origin and Distribution

Black Wheat is not harmful to our body at all. A technique to change the genetic parent of plants to increase its utility for humans. Black Wheat is not developed through genetic engineering. Seven years of long research in different seasons and regions to check its adaptability and yield potential to India's environmental conditions. It has been developed through regular plant breeding, i.e., For this purpose, Exotic germplasm (EC866732) procured from Japan was crossed with a high average yielding and disease-resistant wheat cultivar (PBW621). After selection, black wheat was developed in India at NABI(16). A toughened rachis keeps the seeds (inside the spikelet) attached to the ear during harvesting in domesticated wheat (15). Ricinus fragility allows the ears to shatter and disperse the spikelets(16) more effectively in wild strains. Domestic strains of wild grasses arose as a result of farmers selecting mutant forms of wheat (referred to as "sports") and repeatedly harvesting and sowing them. In the past, white wheat bread was considered a luxury food. The North of the country began to rely less on traditional grains like rye, wheat, and oats during the nineteenth century as a result. To improve wheat's nutritional value, scientists removed the plant's natural mechanisms for dispersing seeds. Findings dating to 9600 BCE in the southern Levant from archaeological analysis of wild emmer suggest that the plant was first cultivated there. Wild einkorn wheat genetic



**Suryakamal Biswal et al.**

research indicates that it was first cultivated in the Karadag Mountains of southeast Turkey. Tell Aswad, in the Damascus basin, near Mount Hermon in Syria, was the site where the earliest carbon-14 dated remains of domesticated emmer wheat were found. Ancient einkorn wheat artefacts from nearby settlements, such as Abu Huraira in Syria, show that the Karadag Mountain Range was where einkorn was domesticated (19). The oldest carbon-14 date for einkorn wheat remains at Abu Huraira is between 7800 and 7500 years BCE (20) with the exception of two grains from Iraq ed-dub. Many sites near the Karadag Range have produced emmer remains that have been dated to between 8600 BCE (at Canyon) and 8400 BCE (at Abu Huraira). As a result of their research, they came to the conclusion that the settlers of Tell Aswad did not domesticate this type of emmer on their own (21).

In Greece, Cyprus and the Indian subcontinent, emmer was grown by 6500 BCE, Egypt by 6000 BCE, and Germany and Spain by 5000 BCE. Egyptians were the first to use the oven to bake bread, making it one of the earliest large-scale food production industries. (23) Wheat had already spread to the British Isles and Scandinavia by 4000 BCE (24, 25, 26, 27). According to Catalogue (28), the oldest evidence for hexaploid wheat has been found in the DNA of wheat seeds dating back to around 6400–6200 BCE. DNA analysis of granary samples from Assures in Macedonia, dating to around 1350 BCE, identified the first identifiable bread wheat (*Triticum aestivum*) with enough gluten for yeasted bread (29). Columbian exchange continued the spread of wheat from Asia to Europe and America. It became a symbol of British global power and a "sign of a high degree of culture" (32). Willem van Zeist and his assistant Johanna Bakker-Hers were able to date these remains to 8800 BCE using these remains as a guide. Domestic strains of wild grasses arose as a result of farmers selecting mutant forms of wheat (referred to as "sports") and repeatedly harvesting and sowing them. A toughened rachis keeps the seeds (inside the spikelet) attached to the ear during harvesting in domesticated wheat (15). Spikelets are more easily dispersed in wild strains because of the ear's more fragile rachis. This 'incidental' selection was an important part of crop domestication, even if farmers didn't select for these characteristics because they made gathering seeds easier. Wheat varieties that have been extensively domesticated are unable to persist in the wild because the features that make wheat a better food source also cause the plant to lose its natural mechanisms for dispersing seeds.

Findings dating to 9600 BCE in the southern Levant from archaeological analysis of wild emmer suggest that the plant was first cultivated there. Wild einkorn wheat was first grown in the Karadag Mountains in south-eastern Turkey, according to genetic research. Ancient einkorn wheat artefacts from nearby settlements, such as Abu Huraira in Syria, show that the Karadag Mountain Range was where einkorn was domesticated (19). The oldest carbon-14 date for einkorn wheat remains at Abu Huraira is between 7800 and 7500 years BCE (20) with the exception of two grains from Iraq ed-dub. Many sites near the Karadag Range have produced emmer remains that have been dated to between 8600 BCE (at Canyon) and 8400 BCE (at Abu Huraira). Tell Aswad, in the Damascus basin near Mount Hermon in Syria, is where the earliest carbon-14 dated remains of domesticated emmer wheat were found, except for Iraq ed-dub. Willem van Zeist and his assistant Johanna Bakker-Hers were able to date these remains to 8800 BCE using these remains as a guide. Moreover, they came to the conclusion that the settlers of Tell Aswad did not domesticate this type of emmer themselves but brought it with them from an unknown location (21). In Greece, Cyprus and the Indian subcontinent, emmer was grown by 6500 BCE, Egypt by 6000 BCE, and Germany and Spain by 5000 BCE. It was in Egypt that bread and ovens were invented, and baking became one of the first large-scale food industries." (23). Wheat had made its way to the British Isles and Scandinavia by the year 4000 BCE (24, 25). Crops of wheat first appeared in China's Yellow River valley around 2600 BCE (27). According to Catalogue (28), the oldest evidence for hexaploid wheat has been found in the DNA of wheat seeds dating back to around 6400–6200 BCE. DNA analysis of granary samples from Assures in Macedonia, dating to around 1350 BCE, identified the first identifiable bread wheat (*Triticum aestivum*) with enough gluten for yeasted bread (29). Wheat spread from Asia to Europe and the Americas during the Columbian exchange. Wheat straw (thatch) was a common roofing material in the British Isles during the Bronze Age and into the late nineteenth century (30, 31). Aristocrats favoured white wheat bread. But in the nineteenth century, it became a staple food in Britain, replacing grains like oats, barley, and rye in the diets of northerners. As a symbol of British power and "a sign of a high degree of culture," (32) it became an iconic image.





Historical Fact

British ports received 70% of American exports in 1880. However, rising temperatures linked to climate change have been linked to a decrease in wheat yields in some areas. There has also been a shift away from corn and soybeans to other crops like soybeans and maize as a result of investments in modern genetic technologies.

Farming System

Wheat yields in Ireland in 2014 were 10 tonnes per hectare, the highest in the world. Some large wheat grain-producing countries have significant losses after harvest due to poor roads, inadequate storage technologies, inefficient supply chains, and farmers' inability to bring the product into retail markets dominated by small shopkeepers. This is in addition to the gaps in farming system technology and knowledge that some countries have. It has been found that about 10% of total wheat production in India is lost at farm level, another 10% is lost due to poor storage and road networks, while additional amounts are lost at retail level. Irrigation has played a significant role in increasing grain production in the Punjab region of India and North China. Transporting a bushel of wheat from Chicago to Liverpool cost 37 cents in 1869. The American wheat frontier rushed westward in the 19th century. Australian wheat grown in the southern winter cropping zone is a good example of this. When nitrogen fertiliser application is minimal, wheat cropping is successful despite the low rainfall (300 millimetres). It wasn't until after 1955 that the annual rate of wheat yield improvement increased tenfold, and this became the primary driver of increased global wheat production. These technological advances and scientific crop management practises with synthetic nitrogen fertiliser and irrigation were key factors in wheat output growth in the second half of the twentieth century. In North America, for example, wheat crop area decreased significantly.

Another 20th-century technological innovation is better seed storage and germination ability (a minor requirement to retain harvested crop for next year's seed). In 1999, about 6% of the world's wheat production was supplied by seed. Population growth rates are decreasing, but wheat yields continue to rise, slowing the global expansion of wheat production. Farming systems, on the other hand, use more than just fertiliser and breeding to increase yields. Fertilizer use has skyrocketed in developing countries over the last 40 years, and semi-dwarf varieties are now widely available (8). The use of (mainly nitrogenous) fertiliser increased 25-fold in developing countries. Over the course of the twentieth century, global wheat production increased by a factor of five. There was a significant increase in wheat crop area until about 1955, but yields per unit area increased much less (about 20%). Rotation cropping (also known as the ley system) and leguminous pastures are used to accomplish this. A 25 percent increase in wheat yields has been achieved in the last decade by rotating in canola. Low rainfall areas benefit from retaining the stubble after harvest and cutting back on tillage, which helps conserve soil water. Only three-quarters of the wheat harvest was used for food and feed in Medieval England because farmers saved a quarter of their harvest for seed.

Geographical Variation

Russian Federation (25.9 million tonnes), United States (24.0 million tonnes), Canada (19.7 million tonnes), France (18.3 million tonnes), and Australia (11.97 million tonnes) were the top wheat exporters in 2016. (16.1 million tonnes). In 2016, the top wheat importers were Indonesia (10.5 million tonnes), Egypt (8.7 million tonnes), Algeria (8.2 million tonnes), Italy (7.7 million tonnes) and Spain (7.7 million tonnes) (7.0 million tonnes). Growth in per capita wheat consumption is outpacing demand for other staple foods in Asia and Africa, both of which are experiencing rapid economic development. Different regions of the world have vastly different wheat farming, trading, policy, sector growth, and grain consumption patterns.

Human Health Effects

Human nutrition relies heavily on wheat, which is consumed by billions of people around the world, especially in developing countries where wheat products are the primary source of food. In several daily servings containing various foods that meet whole grain-rich criteria, wheat is a healthy food source of numerous nutrients and dietary fibre when eaten as a whole grain. Adding dietary fibre to your diet may also help you maintain a healthy weight



**Suryakamal Biswal et al.**

and feel full longer. Natural and biofortified nutrients such as dietary fibre, protein, and minerals can be found in wheat. A health claim stating that "diets low in saturated fat and cholesterol and rich in fruits, vegetables and grain products that contain some types of d-glucose may reduce the risk of some types of cancer, a disease associated with many factors" is allowed for marketing purposes in the United States for food manufacturers who use wheat as a whole grain. A cause-and-effect relationship cannot be established between whole grain and the claimed health benefits of gut and bowel health and weight management or blood glucose/insulin levels. The European Food Safety Authority (EFSA) believes that "the food constituent, whole grain, is not sufficiently characterised about the claimed health effects" and "that cause and effect relationship cannot be established." with regard to these health claims.

Diseases

Missouri wheat production losses due to plant diseases range from 10% to 25%. Wheat is infected by a wide variety of organisms, including viruses and fungi. Many wheat diseases are caused primarily by fungi, bacteria, and viruses. Disease-resistant crops can only be developed through plant breeding and sound crop management practises. In wheat production, fungicides, which are used to prevent major crop losses due to fungal infection, can be a significant variable cost.(33)

The main wheat-disease categories are

- Fungicides are used to control these. Stagonospora (formerly known as Septoria), common bunt (which causes stinking smut), and loose smut are all seed-borne diseases.
- Powdery mildew, leaf rust, Septoria tritici leaf blotch, Stagonospora (Septoria) nodorum leaf and glume blotch, and Fusarium head scab are all leaf and head blight diseases (34).
- They are both soil-borne diseases. 'Take-all' and Cephalosporium stripe are two of the most common crown and root rot diseases.
- Basidiomycete fungi are the cause of stem rust diseases.
- The two most common viral diseases are wheat spindle streak mosaic (yellow mosaic) and barley yellow dwarf. Resistant varieties can be used to control pests.

Pests of Animals

By digging up and eating newly planted seeds and young plants, these animals can cause significant damage to a crop. Cereal post-harvest losses in the United States are estimated at billions of dollars annually. Wheat is no exception to the ravages of borers, beetles, and weevils. Some Lepidoptera (butterfly and moth) larvae, such as the flame, rustic shoulder-knot, setaceous Hebrew character, and turnip moth, feed on wheat as a food plant. By consuming the mature spike grain, they can also cause damage to the crop late in the season. The long-tailed widowbird and rodents feast on wheat crops early in the season. Storage losses can also be caused by rodents. Field mice populations can sometimes soar to plague proportions in major grain-growing regions, thanks to an abundance of readily available food. As the wheat is milled, the device uses electrical signals to identify the insects. There are only 5–10 infected seeds in 30,000 good ones thanks to the new technology. An "insect-o-graph" has been developed by Agricultural Research Service scientists to reduce the amount of wheat that is lost to post-harvest pests. Tracking grain infested by insects is critical to food safety and the value of the crop (35).

DISCUSSION AND CONCLUSION

In comparison to white wheat, black wheat has a higher nutritional value, making it a far better choice for human consumption. As a result, under nutrition in the country could be reduced by 2% annually, while farmers would benefit from higher output prices than their production costs would entail. NNM or 'PoshanAbhiyaan' should include the inclusion of black wheat in their efforts to improve the nutritional status of children, adolescents, and women. These products must be improved nutritionally and functionally in order to provide additional health benefits (38). As a result, the consumption of whole grains is advised for health reasons. Colored wheat varieties, according to this study, contain higher levels of antioxidants and are a superior source of fibres, proteins, and



**Suryakamal Biswal et al.**

phytochemicals. All over the world, people eat a lot of wheat and wheat-based products. Colored wheat varieties, however, were well-suited for commercial product development, paving the way for their industrial use (39). Farmers can easily make more money by cultivating Black Wheat, which does not necessitate the use of complicated or rigorous farming methods. There are no drawbacks to using Black Wheat, other than the cost. For farmers, the seeds are comparatively more expensive than the regular wheat, while from the consumer's perspective, the product's market will also be twice or thrice that the regular wheat. However, the authority hasn't decided on the market price yet (40). The Black wheat flour had higher foam stability, i.e., 110 percent, compared to Netravali wheat flour i.e. The consumption of foods based on Black Wheat would be an essential step towards alleviating protein malnutrition. A significant amount of protein (14.49 percent) was found in Black Wheat in this study, suggesting that it could be used as a source of food. Conventional flours that are low in protein could be bolstered by using this flour. For this reason, people's health will undoubtedly improve as a result. However, all of these properties are dependent on the wheat grain genotype, post-harvest treatments, storage conditions (such as temperature), and the environmental conditions under which it grows. 94% of the time. The highest WAC (1.904g/g), WAI 502g/g and WSI 5.67 g/g, higher OAC (102.7%) and higher foam stability, i.e., 110 percent, make it useful in different foods formulation. The basic baking and functional properties of Black wheat flour in comparison with white Netravali wheat flour have been determined in a laboratory environment. It can be concluded that Black wheat flour was functionally superior in most of the functional characteristics to the white Netravali whole wheat flour. The Black wheat flour had good baking properties, i.e., so it can be used

- Efficiently formulating the different types of products. In the future, it is necessary to study the chemical composition, phytochemical contents, rheological analysis carefully
- and processing aspects of wholegrain black wheat flour to establish how it changes during baking, extrusion and other processing conditions, including cooking, to substantiate the
- Different properties of this flour, and to improve its production technology. Eating black wheat has a number of health benefits, as well as a number of essential nutrients, and it also boosts immunity there for it fulfils the two SD goals of no hunger and good health and well-being.

REFERENCES

1. Kumari and Tzudir, 2021. Black Wheat: Next Big Thing in India's Agricultural Landscape. *Biotica Research Today* 3(4): 240-242.
2. Shewry.P.R. Wheat. *Journal of Experimental Botany*, Vol. 60, No. 6, pp. 1537–1553, 2009.
3. Dhua, S., Kumar, K., Kumar, Y., Singh, L., &Sharanagat, V. S. (2021). Composition, characteristics and health promising prospects of black wheat: a review. *Trends in Food Science & Technology*, 112, 780-794.
4. Li, W., Beta, T., Sun, S., &Corke, H. (2006). Protein characteristics of Chinese black-grained wheat. *Food Chemistry*, 98(3), 463-472.
5. Cui, H. S., Kim, M. R., &Sok, D. E. (2005). Protection by petasignolide A, a major neuroprotective compound in the butanol extract of *Petasites japonicus* leaves, against oxidative damage in the brains of mice challenged with kainic acid. *Journal of agricultural and food chemistry*, 53(22), 8526-8532.
6. Laskowski, W., Górska-Warsewicz, H., Rejman, K., Czczotko, M., &Zwolińska, J. (2019). How important are cereals and cereal products in the average polish diet?. *Nutrients*, 11(3), 679.
7. Sun, Q., Zhang, A., Ma, Z. F., Zhang, H., Li, F., Yang, Y., & Kong, L. (2018). Optimal formulation of a product containing black wheat granules. *International Journal of Food Properties*, 21(1), 2062-2074.
8. Li, W., Shan, F., Sun, S., Corke, H., & Beta, T. (2005). Free radical scavenging properties and phenolic content of Chinese black-grained wheat. *Journal of agricultural and food chemistry*, 53(22), 8533-8536.
9. Gupta, R., Meghwal, M., & Prabhakar, P. K. (2021). Bioactive compounds of pigmented Wheat (*Triticum aestivum*): Potential benefits in human health. *Trends in Food Science & Technology*, 110, 240-252.
10. Tanno, K. I., & Willcox, G. (2006). How fast was wild wheat domesticated? *Science*, 311(5769), 1886-1886.
11. Feldman, M., & Kislev, M. E. (2007). Domestication of emmer wheat and evolution of free-threshing tetraploid wheat. *Israel Journal of Plant Sciences*, 55(3-4), 207-221.





Suryakamal Biswal et al.

12. Colledge, S., & Conolly, J. (Eds.). (2007). The origins and spread of domestic plants in Southwest Asia and Europe (pp. 1-424). Walnut Creek: Left Coast Press.
13. Wheat. Encyclopedia of Earth. National Council of Science and the Environment. Archived 3 December 2013 at the Wayback Machine ed. LakhdarBoukerrou
14. Heun, MR; *et al.* (1997). "Site of Einkorn Wheat Domestication Identified by DNA Fingerprinting".14. Bibcode:1997Sci...278.1312H.
15. AFLP analysis of a collection of tetraploid wheat indicates the origin of emmer and hard wheat domestication in southeast Turkey". *Molecular Biology and Evolution*. 19 (10): 1797–801. doi:10.1093/oxfordjournals.molbev.a004002.
16. Jared Diamond (1997), *Guns, Germs and Steel: A short history of everybody for the last 13,000 years*, Viking UK Random House (ISBN 0-09-930278-0).^ Direct quotation: Grundas ST: Chapter: Wheat: The Crop, in *Encyclopedia of Food Sciences and Nutrition* p. 6130, 2003; Elsevier Science Ltd
17. Piotrowski, Jan (26 February 2019). "Britons may have imported wheat long before farming it". *New Scientist*. Retrieved 4 June 2020.
18. Smith, Oliver; Momber, Garry; *et al.* (2015). "Sedimentary DNA from a submerged site reveals wheat in the British Isles 8000 years ago". *Science*. 347 (6225): 998–1001. Bibcode:2015Sci.347.998S.
19. Brace, Selina; Diekmann, Yoan; *et al.* (2019). "Ancient genomes indicate population replacement in Early Neolithic Britain". *Nature Ecology & Evolution*. 3 (5): 765–771.
20. Long, Tengwen; Leipe, Christian; Jin, Guiyun; Wagner, Mayke; Guo, Rongzhen; Schröder, Oskar; Tarasov, Pavel E. (2018). "The early history of wheat in China from 14C dating and Bayesian chronological modelling". *Nature Plants*. 4 (5): 272–279.
21. Bilgic, Hatice; *et al.* (2016). "Ancient DNA from 8400-year-old Çatalhöyük Wheat: Implications for the Origin of Neolithic Agriculture". *PLOS One*. 11 (3): e0151974.
22. Bilgic, Hatice; *et al.* (2016). "Ancient DNA from 8400-year-old Çatalhöyük Wheat: Implications for the Origin of Neolithic Agriculture". *PLOS One*. 11 (3): e0151974.
23. The science in detail – W heats DNA – Research – Archaeology – The University of Sheffield" Sheffield. Ac. The UK. 19 July 2011. Retrieved 27 May 2012.
24. Belderok B *et al.* (2000) *Bread-Making Quality of Wheat* Springer p. 3.
25. Cauvain SP, Cauvain P (2003) *Bread Making* CRC Press p. 540 ISBN 1-85573-553-9
26. Otter, Chris (2020). *Diet for a large planet*. USA: University of Chicago Press. p. 50.
27. C.Michael Hogan. 2013. Wheat. Encyclopedia of Earth, National Council of Science and the Environment, Washington DC ed. P. Saundry.
28. Gautam, P.; Dill-Macky, R. (2012). "Impact of moisture, host genetics and *Fusarium graminearum* isolates on *Fusarium* head blight development and trichothecene accumulation in spring wheat". *Mycotoxin Research*. 28 (1): 45–58.
29. *Biological Control of Stored-Product Pests*. *Biological Control News* Volume II, Number 10 October 1995 Archived 15 June 2010 at the Wayback Machine, Post-harvest Operations Compendium, FAO.
30. CSIRO Rodent Management Research Focus: Mice plagues Archived 21 July 2010 at the Wayback Machine
31. "ARS, Industry Cooperation Yields Device to Detect Insects in Stored Wheat". USDA Agricultural Research Service. 24 June 2010
32. Kumari, S., & Tzudir, L. (2021). Black Wheat: Next Big Thing in India's Agricultural Landscape. *Biotica Research Today*, 3(4), 240-242.
33. Kumari, A., Sharma, S., Sharma, N., Chunduri, V., Kapoor, P., Kaur, S., ... & Garg, M. (2020). Influence of biofortified coloured wheat (purple, blue, black) on physicochemical, antioxidant and sensory characteristics of chapatti (Indian flatbread). *Molecules*, 25(21), 5071.
34. Kishor Kamal. BLACK WHEAT FARMING. JUST AGRICULTURE | Mar 2021 66JUST AGRICULTURE | Mar 2021 66
35. Joshi, A. A., Kshirsagar, R. B., Sadawarte, S. K., Patil, B. M., & Sawate, A. R. (2022). Comparative evaluation of baking and functional qualities of black wheat flour.





Polysaccharide Based Materials for Food Packaging: A Review

Swarnamayee Dehuri, Ankita Subhrasmita Gadtya, Srikanta Moharana and Susanta Kumar Biswal*

School of Applied Sciences, Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Susanta Kumar Biswal

School of Applied Sciences,
Centurion University of Technology and Management,
Odisha, India
Email: dr.skbiswal@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The polysaccharide based materials shows an environmental friendly technological solution in recent few years. This review discusses some of polysaccharide based polymeric biodegradable materials used for food packaging purposes in today's ever changing marketing environment. Because it decreases uses of fossil fuel and also reduce the carbon footprints product as the polysaccharide based polymers materials are environmentally benign product. This review covered some of recent area of polymer packaging products from bio-based carbohydrates that include plant cellulose and hemi-cellulose, marine polysaccharide. Polysaccharide based materials have wide variety of potential applications in the field of edible coatings and food packaging.

Keywords: Polysaccharide, Cellulose, hemicelluloses, Chitosan, Nano-emulsion

INTRODUCTION

In today's commercial world we can't imagine the transportation of goods and other commercial products without packaging. So the processing, production and marketing of packaging products play a vital role in food safety. Compared to conventional polymers materials use of polysaccharides based polymers like chitosan, alginate (derived from brown seed weeds), dextrin, etc are best substitute of non biodegradable plastic [2]. Currently, to meet the demand of green or sustainable chemistry, the renewable eco friendly polysaccharide based materials widely used in food industry to increase self life and retain original taste color and p are palatability of food stuffs. Cellulose, non cellulose, starch, pectin are carbohydrate based material achieve green chemistry goal due to excellent microstructure and various strategies in developmental packaging [3]. The use of non degradable polymers causes a various environmental pollution and by dumping these plastic in landfills can cause serious environmental hazards. The polysaccharide based polymers have excellent film forming properties makes it more suitable for biodegradable plastic for food packaging applications. [4] During last few times, the metal like aluminum, tin plates, tin free steel and glass are used for packaging but it leads to hazardous environmental issues. so the bio based material i.e. poly



**Swarnnamayee Dehuri et al.**

hydroxyacid and poly lactic acids are used for packaging purposes as it broken down and completely decomposed into soil within few periods of time after disposing.[1]In current era, biodegradable polymers have infinite lists of applications in i.e., lamination film, disposable cutlery, drinking cups, container for food dispense in food factory . Maher and Elsabee *et al* [5-6] have reported that the polysaccharide like cellulose, pectin, chitosan, Pullman and kefiran having capability of film forming most widely used. The current review summarized some of polysaccharides based polymers i.e. biodegradable used for food packaging purposes in today's ever changing marketing environment. Because it decreases uses of fossil fuel and also reduce the carbon footprints product as the polysaccharide based polymers materials are environmentally benign product. This review covered some of recent area of polymer packaging products from biobased carbohydrates that include plant cellulose and hemicelluloses, marine polysaccharide and some of latest research on aero gel packaging [1].

Types of Polysaccharides and Its Source**Plant Based Polysaccharides****Cellulose**

Cellulose, it is easily available polysaccharide found in cell wall of terrestrial plant and also found in sea or marine environments. Gram negative bacteria, fungi and algae also contain cellulose [1, 6]. It is formed by linear combinations of homo polysaccharide and have a D- glucopyranosyl unit joined by β -(1,4) glycosidic bonds (Figure: 1) Cellulose has different characteristics like good stability to chemical reaction, excellent film forming capacity and it higher possibility of synthesizing derivative of cellulose [1, 7]. Sometime applications of cellulose to prepare a edible film have a few applications because it is insoluble in water and also in some organic solvent [1, 8]. Aero gels for food packaging are somehow produced from cellulose. The synthesis of cellulose based aero gel involves the following steps for preparation :(a) by solubilizing the cellulose and its various derivatives in organic solvents, (b)then sol – gel technique that cause aggregation of colloidal particles with a cross linker or by varying the pH and temperature) or by a phase separation process that requires a coagulant. (c) Supercritical drying technique. If we compared silicon aero gel cellulose has capability of high thermal conductivity and high mechanical strength. [1, 9]

Hemicelluloses

It is the type of polysaccharides is obtained from plant wood or by product of plant material. Hemicelluloses contains β - (1,4) linked backbone of ether glucose, mangoes or xylene joined in an equatorial Confirmation. Xylan is most widely used hemicelluloses and second most used biopolymer in plant kingdom. Xylan have β - (1, 4) -D – xylopyranose backbone with various groups attached with (1,2) and (1 ,3) linkage (Fig : 2)

Starch

Starch ,that is consist of amylose and amylopectin .amylose formed by polymerization of α -1,4- linked D- glucose units and amylopectin is formed by short chain interaction of α -1,4- linked D- glucose units and 4-5 % Branch points with 1,6 linkage at a every 20- 30 an hydroglucose units. Most of the polysaccharide from starch derived from potato starch, corn, rice, wheat and topico. This starch based polysaccharide are biodegradable, renewable and easier modifying properties and most importantly it is available at low cost (Fig 3).Starch based film have excellent quality like they are non toxic, odorless, tasteless, colorless, edible and have oxygen scavenger properties [10].

Microbial exopolysaccharides

Microbial exo-polysaccharides found very useful compared to marine and general plant polysaccharides. Generally, microbial exopolysaccharides are prepared from fermentation process. Culture condition affected by various properties of polysaccharides like solubility, molecular mass, chemical structure. So selection of high producing strain and optimization of fermentation process are mostly taken into account in industrial production of edible film for food product [1].





Swarnnamayee Dehuri *et al.*

Marine polysaccharide

Marine polysaccharide like chitosan, alginate, agar agar and Carrageenan derived from sea weeds, marine biotopes, and crustaceans are highlighted for food packaging due to their techno functional applications.

Chitosan

Chitosan formed by polymerization of 2 polymers i.e. N – acetyl glucosamine and glucosamine joined by β -(1-4) glycosidic linkage (Fig : 4) [11, 1]. Chitosan that is derived from chitin that is present in high amount in crustaceans. Chitin insoluble in water but dissolved in high alkaline or hot conditions. Recent study reveal chitosan have good physico-chemical properties and most importantly it have high biocompatible, edibility, bioadhesive, biodegradable and available in non toxic form. Chitosan films have permeable to selective gases like oxygen and carbon dioxide. Moreover, the chitosan based film for food packaging has highly durable coating and film has well anti microbial properties.[1, 12, 13, 14]. Silva *et al* have found that ripening of guava can be delayed by using chitosan solution by suppressing some parameters like respiratory rate, fresh weight loss and by delaying chlorophyll degradation [1,15]

Alginate

Alginates are extracted from (20-40% content of dry weight) brown seed weeds like as *Cophyllum nodosum*, *Laminaria* species and *Ecklonia*. Chemically it is made up (1,4) linked α - L – gluconuronic acid and β -D – mannuronic acid. Gluconuronic and mannuronic acid arranged in homogeneous block that incorporated in to different structures with various physico chemical properties. (as shown in Fig -5) Alginate film have transparent uniform and have highly water soluble capacity and increases ion interaction by use of divalent cation such as calcium ion to cross link alginate .[1,16,17]Franco *et al* proposed a food packaging by incorporating alginate aero gel on the surface of antioxidant compounds quercetin by carbon dioxide supercritical technology. [1,18]. Alginate hydrogel also used for drug delivery, wound healing and packaging of bioactive substances.

Film properties:

Bedan *et al.* have reported that packaging of products polysaccharide film have good performance with higher flexible properties, good optical properties, higher safety and long shelf life for the food products which have highly sensitive to moisture, excellent mechanical strength gas barrier properties.

Barrier properties and water permeability:

Barrier properties of a polymer based film play a vital role in estimation of shelf life of food products. Oxygen and water vapor are two most important barriers parameters that may passes from internal environments to external environments through wall of packaging film can cause change in shelf life of food stuffs .[5]The barrier properties of water vapors are determined by the water vapor permeability(WVP)*i.e.*,the amount of water penetrates per unit of area and unit time (kg / m a Pa)

WVP is calculated in accordance with combined Fick and Henry laws for diffusion of gas through films, by using the equation 1:

$$WVP = \Delta w \cdot x / A \Delta P \dots\dots (1)$$

According to Khan *et al.* where “ Δw ” is the weight gain of the cell after 24 h, x is the thickness of film used, A is the area of a exposed film and ΔP is the differential vapor pressure of water passes through a film. To signify water transfer, the water vapor transmission rate (WVTR), expressed in term of (g/m²day) is also used. The WVP can be estimated from to the WVTR from equation 2.

$$WVP = WVTR \cdot x / \Delta P \dots\dots\dots (2)$$

Where x is the film thickness (m) and ΔP is the pressure term *i.e.*, partial pressure difference across the film (Pa). Generally, commercially synthetic polymer based material have lower value of WVP as compared to polysaccharide-based films. [5].

Mechanical properties

A mechanical property of polysaccharides based film consists of % of elongation, young's modulus, tensile properties, and nature of film. By measuring these properties we know that how the film material will under



**Swarnnamayee Dehuri et al.**

influence of the conditions of food processing and management. Tensile strength is the maximum stress that resist by a film before reach to breaking point and is estimated from the tensile test using the following equation:

$$TS = F / (L - x) \text{----- (3)}$$

Where F =the tensile force (N), L = film width (mm), x =thickness of the film (mm).

Percentage of elongation at break is the maximum elongation of the film before breaking determined from tensile test by use of the equation [4].

$$\% E = 100. (l_1 - l) / l_1 \text{..... (4)}$$

Where l_1 is the initial length of the film and l is the length of polysaccharides based film at the breaking point.

Edible film from corn starch by incorporation of nano emulsion of nutmeg oil:

Y Aisyah and L.P Irwanda *et al* formulate a edible film made from corn starch by changing different concentrations of glycerol (10 % ,20%,30%)and nano emulsion of nutmeg oil(1 % ,2%,3%) & the corn starch based edible film are characterized by its antimicrobial properties and excellent mechanical properties. [19].

MATERIALS AND METHODS

Materials

Nutmeg oil (an essential oil) used for preparing edible film are mainly transported from Indonesia, Jakarta. Other important materials are glycerol (sigma Aldrich, US) and Polyoxyethylene-20-sorbiton monooleate (Tween 80). Corn starch that is available in common market banda Aceh, Indonesia.

Nutmeg oil nanoemulsion preparation:

High pressure homogenization (HPH) techniques used for preparing nano emulsion. Here the water acts as dispersing medium and the nutmeg oil with oil in water as dispersed phase in different types of emulsion. By dispersion of double distilled water with tween 80 as a surfactant into 15 % solution of nutmeg oil in order to prepare a coarse emulsion for edible film. Then the concentration of tween 80 was taken as 20 % of nutmeg oil. A high shear homogenizer was used to homogenize the mixtures, which operate at 12000 rpm for five minutes after that the emulsion of coarse was passed into a HPH which complete 3 cycles at a pressure of 500 bars.

Edible film preparation techniques:

By dissolving glycerol in different proportions (10%, 20%, 30%) and corn starch (3%) to form a aqueous solution. Then the aqueous solution was mixed thoroughly for 30 min at 85 degree Celsius followed by cooling at 45 degree Celsius. After that different proportions of nutmeg oil nano emulsion was added to the suspension. Then the mixture was poured into glass plates of 30 cm x20 cm and was dried for 12 hours at 50 degree Celsius or above. Then cooled for 1 day at room temperature. After cooling the thin film removed from glass plates. Then the films were goes for characterization techniques to check the quality parameters.

Characterization of edible film:**Microstructure of film:**

SEM test results shows that film morphology with 30 % glycerol and 20 % corn starch without addition of emulsion of nutmeg oil shows a surface of smooth and a non porous microstructure. Figure 6 (a). Figure 6 (b) shows that by addition of 1 % nano emulsion of nutmeg oil with 30 % corn starch and 20 % corn starch produced a porous film.

Elongation capacity:

According to observations data elongation value of edible film ranges from 4.81% to 69 .44 % and have average of 31.10 %. According to table-3, 30 % glycerol addition show highest % of elongation i.e52.84 % and by 10 % addition of glycerol shows lowest elongation of 11.52 %. This indicates that with increase in concentration of glycerol can increase the film elongation.



**Swarnnamayee Dehuri et al.**

By increasing glycerol concentration can weaken intermolecular force within matrix of edible film and also enhance flexible properties reduce fragile nature so not break easily.

Anti bacterial properties:

The study reveals that by adding nutmeg oil to prepare edible film can stop the growth of E .coli and staphylococcus aureus. Films with 3 % of nutmeg oil nano emulsion are able to stop growth of E .coli at 14.89 mm and staphylococcus aureus at 18.27 mm. Table 4 shows that with increase in nanoemulsion of nutmeg oil can increase antibacterial activity of film. There are some factors that affect the size of inhibition zone are , culture media, velocity of diffusion of agar in the medium, conditions of incubation and organisms sensitivity . The factors that affect velocity of diffusion of agar are time of Incubation, temperature of Incubation and microorganism concentration. From this review it concluded that even addition of 1% of nanoemulsion of nutmeg oil can able to stop growth of microbes used for testing i.e. E.coli and staphylococcus aureus. Hence the minimal inhibitory ability is addition of 1 % of nutmeg oil nanoemulsion in edible film preparation[19-24].

CONCLUSION

Due excellent properties of biodegradable film for food packaging it increase efficiency and functionality of food stuffs .in next future polysaccharide based polymers are best substitute for synthetic polymer materials. Polysaccharides based material production may meet the demands for edible film, intelligence and active packaging because of it high barrier properties and mechanical strength. It acts as eco-friendly and low cost material can be afforded by every class of people in society. Biopolymer packaging materials are also substitute to synthetic packaging. Sensitivity to moisture and their weak mechanical properties become the limitation of their use. Therefore a new compound integrated into a polymer matrix to form ingenious nanocomposite material in packaging of food.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support provided by Centurion University of Technology and Management, Odisha, India for carrying out the present research work.

REFERENCES

1. Nešić, Aleksandra; Cabrera-Barjas, Gustavo; DimitrijevićBranković,Suzana; Davidović, Sladjana; Radovanović, Neda; Delattre, Cédric (2019). Prospect of Polysaccharide-Based Materials asAdvanced Food Packaging. *Molecules*, 25(1), 135–.doi:10.3390/molecules25010135
2. Raschip, I. E., Fifere, N., & Dinu, M. V. (2021). Polysaccharide-Based Materials as Promising Alternatives to Synthetic-Based Plastics for Food Packaging Applications. In *Bioplastics for Sustainable Development* (pp. 515-554). Springer, Singapore.
3. Deng, J., Zhu, E. Q., Xu, G. F., Naik, N., Murugadoss, V., Ma, M. G., ... & Shi, Z. J. (2022). Overview of renewable polysaccharide-based composites for biodegradable food packaging applications. *Green Chemistry*, 24(2), 480-492.
4. Ferreira, A. R., Alves, V. D., & Coelho, I. M. (2016). Polysaccharide-based membranes in food packaging applications. *Membranes*, 6(2), 22.
5. Cazón, P., Velazquez, G., Ramírez, J. A., & Vázquez, M. (2017). Polysaccharide-based films and coatings for food packaging: A review. *Food Hydrocolloids*, 68, 136-148.
6. Cazón, P., Velazquez, G., Ramírez, J.A., Vázquez, M.,Polysaccharide-based films and coatings for food packaging: A review,*Food Hydrocolloids* (2016), doi: 10.1016/j.foodhyd.2016.09.009.





Swarnnamayee Dehuri et al.

7. Duan, J.; Reddy, K.O.; Ashok, B.; Cai, J.; Zhang, L.; Rajulu, A.V. Effects of spent tea leaf powder on the properties and functions of cellulose green composite films. *J. Environ.Chem. Eng.* 2016, 4, 440–448.
8. Wei, X.; Wang, Y.; Li, J.; Wang, F.; Chang, G.; Fu, T.; Zhou, W. Effects of temperature on cellulose hydrogen bonds during dissolution in ionic liquid. *Carbohydr. Polym.* 2018, 201, 387–391.
9. Long, L.-Y.; Weng, Y.-X.; Wang, Y.-Z. Cellulose aerogels: Synthesis, applications, and prospects. *Polymer* 2018, 10, 623.
10. Dai, L.; Zhang, J.; Cheng, F. Effects of starches from different botanical sources and modification methods on physicochemical properties of starch-based edible films. *Int. J. Boil. Macromol.* 2019, 132, 897–905.
11. Mati-Baouche, N.; Elchinger, P.-H.; de Baynast, H.; Pierre, G.; Delattre, C.; Michaud, P. Chitosan as adhesive. *Eur. Polym. J.* 2014, 60, 198–212.
12. Bouissil, S.; Pierre, G.; El Alaoui-Talibi, Z.; Michaud, P.; El Modafar, C.; Delattre, C. Applications of algal polysaccharides and derivatives in therapeutic and agricultural fields. *Curr. Pharm. Des.* 2019, 25, 1187–1199.
13. Brasselet, C.; Pierre, G.; Dubessay, P.; Dols-Lafargue, M.; Coulon, J.; Maupeu, J.; Vallet-Courbin, A.; DeBaynast, H.; Doco, T.; Michaud, P.; et al. Modification of chitosan for the generation of functional derivatives. *Appl. Sci.* 2019, 9, 1321.
14. Laroche, C.; Delattre, C.; Mati-Baouche, N.; Salah, R.; Ursu, A.V.; Mouliti-Mati, F.; Michaud, P.; Pierre, G.; Laroche, C.D.C. Bioactivity of chitosan and its derivatives. *Curr. Org. Chem.* 2018, 22, 641–667.
15. Silva, W.B.; Silva, G.M.C.; Santana, D.B.; Salvador, A.R.; Medeiros, D.B.; Belghith, I.; Da Silva, N.M.; Cordeiro, M.H.M.; Misobutsi, G.P. Chitosan delays ripening and ROS production in guava (*Psidium guajava* L.) fruit. *Food Chem.* 2018, 242, 232–238.
16. Rhim, J.-W. Physical and mechanical properties of water resistant sodium alginate films. *LWT* 2004, 37, 323–330.
17. Olius, G.O.; Soliva-Fortuny, R.; Martin-Belloso, O. Using polysaccharide-based edible coatings to enhance quality and antioxidant properties of fresh-cut melon. *LWT* 2008, 41, 1862–1870.
18. Franco, P.; Aliakbarian, B.; Perego, P.; Reverchon, E.; De Marco, I. Supercritical adsorption of quercetin on aerogels for active packaging applications. *Ind. Eng. Chem. Res.* 2018, 57, 15105–15113.
19. Y Aisyah¹, L P Irwanda², S Haryani¹, N Safriani¹ Lecturer of Agricultural Product Technology Department, Syiah Kuala University, Banda Aceh 23111, Indonesia ² Undergraduate student of Agricultural Product Technology Department, Syiah Kuala University, Banda Aceh 23111, Indonesia
20. Lima, H. R. S., Airton de Oliveira Farias, E., Teixeira, P. R. S., Eiras, C., & Nunes, L. C. C. (2019). Blend films based on biopolymers extracted from babassu mesocarp (*Orbignya phalerata*) for the electrochemical detection of methotrexate antineoplastic drug. *Journal of Solid State Electrochemistry*, 23(11), 3153-3164
21. Aguirre-Joya, J. A., De Leon-Zapata, M. A., Alvarez-Perez, O. B., Torres-León, C., Nieto-Oropeza, D. E., Ventura-Sobrevilla, J. M., ... & Aguilar, C. N. (2018). Basic and applied concepts of edible packaging for foods. In *Food packaging and preservation* (pp. 1-61). Academic Press.
22. Kraśniewska, K., Galus, S., & Gniewosz, M. (2020). Biopolymers-based materials containing silver nanoparticles as active packaging for food applications—a review. *International Journal of Molecular Sciences*, 21(3), 698.
23. Lima, H. R. S., Airton de Oliveira Farias, E., Teixeira, P. R. S., Eiras, C., & Nunes, L. C. C. (2019). Blend films based on biopolymers extracted from babassu mesocarp (*Orbignya phalerata*) for the electrochemical detection of methotrexate antineoplastic drug. *Journal of Solid State Electrochemistry*, 23(11), 3153-3164.
24. Aguirre-Joya, J. A., De Leon-Zapata, M. A., Alvarez-Perez, O. B., Torres-León, C., Nieto-Oropeza, D. E., Ventura-Sobrevilla, J. M., ... & Aguilar, C. N. (2018). Basic and applied concepts of edible packaging for foods. In *Food packaging and preservation* (pp. 1-61). Academic Press.

Table -3: Effect of concentration of glycerol on % of elongation and tensile strength

| Glycerol concentration | Tensile strength (Kgf/mm ²) | Elongation break (%) |
|------------------------|---|----------------------|
| 10% | 16.00 | 11.52 |
| 20% | 16.67 | 28.93 |
| 30% | 18.04 | 52.84 |





Swarnnamayee Dehuri et al.

Table -4: The inhibition zone diameter of edible film with addition of nano emulsion of nutmeg oil against bacteria

| Type of bacteria | Nutmeg oil nanoemulsion concentration | Inhibition zone (mm) |
|-----------------------|---------------------------------------|----------------------|
| Staphylococcus aureus | 1% | 10.04 |
| | 2% | 14.62 |
| | 3% | 18.27 |
| | 1% | 10.76 |
| Escherichia coli | 2% | 12.22 |
| | 3% | 14.89 |

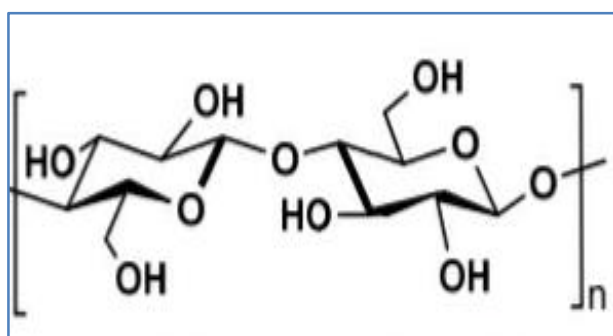


Fig.1: Microstructure of cellulose

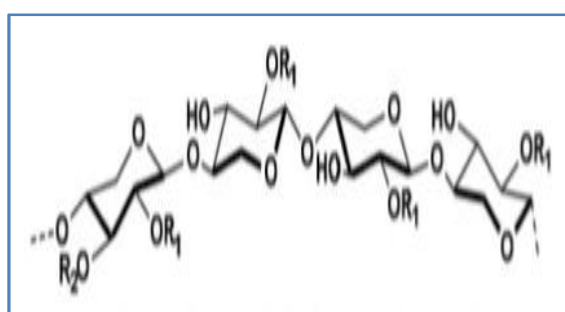


Fig. 2 Hemicelluloses

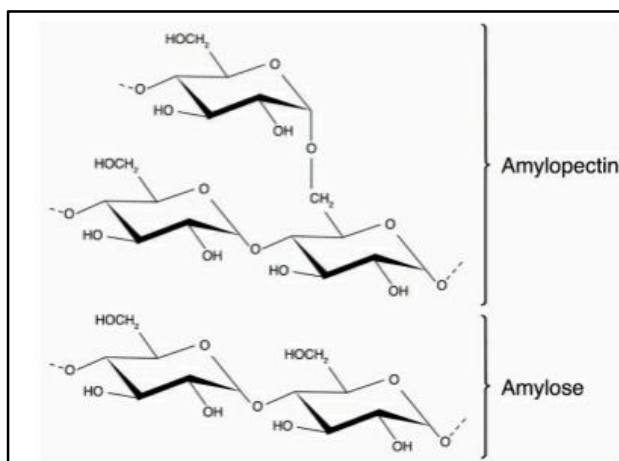


Fig. 3: Chemical Structure of starch polysaccharides

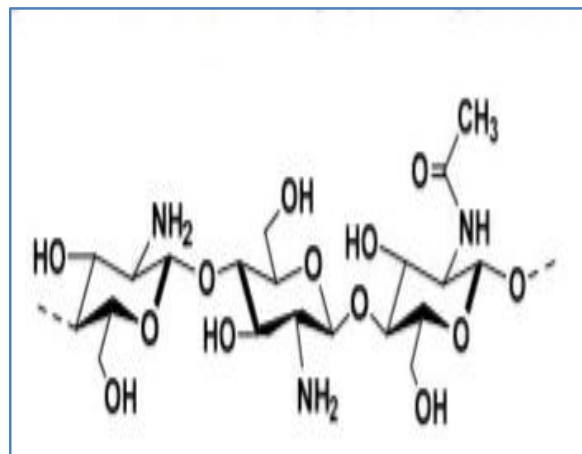


Fig 4: Chemical structure of Chitosan





Swarnnamayee Dehuri et al.

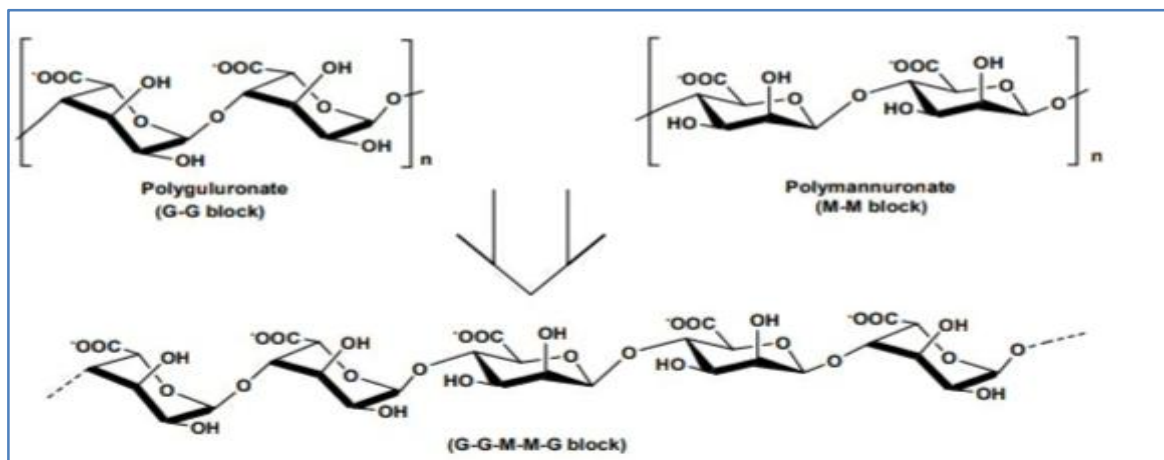


Fig.5. Main Chemical structure of seaweeds alginates

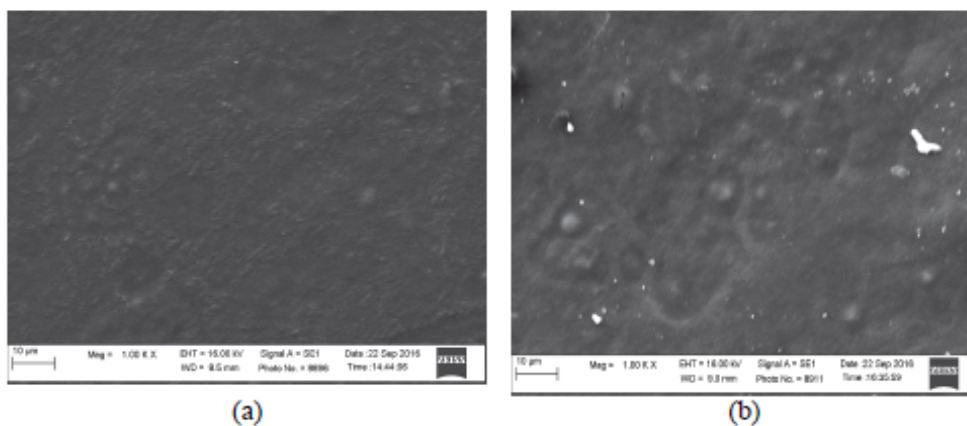


Fig. 6. The film surface with no addition of nutmeg oil nano-emulsion, 20% of starch, and 30% of glycerol (a) and with the addition of 1% nutmeg oil emulsion, 20% starch, and 30% glycerol (b) using 100 x magnifications [19].





A Review on the Potential benefits of *Curcuma angustifolia* to the Medicinal World

Somyashree Nath, B Jyotirmayee and Gyanranjan Mahalik*

Department of Botany, School of Applied Sciences, Centurion University of Management and Technology, Bhubaneswar, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Gyanranjan Mahalik

Department of Botany,
School of Applied Sciences,
Centurion University of Management and Technology,
Bhubaneswar, Odisha, India
Email: gyanranjan.mahalik@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Many plants have been used medicinally in India for a long time. Traditionally used medication relies heavily on medicinal herbs. The Zingiberaceae family has approximately 80 different species of *Curcuma*, one of which is *Curcuma angustifolia* Roxb. Cone-shaped, funnel-shaped blooms in Tufts of pink terminal bracts are seen on the perennial *Curcuma angustifolia* Roxb plant. East Indian arrowroot is a 50-hectare crop grown in Odisha's Keonjhar and Mayurbhanj districts. Besides Asia, the plant is grown in Sri Lanka, Burma, Nepal, Pakistan, and China. This plant rhizome includes starch suitable for feeding youngsters since their bodies quickly assimilate it. The young rhizome may be consumed as a vegetable. Both the tubers and the plant's top are fed to cattle. This plant is used in various traditional remedies for various ailments, including stomach discomfort, diarrhea, and more. Non-irritating diet in some chronic conditions; during convalescence from fevers; during irritation of the alimentary canal, respiratory organs or urinary apparatus; during convalescence from fevers. Tuberculosis patients often use the plant as a general tonic. It is used to treat coughs, bronchitis and as baby food. Rhizomes have medical value because of their bioactive components, including antioxidative and anti-inflammatory properties, anticoagulant properties, and antibacterial properties. Secondary metabolites including flavonoids, tannins, and glycosides are present in the plant, contributing to its antibacterial properties. Camphor, cineol, and methyl eugenol are among the plant's most important chemical constituents. The arrowroot plant's medicinal, morphological, and ethnobotanical value cannot be overstated. This review mainly focuses on the nutritional benefits, essential components, and health benefits of this plant in novel drug development.

Keywords: Arrowroot, Secondary metabolites, Drug Development, Traditional, Remedies



**Somyashree Nath et al.**

INTRODUCTION

India produces large amounts of medicinal herbs, so it is called its botanical garden. From ancient times different parts of several medicinal plants have been used to cure various diseases (1). Synthetic drugs are adequate for controlling other diseases, but these drugs do not come to every people. Around 3.6 lakh species of medicinal herbs are shown on earth, and in India, 1.4 lakh species are present (2). In the recent data, it was found that around 70,000 species are used in medicinal work. Due to complex chemical substances in medicinal plants, these are used as good medicine to cure the disease (3). The genus *Curcuma* belongs to the family Zingiberaceae contains about 80 species, and is allocated in the tropics of Asia, Africa, southeast Asia and other mellow parts of the world (4). *Curcuma angustifolia* is well known as East Indian arrowroot, and it has several medicinal properties (5). Arrowroot is an essential medicinal herb with great value in the national and international market (6). The tribal people of India take it to cure different diseases such as fever, jaundice, kidney disorders, thirst etc. (7). Diarrhoea colitis is fixed with the help of the rhizome of the arrowroot plant (8). Bone fracture, inflammation and intestinal disorders are treated using rhizome of this plant (9). The leaf of arrowroot contains some antimicrobial activity, antibacterial activity, and antifungal activity (10). This species has high nutritional value as well as sources of starch. The powder of this starch has high nutritional value and is also digestible. Therefore, this starch powder has high nutritional value and is also digestible (11). *Curcuma angustifolia* contains branched, fleshy and aromatic rhizome. The roots of this plant bear some conical or ellipsoidal tubers. A single anther is present inside the flower, and it also contains spiral bracts with spike inflorescence (9). Naturally, the cultivation of the arrowroot plant occurs through the rhizome, but it is a prolonged process. The tissue culture technique was a speedy process in which the arrowroot plant is cultivated and time-saving (10) in Odisha *Curcuma angustifolia* cultivated in R-Udayagiri, Gajapati District and also the greenhouse of Siksha O Anusandhan University, Bhubaneswar (11).

Alkaloids, flavonoids, terpenoids, phenols, tannins, saponins, and curcumins are the secondary metabolites present in the rhizome of *Curcuma angustifolia*. Secondary metabolites and starch, glucose, sugar, curcuminoids, curcumol, and zederone are also present in the rhizome. The young rhizome contains camphor, trans-nerolidol, butyl ester, humelen-6, and 7-epoxide. Glycoside tenacissosidas, feronic acids are present in the stem portion. The root contains some acids like cinnamic acid and acetic acid (12). In India, this plant is distributed in Madhya Pradesh, Chhattisgarh, Odisha, West Bengal etc. The leaf oil extracted from *Curcuma angustifolia* has excellent antimicrobial activity and antioxidant activity. The process of gas chromatography-mass spectroscopy extracts the essential oils from the leaf and rhizome. The leaf oil has more antioxidant properties than rhizome oil (13). The oil which are extract from rhizome of *Curcuma angustifolia* plant contains camphor(3.3%), germocrone(3.3%), xanthorrhizol(2.9%), & B – eudesmol(1.4%). But the 14- hydroxy candinene is absent in the rhizome oil of *Curcuma angustifolia* plant.

History

In a particular geographical location, Indigenous knowledge refers to the unique and traditional ability that exists within and developed around the specific conditions of men and women. The indigenous knowledge is accumulated through trial and error experiments. A traditionally weaning food known as shotti is mainly prepared from the rhizome of the *Curcuma angustifolia* plant. This rhizome of the *Curcuma angustifolia* plant is used for medicine by local herbalists. In ancient times the *Curcuma angustifolia* plant is also used for curing worms and stomachaches. The grated rhizome is kept on the navel for 10-20 mins in case of severe stomachache. Finally, the traditional knowledge of the *Curcuma angustifolia* plant and ethnic preparation has a sharp decline.

Common Name

East Indian arrowroot (English), Tekhur (Hindi), Tavakshira (Sanskrit), Gaddalu (Telgu), Tikhur (Gujarat), Tikkur (Bengali), Kaadu arrowroot (Kannad).



**Somyashree Nath et al.**

Distribution and Cultivation

Curcuma angustifolia is found in central, southern and Eastern India but is most commonly seen in India's Northeast & western coastal plains & hills. In Maharashtra, Madhya Pradesh, Andhra Pradesh, Himachal Pradesh, Odisha, Chhattisgarh, Tamilnadu, Kerala, the *Curcuma angustifolia* plant is well developed. This plant is also cultivated in West Bengal, central Himalayas, Bihar, and Karnataka. The state and other countries are also famous for developing *Curcuma angustifolia*. These countries are Asia, Srilanka, Burma, Laos, Nepal, Pakistan, North Australia & China. It requires a temperature of about 34°F. *Curcuma angustifolia* plant goes for shady areas of altitude of 450m and grows best in moist soil, which means sandy, Pebbly or loamy. It is sown in late autumn, and this plant is not required to be watered regularly, but during the dry period, water is required (14).

Plant Description

Curcuma angustifolia is a rhizomatous herb, which belongs to Zingiberaceae family and Liliopsida class. This species is well known as narrow-leaved turmeric or arrowroot in English. It is a perennial plant. *Curcuma angustifolia* has modest and 3 to 4 yellow coloured small spiked inflorescence. It contains funnel-shaped flowers within tufts of pink terminal bracts (18). The calyx is about 1 cm long and very hairy. But the corolla is about 1.5-2 cm long and white. The ovary is inferior, 3-locule initially (14). The flowers are seen at the beginning of the rainy season, i.e. from July to August. Leaves are grown about 36-37 cm long and 8-10 cm wide. The smell and taste of these leaves are almost similar to turmeric leaves. The critical part of this plant is the rhizome which can grow up to 1.5 m in length. The primary sources of this plant's nutritional and medicinal value are robust rhizomes. This plant propagates through the rhizome (15). The fruit is capsulated, fleshy, dehiscent or indehiscent, sometimes berry-like, and the seed is a reddish-brown colour, slight and arillate (16). This plant is grown in moist and cool situations at about 450 m (17).

Climatic Requirement

The ideal temperature is about 34°F. It grows better in moderate sunlight. This plant likes soil with a great capacity to retain moisture, i.e., in sandy, loamy soils. *Curcuma angustifolia* is found in the clearing of the forest. Regular watering is essential to the arrowroot plant. About 2-3 times of watering in a week require the plant until established when the plants are grown, then once a week watering requires during dry weather.

Nutrient Content

The rhizome of *Curcuma angustifolia* is a good source of starch, so it is a better supplement for new-born babies. Other plant parts, such as inflorescence, tuberous roots, and rootstocks, are also good protein and carbohydrate sources (18). The rhizome of the arrowroot plant contains approximately moisture-18%, protein-1.92%, fat-0.50%, ash-0.93% and highest carbohydrate, i.e., 91.5% by gas chromatography-mass spectroscopy, the essential oils are extracted from the leaf and rhizome of *Curcuma angustifolia* plant. The main components of leaf oils are Curzerenone (37.4%), 14-hydroxy cadinene (19.8%), and eudesmol acetate (9.2%). Also, the main components of rhizome oils are Curzerenone (76.3%), camphor (4.1%), germacrene (4.1%).

Phytochemical Constituents

Secondary metabolites are small organic molecules produced by an organism that is not essential for its growth, development and reproduction. The secondary metabolites like alkaloids, flavonoids, terpenoids, phenols, tannins, saponins, curcumins, steroids and oils are present in the rhizomes of the *Curcuma angustifolia* plant. It also contains starch, glucose, sugar, curcuminoids, curcumol, zederone, procurcumenol, gum and fat. By gas chromatography-mass spectroscopy, the young rhizome oil contains primary ingredients compared to matured rhizome oil. The young rhizome oil contains morphine, camphor, 2,7-bapthalenediol, trans-nerolidol, actadecanoic acid, butyl ester, humulen-6, and 7-epoxide. The developed rhizome oil contains ar-curcumin, camphor, Zingiberol, borneol, curzerenone, furanodienone, isofuranodienone, xanthorrhizol isomer, methyl eugenol, palmitic acid, germacrene, isoborneol, curdione, 1,8-cineole. Leaf oil contains curzerenone, 14-hydroxy-cadinene, and eudesmol acetate. Another essential part of this plant is the root with Elemene, D-cymarose, D-glucose 1-l-thebetose, cinnamic acid and acetic acid. The stem of this plant contains glycoside tenacissoidas A-E, feronic acids, polyoxytregnanes marstenacigenins



**Somyashree Nath et al.**

A and B dresgenin. Apart from stem and rhizome, the seeds contain drebogenin, polyhydroxy, pregnanecissogenin, and tenasogenin.

Pharmacological Activities

Antioxidant Activity

Antioxidant activity is the inhibition of nutrients oxidation by restraining oxidative chain reaction. The nutrients are generally lipids and proteins. Due to the antioxidant activity of vitamin C, vitamin E and rosmarinic acid, these are used in cosmetics (19). Although *Curcuma angustifolia* does not create a good relationship between curcumin and phenol content, it is active due to high aromatic oil content, i.e. eugenol, palmitic and camphor, etc. The antioxidant activity of the *Curcuma angustifolia* plant is 58.35±0.06% (20). By gas chromatography- mass spectroscopy, the essential oils are extracted from the rhizome and leaf of the *Curcuma angustifolia* plant. The antioxidant activity of oils was prolonged by various methods like DPPH, ABTS, and reducing power ability (RPA). At last, the leaf oil contains more antioxidant properties than rhizome oil (21).

Antimicrobial Activity

Ethanol, methanol, and petroleum ether are used to screen the rhizome's antimicrobial activity and the *Curcuma angustifolia* plant's leaf. Antimicrobial may be defined as the collective term for all active agents which inhibit the growth of bacteria, prevents the formation of microbial colonies and also destroy microorganisms. A screening test gives preliminary information about antimicrobial activity. At last, this test provides better information about effective concentration (22). Antibacterial activity in a plant is present due to some secondary metabolites like glycoside, flavonoids, tannins and phytosterol (23). Among the different extraction, the aqueous extract shows better antimicrobial and antifungal activity in the *Curcuma angustifolia* plant. These plants show better results against skin disease-causing microbes (24). Through the microwave-assisted process, the aqueous extraction of the rhizome of the *Curcuma angustifolia* plant was extracted, and the silver nanoparticle's biological synthesis was executed. The synthesis of silver nanoparticles from the green synthetic world created a good ecofriendly relationship and a time-consuming process (25).

Antidiabetic Activity

The antidiabetic drug is the drug which can lower the level of glucose (sugar) in the blood; this glucose causes a disease known as diabetes mellitus. Nowadays, about 2.8% of the world's population is caused by diabetes mellitus disease (26). Arrowroot contains a low glycemic index but a high amount of potassium that acts as an antidiabetic agent. So that the, arrowroot flour act as a good role in healthy snacks for diabetes people (27). Due to glucosidase activity in the rhizome of the *Curcuma angustifolia* plant, the methanol extract of this rhizome shows an excellent inhibitory activity. So that the recent research work in antidiabetic activity supports the traditional use of the *Curcuma angustifolia* plant as a medicine (28).

Health Benefits

Curcuma angustifolia is a tropical, perennial plant that belongs to South America, and this plant's root produces gluten-free starch (29). Arrowroot contains more beneficiaries' power in its different parts. This plant creates a better place in the kitchen, infant food, cosmetics items etc.

In health

1. **Increase metabolic rate:** Arrowroot contains a high amount of B- complex vitamins, which help regulate our body's metabolic pathway and circadian rhythm. Hence, the drinks of arrowroot are famous as a workhorse.
2. **Good for heart:** Different research proves that potassium is good for the soul. The arrowroot plant contains a high amount of potassium, so it has a low risk of strokes, heart attack and atherosclerosis. This plant enhances the oxygen flow to our brain.





Somyashree Nath et al.

3. **Essential for good circulation:** *Curcuma angustifolia* plant contains potassium and copper, and iron, which are very important for red blood cell corpuscles. These are also used for blood flow from and to the vital organs, preventing fatigue, weakness, and anaemia.
4. **Helps in weight loss:** Arrowroot is a cholesterol-free and low-calorie tuber, so it helps in weight loss.
5. **Lower the cholesterol level:** By the input of arrowroot daily, it promotes the bile production in the liver, which lowers the cholesterol level in the blood.
6. **Treatment of athlete's foot:** There is a fungal infection due to wearing covered shoes or exposed to dirty water on the athlete's foot. Arrowroot contains antibacterial and antifungal activity. Arrowroot powder quickly soaks all moisture, for which infection rate decreases, so these are used as a treatment for the foot.
7. **Suitable for the kidney:** Potassium in the arrowroot plant helps remove toxins and stressors from the kidney to balance the blood pressure and increase the boosted immunity.
8. **Antidote for poison:** In different parts of the world, arrowroot powder is used to draw out toxins from people wounded by the arrow's poison.
9. **Infant food:** Arrowroot powder increases infant growth and development due to the presence of magnesium, zinc, and iron. It is good food for infants because it is easily digestible and helps cure diarrhea, cough, etc. (30).
10. **Helpful for pregnant women:** Arrowroot plant rich in folate are good nutrition for pregnant women. This folate helps in DNA synthesis and cell division also.

For Skin

Arrowroot powder is a magical ingredient which is helpful for health, and skin, also as a cooking ingredient.

1. **Homemade deodorant:** Usual deodorant irritates some skin. To avoid this irritation, arrowroot powder is used as an organic deodorant. It removes the foul odour of our bodies.
2. **Used as baby talc:** Arrowroot powder is a natural ingredient used as a talcum powder for babies. Along with chamomile powder, arrowroot powder is used as talc for babies, which helps in the rash free, soft body. The arrowroot powder absorbs the moisture, so that typical skin infection does not occur.
3. **Used for making organic compact:** Different chemicals cause the skin to be irritated. So that organically, the mixture makes the compact of arrowroot powder, cocoa powder, cinnamon etc.
4. **Used for a face mask:** A face mask is always crucial for our life, along with yoghurt, the arrowroot powder used for the face mask.
5. **Cure the chickenpox marks:** The spot made through chickenpox is not easily removed. With the help of arrowroot powder and some antibiotic oils, the site may be cured (31).

CONCLUSION

Curcuma angustifolia is a well-known and worldwide distributed plant mainly found in Southern and Eastern India. Different characteristics are investigated in research like phenology, reproductive biology, and plant nutrition. A foreign researcher works with other methods to know which material is responsible for starch production. Researchers work on the new technique of seedlings production and established planting rhizome. It studies rhizospheric bacteria and how it affects the organic soil or plant. Due to the lack of arrowroot's exemplary microbiological and genetic character, these aspects are now underworking. The technique of arrowroot starch extraction has already been available. Different species of arrowroot plant contains additional amount and quality of starch. This extra amount of starch content creates an excellent opportunity to utilize starch in food industries which will also fulfil the SDG goal of good health and well-being.

REFERENCES

1. Williamson EM. Primary Herbs of Ayurveda. China: Churchill Livingstone, 2002.
2. Mehrola MN. Quality control and equipment of medicinal plants used in traditional medicine. *Ethnobotany*. 1990;2:19-20.





Somyashree Nath et al.

3. Jyotirmayee, B., & Mahalik, G. (2022). Traditional Uses and Variation in Curcumin Content in Varieties of Curcuma-the Saffron of India. *Ambient Science*, 9(1): 06-12.
4. Sasikumar, B. (2005). Genetic resources of Curcuma: diversity, characterization and utilization. *Plants Genet. Resour.* 3:230-251.
5. Srivastava, A.K., Srivastava, S.K. and Syamsundar, K.V. (2006). Volatile composition of Curcuma angustifolia Roxb. Rhizome from central and southern India. *Flavour Frag. J.* 21: 423-426.
6. Sharma, A. (2012). Traditional processing of Shotti (*Curcuma angustifolia* Roxb.)-A rhizome Based ethnic weaning food. *India J. Tradit-Knowl.* 11:154-155.
7. Rao, S.M. and Rao, R. (1914). Flowering plants of Travancore, Vol. XIV. Government Press: Trivendrum (Reprinted by BSMP, Dehra Dun), 400.
8. Patel, S., Tiwari, S., Pisalkar, P.S., Mishra, N.K., Naik, R.K. and Khokhar, D. (2015). Indigenous processing of Tikhur (*Curcuma angustifolia* Roxb.) for the extraction of starch in Baster, Chhattisgarh. *Indian J. Nat. Prod. Resour.* 6: 213-220.
9. Jain, S.K. (1995). Ethnobotanical diversity in Zingibers of India, *Ethnobotany.* 7: 83-88.
10. Shukla, A.C., Pandey, K.P., Mishra, R.K., Dikshit, A. and Shukla, N. (2011). Broad-spectrum therapeutic agent. *J. Nat. Prod.* 4:42-50.
11. Rajashekara, N. and Sharma, P.P. (2010). A comparative study of efficacy of Tugaksheeree [*Curcuma angustifolia* Roxb. and *Maranta arundinacea* Linn.] in management of Amlapitta.
12. Ewon Kaliyadasa, Bhagya A Samarasinghe. *African Journal of Agricultural Research* 14 (9), 519-531, 2019
13. SK Shukla, Susmita Shukla, Vijaya Koche, SK Mishra. CSIR, 2007
14. Sudipta Jena, Asit Ray, Ambika Sahoo, Suprava Sahoo, Basudeba Kar, Pratap Chandra Panda, Sanghamitra Nayak. *Plant Cell, Tissue and Organ Culture (PCTOC)* 135 (3), 473-486, 2018
15. Shailja Sharma, Sailesh Kumar Ghataury, Anil Sarathe, Gaurav Dubey and Geeta Parkhe. *Curcuma angustifolia* Roxb, (Zingiberaceae): Ethnobotany, phytochemistry and pharmacology: A review. *J Pharmacogn Phytochem* 2019;8(2):1535-1540.
16. Sudipta Jena, Asit Ray, Anwesha Banerjee, Ambika Sahoo, Noohi Nasim, Suprava Sahoo, Basudeba Kar, Jeetendranath Patnaik, Pratap Chandra Panda, Sanghamitra Nayak. *Natural product research* 31 (18), 2188-2191, 2017
17. Sanatombi Rajkumari & K. Sanatombi. Nutritional value, phytochemical composition, and biological activities of edible Curcuma species: A review.
18. <https://www.sciencedirect.com/topics/agricultural-and-biological-science/antioxidant-activity>
19. Nahak G, Sahu R.K., Evaluation of antioxidant activity in ethanolic extracts of five Curcuma species *International Research Journal of Pharmacy.* 2011; 2(12) :243-248.
20. Jena S, Ray A, Banerjee A, Sahoo A, Nasim N, Sahoo S et al. Chemical composition and antioxidant activity of essential oil from leaves and rhizomes of *Curcuma angustifolia* Roxb. *Natural product Research*, 2017;31(18) :2188-2191. <https://www.sciencedirect.com/topics/engineering/antimicrobial-activity>.
21. Jadhao AS, Bhuktar AS. Physicochemical and Antibacterial Activity of Rhizome of *Curcuma angustifolia* Roxb, (Zingiberaceae). *International Journal of Science and Research.* 3017;6(8):198-200.
22. Dubey S, Sao S. Antimicrobial Activity of Crude Stem Extracts of some Medicinal plants against skin disease-causing Microbes from Chhattisgarh Region. *International Journal of Engineering Technology Science and research.* 2018;5(1) :57-60.
23. Viji MO, Wilson N. *Curcuma angustifolia* rhizome extracts as reducing agent in synthesis of silver nanoparticle. *Romanian J Biophys.*, 2017;27(1-2) L55-60. <https://www.ncbi.nlm.nih.gov>.
24. <https://www.webmed.com>
25. Sheikh Y, Maibam BC, Biswas D, Laisharm S, Deb L, Takukdar NC et al. Antidiabetic potential of selected ethnomedicinal plants of North-East India *Journal of Ethnopharmacology.* 2015;171:37 -41.
26. <https://www.medindia.net/amp/patients/lifestyleandwellness/health-benefits-of-arrowroot.htm>
27. <https://www.coserve-energy-future.com/health-benefits-arrowroot.php>
28. Tabassum, N., & Hamdani, M. (2014). Plants used to treat skin diseases. *Pharmacognosy reviews*, 8(15), 52.





Somyashree Nath et al.

Table 1: Common Name of East Indian Arrowroot in Different Languages

| Language | Common name |
|----------|-----------------------|
| English | East Indian arrowroot |
| Hindi | Tekhur |
| Sanskrit | Tavakshira |
| Kannada | Kaadu arrowroot |
| Telgu | Gaddalu |
| Bengali | Tikhur |
| Gujurati | Tikkur |

Table 2: Morphological Analysis of East Indian Arrowroot

| Plant parts | Character |
|-------------|--|
| Stem | Short, replaced by pseudostems |
| Leaves | Simple, distichous, green glabrous, opposite arrangements and deciduous |
| Flowers | Perennial, bisexual, epigenous, funnel-shaped flowers within Tufts of pink terminal bracts, double anther, a slender style, a rounded stigma |
| Fruit | Capsule, fleshy or dry, dehiscent or indehiscent |
| Seed | Raddish-brown colours, small arillate |
| Rhizome | Strong, grow up to 1.5 m in length |

Table 3: Nutrient Content of Rhizome in Arrowroot plant

| Nutrient Content | Values in percentage |
|------------------|----------------------|
| Moisture | 18 |
| Protein | 1.92 |
| Fat | 0.50 |
| Carbohydrate | 91.5 |
| Ash | 0.93 |

Table 4: Main Components of Leaf Oil

| Components | Value in percentage |
|---------------------|---------------------|
| Curzerenone | 37.4 |
| 14-hydroxy cadinene | 19.8 |
| Eudesmol acetate | 9.2 |

Table 5: Main Components of Rhizome Oil

| Components | Value in percentage |
|-------------|---------------------|
| Curzerenone | 76.3 |
| Camphor | 4.1 |
| Germacone | 4.1 |





Somyashree Nath et al.

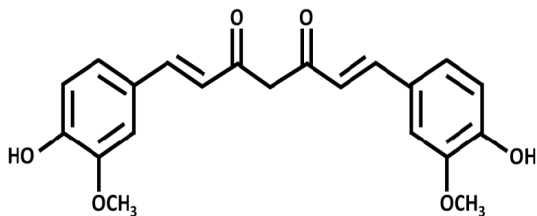


Fig 1: Chemical structure of Curcumin

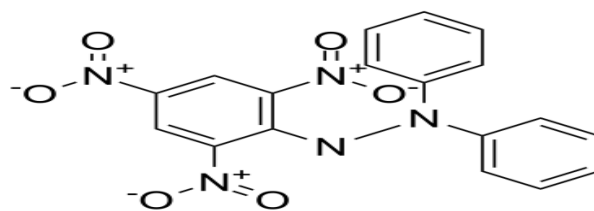


Fig2: Chemical structure of DPPH

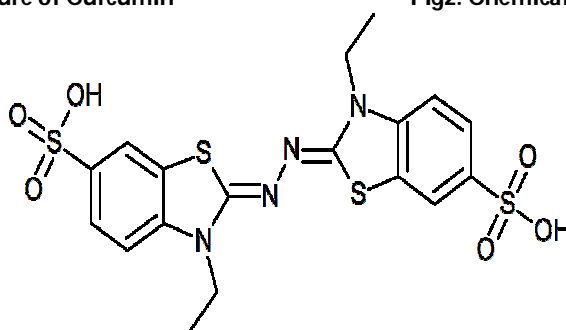


Fig3: Chemical structure of ABTS





Studies on Sequence Concernedness and Phylogenetic Analysis of Mitochondrial Specific Genes.

Utkalini Dehury and Pradip Kumar Prusty*

School of Applied Sciences, Centurion University of Technology and Management, Odisha, India.

Received: 04 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Pradip Kumar Prusty

School of Applied Sciences,
Centurion University of Technology and Management,
Odisha, India.

Email: pradipkumar.prusty@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The specific mitochondrial genes keep important information on the timing extents of evolutionary divergence between genes. Accurate resolutions of evolutionary history depend both on the estimate of the specific gene and recovering the correct piece of genetics. However, the empirical relationship between gene selection and genes is still poor in the order and quality of certain gene estimates. To address this issue, we assessed the accuracy of inferred specific genes in subsets of the mitochondrial genome for mammalian phylogenies with known dependencies using maximum likelihood methods. We estimated specific genes from an 11kb sequence of all 13 protein coding genes and compared them with estimates from single genes (0.218 kb) and from 7 different combinations of genes (235 kb). For each sequence, we separated the component of the likelihood deviation due to branch length differences associated with alternative genetics from that due to those that are independent of the genome. Some of the sequences reconstructed from the same genome gave significantly better estimates than others for the specific genes. The combination of an accurate genome and a much higher gene score suggests that this combination of genes may be useful for assessing phylogenetic relationships to the mammalian divergence at a lower level. Therefore, the correct selection of genes for the sequence is an important factor for a reliable evaluation of evolutionary history based on the molecular data.

Keywords: Genome, phylogenetic, mammalian, molecular

INTRODUCTION

The *Moniliophthora perniciosa* seedling causative agent with cocoa the obroma cocoa tooth fungus firstly divided as basidiomycete as CP(*Crinipellis perniciosa*) & was presently re divided to close relationship with moniliophthoras and ephillipsmoras was a causative factor for cocoa these 2(two) described the 2(two) most deadly cocoa disease





Utkalini Dehury and Pradip Kumar Prusty

over the united states middle perniciosas leads semi-biological lifestyle having a differentiate mycelium at each stage biotrophic mycelium is mononuclear grows very slowly and fills at the inter cellular spaces apoplasts infected plant tissue inside plant although its step was performing in the laboratories a recent study identified conditions and preferred conditions for explant growth mein hard *et al* 2006. the thalamic mycelium is a joint-tightening heteronuclear body sometimes easily grown in sterile cultures because of their economic importance this group participation in complex biological studies on the antibiotic fungus m PG(perniciosoGarcia) *et al* 2007meinhardt *et al* 2006, rincones *et al* 2003, rincones *et al.*, 2006 rincons and other media rio *et al* 2008 scarpari *et al.*, 2005 the genome project was included in we found completed fragments of mg(mitochondrial genomes) except m pernicioso mg (mitochondrial genomes) of 49 fungi were obtained through sequencing fully sequenced and annotated to date this genome has been included in all types of species therefore only five mitochondrial genomes in this study group are important to basidiomycetes mitochondria have generally been considered VEA(vestigialsendosymbiotic ancestors) of proteobacteria gray *et al* other 1999 lang *et al.*, 1999 evolved speed than nuclears dna burger *et al* 2003 burger langs 2003 nosektomaskas 200 3 the reference data with the mitochondrias & core existed on time different mg(mitochondrials genes) encode mm(mitochondrials metabolic) protein were moved some mitochondrial nuclei with all nuclear genomes areport the genome of the fungus mitochondrial material was less than the genome of the plant species less than the animal of the mg(mitochondrial genome) burger *et al*2003 the gene which is part of a typical fungal mg(mitochondrial genome) are significantly reduced compared to other eukaryotic bacteria mg(mitochondrial genomes) about 3040 genes some conservative propertie of them mitochondrial genome is highly content a t no methylation preservation of gene function and larger abundance cam bell *et al* 1999 the genomes of fungi and mitochondria vary widely in size and have different topologies even the used for the genetic codes between perticular gray *et al* 1999 the nos. of genes varies widely starts 3 - 67 of proteins-coding gene& 7-27 of trnas adams palmer 2003 typically hold a set of 14 (fourteen) genes en-coding the hydrophobics subunit on the respiratory chains complex and 2(two) sets of genes of large R the small of ribosomal size range 0154 KB all contributed significant of the magnitude of genomic variability's between species lack of reliable morphological and microstructural properties has caused difficulties in the taxonomic classification of fungi however in recent years the use of data on the mitochondrial sequences of proteins involved in key processes conserved throughout evolution has been widely used to construct phylogenetic trees to characterize the origin and evolution of safe consequently a more than the completed sequence in basidioomicotus may it provides clues of its origins the mitochondrial genome was the evolutionary process of fungal mitochondria plasmids have been found in a variety of fungi griffith 1995 kempken 1995a meinhardt *et al.*, 1990 ,1997) plasmid transition all plasmids with the exception of mitochondria belong to this fungus shepherds 1992 they are 2(two) type of plasmids circular type & linear type of neurosporas there are ring and linear types the absidiaglauca plasmid is circular haenflers *et al.*, 1992 & other example are some linear have functions is very common .Therefore those linear filamentous fungal plasmid were thought to descend from a common ancestor however horizontal movement of linear plasmids was also seen in ascococotakemppen 1995b in most cases there is no function related to these elements but some species have filament mushrooms and activity suppresses the growth of the mycelium Bertrand *et al.*, 1985, 1986 neurospora types inserting dna plasmids to the mitochondrial genome hangs several genes this is the aging and death due to respiratory failure bertrand 2000 griffiths 1992, 1998 rieck *et al.* , 1982 conversely the insertion plasmid of mtdna in the common expected life increases . This is because you are on this host this study was conducted by m noxious we describe its organization content and gene sequence along with comparisons with other mitochondrial genome sequences and phylogenetic analysis.

Phylogenetic Analysis

For a comparison of mg(mitochondrial genome) of m fungi on the genomes of another fungi using the mega 505 nad4l nad5 nad5 and nad5 packages we studied the gene with the acidamino sequence encoding the protein atp6 atp 8 atp9 cob cox 1 cox 2 cox 3 nad 1 nad 2 nad 3 nad 4 and the nad5 package compared with the clustalw sequences of the selected proteins are extract from selected proteins of the fungal mg(mitochondrial genome) stored in the genbank database along with their aligned amino acid sequences





Utkalini Dehury and Pradip Kumar Prusty

Sequencing and Assembling of the Mitochondrial Genome

Genome M. Mycetomatis Sequencing and Assembly Sequencing Roche GS Junior High School 454 Sequencing was sequenced by the guidelines for the manufacturer. In short DNA, it was fragmented thanks to the length of the short film of Anamaga's 600-900 P.N., and then using the EMPCR LIBL amplification kit for the GS Junior Titanium series to enhance the fragment and associated with blue to capture (rugs). In total 5×10 related beads have been applied to GS Junior Titanium Picothi Plate (Roche). As a mitochondrial genome assembly, Roche's Assupler GS de Novo was used. Both ends of the assembled sequence were amplified with primers mmitofw (5'TCATGGCTTAGATGTTGTGG3') and mmitov (5'GAGCTATAGTGGCTCCTAGT3') and rearranged by Sanger sequencing to confirm the circular nature of the mitochondrial genome.

Genome Composition

MG (Mitochondrial Genome) m mycetomatis is a typical rounded dna molecule 45590 bp its size of the MG (Mitochondrial Genome) is smaller than the MG (Mitochondrial Genome) deployed this genome is due to the change in the amount of genes in the total mitochondrial genome m mycetomatis cryptographic structured genes very small 80 genes genome a large and small rRNA subunit and a small rRNA subunit and a small rna subunit and a small rRNA subunit that code up two subjects of the respiratory chain of composite 2 2 encode the two subunits of the two five-hour hippiesaceous sis subunits including the subject and ribosomal protein rps3 of at synthetic enzymes are located in two rooms in the mitochondrial genome but also all genes and tris is in mitochondria a chain found in a genomic plus chain mit other acyl scot mitochondrial mitochondria genome m mycetomatis has a slightly higher content of at rich with a complete content of only 268 areas of gc encoding rna genes which has a slightly higher content of gc at 288 which is a value obtained for mitochondria of other fungus .

All genes are located in the metatarsals, shown in the outer ring of a circle, and transcribed counter clock wise. The following genes are found in the metatarsal bones and 11 genes encoding subunits of the respiratory chain complex (cob, cox1, cox2, cox3, nad1, nad2, nad3, nad4, nad4L, nad5 and nad6), 2 of ATP Dog subunit synthetase. (atp6 and atp8), five hypothetical proteins (x1, x2, x3, x4 and x5) and six intronic proteins (including the ribosomal protein rps3). Introns are indicated by blue boxes in the middle ring below the gene in which they are located. Intron proteins are indicated by pink boxes in the inner ring below the intron and are the genes in which the intron is located.

That Genes Sequence, Gene Bank Accessions number, & location which is simple use in study. After collection process, the tissue sample are stored in below 70% indentured ethanols or frozend@ 80 °C. Genomics Deoxyribonucleic Acid (DNA) is extract using the D-Neasy Tissues Kits .Zhong et al. The mitochondrial genome was then amplified. [24]. The present of PC R product was confirm 1% agarose gel & purify using QIAquick PCR Purifications or QIAquick Gel Extractions. If need, PCR product is sized of an agarose gel .

Genomic Assembly and Gene Identification

Edit and align sequence used for DLS (Dnastar Laser gene Seqman) and megalin programs 25 (Twenty five) proteins code of gene & Ribosomal RNA gene is introduced by using blasts of 26 (Twenty Six) all tRNA genes identified by the tRNA scan-se address of web as 27 with preference and source mitochondroplast or using the potential-based hand its possible secondary structure and anti codon sequence. The data set contains all mitochondrial and nuclear data. The varieties based on HTTP are 17 available cyclic mitochondrial genomes. It is used for extensive grid development analysis. About 50 alignment tables have been used in addition to Neptys SP Pectinia Galdi. Paralvinella Sulfoclola & Auchenoplax Crinita Crinita, we have been interested in the relationship between Trebelliformiaia, so I removed the mitochondrial data of Catarina and Terbratalia Brachiya, and all other rings were used as classifiers. Data sets for nucleotides and amino acids were generated for mitochondria. Philosophy Analysis Includes all genes that contain all genes that contain all genes that encrypt proteins, excepts for ATP -6, ATP-8, & NAD -6 genes.





Utkalini Dehury and Pradip Kumar Prusty

High variable & two (two) RRNA MLSUs & MSSU pier X -28 preferences were used to align the RRNA GBLOCKS 091B 29 gene, and in these areas, the RRNA gene is repeatedly sorted in the RRNA gene and three prostate rich genes. The position was confirmed. For family level analysis, Macclade408 30 and SEA1 V20a11 A 31 were used except for the RRNA gene containing the nucleotide and amino acid sets, and 31 were generated from the aligned nucleotide data except for the RRNA gene .RRK data. Therefore, the data matrix binding was constructed because the mitochondrial data for more than 17 s 28s and the EF1 sequence was added to use Gene Bank data for more than 17, and collected data of two different laboratory conditions. In some cases, the combined data sets were included as shown above to add core data to add the upcoming data related types, and the combined data sets included 11 813 nucleotides and 33 3 1 amino acid positions. Amino acid set. The data set is enabled only for protection. We also wrote a nuclear position kit that produced a nuclear position kit containing 18 -S 28 -s & EF1 sequence only of nucleotide levels of the nucleotide level for the 17th Texanuclear level. data set contained 5526 nucleotide positions analysis of the nuclear ribosomal genetic data .

Phylogenetic Analyses

The highest probability (ML) & Bayesian conclusion (B I) approach was used of mitochondria nuclei & combine of data sets. The total nucleotide data sets of 17- TAXA MLs are analyzed with PAUP4.0B10 [32] of the model GTR + γ + I model defined of the model V3.7 basically on the ACKIKE informations criteria (AIC) [33, 34] .You have started a heuristic search by adding Ranky Taxon (10 replicas) using timber replacement. All model parameters have used fixed values defined in Modeltest V3.7. Bootstrap Analysis Analysis The TAXA has been added using the Boretic Search used by 1000 repeats using Heuristic Search. The analysis of the separated ML was performed as Raxml 7.2.8 [35] using the GTR + γ + I model for each gene and 200 boot strap replication, and follows the best tree retrieval.

Split BI induces non depended substitution patterns for one gene in Mr-Bayes version 3-1-2 [36] & 4 circuits (3 heating and 1 for 5 x 106 (mitochondria & nuclears)/ 2 x 106 (combination) generation, .) Trees are harvested each 100 generations. GTR + γ + I model was selected from the AIC from the detection of sysspective traps in 3/4/22, 21:42, MR Modeltest[37, 38]. SpringerLink <https://link.springer.com/article/10.1186/147121481136/147121481136/14712148113694/2718S> 및 28S RDNA, EF1 α , COX1, COX2, COB, NAD1, NAD3 , NAD4, GTR + I 12 And 16S RDNA, NAD2, NAD4L and NAD5 COX3 and HKY + γ models for GTR + γ . Probability The fusion tree length of the result of L.N identifies the convergence tree length (Burnin = 100 Trees) to identify the convergence tree length (Burnin = 100 Trees) with a tracker V1.4.1 [39]. The store consensus tree, including the rear probability (PP), is determined in the rest of the tree.

Another File-2 keeps a analysis and outputs as result for data sets with 17 injectors more . We see in set of Amino Acid (mitochondria & data combined & 17- types), unwanted & separate ML and B-I partition analysis are performed. To analyze M-L, the selections of the model was output in RAXML 7.2.8 [35], & MTZOA + γ + I + F is selected as battery of the data set. The Unit gene, the MTZOA + γ + i model was choiced for COX-1, COX-2 (optional + F), COX -3, COB & DAYHOFF + NAD-2, NAD-3, NAD-4, NAD-4L, NAD-5 and EF1 α for dayhoff + γ + I for NAD5 and EF1 α . The maximum search of the truth is used using 200 boot straps using Raxml [35], which has been implemented using 200 boot straps, and analyzes lack of lack and analyzes ML separation. To isolate the BI of the amino acid data set, the model's mixed amino acid model is individually specified individually and not displayed .

Non-Stationary Sequence Evolution

For analyzing data in non-stationary sequence evolution We used 2 steps 2.0 [40] to ensure the use of various composite along in vectors the trees branches. Inn fixed bays by Mr Bayes, have been broken tests for a nucleotide data set for a nucleotide data set with 17 taxa, such as mitochondria and fission (Phase 2.0, unable to use parameters of proportional separation in Phase 2.0 Except for). We have been analyzed based on 3(three), 6(six) or 9(nine) complex vector. For one each number of composite vector, have worked four independent execution in parallel with one cold chain (ie, 3, 11, 88 and 1000), respectively. During the 12 * 106th generation, each RAN





Utkalini Dehury and Pradip Kumar Prusty

mileage and trees have been selected for each 1000-generation. The initial 2 x 10⁶ generation is discarded survivors because the convergences on the estimate & the length of tree is specified on Tracer v1.4.1 [39].

Topology Testing

A Class Au accelerated test topology [41 & 42] used to keep the fixed of the alter one hypothesis for understanding of the data set and more understanding of the discrepancy. More specifically, according to ML standard, AU test is 17 TAXA housing (ie, 18-S, 28-S, MTDNA, 18-S / 28-S, 18-S / 18-S / EF1 α , 18-S / MTDNA, 28-S / EF1 α , 28-s / mtdna, EF1 α / MTDNA, 18-S / 28-S / EF1 α , 18-S / 28-S / MTDNA, 18-S / EF1 α / MTDNA, 28-S / EF1 α / MTDNA and 18S / 28S / EF1 α / MTDNA). Based on the earlier results, the below mentioned hypotheses is TRICHOBRANCHIDAE (Triter) as a Terebellidae (TriAA), 2) Terebellidae (Triter), 3) Trichobranchidae (Trichobranchidae) such as the sister of Alvinellidae / ampharetidae. PAUP's analysis is limited to get the best trees, and I got Connurueamia with a specific hypothesis. The analytical settings are cited above.

Spectral Analyzes

That the use of Spectral Analyzes for understand the balanced of certain sides (/ split), and are useful when symbolic traps were detected. [17]. The range divides OTUs into 2(two) groups. In spectrum analysis context, decide other groups of other groups and other groups that we are interested in using the assignment (here to distinguish the use of terminology (using common systematic use here to distinguish between spectrum analysis) . For example, Trichobranchidae, Alvinellidae, and Ampharetidae will be a proper triangle hypothesis, including beautiful, inhority, forbellidae, such as Terebellidae, and all other things. To calculate and visualize Bipartity support, [SAMS, [17], and Microsoft Excel methods, [17], and Microsoft Excel have used a set of 17 years old to Mitochondrial, Nuclear, and Combined Data Set. SAMS was a Split tools of decomposition, which is not required hadamard junction.

As a result, it is not necessary to keep the entire separate place. SAM differentiate impact two two categories / groups. 1) Both group/categories s shows only each status of character, but it different/ change. 2) A noisy OUTGROUP (ie, while the majority of the group may be determined, but during a state only proving only in one state only); 3) Noisy Ingroup and Outgroup [17]. We only learned two results related to these relationships because we are interested in two bilateral relationships in relation to the relationship of Trebelliformia. Perl scripts that receive these Bipartisan data are available in TH upon request.

CONCLUSION

The obtain data of the discovery the simple siomorphic trap in data of molecular of either few examples, which is known to date in contrast itochondrial data to nuclear information place Trichobrachiae as sisters of cerebellae. Nuclear data place Trichobranchidae as sisters of ampharetidae and alvinellidae, while the last2(two)taxa strong exhibiting constitutive aberrations in md(mitochondrial data), as indicated with analysis and skew & receive values. However, due to the misplacement of this Trichobrachiae, this taxon does not show an obvious compositional bias and, unfortunately, uses different proportions. data set to perform ml analysis and break tests to perform ml analysis and break tests use of multiple overhead classes variations in a variety of composite vectors for implementing a variable vector for implementing a remuneration and removable models influence of influence i could not improve simpanophic trap of mitochondrial data therefore a more complex replacement model must be designed to properly resolve the unique reconstruction of the issue tree in the center using a separate and thorough analysis to high node support you can detect traps from molecular data and realize molecular data in molecular data considering the appearance of upcoming next sequence of generation technology here we have to hope that the same analysis is better to choose artifacts due to having systematic error so it will use such a problem as a result this approach can allow for a deeper understanding of signal source and noise by increasing the strength and confidence in the scenic research results.





Utkalini Dehury and Pradip Kumar Prusty

REFERENCES

1. Ahmed A, Adelmann D, Fahal A, Verbrugh H, van Belkum A, et al. Environmental occurrence of *Madurellamyces*, the major agent of human eumycetoma in Sudan. *J Clin Microbiol.* 2002;40:1031–1036
2. Ahmed A, van de Sande W, Verbrugh H, Fahal A, van Belkum A. *Madurellamyces* strains from mycetoma lesions in Sudanese patients are clonal. *J Clin Microbiol.* 2003;41:4537–4541.
3. Ahmed AO, Mukhtar MM, Kools-Sijmons M, Fahal AH, de Hoog S, et al. Development of a species-specific PCR-restriction fragment length polymorphism analysis procedure for identification of *Madurellamyces*. *J Clin Microbiol.* 1999;37:3175–3178.
4. Ahmed AO, van de Sande WWJ, van Vianen W, van Belkum A, Fahal AH, et al. In vitro susceptibilities of *Madurellamyces* to itraconazole and amphotericin B assessed by a modified NCCLS method and a viability-based 2,3-Bis(2-methoxy-4-nitro-5-sulfophenyl)-5-[(phenylamino)carbonyl]-2H-tetrazolium hydroxide (XTT) assay. *Antimicrob Agents Chemother.* 2004;48:2742–2746
5. Ahmed AO, van Leeuwen W, Fahal A, van de Sande WWJ, Verbrugh H, et al. Mycetoma caused by *Madurellamyces*: a neglected infectious burden. *Lancet Infect Dis.* 2004;4:566–574.
6. Ahmed AO, van Vianen W, ten Kate MT, van de Sande WW, van Belkum A, et al. A murine model of *Madurellamyces* eumycetoma. *FEMS Immunol Med Microbiol.* 2003;37:29–36.
7. Ballard JW, Whitlock MC. The incomplete natural history of mitochondria. *Mol Ecol.* 2004;13:729–744
8. Basse CW. Mitochondrial inheritance in fungi. *Curr Opin Microbiol.* 2010;13:712–719.
9. Bullerwell CE, Lang BF. Fungal evolution: the case of the vanishing mitochondrion. *Curr Opin Microbiol.* 2005;8:362–369
10. Cardoso MA, Tambor JH, Nobrega FG. The mitochondrial genome from the thermal dimorphic fungus *Paracoccidioides brasiliensis*. *Yeast.* 2007;24:607–616.
11. Collins RA, Lambowitz AM. Structural variations and optional introns in the mitochondrial DNAs of *Neurospora* strains isolated from nature. *Plasmid.* 1983;9:53–70.
12. Cummings DJ, MacNeil IA, Domenico J, Matsuura ET. Excision-amplification of mitochondrial DNA during senescence in *Podospora anserina*. DNA sequence analysis of three unique "plasmids". *J Mol Biol.* 1985;185:659–680.
13. Cummings DJ, McNally KL, Domenico JM, Matsuura ET. The complete DNA sequence of the mitochondrial genome of *Podospora anserina*. *Curr Genet.* 1990;17:375–402.
14. Hoog GS, Adelmann D, Ahmed AO, van Belkum A. Phylogeny and typification of *Madurellamyces*, with a comparison of other agents of eumycetoma. *Mycoses.* 2004;47:121–130.
15. Hoog GS, van Diepeningen AD, Mahgoub el S, van de Sande WW. New species of *Madurella*, causative agents of black-grain mycetoma. *J Clin Microbiol.* 2012;50:988–994
16. Edgell DR, Chalamcharla VR, Belfort M. Learning to live together: mutualism between self-splicing introns and their hosts. *BMC Biol.* 2011;9:22.
17. Foury F, Roganti T, Lecrenier N, Purnelle B. The complete sequence of the mitochondrial genome of *Saccharomyces cerevisiae*. *FEBS Lett.* 1998;440:325–331.
18. Gautheret D, Lambert A. Direct RNA motif definition and identification from multiple sequence alignments using secondary structure profiles. *J Mol Biol.* 2001;313:1003–1011.
19. Kleidon J, Plesofsky N, Brambl R. Transcripts and transcript-binding proteins in mitochondria of *Neurospora crassa*. *Mitochondrion.* 2003;2:345–360.
20. Kouvelis VN, Ghikas DV, Typas MA. The analysis of the complete mitochondrial genome of *Lecanicillium muscarium* (synonym *Verticillium lecanii*) suggests a minimum common gene organization in mtDNAs of Sordariomycetes: phylogenetic implications. *Fungal Genet Biol.* 2004;41:930–940.
21. Kubelik AR, Kennell JC, Akins RA, Lambowitz AM. Identification of *Neurospora* mitochondrial promoters and analysis of synthesis of the mitochondrial small rRNA in wild-type and the promoter mutant [poky]. *J Biol Chem.* 1990;265:4515–4526.



**Utkalini Dehury and Pradip Kumar Prusty**

22. Laslett D, Canback B. ARAGORN, a program to detect tRNA genes and tmRNA genes in nucleotide sequences. *Nucleic Acids Res.* 2004;32:11–16.
23. Laslett D, Canback B. ARWEN: a program to detect tRNA genes in metazoan mitochondrial nucleotide sequences. *Bioinformatics.* 2008;24:172–175.
24. Lowe TM, Eddy SR. tRNAscan-SE: a program for improved detection of transfer RNA genes in genomic sequence. *Nucleic Acids Res.* 1997;25:955–964.
25. Michel F, Westhof E. Modelling of the three-dimensional architecture of group I catalytic introns based on comparative sequence analysis. *J Mol Biol.* 1990;216:585–610
26. Nowrousian M, Stajich JE, Chu M, Engh I, Espagne E, et al. De novo assembly of a 40 Mb eukaryotic genome from short sequence reads: *Sordariamacrospora*, a model organism for fungal morphogenesis. *PLoS Genet.* 2010;6:e1000891.
27. Paoletti M, Saube SJ. The genome sequence of *Podosporaanserina*, a classic model fungus. *Genome Biol.* 2008;9:223.
28. Sethuraman J, Majer A, Friedrich NC, Edgell DR, Hausner G. Genes within genes: multiple LAGLIDADG homing endonucleases target the ribosomal protein S3 gene encoded within an rnl group I intron of *Ophiostoma* and related taxa. *MolBiolEvol.* 2009;26:2299–2315
29. Silliker ME, Cummings DJ. Genetic and molecular analysis of a long-lived strain of *Podosporaanserina*. *Genetics.* 1990;125:775–781.
30. Tamura K, Peterson N, Stecher G, Nei M, et al. MEGA5: Molecular Evolutionary Genetics Analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. *MolBiolEvol.* 2011;28:2731– 2739
31. Taylor JW, Smolich BD. Molecular cloning and physical mapping of the *Neurospora crassa* 74-OR23-1A mitochondrial genome. *Curr Genet.* 1985;9:597–603
32. Torriani SF, Goodwin SB, Kema GH, Pangilinan JL, McDonald BA. Intraspecific comparison and annotation of two complete mitochondrial genome sequences from the plant pathogenic fungus *Mycosphaerella graminicola*. *Fungal Genet Biol.* 2008;45:628–637.
33. van de Sande WWJ, Fahal AH, de Hoog GS, Van Belkum A. *Madurella*. In: Liu D, editor. *Molecular detection of human fungal pathogens*. Boca Raton: CRC Press, Taylor & Francis Group; 2011. pp. 117–128.
34. van de Sande WWJ, Luijendijk A, Ahmed AO, Bakker-Woudenberg IA, van Belkum A. Testing of the in vitro susceptibilities of *Madurella mycetomatis* to six antifungal agents by using the sensititre system in comparison with a viability-based 2,3-bis(2-methoxy-4-nitro-5-sulfophenyl)-5- [(phenylamino)carbonyl]-2H-tetrazolium hydroxide (XTT) assay and a modified NCCLS method. *Antimicrob Agents Chemother.* 2005;49:1364–1368.
35. vanDiepeningen AD, Goedbloed DJ, Slakhorst SM, Koopmanschap AB, Maas MF, et al. Mitochondrial recombination increases with age in *Podosporaanserina*. *Mech Ageing Dev.* 2010;131:315–322.
36. Woo PC, Zhen H, Cai JJ, Yu J, Lau SK, et al. The mitochondrial genome of the thermal dimorphic fungus *Penicillium marneffeii* is more closely related to those of molds than yeasts. *FEBS Lett.* 2003;555:469–477
37. Wu Y, Yang J, Yang F, Liu T, Leng W, et al. Recent dermatophyte divergence revealed by comparative and phylogenetic analysis of mitochondrial genomes. *BMC Genomics.* 2009;10:238.
38. Zhang N, Castlebury LA, Miller AN, Huhndorf SM, Schoch CL, et al. An overview of the systematics of the *Sordariomycetes* based on a four-gene phylogeny. *Mycologia.* 2006;98:1076–1087.





Effectiveness of Phytoremediation Technique in Environmental Sustainability: A Review

Srotaswini Parida, B Jyotirmayee and Gyanranjan Mahalik*

Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Gyanranjan Mahalik

Department of Botany, School of Applied Sciences,
Centurion University of Technology and Management,
Bhubaneswar, Odisha, India.

Email: gyanranjan.mahalik@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Phytoremediation is a part of bioremediation in which soil and groundwater can be clean up from contamination. Plants are used to extract and eliminate contaminants from the plant or reduce its bioavailability in the soil. The plants absorb ionic compounds on the ground even at low concentrations through the root system. The plants extend their root systems to the ground matrix and the rhizosphere ecosystem, accumulate heavy metals, adjust their bioavailability, regenerate contaminated soils, and stabilize soil fertility. Phytoremediation is helpful because it generates less secondary waste and has less impact on the environment. All plants collect necessary nutrients from soil and water environments, including metals. Some hyper accumulator plants store many metals; some of them are not required for plant function. Plants also accumulate various organic chemicals and use them in their physiological processes or degrade them. Disposal may not be necessary if the organic contaminants are degraded into harmless compounds. Some plants are there accumulate pollutants at toxic waste sites. Mustard plants, alpine pennycress, hemp, and pigweed are used in Phytoremediation. To treat environmental problems, some plants and algae are helpful. Hyperaccumulation of metal, including protection, mutualism, commensalism, biofilm, and interferences with different species of neighbour plants, may be affected.

Keywords: Phytoremediation, Heavy Metals, Soil Fertility, Hyperaccumulator, Toxic

INTRODUCTION

Environmental pollution generated the need to search for new environmentally friendly, low-cost, and more efficient ecological clean-up techniques for its removal or reduction of contaminants. Bioremediation, a branch of environmental biotechnology, is considered one of the most promising alternatives nowadays. This technology uses the fantastic ability of microorganisms or plants to accumulate, detoxify, degrade, or remove environmental

42610



**Srotaswini Parida et al.**

contaminants. Bioremediation provides the transformation or even removal of organic and inorganic pollutants, even when they are present at low concentrations. Continuous efforts are still made to understand how microorganisms and plants remove or transform environmental pollutants. Thus, this particular issue was to explore different visions on bioremediation while addressing recent advances and new ideas from the perspective of efficient process scale-up given application at larger scales(1). Bioremediation occurs naturally, without any chemical catalysts when biological agents come into contact with the contaminants. However, creating the ideal environmental conditions is necessary to facilitate and expedite the bioremediation process (2). The requirements include the right temperature, pressure, pH, and moisture. We can consider three types of bioremediation, i.e.,

Bacterio remediation: In microbial bioremediation, the microbes secrete enzymes to break the contaminants into smaller pieces, which they consume. They release water, carbon dioxide, and amino acids as a byproduct of digestion. These are then removed.

Mycoremediation: Mycoremediation works similarly to bacterioremediation. The digestive enzymes secreted by fungi break down the contaminants such as pesticides, hydrocarbons, and heavy metals.

Phytoremediation: In Phytoremediation, natural chemicals present in plants react with the contaminants. They either neutralize or bind with them to form harmless substances(2).

Absorption of Heavy Metals in Phytoremediation

The accumulation of heavy metals on the ground has increased rapidly for various natural processes and artificial activities (industrial). Since heavy metals are biodegradable, they can last in the environment and enter the food chain through cultivated plants. They can therefore be bio-amplified and accumulate in the human body. Due to its toxic properties, the substantial contamination of metals has brought severe threats to human health and ecosystems. As a result, the restoration of land contamination is the most important. Phytoremediation is a user-friendly approach to the environment that can be a successful attenuation to prepare a soil cost-effectively contaminated with heavy metals(3). Heavy metals are non-degradable by any biological or physical process and are persistent in the soil for a long time, posing a long-term threat to the environment. According to their role in biological systems, heavy metals can be grouped as essential and non-essential. Crucial heavy metals such as Cu, Fe, Mn, Ni, and Zn are required for physiological and biochemical processes during the plant life cycle; however, they may become toxic when present in excess. Non-essential heavy metals like Pb, Cd, As, and Hg are highly contaminated with no known function in plants and may cause environmental pollution and severely affect various physiological and biochemical processes in crop plants and reduce agricultural productivity. They can enter the food chain through crops and accumulate in the human body through biomagnification, thus posing a significant threat to human health. Hence, it is necessary to take remediation measures to prevent heavy metals from entering terrestrial, atmospheric, and aquatic environments and mitigate the contaminated land (3, 4).

Process of Heavy Metal Uptake

Some researchers explore the absorption of contaminants by plants and their mechanisms. It can be used to optimize the factors to improve the performance of plant absorption, according to Sinha et al. The plant acts as both "accumulator" and "exclusion". The accumulator lives despite the concentration of contaminants in the air tissue (16). Biodegradable pollutants limit biological exclusion in inert forms in their tissues and determine the capture of contaminants in that biomass. Plants have evolved a precise and efficient mechanism to obtain micronutrients essential from the environment, even if they are present at low PPM levels. The roots of the pharmaceutical drugs produced by pH changes induced by the reaction of plants and redox are crushed or almost insoluble precipitate and also solubilizing deficient levels of micronutrients, and it can be ingested. Plants also evolved a precise mechanism for transcription and preserved micronutrients (5). These exact mechanisms also capture, translocate, and store toxic elements simulating these chemical properties. Thus, a trace nutrient collection mechanism is exciting to adapt to the meters. The range of known transport mechanisms or particular proteins integrated with plasma cell membranes



**Srotaswini Parida et al.**

involved in the absorption of ions and translocation is the proton pump ("energy consumption and produces an electrochemical gradient") ion species when absorbing heavy metal contaminants. After being caught by roots, BUD translocation is desirable because the efficiency of root biomass is generally impossible. Most of the root metal ion method is barely known. The mechanism of translocation of the importation of import can be closely regulated.

Plants generally do not accumulate trace elements beyond short-term metabolic needs, and these requests change from 10 to 15 ppm from most traces. The exception is the "storage type" plant, which can account for toxic metal ions with 1000 PPMs (17). Another problem is a method that is the method of avoiding plants, and these plants, especially hyper-member plants. Multiple mechanisms are included. Cell storage seems to be necessary. Water that evaporates the plant's leaves acts as a pump to absorb nutrients and other soil substances at the root of the nutrient. This process, called evapotranspiration, is responsible for moving pollution in the development of the plant. Contamination is eliminated by leaving the soil of origin without being contaminated because the contamination is aligned with the roots. Some plants used in the strategy are called "treatment chambers". These plants ride the root of one more than 1 to reach metal concentration ratios. Untreated plants generally have a significant root generating a 1 (18) percentage. Ideally, ultrasound should be prosperous in a toxic environment requiring minor maintenance and the need to produce high biomass, but these requirements are fully compliant. The species of metal accumulated plants concentrate heavy metals, such as Cd, Zn, Co, Mn, Ni, Pb and heavy metal of 1000 times adopted by non-accumulated plants (exclusive). It can be done. In most cases, bacterial microorganisms and fungi living in rivers closely related to plants also help mobilize metallic ions and increase bioavailable proportions. Its roles in eliminating organic contaminants are more critical than in the case of inorganic compounds (4, 15). In phytoremediation technologies, the plant uptakes heavy metal using these phytoextraction mechanisms, phytostabilization, rhizofiltration, and phytovolatilization, as shown in Figure 1.

Phytostabilization: The use of metal-tolerant plant species to immobilize heavy metals belowground and decrease their bioavailability, thereby preventing their migration into the ecosystem and reducing the likelihood of metals entering the food chain. Phytostabilization can occur through precipitation of heavy metals or reduction in metal valence in the rhizosphere, absorption and sequestration within root tissues, or adsorption onto root cell walls. Plant growth facilitates the preservation of soil health in heavy metal-polluted areas. The established vegetation cover can stabilize heavy metals underground, minimize their leaching to groundwater, and prevent the dispersion of heavy metal-containing soil particles by wind (9). One of the advantages of phytostabilization is that disposal of hazardous biomass is not required compared with phytoextraction. The selection of appropriate plant species is crucial for phytostabilization. To fulfil the requirement of highly effective phytostabilization, plants should be tolerant to heavy metal conditions. Plant roots play a pivotal role in immobilizing heavy metals, stabilizing soil structure, and preventing soil erosion, so plants should have dense rooting systems. Plants should be able to produce a large amount of biomass and grow fast to timely establish a vegetation cover in a specific site. In addition, the plant cover should be easy to maintain under field conditions (12). Many plant species, which meet the above requirements, have been identified and used to stabilize heavy metal-polluted soils (19).

Phytostimulation: is how soil microbial activity improve to decompose organic pollutants by organisms associated with roots. This process is performed in the soil layer surrounding the roots, i.e., the rhizosphere. Plant release carbohydrates and acids that stimulate microorganisms' activity, leading to the biodegradation of organic contaminants. This means that the organisms can digest and decompose toxic substances in a harmless form (10).

Rhizofiltration: It is a form of Phytoremediation that involves filtering contaminated groundwater, surface water and wastewater through a mass of roots to remove toxic substances or excess nutrients. Plants absorb contaminants or toxins through their root system, store them into the root biomass, and transport them into the stem and leaves. Plants continue to absorb impurities until harvest. After that, the growth/harvest cycle is continued until the plant is replaced to achieve satisfactory levels of contaminants. This method is intended to concentrate heavy metals as organic contaminants and residues. The process of rhizofiltration is basically for the treatment in the aquatic environment (19).



**Srotaswini Parida et al.**

Phytoextraction: It is the process in which we use plants to remove the contaminated matrix (soil and water) by the absorption of plants. Phytoextraction is mainly used to recover heavy soil metals, which are currently applicable to other materials in the medium. In the phytoextraction process, plant roots can take up metal contaminants. The absorbed metal is stored or accumulated in the plants' aerial portion. This is known as hyperaccumulation. These plant species are highly tolerant of heavy metals and drink a large amount of metal (11).

Phytodegradation: takes place inside the plant or within the plant's rhizosphere. This process allows more compounds and classes to be removed from the environment, including solvents in groundwater, petroleum and aromatic compounds in soils and volatile compounds in the air. In this process, the contaminants break down and take up by plants through metabolic processes within the plant through the enzyme effect. The enzymes present in plant roots break down organic pollutants. Then it incorporates into new plant material (13).

Phytovolatilization: In this process, plants uptake and transpire the contaminants and release the modified form of the impurities to the atmosphere with low concentration. The plant protects the soil's surface, prevents erosion, reduces rain's impact, and stabilizes the ground with its root system. The plant roots release nutrients, which are sustainable for the rhizosphere's microbial community. The population of microbes is more in the rhizosphere than in the soil where the root is not present. It is because of the symbiotic relationship between the plant and microorganisms. This symbiotic relationship can help in the bioremediation process (14).

The Factors Affect Uptake Mechanism

There are so many factors that affect heavy metals' uptake mechanism. In this figure, some factors affect the uptake performance in plants.

The Plant Species: The uptake of heavy metals is affected by plant species depending upon the plants suitable for a hyper accumulation of heavy metals. A large amount of biomass is produced using crop production and management practices.

Properties of Medium: Medium has great importance in this process. Fertilizers, Chelators addition and adjustment of pH enhance the phytoremediation process.

The Root Zone: Through the root zone, absorption of contaminants occurs. When the impurities are degraded in the soil, they can be uptake by the root. The adaptation to drought stresses the root diameter increases and reduces root elongation.

Vegetative Uptake: Nutrient intake is affected by environmental conditions. Temperature affects growth material and, therefore, root length. The root structure in open field conditions differs from that in greenhouse conditions. The success of Phytoremediation, and more specifically Phytoremediation, depends on the pollutant-specific hyper accumulator. Metal uptake by plants depends on the bioavailability of the metal in the water phase, which in turn depends on the retention time of the metal and the interaction with other elements and substances in the water.

Addition of Chelating agent: An increase in heavy metal trapping of heavy metals by energy crops is a heavy metal bioavailability by adding biodegradable physicochemical factors such as chelating agents and trace nutrients and stimulating the collection of final products of heavy metals. The use of Chelating synthetic agents may affect the plant's communities.

Advantages of Phytoremediation: The edge of this technology is reducing contaminants and protecting the environment as a whole. Figure 3 simplifies the specific benefits of Phytoremediation technology.

These are the heavy metal adsorption techniques and effects that reduce the concentration of heavy metal ions at deficient levels and reduce expensive absorbent use. It is also helpful in treating a wide range of toxic and



**Srotaswini Parida et al.**

radionuclides and various environmental pollutants, including organic and inorganic contaminants. The other advantage of Phytoremediation is the generation of plant reduce recycling. It is cost-effective and doesn't require much equipment. Planting trees in remediation sites can make these sites contamination-free (6, 7, 8).

CONCLUSION

Heavy metals pollution is an issue for agricultural production and food health. Therefore, improving the plant's performance is critical to developing very effective Phytoremediation. Fortunately, the genetic engineering approach has emerged as a powerful tool to change high-growth plants, high biomass production, high resistance to heavy metal and accumulation. Therefore, a good understanding of the mechanism of heavy metal absorption, translocation and detoxification of heavy metals, and the identification and characterization of different molecules and signal transduction routes are ideal for the sanitation of the FTI through genetic engineering. It will be essential for the design of plant species. The gene involved in the absorption of heavy metals, translocation, isolation and strength can be exploited to improve the accumulation or resistance of heavy metals in plants. In addition, chelating agents and microorganisms can increase heavy metal bioavailability, which promotes the collection of heavy metals in plants or improves soil health and further promotes the growth and shape of the floor. It is impossible to clean rich soils efficiently, or a good approach is not possible. A combination of different techniques, including genetic engineering, microorganisms and chelates, is essential for very efficient and thorough retrieval in the future. Heavy metal contamination is vital for agricultural production and food health due to the rapid accumulation of environmental toxicity. Several technologies have been developed to prevent or reduce heavy metal contamination and contaminated soil recurrence.

Phytoremediation shows some advantages over other physicochemical technologies. The absorption of heavy metals by plants using phytoremediation technology seems the best way to manage a contaminated environment. It has advantages over other prior art through typical applications. Heavy metal contamination is essential for agricultural production and food health due to the rapid accumulation of environmental toxicity. Several technologies have been developed to prevent or reduce heavy metal contamination and contaminated soil recurrence. Phytoremediation shows some advantages over other physicochemical technologies. The most critical factor is suitable to plant species that can uptake contaminants. Even if it is the best option, some restrictions are there. To optimize this technology, research should be done to minimize these limitations to optimize this technology. Various technologies have been developed to purify contaminated soils to prevent or reduce the contamination of heavy metals. It is a promising technique for the recurrence of rich soils contaminated with metals with good public acceptability, showing various advantages over other physicochemical methods. Phytoremediation can remove pollutants from the environment in a number of ways. The roots of some plants can absorb pollutants from the ground and reassemble the atoms into compounds that are either harmless to the environment as well as it fulfills the SDG goal of climate change.

REFERENCES

1. Arshad, M., Saleem, M., and Hussain, S. (2007). Perspectives of bacterial ACC deaminase in Phytoremediation. *Trends Biotechnol.* 25, 356–362.
2. Ashraf, S., Ali, Q., Zahir, Z. A., Ashraf, S., and Asghar, H. N. (2019). Phytoremediation: environmentally sustainable way for the reclamation of heavy metal polluted soils. *Ecotox. Environ. Safe.* 174, 714–727.
3. Assunção, A., Martins, P. D. C., De Folter, S., Vooijs, R., Schat, H., and Aarts, M. (2001). Elevated expression of metal transporter genes in three accessions of the metal hyperaccumulator *Thlaspi caerulescens*. *Plant Cell Environ.* 24, 217–226.
4. Axelsen, K. B., and Palmgren, M. G. (2001). Inventory of the superfamily of P-type ion pumps in *Arabidopsis*. *Plant Physiol.* 126, 696–706.



**Srotaswini Parida et al.**

5. Baker, A., and Brooks, R. (1989). Terrestrial higher plants that hyperaccumulate metallic elements. A review of their distribution, ecology and phytochemistry. *Biorecovery* 1, 81–126.
6. Bani, A., Pavlova, D., Echevarria, G., Mullaj, A., Reeves, R. D., Morel, J. L., et al. (2010). Nickel hyperaccumulation by the species of *Alyssum* and *Thlaspi* (Brassicaceae) from the ultramafic soils of the Balkans. *Bot. Serb.* 34, 3–14.
7. Banuelos, G., Cardon, G., Mackey, B., Ben-Asher, J., Wu, L., Beuselinck, P., et al. (1993). Boron and selenium removal in boron-laden soils by four sprinklers irrigated plant species. *J. Environ. Qual.* 22, 786–792. DOI: 10.2134/jeq1993.00472425002200040021x
8. Banuelos, G., and Meek, D. (1990). Accumulation of selenium in plants grown on selenium-treated soil. *J. Environ. Qual.* 19, 772–777.
9. Bastow, E. L., Garcia De La Torre, V. S., Maclean, A. E., Green, R. T., Merlot, S., Thomine, S., et al. (2018). Vacuolar iron stores gated by NRAMP3 and NRAMP4 are the primary source of iron in germinating seeds. *Plant Physiol.* 177, 1267–1276.
10. Becerra-Castro, C., Prieto-Fernández, Á, Álvarez-López, V., Monterroso, C., Cabello-Conejo, M., Acea, M., et al. (2011). Nickel solubilizing capacity and characterization of rhizobacteria isolated from hyperaccumulating and non-hyperaccumulating subspecies of *Alyssum serpyllifolium*. *Int. J. Phytoremediation.* 13, 229–244.
11. Berken, A., Mulholland, M. M., Leduc, D. L., and Terry, N. (2002). Genetic engineering of plants to enhance selenium Phytoremediation. *Crit. Rev. Plant Sci.* 21, 567–582.
12. Berti, W. R., and Cunningham, S. D. (2000). "Phytostabilization of metals," in *Phytoremediation of Toxic Metals: Using Plants to Clean-up the Environment*, eds I. Raskin and B. D. Ensley (New York, NY: John Wiley & Sons, Inc.), 71–88.
13. Bizily, S. P., Rugh, C. L., and Meagher, R. B. (2000). Phytodetoxification of hazardous organomercurials by genetically engineered plants. *Nat. Biotechnol.* 18, 213–217.
14. Blaylock, M., and Huang, J. (2000). "Phytoextraction of metals," in *Phytoremediation of Toxic Metals: Using Plants to Clean-up the Environment*, eds I. Raskin and B. D. Ensley (New York, NY: John Wiley & Sons, Inc), 303.
15. Braud, A., Jézéquel, K., Bazot, S., and Lebeau, T. (2009). Enhanced phytoextraction of an agricultural Cr- and Pb-contaminated soil by bioaugmentation with siderophore-producing bacteria. *Chemosphere* 74, 280–286.
16. Jali, P., Acharya, S., Mahalik, G., Pradhan, C., & Das, A. B. (2019). Low dose cadmium (II) induced antifungal activity against blast disease in rice. *Physiological and Molecular Plant Pathology*, 108, 101422.
17. Brown, S. L., Chaney, R., Angle, J., and Baker, A. (1994). Phytoremediation potential of *Thlaspi caerulescens* and bladder campion for zinc-and cadmium-contaminated soil. *J. Environ. Qual.* 23, 1151–1157.
18. Buendía-González, L., Orozco-Villafuerte, J., Cruz-Sosa, F., Barrera-Díaz, C., and Vernon-Carter, E. (2010). *Prosopis laevigata* a potential chromium (VI) and cadmium (II) hyperaccumulator desert plant. *Bioresour. Technol.* 101, 5862–5867.
19. Burges, A., Alkorta, I., Epelde, L., and Garbisu, C. (2018). From Phytoremediation of soil contaminants to photo management of ecosystem services in metal-contaminated sites. *Int. J. Phytoremediation.* 20, 384–397.





Srotaswini Parida et al.

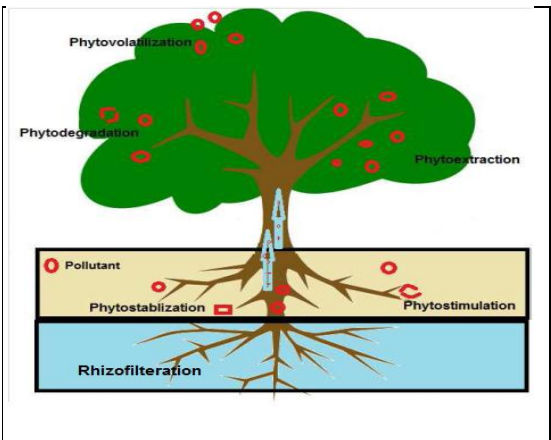


Fig.1: Phytoremediation Technique

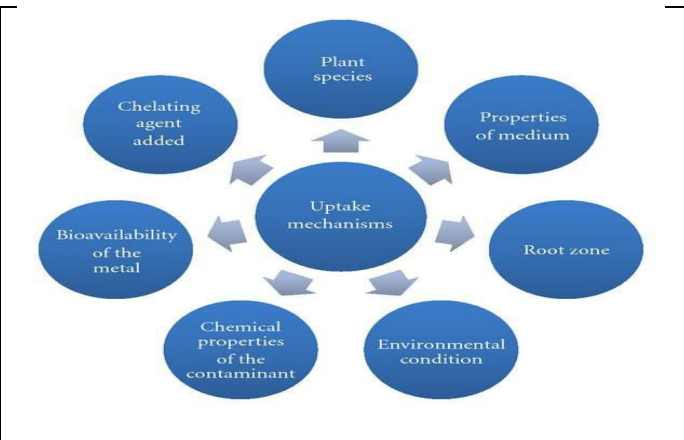


Fig. 2: Factors affecting Heavy Metals Uptake

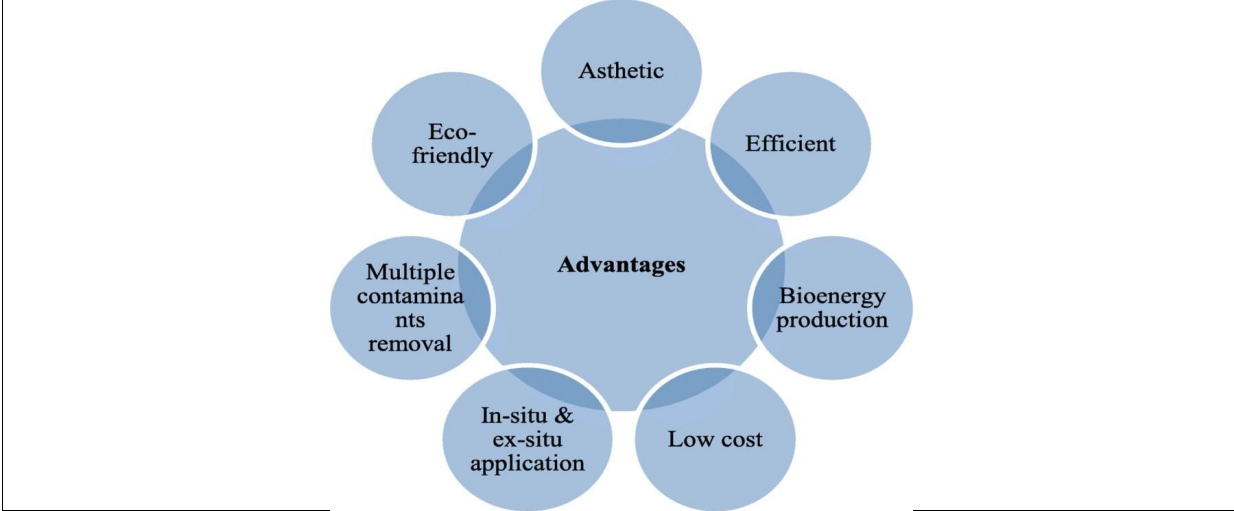


Fig. 3: Benefits of Phytoremediation Technology





A Strategic Review on Plant By-Products from Banana and their Health Benefits

Vangapandu Thriveni^{1*}, M. Viswanath², Archana Mishra¹, Anant Tamang² and Anindita Roy²

¹Assistant Professor, Department of Horticulture, MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapathi, Odisha, India.

²Assistant Professor, Department of Horticulture, Centurion University of Technology and Management, R. Sitapur, Paralakhemundi, Gajapathi, Odisha India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

VangapanduThriveni

Assistant Professor,
Department of Horticulture,
MS Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Paralakhemundi, Gajapathi, Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Banana is noted for being high in several health-promoting bioactive phytochemicals, as well as carbs, dietary fibres, vitamins, and minerals. Banana peel and banana bloom have been designated as a by-product with the potential to be used in the development of novel food products. Furthermore, various research reports have shown that the banana component, such as the peel and bloom, are high in macro- and micronutrients, as well as having health-promoting benefits such as anti-inflammatory and anti-oxidative stress. Because of this, the scientist is attempting to adapt the banana peel and bloom into unique culinary products such as plant-based meat, confectionery, and snacks. The goal of this study is to gather information on banana compositions and to demonstrate a strategic approach to generating unique food items by utilising all agricultural waste and by-products. As a result, the information supplied by this study is important for expanding the possible application of banana peel and bloom, which might help to reduce agricultural waste and produce essential products as an alternative beneficial food source in the future.

Keywords: Banana,by-product, banana peel and banana blossom, bio-active

INTRODUCTION

Most edible bananas are of the genus *Musa*; roughly 70 species have been recognised. Bananas are monocotyledonous plants that belong to the Musaceae family (order Zingiberales) (Gowen, 2012; Perrier *et al.*, 2011). Tropical and subtropical regions, such as Southeast Asia, Latin America, and Africa, are the primary cultivators of

42617



**Vangapandu Thriveni et al.,**

the plant. India, (Southern) China, the Philippines, Indonesia, Thailand, and Vietnam are the top banana-producing countries in Southeast Asia (Sialet *et al.*, 2019). The banana industry is a significant part of worldwide industrial agriculture. The peel is thought to be a fantastic alternate source of nutrients and minerals (de Angelis-Pereira *et al.*, 2016). Furthermore, it includes a high concentration of natural bioactive chemicals (e.g., phenolic compounds, flavonoids, carotenoids, or quercetin) and has strong antioxidant properties as well as antimicrobial/antibiotic properties, all of which are linked to improved health and disease prevention (Vu *et al.*, 2019). The peel is thought to be a fantastic alternate source of nutrients and minerals (de Angelis-Pereira *et al.*, 2016). Furthermore, it includes a high concentration of natural bioactive chemicals (e.g., phenolic compounds, flavonoids, carotenoids, or quercetin) and has strong antioxidant properties as well as antimicrobial/antibiotic properties, all of which are linked to improved health and disease prevention (Vu *et al.*, 2019). Another agricultural by-product of banana plantain or banana agriculture is the banana flower, sometimes known as a banana heart, banana blossom, or banana inflorescence. Although it has been claimed to contain a variety of nutritional benefits as well as functional/bioactive components such as phenolics, antioxidants, dietary fibres, proteins, peptides, and enzymes, among others, which can have a variety of therapeutic effects (Sitthiyaet *et al.*, 2018). Benefits of banana peels include: The peel of a banana includes Crude fat, protein, fibre, ash, and accessible carbohydrate, respectively, ranged from 0.15–14.42 percent, 0.35–10.40 per cent, 0.73–29.45 per cent, 1.55–22.20 per cent, and 21.43–75.59 percent (Saallahet *et al.*, 2020). All green bananas (1), green with a trace of yellow (2), more green than yellow (3), more yellow than green (4), yellow with a trace of green (5), all yellow (6), and all yellow with brown speckles (Soltani *et al.*, 2011); all green bananas (1), green with a trace of yellow (2), more green than yellow (3), more yellow than green (4), yellow with a trace of green (5), yellow with a trace of green (5), all (7). Bananas are harvested when they are fully ripe.

Dietary fiber

The peel of a banana is a good source of dietary fibre. Cultivars or variations, on the other hand, might have a wide range of content. Banana species including *M. paradisiaca*, *M. corniculata* Rumph (Tanduk), *M. acuminata* cv. Berangan, and *M. sapientum* cv. Rastali have more than 30% total dietary fibre (TDF) (Bakaret *et al.*, 2018). Hemicellulose, cellulose, and lignins (Emagaet *et al.*, 2008). SDF consumption has been shown to reduce serum cholesterol and lower the risk of bowel cancer, whilst IDF consumption helps intestinal control (Ramliet *et al.*, 2010). SDF and IDF levels in banana peels have been reported to range from 5.91 to 44.95 per cent and 0.23 to 7.75 per cent, respectively.

Minerals

Banana peel has been shown to be a good source of nutrients including calcium, phosphorus, and potassium, among others (Kookal and Thimmaiah, 2018). Minerals included in banana peel provide a variety of health benefits, including tissue preservation, serving as coenzymes in various enzyme systems, supporting organ and body function regulation, assisting other biochemical and physiological activities, and preventing degenerative neurological illnesses (Godswillet *et al.*, 2020). Unripe banana peel from *M. paradisiaca* exhibited high levels of calcium (525.00 mg/100 g), phosphorus (160.00 mg/100 g), potassium (366.00 mg/100 g), and magnesium (210.00 mg/100 g), but low levels of sulphur, copper, manganese, zinc, iron, and sodium, according to deAngelis-Pereira *et al.* (2016). During the ripening process, the amount of ash in the peel changes.

Beneficial profits of banana inflorescence

The nutritional contents of banana inflorescences, include proximate components, dietary fiber, minerals, and vitamins. The components can vary depending on the cultivars, growing conditions, and preparation method. Banana blossom, according to the data, can be classified a high-protein, high-fiber food. Swe (2012) found that the crude protein content of *M. paradisiaca* L. (Pheekyan) and *M. chilioearpa* Bark flowers was greater than 10%. According to Bhaskaret *et al.* (2012), the protein content of banana blossom (*Musa* sp. cv. Elakki bale) was 12.50 percent. According to Sitthiyaet *et al.* (2018), the maximum protein yield extracted from the banana flower (*M. sapientum* L.) was 252.25 mg/g, and chemical finger printing of proteins revealed the presence of various peptides and amino acids (i.e.,





Vangapandu Thriveni *et al.*,

tyrosine and tryptophan amino acids) with significant antibacterial potential against gram-positive and negative bacteria. Sheng *et al.* (2010) also found that banana blossoms from two cultivars (Baxijiao and Paradisiaca) contained both essential and non-essential amino acids (valine, methionine, isoleucine, leucine, tryptophan, phenylalanine, and lysine) (e.g., aspartic acid, serine, glutamic acid, proline, glycine, alanine, cysteine, tyrosine, histidine, arginine). *Musa* spp. cv. Poovan and cv. Monthan flowers have a crude fibre content of about 15%. (Arya Krishnan and Sinija, 2016). It was also found to contain a high ash content; the value was 8.53–12.80 g/100 g in *M. acuminata* cv. Williams and *Musa* spp. cv. Embul (Yu *et al.*, 2018). A high amount of carbohydrate and a small amount of crude fat has also been detected in the flower. According to Lau *et al.* (2020), banana inflorescence can be a good source of heart-healthy unsaturated fatty acids like oleic, linoleic, and α -linolenic acids (which account for more than 60% of total fatty acids) that may lower the risk of cardiovascular disease.

Banana blooms contain considerable differences in phytochemicals and antioxidant activity. TPC and TFC levels in the banana inflorescence (*M. acuminata*) were 61.77–80.13 mg GAE/g and 23.73–38.15 mg QE/g, according to Marikkaret *et al.* (2016). While the contents were found around 45.06–60.17 mg GAE/g (TPC) and 27.49–29.33 mg QE/g (TFC) in *M. balbisiana*. The antioxidant activities of the banana blossom of the two cultivars were 16.80–25.10 mmole TE/g extract for DPPH, 70.70–404.59 mmole FeSO₄/g extract for FRAP, and 3.72–24.73 mmole TE/g extract for ABTS. TPC, 3.9–4.07 mg/100 g for TFC, 68.37–88.31 mg/100 g for tannin, 1.13–1.43 g/100 g for saponin, and 1.01–36.91 mg/ml for IC₅₀ value of DPPH radical scavenging activity were discovered by Mahmood *et al.* (2011) in banana blossom (*M. paradisiaca*). The banana flower extract (*M. cavendishii*) contained 87.63 mg GAE/L of TPC and 11.78 mg QE/mL of TFC, with IC₅₀ values of 2.20 mg/ml and 2.98 mmol TE/g for DPPH radical scavenging activity and FRAP, respectively (Rodrigues *et al.*, 2020). As a result, banana blossom and its extract have a high phytochemical concentration and antioxidant potency, making them an outstanding health food supplement.

Health Benefits of Bioactive Components in Banana Fruits

Health benefits of phenolics

A flavonoid called leucocyanidin was discovered to be a major component of an aqueous extract of unripe banana pulp that has anti-ulcerogenic action (Lewis *et al.*, 1999). Many flavonoids, particularly leucocyanidin analogues, may thus have significant therapeutic promise in the treatment of gastrointestinal illness. Flavonoids' antioxidant capacity, free radical scavenging ability, and chelating action are all linked to the presence of functional groups in their nuclear structure, according to the structure–activity relationship (Heim *et al.*, 2002). They also linked the majority of flavonoids' health advantages to their antioxidant and chelating activities. Because of these properties, flavonoids are also shown to exhibit antimutagenic and antitumoral activities (Rice Evans *et al.*, 1996). The flavonoids can also inhibit many enzymes, such as oxygenases (prostaglandin synthase), required in the synthesis of eicosanoids. Thus, the flavonoids inhibit hyaluronidase activity and help in maintaining the proteoglycans of connective tissues. This would prevent the spread of bacterial or tumour metastases (Havsteen, 2002). As the flavonoids get preferentially oxidized, they are reported to prevent the oxidation of body's natural water-soluble antioxidants like ascorbic acid (Korkina and Afanasev, 1997). In most cases, the peel of a banana fruit is only used as animal feed after it has been consumed. The disposal of banana peel (pomace) and other by-products from the processing sector is a major environmental issue (Zhang *et al.*, 2005). Anthocyanins, delphinidins, and cyanidins are among the many high-value health-promoting antioxidant phytochemicals found in banana peel (Seymour, 1993). Rebello *et al.* (2014) discovered that banana peel extract has a high amount of total phenolics (29 mg/g as GAE), which are responsible for the strong antioxidant activity. They also found highly polymerized prodelphinidins (3952 mg/kg), flavonol glycosides (primarily 3-rutinosides and largely quercetin-based compounds, 129 mg/kg), B-type procyanidin dimers, and monomeric flavan-3-ols, among other antioxidant chemicals.

Carotenoids

Carotenoids are a group of chemicals that includes over 600 different substances. Some of them are vitamin A precursors, while others are recognised to have high antioxidant potential to scavenge reactive oxygen species (ROS). β -carotene, α -carotene, and γ -cryptoxanthin are provitamin A carotenoids found in banana fruit, while others such as



**Vangapandu Thriveni et al.,**

lycopene and lutein have high antioxidant properties (Erdman *et al.*, 1993). Lycopene has been linked to a reduction in the risk of prostate cancer in men, and lutein has been linked to a reduction in the risk of age-related macular degeneration in humans (Davey *et al.*, 2006). Trans-carotene concentration is higher in yellow- and orange-fleshed banana varieties (Englberger *et al.*, 2006). Fruits high in carotenoids have been shown to increase immunity and lower the risk of diseases like cancer, type 2 diabetes, and cardiovascular issues (Krinsky and Johnson, 2005). Certain banana cultivars rich in provitamin A carotenoids can be produced and consumed by the world's poor, who suffer from severe vitamin A deficiency, and eating of such banana fruit can help to ameliorate vitamin A deficiency (Fungo and Pillay, 2013).

Health benefits of biogenic amines

The decarboxylation of amino acids or the amination of aldehydes and ketones produce biogenic amines (catecholamines), which are known to be abundant in banana peel and pulp. Dopamine, serotonin, epinephrine, and nor-epinephrine are catecholamines that are found in large concentrations in many plants (Ponchet *et al.*, 1982). These biogenic amines are thought to act as neurotransmitters in animals, regulating glycogen metabolism hormonally (Kimura, 1968). When humans eat bananas, the serotonin in the pulp (which ranges from 8 to 50 g/g) produces a feeling of well-being and happiness. Dopamine and norepinephrine are abundant in bananas (Buckley, 1961). Waalkes *et al.* (1958) were the first to record the amounts of serotonin, norepinephrine, and dopamine in banana pulp, which were 28 g/g, 1.9 g/g, and 7.9 g/g, respectively. Dopamine levels in yellow banana (*Musa acuminata*), red banana (*Musa sapientum*), and plantain pulp have been reported to be 42, 54, and 5.5 g/g, respectively (Feldman *et al.*, 1987). They emphasised dopamine's importance in the human brain and body as a neurotransmitter that has a significant impact on mood and emotional stability. Dopamine levels in commercially ripened *Musa Cavendish* peel and pulp have been observed to vary from 80 to 560 mg/100 g and 2.5 to 10 mg/100 g, respectively (Kanazawa and Sakakhibara, 2000). Because tryptophan is one of the precursors for the synthesis of dopamine, the presence of this amino acid in banana peel raises interest in the possibility of developing pharmaceutical formulations to prevent neurodegenerative diseases like Parkinson's disease using this by-product of the food-processing industry.

CONCLUSION

The nutritional value and phytochemical substances in banana peel and flower are plentiful, supporting health advantages. The use of full or substitute agricultural waste or by-products from banana harvesting to create a new food product contributes to a higher value-added product. Furthermore, in the production of meat products, both peel and bloom can be used as alternative protein sources from plant-based foods, resulting in the establishment of a clean eco-system in food manufacturing. Furthermore, several food products containing both banana compositions have been accepted by consumers in recent years. As a result, the peel and blossom are potential ingredients for novel foods, as well as concurrently producing functional plant-based foods for health functionality and long-term sustainability.

REFERENCES

1. Arya Krishnan, S., Sinija, V.R., 2016. Proximate composition and antioxidant activity of banana blossom of two cultivars in India. *Int J Agricultural Sci Food Technology*. 7 (1), 13–22.
2. Bakar, S.K., Ahmad, N., Jailani, F., 2018. Chemical and functional properties of local banana peel flour. *J. Food Nutr. Res.* 6 (8), 492–496.
3. Davey, M. W., Keulemans, J., Swennen, R. (2006). Methods for the efficient quantification of fruit provitamin A contents. *Journal of Chromatography*. 1136: 176–184.
4. de Angelis-Pereira, M.C., Barcelos, M.D.F.P., Pereira, R.C., Pereira, J.D.A.R., de Sousa, R.V., 2016. Chemical composition of unripe banana peels and pulps flours and its effects on blood glucose of rats. *Nutr. Food Sci.* 46 (4), 504–516.



**Vangapandu Thriveni et al.,**

5. Emaga, T.H., Robert, C., Ronkart, S.N., Wathélet, B., Paquot, M., 2008. Dietary fibre components and pectin chemical features of peels during ripening in banana and plantain varieties. *Bioresource Technology*. 99 (10), 4346–4354.
6. Englberger, L., Wills, R. B., Blades, B., Dufficy, L., Daniells, J. W., Coyne, T. (2006). Carotenoid content and flesh color of selected banana cultivars growing in Australia. *Food and Nutrition Bulletin*, 27: 281–291.
7. Erdman, J. W. Jr, Bierer, T. L., Gugger, E. T. (1993). Absorption and transport of carotenoids. *Annals of the New York Academy of Sciences*. 691: 76–85.
8. Feldman, J. M., Lee, E. M., Castleberry, C. A. (1987). Catecholamine and serotonin content of foods: effect on urinary excretion of homovanillic and 5-hydroxyindoleacetic acid. *Journal of the American Dietetic Association*. 87: 1031–1035.
9. Fungo, R., Pillay, M. (2013). β -Carotene content of selected banana genotypes from Uganda. *African Journal of Biotechnology*. 10: 5423–5430.
10. Godswill, A.G., Somtochukwu, I.V., Ikechukwu, A.O., Kate, E.C., 2020. Health benefits of micronutrients (vitamins and minerals) and their associated deficiency diseases: a systematic review. *Int. J. Food Sci.* 3 (1), 1–32.
11. Gowen, S. (Ed.). (2012). Bananas and plantains. Springer Science and Business Media. London. p. 1-533.
12. Havsteen, B. H. (2002). The biochemistry and medical significance of the flavonoids. *Pharmacology & Therapeutics*. 96: 67–202.
13. Heim, K. E., Tagliaferro, A. R., Bobilya, D. J. (2002). Flavonoid antioxidants: chemistry, metabolism and structure-activity relationships. *The Journal of Nutritional Biochemistry*. 13: 572–584.
14. Kanazawa, K., Sakakibara, H. (2000). High content of dopamine, a strong antioxidant, in Cavendish banana. *Journal of Agricultural and Food Chemistry*. 48: 844–848.
15. Kimura, M. (1968). Fluorescence histochemical study on serotonin and catecholamine in some plants. *Japanese Journal of Pharmacology*. 18: 162–168.
16. Kookal, S.K., Thimmaiah, A., 2018. Nutritional composition of staple food bananas of three cultivars in India. *Am. J. Plant Sci.* 9 (12), 2480–2493.
17. Korkina, L. G., Afanas'ev, I. B. (1997). Antioxidant and chelating properties of flavonoids. *Advances in Pharmacology* (San Diego, Calif.), 38: 151–163. Krinsky, N. I., Johnson, E. J. (2005). Carotenoid actions and their relation to health and disease. *Molecular Aspects of Medicine*. 26: 459–516.
18. Lau, B.F., Kong, K.W., Leong, K.H., Sun, J., He, X., Wang, Z., Mustafa, M., Ling, T.C., Ismail, A., 2020. Banana inflorescence: its bio-prospects as an ingredient for functional foods. *Trends Food Sci. Technol.* 97, 14–28.
19. Lewis, D. A., Fields, W. N., Shaw, G. P. (1999). A natural flavonoid present in unripe plantain banana pulp (*Musa sapientum* L. Var. *Paradisiaca*) protects the gastric mucosa from aspirin-induced erosions. *Journal of Ethnopharmacology*. 65: 283–288.
20. Lewis, D. A., Fields, W. N., Shaw, G. P. (1999). A natural flavonoid present in unripe plantain banana pulp (*Musa sapientum* L. Var. *Paradisiaca*) protects the gastric mucosa from aspirin-induced erosions. *Journal of Ethnopharmacology*. 65: 283–288.
21. Mahmood, A., Ngah, N., Omar, M.N., 2011. Phytochemicals constituent and antioxidant activities in *Musa x Paradisiaca* flower. *Eur. J. Sci. Res.* 66 (2), 311–318.
22. Marikkar, J.M.N., Tan, S.J., Salleh, A., Azrina, A., Shukri, M.A.M., 2016. Evaluation of banana (*Musa* sp.) flowers of selected varieties for their antioxidative and antihyperglycemic potentials. *Int Food Res J.* 23 (5), 427–432.
23. Okorie, D.O., Eleazu, C.O., Nwosu, P., 2015. Nutrient and heavy metal composition of plantain (*Musa paradisiaca*) and banana (*Musa paradisiaca*) peels. *J. Nutri. Food.Sci.* 5 (370), 1–3.
24. Perrier, X., De Langhe, E., Donohue, M., Lentfer, C., Vrydaghs, L., Bakry, F., Carreel, F., Hippolyte, I., Horry, J.P., Jenny, C., Lebot, V., 2011. Multidisciplinary perspectives on banana (*Musa* spp.) domestication. *Proc. Natl. Acad. Sci.* 108 (28), 11311–11318.
25. Ramli, S., Alkarkhi, A.F., Shin Yong, Y., Min-Tze, L., Easa, A.M., 2009. Effect of banana pulp and peel flour on physicochemical properties and in vitro starch digestibility of yellow alkaline noodles. *Int. J. Food Sci. Nutr.* 60 (sup4), 326–340.





Vangapandu Thriveni et al.,

26. Ramli, S., Ismail, N., Alkarkhi, A.F.M., Easa, A.M., 2010. The use of principal component and cluster analysis to differentiate banana peel flours based on their starch and dietary fibre components. *Trop. Life Sci. Res.* 21 (1), 91–100.
27. Rebello, L. P. G., Ramos, A. M., Pertuzatti, P. B., Barcia, M. T., Castillo-Munoz, N., Hermosin- Gutierrez, I. (2014). Flour of banana (Musa AAA) peel as a source of antioxidant phenolic compounds. *Food Research International.* 55: 397–403.
28. Rice-Evans, C. A., Miller, N. J., Paganga, G. (1996). Structure-antioxidant activity relationships of flavonoids and phenolic acids. *Free Radical Biology & Medicine.* 20: 933–956.
29. Rodrigues, A.S., Kubota, E.H., da Silva, C.G., dos Santos Alves, J., Hautrive, T.P., Rodrigues, G.S., Campagnol, P.C.B., 2020. Banana inflorescences: A cheap raw material with great potential to be used as a natural antioxidant in meat products. *Meat Sci.* 161, 107991.
30. Saallah, S., Roslan, J., Zakaria, N.N., Pindi, W., Siddiquee, S., Misson, M., Ongkudon, C. M., Jamil, N.H.A.M., Lenggoro, W., 2020. Isolation of nanocellulose from Saba (Musa acuminata x balbisiana) banana peel by one-pot oxidation-hydrolysis system. *AdvAgric Food Res.* 1 (1), 1–14.
31. Seymour, G. B. (1993). Banana. In: Seymour, J. E., Tucker, G. A. (eds.) *Biochemistry of Fruit Ripening*. Chapman and Hall, NY, pp. 83–106.
32. Sheng, Z.W., Ma, W.H., Jin, Z.Q., Bi, Y., Sun, Z.G., Dou, H.T., Li, J.Y., Han, L.N., 2010. Investigation of dietary fiber, protein, vitamin E and other nutritional compounds of banana flower of two cultivars grown in China. *Afr. J. Biotechnol.* 9 (25), 3888–3895.
33. Sial, T.A., Khan, M.N., Lan, Z., Kumbhar, F., Ying, Z., Zhang, J., Sun, D., Li, X., 2019. Contrasting effects of banana peels waste and its biochar on greenhouse gas emissions and soil biochemical properties. *Process Saf Environ Prot.* 122, 366–377.
34. Silva, V.D., Arquelau, P.B., Silva, M.R., Augusti, R., Melo, J.O., Fante, C.A., 2020. Use of paper spray-mass spectrometry to determine the chemical profile of ripe banana peel flour and evaluation of its physicochemical and antioxidant properties. *Quim. Nova.* 43 (5), 579–585.
35. Sitthiya, K., Devkota, L., Sadiq, M.B., Anal, A.K., 2018. Extraction and characterization of proteins from banana (Musa Sapientum L) flower and evaluation of antimicrobial activities. *J. Food Sci. Technol.* 55 (2), 658–666.
36. Soltani, M., Alimardani, R., Omid, M., 2011. Evaluating banana ripening status from measuring dielectric properties. *J. Food Eng.* 105 (4), 625–631.
37. Vu, H.T., Scarlett, C.J., Vuong, Q.V., 2019. Changes of phytochemicals and antioxidant capacity of banana peel during the ripening process; with and without ethylene treatment. *Sci. Hortic.* 253, 255–262.
38. Waalkes, T. P., Sjoerdsma, A., Creveling, C. R., Weissbach, H., Udenfriend, S. (1958). Serotonin, norepinephrine, and related compounds in bananas. *Science (New York, N.Y.)*. 127: 648–650.
39. Waalkes, T. P., Sjoerdsma, A., Creveling, C. R., Weissbach, H., Udenfriend, S. (1958). Serotonin, norepinephrine, and related compounds in bananas. *Science (New York, N.Y.)*. 127: 648–650.
40. Waalkes, T. P., Sjoerdsma, A., Creveling, C. R., Weissbach, H., Udenfriend, S. (1958). Serotonin, norepinephrine, and related compounds in bananas. *Science (New York, N.Y.)*. 127: 648–650.
41. Yu, D., Huang, P., Chen, Y., Lin, Y., Akutse, K.S., Lan, Y., Wei, H., 2018. Effects of flower thrips (Thysanoptera: Thripidae) on nutritional quality of banana (Zingiberales: Musaceae) buds. *PLoS one.* 13, (8) -2199.
42. Zhang, P., Whistler, R. L., BeMiller, J. N., Hamaker, B. R. (2005). Banana starch: production, physicochemical properties, and digestibility—a review. *Carbohydrate Polymers*, 59: 443–458.





Structural and Functional Domain Organization of Dead-Box RNA Helicases, A Review

Kiran Priyadarshini Sahu and Pradip Kumar Prusty*

School of Applied Sciences, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Pradip Kumar Prusty

School of Applied Sciences,
Centurion University of Technology and Management,
Odisha, India.

Email: pradipkumar.prusty@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

DEAD-box protein RNA helicases have been shown to participate in all aspects of RNA metabolism. They are found in most organisms and function as RNA helicases or RNPsases. The properties of these enzymes in vivo are still poorly understood, but some have been extensively characterised in vitro, and the solved crystal structures of a few are now available. Taken together, this data sheds light on the regulation of ATP and RNA binding, as well as ATPase and helicase activity. This review will concentrate on the molecular characteristics of members of the DEAD-box protein family as well as their enzymatic activities. DEAD-box RNA helicases play a variety of, often critical, roles in all RNA-mediated processes. Members of this protein family have been linked to human disease, including cancer and viral infections. DEAD-box proteins have two conserved domains that help with RNA and ATP binding. Despite recent breakthroughs, the molecular details of how these enzymes convert chemical energy into RNA remodelling remain unknown. When combined with prior knowledge, this allows for a family-wide comparative structural analysis. We propose a general mechanism for RNA binding site opening. This study also sheds light on the diversity of DExD/H- proteins, which has implications for understanding the functions of individual members of the family. Could indicate a test condition or a lack of a cooperative partner, as it could simply be an extra delay

Keywords: DEAD-box, as RNA helicases, ATPase, metabolism, RNA

INTRODUCTION

Work, however, is scarce. When tested, multiple spirals represent a depressing theme or process. This is simply a subset of the standard functionality shared by all members. NTPs that are nucleic acid dependent. tying work Regardless of what they do in vitro, members of this class of proteins are known as "helicases," despite much debate



**Kiran Priyadarshini Sahu and Pradip Kumar Prusty**

and discussion. In addition, not all cyclic bilayer functional proteins in vitro are considered helicases. Encoding Helicase is a major component of eukaryotic and prokaryotic genomes (Shiratori *et al.* 1909, Silverman *et al.* 2003). The division of these proteins into three major families and two (here referred to as SFI to SF5) is based on the appearance and characteristics of the arrows stored in the main sequence (Gorbaleaya and Koomes (Shiratori *et al.* 1909, Silverman *et al.* 2003). The division of these proteins into three major families and two (here referred to as SFI to SF5) is based on the appearance and characteristics of the arrows stored in the main sequence (Gorbaleaya and Koonin, 1993). Among the saved motifs, all helices have Walker motors A and B (Walker *et al.*, 1982), which are also found in most ATPases in general. SFI and SF2 contain DNA and RNA helices that appear to function as monomers or dimers (Tutera and Turcja 200e, Tutaja and Tutcja, 2001a). Furthermore, these two higher families exhibit the same tall sequence in their recorded motifs. Several structures of the DNA and RNA helix from different major families.

Family matters have been resolved. All SFI components, as well as the SF2 helix, are housed in the same package with two domains as Rec A. (Canthers and McKay, 2002). Although the sequences of all proteins differ, the structural similarity suggests that they can perform enzymatic activities in the same way. SFT, SE4, and SFS are mostly made up of helices. Bacterial or viral origin hexameric bacteria (Patel and Photos 2000). Large families are structurally distinct in the SFI and SF2 helices because, like airborne RecA, they contain only one domain and only two species survive. Following Ciorhalenya and Koonin's 1993 division, DEAD box and related families of DEAH, DEXH, and Dix D, also known as helicases of the DEXDXH family, members of SF2, share eight motifs (Tanner and Linder), 2001; These closest families can be classified differently according to the purpose of preservation The dead box family is the largest family and is governed by the presence of nine archival images and Bacterial helicases and its control.

Structure of Dead-Box RNA Helicase

PRODUCTS Several helicase crystal structures have been discovered in the last ten years, including SF1 Pet A (Subramanya *et al.*, 1996; Velankar *et al.*, 1999), SF2 Uvr B (Theis *et al.*, 1999), SF1 Rep (Korolev *et al.*, 1997), and the helicase domain of the hepatitis C virus SF2 NS3 (Figure 2A, Yao *et al.*, 1997, Kim *et al.*, 1998). In addition, four DEAD box SF2 proteins were identified (Benz *et al.*, 1999; Caruthers *et al.*, 2000; Story *et al.* 2001 Carmel and Matthews, 2004; Shi *et al.*, 2004; Zhan *et al.*, 2004). MIDEAD crystal structure of Methenococcus annushil Story *et al.* is one of the DEAD box proteins.2001 and the human splicing factor UAP56 (Shi *et al.*... 2004) are the only quasi-simple structures of complete proteins. In addition to these structures, the two regions of yeast translation initiation factor eIF4A Cannhers *et al.*, 2000) and crystalline UAP56 (Zhao *et al.*, 2004) were resolved separately, as were the structures. Full bamboo. Rebuild by combining these two areas together. Finally, the amoterminal domain of Bat DEAD was recrystallized and resolved IE: Ca. All these DEAD box proteins have no long amine and carboxyl termini, are located close together and are small in size. The helicase core alone, all SFI immobilized and SF2 helix crystal structures exhibit two nested globular domains, whose repositories typically consist of five p fibers surrounded by five helices. Like the Rec A , ATPase synthesis (Indaba and Steitz 1992). These two domains represent approximately 350,400 fossils and form the core of the helicase bacterium. The amine-terminal domain (referred to as domain 1 in SF2 and Ia in SF1) contains the ALP Q-binding motif (if present), 1 and 11, the ATP III hydrolysis motif and the RNA-binding motif here, and the In-terminus (Swine: 2) Carboxy domain (domain 2 in SF2 and 20. In SF1, contains the IV and V RNA binding motifs. And the V1 motif, can bind ATPase and release functions. Indaba *et al.*, 2001, suggested that the Ia and Ib motifs are structurally similar to the V and IV motifs. . It is suggested that they perform the same tasks, though this was not done for testing purposes. Stratigraphy. Surprisingly, the distances and orientations of the two domains differ significantly between the different crystal structures of the SF2 helices. Domains 1 and 2 are close to HCV NS3MjDEAD or UvrB structures, but are further away from UAP56 or eIF4A structures. Furthermore, when compared to ICV NS3, UVB, or MIDEAD, the two domains in UAPS are rotated by more than 50 degrees (Shi *et al.*, 2004). These differences in domain location and domain location indicate structural flexibility of SF2 helicases, which may be important in their operation. The presence of DEAD box proteins is a distinguishing feature. These extra structures. Corresponds to and includes the recently discovered Q motif for the DEAD box protein family (Tanner *et*



**Kiran Priyadarshini Sahu and Pradip Kumar Prusty**

al., 2003). (see Section 3.2). Q motifs and other conserved motifs (1–VI) are frequently found in strandloop or helix loop transitions, as well as in Flanking sequences from other helicase families (Tanner and Linder, 2001; Carmel and Matthews, 2014). DEADux protein length and structure vary greatly. They are taken into consideration. To improve interactions with substrates or cofactors, or to carry out additional functions Although there is no structural data for the DEAD box proteins in this flanking arrangement, additional structures are not conserved. SF1 Per A Domain (domains 13 and 2B, Korelev *et al.*, 1996), SFI Representative (domains 13 and 2B, Korelev *et al.*, 1996) (domains 1B and 2B: Subramanyal *et al.*, 1996). These extra structures. Corresponds to and includes the recently discovered Q motif for the DEADbox protein family (Tanner *et al.*, 2003). They are no longer an issue. These extra domains (included within the basic sequence in the case of SFI proteins) are mostly helices that interact with the main domains 1 and 2 of 1A and 2A. PerA requires embedded sequences to bind and release ds DNA. In NS3, on the other hand, carboxyl flanking terminal sequences improve helicase substrate coherence, whereas amino terminal dunking sequences have serine protease activity, which alters the biochemical functions of full length NS3 (Tomei *et al.*, 1992). 2004 (Kuang *et al.*) As a result, side effects appear to alter and possibly regulate the enzymatic activities of the helicase core (Korley *et al.*, 1998). (See also Section 3.2.) Q motifs are also used.

DNA Identification

The packaging of a fragrant residue also appears to be common, although a pleasant group may be given the remotest remotely in the main sequence, as noted in SE1 PeeA (Komlev *et al.*, 1998; Tanner, 2003). With the exception of conserval glutamine and aromatic residue. Some Q motif properties of the DEADx protein are not found in any of the other helicase families tested (Farmer *et al.*, 2003 although some stored residues are commonly found to be associated with glutamine. However, while glutamine is essential for the DEAD box proteins in vivo, it has no effect on a few important SFI (Da2) and SF2 (Rad3, M4, and SthI) DNA and RNA helicases. *S. cerevisia* because changing this ATP hydrolysis and nucleotide binding It is thus proposed that the Q motif, by interacting with the I motif and being important for both ATP and RNA binding, can form the associated nucleotide sensor and may not act as an ATPase activity regulator, activating ATP hydrolysis only when the substrates are appropriately bound to the box proteins (Cordin *et al.*, 2004). Glutamate, on the other hand, is stored in the 15-22 residue range. The structure of Pedestrian motif A in SFI and SF2 is similar, and its sequence is Highly Economized. This motif's rare properties include several crista structures of the DEAD box neoplastic protein. Ploop, or phosphate ring, of the motif found in two different statements (Tanner *et al.*, 2003; Shi *et al.*, 2004): the "open" transition. Johnson and McKay (1999); Carmel and Matthews (2004); Shi *et al.* (2004)). The open ring was discovered in cI FAA and UAP56 nucleotide bound forms, MDEAD bound to sulphate and UAP56 bound to citrate. This is consistent with the pattern I've observed in NTP ases in general when polished with or without figs. In the absence of the binding ligand, the closed ploop was only seen in the polished F4A, LAPS, and Be DEAD structures. This closing combination causes the actuator found at the end of the term of the amine unit 1 to expand. Because ATP cannot be bound in this closed state due to a lethal obstruction, the chain breaks. Before the rod can be inserted, the helix of sample 1 must be opened. account number 21 DEAD box protein alanine variation during ATPase and helicase activity (Svitkin *et al.*, 2001) Similar mutations in the DEAD box motif, on the other hand. Pip22 has little or no effect on yeast growth (Schneider *et al.*, 2004). Schriver and Meszaros (2000) demonstrated that a modification (Val) in the Prp22 Ia motif can alter the in vitro helicase function of the motif III mutant, possibly by opening up interstitial breakage holes for ATP hydrolysis. This suggests that the motif is not restricted to RNA binding and also contributes to the structural rearrangements that occur during ATP binding and hydrolysis. Consistent with this view, an additional interaction is observed between the original La motif remnant and the motif I glutamate residue in the crystal structure of MIDEAD and UAPS6 (Fig. Zhon *et al.* 2004) 35 GG Cable, which is present in many DEAD box proteins, was identified in the first work by Linder with his collaborators in 1989 as part of the archive describing the DEAD box family of proteins. (Linder *et al.*, 1989). This structural element is part of the domain and resides in a loop structure between the This and I motifs (Figures 2B and C). They simplify the formation of a pointed fan in this loop. They have been suggested to participate in protein interactions in cI4A (eg, binding of all 40i; Henr *et al.*, 1999), and conversion of these glycines to ell 4A affects growth (Schmid and Linder, 1991) 3.6. This motif is also known as the Walker B motif. Along with the Walker A motif, the Walker B motif is known to be essential for ATPase activity and is present in many families.





Kiran Priyadarshini Sahu and Pradip Kumar Prusty

In the published structure of the DEADbox protein, the reserve lysine of motif 1 interacts with native aspartate. From motif I in the free ligand structure but not in front of the binding nucleotide when interacting with the bound Mg²⁺ ion in the nucleotide bound.

The alanine variation of the motif in the DEADbox protein in both ATPase and helicase activities (Svitkin *et al.*, 2001) However, similar mutations in the *DEAH box* motif Ia. The Pip22 protein has little or no effect on yeast growth (Schneider *et al.*, 2004). Schriver and Meszaros, 2000, showed that modification (Val) in the Prp22 Ia motif could alter the helicase function of the motif III mutant in vitro, possibly by opening the intervertebral fracture to hydrolyzed ATP. The interaction of motif I with motif II, motif II with motif III, and the possible interaction of motif II and motif III with motif VI may provide a frame-bound ATP packet, which can be resulting in the appropriate remaining suspension. Required for hydrolysis. Motif III (SAT, Figure 1) was suggested to play a role in linking ATPase and helicase activities. Alteration of the eIF4A motif in the *DEAH box*-associated proteins results in loss of helicase activity. However, these changes are only minor. Impact on ATP binding. ATP hydrolysis and RNA binding (Pause and Sonenberg, 1992; Schwer and Meszaros, 2000). Rockak *et al.* 2005, found that alanine substitution of the serine and threonine III motifs in Has1 slightly decreased ATP binding and hydrolysis (about twice each) and slightly reduced RNA inhibition. As a result, helicase activity was significantly reduced.

In contrast to the resolved crystal structure of the DEXH NS protein (Kim *et al.*, 1998), where the III motif appears to be part of the flexible binding region between domain 1 and domain 2 (Figure 2A), it appears to be entirely part of domain 1 in the DIE box proteins. It is separated from domain 2 by a spiral sheet structure (Figure 28. C and 3: Stery *et al.*, 2001; Carmel and Matthews, 2004) However, this structure may have evolved into a gap between domains. During the ATPase or helicase reaction. As mentioned before, the In motif interacts with motifs I and III. Motif V is proposed to be an RNA-binding motif associated with motifs Ia, I and IV. However, the role of ATPase activity or of a combination of ATPase and helicase functions cannot be ruled out (Caruthers *et al.*, 2000). The V motif is part of the link between domain 1 and domain 2 that points to the RNA binding medium. Its matching sequence in TDVARGID (Figure 1). In eIF4A, the storage arginine of the V motif is a loop that has been proposed to associate with a false motif with associated oligonucleotides (Caruthers *et al.*, 2000).

DNA Protein Evolution

Finally, except for Dbp A and related proteins (Fuller Pace *et al.*, 1903; Kossen and Uhlenbeck 1999) and low levels of Prp5 (O'Day *et al.*, 1996), DEADox protein is reported to be specific protein. Recommended RNA launcher For most proteins in the DEAD box, such as translation elements for ery units of degradation equipment, no substrate specifications are expected as they will meet a wide variety of different substrates. On the other hand, DEAD box proteins involved in ribosome biogenesis or pre mRNA splicing may contain certain substrates in vivo although in vitro tests fail to produce it. Therefore, in vitro substrates are widely used by total yeast RNA, total RNA, poly (A) and poly (U) RNA. In proteins such as Dall, CA or Sm, there is no ATPase activity where there is a blunt end RNA chiplex (Iost *et al.*, 1999; Hizchand *et al.*, 2004) In contrast, RhlE is shown to be stimulated not only that. With ssRNA or duplex with 3' or 5' overhang but also with empty RNA duplex (Bizchard *et al.*, 2004). It has been shown in eIF4A that the binding of ATP and RNA is unordered and a rate-limiting step, like the binding of RNA and ATP, and the release of ADP and Pi. Fast events emerge (Lorsch and Herschlag, 1998). This may be due to the lack of helicase activity reported in eIF4A. Association between RNA binding and ATP binding RNA binding is stronger in the presence of an ATP or I analog that can be diluted with water, but is significantly reduced by masking the ADP or ATPYS analog of ATPYS slow (Lonich and Herschlag, 1998; Pink and Herschlag, 2003; Condin *et al.*, 2004). It is not clear how the proteins differentiate between RNA and DNA because no DEADbox protein is covered by the binding RNA substrate. However, it is possible that helicases detect RNA through the formation of interactions with 2' hydroxyls. As noted above, encoding a specific RNA target may not be a common factor, at least in vitro, and indeed most of the DEAD box proteins tested were uncharacterized. Specific RNA techniques, although the helicase core may lack the substrate specification. Specific specifications can be provided for regions or regions located at the aminoterminal and carboxylterminal ends of the protein. The best example is EcolE helicase DbpA, whose ATPase





Kiran Priyadarshini Sahu and Pradip Kumar Prusty

performance is strongly enhanced by a specific conformation. (192) of 23S rRNA found in peptidyl transfer center on mature bacterial ribosome (FullerPace *et al.*, 1993; Nicol and FullerPace, 1995; Tau *et al.*, 2001). This specific RNA structure interacts strongly with the tighuly (A20 nM) and additional site binding RNA found in the carboxylterminal protein component. In addition to 1192, other structural features of the 1189 1193 23S RNA substrate play an important role, as they can establish additional binding to protein and regulate ATP compliance and hydrolysis levels (Kousen *et al.* 2002: Polach and Uhlenbeck, 2002: Karginov and hienheck, 2004). Finally, it is demonstrated using RNA printing tests that interactions between DbpA and its RNA target are altered by nucleotide binding (Karginoy and Uhlenbeck, 2004). Kossen *et al.* also showed that transferring the Dbp A-bound carboxyl terminus protein to DEAD box the nonspecific Sm B protein delivering this 1192 protein directly from 23S RNA without changing the kinetic parameters of ATP hydrolysis (Table 1). This suggests that the RNA- binding region of DbpA provides self-expression (Kossen *et al.*, 2002). The presence of additional unidentified RNA motifs, such as RGG dumains, also influenced functions. However, it appears that However, although this model can still use up to 10 specific DEADbox proteins, this does not appear to be the case for DbpA. Diges and Uhlenbeck. 2005. DbpA was recently shown to be a strong 3-5 spirochete requiring a 5-row circuit for duplex loading (Figure 6CX 3 of duplex H92 can express many different forms of the protein that it can use. Used to obtain a maximum of 3 charges while binding to a specific RNA substrate (Figure C). RNA duplex. (162 bp duplex, Hirling *et al.*, 1989: 36 to 46 bpRessler *et al.*, 2001) In addition, helicase activity was DIE. Box proteins are highly dependent. In stable duplex is used: LAG stabilization") in a population consisting of 15 to 10 kcal/male and whose annual duration varies between 10 and 25 bp. As expected, a negative relationship between duplex stability and helicase activity is observed (Rossler *et al.*, 2001; Bizebard *et al.*, 2004). Using duplexers of increasing length and stability, Rogers *et al.*, 1999, demonstrated that ell4A could promote the separation of a few base pairs, and proposed that, in the field low A6 duplexer, this release cripples full duplexer. However, if several long duplex pits are separated by full duplex stability, it is not significantly reduced, and duplex is not reduced to a reduced extent. So a tear was planned. Hizchard *et al.*, 2004 showed that the length of the single-stranded protrusion is required for helicase function and that the minimum length requirement varies among proteins. The size of the unfinished helix of DEAD box is thought to be about 56 bp (Rogers *et al.*, 19991)

DNA Analyses

Wading ty to trees Major ungtingchem models (Aland the native milling ® as Maulifual verms of the theme of the acte) (section 4.3). ADP and Pian t nad wadas nad wadas nad wadas nad wadas nad the protein fe can intercept RNA and become charged anywhere in the tidal extinction model. Two latent objects indg AL cause tomorrow's movements, bringing it closer to domain 2, as hinted in indvem. This is the RNA for transmitting the 'cual command. It has limits. Proteolytic assays are commonly used to test for mutations caused by nucleotide and bound RNA, respectively, further evidence for the different forms of RNA protein complexes seen in genetic translocation assays nucleotide-based electrophoresis (Cordin *et al.* 2004) and RNase defense testing (Karginov and Uhlenbeck. 2004). Finally, structural data from the IF4A, MjDEAD, UAP56 and DEXH box HCV NS3 helicases show distinct structures of the two domains involved in RNA nucleotide binding (Yao *et al.*, 1997; Kim *et al.*, 1998: Caruthers: Caruthers) *et al.* , 2018, Story *et al.*, 2001; Caruthers and McKay, 2002; Shi *et al.*, 2004). Henn *et al.*, 2002. It has been shown that in ADP binding, but not ATPy binding, the digestion pattern of DopA protease is different from that of unbound protein. This indicates that DbpA is passing. Corresponding changes in binding to ADP. The formal protein Den also changes RNA binding. These changes lead to incr ADP band helium fan hom KNA livsociato mu strong in the fou protein bound to the te Chelevel RNA structure in which the helicase bacteria bind to the subtitle near the dead dres pertahotint of the structure will reduce a few Bay cheese duplication regions. The duplicate description, in either case, is based on reading the content together and will completely melt you. Several studies have shown that heliae cause long-term changes in NTPase and helicase activity (Lorsch und Herschlag, 1998b) in different adenosine nucleotides, it is possible that each nucleotide harvests and strengthens the diffract. The compatibility also depends on whether the RNA is bound.





Kiran Priyadarshini Sahu and Pradip Kumar Prusty

CONCLUSION

As discussed earlier, the DEAD box proteins represent a large family of helicases. They are involved in the control of all RNA-related processes in the cell. From writing to destruction. This chapter will briefly review our understanding of the potential role of various DEAD box proteins in the cell (Figure 91, The most comprehensive review can be found elsewhere. RNA for vitamins. Activator of transcription and interacts with various transcription factors and nuclear receptors (Endoh *et al.*, 1909; Watanabe *et al.*, 2001; Wilson *et al.*, 2004). 2005). In the case of DP103 and p72, helicase activity is not required for function. Interestingly, ATPase or positive helicase function is not required for HD AC, p53 or Eremediated transcriptional control, the hutbased p300 script requires p68 to have ATPase function. These results indicate that some helicases do not always require their enzymatic activities and that the requirement for enzyme activity depends on the context of the helicases they are using and their colleagues.

Pre-RNA classification is a multi-step process that requires two transesterification reactions and multiple structural rearrangements of a large RNP complex known as the spliceosome. Reproduction of multiple DEADboxes and DEAHibosomes is a multi-step process involving multiple RNA species, multiple ribosomal proteins, and various transactivation factors. In eukaryotes, it begins in the nucleoli, continues in the nucleus, and ends in the cytoplasm. Ribosomal RNA (rRNA) is transcribed as two precursors (pre55 and 35S prerRNA in *S cerevisiae*. 35S prerRNA is then released and modified in a high-persistence medium and synergistically to produce three proteins) rshosRNA plays an important role at critical stages of splicing *DEAH box* proteins involved in the early stages of prespliceosome assembly and its continuation including the active spliceosome, while *DEAH box* proteins are required required in the later stages of recombination and re-digestion (Laking *et al.*, 1998 Silverman *et al.* 2003, Rocaic et me ander., 2004).

REFERENCES

1. Anderson, J.S.J., Parker, R.P., 1998. The 3' to 5' degradation of yeast mRNAs is a general mechanism for mRNA turnover that requires the SKI2 DEVH box protein and 3' to 5' exonucleases of the exosome complex. *EMBO J.* 17, 1497–1506.
2. Askjaer, P., Rosendahl, R., Kjems, J., 2000. Nuclear export of the DEAD box An3 protein by CRM1 is coupled to An3 helicase activity. *J. Biol. Chem.* 275, 11561–11568.
3. Aubourg, S., Kreis, M., Lecharny, A., 1999. The DEAD box RNA helicase family in *Arabidopsis thaliana*. *Nucleic Acids Res.* 27, 628–636.
4. Bates, G.J., *et al.*, 2005. The DEAD box protein p68: a novel transcriptional coactivator of the p53 tumour suppressor. *EMBO J.* 24, 543–553.
5. Benz, J., Trachsel, H., Baumann, U., 1999. Crystal structure of ATPase domain of translation initiation factor eIF4A from *Saccharomyces cerevisiae*—the prototype of the DEAD box protein family. *Structure Fold Des.* 7, 671–67
6. Bernstein, D.A., Zittel, M.C., Keck, J.L., 2003. High-resolution structure of the *E. coli* RecQ helicase catalytic core. *EMBO J.* 22, 4910–4921.
7. Berthelot, K., Muldoon, M., Rajkowitsch, L., Hughes, J., McCarthy, J.E., 2004. Dynamics and processivity of 40S ribosome scanning on mRNA in yeast. *Mol. Microbiol.* 51, 987–1001.
8. Bi, X., Goss, D.J., 2000. Wheat germ poly(A)-binding protein increases the ATPase and the RNA helicase activity of translation initiation factors eIF4A, eIF4B, and eIF-iso4F. *J. Biol. Chem.* 275, 17740–17746.
9. Bi, X., Ren, J., Goss, D.J., 2000. Wheat germ translation initiation factor eIF4B affects eIF4A and eIF4F helicase activity by increasing the ATP binding affinity of eIF4A. *Biochemistry* 39, 5758–5765.
10. Bizebard, T., Ferlenghi, I., Iost, I., Dreyfus, M., 2004. Studies on three *E. coli* DEAD-box helicases point to an unwinding mechanism different from that of model DNA helicases. *Biochemistry* 43, 7857–7866.
11. Blum, S., *et al.*, 1992. ATP hydrolysis by initiation factor 4A is required for translation initiation in *Saccharomyces cerevisiae*. *Proc. Natl. Acad. Sci. U. S. A.* 89, 7664–7668.





Kiran Priyadarshini Sahu and Pradip Kumar Prusty

12. Carmel, A.B., Matthews, B.W., 2004. Crystal structure of the BstDEAD Nterminal domain: a novel DEAD protein from *Bacillus stearothermophilus*. *RNA* 10, 66–74.
13. Carpousis, A.J., 2002. The *Escherichia coli* RNA degradosome: structure, function and relationship in other ribonucleolytic multienzyme complexes. *Biochem. Soc. Trans.* 30, 150–155.
14. Carpousis, A.J., Vanzo, N.F., Raynal, L.C., 1999. mRNA degradation. A tale of poly(A) and multiprotein machines. *Trends Genet.* 15, 24–28. Caruthers, J.M., McKay, D.B., 2002. Helicase structure and mechanism. *Curr. Opin. Struct. Biol.* 12, 123–133.
15. Caruthers, J.M., Johnson, E.R., McKay, D.B., 2000. Crystal structure of yeast initiation factor 4A, a DEAD-box RNA helicase. *Proc. Natl. Acad. Sci. U. S. A.* 97, 3080–3085.
16. Chamot, D., Colvin, K.R., Kujat-Choy, S.L., Owttrim, G.W., 2005. RNA structural rearrangement via unwinding and annealing by the cyanobacterial RNA helicase, CrhR. *J. Biol. Chem.* 280, 2036–2044.
17. Chan, C.C., *et al.*, 2004. eIF4A3 is a novel component of the exon junction complex. *RNA* 10, 200–209.
18. Chang, T.-H., Latus, L.J., Liu, Z., Abbott, J.M., 1998. Genetic interactions of conserved regions in the DEAD-box protein Prp28p. *Nucleic Acids Res.* 25, 5033–5040.
19. Charollais, J., Pflieger, D., Vinh, J., Dreyfus, M., Iost, I., 2003. The DEAD-box RNA helicase SrmB is involved in the assembly of 50S ribosomal subunits in *Escherichia coli*. *Mol. Microbiol.* 48, 1253–1265.
20. Charollais, J., Dreyfus, M., Iost, I., 2004. CsdA, a cold-shock RNA helicase from *Escherichia coli*, is involved in the biogenesis of 50S ribosomal subunit. *Nucleic Acids Res.* 32, 2751–2759.
21. Chen, J.Y.-F., Stands, L., Staley, J.P., Jackups Jr., R.R., Latus, L.J., Chang, T.-H., 2001. Specific alterations of U1-C protein or U1 small nuclear RNA can eliminate the requirement of Prp28p, an essential DEAD box splicing factor. *Mol. Cell* 7, 227–232.
22. Chuang, R.-Y., Weaver, P.L., Liu, Z., Chang, T.-H., 1997. Requirement of the DEAD-box protein Ded1p for messenger RNA translation. *Science* 275, 1468–1471.
23. Coburn, G.A., Miao, X., Briant, D.J., Mackie, G.A., 1999. Reconstitution of a minimal RNA degradosome demonstrates functional coordination between a 3' exonuclease and a DEAD-box RNA helicase. *Genes Dev.* 13, 2594–2603.
24. Collier, J.M., Tucker, M., Sheth, U., Valencia-Sanchez, M.A., Parker, R., 2001. The DEAD box helicase, Dhh1p, functions in mRNA decapping and interacts with both the decapping and deadenylase complexes. *RNA* 7, 1717–1727.
25. Cordin, O., Tanner, N.K., Doere, M., Linder, P., Banroques, J., 2004. The newly discovered Q motif of DEAD-box RNA helicases regulates RNA-binding and helicase activity. *EMBO J.* 23, 2478–2487.
26. Daugeron, M.C., Kressler, D., Linder, P., 2001. Dbp9p, a putative ATP-dependent RNA helicase involved in 60S-ribosomal-subunit biogenesis, functionally interacts with Dbp6p. *RNA* 7, 1317–1334.
27. de la Cruz, J., Kressler, D., Tollervy, D., Linder, P., 1998. Dob1p (Mtr4p) is a putative ATP-dependent RNA helicase required for the 3' end formation of 5.8S rRNA in *Saccharomyces cerevisiae*. *EMBO J.* 17, 1128–1140.
28. de la Cruz, J., Kressler, D., Linder, P., 1999. Unwinding RNA in *Saccharomyces cerevisiae*: DEAD-box proteins and related families. *Trends Biochem. Sci.* 24, 192–198. de la Cruz, J., Kressler, D., Linder, P., 2003. Ribosomal subunit assembly. In: Olson, M.O.J. (Ed.), *The Nucleolus*. Kluwer Academic/Plenum Publishers, New York, pp. 263–290.
29. Diges, C.M., Uhlenbeck, O.C., 2001. *Escherichia coli* DbpA is an RNA helicase that requires hairpin 92 of 23S rRNA. *EMBO J.* 20, 5503–5512. Diges, C.M., Uhlenbeck, O.C., 2005. *Escherichia coli* DbpA is a 3'-N5' RNA helicase. *Biochemistry* 44, 7093–7911.
30. Dillingham, M.S., Sultanas, P., Wigley, D.B., 1999. Site-directed mutagenesis of motif III in PcrA helicase reveals a role in coupling ATP hydrolysis to strand separation. *Nucleic Acids Res.* 27, 3310–3317.
31. Dziembowski, A., *et al.*, 2003. The yeast mitochondrial degradosome. Its composition, interplay between RNA helicase and RNase activities and the role in mitochondrial RNA metabolism. *J. Biol. Chem.* 278, 1603–1611.
32. Endoh, H., *et al.*, 1999. Purification and identification of p68 RNA helicase acting as a transcriptional coactivator specific for the activation function 1 of human estrogen receptor alpha. *Mol. Cell. Biol.* 19, 5363–5372.



**Kiran Priyadarshini Sahu and Pradip Kumar Prusty**

33. Estruch, F., Cole, C.N., 2003. An early function during transcription for the yeast mRNA export factor Dbp5p/Rat8p suggested by its genetic and physical interactions with transcription factor IIH components. *Mol. Biol. Cell.* 14, 1664–1676.
34. M.E., *et al.*, 2004. Protein displacement by DExH/D “RNA helicases” without duplex unwinding. *Science* 304, 730–734. Ferraiuolo, M.A., *et al.*, 2004. A nuclear translation-like factor eIF4AIII is recruited to the mRNA during splicing and functions in nonsense-mediated decay. *Proc. Natl. Acad. Sci. U. S. A.* 101, 4118–4123.
35. Flores-Rozas, H., Hurwitz, J., 1993. Characterization of a new RNA helicase from nuclear extracts of HeLa cells which translocates in the 5' to 3' direction. *J. Biol. Chem.* 268, 21372–21383.
36. Fuller-Pace, F.V., Nicol, S.M., Reid, A.D., Lane, D.P., 1993. DbpA: a DEAD box protein specifically activated by 23S rRNA. *EMBO J.* 12, 3619– 3626.
37. Gallivan, J.P., McGarvey, M.J., 2003. The importance of the Q motif in the ATPase activity of a viral helicase. *FEBS Lett.* 554, 485–488.
38. Gatfield, D., *et al.*, 2001. The DExH/D protein HEL/UAP56 is essential for mRNA nuclear export in *Drosophila*. *Curr. Biol.* 11, 1716–1721.
39. Gillian, A.L., Svaren, J., 2004. The Ddx20/DP103 dead box protein represses transcriptional activation by Egr2/Krox-20. *J. Biol. Chem.* 279,9056–9063.
40. Goralenya, A.E., Koonin, E.V., 1993. Helicases: amino acid sequence comparisons and structure–function relationships. *Curr. Opin. Struct. Biol.* 3, 419–429.
41. Goralenya, A.E., Koonin, E.V., Donchenko, A.P., Blinov, V.M., 1988. A novel superfamily of nucleoside triphosphate-binding motif containing proteins which are probably involved in duplex unwinding in DNA and RNA replication and recombination. *FEBS Lett.* 235, 16–24.
42. Henn, A., Shi, S.P., Zarivach, R., Ben-Zeev, E., Sagi, I., 2002. The RNA helicase DbpA exhibits a markedly different conformation in the ADP- bound state when compared with the ATP- or RNA-bound states. *J. Biol. Chem.* 277, 46559–4665.
43. Hieronymus, H., Silver, P.A., 2003. Genome-wide analysis of RNA-protein interactions illustrates specificity of the mRNA export machinery. *Nat. Genet.* 33, 155–161.
44. Hirling, H., Scheffner, M., Restle, T., Stahl, H., 1989. RNA helicase activity associated with the human p68 protein. *Nature* 339, 562–564.
45. Hodge, C.A., Colot, H.V., Stafford, P., Cole, C.N., 1999. Rat8p/Dbp5p is a shuttling transport factor that interacts with Rat7p/Nup159p and Gle1p and suppresses the mRex NA port defect of xpo1-1 cells. *EMBO J.* 18, 5778–5788.
46. Honig, A., Auboeuf, D., Parker, M.M., O'Malley, B.W., Berget, S.M., 2002. Regulation of alternative splicing by the ATP-dependent DEAD-box RNA helicase p72. *Mol. Cell. Biol.* 22, 5698–5707.





Performance of Finger Millet on Residual Soil Nutrient Status of Preceding Leguminous Crops under Integrated Nutrient Management – A Review

Jnana Bharati Palai^{1*}, G.C. Malik², Sagar Maitra¹, Tanmoy Shankar¹, Ashwini T.R. and M. Narendra Verma¹

¹Centurion University of Technology and Management, Odisha, India

²Palli-Siksha Bhavana, Visva-Bharati, West Bengal, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Jnana Bharati Palai

Centurion University of Technology and Management,
Odisha, India

Email: jnana@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Finger millet (*Eleusine coracana* L. Gaertn) is a vital minor millet that is considered as 'nutri-cereal'. Demand for finger millet is increasing day by day as compared to other minor or small millets, as it is rich in iron, calcium phosphorous, vitamin A and B and richest source of calcium. Use of only chemical fertilizer through increases yield, also affects the soil health. Integrated nutrient management (INM) aspect includes judicious use of chemical fertilizer, organic manure and bio-fertilizer and this approach maintains sustainability. INM in legumes leaves more residual soil nutrient, which can be utilized by growing low nutrient requiring finger millet. Growth, yield, nutrient uptake and economics of the crop showed better result on residual soil fertility of previous leguminous crop.

Key words: finger millet, INM, residual nutrient, growth, yield, nutrient uptake, economics

INTRODUCTION

The small millets got enough popularity due to their nutritional qualities during the recent years (Maitra, 2020; Maitra *et al.*, 2020). Finger millet (*Eleusine coracana* L. Gaertn) is the most important small millet in terms of area and production (Maitra *et al.*, 1998). The crop is considered as the fourth important millet in the world (Gupta *et al.*, 2012). Finger millet grain (per 100 g) contains 72.0 g carbohydrate, 7.3 g protein, 1.3 g fat, 2.7 g minerals, 18.8 g dietary fibre and 344 mg calcium (ICAR, 2009). It is the highest source of Ca among all cereals and millets. It is also rich in iron and phosphorus, as well as a good source of A and B vitamins (Upadhyaya *et al.*, 2006). The people, those who are involved in hard work, it ensures a good diet for them. Finger millet straw can be a nutritious fodder for cattle. Flour of finger millet malted grain is used for preparation of cakes, porridge and infant foods. It is a good diet for diabetic



**Jnana Bharati Palai et al.,**

patients (Sandhya *et al.*, 2017). Finger millet is a commonly cultivated crop in south Asia including India and many parts of eastern and southern Africa. Globally, finger millet production ranks sixth among cereals, which contributes about 12% of total millet production (Mundada *et al.*, 2020). Finger millet production is proportionately higher than other small millet production (Fig.1). India it is cultivated over an area of 1.0 million hectare with total production of about 1.76 million tonnes and with productivity of 1747 kg ha⁻¹ in 2019-20 (Anonymous, 2021). Finger millet is cultivated mainly in low fertile soil of tropics and subtropics by the Indian farmers. Although it is a less nutrient requiring crop, but its cultivation under less fertile soil and input reduces the yield potential of the crop (Maitra *et al.*, 1997, 2020). To enhance productivity and to maintain sustainability, diversification of the cropping system is required and the applied sources of nutrients should be proportionate to soil biodiversity (Dhiman and Dubey, 2017; Ramya *et al.*, 2020). That's why inclusion of leguminous crops in the cropping system can improve productivity in a sustainable manner (Praharaj and Maitra, 2020). Continuous use of chemical fertilizer has detrimental effects on soil health, agroecosystem and environment as a whole. Moreover, over-dependence on high energy and fossil fuel involving chemicals as fertilizers increases cost of cultivation and reduces nutrient recovery (Woods *et al.*, 2010; Ye *et al.*, 2020). Addition of organics as an input in crop production improves the quality and sustainability of crops (Latha and Sharanappa, 2014). This article includes how finger millet performs on residual soil nutrient status of preceding leguminous crops. Further, the article addresses some of the Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 and SDG 15 (life on land) (UN, 2021).

Effect of INM on post harvest soil fertility of legumes

Application of organic manures and biofertilizers is beneficial for soil health improvement as well as enrichment of soil fertility (Palai *et al.*, 2021). Supplementation of 5 t FYMha⁻¹ along with a RDF of 20:40:40 kg N, P and Kha⁻¹) improved available P, K and organic carbon in soil (Babu *et al.*, 2008). Mohapatra and Dixit (2010) observed that the treatment RDF (20:40:40 kg of N, P and K ha⁻¹) + gypsum @ 250 kg ha⁻¹ + lime @ 50 % lime requirement (LR) + *Rhizobium* recorded better post-harvest soil fertility such as 76.1, -0.7, -8.6, + 36.6, -1.2 and -0.99 kg ha⁻¹ available N, P, K, Ca, S and B, respectively. There was positive balance for N and Ca; whereas, slightly negative balance on P, K, S and B. Application of lime + FYM + 50% NPK on groundnut enhanced the available N, P and K content in post-harvest soil (Singh *et al.*, 2011). Patra *et al.* (2011) observed from the nutrient budget that combined application of inorganic and organic sources of nutrients such as RDF (20-60-60 kg NPK ha⁻¹) + vermicompost @ 2.5 t ha⁻¹ and RDF + phosphocompost @ 2.5 t ha⁻¹ recorded higher nutrient (N, P and K) balance after harvesting groundnut in sandy loam soil; whereas, only RDF application showed negative nutrient balance. Use of the treatment NPK + FYM in groundnut along with the leaf shedding property of the crop improved the soil organic matter status. Sole application of lime (PMS) or addition of FYM increased the soil pH in acidic soil and FYM also showed buffering action (Pattanayak *et al.*, 2011). Choudhary *et al.* (2011) while performed budgeting of nutrient application reported that maximum soil available N 164.1 kg ha⁻¹ and P 16.6 kg ha⁻¹ were obtained from application of 25 kg N + 50kg P₂O₅ + 40 kg K₂O ha⁻¹ along with the biofertilizers, viz., *Rhizobium*, VAM and PSB; whereas, minimum nutrient availability was recorded with the application of RDF as NPK (chemical fertilizers) alone. Qureshi and Bashir (2016) reported that in field pea the treatment 100% RDF (N₃₀P₅₀K₂₀S₂₀) + 20t FYM ha⁻¹ + *Rhizobium* inoculation showed the highest level of available N (272.32 kg ha⁻¹), P (31.64 kg ha⁻¹), K (271.67 kg ha⁻¹) and 0.73% OC% and lowest was recorded with absolute control. Umadevi *et al.* (2017) recorded that application of 100% RDF through only inorganic fertilizer in both *kharif* groundnut showed lesser (155.4 kg N, 27.1 kg P₂O₅ and 151.2 kg K₂O ha⁻¹) nutrient availability in post-harvest soil, whereas, it was more (176.4 kg N, 33.3 kg P₂O₅ and 172.4 kg K₂O ha⁻¹) when 100% N applied through FYM. Irungbam *et al.* (2018) found that 50% RDF + 50% N as FYM resulted in higher total N% (0.069) in soil, available P₂O₅ (18.44 kg ha⁻¹) and OC% (0.73) than 100% RDF and at par.

Residual effect of INM on finger millet production**Growth and yield**

One experiment on sorghum-wheat cropping system was conducted by Patidar and Mali (2002) and recorded that both the treatments, namely, 75% RDF and 100% RDF tested in sorghum resulted in significantly higher number of grains ear⁻¹, grain and straw yields of next wheat crop over the control. Application of 100% RDF to proceeding soybean crop at New Delhi significantly increased the different growth parameters such as height of plant, tiller



**Jnana Bharati Palai et al.,**

numbers and dry matter produced, whereas, the yield attributes such as number of ears, weight of ear and test weight as well as the grain and straw yield of succeeding crop wheat over control and 50% RDF (Shivakumar and Ahlawat, 2008). Tanwar and Shaktawat (2003) conducted an experiment on soybean-wheat cropping system at Udaipur (Rajasthan) in clay loam soils and found that application of P @ 38.7 kg ha⁻¹ to soybean significantly increased grain and straw yield of succeeding crop wheat over P @ 12.9 kg ha⁻¹ and P @ 25.8 kg ha⁻¹. Bodruzzaman *et al.* (2010) also stated that there was residual effect on succeeding crop wheat from FYM treated previous crop rice. Further, they mentioned that FYM could help in sustaining a long term rice-wheat cropping system. Shuaibuet *al.* (2015) studied on residual effect of legume and nitrogenous fertilizer on growth and yield of sorghum and reported that different growth attributes such as plant height, number of leaves per plant and yield attribute (1000 grain weight) and grain yield of sorghum was higher in cowpea and soybean residue plot than the fallow land. Riley (2016) observed that application of inorganic fertilizers gives higher yield in the applied season. But it has very little residual effect on the succeeding crop. Though organic manures are less efficient in nutrient supplementation than inorganic fertilizers, on a long term basis organic manures improve residual soil nutrient and crop yield as well as higher nutrient uptake. Balasubramanian *et al.*, (2016) also proved that residual effect of the treatment 100 % RDN + FYM @ 12.5 t ha⁻¹ from the preceding rice crop on growth parameter such as dry matter production (2141 kg ha⁻¹) and grain yield (497 kg ha⁻¹) of succeeding black gram was significantly higher than the treatment 100 % recommended dose of fertilizer N (RDN).

Nutrient content and uptake

Patidar and Mali (2002) found that residual effect of 100% RDF applied to the preceding crop sorghum showed highest N and P accumulation in succeeding wheat and increased by 20.5 and 20.7% over control followed by 75% RDF application, which increased 14.0 and 10.8% accumulation of N and P respectively. Another field study was carried out on pigeon pea-wheat cropping system on sandy loam soils at New Delhi and it was observed that application of maximum level of P (34.3 kg ha⁻¹) to pigeon pea resulted in maximum P uptake and also increased N and P availability to pigeon pea-wheat cropping system facilitating proliferation of root and shoot growth of pigeon pea (Singh and Ahlawat, 2007). According to Balasubramanian *et al.* (2016), significantly higher N (36.4 kg ha⁻¹), P (12.8 kg ha⁻¹) and K (38.5 kg ha⁻¹) uptake were recorded by succeeding black gram in rice-black gram cropping system as residual effect of the treatment 100 % RDN + FYM @ 12.5 t ha⁻¹ applied to the preceding rice and the treatment proved its superiority to 100 % RDN applied to rice.

Nutrient balance

Both N and P balance were higher in FYM treated plot than chemical fertilizers treated plot in lowland rice ecosystem (Tadesse *et al.*, 2013). Application of FYM @ 7.5 t ha⁻¹ resulted in higher N balance (21.8 kg ha⁻¹) and P balance (7.1 kg ha⁻¹). Whereas application of chemical fertilizer, i.e., 120 kg N ha⁻¹ and 100 kg P₂O₅ ha⁻¹ showed lower N (-5.1 kg ha⁻¹) and P (2.9 kg ha⁻¹) balance. Tiwari *et al.* (2010) also reported the similar findings that chemical fertilizers showed negative nutrient balance in soil; whereas, FYM showed positive nutrient balance. According to Dhadge (2009), N balance in post-harvest soil of maize in groundnut-maize cropping sequence was highest in the treatment 100% N through organic manure, whereas, P and K balance were highest in 25% RDF + 75% N (FYM) + *Rhizobium* + PSB.

Interaction effect of residual nutrient and *Rhizobium* on finger millet

Dubey and Datt (2008) concluded from their study that residual effect of *Rhizobium* inoculation in French bean significantly affected the yield of succeeding wheat. The treatment N @ 20 kg ha⁻¹ + *Rhizobium* inoculation gave highest grain yield (12.8 q ha⁻¹) of wheat and lowest yield of wheat was noted from the untreated plot. Shivakumar and Ahlawat (2008) found that 100 % RDF application to both the crops (soybean-wheat) resulted in significantly higher soil available N and P contents after completion of soybean-wheat system over 50 % RDF and control to soybean only. Tripathi *et al.* (2009) investigated on the residual effect of INM in sunhemp on succeeding rice crop at Pratapgarh, Uttar Pradesh and mentioned that integrated use of RDF and biofertilizer on sunhemp didn't show any significant effect on grain yield of succeeding rice crop. Residual effect of the treatment 75% NPK + *Rhizobium* + PSB gave highest grain yield (27.7 q ha⁻¹) of rice. The above treatment also recorded the highest N (72.5 kg ha⁻¹), P (12.5

42633



**Jnana Bharati Palai et al.,**

kg ha⁻¹) and K uptake (82.5 kg ha⁻¹) of rice and it was statistically at par with 100% RDF. Chaudhary *et al.* (2011) conducted a trial at Jobner, Jaipur (Rajasthan) to study the impact of INM on fenugreek-fodder pearl millet cropping system and observed that the residual effect of 100% RDN (inorganic) + *Rhizobium* inoculation gave significantly higher fodder productivity of pearl millet (12.30 t ha⁻¹ and 16.46 t ha⁻¹ at first and second cut, respectively) over sole application of organic source of nutrient and in combination. Another experiment conducted at Lahaul and Spiti (Himachal Pradesh) on garden pea-buckwheat cropping system by Sharma *et al.* (2011) to investigate both direct and residual effects of integrated nutrient management and noted that residual effect of RDF provided to garden pea was maximum with 150% RDF and least with 50% RDF. The treatment 150% RDF recorded maximum grain (2.14 and 2.1 t ha⁻¹ in the first and second year, respectively) and straw yield (2.98 and 2.78 t ha⁻¹ in the first and second year, respectively) of buckwheat and it was followed by 100 and 50% RDF.

Effect of INM on economics of legume-cereal cropping system

The Benefit:cost ratio of groundnut-maize cropping sequence was highest (3.01) in 100% RDF and lowest (2.32) in 100% N through organic manure the treatment applied to preceding crop groundnut Dhadge (2009). Further, Dhadge (2009) mentioned that highest gross return (₹176889/-) from the groundnut-maize cropping sequence was obtained from the treatment 75% RDF + 25% N(FYM) + *Rhizobium* + PSB and was lowest (₹156556/-) in treatment comprising of 100% N through organic manure. Dhadge (2009) revealed a trend in the result that gross return was highest at 75% RDF + 25% N(FYM) + *Rhizobium* + PSB. Baishya *et al.* (2014) also found highest gross return (₹80.9 x 10³ ha⁻¹), net return (₹55.7 x 10³ ha⁻¹) and B:C from the treatment 75% N (inorganic fertilizer) + 25% N (FYM) followed by 100% N inorganic fertilizer whereas lowest gross return, net return and B:C in 100% N FYM. Dhadge (2009) recorded that the treatment 75% RDF + 25% N through FYM + *Rhizobium* + PSB resulted in highest (3.85) B:C ratio and it was closer to the treatment 100% RDF (3.83). The lowest recorded B:C ratio was 3.22 from 100% N through FYM.

CONCLUSION

The article clearly mentioned that integrated nutrient management can improve soil fertility and crop productivity. Inclusion of legumes in the cropping system has a great impact on agricultural sustainability. From the review of different literature, it is concluded that satisfactory growth and yield of finger millet, a less nutrient requiring crop, can be obtained by growing under the residual soil fertility of the preceding leguminous crop. This practice has enough potential increase profitability and agricultural sustainability.

REFERENCES

1. Anonymous. 2021. Five Year Series data from 2015-16 to 2019-20. Latest APY State Data. Department of Agriculture, Cooperation & Farmers Welfare. Directorate of Economics & Statistics, Government of India. https://eands.dacnet.nic.in/APY_96_To_06.htm (Accessed on 2nd September 2021)
2. Babu, M.V., Balaguravaiah, D., Adinarayana, G, Prathap, S. and Reddy, T.Y. 2008. Effect of tillage and nutrient management on rainfed groundnut production and soil properties in Alfisols. *Legume Research*. 31(3): 192-195.
3. Baishya, L.K., Ansari, M.A., Singh, R., Deka, B.C., Prakash, N. and Ngachan, S.V. 2014. Response of groundnut (*Arachis hypogaea*) cultivars to integrated nutrient management on productivity, productivity and nutrient uptake in NEH region. *Indian Journal of Agricultural Sciences*84(5):612-615.
4. Balasubramanian, A., Stalin, P., Saravanaperumal, M. and kumar, S.R.V. 2016. Residual effect of Integrated Nutrient Management practices on growth and yield of rice fallow blackgram (*Vigna mungu*L.). *Journal of Emerging Technologies and Innovative Research*3(5):597-603.
5. Balasubramanian, A., Stalin, P., Saravanaperumal, M. and kumar, S.R.V. 2016. Residual effect of Integrated Nutrient Management practices on growth and yield of rice fallow blackgram (*Vigna mungu*L.). *Journal of Emerging Technologies and Innovative Research*3(5):597-603.





Jnana Bharati Palai et al.,

6. Bodruzzaman, M., Meisner, C.A., Sadat M.A. and Hossain, M.I. 2010. Long-term effects of applied organic manures and inorganic fertilizers on yield and soil fertility in a wheat-rice cropping pattern," 19th World Congress of Soil Science, Soil Solutions for a Changing World, Brisbane, 1-6 August 2010.
7. Choudhary, S.K., Jat, M.K., Sharma, S.R. and Singh, P. 2011. Effect of INM on soil nutrient and yield in groundnut field of semi-arid area of Rajasthan. *Legume Research*34(4): 283-287.
8. Dhadge, S.M. 2009. Effect of INM on summer groundnut-kharif maize crop sequence for seed production. PhD thesis. MPKV, Rahuri, Maharashtra. India.
9. Dhadge, S.M. 2009. Effect of INM on summer groundnut-kharif maize crop sequence for seed production. PhD thesis. MPKV, Rahuri, Maharashtra. India.
10. Dhiman, S. and Dubey. Y.P. 2017. Studies on impact of nutrient management and tillage practices on yield attributes and yield on gram – maize cropping sequence. *Indian Journal of Agricultural Research*51 (4): 305-312.
11. Directorate of Economics and Statistics, 2022. Second Advance Estimates of Production of Foodgrains for 2021-22. Chrome
xtension://efaidnbmnnnibpcjpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fends.dacnet.nic.in%2FAdvance_Estimate%2FTime%2520Series%2520%2520AE%25202021-22%2520(English).pdf&clen=102977&chunk=true
12. Dubey, Y. and Datt, N. 2008. Affectivity of Rhizobium leguminosarum phaseoli with nitrogen in French bean (*Phaseolus vulgaris*) wheat (*Triticum aestivum*) cropping sequence. *Indian Journal of Agricultural Sciences*78 (2):167-169
13. ICAR. 2009. Hand book of agriculture (6th edition). Indian Council of Agriculture Research, New Delhi, pp.1086.
14. Irungbam, P., Pramanick, M., Lepcha, R. and Sanatombi, Y. 2018. Productivity of summer groundnut (*Arachis hypogaea* L.) And soil properties as influenced by Different nutrient management in new alluvial zone of west Bengal. *The Bioscan*. 13(1): 261-265.
15. Latha, H.L. and Sharanappa, 2014. Effect of organic amendments on the productivity and quality of produce and soil in groundnut (*Arachis hypogaea*)-onion (*Allium cepa*) cropping system. *Indian Journal of Agricultural Sciences*84(8): 999-1003.
16. Maitra, S. 2020. Potential horizon of brown-top millet cultivation in drylands: A review. *Crop Research*, 55(1-2): 57-63. DOI: 10.31830/2454-1761.2020.012
17. Maitra, S., Ghosh, D. C. Sounda, S., Jana, P. K. and Roy, D. K. 1998. Effect of seed treatment on growth and productivity of finger millet under rained lateritic belt of West Bengal. *Indian Agriculturist*, 42 (1): 37- 43.
18. Maitra, S., Reddy, M.D. and Nanda, S.P. 2020. Nutrient Management in finger millet (*Eleusine coracana* L. Gaertn) in India. *International Journal of Agriculture, Environment and Biotechnology*13(1): 03-21.
19. Maitra, S., Roy, D.K., Mandal, B. K., Saren, B.K., Ghosh, T. K. and Roy, A. 1997. Effect of different nutrients and other agronomic management practices on growth and yield of finger millet in sub-tropical humid region of West Bengal. *Environment and Ecology*. 15 (2): 263-268.
20. Mohapatra, A.K.B. and Dixit, L.2010. Integrated nutrient management in rainy season groundnut (*Arachis hypogaea*). *Indian Journal of Agronomy*. 55(2): 123-127.
21. Mundada, P.S., Nikam, T.D., Kumar, S.A, Umdale, S.D., and Ahire, M.L. 2020. Morpho-physiological and biochemical responses of finger millet (*Eleusine coracana* (L.) Gaertn.) genotypes to PEG-induced osmotic stress. *Biocatalysis and Agricultural Biotechnology*23:101488.
22. Palai, J.B., Malik G.C., Maitra S. and Banerjee, M. 2021. Role of Rhizobium on Growth and Development of Groundnut: A Review. *International Journal of Agriculture, Environment and Biotechnology*14(1): 63-73.
23. Patidar, M. and Mali, A.L. 2002. Residual effect of farmyard manure, fertilizer and biofertilizer on succeeding wheat (*Triticum aestivum*). *Indian Journal of Agronomy* 47(1):26-32.
24. Patra, P.S., Singh, A.C. and Mahesh, S.S. 2011. Yield, nutrient uptake and quality of groundnut (*Arachis hypogaea*) kernels as affected by organic sources of nutrient, *Indian Journal of Agronomy* 56(3): 237-241.
25. Pattanayak, S.K., Mishra, U.K., Sarkar, A.K. and Majumdar, K. 2011. Integrated nutrient management for groundnut and red gram on acid soils of Odisha. *Better Crops – South Asia*95(2): 8-10.
26. Praharaj, S. and Maitra S. 2020. Importance of legumes in agricultural production system. *Agro Economist* 7(2):69-71.





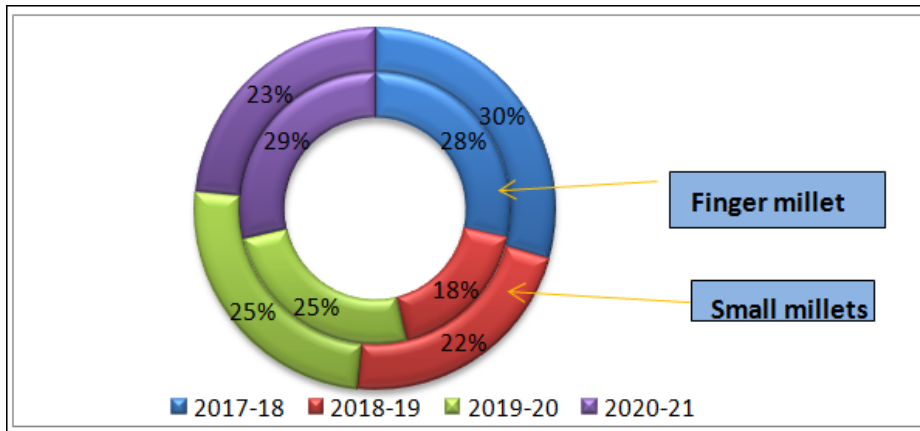
Jnana Bharati Palai et al.,

27. Oureshi, F. and Bashir, U. 2016. Effect of integrated nutrient management on sustainable production and profitability of field pea (*Pisum sativum*L.) and soil fertility in sub-tropical conditions. *Legume Research*39 (1): 101-105.
28. Ramya P., Maitra Sagar, Shankar T., Adhikary, R., and Palai J.B. 2020. Growth and productivity of Finger millet (*Eleusine coracana* L Gaertn) as influenced by integrated nutrient management. *Agro Economist*, 7(2 Special issue):19-24.
29. Riley, H. 2016. Residual value of inorganic fertilizer and farmyard manure for crop yields and soil fertility after long-term use on a loam soil in Norway. *Nutrient Cycling in Agroecosystems*104:25–37.
30. Sandhya, R.Y, Triveni, U., Patro, T.S.S.K. and Anuradha, N. 2017. Effect of nutrient management on yield and quality of finger millet (*Eleusine coracana* (L.) Gaertn). *International Journal of Chemical Studies*5(6): 1211-1216.
31. Shivakumar, B.G. and Ahlawat, I.P.S. 2008. *Integrated nutrient management in soybean (Glycine max)–wheat (Triticum aestivum) cropping system. Indian Journal of Agronomy*53(4): 273-278.
32. Shuaibu, Y.M., Garba, A.A. and Voncir, N. 2015. Influence of legume residue and nitrogen fertilizer on the growth and yield of sorghum (*Sorghum Bicolor* (L.) Moench) in Bauchi State, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*15(3):10060-10076.
33. Singh, G.P., Singh, P.L. and Panwar, A. S. 2011. Response of Groundnut (*Arachis hypogaea*) to biofertilizer, organic and inorganic sources of nutrient in North East India. *Legume Research*34(3): 196-201.
34. Singh, U. and Ahlawat I.P.S. 2007. Phosphorus management in pigeonpea (*Cajanus cajan*) – wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*52(1):21-26.
35. Tadesse, T., Dechassa, N., Bayu, W., Gebeyehu, S. 2013. Effects of Farmyard Manure and Inorganic Fertilizer Application on Soil Physico-Chemical Properties and Nutrient Balance in Rain-Fed Lowland Rice Ecosystem. *American Journal of Plant Sciences*4: 309-316.
36. Tanwar, S.P.S. and Shaktawat, M.S. 2003. Influence of phosphorus sources, levels and solubilizers on yield, quality and nutrient up take of soybean (*Glycine max*)–wheat (*Triticum aestivum*) cropping system in southern Rajasthan. *Indian Journal of Agricultural Sciences* 73(1):3-7.
37. Tiwari, K.R., Sitaula, B.K., Bajracharya, R.M. and Borresen, T. 2010. Effects of Soil and Crop Management Practices on Yields, Income and Nutrients Losses from Up-land Farming Systems in the Middle Mountains Region of Nepal. *Nutrient Cycling in Agroecosystems*86(2): 241-253.
38. Tripathi, M.K., Majumdar, B., Sarkar, S.K., Chaudhary, H. and Mahapatra, B.S. 2009. Effect of integrated nutrient management on sunhemp (*Crotalaria juncea*) and its residual effect on succeeding rice (*Oryza sativa*) in eastern Uttar Pradesh. *Indian Journal of Agricultural Sciences* 79(9):694-8.
39. Umadevi, G.D., Sunitha, N., Reddi Ramu, Y. and Naidu, M.V.S. 2017. Organic groundnut production under rainfed conditions for sustained productivity. *Bulletin of Environment. Pharmacology and Life Sciences*6 (2): 99-102.
40. UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
41. Upadhyaya, H.D., Gowda, C.L.L., Pundir, R.P.S., Reddy, V.G., Singh, S. 2006. Development of Core Subset of Finger Millet Germplasm Using Geographical Origin and Data on 14 Quantitative Traits. *Genetic Resources and Crop Evolution* 53(4): 679-685.
42. Woods, J., Williams, A., Hughes, J. K., Black, M., and Murphy, R. 2010. Energy and the food system. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences* 365(1554): 2991–3006.
43. Ye, L., Zhao, X., Bao, E., Li, J., Zou, Z. and Cao, K. 2020. Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. *Scientific Reports*10: 177.





Jnana Bharati Palai et al.,



(Source: DES, GOI, 2022)

Fig. 1: Comparison between finger millet with other small millet production





Exigency of Conserving Globally Vulnerable *Saraca asoca*

Abha Manohar K^{1*} and Gopal Shukla²

¹ Centurion University of Technology and Management, Odisha, India

² Uttar Banga Krishi Viswavidyalaya, West Bengal, India

Received: 07 Mar 2022

Revised: 09 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Abha Manohar K

Centurion University of Technology and Management,
Odisha, India

Email: abha.manohar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Saraca asoca is well known for its medicinal properties especially in treating gynecological ailments along with bacterial infestations, blood related diseases, skin disorders etc. The dwindling and scattered population in wild along with unscientific harvesting of bark for commercial and pharmaceutical industry has made the species globally vulnerable. Seed, flower, leaves and roots of the plant are considered therapeutically valuable but bark is highly priced in commerce. The tree has been used by indigenous communities and mentioned in age old ayurvedic literature as several commercial *S. asoca* formulations used for curing different ailments. Ashoka bark is heavily adulterated in the market which is only be reduced by creating quality populations. Lack of existing stands in wild and low survivability of seeds by predation are the major hindrances behind natural regeneration in forests. So as to develop conservation strategies of this treasured resource along with *in situ* and *ex situ* conservation methods, people's awareness programmes should be conducted based on conservation priority sites for *Saraca asoca*.

Keywords: Ashoka, Pharmaceutical value, Sustainable, conservation, Livelihood

INTRODUCTION

Saraca asoca (Roxb.), De. wild or *Saraca indica* is one of the most ancient evergreen tree of India, frequently known as a "Ashok briksh" or "Ashoka" belonging to family Caesalpinaceae. It is a Sanskrit word which means "without sorrow" or which that gives no grief. In a reference to this its bark's reputation for keeping healthy and youthful and Buddha was said to be born under this tree. Across India, Ashoka tree is believed to be sacred and apart from Ramayana, Ashoka tree is mentioned in Buddhism and Jainism as well. Charaka Samhita which is believed to have been composed in 1000 BC describes about Ashoka tree and its medicinal benefits (Kashyup *et al.*, 2006). Ashoka tree has been mentioned in some of the oldest Indian text apart from Ayurveda. It is considered as



**Abha Manohar and Gopal Shukla**

one of the most legendary and sacred trees of India. *Saraca asoca* is grown all over India and mainly cultivated in many gardens for evergreen beautiful foliage. It is distributed all over country, particularly in southern India, Assam, Odisha and West Bengal as well in central and eastern Himalayas up to 750 m altitude (Patwardhan et al., 2016; Kulkarni, 2018). Number of individual trees from the forest is rapidly decreased because of non sustainable harvesting practices and degradation of ecosystems (Manohar et al. 2020). It is placed under globally vulnerable category according to International Union of Conservation of Nature and Natural resources (IUCN, 2022). The declining population can only be restored and multiplied through both in situ and ex situ conservation efforts. The seeds of the species were reported with less germination (Manohar et al 2020). Conservation of this species also addresses Sustainable Development Goals, viz., SDG-3 (Good health and well-being), SDG-8 (Decent work and Economic Growth), SDG-12 (Responsible consumption and production), SDG-15 (Life on Land) .

Distribution

Asoka grows well in moist tropical areas with well-distributed rainfall. It also thrives well in partially shaded locations. Asoka tree is mainly distributed in Asia and some parts of North America. In Indian subcontinent, West Bengal, Assam, Odisha, Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, Meghalaya and Maharashtra. Originally it was distributed in the central areas of the Deccan plateau, as well as the middle section of the Western Ghats in the western coastal zone of the Indian subcontinent. As a wild tree, the Ashoka is a vulnerable species. *Saraca asoca* is also found in countries such as Pakistan, Sri Lanka, Bangladesh as well as in Burma (Saha et al., 2012).

Morphological characteristics

The leaves are paripinnate, alternate, distichous and 7-30 cm long and its petiolule 0.1-0.6 cm long and opposite leaflets, 4-6 pairs, narrow elliptic-oblong or lanceolate, and its apex acute to acuminate, base acute to rounded or subcordate, glabrous, midrib raised above and tertiary nerves reticulate (Pradhan et al., 2009). The bark is dark brown or grey or almost black with warty surface. Stem bark are rough and uneven due to the presence of rounded or projecting lenticles and channeled, smooth with circular lenticles and transversely ridged. Floral inflorescence carrydense corymbs, orange colour to red in color with a peculiar fragrance. Fruit is a pod, oblong and apiculate, four to eight seeded, flat and black coloured, leathery pod. The pod is dehiscent, woody, and tapering at both ends. Seeds are ellipsoid-oblong and compressed. Flowering and fruiting occur from July to October (Pradhan et al., 2009).

Nursery Technology

- Seeds are collected in December–January and seedlings are raised in a nursery in March of polybags of 25 cm × 20 cm size. The seeds germinate in about 15 days.
- For land preparation pits of size 45 cm × 45 cm × 45 cm are prepared at a spacing of 3 m × 3 m.
- Two-month-old seedlings are transplanted in the pits during monsoon season in June/July.
- Ashoka performs better when grown as a mixed crop with perennial trees like coconut, which provide partial shade to the crop. Intercropping with herbs and medicinal plants can also be done for earlier economic returns.

Medicinal Value and Phytochemistry

It is a major valuable medicinal tree of traditional Indian Medicine system and its bark is possess variety of chemical, which is used for women disorder (Begum et al., 2014). Due to its immense medicinal values, the species gaining importance among the plant biotechnologists and pharmacologists in terms of its pharmaceutical importance (Smitha, 2013; Begum et al., 2014). Ashoka tree has mythological importance and occupies a privileged place in many Indian folk and socio-cultural traditions. The legendary Indian text, Ramayana has a mention of the Ashoka tree. In India, Married women are generally known to eat Ashoka flower buds as a ritual to invoke deities for child protection as well as different gynecological problems (Pradhan et al., 2009). Traditionally it is used for treating women related problems such as leucorrhoea, menorrhagia, dysfunctional uterine bleeding, and bleeding hemorrhoids etc. It is believed that the persons suffering from mental disorder are advised to take bath under the shade of Ashok tree. Generally natives prepared special herbal Mala for mental piece using root pieces of Sita Ashok. The Ashoka herb is also said to improve the complexion of skin. This herb can be used to obtain relief from burning sensations on the skin. It also helps to get rid of the toxins from the body. The Ashoka herb is also effective



**Abha Manohar and Gopal Shukla**

in purifying the blood naturally and in preventing skin allergies (Gahlaut et al, 2013; Bhalerao et al., 2014). In many region of India, traditionally on belief people wear root pieces of Ashoka as herbal rosary for mental tranquility. Our numbers of ancient scriptures describe the importance of Asoka like in Charaka Samhita (1000 BC), Susruta(500 BC), Dhanvantari Nighantu (9th century AD), Raj Nighantu, Kayadeva Nighantu etc.

Table 1 shows phytoconstituents seen in different parts of the tree. Many ayurvedic and allopathic drugs are derived from Ashoka (Table 2.) which shows the necessity to conserve the tree and extended commercialization of the species (Haridasan et al., 2003).

Pharmacological and Biological activity

Anti-menorrhagic, oxytocic and uterine tonic, Anticancer, Anti-inflammatory, anti-arthritis and cardio-protective effect, Antibacterial, Antifungal, Anti-nephrolithiatic, Central nervous system depressant and brain tonic, Antioxidant, anti-diabetic and hypolipidemic, Dermato-protective, Analgesic, Larvicidal, Anti-helminthic, Anti-mutagenic and genoprotective effect, Antimicrobial activity, Anti-inflammatory activity, Uterine tonic activity, CNS depressant activity, Anti-diabetic activity, Anthelmintic activity, Analgesic activity, Larvicidal activity, Antiulcer activity, Anticancer activity, Anti-oxytocic activity ((Varghese et al., 1992, 1993; Bhandary et al., 1995; Ghosh et al., 1999; Mitra et al., 1999; Mujumdar et al., 2000).

Need of Conservation

Ashoka tree occupies a great position in ancient folklore and related to many spiritual beliefs. It has got a fascinating history in India. Medicinal and pharmaceutical values of this tree is immense especially in curing women disorders. As the population has become very scattered and only in forests its very difficult to meet the demand. Thus reducing the population in the wild. Conservation is the only way to save the species. If not its not too long for the extinction of this valuable tree. *Ex situ* and *in situ* methodologies can be adopted to commercialize this species. In order to conserve and commercialize the species, information on seed quality, seed requirement, pre-sowing treatment, germination behavior, seedling vigour, time and duration of seed collection is also important (Rajashekara, 2004; Ingle and Venugopal, 2009). National Medicinal Plants Board is giving funds for the conservation of this species through projects (Manohar et al. 2020). Also it can be used to enhance the income of farmers in rural areas as the bark is fetching good amount of money. This will also generate income. So the conservation through commercialization in the species is highly recommended.

CONCLUSION

Ashoka is the most ancient tree of India, Ashoka is used in many pharmacological activities like anti-cancer, anti menorrhagic , anti oxytoxic , anti –microbial activity and have extend uses in ayurveda , unani and homeopathy. From a farmers perspective this tree is very promising on a long term goal as presently there are no harmful insects or pests associated with this. The global scenario is now changing towards the use of nontoxic plant product having traditional medicine use, development of modern drug from *Saraca indica* should be emphasized for the control of various diseases.

REFERENCES

1. Begum NS, Ravikumar K and Ved DK. (2014). 'Asoka'- an important medicinal plant, its market scenario and conservation measures in India. Curr. Sci., 107: 26-28.
2. Bhandary M J, Chandrasekhar M J K R and Averiappa K M K (1995) Medical ethnobotany of the Siddis of Uttara Kannada district, Karnataka. India Journal of Ethnopharmacology 47: 149-158.





Abha Manohar and Gopal Shukla

3. Dhawan B.N., Patnaik G.K., Rastogi R.P., Singh K.K., Tandon J.S., (1977). *Indian Journal of Experimental Biology*, **15**: 208-219.
4. Gahlaut A., Shirolkar A., Hooda V., and Dabur R. (2013). Sitosterol in different parts of *Saracaasoca* and herbal drug ashokarista: quali-quantitative analysis by liquid chromatography-mass spectrometry. *Journal of Advanced Pharmaceutical Technology & Research*, **4**: 146–150.
5. Ghosh S, Majumder M, Majumder S, Ganguly N K and Chatterjee B P (1999) Saracin: a lectin from *Saraca indica* seed integument induces apoptosis in human Tlymphocytes. *Archives of Biochemistry and Biophysics* 371: 163-168.
6. Haridasan K, Sharma A, Buyan C R and Bisht N S (2003) Medicinal Sector in Arunachal Pradesh- on overview. *Indian Forester* 129: 37-47.
7. Ingle M R and Venugopal C K (2009) Effect of different growth regulators on rooting of stevia (*Stevia rebaudiana*Bertoni) cuttings. *Karnataka Journal of Agricultural Sciences* 22: 460-461.
8. IUCN (2022) The IUCN red list of threatened species. Version 2019.3. <http://www.iucnredlist.org/> Assessed on 12-03-2022
9. Kulkarni R V (2018) *Saracaasoca* (Ashoka): a review. *World journal of Pharmaceutical Research* 7: 536-544.
10. Manohar KA, Shukla G, Chakraborty M, Kundu A, Maitra S, Chakravarty S (2020) Effect of pre-sowing seed treatments on germination behaviors of *Saracaasoca* (Roxb.) Willd. *Medicinal Plants*. 12(2): 309-317.
11. Mitra S K, Gopumadhavan S, Venkatarangana M V, Sharma D N K and Anturlikar S D (1999) uterine tonic activity of U-3107 (even care), a herbal preparation in rats. *Indian journal of pharmacology* 31: 200-203.
12. Gupta M., Sasmal S., Mukherjee A. (2014). Therapeutic effects of acetone extract of *Saracaasoca* seed on rats with adjuvant-induced arthritis via attenuating inflammatory responses. *ISRN Rheumatol*, pp.1–12.
13. Kalakotla S., Mohan G.K., Rani M.S., Divya L., Pravallika P.L., (2014). Screening of *Saraca indica* (Linn.) medicinal plant for antidiabetic and antioxidant activity. *Der Pharmacia Lettre Journal*, **6**: 227–233.
14. Patwardhan A, Pimputkar M, Mhaskar M, Agarwal P, Barve N, Gunaga R and Vasudeva R (2016) Distribution and population status of threatened medicinal tree *Saracaasoca* (Roxb.) De Wilde from Sahyadri–Konkan ecological corridor. *Current Science* 111: 1500-1506.
15. Pradhan P., Joseph L., Gupta V., Chulet R., Arya H., Verma R, Bajpai A (2009). *Saracaasoca* (Ashoka): a review. *Journal of Chemical and Pharmaceutical Research*, **1**: 62–71.
16. Rajasekaran T, Giridhar P and Gokare R (2007) Production of stevioside in ex vitro and in vivo grown *Stevia rebaudiana* Bertoni. *Journal of the Science of Food and Agriculture*. 87: 420-424.
17. Saha J., Mitra T., Gupta K., and Mukherjee S. (2012). Phytoconstituents and HPTLC analysis in *Saracaasoca* (roxb.) Willde. *International Journal of Pharmacy and Pharmaceutical Sciences*, **4**: 96–99.
18. Smitha GR and Das M (2016). Effect of seed moisture content, temperature and storage period on seed germination of *Saracaasoca* - an endangered medicinal plant. *Medicinal Plants*, 8(1):60–64.
19. Varghese V D, Nair S C and Panillar K R (1992) Potential anticancer activity of *Saracaasoca* towards transplantable tumours in mice. *Indian Journal of pharmaceutical Science* 54: 37-39.

Table.1

| Plant Part | Phytoconstituent |
|------------|--|
| Flower | Oleic, linoleic, palmitic and stearic acid, sitosterol, quercetin, kaempferol, quercetin, apigenin- 7-0-p-D-glucoside, Pelargonidin- 3, 5- diglucoside, cyanidin-3, 5- diglucoside, palmitic, stearic, linolenic, leucocyanidin and gallic acid. |
| Bark | Procyanidin, epicatechin, 11'- deoxyprocyanidin B, catechin, leucopelargonidin and leucocyanidin. |
| Dried bark | Glycosides, Iyoside, nudiposide, 5-methoxy- 9-β-xylopyranosyl, isolaricresinol, and schizandriside, and three flavonoids, epicatechin, epiafzelechin-(4β→8)-epicatechin and |





Abha Manohar and Gopal Shukla

| | |
|---------------------|--|
| | procyanidin B2, together with β -sitosterol glucoside |
| Seed and pod | Oleic, linoleic, palmitic and stearic acids, catechol,(-) epicatechol and leucocyanidin. |

(Dhawan *et al.*, 1977)**Table 2.**

| Trade name | Form | Indications recommended for | Company |
|------------------------------------|------|---|----------------------|
| Evecare ^a | S | Menstrual disorders | Himalaya |
| Menosan ^a | T | Menopause-related indications | Himalaya |
| Ovoutoline ^a | S&T | Menorrhagia, dysmenorrhea, irregular menstruation, postmenopausal syndrome | Zandu |
| Restone ^a | T | Premenstrual tension, menopausal syndrome, genitourinary diseases | Maharishi Ayurveda |
| Menorex ^b | C | Menorrhagia, dysmenorrhea, irregular menstruation | Arya Vaidya Pharmacy |
| Femiplex ^a | C | Leucorrhoea | Charak |
| Ayapon ^a | T | Menorrhagia, metrorrhagia, pubertal and menopausal bleeding, etc. | Alarsin |
| Shvet ^a | C | Leucorrhoea, menorrhagia, dysfunctional uterine bleeding | Shree Dhanvantari |
| Pradarsudha ^a | S | Leucorrhoea, menorrhagia | Patanjali Ayurved |
| Femohills ^a | C | Leucorrhoea, menorrhagia, dysmenorrhea, lower back pain | Herbalhills |
| Menocramp ^a | T | Spasmodic and lower back pain, stress and mood swings | Solumiks |
| Ashotone ^a | T | Excessive bleeding, stress | Solumiks |
| AsokChurna ^b | P | Leucorrhoea, dysmenorrhea, gynecological disorders | Hidco |
| PradarantakC hurna ^c | P | Leucorrhoea, irregular menses, premenstrual syndrome, ovarian cysts, uterine fibroids, dysfunctional uterine bleeding | Charak |
| M2-Tone Forte ^a | S | Excessive bleeding, menstrual flow issues | Charak |
| M2-Tone ^a | T | Irregular menses, gynaecological disorders | Charak |
| Masturin ^a | S | Irregular menses, leucorrhoea, dysmenorrhea, uterine inflammation | Hamdard |
| Ashokrista ^a | S | Leucorrhoea, dysmenorrhea, menorrhagia, dysfunctional uterine bleeding, gynecological disorders | Several |

(*Source: Internet. This is not a comprehensive list. ^aAshoka + other herbs, ^bAshoka only; ^cAshoka + ayurvedic formulation; S, Syrup; T, Tablets; C, Capsules and P, Powder





Effects of Rice Herbicides on Soil Enzymes (Fluorescein Diacetate and Dehydrogenase Activity) of Succeeding *Toria* Sown with Stubble Mulch and Minimum Tillage

Ashirbanchan Mahapatra^{1,2,3}, Mahesh Chandra Bhambri¹, Sanjoy Saha^{2*}, Sushmita Munda² and Nitish Tiwari¹

¹Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

²Crop Production Division, ICAR–National Rice Research Institute, Cuttack, Odisha, India

³Centurion University of Technology and Management, Paralakhemundi, Odisha, India.

Received: 05 Mar 2022

Revised: 06 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Sanjoy Saha

Crop Production Division,
ICAR–National Rice Research Institute,
Cuttack, Odisha, India.
Email: ssahacrr@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Herbicides may have detrimental effect on the soil environment affecting the activity of soil microorganisms for a long time even in the succeeding crop. Therefore an experiment was conducted in the wetland dry seasons of 2018-19 and 2019-20 at ICAR – National Rice Research Institute, Cuttack, Odisha laid out in randomized block design comprising of ten weed management treatments in transplanted rice in wet season comprising of three herbicide mixtures i.e. flopyrauxifen-benzyl + cyhalofop-butyl at (25+125) g ha⁻¹ at 18 daysafter transplanting (DAT) (W₁), fenoxaprop-p-ethyl + ethoxysulfuron at (50+15) g ha⁻¹ at 18 DAT (W₂) and cyhalofop-butyl + penoxsulam at (100+30) g ha⁻¹ at 18 DAT (W₃); three sequential application of herbicides i.e. bispyribac-sodium at 30 g ha⁻¹ at 9 DAT *fb* ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W₄), flucetosulfuron at 25 g ha⁻¹ at 9 DAT *fb* ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W₅) and cyhalofop-butyl at 100 g ha⁻¹ at 9 DAT *fb* ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W₆); two herbicide checks i.e. bensulfuron-methyl + pretilachlor at (60+600) g ha⁻¹ at 4 DAT (W₇) and bispyribac-sodium at 30 g ha⁻¹ at 2 leaf stage of weeds (W₈); one weed free check (Hand weeding at 20, 40 and 60 DAT) (W₉) and one weedy check (Untreated) (W₁₀); replicated thrice. After harvest of wet season rice, *toria* was sown with resource conservation technologies *viz.* minimum tillage and rice stubble mulch in the succeeding dry season and the residual effects of the rice weed management treatments on soil environment i.e. soil enzymes i.e. FDA hydrolase activity and dehydrogenase activity were studied at 30, 45 and 60 days after sowing of *toria*. The effects of the preceding season weed management treatments were found non-significant on the soil environment of *toria* in the dry season.



**Ashirbachan Mahapatra et al.,****Keywords:** Herbicides, Minimum Tillage, Fluoresce indiacetated activity, Dehydrogenase activity, Rice, *Toria*

INTRODUCTION

The Rapeseed-mustard occupies 2nd position after groundnut out of the seven edible oilseeds in India which contributes nearly 29% of production (Shekhawat et al., 2012). Rice-based cropping system is one of the major cropping systems adopted in India. In Eastern Indian rainfed situation, mostly followed cropping system is rice-fallow (nearly about 9.73 million ha area)(Kumar et al., 2018) cropping system in which the residual moisture in the soil is subjected to evaporation loss. A short duration crop can easily be grown in this duration in order to increase the productivity of the land as well as profit of the farmers. Being a short duration crop (70-80 days), toria is well suited to be included in the existing rainfed situation as in sequence after cultivation rice. Hence, it's cultivated largely in eastern India, including the state of Assam, Bihar, Odisha and West Bengal mainly as winter crop after harvest of rice (Samant, 2015). Out of the 17 SDGs suggested by UNDP, rice-based cropping system with resource conservation technologies has potential to fulfill SDG 2 and 3 (FAO, 2021). Among different biotic stresses, one of the major problems is weed infestation to reduce the crop yield. Therefore timely weed control must be done in order to check yield loss. Out of different weed control methods, herbicidal weed control has its great importance due to its cost effectiveness and efficiency. However, due to herbicide application, there may be qualitative and quantitative alterations in the soil environment of the crop i.e. soil microbial populations and their enzymatic activities (Xia et al., 2011). Several literatures reported that recommended doses of herbicides didn't have harmful effect on soil environment (Selvamani and Sankaran, 1993) but the non-target organisms including microorganisms may be affected by some of the herbicides (Latha and Gopal, 2010). Even it was so reported that, the growth and activities of the soil microbes may be stimulated by application of some herbicides (Wardle and Parkinson, 1990). However, information regarding the effects of different herbicides applied in wet season rice, on soil enzymes in succeeding *toria* crop is limited.

MATERIALS AND METHODS

The field experiment was conducted at ICAR–National Rice Research Institute, Cuttack, Odisha in wet and dry seasons of 2018-19 and 2019-20. The experiment was laid out in Randomized Block Design with ten weed management treatments in wet season transplanted rice (TPR) and the residual effects of the same treatments were studied in the succeeding *toria* crop in the dry season with three replications. The *toria* was sown after harvest of TPR with resource conservation technologies i.e. minimum tillage and wet season rice stubble mulch. The ten weed management treatments in rice were three herbicide mixtures i.e. flopyrauxifen-benzyl + cyhalofop-butyl at (25+125) g ha⁻¹ at 18 days after transplanting (DAT) (W_1), fenoxaprop-p-ethyl + ethoxysulfuron at (50+15) g ha⁻¹ at 18 DAT (W_2) and cyhalofop-butyl + penoxsulam at (100+30) g ha⁻¹ at 18DAT(W_3); three sequential application of herbicides i.e. bispyribac-sodium at 30g ha⁻¹ at 9DAT *fb*e thoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_4), flucetosulfuron at 25 g ha⁻¹ at 9 DAT *fb*ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_5) and cyhalofop-butyl at 100 g ha⁻¹ at 9 DAT *fb*ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_6); two herbicide checks i.e. bensulfuron-methyl + pretilachlor at (60+600) g ha⁻¹ at 4 DAT (W_7) and bispyribac-sodium at 30 g ha⁻¹ at 2 leaf stage of weeds (W_8); one weed free check (Hand weeding at 20, 40 and 60 DAT) (W_9) and one weedy check (Untreated)(W_{10}).

Soil microbial analysis

Soil samples from each plot consisted of composite samples were collected with as ample probe augur (0-15cm) at 30, 45 and at 60 days after sowing (DAS) of dry season *toria*. Collected soil was thoroughly mixed and composite samples were prepared.



**Ashirbachan Mahapatra et al.,****Fluoresce indiacetate (FDA) activity**

FDA hydrolase activity was measured by the potassium phosphate buffer method (pH 7.6) followed by extraction with chloroform / methanol (2:1 v/v) as described by Adam and Duncan (2001).

Dehydrogenase activity (DHA)

Dehydrogenase activity (DHA) was determined by reduction of triphenyltetrazolium chloride (TTC) (Casida et al., 1964). Soil samples were treated with CaCO₃ and TTC and incubated for 24 h at 37°C. The triphenylformazan (TPF) was extracted from the reaction mixture with methanol and assayed at 485 nm.

RESULTS AND DISCUSSION**FDA hydrolase activity**

FDA hydrolase activity measures the early detrimental effect of xenobiotics on soil microbial biomass and is considered as an accurate expression of total microbial activity (Nayak et al., 2007). The FDA hydrolase activities as influenced by different weed management treatments are presented in Table 1. The weed management treatments of wet season rice though influenced FDA hydrolase activity in succeeding *toria*, but there was no significant difference among the effects of the treatments during both the years of experiments. However, it can be noticed that the FDA hydrolase activity gradually increased from 30 to 60 DAS and the activity was highest in bispyribac-sodium (W₈), weed free (W₉) and weedy check (W₁₀) treatments. The treatments had no detrimental effects on FDA hydrolase activity in the succeeding *toria*.

Dehydrogenase activity (DHA)

Soil DHA is considered as a valuable parameter for assessing the impact of herbicide treatments on the soil microbial biomass (Sheeja et al., 2015). Data regarding DHA as influenced by different weed management treatments are presented in Table 2. There was no significant difference observed among the effects of the wet season rice weed management treatments on DHA in succeeding *toria*. However the overall DHA increased from 30 to 60 DAS and the rate of increase of the DHA was more in 30-45 DAS than 45-60 DAS in all treatments. The increase in DHA might be due to decomposition of rice stubbles. The treatments had no detrimental effects on DHA in the succeeding *toria*.

CONCLUSION

The herbicide mixtures, sequential application of herbicides and single herbicide used in the experiment were found to be safe having no harmful effects on soil enzymes i.e. FDA hydrolase activity and dehydrogenase activity in the soil environment of succeeding *toria* crop.

REFERENCES

1. Adam, G., Duncan, H. 2001. Development of sensitive and rapid method for the measurement of total microbial activity using fluoresce indiacetate (FDA) in a range of soils. *Soil Biology and Biochemistry* 33: 943-951.
2. Casida, L.E., Klein, D.A., Santoro, T. 1964. Soil dehydrogenase activity. *Soil Science* 98: 371-376.
3. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 30th April, 2022).
4. Kumar, R., Mishra, J.S., Hans, H. 2018. Enhancing productivity of rice-fallows of eastern India through inclusion of pulses and oil seeds. *Indian Farming* 68(8): 7-10.
5. Latha, P.C., Gopal, G. 2010. Influence of herbicides on cellulolytic, proteolytic and phosphate solubilizing bacteria. *International Journal of Plant Protection* 3(1): 83-88.
6. Nayak, D., Jagadeesh Babu, Y., Adhya, T.K. 2007. Long-term application of compost influences microbial biomass and enzyme activities in a tropical Aeric Endoaquept planted to rice under flooded condition. *Soil Biology and Biochemistry* 39: 1897-1906.





Ashirbachan Mahapatra et al.,

7. Samant, T.K. 2015. On farm assessment of toria (*Brassica campestris* L.) variety Sushree under mid central tableland zone of Odisha. International Journal of Applied Research 1(9):84-86.
8. Selvamani, S., Sankaran, S. 1993. Soil microbial populations as affected by herbicides. Madras Agricultural Journal 80:397-399.
9. Sheeja, K.R., Elizabeth, K.S., Girija Devi. L. 2015. Impact of new herbicide molecule bispyribac sodium + metamifop on soil health under direct seeded rice lowland condition. Field Crops Research 50(1-3):1-8.
10. Shekhawat, K., Rathore, S.S., Premi, O.P., Kandpal, B.K., Chauhan, J.S. 2012. Advances in agronomic management of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson): An overview. International Journal of Agronomy, 2012.
11. Wardle, Parkinson. 1990. Effect of three herbicides on soil microbial biomass and activity. Plant and Soil 112:21-28
12. Xia, X., Zhao, M., Wang, H., Ma, H. 2011. Influence of butachlor on soil enzyme and microbial growth. Journal of Food, Agriculture and Environment 9(2):753-756.

Table 1: Residual effects of wet season rice herbicides on FDA hydrolase activity in succeeding toria

| Treatments | FDA hydrolase Activity ($\mu\text{g g}^{-1}\text{soil h}^{-1}$) | | | | | | | | |
|-----------------|---|---------|------|---------|---------|------|---------|---------|------|
| | 30DAS | | | 45DAS | | | 60DAS | | |
| | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean |
| W ₁ | 3.11 | 3.17 | 3.14 | 4.44 | 4.53 | 4.48 | 6.06 | 6.17 | 6.11 |
| W ₂ | 3.10 | 3.14 | 3.12 | 4.42 | 4.49 | 4.46 | 6.04 | 6.11 | 6.07 |
| W ₃ | 3.07 | 3.13 | 3.10 | 4.38 | 4.48 | 4.43 | 5.98 | 6.09 | 6.04 |
| W ₄ | 3.15 | 3.19 | 3.17 | 4.49 | 4.56 | 4.53 | 6.13 | 6.20 | 6.17 |
| W ₅ | 3.02 | 3.11 | 3.06 | 4.30 | 4.45 | 4.37 | 5.87 | 6.05 | 5.96 |
| W ₆ | 3.11 | 3.16 | 3.14 | 4.44 | 4.52 | 4.48 | 6.06 | 6.15 | 6.10 |
| W ₇ | 3.02 | 3.08 | 3.05 | 4.30 | 4.40 | 4.35 | 5.87 | 5.99 | 5.93 |
| W ₈ | 3.26 | 3.35 | 3.30 | 4.64 | 4.79 | 4.72 | 6.34 | 6.52 | 6.43 |
| W ₉ | 3.35 | 3.39 | 3.37 | 4.77 | 4.85 | 4.81 | 6.51 | 6.59 | 6.55 |
| W ₁₀ | 3.31 | 3.36 | 3.33 | 4.71 | 4.80 | 4.76 | 6.44 | 6.53 | 6.49 |
| SE m \pm | 0.13 | 0.11 | 0.07 | 0.19 | 0.11 | 0.10 | 0.26 | 0.21 | 0.14 |
| CD(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

All the treatments are described in the materials and methods

Table 2: Residual effects of wet season rice herbicides on Dehydrogenase activity (DHA) in succeeding toria

| Treatments | Dehydrogenase activity (DHA) ($\text{mg g}^{-1}\text{soil h}^{-1}$) | | | | | | | | |
|-----------------|---|---------|--------|---------|---------|--------|---------|---------|--------|
| | 30DAS | | | 45DAS | | | 60DAS | | |
| | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean |
| W ₁ | 133.39 | 139.31 | 136.35 | 164.07 | 171.35 | 167.71 | 182.74 | 190.85 | 186.80 |
| W ₂ | 131.58 | 136.10 | 133.84 | 161.84 | 167.41 | 164.62 | 180.26 | 186.46 | 183.36 |
| W ₃ | 130.07 | 134.28 | 132.17 | 159.98 | 165.16 | 162.57 | 178.19 | 183.96 | 181.08 |
| W ₄ | 135.05 | 141.04 | 138.05 | 165.25 | 172.58 | 168.91 | 185.02 | 193.23 | 189.12 |
| W ₅ | 128.64 | 133.78 | 131.21 | 157.40 | 163.69 | 160.55 | 176.23 | 183.28 | 179.75 |
| W ₆ | 132.83 | 138.19 | 135.51 | 162.53 | 169.09 | 165.81 | 181.97 | 189.32 | 185.65 |
| W ₇ | 128.96 | 134.43 | 131.69 | 157.80 | 164.48 | 161.14 | 176.68 | 184.16 | 180.42 |
| W ₈ | 139.00 | 144.59 | 141.79 | 171.72 | 178.62 | 175.17 | 190.43 | 198.08 | 194.26 |
| W ₉ | 143.61 | 150.22 | 146.91 | 177.41 | 185.58 | 181.50 | 196.74 | 205.80 | 201.27 |
| W ₁₀ | 141.64 | 147.88 | 144.76 | 174.99 | 182.69 | 178.84 | 194.05 | 202.60 | 198.32 |
| SE m \pm | 5.03 | 5.24 | 5.13 | 6.17 | 6.43 | 6.30 | 6.89 | 7.17 | 7.03 |
| CD(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

All the treatments are described in the materials and methods





Role of Minor Millets in Malnutrition Elevation in India

Junaid Hasemi, SanabamTarunibala Devi and Jnana Bharati Palai*

Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Jnana Bharati Palai

Centurion University of Technology and Management,
Odisha, India

Email: jnana@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Minor millets are a category of small-grained cereal crops with a short, thin culm and small grains that have a unique capacity to thrive in difficult situations such as low rainfall, poor soil fertility, and uneven terrain. They are also more nutrient-dense than traditional grains. Malnutrition is pervasive in many developing nations; for example, India is one of many countries where child malnutrition is severe. Minor millets are well-known for their health advantages. All small millets are high in dietary fibre and can be used as both a preventative and therapeutic meal. The minor millets have substantially higher content of fiber, protein and minerals compared to fine cereals like rice and wheat. Millets are also gluten free and easily digestible, making intolerance, stomach ulcers, or excessive cholesterol. Three varieties of minor millets, proso millet, foxtail millet, and pearl millet, were farmed and exposed to three levels of salt stress (1.5, 5.5, and 9.5dS/m).Millet eating by women has been reported to aid in the prevention of gallstones due to its high insoluble fibre content.

Keywords: Minor millet, nutritional value, functional food, abiotic stress tolerance, wider adaptation

INTRODUCTION

Minor millets are a category of small-grained cereal crops with a short, thin culm and small grains that have a unique capacity to thrive in difficult situations such as low rainfall, poor soil fertility, and uneven terrain (Hrideek andNampoothiri,2017; Brahmachari *et al.*, 2019).Minor millets have a diverse genetic makeup and require few cultivation inputs. They are also more nutrient-dense than traditional grains (Banerjee and Maitra, 2020). Millets, which are grown for both food and fodder, provide food and livelihood stability to millions of people while also assisting in efficient farming especially for small/marginal farmers and residents of rain-fed/ remote tribal communities (Reynolds *et al.*,2015). Minor millets or coarse grains are the primary source of nutrition for tribal peoples in areas where main cereals such as rice, wheat, and maize are rarely grown due to low yields. Malnutrition is pervasive in many developing nations; for example, India is one of many countries where child malnutrition is severe(Pasricha and Biggs,2010). Minor millets are essential food group that has been missing from the food basket in

42647



**Junaid Hasemi et al.,**

recent years. Minor millets are well-known for their health advantages. Cereals are a cheaper source of dietary calories in the current context, but small millets give higher nutrition with micronutrients such as vitamin B complex, calcium, iron, and sulphur (Nuss and Tanumihardjo, 2010). All small millets are high in dietary fibre and can be used as both a preventative and therapeutic meal. Aside from the nutritional advantages, tiny millets crops can adapt to a wider range of growth conditions. Despite their high nutritional benefits and resistance to climate change, tiny millets are becoming less popular around the world (Padulosi et al., 2009; Maitra et al., 2022). Since modernization forced Indians to convert to wheat and rice, research (NCAER) on minor millets has indicated an exponential drop in consumption of resilient millets from 32.9 kg in 1960 to 4.2 kg in 2010. To achieve inclusive and fair growth and development in our country, the second green revolution must focus primarily on nutrition, which was overlooked in the first green revolution, which was focused on production (Negin et al., 2009). In our country, inner invisible hunger (micronutrient insufficiency) is a major issue. Eradication of extreme poverty and hunger is the first of the Millennium Development Goals (MGDs) proposed by the United Nations in the year 2000. India is far away from achieving this goal (Patwari, 2013). Further, cultivation of small millets addresses some of the Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and wellbeing) and SDG 15 (life on land) (UN, 2021).

Reasons for unpopularity of millets

- Lack of technical understanding among farmers and processors about diverse processing methods in contrast to their own ancient methods of processing are credible factors for millets' lack of popularity. Adoption and diversification of new things are cultural challenges (d'Alpoim and Bocinsky, 2018).
- People are unaware of the nutritional significance of small millets, and there is a wide-spread belief that millets are poor man's crop (Shanthakumaret al., 2010).
- Consumers' unwillingness to purchase and condition (Kuo and Nakhata, 2019).

Salient features of minor millets**High nutritional value**

The minor millets have substantially higher content of fiber, protein and minerals compared to fine cereals like rice and wheat (Table-1) (Verma and Patel, 2013). Millets like Jowar has protein content of 10.4g, Bajra 11.6g, the 12.5g of proso millets, 12.3g of foxtail millet, and 11.6 of barnyard millet is equal to wheat's 11.8g and significantly greater than rice's 6.8g. In comparison to wheat and rice, finger millet has a lower protein content (7.3g), but it is higher in mineral matter and calcium. Millets in general have more fibre than fine cereals (Table 1). In compared to wheat 1.2g and rice 0.2g, tiny millets such as barnyard millet 14.7g, kodo millet 9g, little millet 8.6g, and foxtail millet 8.0g are the richest in fibre. As a result, millets are now referred to as millets. "Miracle grains/ AdbhutAnaj and nutria-cereals" (Senthilvel et al., 2008).

Finger millet has 16 times the calcium content of maize, and some believe it could eventually replace rice as a staple diet, which is especially important to humans due to the availability of key minerals (Hassan et al., 2021). Millets are also rich in micronutrients (Table-2). Iron and zinc are two essential minerals for human health. To combat its prevalent malnutrition, researchers should look into increasing the iron content of minor millets grains. Millets are also gluten free and easily digestible, making intolerance, stomach ulcers, or excessive cholesterol (Badiuet al., 2014). Despite the fact that has been very little research done in this area, it looks that small millets are a good source of antioxidants and may have anticarcinogenic qualities. Millets can so help to diversify one's diet. In all of India and rural areas, the states of Assam and Bihar had the largest consumption of tiny millets. Ragi has nearly ten times the calcium of wheat or rice among tiny millets (Verma and Patel, 2013).

Medical Benefits

- Lignans are a type of phytonutrient found in millet that is beneficial to the human body. Under the influence of interstitial friendly flora, these lignans are transformed to mammalian lignans are transformed to mammalian lignans, which protest against hormone-dependent malignancies like breast cancer and reduce the risk of heart disease (Hwang et al., 2015)



**Junaid Hasemi et al.,**

- If ingested on a daily basis, minor millet is particularly beneficial to postmenopausal women (Canderelliet al.,2007).
- It has been observed that if children consume whole grains like minor millet it has a reducing effect of wheezing and asthma on them (Venter et al.,2020).
- Millet eating by women has been reported to aid in the prevention of gallstones due to its high insoluble fibre content (Attiliet al.,1997).
- Phosphorus is a material that aids in the creation of the mineral matrix of the bone and is also a vital component of ATP (adenosine triphosphate) in our bodies, as well as significant constituent of nucleic acids, which make up the genetic code (Wildman and Medeiros,2000).
- According to a recent study, consuming little amounts of millet on a daily basis reduced the chance of developing type 2 diabetes. This happens because whole grains like minor millet are high in magnesium, which serves as a co-factor in a variety of biochemical activities in the body and hence aids glucose and insulin secretion (Saikia and Deka.,2011).
- Magnesium can also help to reduce the number of migraine attacks you have. It is also highly good for patients who have atherosclerosis or diabetic heart disease (Tangetal.,2018)

Ability to withstand adverse soil and climate**Salinity Tolerance**

In the southern Khorasan area in eastern Iran, three varieties of minor millets, proso millet, foxtail millet, and pearl millet, were farmed and exposed to three levels of salt stress (1.5, 5.5, and 9.5 d/m). Under both salt stress and normal conditions, the pearl millet type from Birjand, followed by foxtail millets, demonstrated the highest production potential. Proso-millet variety from Ghaen, on the other hand, demonstrated increased salt tolerance (Gehrken,1985).

Drought tolerance and water logging tolerance:

Among the different millets, samai (little millet) also known as the poor man's crop is an important dryland capable of with-standing both drought and water-logging (Choudhary et al.,2019).

Heat Tolerance

Pearl millet another minor millet a versatile crop capable of growing in the dry desert areas due to its drought hardiness and high temperature tolerance (Bidinger et al.,2004). A lot of heat is available in pearl millet hybrids such as HHB-67, HHB-68 and HHB-60.

Adaptation to infertile soil conditions:

The root system of foxtail millet is reduced and enhanced in response to low nitrogen and phosphate levels in the soil (Nadeem et al., 2020; Maitra et al., 2020). Despite having a reduced root system when nitrogen levels are low, foxtail millet increases biomass accumulation and root thickness, presumably for nutrient transfer. The low phosphate content of foxtail millet shows its internal nitrogen status, which works as a signal regulating nitrogen transporter expression and hence characterises its inherent relationship with nitrogen nutrition (Nadeem et al.,2020). Also, lately brown-top millet another minor millet has been recognized recently due to its huge potential and wider adaptability to grown in a variety of soils and climates and having the quality to tolerate a moderate level of environmental stress as C4 plants. Being a facultative upland plant, brown-top millet prefers sandy loam soils with a pH 5-6.5 under full sun but its speciality is that it can be also be grown in the partial shade which ensures wider choice of adoption even in fruit orchards or in agroforestry system (BGBD,2015).

Among the several little millets, the relevance of brown top millet has lately been recognised, as it has enormous potential to make a living in resource-poor and vulnerable ecological situations, ensuring economic and nutritional security as well as small-scale production sustainability (Béné et al.,2007; Maitra et al., 2020b).



**Junaid Hasemi et al.,****Incorporation of minor millets in Indian food supply chain**

- To feed the population we first need to produce then only we can process minor millets and and enjoy its nutritional benefits (Salehet *et al.*,2013). But the scope for enhancement of productivity under irrigated conditions is limited because of over-exploitation of available resources, but there is ample opportunity for boosting yield in drylands by adopting suitable crops and cropping systems. The combination of cereal and legume in intercropping can be a major help to the farmers in subsistence farming targeting livelihood security (Maitra,2020c). They also have numerous advantages, such as increased crop productivity, increased resource efficiency, reduced water run-off and soil conservation in erosion-prone areas, prevention of soil nutrient loss, improved soil health, insurance against crop failure due to unusual weather, and a higher monetary return and benefit-cost ratio(DeVincentis *et al.*,2020; Maitra, 2020b; Maitra *et al.*, 2022).
- Snacking is becoming a common practice especially in children and adults therefore an attempt to develop some healthy snacks like muffin (Benton,2004), cakes and biscuits from processed malted finger millet flour to get the maximum advantage of their nutrient content in terms of bioavailability. Malting Finger millet malt (FMM) can be prepared by different methods given by with slight modifications that is by steeping finger millet grains for 18-24 h at room temperature and allowed to sprout for 48-120 h. Grains were dehydrated for 60 mins at 60 °C. Further rootlets of grains were removed and powdered to obtain flour for later usage. Also, the above process can be repeated by blanching, pressure cooking or roasting the grains field (Khokhar andApenten,2003).
- After fermenting and cooking the ready-made mix to create idli and dosa, germinated powders of minor millets were blended and incorporated (Ashworth *et al.*,1992)with other fundamental traditional components like rice powder and de-husked black gramme powder in defined proportions. In comparision to rice-based idli, high proportions of protein (15-18%), fat (8.5-9.8), and carbohydrate (69-72%) were determined for dosa. In millet-based meals, processing stages such as decortication, germination, and fermentation also considerably reduced antinutrients such phytic acids (69%) and tannin(78%) concentration (Krishnamoorthy*et al.*,2013).

CONCLUSION

Millets are easily accessible and inexpensive. This is primarily due to a lack of awareness and information among the general public about the various types of food available, particularly little millets. The majority of developing countries grow millets to suit their food and nutrition needs, whereas affluent countries feed animals with them. Minerals, vitamins, protein, carbs, and amino acids all abundant in these foods. When compared to cereals, they play a vital role in sustainability because they consume less water. They can be cultivated with less pesticide and fertiliser in locations where main crops are not grown. Millets are a rich source of dietary fibre, protein, and minerals that can be added to people's daily diets as they have wide health benefits such as preventing diabetes, cardio-vascular diseases, obesity, gastro-intestinal problems, and cancer, among other things, as the population grows and they consume fast foods and eat an unbalanced diet. They contain anti-oxidants and provide energy throughout the day by digesting slowly.

REFERENCES

1. Ashworth, A., Draper, A., & World Health Organization. (1992). The potential of traditional technologies for increasing the energy density of weaning foods: a critical review of existing knowledge with particular reference to malting and fermentation.
2. Attili, A. F., Capocaccia, R., Carulli, N., Festi, D., Roda, E., Barbara, L., ... & Scafato, E. (1997). Factors associated with gallstone disease in the MICOL experience. *Hepatology*, 26(4), 809-818.
3. Badiu, E., Aprodu, I., & Banu, I. (2014). Trends in the development of gluten-free bakery products. *Annals of the University Dunarea de Jos of Galati Fascicle VI--Food Technology*, 38(1).
4. Béné, C., Macfadyen, G., & Allison, E. H. (2007). *Increasing the contribution of small-scale fisheries to poverty alleviation and food security* (No. 481). Food & Agriculture Org.





Junaid Hasemi et al.,

5. Benton, D. (2004). Role of parents in the determination of the food preferences of children and the development of obesity. *International journal of obesity*, 28(7), 858-869.
6. BGBD, F. O. (2015). *Faculty of natural resource and environmental sciences* (Doctoral dissertation, Busitema University).
7. Bidinger, F. R., & Hash, C. T. (2004). Pearl millet. *Physiology and biotechnology integration for plant breeding*, 225-270.
8. Canderelli, R., Leccesse, L. A., Miller, N. L., & Unruh Davidson, J. (2007). Benefits of hormone replacement therapy in postmenopausal women. *Journal of the American Academy of Nurse Practitioners*, 19(12), 635-641.
9. Choudhary, S. K., Kumar, R., & Gupta, S. K. (2019). Integrated farming system (IFS) is possible way out for double farmer's income. *Journal of Pharmacognosy and Phytochemistry*, 5, 282-289.
10. d'Alpoim Guedes, J., & Bocinsky, R. K. (2018). Climate change stimulated agricultural innovation and exchange across Asia. *Science advances*, 4(10), eaar4491.
11. DeVincentis, A. J., Solis, S. S., Bruno, E. M., Leavitt, A., Gomes, A., Rice, S., & Zaccaria, D. (2020). Using cost-benefit analysis to understand adoption of winter cover cropping in California's specialty crop systems. *Journal of environmental management*, 261, 110205.
12. Englyst, H. N., & Hudson, G. J. (1996). The classification and measurement of dietary carbohydrates. *Food chemistry*, 57(1), 15-21.
13. Gehrken, U. (1985). Physiology of diapause in the adult bark beetle, *Ips acuminatus* Gyll., studied in relation to cold hardiness. *Journal of insect physiology*, 31(12), 909-916.
14. Gruère, G. P., Nagarajan, L., & King, E. D. I. (2007). *Collective Action and Marketing of Underutilized Plant Species: The Case of Minor Millets in Kolli Hills, Tamil Nadu, India* (No. 577-2016-39151).
15. Hassan, Z. M., Sebola, N. A., & Mabelebele, M. (2021). The nutritional use of millet grain for food and feed: a review. *Agriculture & Food Security*, 10(1), 1-14.
16. Hrideek, T. K., & Nampoothiri, K. U. K. (2017). Millets as an integral Part of Nutritional Diet in India. In *Examining the Development, Regulation, and Consumption of Functional Foods* (pp. 83-108). IGI Global.
17. Hwang, C. F., Yin, T. C., Chang, N. Y., & Ho, C. T. (2015). Efficiency of a SDG-β-glucosidase from *Bacillus altitudinis* HK02 for the deglycation of glycosides from flaxseeds. *Process Biochemistry*, 50(12), 2188-2193.
18. Khokhar, S., & Apenten, R. K. O. (2003). Antinutritional factors in food legumes and effects of processing. *The role of food, agriculture, forestry and fisheries in human nutrition*, 4, 82-116.
19. Krishnamoorthy, S., Kunjithapatham, S., & Manickam, L. (2013). Traditional Indian breakfast (Idli and Dosa) with enhanced nutritional content using millets. *Nutrition & Dietetics*, 70(3), 241-246.
20. Kuo, H. C., & Nakhata, C. (2019). The impact of electronic word-of-mouth on customer satisfaction. *Journal of Marketing Theory and Practice*, 27(3), 331-348.
21. Maitra, S. (2020a). Intercropping of small millets for agricultural sustainability in drylands: A review. *Crop Research (0970-4884)*, 55.
22. Nadeem, F., Ahmad, Z., Ul Hassan, M., Wang, R., Diao, X., & Li, X. (2020). Adaptation of foxtail millet (*Setaria italica* L.) to abiotic stresses: a special perspective of responses to nitrogen and phosphate limitations. *Frontiers in plant science*, 11, 187.
23. National Institute of Nutrition. (2007) Nutritive value of Indian foods, MILLET in your Meals, <http://www.sahajasamrudha.org/>
24. Negin, J., Remans, R., Karuti, S., & Fanzo, J. C. (2009). Integrating a broader notion of food security and gender empowerment into the African Green Revolution. *Food Security*, 1(3), 351-360.
25. Nuss, E. T., & Tanumihardjo, S. A. (2010). Maize: a paramount staple crop in the context of global nutrition. *Comprehensive reviews in food science and food safety*, 9(4), 417-436.
26. Padulosi, S., Mal, B., Ravi, S. B., Gowda, J., Gowda, K. T. K., Shanthakumar, G., ... & Dutta, M. (2009). Food security and climate change: role of plant genetic resources of minor millets. *Indian Journal of Plant Genetic Resources*, 22(1), 1-16.
27. Pasricha, S. R., & Biggs, B. A. (2010). Undernutrition among children in south and south-east Asia. *Journal of paediatrics and child health*, 46(9), 497-503.
28. Patwari, A. K. (2013). Millennium development goals and child undernutrition. *Indian pediatrics*, 50(5), 449-452.





Junaid Hasemi et al.,

29. Reynolds, T. W., Waddington, S. R., Anderson, C. L., Chew, A., True, Z., & Cullen, A. (2015). Environmental impacts and constraints associated with the production of major food crops in Sub-Saharan Africa and South Asia. *Food Security*, 7(4), 795-822.
30. Saikia, D., & Deka, S. C. (2011). Cereals: from staple food to nutraceuticals. *International Food Research Journal*, 18(1).
31. Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Comprehensive reviews in food science and food safety*, 12(3), 281-295.
32. Senthilvel, S., Jayashree, B., Mahalakshmi, V., Kumar, P. S., Nakka, S., Nepolean, T., & Hash, C. T. (2008). Development and mapping of simple sequence repeat markers for pearl millet from data mining of expressed sequence tags. *BMC Plant Biology*, 8(1), 1-9.
33. Shanthakumar, G., Yenagi, N. B., Shekhar, G. C., & Halikatti, S. I. (2010). Food security and income enhancement of rural poor through improved production technology and value addition of nutritious small millets: A case study from Northern Karnataka. *Minor Millets in South Asia: Learnings from IFAD-NUS Project in India and Nepal*, 69.
34. Shiferaw, B., Smale, M., Braun, H. J., Duveiller, E., Reynolds, M., & Muricho, G. (2013). Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security. *Food Security*, 5(3), 291-317.
35. Tang, N., Jiang, S., Yang, Y., Liu, S., Ponnusamy, M., Xin, H., & Yu, T. (2018). Noncoding RNA s as therapeutic targets in atherosclerosis with diabetes mellitus. *Cardiovascular Therapeutics*, 36(4), e12436.
36. Venter, C., Greenhawt, M., Meyer, R. W., Agostoni, C., Reese, I., du Toit, G., ... & O'Mahony, L. (2020). EAACI position paper on diet diversity in pregnancy, infancy and childhood: Novel concepts and implications for studies in allergy and asthma. *Allergy*, 75(3), 497-523.
37. Verma, V., & Patel, S. (2013). Value added products from nutri-cereals: Finger millet (*Eleusine coracana*). *Emirates Journal of Food and Agriculture*, 169-176.
38. Verma, V., & Patel, S. (2013). Value added products from nutri-cereals: Finger millet (*Eleusine coracana*). *Emirates Journal of Food and Agriculture*, 169-176.
39. Wildman, R. E., & Medeiros, D. M. (2000). *Advanced human nutrition* (p. 521). Boca Raton, FL: CRC press.
40. UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
41. Maitra, S., Pine, S., Banerjee, P. & Shankar, T. (2022). Millets: Robust Entrants to Functional Food Sector, In: Bioresource Technology: Concept, Tools and Experiences (Eds. Pirzadah, Tanveer Bilal, Malik, B., Bhat, A., Hakeem, K.R., 2022, Wiley Online Library, <https://doi.org/10.1002/9781119789444.ch1>
42. Banerjee P. & Maitra S. (2020). The Role of Small Millets as Functional Food to Combat Malnutrition in Developing Countries. *Indian Journal of Natural Sciences*, 10(60): 20412-20417
43. Brahmachari, K., Sarkar, S., Santra, D. K. & Maitra, S. (2018). Millet for Food and Nutritional Security in Drought Prone and Red Laterite Region of Eastern India, *International Journal of Plant & Soil Science*, 26(6): 1-7
44. Maitra, S. (2020b). Potential horizon of brown-top millet cultivation in drylands: A review. *Crop Research*. 55(1-2): 57-63. DOI: 10.31830/2454-1761.2020.012
45. Maitra, S., Pine, S., Shankar, T., Pal, A. and Pramanick, B. (2020) Agronomic Management of Foxtail millet (*Setaria italica* L.) in India for Production Sustainability: A Review. *International Journal of Bioresource Sciences*, 7(1): 11-16.

Table 1: Coarse and fine cereals have different nutritional values (per 100g)

| Crop | Protein (g) | Carbohydrate (g) | Fat (g) | Crude Matter (g) | Mineral matter(g) | Calcium (mg) | Phosphorus (mg) |
|---------------|-------------|------------------|---------|------------------|-------------------|--------------|-----------------|
| Sorghum | 10.4 | 72.6 | 1.9 | 1.6 | 1.6 | 25 | 222 |
| Pearl millet | 11.6 | 67.5 | 5.0 | 1.2 | 2.3 | 42 | 296 |
| Finger millet | 7.3 | 72.0 | 1.3 | 3.6 | 2.7 | 344 | 283 |
| Proso millet | 12.5 | 70.4 | 1.1 | 2.2 | 1.9 | 14 | 206 |





Junaid Hasemi et al.,

| | | | | | | | |
|------------------------|------|------|-----|------|-----|----|-----|
| Foxtail millet | 12.3 | 60.9 | 4.3 | 8.0 | 3.3 | 31 | 290 |
| Kodo millet | 8.3 | 65.9 | 1.4 | 9.0 | 2.6 | 27 | 188 |
| Little millet | 8.7 | 75.7 | 5.3 | 8.6 | 1.7 | 17 | 220 |
| Barnyard millet | 11.6 | 74.3 | 5.8 | 14.7 | 4.7 | 14 | |
| Wheat | 11.8 | 71.2 | 1.5 | 1.2 | 1.5 | 41 | 306 |
| Rice | 6.8 | 78.2 | 0.5 | 0.2 | 0.6 | 10 | 16 |

(Source: National Institute of Nutrition, 2007)

Table 2: Micronutrient profile of millets (mg/100g)

| Crop | Mg | Na | K | Cu | Mn | Mb | Zn | Cr | Su | Cl |
|------------------------|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Foxtail millet | 81 | 4.6 | 250 | 1.40 | 0.60 | 0.070 | 2.4 | 0.030 | 171 | 37 |
| Proso millet | 153 | 8.2 | 113 | 1.60 | 0.60 | - | 1.4 | 0.020 | 157 | 19 |
| Finger millet | 137 | 11.0 | 408 | 0.47 | 5.49 | 0.102 | 2.3 | 0.028 | 160 | 44 |
| Little millet | 133 | 8.1 | 129 | 1.00 | 0.68 | 0.016 | 3.7 | 0.180 | 149 | 13 |
| Barnyard millet | 82 | - | - | 0.60 | 0.96 | - | 3 | 0.090 | - | - |
| Kodo millet | 147 | 4.6 | 144 | 1.60 | 1.10 | - | 0.7 | 0.020 | 136 | 11 |
| Sorghum | 171 | 7.3 | 131 | 0.46 | 0.78 | 0.039 | 1.6 | 0.008 | 54 | 44 |
| Bajra | 137 | 10.9 | 307 | 1.06 | 1.15 | 0.069 | 3.1 | 0.023 | 147 | 39 |

(Source: NIN, 2007)





Conservation Agriculture: a Tool for Agricultural Sustainability and Climate Change Adaptation– A Review

Santosh Kumar Lenka*, Monalisa Sahoo and Swarnali Duary

Department of Agronomy, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Santosh Kumar Lenka

Department of Agronomy,

Centurion University of Technology and Management,

Odisha, India.

Email: santosh.lenka@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Faulty agricultural practices and heavy tillage lead to a larger loss of soil carbon and an increase in greenhouse gas emissions, primarily CO₂, which has an impact on not just soil productivity but also atmospheric quality, resulting in "climate change." Conservation agriculture (CA) has emerged as a potential approach for maximizing the use of existing resources while ensuring long-term output. CA-based management approaches are extremely viable for bringing sustainability to agricultural crop production by saving inputs, lowering energy usage, and minimizing greenhouse gas emissions. Multiple ecosystem services, such as supplying, regulating, and sustaining, can be provided by the CA system. Regulatory services include enhancing carbon status as well as the overall soil health, all of which contribute to provisioning services in terms of crop and water productivity. Increased soil carbon sequestration enhances supporting functions, such as soil aggregation, which increases accessible soil moisture and can help plants grow and develop more effectively. It also improves both above- and below-ground soil biodiversity. This article examines conservation agriculture as a feasible approach for ensuring sustained agricultural production and mitigating climate change.

Keywords: Conservation Agriculture, climate change, residue retention, no-till, sustainability, greenhouse gases

INTRODUCTION

Conservation Agriculture (CA) is a holistic approach since it generates profitable crops while conserving natural resources. Farmers benefit from CA because it increases water quality, soil fertility, and erosion control, as well as helping to combat climate change by enhancing the sequestration of carbon (Kassam *et al.*, 2009; Jat *et al.*, 2012). CA



**Santosh Kumar Lenka et al.,**

systems are also tolerant to harsh climatic events, contributing to agricultural system resilience and adaptability to climate change. As a result, CA becomes a critical component of long-term production intensification that combines high output with environmental service supply. Although CA is a promising option and can blend in almost every agro-ecological system, there is still much debate regarding its practicability in small and marginal farmers, where crop residues compete with soil retention for use as animal feed (Valbuena *et al.*, 2012; Hossain *et al.*, 2021a). There are also differences in the influence of CA on crop yields across varied locations (Pittelkowitz *et al.*, 2015; Arya *et al.*, 2015; Thierfelder *et al.* 2015). Farmers in Rajasthan's arid region never consider leaving crop residues (*viz.* bajra, sorghum, maize, wheat, and barley) on the soil surface, according to researchers, because the cost of fodder is significantly higher (600-700 Rs/q). Furthermore, the agriculture here is livestock-based and hence, they are always drawn to quick rewards. Even if the water level in the Jhunjhunu area of Rajasthan is below the danger level, farmers are still engaging in improper agricultural methods to satisfy their current desire. CA helps in preventing climate change via. carbon sequestering in soil (Hobbs and Govaerts, 2010; Lal, 2015; Kar *et al.*, 2021), despite the experimental evidence being mixed and the matter causing dispute (Neufeldt *et al.*, 2015; Powlson *et al.*, 2014). Nonetheless, CA is considered a viable option in many regions of the world (Hossain *et al.*, 2021b). Soil regeneration, input optimization, labour, and profit maximization are all pillars of CA. When CA is practiced it gives positive outcomes. An organic soil cover prevents erosion, generates a favourable microclimate; provides organic matter, improves soil fertility and prevents erosion; whereas crop rotation promotes good biodiversity. The United Nations Food and Agriculture Organization (FAO) defines conservation agriculture as follows:

“CA is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by three principles which are linked to each other, namely: (1) continuous minimum mechanical soil disturbance; (2) permanent organic soil cover; and (3) diversified crop rotations in the case of annual crops or plant associations in case of perennial crops.” Reduced tillage, cover crop management, crop residue management, and sensible crop rotation are all examples of CA (Wright and Hons 2004; Thierfelder *et al.*, 2005).

Conservation Agriculture in the World

Conservation tillage was established in the United States in 1935 which was known to be the dust bowl in the 1930s. The main goal was to keep 30 per cent of the soil covered by crop residue. Direct sowing, crop rotations and residue retention were used to pioneer minimal tillage in Brazil. In the United States, the first zero-tillage method was established. In Brazil, it was completely developed and was known as CA. CA is estimated to have spread across 95 million hectares around the world (Derpsch, 2008; Pramanick *et al.*, 2021). The area practicing CA doubled between 1999 and 2005 (45.5 million ha to 95 million ha). Brazil, Argentina, Paraguay, Australia, and Canada are the countries with the most no-tillage land, followed by the United States, Brazil, Argentina, Canada, Australia, and Paraguay. Latin America, on the other hand, is entitled to the highest adoption rates and best quality CA systems (permanent no-tillage): CA systems cover over 60% of total agricultural land in Argentina, Brazil, and Paraguay (Derpsch, 2005).

Purpose of Conservation Agriculture

According to the FAO, CA combines overall natural resource management with external inputs to conserve, improve and more efficient use of natural resources. CA is sometimes referred to as "resource-efficient" or "resource-effective" agriculture since it helps to save natural resources while both increasing and maintaining agricultural productivity (Garcia-Torres *et al.*, 2003). Conservation technologies (RCT) are based on principles of CA which have been found to increase yield as well as resource use efficiency, all while lowering the impact on the environment (Das *et al.*, 2021). According to CA, the soil is a living entity that is necessary to preserve life on this planet. Larger yields, lower production costs, decreased labour, increased farm profits, better production consistency, and hence improved food security are some of the economic benefits of CA. As a result, CA may be a realistic choice for eliminating hunger



**Santosh Kumar Lenka et al.,**

while also ensuring overall sustainability. Conservation agriculture also has an impact on global warming. CA has been demonstrated to aid in soil carbon sequestration as organic carbon can be harvested at a rate of 0.5 t/ha/year in humid temperate climates (Baker *et al.*, 2007). As a result, CA may be represented as a strategy that aids in climate change mitigation. Further, the CA addresses some of the Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 15 (life on land) (UN, 2021).

The Principles of CA Conservation

Agriculture highlights the significance of the soil as a living entity that is necessary for the survival of living beings on this planet. It underlines the importance of safeguarding the top 0-15 cm of soil, which is both active and vulnerable to erosion and degradation. The principles of (CA) and the acts that will be encouraged are as follows:

Principle 1: Minimum soil disturbance

When the land is neither ploughed nor rotated, this approach argues for minimal soil disturbance. Continuous tillage degrades soil structure, resulting in a hardpan that hinders water infiltration and proper crop root development. To lessen the soil crusting due to the impact of rain and subsequent losses caused by it, minimal or no-tillage with mulching was proposed (Landers, 1999; Roose and Barthes, 2001). This lack of soil disturbance aids in the preservation of general soil structure, such as aggregate stability and porosity, which allow for water and gas exchange and provide habitat for a diverse range of soil biota.

Principle 2: Crop rotation

Crop rotation is a technique of sequentially planting two (or more) different crops in the same area. Legumes, deep-rooted crops, and high-residue crops should all be included in crop rotations. Crop rotation is an agricultural management technique that has been used for centuries. With the increasing population of beneficial soil biota, the pest and disease problems can be kept at bay, sensible crop rotations can mitigate pest and disease problems associated with not tilling the soil. Howard (1996) cited examples of disease management using rotation as well as a historical look at the cultural control of plant diseases. By increasing microbial variety, which helps keep pathogenic organisms in control, rotations reduce the likelihood of disease and pest outbreaks produced by pathogens (Leake 2003). In zero-till systems, crop rotation with a varied rooting pattern along with negligible soil disturbance results in a more extensive network of root channels and macropores. This facilitates water infiltration to larger depths. Crop rotation also disturbs many weeds' life cycles, resulting in a reduction in overall weed growth. When compared to monoculture, these benefits result in a yield increase of about 10% for crops grown in rotation.

Principle 3: Maximum soil cover

Above the soil surface, a protective layer should be applied. Plants are either allowed to flourish or are killed, and their residues are allowed to degrade in soil. This is primarily used to prevent chemical and physical deterioration of organic matter-rich soils. Plant residues help in capturing rainwater, regulate temperatures by enhancing water penetration, act as a windbreak, etc. Surface crop cover encourages microbial activity, which is especially beneficial in tropical and subtropical regions. Kumar and Goh (2000) studied the effects of crop residues and management strategies on nitrogen dynamics in soil, crop yield as well as overall soil health. Crop residues from farmed crops are a crucial component in crop production, according to the study, because of their impact on soil activity and soil and water quality. Soil aggregation and associated labile nutrient pools may be influenced by cover crops, altering soil and yield (Sainjuet *et al.*, 2003; Holeplasset *et al.*, 2004).

Principle 4: Use of appropriate fertilizer

The fourth principle for CA is the use of adequate fertilizer (Vanlauwea *et al.*, 2014). The lack of organic resources makes it difficult for smallholder farmers to embrace CA. Appropriate fertilizer application boosted crop yield and crop residue availability throughout soil fertility gradients, notably on mid-distance and remote fields, which account for the majority of small scale farming fields.





Santosh Kumar Lenka et al.,

Advantages of Conservation Agriculture

For both farmers and the environment, conservation agriculture is beneficial in many aspects. Numerous people involved in global food production, on the other hand, are not recognizing it as a better alternative to traditional practices that have been shown to have detrimental environmental implications. This is primarily due to a shift in mindset that realizes how higher yields may be obtained with fewer inputs. Despite these challenges, farmers, researchers, academics, and extensionists around the world are increasingly recognizing conservation agriculture. Conservation agriculture (CA) is a style of farming that maximizes the amount of land available for food production.

Land

Conservation agriculture improves soil physical properties and protects it from erosion by minimizing soil disturbance and preserving permanent soil cover. Reduced runoff, which generally contains residual agrochemicals and soil sediments, is one of the key advantages of conservation tillage (Kukul *et al.*1991). For example, the lower runoff associated with zero till plots prevent contamination of water resources (Duiker and Myers, 2005.). When used in heavily ploughed soil, these agrochemicals travel more freely beyond the vadose zone than when used in less ploughed soil. Furthermore, CA methods increase soil organic matter (SOM). Hence, arable land is more productive and sustainable under CA. At the surface, the bulk density of soil managed under conservation agriculture is considerably low. This is due to the mulch layer over the untilled soils (Beisecker, 1994), which increases the organic matter which acts as a feed for soil organisms. Furthermore, the bulk density of subsurface soils (25–30 cm soil depth) is also lower than that of traditionally cultivated soils (Tebrugge and During 1999). The FAO now considers "limiting in-field traffic" as a component of CA because no-tillage minimizes the traffic of the ground and consequently compaction. Instead of planting on the flat, field traffic is directed to permanent rails that can be paired with a permanent bed planting system (Sayre and Hobbs, 2004).

Labour

After permanent soil cover/crop rotations are established, there are fewer weeding and bug issues because no-till land is not removed before planting. A substantial percentage of the labour savings is due to the no-tillage activities under CA, which reduces labour during the crop season.

Water

Conservation agriculture uses less amount of water because of the increased water holding capacity and infiltration due to crop residue in the soil. Crop residue cover acts as a soil cover and hence helps maintain soil temperature and reduces evaporation losses, which is particularly beneficial in subtropical and tropical climates. During drought years, the benefits of conservation agriculture are observed maximum in dry land areas, where the risk of total crop failure is considerably lowered due to the enhanced efficiency of water. In low-rainfall areas, CA aids in the retention of water in the higher soil layers (Rasmussen 1999). Direct drilling along with retention of crop residue has been shown to increase rain infiltration and reduces surface run-off when compared to cultivated soil (Carter and Steed, 1992).

Nutrients

Biochemical decomposition of organic crop wastes near the soil surface improves soil nutrient availability and recycling, which is also important for feeding soil bacteria. While growing nitrogen-fixing legume species can meet the nitrogen needs and the additional necessary nutrients can be fulfilled by other chemical and organic sources. Conservation agriculture, in general, improves soil fertility over time, needing fewer fertilizer inputs to achieve optimal yields. According to Ismail *et al.* (1994) and Rahman *et al.* (1995), exchangeable Ca, Mg, and K were significantly higher in the surface soil under NT than in ploughed soil. According to Ali *et al.* (2006), traditional till plots had the lowest values of soil OM and other primary and secondary nutrients which could be related to topsoil inversion, which causes subsoil to come to the surface which leads to leaching of nutrients.



**Santosh Kumar Lenka et al.,****Soil biota**

Pests are kept in check by predatory spiders, wasps, nematodes, mites, springtails, helpful microorganisms, as well as a wide population of beneficial soil critters. Earthworms and other animals also burrow into the soil, forming microscopic channels that allow water and air to circulate which loosens the soil and allows for better root penetration. SOC content is the biological quality of soil that is most impacted by tillage (Doran, 1980). The quantity of organic matter in the soil has a big impact on the activities of soil organisms, which in turn has a big impact on changes in SOC. Earthworms, an integral component of the soil macrofauna, play a vital role in soil fertility dynamics by improving infiltration through their burrowing activities. Rasmussen (1999) documented the notion that tillage practices affect the number of earthworms in a plough less tillage review. Anderson (1987) discovered a much greater population of earthworms in no-till soil than in ploughed soil during a six-year study. Cookson *et al.* (2008) noticed a drop in fungal population and an increase in bacterial population with increasing tillage activity due to disruption of fungal mycelium. They also discovered that the microbial community's composition and substrate consumption changed in no-till soil, with different substrate utilization.

Economic benefits

CA farmers have higher yields (up to 45-48 percent higher) while using fewer inputs leading to higher total farm earnings. More than any other aspect, the economic benefits of NT have resulted in broad adoption among large and small-scale farmers all over the world.

Environmental benefits

Conservation agriculture is a set of environmentally friendly technologies. It frees up resources for other uses, such as conservation for future generations. Because no-till agriculture uses fewer fossil fuels, it emits fewer greenhouse gases in the atmosphere. When used for ploughing, tractors burn a lot of fossil fuels, which raises expenses while also generating greenhouse gases (mainly CO₂) and contributes to global warming (Grace *et al.* 2003). According to Gattinger *et al.* (2014), changes in agriculture and land use, particularly deforestation in tropical areas, contribute to roughly one-third of global greenhouse gas emissions, with 74 percent originating from developing countries. According to Tubiello *et al.* (2013), agriculture direct emissions amounted to 10–12% of greenhouse gas emissions in 2010. Fertilizers and other crop inputs contribute to the release of CH₄ (20 times more than CO₂ as a GHG), as well as nitrogen oxides (NO_x) and ammonia (Yan *et al.*, 2003). Cultural operations and fertilizer input supply to the ever-increasing global population's demand for food may result in increased emissions of all of these gases, leading to catastrophic climate change. Pesticide application is reduced under CA, which reduces overall soil, air and water pollution.

Equity considerations

Conservation agriculture may aid many marginal and small farmers to maximize their yields with limited resources. One of the major challenges to the technique is reaching small scale farmers, availability of specific equipment and gear, such as no-till planters, etc. This can be addressed by providing equipment in rent for farmers who would not otherwise be able to afford it. Policies that support the use of CA must also be developed. The system becomes much more "scale neutral" when a greater number of small farmers have access to CA technologies.

Active role for farmers

CA techniques, like any other technology, are effective only when it is combined with expert management and agro-ecological factors that influence productivity on a given farm or location. As a result, farmers are urged to test the approaches and evaluate the results for themselves, rather than simply "adopting" conservation agriculture technologies. While selecting cover crop species, the farmer must take into account the farm's specific agroecological circumstances, such as soil type, climate, terrain, seed availability, and the principal role of green manures and crop wastes. Different crop spacing, use of pesticides, and irrigation demands must all be established according to the farmer's needs and the resources available.





Santosh Kumar Lenka et al.,

Challenges in conservation agriculture

Even in industrialized countries with robust agricultural extension programmes and well-educated farmers, CA adoption has been slow. This is likely due to farmers' persistent need for quick fixes and immediate rewards, although full economic benefits of CA can only be realized throughout the medium to long term, once its principles are well-established throughout the farming sector. Even though CA procedures can give numerous benefits, there are several significant barriers to their implementation, according to experience.

Change of perspective

Farmers must change their perspective about the traditional ways of preparing the land with a hoe or plough in favour of biological tillage by earthworms and by plant roots. As a result of the transformation, farmers are encouraged to regard their farms as an enterprise rather than just subsistence farming.

Appropriate soil type

CA is often difficult in wetlands and soils with inadequate drainage. Increased water infiltration can exacerbate drainage issues, and heavy mulch might hinder drying and promote disease concerns.

Affordable access to fertilizer and herbicides

When starting CA to enhance crop yields and available crop residues, it may be required to utilize fertilizers as a supplement to legume residues in some circumstances. Large carbon inputs to the soil, such as mulch, might encourage bacteria to immobilize nitrogen, making it inaccessible to crops. Hence, nitrogen additions can assist avoid yield penalties with CA.

Weed control

In smallholder farming systems, weeds constitute a big problem. In the initial years of CA adoption, eliminating tillage may raise weed pressure, but weeds will diminish with time if well-managed. Herbicides are used to control weeds in several CA environments.

Delayed yield benefits

While CA can boost yields over time, farmers may have to wait for 3 to 7 years to see results. Farmers must gain experience with CA over time, and the process of improving soil structure and fertility is slow. Savings in labour or other costs will most likely be the most immediate benefits. Insecure land tenure, like other long-term sustainability investments, adds a layer of complexity to CA practice.

Limited crop residues

If crop yields are poor (areas less than 500 m²), there may not be enough residue to implement CA efficiently. A common barrier to CA usage is the necessity for crop waste as animal feed. In conservation agriculture, it's critical to keep the soil covered. However, it can be challenging. Farmers can use crop wastes for a variety of things, including fodder, fencing, roofing, and fuel. The livestock can be allowed to graze on stubble left on the soil. In dryer places, growing a cover crop is not feasible, therefore the crop wastes are an important source of animal feed.

Land tenure and smallholding

Farmers can practice conservation agriculture on their land for very little money. Due to lesser investment in the development of technology for small and marginal farmers, only a small percentage of the area of the world under CA is consistently applied on small farms (Wall and Ekboir, 2002).

Impact of climate change

Climate change has been obvious for decades, as evidenced by the rise in sea level, increased simulations of temperature, and increase or decrease in rainfall (IPCC, Fourth Assessment Report, 2007). Similarly, extreme events such as the increased likelihood of cyclones, increased rainfall intensity, and drought length may occur more frequently. The model's results also showed rising temperatures and changes in rainfall around the world, with some



**Santosh Kumar Lenka et al.,**

parts experiencing drought and others experiencing floods. Rainfall predicting, on the other hand, is more difficult than temperature forecasting, which has more certainty in models. Extreme climatic occurrences such as floods, droughts, etc. have all been simulated in the same way by climate modelers. All of these extreme events have negative effects on crop yield, however a slight increase in temperature enhances productivity, but beyond 1°C, it turns negative. CO₂ increases, on the other hand, have a large positive impact on agricultural productivity. Because agriculture has a greater global influence than anything else, it is critical to reform agriculture to assure yield sustainability, mitigate climate change, and establish a climate-resilient system.

As a result of this adaptable system, climate change will have minimal effect on agriculture. Meanwhile, promoting climate-wise agriculture to lower GHGE (Greenhouse Gas Emissions), increase resilience, and reduce wastes while increasing small and large-scale farmers' output could be beneficial. Plant diseases, as well as insects/pests, are the main causes of yield decline. Changes in pest/disease patterns and weed life cycles as a result of global climate change may influence agriculture (Estay *et al.*, 2009). Since the temperature is likely to rise between 0.9 and 3.5 degrees Celsius by 2100, resulting in numerous hot days and nights, changes in rainfall patterns will affect the impacts of biotic variables (Dukes *et al.*, 2009). As a result, the intensity and frequency of these variables will have a major impact on agricultural product quality and quantity (Mestre-Sanchis and Feijoo-Bello, 2009). Hence, it is likely that as a result of climate change, some diseases could become more prevalent while others will become less prevalent, resulting in a net effect (Coakley *et al.*, 1999).

Conservation agriculture and climatic change

Climate change adaptation has been widely debated and encouraged in recent years as a critical aim for all human systems, particularly agriculture. Agricultural productivity will be significantly damaged due to climate change, limiting many regions' ability to make the necessary advances in food security (Lobell *et al.* 2008). These hazards, however, may be significantly avoided with planning and careful management of agricultural systems. To prevent food supply disruptions, deliberate work is needed to establish institutions and systems that can quickly adjust to changing conditions. By decreasing existing emission sources, CA can help to reduce greenhouse gas (GHG) emissions in the atmosphere. Overall, there is a scarcity of data on the greenhouse gas (GHG) effects of CA practices, particularly in developing nations in the tropics and subtropics (Govaerts *et al.*, 2009). Though many researchers have looked at GHG stocks and fluxes related to CA systems, the data from these studies a wide range of places, making them difficult to compare or meta-analyze (Nair *et al.*, 2009). Dendooven *et al.* (2011) investigated the effects of CA on net global warming potential (GWP), accounting for carbon sequestration, greenhouse gas emissions, fuel consumption as well as fertilizers and seed production. Tillage had a big impact on the organic C content of the soil in the 0-60cm layer. In zero tillage with residue retention, the soil organic C content was 118103 kg C ha⁻¹, about 40,000 kg C ha⁻¹ greater than in tillage or zero tillage with residue removal. In comparison to tillage or zero tillage with residue removal, zero tillage with residue retention sequestered approximately 2000 kg ha⁻¹ y⁻¹ in the soil over the nearly 20-year trial period (Dendooven *et al.*, 2011). Zero tillage reduced C emissions from farm operations by 74 kg C ha⁻¹ y⁻¹ when compared to CT. While the amount of carbon that may be stored in soil is limited, the reduction in net CO₂ flow to the atmosphere as a result of reduced fossil-fuel usage can be sustained indefinitely (West and Marland, 2008). The net GWP for zero tillage with residue retention (40 kg CO₂ ha⁻¹ y⁻¹), compared to the other management practices (approximately 2000 kg CO₂ ha⁻¹ y⁻¹), was near neutral (keeping in mind soil carbon sequestration, GHG emissions from soil and farm fuel, as well as fertilizer and seed production). N fertilizers are a substantial direct source of N₂O and NO_x emissions in the field, as well as an indirect source due to the use of fossil fuel energy in fertilizer manufacturing and transportation (Ortiz- Monasterio *et al.*, 2010). Efficient fertilizer management can assist reduce N₂O and NO_x emissions in the field while also improving fertilizer efficiency, minimizing fertilizer use, and reducing emissions. Sensor-based nitrogen management is a new method that uses an optical sensor to assess the canopy's NDVI (Normalized Differential Vegetative Index). This vegetative index, along with an N rich strip (a well-fertilized portion of the field) and a cropping algorithm, can be used to estimate the optimal N fertilization rate (Raun *et al.*, 2009). The N fertilizer is administered when the crop is in high demand, which minimizes the chances of creating ideal conditions for N₂O emissions. Conservation agriculture can affect the recycling of C and N in comparison to conventional systems (Govaerts *et al.*, 2006), hence more research is needed to



**Santosh Kumar Lenka et al.,**

be done on this aspect. Irrigation and other agricultural inputs have a hidden carbon cost (West and Marland, 2002). As previously stated, the destruction of physical soil properties in conventionally tilled beds (CTB) might have an impact on resource efficiency. Because of the poor infiltration in CTB, irrigation efficiency may suffer. In addition, in permanent bed systems having residue retention, conservation of water is more due to reduced evaporation compared to CTB. Further research is needed in CA, to estimate the irrigation water requirement versus traditional systems. Global warming may be advantageous in some areas but dangerous in others where ideal temperatures already exist; for example, the rice-wheat mega-environments in the IGP, which account for 15% of global wheat production, are an example. In the IGP, terminal heat stress affects wheat yield dramatically due to induced maturity, which can be reduced by using CA (Advance wheat sowing with zero tillage). Climate change will be more evident in tropical and subtropical regions, which are home to the majority of the world's population and, sadly, the majority of developing countries. Climate change will impact negatively grain production potential in developing countries, which might be severe (Fischer *et al.*, 2005).

Climate change is expected to reduce crop yields by at least 20% by 2050 in South Asia and Sub-Saharan Africa (Et aller and von Braun, 2013; AGRA, 2014; Chattaraj *et al.*, 2014), with 40% and 30% chances of crop failure for maize and wheat, respectively (Et aller and von Braun, 2013; AGRA, 2014; Chattaraj *et al.*, 2014). (Lobell *et al.*, 2008; Thornton *et al.*, 2011; Cairns *et al.*, 2013). Because of rising CO₂ concentrations and temperatures, there is a risk that temperature region production will grow. If the temperature rises in temperate locations, they can employ the same technology, crops, and varieties that are currently used in tropical and subtropical regions, but those areas where optimal temperatures already exist will have no choice. We cannot predict exactly what will happen if CO₂ concentrations rise because, in the case of agriculture, most studies related to climate change (increase in temperature) are conducted under controlled conditions, meaning that only the temperature rises while all other factors remain constant, but this will never happen in nature. After all, if the temperature rises, many things associated with the temperature will also change and affect it at the same time. By minimizing tillage and residue burning and increasing nitrogen usage efficiency, agronomical strategies must seek to reduce greenhouse gas emissions. In the IGP, resource conservation techniques are becoming more common in R-W cropping systems, saving fuel and labour and hence greatly lowering CO₂ emissions. In traditional paddy fields, CH₄ emissions with 21 times warming potential than that of CO₂ are prevalent and important. By switching to an aerobic method of rice cultivation with direct seeding, or a no-till (NT) rice system, this GHG output can be reduced. In South Asia, direct seeding and NT may be a better alternative (Grace *et al.* 2003). The warming potential of N₂O is 310 times that of C₂O, and its emissions are influenced by inadequate nitrogen management. According to Lal (2005), implementing improved agricultural land management methods will increase food security as well as fuel emissions at a rate of 0.5 Pg C yr⁻¹. Climate change will have a significant impact on rice-rice, rice-wheat, and maize-based cropping systems, which accounts for almost 80% of total cereals grown in South Asia.

CONCLUSIONS

We will have to produce more with less in the coming decade by increasing the efficiency of natural and applied resources while minimizing environmental damage. Climate change is rapidly affecting agriculture. Agricultural and land management strategies such as minimizing GHG emissions from cropping systems, cultivar modifications remote sensing, increasing input use efficiency, modelling, and managing pests and diseases may be utilized to ensure crop yield sustainability. In the long run, this will result in improved crop productivity and more efficient resource utilization. To reduce GHG emissions, reduction in the use of high energy inputs, and enhance production efficiency, combining conventional and biotechnological technologies may be considered. Mitigation measures with a synergistic link between crop yield along with climate change should be used to save the future. According to the statistics, CA can provide a spectrum of advantages in terms of both agriculture and the environment.





Santosh Kumar Lenka et al.,

REFERENCES

1. AGRA., Alliance for a Green Revolution in Africa (AGRA). 2014. Africa Agriculture Status Report: Climate change and smallholder agriculture in subSaharan Africa. Nairobi, Kenya. <http://www.agra.org/our-results/agra-statusreports> (last accessed 28.10.15.).
2. Ali, A., Ayuba, S. A., & Ojeniyi, S. O. 2006. Effect of tillage and fertilizer on soil chemical properties, leaf nutrient content and yield of soyabean in the Guinea savanna zone of Nigeria. *Nigerian Journal of Soil Science*, 16, 126–130.
3. Anderson, E. L. 1987. Corn root growth and distribution as influenced by tillage and nitrogen fertilization. *Agronomy Journal*, 79, 544–549.
4. Aryal, J. P., Sapkota, T.B., Jat, M.L., Bishno, i.D., 2015. On-farm economic and environmental impact of zero-tillage wheat: a case of north–west India. *Exp. Agric.* 51, 1–16.
5. Baker, C. J., Saxton, K. E., Ritchie, W. R., Chamen, W. C. T., Reicosky, D. C., Ribeiro, M. F. S., Justice, S.E. and Hobbs, P.R. (2007). No-Tillage Seeding in Conservation Agriculture. In: Baker, C.J. and Saxton, K.E., eds.: No-Tillage Seeding, Sec. Revised Edition, CABI, London, and FAO, Rome, 326p. [Expanded and updated edition of a previous "No-tillage Seeding: Science and Practice (1996)", describing a range Network, Centre de Cooperation Internationale–de Recherche Agronomique pour le Développement (CIRAD), FAO, Rome, 45 p. [Case study presenting the status of CA in Ghana; analyses ongoing CA.
6. Beisecker R. 1994. Einfluulangja ^ EhrigunterschiedlicherBodenbearbeitungssysteme auf das ` BodengefuEge, die Wasserinfiltration und die Stoffverlagerungeines Lo ` E` u- und eines Sand- ^ bodens. *BodenoEkologie und Bodengeneese* 12, 195.
7. Cairns, J. E., Hellin, J., Sonder, K., Araus, J.L., MacRobert, J.F., Thierfelder, C., Prasanna, B.M., 2013. Adapting maize production to climate change in sub-Saharan Africa. *Food Secur.* 5, 345–360.
8. Carter M. R., Steed G.R. 1992. The effects of direct-drilling and stubble retention on hydraulicproperties at the surface of duplex soils in North-Eastern Victoria, Aust. *J. Soil Res.* 30, 505–516.
9. Chattaraj, S., Chakraborty, D., Sehgal, V.K., Paul, R.K., Singh, S.D., Daripa, A., Pathak, H., 2014. Predicting the impact of climate change on water requirement of wheat in the semi-arid Indo-Gangetic Plains of India. *Agric. Ecosyst. Environ.* 197, 174–183.
10. Coakley S. M., Scherm H., Chakraborty S. 1999. Climate change and plant disease management. *Annu Rev Phytopathol.* 37: 399–426.
11. Cookson, W. R., Murphy, D. V., & Roper, M. M. 2008. Characterizing the relationships between soil organic matter components and microbial function and composition along a tillage disturbance gradient. *Soil Biology and Biochemistry*, 40, 763–777.
12. Das, P., Pramanick, B., Goswami, S.B., Maitra, S., Ibrahim, S.M., Laing, A.M., Hossain, A. 2021. Innovative land arrangement in combination with irrigation methods improves the crop and water productivity of rice (*Oryza sativa* L.) grown with okra (*Abelmoschus esculentus* L.) under raised and sunken bed systems. *Agronomy*, 11, 2087.
13. Dendooven, L., Patino-Zuniga, L., Verhulst N., Luna-Guido M., Marsch, R. and Govaerts, B. 2011. Global warming potential of agricultural systems with contrasting tillage and residue management in the central highlands of Mexico. *J. Farming Systems Res. Extension.* 4: 35-66.
14. Derpsch R., 2008. No-tillage and conservation agriculture: a progress report. In: Goddard T., Zoebisch M., Gan Y., Ellis W., Watson A., Sombatpanit S. (Eds.). No-Till farming systems book. Special publication III of the world association of soil and water conservation. Bangkok, 7–39.
15. Derpsch, R. 2005. *The Extent of Conservation Agriculture Adoption Worldwide: Implications and Impact*. Proceedings of the 3rd World Congress on Conservation Agriculture, Nairobi, Kenya, 3-7October 2005, African Conservation Tillage Network, Harare, Zimbabwe.
16. Doran, J. W. 1980. Soil microbial and biochemical changes associated with reduced tillage. *Soil Sci. Soc. Am. J.*, 44, 765–771.





Santosh Kumar Lenka et al.,

17. Duiker, S. W., & Myers, J. C. 2005. Better soil with the No-till system: A publication to help farmers understand the effects of No-till system on the soil (24 pp.). Pennsylvania Conservation Partnership, USDA Natural Resources Conservation Service.
18. Dukes J. S., Pontius J., Orwig D., Garnas J. R., Rodgers V. L., Brazee N., Cooke B., Theoharides K. A., Stange E. E., Harrington R., Ehrenfeld J., Gurevitch J., Lerdau M., Stinson K., Wick R., Ayres M. 2009. Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: What can we predict? *Can J Forest Res.* 39: 231–248.
19. Dumanski, J., Peiretti, R., Benetis, J., Mc Garry, D. and Pieri, C. 2006. The paradigm of conservation tillage. *Proc. World Assoc. Soil and Water Conserv.*, P1: 58-64.
20. Estay S. A., Lima M., Labra F. A. 2009. Predicting insect pest status under climate change scenarios: combining experimental data and population dynamics modelling. *J Applied Entom.* 133(7): 491–499.
21. *Et aller*, T., von Braun, J., 2013. Climate change impacts on food security. *Science* 341, 508–513.
22. FAO (Food and Agriculture Organization). 2007. Agriculture and Consumer Protection Department. Rome, Italy. (Accessed November 2007).
23. Fischer G., Shah M., Tubiello F. N., van Velhuizen H. 2005. Socioeconomic and climate change impacts on agriculture: an integrated assessment, 1990–2080. *Philos T R Soc.* 1463: 2067–2083.
24. Garcia-Torres L., Benites J., Martinez-Vilela A., Holgado-Cabrera A. 2003. Conservation agriculture: environment, farmers experiences, innovations, socio-economy, policy. Kluwer Academic Publishers, Boston, USA.
25. Gattinger, A., Jawtusich, J., Muller, A., & Mäder, P. 2014. Climate change and agriculture: No-till agriculture – a climate smart solution? (pp. 24). Report no. 2. Mozartstraße 9, 52064 Aachen, Germany: BischöflichesHilfswerk, MISEREORe.V
26. Govaerts, B., Sayre, K. D., Ceballos-Ramirez, J. M., Luna-Guido, M. L., Limon-Ortega, A., Deckers, J. and Dendooven, L. 2006. Conventionally tilled and permanent raised beds with different crop residue management: Effects on soil C and N dynamics', *Plant and Soil*, 280: 143–155.
27. Govaerts, B., Sayre, K. D., Goudeseune, B., De Corte, P., Lichter, K., Dendooven, L. and Deckers, J. 2009. Conservation agriculture as a sustainable option for the central Mexican highlands, *Soil & Tillage Research*, 103: 222-230.
28. Grace P. R., Harrington L., Jain M. C., Robertson G. P., 2003. Long-term sustainability of the tropical and subtropical rice-wheat system: an environmental perspective. In *Improving the productivity and sustainability of rice-wheat systems: issues and impact* Ladha J.K, Hill J, Gupta R.K, Duxbury J, Buresh R.J *ASA special publications* 65pp. 27–43. Eds. Madison, WI:ASA. ch. 7.
29. Hobbs, P. R., Govaerts, B., 2010. How conservation agriculture can contribute to buffering climate change. In: Reynolds, M.P. (Ed.), *Climate Change and Crop Production*. CABI, Wallingford, UK, pp. 177–199.
30. Holeplass H., Singh B. R., Lal R. 2004. Carbon sequestration in soil aggregates under different crop rotations and nitrogen fertilization in an inceptisol in southeastern Norway, *Nutr. Cycl. Agroecosys.* 70(2), 167–177.
31. Hossain, A., Mottaleb, K. A., Maitra, S., Mitra, B., Ahmed, S., Sarker, S., Apurbo K. Chaki, A. K., Laing, A. M.) Conservation Agriculture: Next-Generation, Climate Resilient Crop Management Practices for Food Security and Environmental Health. In: Jayaraman *et al.* (eds). *Conservation Agriculture: A Sustainable Approach for Soil Health and Food Security*. Springer, Singapore. https://doi.org/10.1007/978-981-16-0827-8_28 pp. 585-609.
32. Hossain, A., Mottaleb, K.A., Maitra, S., Mitra, B., Alam, M. K., Ahmed, S., Mst. Tanjina Islam, M. T., Sarker, K. K., Sarker, S., Chaki, A. K., Hoque, M. A., Skalicky, M., Brestic, M., Laing, A. M. 2021. Conservation agriculture improves soil health: Major research findings from Bangladesh. In Book: S. Jayaraman *et al.* (eds.), *Conservation Agriculture: A Sustainable Approach for Soil Health and Food Security*, https://doi.org/10.1007/978-981-16-0827-8_26, pp. 511-561.
33. Howard R. J. 1996. Cultural control of plant diseases: a historical perspective. *Can. J. Plant Pathol.* **18**, 145–150.
34. Ismail, L., Blevins, R. L., & Frye, W. W. 1994. Long-term no-tillage effects on soil properties and continuous corn yields. *Soil Science Society of America Journal*, 58, 193–198.
35. Jat, R.A., Wani, S.P., Sahrawat, K.L., 2012. Conservation Agriculture in the semi-arid tropics: prospects and problems. *Adv. Agron.* 117, 191–273.





Santosh Kumar Lenka et al.,

36. Kar, S., Pramanick, B., Brahmachari, K., Saha, G., Mahapatra, B.S., Saha, A., Kumar, A. 2021. Exploring the best tillage option in rice based diversified cropping systems in alluvial soil of eastern India. *Soil and Tillage Research*, 205, 104761. <https://doi.org/10.1016/j.still.2020.104761>
37. Kassam, A., Friedrich, T., Shaxson, F., Pretty, J., 2009. The spread of conservation agriculture: justification, sustainability and uptake. *Int. J. Agric. Sustain.* 7, 292–320.
38. Kemper, W. D., Trout, T. J., Seeger, A., & Bullock, M. 1987. Worms and water. *Journal of Soil and Water Conservation*, 42, 401–404.
39. Kukal, S. S., Sur, H. S., & Gill, S. S. 1991. Factors responsible for soil erosion hazard in submontane Punjab, India. *Soil Use and Management*, 7, 38–44.
40. Kumar K., and Goh K. M. 2000. Crop residues and management practices: effects on soil quality, soil nitrogen dynamics, crop yield and nitrogen recovery. *Adv. Agron.* 68, 198–279.
41. Lal, R. 2005. Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands. *Land Degrad. Dev* 17, 197–209.
42. Lal, R., 2015. Sequestering carbon and increasing productivity by conservation agriculture. *J. Soil Water Conserv.* 70, 55A–62A.
43. Landers, J., 1999. How and why the Brazilian zero tillage explosion occurred? In: Stott, D.E., Mohtar, R.H., Steinhardt, G.C. (Eds.), *Sustaining the Global Farm. Selected Papers from the 10th International Soil Conservation Organization Meeting held May 24–29, 1999 at Purdue University and the USDA-ARS National Soil Erosion Research Laboratory.* , pp. 29–39.
44. Leake A. R. 2003. Integrated pest management for conservation agriculture. In *Conservation agriculture: environment, farmers experiences, innovations, socio-economy, policy* Garcia-Torres L, Benites J, Martinez-Vilela A, Holgado-Cabrera A pp. 271–279. Eds. Dordrecht, The Netherlands; Boston, Germany; London, UK: Kluwer Academia Publishers.
45. Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P., Naylor, R. L., 2008. Prioritizing climate change adaptation needs for food security in 2030. *Science* 319, 607–610.
46. Mestre-Sanchis F, Feijoo-Bello M. L. 2009. Climate change and its marginalizing effect on agriculture. *Ecol Econ.* 68: 896–904.
47. Montpellier Panel 2014. The Montpellier Panel, December 2014. No Ordinary Matter: conserving, restoring and enhancing Africa's soils. http://ag4impact.org/wp-content/uploads/2014/12/MP_0106_Soil_Report_LR1.pdf (last accessed 28.10.15.).
48. Nair, P. K. R., Kumar, B. M, and Nair, V. D. 2009. Agroforestry as a strategy for carbon sequestration. *Journal of Plant Nutrition and Soil Science* 172: 10-23.
49. Neufeldt, H., Kissinger, G., Alcamo, J., 2015. No-till agriculture and climate change mitigation. *Nat. Clim. Change* 5, 488–489.
50. Ortiz-Monasterio, I., Wassmann, R., Govaerts, B., Hosen, Y., Katayanagi, N. and Verhulst, N. 2010. Greenhouse gas mitigation in the main cereal systems: rice, wheat and maize. *Climate Change and Crop Production*, CABI, Oxford shire. pp 151-176.
51. Pittelkow, C. M., Liang, X., Linquist, B. A., et al., 2015. Productivity limits and potentials of the principles of conservation agriculture. *Nature* 517, 365–368.
52. Powlson, D. S., Stirling, C. M., Jat, M. L., Gerard, B. G., Palm, C. A., Sanchez, P. A., Cassman, K. G., 2014. Limited potential of no-till agriculture for climate change mitigation. *Nat. Clim. Change* 4, 678–683.
53. Pramanick B., Kumar M., Singh S.K., Sapna K., Maitra S. (2021) Soil-Centric Approaches Towards Climate-Resilient Agriculture. In: Rakshit A., Singh S., Abhilash P., Biswas A. (eds) *Soil Science: Fundamentals to Recent Advances*. Springer, Singapore. https://doi.org/10.1007/978-981-16-0917-6_17 In: Rakshit A., Singh S., Abhilash P., Biswas A. (eds) *Soil Science: Fundamentals to Recent Advances*. Springer, Singapore. https://doi.org/10.1007/978-981-16-0917-6_17.
54. Rahman, M. H., Okubo, A., Sugiyama, S., & Mayland, H. F. 2008. Physical, chemical and microbiological properties of an Andisol as related to land use and tillage practice. *Soil Tillage Res.*, 101, 10–19.
55. Rasmussen, K. J. 1999. Impact of ploughless soil tillage on yield and soil quality: A Scandinavian review. *Soil and Tillage Research*, 53, 3–14.





Santosh Kumar Lenka et al.,

56. Raun, W. R., Ortiz-Monasterio, I. and Solie, J.B. 2009. Temporally and spatially dependent nitrogen management in diverse environments .pp 203–214.
57. Roose, E., Barthes, B., 2001. Organic matter management for soil conservation and productivity restoration in Africa: a contribution from Francophone research. *Nutr. Cycl. Agroecosyst.* 61, 159–170.
58. Sainju U. M., Terrill T. H., Gelaye S., Singh B. P. 2003. Soil aggregation and carbon and nitrogen pools under rhizoma peanut and perennial weeds, *Soil Sci. Soc. Am. J.* 67, 14–155.
59. Sayre K.D., Hobbs P.R. 2004. The Raised-Bed System of Cultivation for Irrigated Production Conditions. In: Lal R., Hobbs P., Uphoff N., Hansen D.O. (Eds.). *Sustainable agriculture and the rice-wheat system*. Ohio State University. Columbus, Ohio, USA. Paper 20, 337–355.
60. Tebrugge F., Düring R.A. 1999. Reducing tillage intensity — a review of results from a long-term study in Germany, *Soil Till. Res.* 53(1), 15–28.
61. Thierfelder E. Amezcua C., Stahr K. 2005. Effects of intensifying organic manuring and tillage practices on penetration resistance and infiltration rate, *Soil Till. Res.* 82(2), 211–226.
62. Thierfelder, C., Matamba-Mutasa, R., Rusinamhodzi, L., 2015. Yield response of maize (*Zea mays* L.) to conservation agriculture cropping system in Southern Africa. *Soil Till. Res.* 146, 230–242.
63. Thornton, P.K., Jones, P.G., Ericksen, P.J., Challinor, A.J., 2011. Agriculture and food systems in sub-Saharan Africa in a 4 C+ world. *Philos. Trans. R. Soc. Lond. A* 369, 117–136.
64. Tubiello, F. N., Salvatore, M., Rossi, S., Ferrara, A., Fitton, N., & Smith, P. (2013). The FAOSTAT 19 database of greenhouse gas emissions from agriculture Available at. *Environmental Research Letters*, 8, 015009.20, <http://dx.doi.org/10.1088/1748-9326/8/1/015009>. Accessed 20.12.14.
65. UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
66. United Nations Conference on Sustainable Development (UNCSD) (2012) Available at: <http://www.uncsd2012.org/about.html> (accessed 30 August 2012).
67. Valbuena, D., Erenstein, O., Tui, S.H., et al., 2012. Conservation Agriculture in mixed crop–livestock systems: scoping crop residue trade-offs in Sub-Saharan Africa and South Asia. *Field Crop. Res.* 132, 175–184.
68. Vanlauwe, B., Wendt, J., Giller, K.E., Corbeels, M., Gerard, B., Nolte, C. 2014. A fourth principle is required to define Conservation Agriculture in sub-Saharan Africa: The appropriate use of fertilizer to enhance crop productivity. *Field Crops Res.* 155, 10–13.
69. Wall P., Ekboir J. 2002. Conservation agriculture for small farmers: challenges and possibilities. In ASA, CSCA, SSSA Meeting, Indianapolis, IN, USA 10–14 November.
70. West, T. O., Marland, G. 2002. A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: Comparing tillage practices in the United States', *Agriculture, Ecosystems and Environment*. 91: 217–232.
71. Wright A. L., Hons F. M. 2004. Soil aggregation and carbon and nitrogen storage under soybean cropping sequences, *Soil Sci. Soc. Am. J.* 68, 507–513.
72. Yan Y., Ohara T., Akimoto H. 2003. Development of regionspecific emission factors and estimation of methane emission from rice fields in the East, Southeast and South Asian countries. *Glob Change Biol.* 9: 237–254.





Crop Acreage and Yield Estimation using Remote Sensing and GIS and Various Related Schemes

Guntamukkala Sekhar^{1*}, Jogesh Goswami², Jami Naveen³ and Elumle Priyanka⁴

¹Assistant Professor, Centurion University of Technology and Management, Odisha, India

²Professor, Department of Agronomy, Assam Agricultural University, Jorhat, Assam, India

³Young Professional-II, Central Research Institute for Dryland Agriculture, Hyderabad, Telangana, India

⁴Ph.D. Scholar, Assam Agricultural University, Jorhat, Assam, India

Received: 06 Mar 2022

Revised: 10 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Guntamukkala Sekhar

Assistant Professor,

Centurion University of Technology and Management,

Odisha, India

Email: guntamukkala.sekhar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Agriculture is the foundation of any country's economy. As a result, it is critical to monitor crop growth status and forecast crop output regularly. Crop mapping that is precise and sensible, planting area statistics, and growth status monitoring are all requirements for good agricultural management and policy-making. Crop yield estimation in various countries is based on traditional data collection techniques for crop and yield estimation, which include on-the-ground field visits and reports. They are prone to large errors due to insufficient ground observations, which leads to inaccurate crop yield and production estimates. A wide range of crop growth dynamic information can be obtained in real-time using RS. Crop acreage and yield prediction can be accomplished using RS data alone or by incorporating RS data into crop growth and development simulation models. At any time, the NDVI is a reliable indicator of the total green biomass. With the introduction of IRS 1A in 1988, India launched a national level program called Crop Acreage Production Estimation (CAPE), which carried out area and production estimation of major crops at the district and state levels. In 2007, the Ministry of Agriculture launched the "FASAL" program, which was based on the knowledge gained through the CAPE project. The use of satellite RS and GIS data has proven to be more cost effective, consistent, appropriate, and faster than traditional ground-based agricultural asset surveys. More research is needed to estimate crop yields using satellite data. Because of the large spatial variability in soil, rainfall, and management conditions, crop simulation models do not represent spatial features. With the availability of very high resolution satellite data with high temporal frequency, novel techniques such as Machine Learning, AI, and big data analytics, and increased availability of UAV-based observation, satellite remote sensing may soon play a significant role in crop production estimation.





Guntamukkala Sekhar et al.,

Keywords: Remote sensing, GIS, Yield estimation, crop acreage, crop models.

INTRODUCTION

Agriculture is the backbone of the Indian economy, accounting for nearly 30% of GDP and employing 70% of the workforce. Estimating crop production ahead of harvest is extremely useful in farming for purposes such as implementing appropriate agricultural management and pricing agricultural commodities for export/import (Doi *et al.* 2022). Estimating crop production entails calculating the total area under crop and predicting the yield per unit area. Crop acreage and yield estimation are required because they play an important role in the national economy; in planning food security for a district/population; in the country in warning decision-makers about potential crop yield reductions; in allowing timely import and export decisions; and in assisting private companies in planning supply chain decisions such as production scheduling. The accuracy and speed of crop yield estimation influence agricultural-economic and yield price policy (Tikkiwal and Khandelwal, 2012; Kosmowski *et al.*, 2021).

Crop yield estimation in various countries is based on traditional data collection techniques for crop and yield estimation, which include on-the-ground field visits and reports. These reports are frequently subjective and take more time and money to complete. They are prone to large errors due to insufficient ground observations, which leads to inaccurate crop yield and production estimates (Bhattacharyay *et al.*, 2020; Gummadi *et al.*, 2022). Because of their unique advantages of providing multi-spectral, multi-temporal, and multi-spatial resolutions, remote sensing techniques have demonstrated their potential in providing information on the characteristics and spatial distribution of natural resources, including agricultural resources (Lin *et al.*, 2022). Satellite remote sensing data has also proven to be more cost-effective, reliable, timely, and faster than traditional ground-based agricultural resource surveys. Remote sensing spectral reflectance data is a manifestation of the integrated effect of weather, soil, cultural practices, and crop characteristics that can be used to identify and monitor crop growth and estimate crop yield. (Safdary *et al.*, 2022; Prasanth Kumar *et al.*, 2021; Torre *et al.*, 2021). Further, it addresses some Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 15 (life on land)(UN, 2021).

Methods that are used for crop acreage and yield estimation:

CONVENTIONAL METHODS

Empirical statistical models

These models take crop yield into account for many years, and effective crop yield factors are discovered. An empirical equation and the coefficients of each factor are used to relate crop yield to the effective parameter. Crop yield is estimated using these coefficients.

Crop growth models

Crop yield is estimated using crop growth models as a function of the complex interaction of various physiological processes with the environment. They estimate biomass production potential using a crop growth simulator that runs daily. Running these methods presents too many challenges, such as requiring too many ground factors, a lack of data in a correct format, and a high cost.

Crop cutting experiments (CCE)

It is a process used to analyze the overall yield of the village. The values acquired by this are the base for the nationwide yield values. Select a 5x5(25 sq.m) area in the field to harvest the crop and weigh the produce. Per say



**Guntamukkala Sekhar et al.,**

take the weight obtained as X and the next step goes like $X*4000/25$. The result obtained is the yield for one acre. A stratified random sampling technique is used taking block as a primary unit of planning by the agricultural department of each state. Under PMFBY, each state is required to conduct four CCEs in each gram panchayat for each crop and submit a yield report within one month of harvest. (Verma *et al.*, 2022).

REMOTE SENSING AND GIS METHODS

Remote sensing (RS) is the science of acquiring information about objects or areas from a range, typically from aircraft/satellites, whereas GIS is a system designed to capture, store, evaluate, manipulate, manage, and display various types of geographical data. The remote sensing and GIS methods can overcome all the disadvantages of conventional methods. Several RS satellites were launched by India, starting from the first RS satellite IRS 1A in 1988 to the latest launch of RISAT 2BR1 on December 11th, 2019. (Ray *et al.*, 2022)

Spectral signature of vegetation

The vegetation has a distinct spectral signature, but the reflectance of different types of vegetation varies. Plants that have been diseased or stressed can also be identified by their spectral signatures. The spectral reflectance of vegetation is affected by leaf pigments, cell structure, and water content. Deciduous trees, for example, have higher near-infrared reflectance than conifers. The reflectance in the visible bands is relatively low because the majority of light is absorbed by the leaf pigments. Chlorophyll absorbs energy in the blue and red wavelengths and reflects it in the green wavelengths. This is why healthy vegetation has a green appearance. Because of the cellular structure of the leaves, specifically the spongy mesophyll, the reflectance of healthy vegetation is much higher in the near-infrared (NIR) region than in the visible region. Thus, healthy vegetation can be identified simply by its high NIR reflectance and low visible reflectance. The reflectance in shortwave infrared wavelengths is related to the water content and structure of the vegetation. Water absorbs more strongly at 1.45, 1.95, and 2.50 μ m. Outside of these absorption bands in the SWIR region, the reflectance of leaves generally increases as the leaf's water content decreases. (Awad, 2019).

Vegetation Indices (VIs) are mixtures of surface reflectance at two or more wavelengths that are designed to highlight a specific property of vegetation. They are obtained from vegetation's reflectance properties. Each VI is designed to highlight a different aspect of vegetation. The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically but not always from a space platform, and determine whether or not the target being perceived contains live green vegetation. Other VI's include the Vegetation Condition Index (VCI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SATVI), and Temperature Condition Index (TCI), etc. (Sahoo and Manjunath, 2015; Torre *et al.*, 2021; Hassan *et al.*, 2022).

Applications of RS in Agriculture

RS can be applied in agriculture in various ways *viz.* land monitoring; crop stress detection, pest/disease identification, and monitoring, soil mapping, drought monitoring, flood mapping; crop area and production forecast.

Yield forecast in India

The Directorate of Economics and Statistics and the Ministry of Agriculture and Farmers Welfare will release yield forecasts in India. They will release four advance estimates for both *Kharif* and *rabi* every year. Another organization called "National Bulk Handling Corporation", located in Mumbai also releases crop forecasts for *Kharif* and *rabi*.

Yield forecast in China

Crop Watch is China's leading crop monitoring system. It assesses the national and global crop production using RS & ground-based indicators. They publish the bulletin every quarter.

Yield forecast in the US

The USDA publishes World Agricultural Supply and Demand Estimates (WASDE) every month. It forecasts crop supply and demand for major crops.



**Guntamukkala Sekhar et al.,****Satellite remote sensing for crop and yield estimation**

Crop yield estimation with RS began in India in the 1970s, using ISRO and ICAR Color Infrared (CIR) aerial data as part of the Agricultural Resource Inventory and Survey Experiment (ARISE). With the introduction of IRS 1A in 1988, a nationwide program known as Crop Acreage Output Estimation (CAPE) was established, which estimated the acreage and production of main crops at the district and state levels. In 2007, the Ministry of Agriculture developed the "FASAL" initiative, based on the knowledge gathered via the CAPE project to meet the needs of the Ministry of Agriculture (Kasampalis et al., 2018). RESOURCESAT-2 and 2A with 56m resolution data (AWiFS) collect data every 2-3 days; LISS III with 23m resolution collects data every 12-13 days; LISS IV with 5.8m resolution collects data every 25-26 days are a few examples of high temporal and spatial resolution sensors. Every 25 days, a microwave (SAR) satellite with a resolution of 24 meters collects data. Because microwaves can penetrate the cloud, this data was particularly beneficial for rice crop monitoring during the Kharif season, when cloud-free data is difficult to come by.

RS METHODS FOR ACREAGE ESTIMATION

There are mainly two approaches for crop area estimation

Boundary overlaying approach

In this method. The boundary is superimposed on the satellite data and all pixels inside the boundary are analyzed. This method is suitable for a block/district

Sample segment

The sample segment includes two steps i.e. Stratification followed by a random selection of sample segments. The stratification is based on various criteria viz. agro-climatic regions, historical crop production, crop condition as seen in satellite imageries, etc. Random assortment of sample segments (5.5 x 5.5 km or 7.5 x 7.5 km, 10 x 10 km) with a sampling fraction of 10 percent. This method is suitable for large areas such as a state or country. Despite abundant RS and GIS technologies, there are few limitations to the nationwide crop acreage and yield estimation such as small field size; large diversity of crops sown in an area; field to field crop diversity and management practices; intercropping and mixed cropping, and high cloud coverage during Kharif season. (Doi et al., 2022)

RS METHODS FOR YIELD ESTIMATION**RS methods based on Empirical-statistical models**

Spectral indices are determined using satellite photos rather than ground measurements using traditional methods.

RS methods developed based on the water consuming balance model

The crop yield is evaluated as a function of the evaporation fraction taken during the crop growth phases in these methods. The evaporation fraction is estimated in these sets after the entire growth period is divided into 10 day sets.

RS methods based on crop growth model

It is based on the intricate interplay of several physiological processes with their surroundings. The direct use of a driving variable calculated from RS information; updating of a model state variable (for example, LAI) generated from RS data; and calibration of model variables using satellite images have all been highlighted as techniques of data integration.

Monteith model

The yield is estimated using biomass in this model. The biomass can be determined as a multiplication product of APAR and LUE whereas the crop yield is determined by multiplying APAR, LUE, and HI. Where 'HI' is the Harvest index and APAR is the absorbed photosynthetically active radiation (Shafian, 2009). Crop growth simulation modeling uses environmental variables to explain continuous crop growth and estimate crop production. Automation of Crop Simulation based Yield Forecasting is a new crop yield simulation software developed jointly by the ICAR and the IASRI. The major goal of this model's development is to improve the agricultural yield estimation

42669



**Guntamukkala Sekhar et al.,**

process from data preparation to final forecast. It is developed with a computer programming software called MATLAB Code and this uses DSSAT (Decision Support System for Agro-technology Transfer). By using this yield simulation model, the crop parameters (sowing date, anthesis date, LAI, HI) can be extracted automatically for every district.

Crop acreage and yield estimation related schemes in India**FASAL (Forecasting Agricultural output using Space, Agro-meteorology, and Land-based observations)**

It was started in 2006 by the Directorate of Economics & Statistics (DES). With the advancement of technology, now MNCFC (Mahalanobis National Crop Forecasting Centre) which was inaugurated in 2012 is taking the activities of FASAL. FASAL's goals are to establish a forecasting relationship between weather and crop growth, development, and yield; to determine genetic coefficients for popular varieties for use in crop simulation models; to develop yield forecast models based on multiple correlations and regression techniques, as well as crop growth simulation models; and to provide yield forecast issues at the mid-season (F2) and pre-harvest stages (F3). Two smartphone applications were also developed under FASAL viz. Ground truth application and Crop cutting experiment application. The common features of these two applications were collecting field photographs (640x480) and GPS coordinates. Ground Truth Application is useful in creating a national geospatial database of crops. Whereas the Crop Cutting Experiment (CCE) application is used to collect data for CCE. The data received from applications reach ISRO's Bhuvan Server (Sharma *et al.*, 2022; Verma *et al.*, 2022).

CHAMAN (Coordinated Programme on Horticulture Assessment and Management using geo Informatics)

A project called CHAMAN has been launched by the DAC&FW, Ministry of Agriculture & Farmer's Welfare, as part of the Mission for Integrated Development of Horticulture (MIDH). The program's goal is to create and solidify a scientific approach for estimating horticulture crop area and production. It consists of two major components for estimating horticulture crop area and production viz. remote sensing technology and sample survey methodology. The Mahalanobis National Crop Forecast Centre (MNCFC) for the first component and the Indian Agricultural Statistics Research Institute (IASRI) for the second component were both involved in this effort. Depending on the crop's spatial extent, satellite data from LISS III (23.5 m resolution) or LISS IV will be used. If Indian satellite data is not available during crop growth, foreign satellite data will be investigated. (Singh *et al.*, 2017; Handique *et al.*, 2022).

ICAR-All India Coordinated Research Project on Agro meteorology (ICARAICRPAM)

The Indian Council of Agricultural Research (ICAR) launched the All India Coordinated Research Project on Agrometeorology (AICRPAM) at the Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, to better understand the relationships between weather and crop production systems to generate information on the appropriate use of inputs, pest and disease management, and developing strategies to manage aberrant weather conditions for improved crop production. The AICRPAM's goals are to research the agricultural climate with crop planning and crop production potential in various agroclimatic regions; to establish crop-weather relationships for the major rainfed and irrigated crops in various agroclimatic regions; to evaluate various crop microclimate modification techniques for increasing crop water use efficiency and productivity, and to research the effect of weather on the occurrence and spread of diseases.

AMUL inks a memorandum of understanding with ISRO for fodder acreage estimation

Fodder acreage estimation is a decision-making tool used by dairy investors to monitor and plan fodder development activities. The availability of feed from arable land, forest, and grazing lands, which are critical inputs for enhancing milk production and the survival of the bovine population, is closely linked to the development and growth of dairy animals. The major goals of this MoU were to identify the differences between food and fodder crops at the village level, as well as to select appropriate sites of present fallows and cultivable wastelands for green fodder farming at the village level. (Tiwari, 2022).





Guntamukkala Sekhar et al.,

Utilization project on rice productivity from SCATSAT-1 DATA

The space-borne scatterometer of SCATSAT-1 will provide global coverage within 2 to 4 days. The SW SAR retrieves plant parameters (fresh grain weight and grain yield). High temporal and spatial resolution (2km) study backscattering behavior of rice crop at the heading stage to grain yield. The objectives of this project were: to develop a grain yield model for rice crops using SCATSAT-1 data; to develop grain yield models for 13 major rice growing states (Singh *et al.*, 2022).

Crop acreage and yield estimation related schemes in foreign nations

Remote sensing-based Information And Insurance for Crops in Emerging Economies (RIICE)

Remote sensing technologies are used by RIICE to map and sense rice growth in Asian countries (India, Cambodia, Indonesia, Thailand, and Vietnam). The major goal of this program is to lessen rice smallholder farmers' vulnerability in low-income Asian countries and beyond. Such data assists governments in preparing for potential food shortages, as well as stakeholders in better managing the risks involved. It is also a crucial alternative for governments in developing agricultural insurance solutions. Tamil Nadu introduced RIICE technology in 2016 into its new insurance system, so that now more than one million farmers are insured. The field validation can be drastically reduced in areas with expertise over time (Yadav, 2016; Holecz *et al.*, 2022).

Group on Earth Observations Global Agricultural Monitoring Initiative (GEOGLAM)

During the French G20 Presidency in 2011, the Group of Twenty (G20) Agriculture Ministers gave GEOGLAM a policy mandate. This program's major goal is to improve market transparency and food security by producing and disseminating relevant, timely, and actionable information on agricultural circumstances and production perspectives at the regional, national, and global levels.(Sobue *et al.*, 2022).

NASA Harvest

NASA and the University of Maryland collaborated on the project. The major goal of this effort is to improve the use of satellite data in food security and agriculture decision-making at all scales, from farm to global, both in the United States and around the world.(Becker-Reshef *et al.*, 2022).

Big data analytics, deep learning, AI, IoT

With the availability of very high resolution satellite data and high temporal frequency, newer techniques such as Big Data Analytics, Deep Learning, Artificial Intelligence, and the Internet of Things (IoT), the accuracy of crop acreage and yield estimation from RS and GIS techniques can be further improved in the future (Sun and Scanlon, 2019; Colombo-Mendoza *et al.*, 2022)

CONCLUSION

The Indian remote sensing program has included crop production estimation as a crucial component. Crop yield valuation using satellites still requires additional research. There are several concerns with crop evaluation, such as the lack of data for the Kharif season and the accuracy of production estimations, particularly for horticulture crops. Because of the high regional diversity in soil, rainfall, and management conditions, crop simulation models do not capture spatial aspects. It's possible that satellite remote sensing will soon play a key role in crop production estimation, thanks to the availability of very high resolution satellite data with high temporal frequency, innovative techniques such as machine learning, AI, and big data analytics, and the ready availability of UAV-based observation.

REFERENCES

1. Awad, M. M. (2019). Toward Precision in Crop Yield Estimation Using Remote Sensing and Optimization Techniques. *Agriculture*. 9 (54). 13p.





Guntamukkala Sekhar et al.,

2. Becker-Reshef, I., Bandaru, V., Barker, B., Coutu, S., Deines, J. M., Doorn, B. and Justice, C. (2022). The NASA Program on and. In *Remote Sensing of Agriculture and Land Cover/Land Use Changes in South and Southeast Asian Countries* (pp. 53-80). Springer, Cham.
3. Bhattacharyay, D., Maitra, S., Pine, S., Shankar, T. and Pedda Ghouse Peera S.K. (2020). Future of Precision Agriculture in India. In: Protected Cultivation and Smart Agriculture edited by Sagar Maitra, Dinkar J Gaikwad and Tanmoy Shankar, pp. 289-299.
4. Colombo-Mendoza, L. O., Paredes-Valverde, M. A., Salas-Zarate, M. D. P., & Valencia-García, R. (2022). Internet of Things-Driven Data Mining for Smart Crop Production Prediction in the Peasant Farming Domain. *Applied Sciences*, 12(4), 1940.
5. Gummadi, S., Dinku, T., Shirsath, P. B. and Kadiyala, M. D. M. (2022). Evaluation of multiple satellite precipitation products for rainfed maize production systems over Vietnam. *Scientific reports*, 12(1), 1-18.
6. Handique, B. K., Goswami, C., Jena, P., Dutta, F., Samiam, R., Nongrum, I. and Ray, S. S. (2022). Applications of Advanced Geospatial Technology for Expansion of Area under Horticultural Crops in North Eastern Region of India. *Journal of the Indian Society of Remote Sensing*, 1-15.
7. Hassan, D. F., Abdalkadhum, A. J., Mohammed, R. J., Shaban, A. (2022). Integration Remote Sensing and Meteorological Data to Monitoring Plant Phenology and Estimation Crop Coefficient and Evapotranspiration. *Journal of Ecological Engineering*, 23(4), 325–335 <https://doi.org/10.12911/22998993/146267>
8. Holecz, F., Setiyono, T. D., Barbieri, M., Collivignarelli, F., Gatti, L., Anthony, M. and Zaugg, B. (2022). RIICE: The Service and Its Operational Use. In *Remote Sensing of Agriculture and Land Cover/Land Use Changes in South and Southeast Asian Countries*. pp. 105-131. Springer, Cham.
9. Kasampalis, D. A., Alexandridis, T. K., Deva, C., Challinor, A., Moshou, D. and Zalidis, G. (2018). Contribution of Remote Sensing on Crop Models: A Review. *Journal of Imaging*. 52(4). 19p.
10. Kosmowski, F., Chamberlin, J., Ayalew, H., Sida, T., Abay, K., & Craufurd, P. (2021). How accurate are yield estimates from crop cuts? Evidence from smallholder maize farms in Ethiopia. *Food policy*, 102, 102122.
11. Lin, L., Di, L., Zhang, C. Guo, L., Di, Y., Li, H. and Yang, A. (2022). Validation and refinement of cropland data layer using a spatial-temporal decision tree algorithm. *Scientific Data* 9, 63. <https://doi.org/10.1038/s41597-022-01169-w>
12. Prasanth Kumar, P., Sairam, M., Shankar, T., Praharaj, S. and Maitra, S. (2021). Application of Remote Sensing in Agriculture. *Indian Journal of Natural Sciences*. 12(69): 37475-37479.
13. Ray, S. S., Dadhwal, V. K. & Navalgund, R. R. (2022). Progress and Challenges in Earth Observation Data Applications for Agriculture at Field Scale in India and Small Farm Holdings Regions. *Journal of the Indian Society of Remote Sensing*. 50, 189–196. <https://doi.org/10.1007/s12524-022-01523-w>.
14. Safdary, R., Soffianian, A. and Pourmanafi, S. (2022). Application of Landscape Metrics and Object-Oriented Remote Sensing to Detect the Spatial Arrangement of Agricultural Land. *Quaestiones Geographicae*, 41(1). <https://doi.org/10.2478/quageo-2022-0002>
15. Sahoo, R. N; Ray, S.S. and Manjunath, K. R. (2015). Hyperspectral Remote Sensing. *Current Science*, 108(5). 848-859.
16. Sakurai, G., & Iizumi, T. (2020). Seasonal Predictability of Four Major Crop Yields Worldwide by a Hybrid System of Dynamical Climate Prediction and Eco-Physiological Crop-Growth Simulation. *Frontiers in Sustainable Food Systems*, 4, 84.
17. Shafian, S. (2009). Assessment crop yield estimation methods by using satellite imagery. *Geospatial World*. Available at: <http://www.geospatialworld.net/article/assessment-crop-yield-estimation-methods-by-using-satellite-imagery/>
18. Sharma, P. K., Sharma, S., Choudhary, L., Nepal, M., Mushtaq, A., & Parray, T. A. (2022). Apple Farmer's Willingness to Pay for Rwbcs: Determinants and Empirical Evidences from Jammu and Kashmir, India.
19. Singh, A., Mehrotra, R., Rajput, V. D., Dmitriev, P., Singh, A. K., Kumar, P. and Singh, A. K. (2022). Geoinformatics, Artificial Intelligence, Sensor Technology, Big Data: Emerging Modern Tools for Sustainable Agriculture. *Sustainable Agriculture Systems and Technologies*, 295-313.
20. Singh, K. K; Baxla, N; Chattopadhyay, R; Balasubramanian, P. K; Singh, M; Gohain, G. B; Vishnoi, L. and Singh, P. (2017). FASAL Technical Report-2017. Indian Meteorological Department, New Delhi. 162p.





Guntamukkala Sekhar et al.,

21. Sobue, S., Samarakoon, L., Steventon, M., Oyoshi, K., & Le Toan, T. (2022). Asia-RiCE: Collaborative Framework for Rice Crop Management in Asia. *Remote Sensing of Agriculture and Land Cover/Land Use Changes in South and Southeast Asian Countries*, 81.
22. Sun, Y. A. and Scanlon, B. R. (2019). How can Big Data and machine learning benefit environment and water management: a survey of methods, applications, and future directions? *Environmental Research Letters*. 14 (2019) 073001.
23. Tikkiwal, G. C. and Khandelwal, A. (2012). Crop acreage and crop production estimates for small domains – revisited. *Statistics In Transition-new series*. 13(1). pp. 47—64.
24. Tiwari, S. P. (2022). Information and communication technology initiatives for knowledge sharing in agriculture. arXiv preprint arXiv:2202.08649.
25. UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
26. Verma, D., Singh, A. N., Kalubarme, M. H., Saroha, G. P. and Sharma, R. (2022). Varietal Discrimination, Acreage Estimation and Yield Prediction of Basmati Aromatic Rice in North-Western India Using Satellite Data. In *Remote Sensing of Agriculture and Land Cover/Land Use Changes in South and Southeast Asian Countries*. pp.163-186. Springer, Cham.
27. Yadav, M. (2016). Remote Sensing based Information and Insurance for Crops in Emerging Economy Role of Remote Sensing Technology in PMFBY: The experience from RIICE project in Tamil Nadu. Available at: <http://www.researchgate.net/publication/326010676>





Climate Resilient Agronomic Techniques for Sustainable Agriculture

Guntamukkala Sekhar^{1*}, Jogesh Goswami², Jami Naveen³ and Elumle Priyanka⁴

¹Assistant Professor, Centurion University of Technology and Management, Odisha, India

²Professor, Department of Agronomy, Assam Agricultural University, Jorhat, Assam, India

³Young Professional-II, Central Research Institute for Dryland Agriculture, Hyderabad, Telangana, India

⁴Ph.D. Scholar, Assam Agricultural University, Jorhat, Assam, India.

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Guntamukkala Sekhar

Assistant Professor,

Centurion University of Technology and Management,

Odisha, India.

Email: guntamukkala.sekhar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Climate change has the potential to diminish agricultural income by 15 to 25 percent. As climate change has an impact on food production, both in terms of quality and quantity, climate resilient agriculture has become a major challenge in meeting the needs of an ever increasing population. Given the poor's reliance on agriculture and agriculture's vulnerability to climate change, agronomical research should keep up the pace to create need-based, appropriate technologies to accomplish the sufficiency in food production. Climate resilient agronomic techniques have the prospective to amend the present situation and sustain agricultural output on a global, regional and local scale, particularly in a sustainable manner. Improved access to and use of technology, and increased adaptation of crops to climatic stress can help India manage to change climate scenarios and achieve sustainable development goals (SDGs). In this situation, agronomists are expected to play a significant role in furthering the transition to climate resilient agriculture and improving food systems from conventional to sustainable, as well as acting as a link between farmer practices and scientific discoveries.

Keywords: Sustainable, Agronomy, Climate change, Resilient, Crops.

INTRODUCTION

Climate change has a negative influence on agricultural output around the world as temperatures rise and precipitation falls, especially in India where more than 50 percent of India's population is involved in agriculture (Chowdhary *et al.*, 2022). Changes in climatic suitability of crop species as a result of global warming, and extreme weather, such as high temperatures, rainstorms, and floods, reduce crop yields. Furthermore, it results in drier and



**Guntamukkala Sekhar et al.,**

warmer soil, which harms beneficial soil microbes and animal growth, impacting soil health and increasing the severity of plant diseases, pests, weeds, and other challenges, all of which have a significant impact on crop output and quality (Yu *et al.*, 2022) The performance of the summer monsoon (June to September), which supplies roughly 75% of the yearly precipitation, is intimately tied to agricultural production in India. Apart from inter-annual variations in summer monsoon rainfall, many hydro-meteorological phenomena have been discovered to have an impact on Indian agriculture at various spatial scales (Khan *et al.*, 2022). Droughts and floods that occur during the same crop-growing season might substantially sabotage our efforts to increase production using present technologies. Similarly, edaphic restrictions such as low soil organic matter (SOM) and inadequate water and nutrient retention capacity render rainfed agriculture very fragile and less resilient, necessitating a new perspective and strategy (Mykonda and He, 2022). Land degradation results in the loss of soil and plants, both of which are essential for all forms of life on Earth's lithosphere (Chary *et al.*, 2022; Sethi, 2022). The human population grows every day, putting pressure on the soil to produce more food, fiber, and fuel to feed the rising population. Better and more climate resilient agronomic practices would not only increase productivity but will also improve soil health and related ecosystem services (MacMillan *et al.*, 2022). Thus, a scientific approach combined with superior technical interventions can ensure sustainable agricultural productivity and related services which is the need of the hour. Today, sustainable production is the most important requirement for meeting human food needs, with the Sustainable Development Goals emphasizing the need to feed the hunger, achieve food security, and improve nutrition for populations while maintaining environmental safety, social fairness, and a farming system that uses fewer inputs and resources without lowering crop yield (Viana *et al.*, 2022). In this environment, agronomists are anticipated to play a major role in advancing the transition to sustainable agriculture and improving food systems from conventional to sustainable, as well as acting as a bridge between farmer practices and scientific advances.

Climate-resilient agriculture technologies

To address climate change challenges and reduce the negative effects of abiotic pressures, an all-inclusive system biology approach should be used. To resolve the abrupt rising concerns of climate change and abiotic pressures, science-led development in a holistic system approach with the optimal use of sophisticated research is required today. To make agroecological conditions more suited and agriculture lucrative, the following technologies could be considered:

New Traits, Varieties, Crops, and cropping systems for climate resilient agriculture

Choosing the right crops and varieties will not only help you enhance single-crop yield but will also help you increase cropping intensity. Effective agricultural seasons have been calculated for different regions of the country based on the analysis of long-term climate data in terms of the probability of monsoon onset, withdrawal, and occurrence of dry spells. These will be useful in determining which crops are most effective and when they should be planted. To address the dual concerns of climate change and hunger, the ICAR recently identified 35 novel crop varieties in India with specific features such as climate resilience and nutrition rich varieties. Among them are drought tolerant chickpea, wilt and sterility mosaic resistant pigeon pea, early maturing soybean, disease-resistant rice varieties, bio-fortified wheat, pearl millet, mustard, maize and chickpea, quinoa, buckwheat, winged bean, and faba bean, as well as bio-fortified wheat, pearl millet, mustard, maize and chickpea, quinoa, buckwheat (PIB, 2021). Intercropping with suitable base and companion crop combinations, plant population, and nutrient management will boost production, profitability, and risk minimization (Huss *et al.*, 2022). The adoption of cereal-based farming systems, particularly rice-wheat cropping systems, has been highly exploitative, putting great pressure on natural resources beyond their carrying capacity, resulting in the deterioration of not only the crop ecosystem but also the entire life-supporting system. As a result, the agricultural production system's long-term viability is jeopardized, and natural resources as a whole are adversely impacted. Crop diversification, as a departure from traditional crops such as rice-wheat/cereal-cereal based cropping systems and agri-horticultural systems, may aid in increasing profit generation and also can improve adaptation to multiple abiotic and biotic stresses (Zohry and Ouda, 2022). With modern agriculture technologies such as rainwater management, crop selection, short-duration varieties, and other agronomical approaches, more agricultural land can be put under intensive cropping systems such as relay cropping and double cropping. Rainwater collected in agricultural ponds can also be used to establish a winter crop, allowing



**Guntamukkala Sekhar et al.,**

for double cropping. For the diverse agro-climatic zones of India, several new double cropping systems combining millets, legumes, and oilseeds have been developed (Singh *et al.*, 2009).

Use of advanced farm machinery

Increased germination and needed plant population, high crop stand, and sustained crop productivity can be achieved from timely operations. Due to a lack of access to farm machinery, large portions of rainfed regions stay fallow or are planted late, resulting in low crop output. As a result, better access to agricultural machinery for sowing, harvesting, and other operations is a key adaptation strategy for dealing with climatic variabilities such as late monsoon on-set, mid-season, and terminal droughts, as well as for timely seeding of post-rainy crops. The energy requirements of main agricultural operations in dryland agriculture were calculated, and the best biological and mechanical energy combinations were found. For varied operations, several efficient low-cost farm implements were designed which results in a 20–59 percent reduction in operation costs, a 45–64 percent reduction in operation time, a 31–38 percent reduction in seed and fertilizer savings, and an 18–53 percent increase in dryland crop yield (Srinivasarao, 2013).

Contingency crop planning

In the event of late-onset monsoon, mid-season, or terminal droughts, contingency crop planning is primarily targeted at stabilizing crop output. Different weather conditions are covered by contingency planning, such as the late onset of monsoon, mid-season drought, and terminal drought. Changes in crop/cropping systems, crop management, soil nutrient, and moisture conservation methods are among the suggested drought-resilience measures (Yu *et al.*, 2022).

Conservation and harvesting of Rainwater

In arid and semiarid environments, rainwater management entails choosing short-duration, low-water-demanding crops and saving as much rainwater as possible so that crops do not experience moisture stress during the growing season. In addition to in-situ conservation, efforts must be taken to transfer excess water into storage facilities, which can be used as a stand-alone resource or in combination with groundwater to meet important irrigation needs. In areas with excessive rainfall, the aim is to save as much rainwater as possible while harvesting the surplus water for life-saving irrigation, agricultural intensification, and maximizing returns from the captured water. Apart from increasing water availability through various techniques, increasing water-use efficiency should be a priority in preventing various types of water-related losses. Soil structure and porosity are improved, infiltration and hydraulic conductivity are increased, and thus soil water storage is increased, allowing crops to tolerate moisture stress. In most cases, these procedures are more practicable and they can be implemented by an individual farmer with a lower draught, making them suitable even for a small landholding (Chamiet *et al.*, 2022).

Soil health restoration

Existing demographic movements and anticipated worldwide population expansion (approximately 9 billion by 2050) are expected to show a 60% rise in food, feed, and fiber requirements by 2050 (Lancet, 2020). To feed the increasing population the soils are to be managed sustainably by diverse crop rotations with legumes, as well as INM, incorporating the addition of farmyard manure, crop residues, brown manuring, soil carbon sequestration, precision nutrient management, and water conservation practices. Indian soils are deficient not just in NPK, but also in secondary nutrients (S, Ca, and Mg), as well as micronutrients (B, Zn, Cu, Fe, Mn, and so on) in the majority of the country. As a result, soil and land protection are critical for food security as well as the supply of a variety of other ecosystem services (MacMillan *et al.*, 2022). The 2030 outline for sustainable development, which includes seventeen Sustainable Development Goals, was endorsed by the United Nations General Assembly in 2015. (SDGs). Six Sustainable Development Goals (SDGs) are directly related to agriculture, i.e. The most direct link between soils, food production, and healthy living is zero hunger (Goal 2: Ending hunger, ensuring food security and improved nutrition, and promoting sustainable agriculture). Furthermore, enhancing soil quality is a necessary step toward attaining other SDGs, such as Goal 1: No Poverty, Goal 3: Maintaining Good Health and Well Being, Goal 6: Safe Drinking Water and Sanitation, Goal 13 is about climate action, and Goal 15 is about life on land. It is critical to scale



**Guntamukkala Sekhar et al.,**

up technologies that aid in enhancing soil health to achieve the objective of sustainable development (Wag *et al.*, 2022).

Brown manuring

Brown manuring is commonly done by planting rice and *Sesbania* spp. together, and after the dhaincha plants reach a height of approximately 25-30 DAS, a herbicide such as 2,4-D/Bispyribac sodium is used to destroy the *Sesbania* plants, depending on the nature of the weeds. *Sesbania* plants will turn brown after 4 to 5 days after spraying and then begin to die. It solely affects *Sesbania* plants, not rice plants. This is referred to as the knocking down effect. Brown manuring is usually recommended for rice that is directly seeded/aerobic condition to control weeds and to help overcome the negative effects of early season drought owing to *sesbania*'s smothering impact (Singh *et al.*, 2022; Rose *et al.*, 2022).

Soil carbon sequestration and nutrient management

Carbon management in the soil is a critical requirement for climate-resilient agriculture. Soil organic carbon and organic matter are depleting day by day as a result of the continued use of chemical fertilizers. Continuous cropping reduces organic C levels by 50-70 percent, bringing them closer to the climatic and precipitation-driven equilibrium values. Organic carbon content in the soil is the master controller of the soil properties such as biological, physical, and chemical qualities (Mkonda and He, 2022). To restore soil health and solve global warming challenges, it is critical to scale up technologies such as biochar, crop residue recycling, agroforestry, and afforestation for enhancing carbon sequestration. With the conversion of open forests to moderately dense forests and the afforestation of an additional 5 million hectares, the world's forests will be more densely forested than ever before thereby India has the potential to trap 3 billion tonnes of CO₂ equivalent. Reduced tillage, crop rotations, growth of cover crops, contour farming in hilly areas, proper crop residue management, integrated farming system, organic farming, INM, and rotation of legume crops are some of the agronomical strategies that improve soil organic carbon levels (Yu *et al.*, 2022). A lower trend in total factor productivity and compound growth rates of major crops, as well as low nutrient consumption efficiency, has resulted from the deterioration of soil health. Soil health decrease is mostly caused by a large nutrient gap between demand and supply. The current level of nutrient usage efficiency is relatively bad in the case of P (15-20%), N (30-50%), S (8-12%), Zn (2-5%), Fe (1-2%), and Cu (1-2%) due to deterioration in the chemical, physical, and biological health of the soils (Sarkar *et al.*, 2022).

Nutrient management through Precision agriculture

The delineation and mapping of macro and micronutrient deficits utilizing GIS and GPS methods, as well as simulation modeling, are being studied to help with nutrient management decisions in significant agroecosystems. For assuring sustainable agriculture production, soil fertility evaluation, monitoring, and accurate fertilizer recommendations have assumed precedence. In agriculture, the creation of fortified fertilizers and other controlled release fertilizers, as well as the efficient usage of organic wastes, indigenous minerals, and industrial by-products, have all become priorities. Because of the involvement of nanoscience and technology, commercial nano-urea and other formulations are now available, which will not only improve nutrient usage efficiency but also lower cultivation costs. Fertilizers, manures, biosolids, and other sources of nutrients are not always utilized efficiently by crops. Climate change can be mitigated using Site-Specific Nutrient Management (SSNM) and Integrated Nutrient Management (INM). Furthermore, the use of nitrogenous fertilizer based on LCC and Green seeker has been extensively documented and is currently being scaled up to boost NUE (Madan *et al.*, 2022).

Water management

Innovative water management technologies such as micro-irrigation, furrow irrigated raised beds, cover-crop methods, rainwater harvesting structures, greenhouses, reuse of wastewater, and laser land leveling can assist farmers in decreasing the impact of climate variations. Several technologies based on precise crop water needs estimation, adoption of scientific water conservation methods, groundwater recharge techniques, proper scheduling of fertilizer and irrigation, growing less water-demanding crops, adjusting planting may help farmers achieve satisfactory crop yields, even in years with low rainfall and warmer temperatures (Chami *et al.*, 2022).





Guntamukkala Sekhar et al.,

Conservation Agriculture

No-tillage or reduced agriculture often increases the soil carbon uptake and decreased N₂O emissions, whereas soil disturbance stimulates soil carbon losses through accelerated decomposition and erosion. Many crops may now be produced with minimum tillage (reduced tillage) or no-tillage thanks to advances in weed control technology and farm automation (no-till). These approaches are becoming more widely used around the world. Furthermore, reusing crop wastes improves soil carbon, but burning residues increases aerosol and GHG emissions (Singh and Sinha, 2022). The effectiveness of reduced tillage in increasing the storage of more water is widely acknowledged. This is especially significant in arid and semi-arid zones, where agricultural residue management is critical for achieving long-term crop output. In comparison to traditional tillage, conservation agriculture saves about 25%–30% irrigation water, 3% nitrogen, 50% labor, and 60% fuel costs, in addition to the non-monetary benefits of timely crop seeding. The savings come from the fact that zero-tillage wheat can be planted just after rice harvest, taking advantage of residual moisture for germination and potentially avoiding pre-sowing irrigation, as well as the fact that irrigation water runs faster in untilled soil than it does in tilled soil. ZT combined with crop residue retention on the soil surface significantly minimizes erosion and improves water-use efficiency when compared to CT (Kruger *et al.*, 2022).

Integrated Farming System

With changing climatic conditions and diminishing natural resource availability, meeting the diverse needs of a growing global population, while also maintaining environmental quality, natural resources, and ensuring adequate profitability to farm families, has emerged as the most difficult challenge. Agriculture's production system must be sustainable and resilient, with increased productivity, greater income, job creation, risk reduction, resource usage, conservation, and climate change mitigation and adaptation all being priorities. Spreading risks and creating buffers, i.e. not putting "all fruits in one basket," is one of the major approaches for drought mitigation and farm resilience. The farming systems approach is thought to be important and relevant, particularly for small and marginal farmers, because location-specific IFS will be more resilient and adaptive to climate variability (Choudhury *et al.*, 2022). IFS has a lot of potential for dealing with these difficulties, especially in high-stress environments. Due to the high risk of producing arable crops in these pressured areas, farmers have been using a little amount of high-quality inputs, resulting in poor soil health and crop production. In general, farming methods in regions with rainfall of 500 to 700 mm should be centered on livestock with the promotion of low-water needing grasses, trees, and bushes to meet the farmers' food, fuel, and timber needs. Crop, horticulture, and livestock based farming systems can all be used in areas with 700 to 1,100 mm of rainfall, depending on the soil type and marketability criteria. In this location, runoff collecting is an important part of the watershed-based farming system. IFS module integrating paddy with fisheries is ideal in locations when rainfall exceeds 1,100 mm. In arid and semiarid environments, for providing nutritional security, profitability, gainful employment, and environmental security, IFS appears to be a necessary alternative (Panwar *et al.*, 2018). There is also a pressing need to scale up IFS implementation to the necessary level and realize its full potential.

CONCLUSION

Aberrant rainfall, an increase in the frequency of droughts, and natural calamities are rendering farmers more vulnerable. Climate change has an impact on food production, both in terms of quality and quantity where climate resilient agriculture can provide a way to meet the needs of an ever increasing population. As a result, large scale adoption of climate resilient agronomic solutions is required to provide climate resilient, sustainable agriculture output. Given the poor's reliance on agriculture and agriculture's vulnerability to climate change, agronomical research should keep up the pace to create need-based, appropriate technologies to accomplish the aims of sustainable development. Further, the article addresses some Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and wellbeing) and SDG 15 (life on land)(UN, 2021).





Guntamukkala Sekhar et al.,

REFERENCES

- Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S. and Aftab, T. 2021. Climate change impact on plants: Plant responses and adaptations, *In: Tariq Aftab, T. and Roychoudhury, A. (Eds), Plant Perspectives to Global Climate Changes*, (pp. 1-24) Elsevier Inc., Academic Press, <https://doi.org/10.1016/B978-0-323-85665-2.00004-2>.
- Chary, G. R., Bhaskar, S., Gopinath, K. A., Prabhakar, M., Prasad, J. V. N. S., Rao, C. A., Rao, K. V. (2022). Climate resilient rainfed agriculture: Experiences from India. *In Climate Change Adaptations in Dryland Agriculture in Semi-Arid Areas* (pp. 3-18). Springer, Singapore.
- Chowdhary, S. K., Jain, S. K., Rawat, S., & Urooj, S. (2022). Smart Monitoring IoT-Based System for Hydroponic Agriculture. *In Transitioning From Globalized to Localized and Self-Reliant Economies* (pp. 208-231). IGI Global.
- Choudhury, B. U., Nengzouzam, G., and Islam, A. (2022). Evaluation of climate change impact on soil erosion in the integrated farming system based hilly micro-watersheds using Revised Universal Soil Loss Equation. *Catena*, 214, 106306.
- Huss, C. P., Holmes, K. D. and Blubaugh, C. K. (2022). Benefits and Risks of Intercropping for Crop Resilience and Pest Management. *Journal of Economic Entomology*. toac045, <https://doi.org/10.1093/jee/toac045>
- Khan, A.A., Khan, S.U., Ali, M.A.S. (2022). An impact of climate change and groundwater salinity on shadow price of water, farmers' revenue, and socioeconomic and environmental indicators in district Kohat-Pakistan. *Environmental Science and Pollution Research*. 29, 7352–7365. <https://doi.org/10.1007/s11356-021-16179-1>
- Kruger, E., Smith, H., Ngcobo, P., Dlamini, M., & Mathebula, T. (2022). 21 Conservation Agriculture Innovation. *Conservation Agriculture in Africa: Climate Smart Agricultural Development*, 345.
- Lancet, (2020). World population likely to shrink after mid-century, forecasting major shifts in global population and economic power. Available at: <https://www.sciencedaily.com/releases/2020/07/200715150444.htm>
- MacMillan, J., Adams, C. B., Hinson, P. O., DeLaune, P. B., Rajan, N., & Trostle, C. (2022). Biological nitrogen fixation of cool-season legumes in agronomic systems of the Southern Great Plains. *Agrosystems, Geosciences & Environment*, 5(1), e20244.
- Mkonda, M. Y., & He, X. (2022). The Influence of Soil Organic Carbon and Climate Variability on Crop Yields in Kongwa District, Tanzania. *Environmental management*, 1-9.
- Panwar, A.S., Ravisankar, N., Shamim, M. and Prusty, A. K. (2018). Integrated Farming Systems: A Viable Option for Doubling Farm Income of Small and Marginal Farmers. *Bulletin of the Indian Society of Soil Science*, No. 32, pp. 68-88.
- PIB. (2021). PM to dedicate to the Nation 35 crop varieties with special traits on 28th September. Available at: <https://pib.gov.in/PressReleaselframePage.aspx?PRID=1758664>
- Rose, T. J., Thompson-Brewster, E., Cornish, P. S. and Armstrong, R. (2022). Phosphorus constraints to potential land area cropped under organic and regenerative systems in Australia. *Crop and Pasture Science*.
- Sethi, S. (2022). Utilization of beneficial fungal strain/bacterial strains in climate-resilient agriculture. *In Microbiome Under Changing Climate* (pp. 313-331). Woodhead Publishing.
- Singh, K.K., Ali, M. and Venkatesh, M.S. (2009). Pulses in Cropping Systems. Technical Bulletin, IIPR, Kanpur.
- Singh, S., & Sinha, R. K. (2022). Vermicomposting of organic wastes by earthworms: Making wealth from waste by converting 'garbage into gold' for farmers. *In Advanced Organic Waste Management* (pp. 93-120). Elsevier.
- Singh, G., Bhattacharyya, R., Dhaked, B. S. and Das, T. K. (2022). Soil aggregation, glomalin and enzyme activities under conservation tilled rice-wheat system in the Indo-Gangetic Plains. *Soil and Tillage Research*, 217, 105272.
- Srinivasarao, Ch., Sreenath Dixit., Srinivas, I., Sanjeeva Reddy, B., Adake, R.V. and Shailesh Borkar. (2013). Operationalization of Custom Hiring Centres on Farm Implements in Hundred Villages in India. Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh 151 p.
- UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
- Viana, C. M., Freire, D., Abrantes, P., Rocha, J. and Pereira, P. (2022). Agricultural land systems importance for supporting food security and sustainable development goals: A systematic review. *Science of The Total Environment*, 806, 150718.





Guntamukkala Sekhar et al.,

21. Wang, M., Janssen, A. B., Bazin, J., Strokal, M., Ma, L. and Kroeze, C. (2022). Accounting for interactions between Sustainable Development Goals is essential for water pollution control in China. *Nature communications*, 13(1), 1-13.
22. Yu, T., Mahe, L., Li, Y., Wei, X., Deng, X., & Zhang, D. (2022). Benefits of crop rotation on climate resilience and its prospects in China. *Agronomy*, 12(2), 436.





Emerging Impressions of Ethno-Medicinal Plants and Nutraceuticals

Abha Manohar K^{1*}, Aakanksha Pandey², Biplov Chandra Sarkar³, Siddhartha Shankar Sharma¹ and Gopal Shukla⁴

¹Centurion University of Technology and Management, Odisha, India

²Punjab Agricultural University, Punjab, India

³North Eastern Hill University, Meghalaya, India

⁴Uttar Banga Krishi Viswavidyalaya, West Bengal, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Abha Manohar K

Centurion University of Technology and Management,
Odisha, India.

Email: abha.manohar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Nutritionally rich and medicinally important ethnic plants are valued like never before in this era. Ethnic knowledge harbors many different plants which are less known to modern science. Food can be effectively used as medicine if it's been taken wisely. The global nutraceutical market is growing at a high pace while in India it is evolving and gaining momentum. Nutraceuticals help to reduce the risk of various chronic lifestyle-related diseases as it modulates metabolism. It is very relevant in present times as globalization and economic development has damaged our eating habits thus questioning healthy living. A systematic key approach is needed as there are many misconceptions and duplicate products are surrounded by this industry. For the wellbeing of humankind and to regulate and minimize those misconceptions it is essential to raise scientific backup and popularization of this idea. People nowadays embrace living naturally and healthily. Owing to the high acceptability of this term, it is widely used in marketing varied products. Thus there is a great scope for this newly emerging science along with incorporating traditional knowledge in research and quality improvement.

Keywords: Environment, Health, Food security, Sustainable Development Goals, Livelihood

INTRODUCTION

Recent years have witnessed sudden progress in the use of plant resources in healthcare. The age-old relationship of Human beings with plants is inevitable. Plant diversity is very vital for India's ecological, environmental and healthcare sector as well. Indigenous people play a key role in the usage of traditional ways of using plants as a healing remedy for various diseases, culinary purposes, other construction, and craftworks too (Bent and Ko, 2004).



**Abha Manohar et al.,**

Plants possess a wide range of secondary metabolites in them which can be carefully utilized by humans for different applications like Antibiotics, anti mycotics, animal nutrition, cosmetics, food additives, bio repellents, etc. (Juan et al., 2007). It is very relevant in present times as globalization and economic development has damaged our eating habits thus questioning healthy living. Foods with high calorie, carbohydrates, and unsaturated fats have made human health terrible in the present times. Health is always of paramount importance in any human and people are very conscious in the verge of Covid-19 and other new diseases.

Back to nature is the only way to combat most of these lifestyle-related diseases/disorders. Ancient time's people were using only natural products for nutrition and medical purpose as well. But modernization has destroyed most of the plant resources and thus such traditional practices. Still, in some places of the world people are relying on ethnic medicine mostly because of the poor economic status or areas not in reach. The sudden surge in medicinal and aromatic plants in healthcare is mainly due to the various side effects created by unsafe synthetic pharmacological agents. People are more concerned about maintaining their health with safer and effective natural products. Going back to nature is the only way to this. This paper emphasises over sustainable development goals (SDG) viz. SDG-3 (Good health and well-being), SDG-8 (Decent work and Economic Growth), SDG-12 (Responsible consumption and production), SDG-15 (Life on Land).

Ethnomedicinal plants and nutraceuticals

These days ethnobotany & ethnomedicinal plants has got wide acceptance in the public. According to International Union for Conservation of Nature (IUCN) and the World Wildlife Fund (WWF), there are between 50,000 and 80,000 flowering plant species used for medicinal uses. Out of the 60,000 plant species that are listed as threatened for extinction, approximately 20,000 or even more are from India alone (Kala and Sajwan, 2007). About 60% of the world population and 80% of the population of developing countries rely on traditional medicine. According to Bhat et al. (2013), more than 4.5 billion people in the developing world rely on medicinal plants as components of their healthcare. The highest popularity of medicinal plant in rural areas is due to high cost of allopathic drugs and side effects (Marwat et al., 2008). Ancient times people were using natural products for nutrition as well as for healthcare. Still the ethnic people are using medicinal plants for their medical purposes firstly because it is easily available and secondly because of the poor economic conditions prevailing in such communities. There are so many unknown sources and uses of plant species among tribal people (Lepcha et al. 2019). The knowledge source is depleting as the younger generation doesn't care about such things and they are moving towards cities. Ethnobotany can be defined as the total natural and traditional relationship and interactions between man and his surrounding plant wealth (Das and Rahman., 2014). It has been estimated that 5-10% of the existing plant species in India have been surveyed for biologically active compounds (Singh et al., 2012). Only 25% of the medical drugs are based on plant sources in the developed countries (Crag et al., 1997).

The daily rigorous life made people focus on ready to eat or readymade things. In the present the aftermath of lifestyle made them realized the usefulness of dietary supplements, nutritional therapy, phytotherapy and nutraceuticals. Nutraceuticals (Nutrients + Pharmaceuticals) are nonspecific biological therapies used to promote wellness, prevent malignant processes and control symptoms. They are categorized as follows based on their chemical constituents (a) Nutrients (vitamins, minerals, Amino acids, etc.) (b) Ayurvedic Herbs or botanicals and (c) Dietary supplements (probiotics, prebiotics, antioxidants, enzymes) (Hathcock, 2001).

Nutraceuticals origin and development

Dr. Stefen DeFelise coined the term Nutraceutical from "Nutrition and Pharmaceutical" in 1989. He defined nutraceutical as a food or a part of food that provides medical or health benefits, including the prevention and treatment of disease. Such products range from isolated nutrients, dietary supplements, and specific diets to genetically engineered designer food and herbal products. Nutraceuticals refer to natural functional/medical foods or bioactive phytochemicals that are health-promoting, disease-preventive, curative, functional foods and beverages containing specific ingredients (vitamins, lipids, proteins, carbohydrates, minerals, or other necessary nutrients) with health benefits. Dietary supplements provide nutraceuticals in a nonfood matrix (tablet or capsule) at a dosage that

42682



**Abha Manohar et al.,**

exceeds the amount present in normal food (Zeise, 1999; Brower,1998). When such nutraceuticals are used for treatment or prevention of disease, they can be coined as a drug. Vegetables, fruits, whole grains, herbs, nuts, and seeds contain an abundance of phenolic compounds, terpenoids, sulfur compounds, pigments, and other natural antioxidants which act as compounds for the treatment of various disease conditions. (Prabu et al.,2012). Nutraceuticals is a very broad term which includes a variety of substances/compounds ranging from essential metals, large polymers up to bacteria.

Ethnomedicinal plants derived nutraceuticals

Ethnomedicinal plant bioactives, an important category of nutraceuticals, are commonly used by people who seek conventional health care. These harbor a wide variety of active phytochemicals including the flavonoids, terpenoids, lignans, sulfides, polyphenols, carotenoids, coumarins, saponins, plant sterols, uramins and phthalates (Craig, 1999). Ethnic plants have been used for medicinal purposes throughout history. Their health properties are linked to a number of chemical constituents, including vitamins, flavonoids, terpenoids, carotenoids, phytoestrogens and minerals (Calucci et al., 2003; Suhaj 2006). Plants such as basil, lemon balm, marjoram, mint, oregano, rosemary, sage, savory and thyme, appear to be particularly rich in flavonoids, phenolic acids and terpenoids with high levels of bioactivity (Table 1). Some other herbs such as chervil, coriander, dill, fennel, lovage and parsley, the second most important herb family, have been shown to have high levels of flavonoids. Some of the examples are given below:

Role of nutraceuticals in combating various disease

Nutraceuticals have received considerable interest because of their presumed safety and potential nutritional and therapeutic effects". The concept of nutraceuticals was started from the survey in U.K., Germany and France which concluded that diet is rated more highly by consumers than exercise or hereditary factors for achieving good health. In recent years there is a growing interest in nutraceuticals which provide health benefits and are alternative to modern medicine. By using nutraceuticals, it may be possible to reduce or eliminate the need for conventional medications, reducing the chances of any adverse effect. Nutraceuticals often possess unique chemical actions that are unavailable in pharmaceuticals. The entire world is fighting diseases characteristic of the modern age such as obesity, osteoporosis, cancer, diabetes, allergies, and dental problems. With a global increase in the prevalence of obesity, both nutrition and exercise play key roles in its prevention and treatment. Nutrients, herbals and dietary supplements are major constituents of nutraceuticals which make them instrumental in maintaining health, act against various disease conditions and thus promote the quality of life. Using food products to promote health and cure disease is renowned. Currently most of the drug molecules available in the formulations were anciently used in their crude form (Table 1).

There are multiple different products that fall under the category of nutraceuticals.

1). Dietary Supplements 2). Functional Foods 3). Medicinal plants 4). Pharmaceuticals

From the consumers' point of view nutraceuticals may offer many benefits:

1. May increase the health value of our diet. 2. May help us live longer. 3. May help us to avoid particular medical conditions. 4. May have a psychological benefit from doing something for one self. 5. May be perceived to be more "natural" than traditional medicine and less likely to produce unpleasant side effects. 6. May present food for populations with special needs (e.g. nutrient-dense foods for the elderly).

CONCLUSION

It is observed that very few countries have accepted the terminology of Nutraceuticals and designed regulatory guidelines. Absence of regulatory guidelines for nutraceuticals may flood the healthcare market with spurious and inferior quality products. This is high time for the India government to accept and define these new terms of Nutraceuticals, Functional Foods, and Dietary supplements. The government also has to prepare proper regulatory guidelines to control the healthcare market and to restrict the entry of spurious and inferior quality nutraceutical products. A nutraceutical may be beneficial to our health but we are still learning about their benefits and possible



**Abha Manohar et al.,**

harmful effects. Government regulatory bodies also face challenges in this new category of health products, which lies between food and drugs. Health professional, nutritionists and regulatory toxicologist should strategically work together to plan appropriate regulation to provide ultimate health and therapeutic benefit to mankind.

REFERENCES

1. Bent S, Ko R Commonly used herbal medicines in the United States: a review. *Am J Med*2004; 116 (7): 478–485.
2. Bhatt P, Joseph GS, Negi PS, Varadaraj MC. Chemical composition and nutraceutical potential of Indian borage (*Plectranthus amboinicus*) stem extract. *J Chem* 2013; <https://doi.org/10.1155/2013/320329>.
3. Brower V. Nutraceuticals: Poised for a healthy slice of the healthcare market? *NatBiotechnol*1998; 16:728-31.
4. Calucci Lucia, Calogero Pinzino, Maurizio Zandomeneghi, Antonella Capocchi, Silvia Ghiringhelli, Franco Saviozzi, Sabrina Tozzi, Luciano Gallesch. Effects of gamma-irradiation on the free radical and antioxidant contents in nine aromatic herbs and spices. *J Agric Food Chem* 2003; 51(4):927-934.
5. Chen PF, Chang ST, Wu HH. Antimite activity of essential oils and their components from *Cinnamomum osmophloeum*. *Quart J Chin For* 2002; 35: 397– 404
6. Crag GM, Newman DJ, Snader KM. Natural Products in drug discovery and development. *J of Nat Prod* 1997; 60: 52-60.
7. Craig WJ. Health-promoting properties of common herbs. *American J. Nutr.* 1999 ; 70: 491S-9S.
8. Das U, Chowdhury Habibur Rahaman. An observation on the phytotherapeutic uses of plants by the tribal people of some forest areas in Birbhum and Burdwan districts, West Bengal, India. *J Appl Pharm Sci*2014; 4 (4) :72-78.
9. Gopal Shukla V, Pala NA, Manohar A, Puri A, Chakravorty S. 2020. Bioprospecting Wild Plant Resources to Ensure Food and Nutritional Security. In: *Recent Trends & Advances in Food Science & Post Harvest Technology*. Eds. Ivi Chakraborty, Riadh Ilahy, Balaji Vikram, Sujayasree O.J., Arghya Mani. Sathish Serial Publishing House Pp.403
10. Hathcock J. Dietary supplements: How they are used and regulated. *J Nutr*2001 ;131:1114-7.
11. Juan Carlos Espín, María Teresa García-Conesa, Francisco A Tomás-Barberán. Nutraceuticals: Facts and fiction, *Phytochemistry*2007; 68 (22–24): 2986-3008.
12. Kala CP, Sajwan BS. Revitalizing Indian systems of herbal medicine by the National Medicinal Plants Board through institutional networking and capacity building. *Curr Sci* 2007; 797-806.
13. Lepcha LD, Shukla G, Sarkar BC, Tamang M, Chettri R, Abha MK, Pala NA, Chakravarty S. Ethno-botanical plant diversity in home gardens based agroforestry system in kanchendzonga biosphere reserve, Sikkim, India. *Journal of Tree Sciences*. 2019;38(2):59-69.
14. Marwat SK, Khan MA, Rehman FU, Ahmad M, Zafar M. Biodiversity and importance of floating weeds of Dara Ismail, Khan District of Kpk, Pakistan. *Afr J Tradit Complement Altern Med* 2011; 8(5):97-107.
15. Prabu SL, Suriyaprakash TN, Kumar CD, Kumar SS. Nutraceuticals and their medicinal importance. *Int J Health Allied Sci* 2012;1:47-53.
16. Pulliainen K, Nevalainen H, Vakevainen H, Jutila K, Gummer CL. An analytical method for the determination of betaine (trimethylglycine) from hair. *Int J Cosmet Sci*2010; 32: 135–138
17. Rajasekaran A, Sivagnanam G, Xavier R. Nutraceuticals as therapeutic agents: A review. *Res J Pharm Tech*2008; 1:328-40.
18. Rishi RK. Nutraceutical: Broadline between food and drug. *Pharmacol*2006;51-53.
19. Singh S, Taneja M, Majumdar DK. Biological activities of *Ocimum sanctum* L. fixed oil- An overview. *Indian J Exp Biol* 2012; 45: 403-412.
20. Steiber A, Kerner J, Hoppel C. Carnitine: a nutritional, biosynthetic, and functional perspective. *Mol Aspects Med*2004; 25 (5-6): 455–73
21. Suhaj M. Spice antioxidants isolation and their antiradical activity: A review. *J Food Compost Anal* 2006; 19:531-537.
22. Zeisel SH. Regulation of “nutraceuticals”. *Science* 1999; 285:185-6.





Abha Manohar et al.,

Table 1. Functional and Nutraceutical Components in Common Herbals:

| Common Name | Scientific Name | Constituent | Health Benefits |
|-----------------|------------------------------|--------------------------------|---|
| Garlic | <i>Allium sativum</i> | Alliin and Alicin | Anti-inflammatory, antibacterial, antigout, nervine tonic |
| Maiden Hairtree | <i>Ginkgo biloba</i> | Ginkgolide and bilobalide | PAF antagonist, memory enhancer, antioxidant |
| Ginger | <i>Zingiber officinale</i> | Zingiberene and gingerols | Stimulant, Chronic bronchitis, hyperglycemia, Throat pain |
| Echinacea | <i>Echinacea purpurea</i> | Alkyl amide and Echinacoside | Anti-inflammatory, Antiviral, immunomodulatory |
| Ginseng | <i>Panax ginseng</i> | Ginsenosides and Panaxinosides | Stimulating immune and nervous system |
| Liquorice | <i>Glycyrrhiza glabra</i> | Glycyrrhizine and Liquirtin | Anti-inflammatory and Anti allergic, Expectorant |
| Turmeric | <i>Curcuma longa</i> | Curcumin | Anti-inflammatory, anti arthritic, anticancer, and antiseptic |
| Onion | <i>Allium cepa</i> | Allicin and Allin | Hypoglycemic activity, Antibiotic and Anti atherosclerosis |
| Valeriana | <i>Valeriana officinalis</i> | Valerenic acid and valerate | Tranquilizer, migraine and menstrual pain, intestinal cramps, bronchial spam |
| Aloes | <i>Aloe barbadensis</i> | Aloins and Alosin | Dilates capillaries, anti-inflammatory emollient, wound healing properties. |
| Golden seal | <i>Hydrastis Canadensis</i> | Hydrastine and berberine | Antimicrobial, astringent, antihemorrhagic, treatment of mucosal inflammation |
| Senna | <i>Cassia angustifolia</i> | sennosides | Purgative |
| Bael | <i>Aegle marmelos</i> | Marmelosin | Digestive, Appetizer, treatment of diarrhea, dysentry |
| Brahmy | <i>Centella asiatica</i> | Asiaticoside and madecosside | Nervine tonic, spasmolytic, Anti-anxiety. |

(Pulliainen et al., 2010; Chen et al., 2002; Steiber et al., 2004; Rishi, 2006; Rajasekharan et al., 2008).





Effects of Rice Herbicides on Soil Enzyme β -glucosidase and Microbial Biomass Carbon of Succeeding *Toria* Sown with Stubble Mulch and Minimum Tillage

Ashirbachan Mahapatra^{1,2&3}, Mahesh Chandra Bhambri¹, Sanjoy Saha^{2*}, Sushmita Munda² and Nitish Tiwari¹

¹Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

²Crop Production Division, ICAR–National Rice Research Institute, Cuttack, Odisha, India

³Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Received: 09 Mar 2022

Revised: 10 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Sanjoy Saha

Crop Production Division,
ICAR–National Rice Research Institute,
Cuttack, Odisha, India
Email: ssahacri@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The activity of soil microorganisms in the succeeding crop may be affected by the residual effect of herbicides used in the preceding crop. Therefore an experiment was done in the wet and dry seasons of 2018-19 and 2019-20 at ICAR – National Rice Research Institute, Cuttack, Odisha laid out in randomized block design comprising of ten weed management treatments in transplanted rice in wet season, comprising of three herbicide mixtures i.e. fluroxypyr-benzyl + cyhalofop-butyl at (25+125) g ha⁻¹ at 18 days after transplanting (DAT) (W₁), fenoxaprop-p-ethyl + ethoxysulfuron at (50+15) g ha⁻¹ at 18 DAT (W₂) and cyhalofop-butyl + penoxsulamat (100+30) g ha⁻¹ at 18 DAT (W₃); three sequential application of herbicides i.e. bispyribac-sodium at 30 g ha⁻¹ at 9 DAT, fluroxypyr at 15 g ha⁻¹ at 21 DAT (W₄), fluroxypyr at 25 g ha⁻¹ at 9 DAT, fluroxypyr at 15 g ha⁻¹ at 21 DAT (W₅) and cyhalofop-butyl at 100 g ha⁻¹ at 9 DAT, fluroxypyr at 15 g ha⁻¹ at 21 DAT (W₆); two herbicide checks i.e. bensulfuron-methyl + pretilachlor at (60+600) g ha⁻¹ at 4 DAT (W₇) and bispyribac-sodium at 30 g ha⁻¹ at 2 leaf stage of weeds (W₈); one weed free check (Hand weeding at 20, 40 and 60 DAT) (W₉) and one weedy check (Untreated) (W₁₀); replicated thrice. After harvest of wet season rice, *toria* was sown with resource conservation technologies viz. minimum tillage and rice stubble mulch in the succeeding dry season and the residual effects of the rice weed management treatments on soil enzyme i.e. β -glucosidase and microbial biomass carbon were studied at 30, 45 and 60 days after sowing of *toria*. The effects of the preceding season weed management treatments were found non-significant on the soil environment of *toria* in the dry season.



**Ashirbachan Mahapatra et al.,****Keywords:** Herbicides, Minimum Tillage, β -glucosidase activity, Microbial biomass carbon, Rice, Toria

INTRODUCTION

Among seven edible oilseed crops cultivated in India, Rapeseed-mustard ranks second contributing 28.6% of the total oilseed production (Shekhawat et al., 2012). Rice-based cropping system is one of the major cropping systems adopted in India. Rice-fallow is the most followed cropping system in Eastern India rainfed situation accounting for an area about 9.73 million ha (Kumar et al., 2018). In this area, the residual moisture in the soil is subjected to loss by evaporation during *rab* season after harvest of rice. A short duration crop can easily be grown in this area which will not only utilize the available soil moisture efficiently, but also increase the productivity of land as well as the profit of farmers. Toria, being a short duration crop (70-80 days), is well suited to be included in the existing rainfed situation as in sequence after cultivation rice. Therefore, it's cultivated largely in eastern India, including the state of Assam, Bihar, Odisha and West Bengal mainly as winter crop after harvest of rice (Samant, 2015). Out of the 17 SDGs suggested by UNDP, rice-based cropping system with resource conservation technologies has potential to fulfill SDG 2 and 3 (FAO, 2021). Among different biotic stresses, weed infestation is only responsible to compromise the yield up to about 40% in crops. In order to check this loss, timely and efficient weed management is required which can be effectively done by herbicidal weed control in rice. However, due to herbicide application, there may be qualitative and quantitative alterations in the soil environment of the crop i.e. soil microbial populations and their enzymatic activities (Xia et al., 2011). Several literatures reported that recommended doses of herbicides didn't have harmful effect on soil environment (Selvamani and Sankaran, 1993) but the non-target organisms including microorganisms may be affected by some of the herbicides (Latha and Gopal, 2010). Even it was reported that, the growth and activities of the soil microbes may be stimulated by application of some herbicides (Wardle and Parkinson, 1990). Further more, information regarding the effects of different herbicides applied in wet season rice, on soil enzymes in succeeding *toria* crop is limited. Considering the above mentioned facts, the present experiment was conducted to study residual effect of wet season rice herbicides on soil environment in succeeding *toria*.

MATERIALS AND METHODS

The field experimentation was executed at ICAR – National Rice Research Institute, Cuttack, Odisha in wet and dry seasons of 2018-19 and 2019-20. The experiment was laid out in Randomized Block Design with ten weed management treatments in wet season transplanted rice (TPR) and the residual effects of the same treatments were studied in the succeeding *toria* crop in the dry season with three replications. The *toria* was sown after harvest of TPR with resource conservation technologies i.e. minimum tillage and wet season rice stubble mulch. The ten weed management treatments in rice were three herbicide mixtures i.e. flopyrauxifen-benzyl + cyhalofop-butyl at (25+125) g ha⁻¹ at 18 days after transplanting (DAT) (W_1), fenoxaprop-p-ethyl + ethoxysulfuron at (50+15) g ha⁻¹ at 18 DAT (W_2) and cyhalofop-butyl + penoxsulam at (100+30) g ha⁻¹ at 18 DAT (W_3); three sequential application of herbicides i.e. bispyribac-sodium at 30 g ha⁻¹ at 9 DAT, ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_4), flucetosulfuron at 25 g ha⁻¹ at 9 DAT, ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_5) and cyhalofop-butyl at 100 g ha⁻¹ at 9 DAT, ethoxysulfuron at 15 g ha⁻¹ at 21 DAT (W_6); two herbicide checks i.e. bensulfuron-methyl + pretilachlor at (60+600) g ha⁻¹ at 4 DAT (W_7) and bispyribac-sodium at 30 g ha⁻¹ at 2 leaf stage of weeds (W_8); one weed free check (Hand weeding at 20, 40 and 60 DAT) (W_9) and one weed check (Untreated) (W_{10}).



**Ashirbachan Mahapatra et al.,****Soil microbial analysis**

Soil samples from each plot consisted of composite samples were collected with as ample probe augur (0-15cm) at 30, 45 and at 60 days after sowing (DAS) of dry season *toria*. Collected soil was thoroughly mixed and composite samples were prepared.

 β -Glucosidase activity

β -Glucosidase activity assessment was done by treating soil sample with toluene, modified universal buffer (pH 6.0) and *p*-nitrophenyl- β -D-glucoside solution (Eivazi and Tabatabai, 1977). After 1 h of incubation at 37°C, 0.5 M CaCl₂ and 0.1 M Tris (hydroxymethyl) amino methane buffer pH 12 was added. The suspension was filtered and the filtrate was measured at 420nm.

Soil microbial biomass carbon (MBC)

Soil microbial biomass carbon (MBC) was measured by modified chloroform fumigation extraction method (Vance et al., 1987). 10 g of fresh soil sample was taken and treated with 2 mL ethanol free chloroform and incubated for 24 hrs. In another set, soil was kept in similar condition without treatment of chloroform. After incubation, the lid of each container was opened to remove the chloroform vapors in which 40 mL of 0.5 M K₂SO₄ was added and the content was shaken for at least 1 hr. Then filtration of the suspension was done and the filtrate was measured at 280nm.

RESULTS AND DISCUSSION **β -Glucosidase activity**

Generally β -glucosidase is hydrolyzed to serve as energy sources for microorganisms in soil. The β -glucosidase activity as influenced by different wet season rice weed management treatments are presented in Table 1. The treatments did not show significant effects on the β -glucosidase activity of the succeeding *toria* crop, but the activity increased gradually from 30 to 60 DAS. The decomposition of rice stubbles and minimum tillage which facilitates microbial activity might be responsible for the higher activity of β -glucosidase (Sharma et al., 2020). The treatments had no harmful effects on β -glucosidase activity in the succeeding *toria*.

Soil microbial biomass carbon (MBC)

MBC is considered to be one of the most responsible soil microbiological parameters for regulation of nutrient cycling (Singh et al., 2014) and is closely related to the primary output of an ecosystem (Marcel et al., 2008) and soil health (Sparling, 1997). The data on MBC as influenced by the wet season weed management treatments are presented in Table 2 which depict that the effect of different weed management treatments of preceding rice crop didn't affect the biological property of soil significantly. The rate of increase of MBC from 30-45 DAS was higher than that at 45-60 DAS. The treatments had no harmful effects on MBC in the succeeding *toria*.

CONCLUSION

The herbicide mixtures, sequential application of herbicides and single herbicide used in the experiment were found to be safe having no harmful effects on the soil microbial biomass and enzyme i.e. β -glucosidase in succeeding *toria* crop. The resource conservation technologies i.e. minimum tillage and rice stubble mulch may have very good effect on facilitating the degradation of rice herbicides also on increasing the microbial biomass carbon and β -glucosidase activity in the succeeding *toria* in the dry season after harvest of wet season rice.

References

1. Eivazi, F., Tabatabai, M.A. 1977. Phosphates in soils. Soil Biology and Biochemistry 9:167–172.





Ashirbachan Mahapatra et al.,

2. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 30th April, 2022).
3. Kumar, R., Mishra, J.S., Hans, H. 2018. Enhancing productivity of rice-fallow of eastern India through inclusion of pulses and oilseeds. *Indian Farming* 68(8):7-10.
4. Latha, P.C., Gopal, G. 2010. Influence of herbicides on cellulolytic, proteolytic and phosphatase solubilizing bacteria. *International Journal of Plant Protection* 3(1):83-88.
5. Marcel, G.A., Heijden, V.D., Bardgett, R.D., Van Straalen, N.M. 2008. The unseen majority: Soil microbes as drivers of plant diversity and productivity in terrestrial ecosystems. *Ecology Letters* 11:296-310.
6. Samant, T.K. 2015. On farm assessment of toria (*Brassica campestris* L.) variety Sushree under mid central tableland zone of Odisha. *International Journal of Applied Research* 1(9):84-86.
7. Selvamani, S., Sankaran, S. 1993. Soil microbial populations as affected by herbicides. *Madras Agricultural Journal* 80:397-399.
8. Sharma, S., Singh, P., Kumar, S. 2020. Responses of soil carbon pools, enzymatic activity and crop yields to nitrogen and straw incorporation in a rice-wheat cropping system in north-western India. *Frontier in Sustainable Food Systems* 4:532704.
9. Shekhawat, K., Rathore, S.S., Premi, O.P., Kandpal, B.K., Chauhan, J.S. 2012. Advances in agronomic management of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson): An overview. *International Journal of Agronomy*, 2012.
10. Singh, M., Bhullar, M.S., Chauhan, B.S. 2014. The critical period for weed control in dry-seeded rice. *Crop Protection* 66:80-85.
11. Sparling, G.P. 1997. Soil microbial biomass, activity and nutrient cycling as indicator of soil health. In: Pankhurst C, Doube BM, Gupta VVSR. (Eds.). *Biological indicators of soil health* Wallingford: CAB International, 97-119.
12. Vance, E.D., Brookes, P.C., Jenkinson, D.S. 1987. An extraction method for measuring soil microbial biomass C. *Soil Biology and Biochemistry* 19(6):703-707.
13. Wardle, Parkinson. 1990. Effect of three herbicides on soil microbial biomass and activity. *Plant and Soil* 112:21-28.
- a. Xia, X., Zhao, M., Wang, H., Ma, H. 2011. Influence of butachlor on soil enzymes and microbial growth. *Journal of Food, Agriculture and Environment* 9(2):753-756.

Table 1: Residual effects of wet season rice herbicides on β -glucosidase activity in succeeding toria

| Treatments | β -Glucosidase activity ($\mu\text{g g}^{-1} \text{ soil h}^{-1}$) | | | | | | | | |
|-----------------|--|---------|-------|---------|---------|-------|---------|---------|--------|
| | 30DAS | | | 45DAS | | | 60DAS | | |
| | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean |
| W ₁ | 55.27 | 58.21 | 56.74 | 73.97 | 75.87 | 74.92 | 115.71 | 118.58 | 117.15 |
| W ₂ | 53.21 | 55.72 | 54.46 | 71.08 | 72.90 | 71.99 | 110.48 | 113.71 | 112.10 |
| W ₃ | 52.34 | 54.86 | 53.60 | 70.46 | 71.88 | 71.17 | 109.38 | 112.04 | 110.71 |
| W ₄ | 55.96 | 58.94 | 57.45 | 75.07 | 76.73 | 75.90 | 117.44 | 119.99 | 118.72 |
| W ₅ | 52.74 | 55.31 | 54.02 | 70.63 | 72.41 | 71.52 | 110.18 | 112.92 | 111.55 |
| W ₆ | 54.51 | 57.19 | 55.85 | 72.92 | 74.65 | 73.79 | 113.79 | 116.58 | 115.18 |
| W ₇ | 53.18 | 55.90 | 54.54 | 71.61 | 73.12 | 72.36 | 111.87 | 114.07 | 112.97 |
| W ₈ | 57.01 | 59.80 | 58.41 | 76.13 | 77.77 | 76.95 | 118.78 | 121.68 | 120.23 |
| W ₉ | 59.75 | 61.72 | 60.73 | 79.19 | 80.05 | 79.62 | 124.02 | 125.42 | 124.72 |
| W ₁₀ | 58.64 | 60.21 | 59.43 | 78.04 | 78.25 | 78.15 | 122.06 | 122.48 | 122.27 |
| SEm \pm | 1.66 | 1.72 | 1.69 | 2.21 | 2.24 | 2.22 | 3.45 | 3.50 | 3.47 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

All the treatments are described in the materials and methods





Ashirbanchan Mahapatra et al.,

Table2: Residual effects of wet season rice herbicides on microbial biomass carbon (MBC) in succeeding toria

| Treatments | Microbial biomass carbon (MBC)(μgg^{-1}) | | | | | | | | |
|-----------------|---|---------|--------|---------|---------|--------|---------|---------|--------|
| | 30DAS | | | 45DAS | | | 60DAS | | |
| | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean | 2018-19 | 2019-20 | Mean |
| W ₁ | 129.06 | 133.90 | 131.48 | 153.06 | 159.03 | 156.05 | 167.66 | 174.33 | 171.00 |
| W ₂ | 127.65 | 131.39 | 129.52 | 151.32 | 155.94 | 153.63 | 165.72 | 170.89 | 168.31 |
| W ₃ | 126.46 | 129.96 | 128.21 | 149.87 | 154.19 | 152.03 | 164.10 | 168.94 | 166.52 |
| W ₄ | 130.36 | 135.26 | 132.81 | 153.99 | 160.00 | 156.99 | 169.44 | 176.19 | 172.82 |
| W ₅ | 125.34 | 129.57 | 127.45 | 147.84 | 153.03 | 150.44 | 162.56 | 168.40 | 165.48 |
| W ₆ | 128.62 | 133.02 | 130.82 | 151.86 | 157.26 | 154.56 | 167.06 | 173.13 | 170.10 |
| W ₇ | 125.60 | 130.07 | 127.83 | 148.15 | 153.65 | 150.90 | 162.91 | 169.09 | 166.00 |
| W ₈ | 133.46 | 138.03 | 135.75 | 159.06 | 164.73 | 161.90 | 173.69 | 180.00 | 176.84 |
| W ₉ | 137.07 | 142.45 | 139.76 | 163.52 | 170.18 | 166.85 | 178.63 | 186.04 | 182.34 |
| W ₁₀ | 135.53 | 140.61 | 138.07 | 161.62 | 167.92 | 164.77 | 176.52 | 183.53 | 180.03 |
| SEm \pm | 4.31 | 4.43 | 9.45 | 5.12 | 5.25 | 4.29 | 5.61 | 5.77 | 4.70 |
| CD(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

All the treatments are described in the materials and methods





Agronomic Biofortification of Cereal Grains with Micronutrients: A Rational Approach to Alleviate Hidden Hunger

Suprava Nath¹, Masina Sairam² and Jnana Bharati Palai^{2*}

¹Department of Agronomy, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India

²Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Jnana Bharati Palai

Centurion University of Technology and Management,
Odisha, India.

Email: jnana@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Micronutrient malnutrition is a very common health issue across the world and more especially in the developing countries. There are more than two billion human population in world suffer from malnutrition problem due to micronutrient deficiency. To overcome such problem, fortification of food as well as diet supplements can be done, but common people with low purchasing capacity will not be able to avail them. Another option is genetic biofortification, however, it is time consuming to develop micronutrient rich varieties or hybrids. In this regard, an agronomic biofortification approach can be adopted which is easy and cheap, and in a reach of the common people. The article focuses of the technology of agronomic biofortification of cereals.

Keywords: Agronomic biofortification, malnutrition, micronutrients, advantages.

INTRODUCTION

Cereals are staple food in most of the developing low-income countries particularly in Africa and Asia, contributing as much as 55% of the dietary energy (Dharminder *et al.*, 2021; Midya *et al.*, 2021; Pattanayak *et al.*, 2022) compared with that of high-income countries where the share is 45% (Fig. 1). About 90% of rice is grown and consumed in South, South east, and East Asia, where about 62.5% of the world's total 925 million hungry people reside (FAO, 2010). As many as 79.1% of India's children between the ages of 3 and 6 years, and 56.2% of married women (15–49 years) are anaemic (Krishnaswamy, 2009). It is estimated that 60–70% of population in Asia and sub-Saharan Africa is at risk of low Zn deficiency intake (Gibson, 2006). Then acute lack of micronutrients can lead to severe yet often invisible health problems, particularly among young children and women; hence, considered as 'hidden hunger'. In the article, agronomic biofortification of cereals with micronutrients has been discussed. Further, the article



**Suprava Nath et al.,**

addresses some Sustainable Development Goals (SDG) such as SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and wellbeing) and SDG 15 (life on land) (UN, 2021).

Measures to Alleviate Hidden Hunger

Hidden hunger can be eased by both direct as well as indirect interventions. Direct (nutrition-specific) measures are based on consumption behaviour which includes diversification from existing diets, supplementation of various essential micronutrients, modification of food habits and fortification of foods. Indirect (nutrition-sensitive) measures focus the underlying causes of malnutrition and comprise biofortification.

What is biofortification?

Biofortification is the process of increasing the content or/and bioavailability of essential nutrient elements in crops at the time of plant growth through genetic and/or agronomic pathways (Praharaj *et al.*, 2021). Genetic approach involving plant breeding (genetic biofortification) and application of essential micronutrients especially Zn and Fe fertilizers (agronomic biofortification), are two important agricultural tools to improve the grain concentration of Zn and Fe. Even though genetic engineering opens more doors to increase dramatically the bioavailability of Zn and Fe in grains, its acceptability by consumers and regulatory bodies is very limited, and genetically modified crop cultivation and marketing are not likely to be relaxed in the near future. In contrast to genetic engineering, agronomic biofortification is potentially more sustainable, more economical, and more readily implemented than other strategies.

What is agronomic biofortification?

Agronomic biofortification unlike of genetic biofortification is achieved through application of essential micronutrient fertilizers either to the cultivated soil and/or foliar application directly to the crop canopy (Fig. 2). Agronomic biofortification mainly focuses on starchy staple crops (maize, wheat, rice, sorghum, millet, sweet potato), as they dominate diets worldwide, particularly among vulnerable groups to essential micronutrient deficiencies particularly Fe and Zn. Thus, agronomic biofortification provide a plausible means of reaching malnourished populations with burden of poverty having limited or no access to diversified diets, externally available supplements, and commercially fortified foods.

Agronomic Biofortification through Soil Application of Fertilizers

Many soils have become deficient in essential micronutrients especially Fe and Zn due to nonjudicious application of synthetic chemical fertilizers and focusing more on only application of major nutrients particularly N, P and K. Now these soils also have become non-responsive to NPK due to multiple micronutrient deficiencies. Soil application with small amounts of (multiple) micronutrients has been suggested as a sustainable strategy to increase both crop yield as well as nutritional quality of these crops. For soil application, water soluble forms of Zn is preferred and coming to Fe fertilizers, soil application is not recommended. Shivay and Prasad (2012) from New Delhi, India reported that on Zn-deficient soils, Zn application (as zinc sulphate heptahydrate or ZSHH) increased both grain yield and Zn concentration in rice grain. Application of Zn when soil applied also increased Zn harvest index by 2%.

Agronomic Biofortification through Foliar Application of Micronutrients

Foliar pathways are generally more effective in ensuring uptake into the plant because immobilization in the soil is avoided. From the viewpoint of biofortification, foliar application of essential micronutrients particularly Zn and Fe has been reported to be beneficial than soil application. Chelated Fe and Zn fertilizers are better for foliar application.

Application of 1.2 kg Zn ha⁻¹ as foliar spray gave similar rice grain yield but significantly increased grain Zn concentration as compared with application of 5.3 kg Zn ha⁻¹ as soil application. For both soil and foliar application, Zn harvest index was similar, but agronomic efficiency of Zn was about four times higher with foliar application as compared to soil application. Also, rate of Zn application was much lower when applied as foliar spray (Shivay *et al.*, 2010a).





Suprava Nath et al.,

CONCLUSION

Agronomic biofortification is the simplest and fastest mean for bio fortification of major cereal grains with Fe, Zn, or other micronutrients in developing countries, where cereals are the staple food. Agronomic biofortification is the only effective way to reach the poorest of the poor rural masses, who will otherwise, never have money to buy mineral supplements nor can afford to diversify the components of their diet by incorporating animal products.

REFERENCES

1. FAO, 2010. The State of Food Insecurity in the World: Addressing Food Insecurity in Protracted Crises. The Food and Agriculture Organization of the United Nations, Rome, p. 58.
2. Gibson, R.S., 2006. Zinc: the missing link in combating micronutrient nutrition in developing countries. Proc. Nutr. Soc. 65, 51–60.
3. Krishnaswamy, K., 2009. The problem and consequences of double burden—a brief overview. In: Symposium on Nutrition Security for India—Issues and Way Forward, 3–4 August, New Delhi, Programme and Abstracts. Indian National Science Academy, New Delhi, pp. 5–7.
4. Shivay, Y.S., Prasad, R., 2012. Zinc coated urea improves productivity and quality of basmati rice (*Oryza sativa*) under zinc stress condition. J. Plant Nutr. 35, 928–951.
5. Shivay, Y.S., Prasad, R., Rahal, A., 2010a. Genotypic variation for productivity zinc utilization efficiencies, and kernel quality in aromatic rices under low available zinc conditions. J. Plant Nutr. 33, 1835–1848.
6. Dharminder, Singh, R.K., Kumar, V., Pramanick, B., Alsanie, W.F., Gaber, A., Hossain, A. 2021. The use of municipal solid waste compost in combination with proper irrigation scheduling influences the productivity, microbial activity and water use efficiency of direct seeded rice. Agriculture 11: 941.
7. Pattanayak, S., Jena, S., Das, P., Maitra, S., Shankar, T., Praharaj, S., Mishra, P., Mohanty, S., Pradhan, M., Swain, D.K., Pramanick, B., Gaber, A., Hossain, A. 2022. Weed Management and Crop Establishment Methods in Rice (*Oryza sativa* L.) Influence the Soil Microbial and Enzymatic Activity in Sub-Tropical Environment. Plants, 11, 1071.
8. Midya, A., Saren, B.K., Dey, J.K., Maitra, S., Praharaj, S., Gaikwad, D.J., Gaber, A., Alsanie, W.F., Hossain, A. 2021. Crop Establishment Methods and Integrated Nutrient Management Improve: Part I. Crop Performance, Water Productivity and Profitability of Rice (*Oryza sativa* L.) in the Lower Indo-Gangetic Plain, India. *Agronomy*, 11, 1860. doi: 10.3390/agronomy11091860
9. UN. 2021. The 17 Goals, Department of Economic and Social Affairs, Sustainable Development. <https://sdgs.un.org/goals> (Accessed 25 December, 2021).
10. Praharaj, S., Skalicky, M., Maitra, S., Bhadra, P., Shankar, T., Brestic, M., Hejnak, V., Vachova, P., Hossain, A. 2021. Zinc biofortification in food crops could alleviate the zinc malnutrition in human health. *Molecules*, 26, 3509. <https://doi.org/10.3390/molecules26123509>





Suprava Nath et al.,

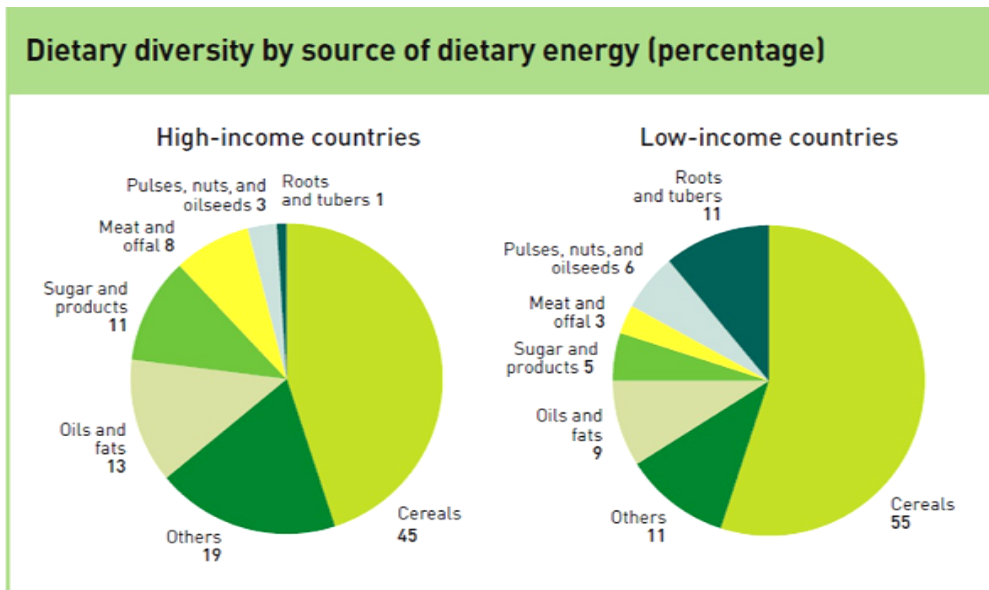


Figure 1: Contribution of cereals to the dietary energy in high-income and low income countries

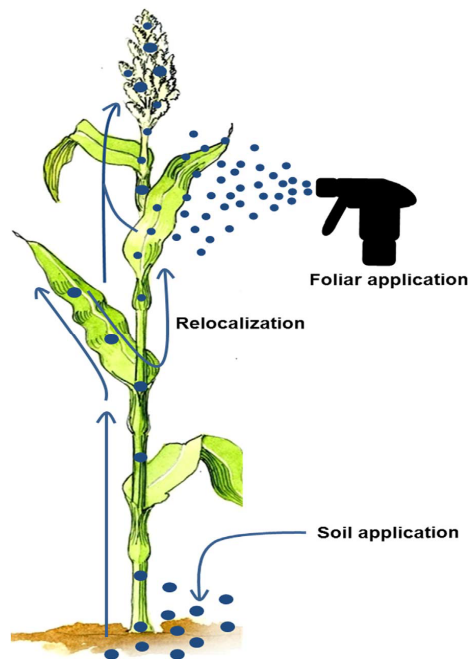


Fig. 2: Agronomic biofortification is the process through which micronutrient-containing mineral fertilizer (blue circles) is applied to the soil and/or plant foliage, with the aim to enhance micronutrient contents in edible part of various food crops.





Climate Change and Tropical Forestry: Monitoring and Policies

Athira James¹ and Abha Manohar K^{2*}

¹ Georg August University of Gottingen, Germany

²Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Abha Manohar K

Centurion University of Technology and Management,
Odisha, India.

Email: abha.manohar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Managing climate change sustainably is crucial for survival of forests. The ultimate goal of Sustainable Development Goals (SDGs) is to end poverty and improve human welfare without imposing significant costs on earth's life supporting systems. The SDGs has a very high potential to be affected by the climate change mitigation and adaptation efforts. Moreover the strategies that help advance one SDG may result in negative effect on other SDGs. This interactions and the resulting synergies or trade-offs will contribute to the outcomes of the efforts. The study enlists various synergistic interactions of SDG 1 and SDG 10 in climate adaptation.

Keywords: Climate change, mitigation, adaptation, forestry, sustainable development goals

INTRODUCTION

Forests plays an important role in climate change mitigation and adaption by the global carbon cycle in two ways (Manish et al., 2022; Rai et al., 2021; Shukla et al., 2020). First, they are carbon sink that remove nearly 3 billion tons of anthropogenic carbon every year, 30% of all CO₂ emissions from fossil fuel burning and net deforestation (Canadell and Raupach, 2008). Second, forests covering 30% of global land area store more than double the amount of carbon in the atmosphere (Field et al., 2004). The main strategies that can be used to mitigate carbon emissions through forestry activities are; increasing forested land through reforestation, increasing carbon density of existing forests, replacing fossil fuels with forest products or other renewable sources of energy, and reducing emissions from deforestation and forest degradation. However the achievable climate change mitigation by forests is challenged by the competing land uses such as agriculture, urbanisation, bioenergy, conservation and sociocultural considerations. The ability of a species to maintain fundamental ecosystem processes under disturbances such as changing climate is its resistance. Managing the forests to improve its resistance and thus better adapt to varying environments is of utmost importance considering the ecosystem services provided and their role in the carbon cycle. Considering its extended time frame, all decisions in forest management will have a different outcome in future climate. The forestry



**Athira James and Abha Manohar K**

sector has significant roles in the national and rural economy, providing jobs and income for forest owners, forest workers, logging firms, and various forestry-related services and industries (Chakravarty et al., 2020). Also, the changing climate risks the potential of forests to sequester carbon due to rising temperatures, changing seasonality of precipitation, and increases in the frequency, severity, or extent of natural disturbance such as drought, wildfire, and forest pests and pathogens (Miller and Stephenson, 2015).

Sustainable Development Goals

In September 2015, the United Nations adopted the SDGs. SDGs were the updated form of the Millennium Development Goals by defining broader and more ambitious development objectives that apply to all countries. There are 17 SDGs and the 2030 Agenda for Sustainable Development addresses the economic, social, and environmental sustainability and designs a pathway toward inclusive green growth. Sustainable development is defined as the development that meets the needs of present and future generations through balancing economic, social and environmental considerations. Synergies and trade-offs can occur when climate change mitigation and adaptation by forests through emission reduction interact with the various SDGs. This report will assess the trade-offs on the SDG 1 (poverty eradication) and SDG 10 (reduced income inequality) and how it is affected by climate adaptation.

Trade-offs on SDG 1 and SDG 10 and its interactions with climate mitigation

Paris Agreement adopted in December 2015 aims at improving the global response to climate change through a more bottom-up approach by country driven emission reduction and adaptation plans. It aims at maintaining the global average temperature rise to below 2°C of the pre-industrial times, better climate change adaptation and climate resilience and mobilizing financial flows to achieve mitigation and adaptation goals (UNFCCC, 2015). In the 2030 Agenda for Sustainable Development the climate change objectives are integrated with the economic and developmental objectives as they are intertwined in many levels. A study by Campagnolo and Davide, 2019 investigated the synergies and trade-offs between climate mitigation and SDGs through an ex ante assessment. The results shows that the countries with full implementation of their Nationally Determined Contributions (NDCs) will slow down poverty reduction. This effect increases with the more stringent the mitigation targets. The effect of climate mitigation on inequality is very limited as discussed in the study. Eventhough some equity driven pro-poor results are found with stringent mitigation efforts, it is usually cancelled out by the rise in poverty prevalence in 2030 compared to the baseline scenario. Warming of 1.5 °C will have severe impacts on most nations but the effects will be disproportionately distributed among countries. The vulnerable populations will be the ones in developing countries as the ecosystems damage and the food security will be affected. This will result in high food prices, poverty, income losses, loss of livelihood opportunities, adverse health impacts and even population displacements. The people who are directly dependent on agriculture, forests or other natural resources and indigenous people will be most affected in such countries (Shukla et al., 2018). Incorporating indigenous and local knowledge's is significant in climate adaptation and sustainable development and it will create synergies between poverty alleviation (Lepcha et al., 2019). and reduced inequality. Sustainable development pathways with high inequality will be associated with higher challenges in climate mitigation and adaptation.

This will result in poorer outcomes from such efforts and results in more warming which in turn results in increased poverty. Agriculture adaptation to climate through climate smart agriculture is possible through technology transfers between developed and developing nations. Such adaptations would result in better productivity even in warmer climates, or during climate extremes and contribute to food security. Food security and better livelihood options will reduce the income inequalities between nations. A well adapted agriculture system will contribute to safe drinking water, health, biodiversity and equity goals (De Clerck, 2016). Agricultural adaptation measures can also cause health risks with use of fertilisers and pesticides, introducing new crop mixes can cause income losses, and might result in culturally inappropriate foods (Carr and Thompson, 2014). Some adaptation measures can be beneficial for land rich farmers and be detrimental to land poor farmers. This will result in increased income inequality within the nation. There can also be trade-offs when agricultural adaptation to food security (SDG 1 and SDG 10) cause negative ecosystem impacts (SDG 15). Coastal adaptations are needed adapt to sea level rises and



**Athira James and Abha Manohar K**

restore coastal ecosystems. Planting mangrove forests in coasts is both a climate mitigation and adaptation strategy by reducing coastal vulnerability, protecting coastal ecosystems and improving food security. It will enhance the livelihoods of coastal communities and synergistic outcomes of reduced income inequality and poverty reduction can be achieved.

CONCLUSION

The report investigates synergies and trade-offs between emission reduction policies and SDGs. Stringent climate mitigation strategies can create positive and negative non-climate outcomes that affect sustainable development. A study finds that the NDCs and stringent mitigation plans make it harder for developing nations to reduce poverty. The global poverty in 2030 is estimated to be 4% higher than the baseline scenario. Climate funds and transfers make a positive impact, but do not offset total poverty increase. While the income inequality shows reduction with climate mitigation though limited. Agriculture and coastal adaptations mainly shows synergistic effects on SGD 1 and SDG 10 though it shows trade-offs with other SDGs. Actual implementation of climate adaptation or mitigation without considering the trade-offs across different SDGs and development pathways will be challenging.

REFERENCES

1. Campagnolo J and Davide M. 2019. Can the Paris deal boost SDGs achievement? An assessment of climate mitigation co-benefits or side-effects on poverty and inequality. *World Development*. 112:96-109.
2. Canadell JG and Raupach MR. 2008. Managing Forests for Climate Change Mitigation. *Science*. 320(5882): 1456-1457.
3. Carr CR and Thompson MC. 2014. Gender and climate change adaptation in agrarian settings. *Geography Compass*. 8(3): 182-197.
4. Chakravarty S, Puri A, Abha MK, Rai P, Lepcha U, Pala NA, Shukla G. 2020. Linking Social Dimensions of Climate Change: Transforming Vulnerable Smallholder Producers for Empowering and Resiliency. In *Climate Change and Agroforestry Systems: Adaptation and Mitigation Strategies*. CRC Press. pp. 169-208.
5. DeClerck FAJ. 2016. Agricultural ecosystems and their services: the vanguard of megadisturbance. *Science*, 349:823-826.
6. Field CB, Raupach MR and Victoria R. 2004. Global Carbon Cycle: Integrating Humans, Climate and the Natural World, C. B. Field and M. R. Raupach, Eds. (Island Press, Washington, DC), pp. 17-44.
7. Lepcha LD, Shukla G, Sarkar BC, Tamang M, Chettri R, Abha MK, Pala NA, Chakravarty S. Ethno-botanical plant diversity in home gardens based agroforestry system in kanchendzonga biosphere reserve, Sikkim, India. *Journal of Tree Sciences*. 2019;38(2):59-69.
8. Millar CI and Stephenson NL. 2015. Temperate forest health in an era of emerging
9. Parties, Paris. Twenty-first session Paris, 30 Nov. to 11 Dec. 2015. Sustainability? *Current Opinion in Environmental Sustainability*. 23: 92-99.
10. Rai P, Vineeta, Shukla G, Manohar K A, Bhat JA, Kumar A, Kumar M, Cabral-Pinto M, Chakravarty S. 2021. Carbon Storage of Single Tree and Mixed Tree Dominant Species Stands in a Reserve Forest—Case Study of the Eastern Sub-Himalayan Region of India. *Land*. 10(4):435. <https://doi.org/10.3390/land10040435>
11. Roy M, Sarkar BC, Manohar KA, Shukla G, Nath AJ, Bhat JA, Chakravarty S. 2022. Fuelwood species diversity and consumption pattern in the homegardens from foothills of Indian Eastern Himalayas. *Agroforestry Systems*. 96(3):453-64.
12. Shukla G, Kumari A, Abha MK, Chakravarty S. 2018. Fuelwood extraction by indigenous, rural and urban poors do not risk trees and forest: A case study from Jharkhand, India. *Forestry Research and Engineering: International Journal* :2.
13. Shukla G, Rai P, Manohar KA, Chakravarty S. Quantification of diversity, biomass and carbon storage of climber and liana community in a foothill forest of Indian eastern Himalayas. *Acta Ecologica Sinica*. 2020 Dec 1;40(6):478-82.
14. UNFCCC. 2015. Adoption of the Paris Agreement, UNFCCC Conference of the Parties, Paris. Twenty-first session Paris, 30 Nov. to 11 Dec. 2015.





Estimation of Maize Yield using DSSAT Model under Varied Irrigation and Nitrogen Levels

M.Roja^{1*}, M.Devender Reddy¹, V.Ramulu³ and A.M.Rao²

¹Centurion University of Technology and Management, Paralakhemundi, Odisha, India.

²Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad, Telangana, India.

Received: 04 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

M.Roja

Centurion University of Technology and Management,
Paralakhemundi, Odisha, India.

Email: rojamandapati93@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Maize is an important cereal crop after rice. Crop models are used to simulate the effect of different management practices and climate on crop growth, yield and other yield parameters under varied climatic conditions. Crop models will be helpful in reducing the time and money in conducting field experiments which are expensive and time bearing. These result can be used for extrapolate for similar management practices in different locations. DSSAT CERES maize is used in this study to select best management practice under different nitrogen and irrigation levels. The results revealed that highest grain yield (7.35 t/ha) has been observed in Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO₃ at 8 days interval) compared to fertigation at 1.0 Epan with 100% RDF through conventional fertilizers (N&K fertigation and P as basal soil application). Simulated water productivity was highest (1.73 kg m⁻³) in case of drip irrigation at 1.0 Epan by fertigation 100 % RDF (MAP, urea, KNO₃) which was near with fertigation at 0.75 Epan (1.68 kg m⁻³). This can be due to application of fertilizers and irrigation through drip irrigation, leading to maintaining of optimum soil moisture throughout the root zone and efficient fertilizer nutrient uptake. This results states that DSSAT model can be efficiently used for choosing best management practices by saving irrigation amount and fertilizers without compromising in the yield.

Keywords: DSSAT model, Fertigation through soluble fertilizers, Drip irrigation, water productivity, Maize hybrid, Rabi season



**Roja et al.,**

INTRODUCTION

Availability of water for irrigation is decreasing year after year due to competition from other sectors like industry, domestic and electricity etc. Further, the demand for irrigation is increasing as more cropped area is converted irrigated area mostly through ground water. The increasing demand for irrigation water leading to emphasis on adoption of suitable methods of irrigation for increasing the water use efficiency. Proper understanding of the relation between crop yield and water use is an essential component in improving water productivity. Due to introduction of high yielding maize hybrids, more area is being cultivated during Rabi under surface irrigation method. This method of irrigation results in low water use efficiency. Under shortage of water, shift from surface to drip irrigation is vital to minimize the losses from surface method of irrigation.

Crop models are mathematical representation of the system comprising of interaction between crop management, climate and soil. Numerous crop models have been designed for varied purposes like yield estimation, effect of different management practices, varieties and climate change on crop growth and yield. One of the most widely used crop model is DSSAT (Decision Support System for Agro-technology Transfer) which is developed by Hoogenboom *et al.*, with an objective of integrating crops with soil, climate and varied management practices (Hoogenboom *et al.*, 2019). DSSAT model is being utilized in several parts throughout the world under different crop, soil, climate (Liu *et al.*, 2012, Kisekka *et al.*, 2015, Araya *et al.*, 2017, Yakoub *et al.*, 2017, Kaur and Arora, 2018, Malik and Dechmi, 2019, Adnan *et al.*, 2020, Zhang *et al.*, 2019), fertilizer (Liu *et al.*, 2012, Yakoub *et al.*, 2017, Kaur and Arora, 2018, Malik and Dechmi, 2019) and irrigation levels (Kadiyala *et al.*, 2015; Kisekka *et al.*, 2016; Araya *et al.*, 2017; Kaur and Arora, 2018; Malik and Dechmi, 2019).

CERES maize is one among the DSSAT crop modules which is being widely used to estimate the crop yield, LAI (Marek *et al.*, 2017) under varied irrigation and fertilizer terms and will simulate crop growth, yield and development under daily conditions with varied inputs and management. These crop models helps in reducing the time and human resources for conducting field experiments and offers an outline for integrating new techniques and management practices in varied climatic conditions (Tsuji *et al.*, 1998). For validating the model and estimating the yield of maize for Telangana region of India under different nutrient and irrigation levels on maize during Rabi season, the data of an experiment was used (Ramulu *et al.*, 2010) in this DSSAT model.

MATERIALS AND METHODS

Experiment details

The experiment conducted at Water Technology Centre, ANGRAU, Rajendranagar, Hyderabad during *rabi* (Ramulu *et al.*, 2010) was used for validation of DSSAT model. The soil of the experiment was sandy clay loam in texture with pH 8.19, EC of 0.57 ds/m, field capacity 14.82 %, available nitrogen 242 kg h⁻¹, available phosphorus 37 kg ha⁻¹ and available potassium 526 kg ha⁻¹. Climatic condition of the site was semi-arid tropical climate.

Treatment details

DEKALAB super 900M maize hybrid was used for cultivation. The treatment combinations include different irrigation methods (surface and drip), levels (1.0 and 0.75 Epan), fertigation levels (100 and 75 % RDF) and fertilizer forms (water soluble and straight fertilizers) (Table 1) which were replicated three times. Spacing of 60cm X 20 cm was maintained all over the field. Fertilizer level of 120:60:50 NPK kg/ha was made through straight fertilizers in conventional form and in case of drip irrigation water soluble fertilizers 19-19-19 (NPK), Mono Ammonium Phosphate (12-61-0 NPK) and KNO₃ (13-0-46 NPK) were used as fertigation at 8 days interval from 12 DAS to 80 DAS. Irrigations were scheduled based on the meteorological data taken from the Agro met observatory, Rajendranagar. In case of surface methods, irrigation was scheduled at 6-8 days interval and 3 days in case of drip



**Roja et al.,**

irrigation. All the management practices were followed as per recommendation. Data on growth, yield, yield attributes and water consumed are presented in table 1.

Model description

DSSAT (Decision support system for Agro Technology transfer) which can be used to simulate for 42 crops. Here CERES maize (DSSAT 4.7 version) has been used in this study which can simulate nitrogen transformation, crop growth, grain and straw yield, water use, water productivity and many other parameters at field level under different management practices on a daily basis. Input parameters required for DSSAT are climate, soil, genotype and detailed management practices.

Climatic parameters like maximum temperature, minimum temperature rainfall for model were collected from IMD by giving respective latitude and longitude values. Weather man module which is available in DSSAT is used for setting climate data. Solar radiation data was collected from NASA power. Soil required data for model were collected from the field analysis and ISRIC (*International Soil Reference and Information Centre*). *Physical and chemical parameters were also calculated by using analysed soil samples. Genotype characters of respective cultivars were collected from the previous studies. Followed management practices were fed in to the model.*

RESULTS AND DISCUSSION

Grain yield

Highest grain yield has been observed (7.46 t/ha) in drip irrigation scheduled at 1.0 Epan with 100% RDF by water soluble fertiliser– MAP, Urea, KNO₃ at 8 days interval compared to fertigation at 1.0 Epan with 100% RDF through conventional fertilizers (N&K fertigation and P as basal soil application). Lowest yield (4.31 t /ha) was observed in case of fertigation at 0.75 Epan with 75 % RDF fertigation of water soluble fertilizers (N & K fertigation and P as basal soil application).

In simulated DSSAT model, highest grain yield (7.35 t ha⁻¹) was observed in drip irrigation scheduled at 1.0 Epan with 100% RDF by water soluble fertiliser– MAP, Urea, KNO₃ applied at 8days interval followed by drip irrigation at 1.0 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied). There is no significance difference between Drip irrigation at 1.0 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied) (6.02 t ha⁻¹) and Drip irrigation at 1.0 Epan + 75% RDF Drip irrigation at 1.0 Epan + 75% RDF (NPK fertigation – MAP, Urea, KNO₃ at 8 days interval)(6.00 tha⁻¹). Lowest grain yield was observed in drip irrigation at 0.75 Epan with 75% RDF (Table 1).

Highest grain yield observed with 100 % RDF at 1.0 Epan was due to maintenance of required soil moisture and increased nutrient dynamics in the root zone and in plants under drip fertigation. The grain yield obtained with Model and through experiment was of trend similar which indicates that the DSSAT model can be used for yield estimations in different agro climatic zones.

Water Productivity

Observed water productivity was highest (1.70 kg m⁻³) in case of drip irrigation at 1.0 Epan by fertigation 100 % RDF (MAP, urea, KNO₃) which was near with fertigation at 0.75 Epan (1.50 kg m⁻³). DSSAT model simulated results were on par with the observed values in case of water productivity. Highest water productivity (1.73 kg/m³) was observed in case of Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO₃ at 8 days interval) (1.0Epan + 100% RDF) followed by treatment eight (0.75 Epan +75 % RDF).

Highest water productivity has been recorded due to application of required irrigation water thus by maintaining optimum moisture level in the root zone throughout the growing period and efficient use of fertilizer by the crop. DSSAT model water productivity is slightly higher than that of observed values due to considerable higher

42700





Roja et al.,

estimation of yields. Both observed (0.74 kg m^{-3}) and model simulated (0.80 kg m^{-3}) lowest water productivity has been observed in case of ridge and furrow irrigation with 100 % RDF because of more usage of water in this treatment when compared to rest leading to applying more water than required (Table 2).

CONCLUSIONS

The DSSAT model predicted the highest grain yield and water productivity with drip irrigation at 1.0 Epan and fertigation with 100 % RDF through water soluble fertilisers (MAP, Urea and KNO_3) at 8 days interval from 12-80 DAS. This DSSAT model estimation indicate that this model can be used to select suitable management practices under different climatic conditions by minimising the irrigation amount and increasing nutrient uptake.

REFERENCES

1. Hoogenboom, G., Porter, C.H., Boote, K.J., Shelia, V., Wilkens, P.W., Singh, U., J. W., White, Asseng, S., Lizaso, J.I., Moreno, L.P., Pavan, W., Ogoshi, R., Hunt, L.A., Tsuji, G.Y., Jones, J.W., 2019. The DSSAT crop modeling ecosystem. In: Boote, K.J. (Ed.), *Advances in Crop Modeling for a Sustainable Agriculture*. Burleigh Dodds Science Publishing, Cambridge, United Kingdom, pp. 173–216. <https://doi.org/10.19103/AS.2019.0061.10>.
2. Liu, Y.Y., Dorigo, W.A., Parinussa, R.M., de Jeu, Ram., Wagner, W., McCabe, M.F., Evans, J.P. and Van Dijk, A.I.J.M., 2012, "Trend-preserving blending of passive and active microwave soil moisture retrievals". *Remote Sensing of Environment*, 123:280–297.
3. Kisekka, I., Aguilar, J.P., Rogers, D., Holman, J., O'Brian, D. and Klock, N., 2015. "Assessing deficit irrigation strategies for corn using simulation", in 2015 ASABE/IA irrigation symposium: emerging technologies for sustainable irrigation-a tribute to the career of Terry Howell. Sr. Conference Proceedings. *American Society of Agricultural and Biological Engineers*, 1–28
4. Zhang, D., Wang, H., Li, D., Li, H., Ju, H., Li, R., Batchelor, W. and Li, Y., 2019, "DSSAT-CERES-Wheat model to optimize plant density and nitrogen best management practices", *Nutrient Cycling in Agro-ecosystems*, 114, 19–32.
5. Kadiyala, D.M., Jones, J., Mylavarapu, R & Reddy, M. (2015). Identifying irrigation and nitrogen best management practices for aerobic rice–maize cropping system for semi-arid tropics using CERES-rice and maize models. *Agricultural Water Management*. 149. 10.1016/j.agwat.2014.10.019.
6. Araya, A., Kisekka, I., Prasanna H., Gowda, P.V. and Vara Prasad. 2017. Evaluation of water-limited cropping systems in a semi-arid climate using DSSAT-CSM, *Agricultural Systems*, 150:86-98.
7. Yakoub, A., Ioveras, J., Biau, A., Lindquist, J.L., and Lizaso, J.I. 2017. Testing and improving the maize models in DSSAT: Development, growth, yield, and N uptake. *Field Crops Research*, 212 (95-106).
8. Payero, J., David, T., Suat, I., Davison, D and James, P. (2008). Effect of irrigation amounts applied with subsurface drip irrigation on corn evapotranspiration, yield, water use efficiency, and dry matter production in a semiarid climate. *Agricultural Water Management*. 95(895-908).
9. Kaur, R., and Arora, V.K., 2018. Assessing spring maize responses to irrigation and nitrogen regimes in north-west India using CERES-Maize model, *Agricultural Water Management*, 209:171-177
10. Malik, W., and Dechmi, F., 2019. DSSAT modelling for best irrigation management practices assessment under Mediterranean conditions, *Agricultural Water Management*, 216 (27-43)
11. Marek, G.W., Marek, T.H., Xue, Q., Gowda, P.H., Evett, S.R. & Brauer, D.K. 2017. "Simulating Evapotranspiration and Yield Response of Selected Corn Varieties under Full and Limited Irrigation in the Texas High Plains Using DSSAT-CERES-Maize. *Trans. Transactions of the ASABE*, 60(3): 837-846, ISSN: 2151-0040, DOI: <https://doi.org/10.13031/trans.12048>
12. Adnan, A., Diels, J., Jibrin, J.M., Kamara, A.Y., Shaibu, A.S., Craufurd, A., Menkir, A. 2020. CERES-Maize model for simulating genotype-by-environment interaction of maize and its stability in the dry and wet savannas of Nigeria, *Field Crops Research*, 253.





Roja et al.,

13. Liu HL, Yang JY, Drury CF, Reynolds WD, Tan CS, Bai YL, He P, Jin J, Hoogenboom G (2011a) using the DSSATCERES-Maize model to simulate crop yield and nitrogen cycling in fields under long-term continuous maize production. *Nutrient Cycling in Agroecosystems*, 89:313–328
14. Ramulu, V., M.D.Reddy and A.M.Rao. 2010. Response of rabi maize to irrigation schedules and fertigation levels. *Agricultural Science Digest* 30(2):104-106.
15. Tsuji, G.Y., Hoogenboom, G., Thornton, P.K. (Eds.) (1998). Under-standing options for agricultural production. *Systems Approches for Sustainable Agricultural Development*. Kluwer Academic Publishers, Dordrecht, The Netherlands 1998,400.

Table 1: influence of different irrigation and nitrogen levels on observed and simulated grain yield of maize

| Sno | Treatments | Observed grain Yield (t ha ⁻¹) | Simulated grain yield (t ha ⁻¹) |
|-----|---|--|---|
| 1 | Ridges & Furrow irrigation + 100% RDF (NPK conventional soil applied) | 5.7 | 5.89 |
| 2 | Drip irrigation at 1.0 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied) | 6.02 | 6.03 |
| 3 | Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – 19:19:19, MAP, Urea at 8 days interval) | 4.91 | 5.34 |
| 4 | Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 7.46 | 7.35 |
| 5 | Drip irrigation at 1.0 Epan + 75% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 6.00 | 6.34 |
| 6 | Drip irrigation at 0.75 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied) | 4.31 | 4.61 |
| 7 | Drip irrigation at 0.75 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 4.61 | 4.81 |
| 8 | Drip irrigation at 0.75 Epan + 75% RDF 5.50 5.40 50.45 (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 5.50 | 5.61 |

Table 2: influence of different irrigation and nitrogen levels on observed and simulated water use and water productivity of maize

| Treatments | Observed total volume (m ³ /ha) | Simulated total volume (m ³ /ha) | Observed Water Productivity (kg m ⁻³) | Simulated water productivity (kg m ⁻³) |
|--|--|---|---|--|
| Ridges & Furrow irrigation + 100% RDF (NPK conventional soil applied) | 7702 | 7380 | 0.74 | 0.80 |
| Drip irrigation at 1.0 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied) | 4371 | 4240 | 1.38 | 1.42 |





Roja et al.,

| | | | | |
|--|------|------|------|------|
| Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – 19:19:19, MAP, Urea at 8 days interval) | 4371 | 4240 | 1.12 | 1.26 |
| Drip irrigation at 1.0 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 4371 | 4240 | 1.70 | 1.73 |
| Drip irrigation at 1.0 Epan + 75% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 4371 | 4240 | 1.37 | 1.50 |
| Drip irrigation at 0.75 Epan + 100% RDF (conventional fertilizers - N & K fertigation at 8 days interval & P as basal soil applied) | 3672 | 3330 | 1.18 | 1.38 |
| Drip irrigation at 0.75 Epan + 100% RDF (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 3672 | 3330 | 1.27 | 1.44 |
| Drip irrigation at 0.75 Epan + 75% RDF 5.50 5.40 50.45 (NPK fertigation – MAP, Urea, KNO ₃ at 8 days interval) | 3672 | 3330 | 1.50 | 1.68 |





Complex Network Control Infrastructure Processes for Remote Cloud Computing Services

Dhawaleswar Rao CH*

Department of Computer Science and Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 04 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Dhawaleswar Rao CH

Department of Computer Science and Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: dhawaleswarrao@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

It's possible to look at cloud radio access networks and mobile cloud computing as a whole. In this article we have discussed how C-RAN works to constantly improve the efficiency of MCC services on wireless networks in the coming decade. The fact that channel state knowledge is no longer relevant is an inherent barrier in such a system. Sub-optimal C-RAN procedures can only be carried out if the CSI delayed is extended promptly. This may be expressed as the issue of topology configuration and rate allocation with delayed CSI in a stochastic optimization system. This approach makes the most of MCC resources while keeping response latency to a minimum for each MCC client. As a result of the probabilistic optimisation, an optimal path will be found with low measurement costs. Offline and online architectures are designed using an optimization method. According to the simulation results, cloud computing will have a significant influence on the architecture and operation of future mobile wireless networks with the introduction of MCC and C-RAN technologies, and the suggested scheme would allow significant efficiency increases over present systems.

Keywords: Mobile Networks, Cloud Computing, Information and communication technology, Resource use efficiency, Sustainable infrastructure.

INTRODUCTION

According to UN SDG (United Nations Sustainable Development Goals), building resilient infrastructure, promoting sustainable industrialization, and fostering innovation are all goals of SDG 9 [16].



**Dhawaleswar Rao et al.**

Cloud computing will have an impact on the construction and management of wireless networks [1]. On the one hand, a rising number of end-users are using mobile devices to access cloud computing systems, such as smartphones and tablets, thanks to recent breakthroughs in new wireless technologies and apps [2]. Mobile cloud computing, which is generally recognised as a mobile computing fascinating paradigm with a significant market [4], is included in the cloud computing environment. MCC will disseminate the specifications of mobile devices in terms of processing capability and data storage on efficient cloud computing systems with a modest amount of computation, storage, and power on mobile devices, bridging the gap between rising computing demands and mainstream mobile technology [3]. Strong cloud computing systems help both radio access networks and mobile end users, and they aid in the definition of cloud radio access networks [5]. C-RAN keeps computational resources for baseband care in a central WLAN Cloud of powerful computer devices, unlike standard cellular networks, which keep them at each cell site [6]. The transition from dispersed to unified baseband networks will result in significant cost savings due to centralised administration. The network's efficiency has improved as a result of enhanced coordinated signal processing techniques [7].

Despite some great research on cloud computing for end users and access networks, the literature has tended to focus on these two crucial areas separately [8]. Adoption of these two advanced technologies, however, is essential in order to offer enhanced services in next-generation wireless networks [9], as shown in the next section. The C-RAN and MCC technologies work together to improve network performance. C-RAN for next-generation wireless networks in MCC systems has not been properly examined in previous studies. These are the work's distinguishing features [10]. It is proposed that C-RAN be configured dynamically to improve MCC service efficiency in a holistic manner. In addition to TCP connections that have crucial requirements on the delay of each user response, MCC mobile search engine services are also taken into account in addition to C-RAN topology configuration and rate allocation. This job will enhance MCC users' TCP end-to-end efficiency in cellular networks in the coming decade. One of the most important problems of C-RAN is that the CSI is unreliable because of delayed information processing and transfer [11].

For example, the inter-BS interface X2 in LTE-Advanced is designed to have a 20ms delay for control plan communications, with a normal latency value of 10ms on average. Incomplete CSI is commonly hampered by not just CRAN but also wireless networks. Because traditional knowledge theory methodology is incapable of resolving this problem, a stochastic strategy to reducing the impacts of bruises and delays in CSI is used, using well-defined processes [12]. To produce an ideal strategy, the basic structure of the topology configuration and rate allocation difficulties is employed. Cloud user response latency has been regarded as one of the most important cloud computing performance indicators. The delay in response that each MCC user feels as a restriction in implementing the technique is simulated in order to improve MCC users' QoS [13]. The balance between structural productivity and fairness is being examined among MCC users. The delayed CSI in C-RAN will be utilised to investigate such a trade-off. The issue is that in MCC systems, this value is modified to optimise the Jain fairness index. In light of the evolution of MCC and C-RAN platforms, extensive simulations show that cloud computing can have a significant impact on the architecture and application of wireless Next Generation networks.

Related Work

This is described with two operating systems [14]. It is essentially made up of C-RAN and cloud computing. In this study, the problem is tackled using two subsystems. Wireless networking takes place largely at the C-RAN, whereas cloud data transfer happens within the data centre of the OTT service provider. Remote radio heads (RRHs) and a wireless cloud baseband (BBU) pool are provided by C-RAN conventional base stations in diverse geographic locations [6]. Backhaul networks are used to link RRHs to the cellular cloud [15]. Although optical networks can enable high-bandwidth, low-latency communication between the RRHs and BBU pools, they are not always a practical solution. Microwave lines and non-line-of-sight wireless connections, on the other hand, will allow for greater customization while maintaining low latency. Please keep in mind that the cloud implementation for the Wi-Fi network is unique. The virtual base station pool, for example, is the primary processing and control centre. The





Dhawaeswar Rao et al.

cellular network cloud is about to become live, which is fantastic. Each antenna in the C-RAN mentioned in this article has a B-RH, which is referred to as a set B. Many mobile cloud providers need safe data flow across all platforms from start to end. There is a split-TCP proxy in the wireless network cloud. The split point for TCP traffic is the split-TCP proxy. In both cloud and traditional cells, this split-TCP proxy is extensively employed. Split-TCP is another common cloud-computing solution. It ensures that data is sent efficiently.

A client can create a TCP connection through the split TCP proxy next door, and the divided TCP proxy provides for a durable TCP connection with a large TCP connection window. By providing a partition point between the mobile broadband hosts, the built TCP proxy addresses the wireless-related difficulty in wireless networks. Each segment is first recognised locally, then saved and sent across the second TCP channel. The Split-TCP proxy is possible in system design gateways because user data flows are tunnelled to SAE-GW before being broadcast to the internet on LTE networks (SAE-GW). The website also shows how smart phones, cloud wireless networking, and OTT service providers are linked. TCP is transferred from the mobile PC to the backend node of the OTT cloud-based service provider. The Split-TCP proxy divides the end-to-end link between the mobile user and the server backend into two halves at the wireless cloud's edge, while maintaining a continuous connection with the backend server. Meanwhile, the wireless network cloud operates continuously on broadband networks, providing the best possible support for the top layer. Both the configuration of topology and the distribution of price are difficult undertakings. The topology configuration keeps track of how RRHs work together. RRH's B and C, for example, collaborate to provide a bundle that serves both MCC users. The wireless cloud must analyse the data rates that MCC users will utilise after topology initialization. The signals are processed jointly in a cooperative set to confirm that they are all present.

METHODOLOGY

The suggested architecture is made up of several components, including a desktop, app resources, SaaS, multi factor authentication, access point, and identity provider. All of the units were linked together. The access point is critical for keeping the app connected to the client. If the actual channel power of a single consumer u exceeds the assigned transmission rate in the proposed architecture from Figure 1, the resultant transmission rate is equal to the assigned rate; otherwise, the resultant transmission rate is equal to the assigned rate. The behaviour of the wireless cloud in slot t has an effect on the output of a consumer u . When calculating the time it takes to reach C-RAN, this is taken into account. The CSI is derived from the pilot signals of the RRH. After channel estimate, the CSI will be sent to the wireless network cloud through backhaul networks. After acquiring CSI in the wireless network cloud, the RRHs decide how to communicate and what rates MCC users should send. After then, the customer's information is sent. Consumer signals are transported from the MCC to the RRH and then relayed across backhaul networks, similar to CSI measurement and propagation.

At the time of decision-making, the available CSI is postponed. The cumulative delay between the actual channel state and that of observation can be built up at the moment of decision-making. It is possible to map the delay into the Markov chains in seconds. The d Phase Transformation Probability is obtained by multiplying matrix A by d times, ad . Given the late steps, the conviction state may be determined, which is based on a large amount of past activity experience and observation history. A confidence condition bt at slot t is the probability distribution of the state space. The analogous variable in bt , referred to as b , calculates the likelihood that the state is st at the moment of slot (st). The confidence is utilised to communicate the state- b aspect of both the bt and the vector bt (st). Time stamping techniques can be used to calculate the frequency of delays periods d . The finding is just postponed by d measures in such an inference. Represent the observation as a random O_t vector at time t . $O_t = \text{Std}, t = d + 1, \dots$, as a consequence, a clear connection between present condition and monitoring may be established. If getting the number of delays proves difficult, Bayesian techniques can be used to derive the belief condition. The observation function $B(\bullet)$ is first introduced. Assume that the system is found at $t = 0$ — this is O . The observation $B(\bullet)$ feature depicts the probability relationship between the observations o - testifies to a state and s - connects to one state in a realistic manner.



**Dhawaleswar Rao et al.**

The new belief can indicate the potential of terminating in a new state $st+1$, the likelihood of observer $ot + 1$, and the observed belief distribution bt if a new observation is made at time $t + 1$. The new belief can indicate the possibility of ending in a new state $st+1$, the likelihood of observer $ot + 1$, and the observed belief distribution bt . The rule for shifting one's belief status depending on prior beliefs and current observations about a topic. Split-TCP is a data transmission protocol that is commonly used in data centres and older cellular networks. MCC applications are expected to play a critical role in the next generation. In this project, the transport layer protocol split-TCP is employed. It is based on a widely used TCP paradigm.

Evaluation Of The Proposed System

The proposed method, on the other hand, provides greater reliability than, instance, the current methodology, which has a delay of 10 experiments, or around 30%. Meanwhile, when CSI is delayed more, the user reaction time increases, with the present system assuming flawless CSI. The recommended technique will be more efficient if the reaction time is smaller than the current system in the case of high mobility, given that CSI is optimal, as proven. When the latency is zero, the system already outperforms the present systems. This is because it expressly includes the output of split-TCP connections with MCC services in the proposed system. The present techniques, on the other hand, simply try to improve the physical layer efficiency, which isn't particularly great in MCC. In terms of performance, the present regime is the least effective of the three when solely considering physical layer performance. They both show that the existing physical layer performance maximisation approach does not guarantee improved TCP performance. The results are measured in terms of response time. For a low mobility scenario, the existing approach respond latency to enhance physical layer output grows as the CSI delay increases. Close to the currently used technique, which assumes CSI perfection? In the case of high mobility, the proposed device outperforms the CSI since the CSI latency exceeds two samples.

CONCLUSION AND FUTURE WORK

This article examines cloud RAN and mobile cloud networking in next-generation broadband networks. The topology design and rate allocation challenges in C-RAN have been investigated in order to increase end-to-end TCP efficiency for MCC users in next-generation wireless networks. The C-imperfect RAN's CSI conundrum was suggested as a decision-making tool. The reaction time of each MCC user was set as a limit. The balance of performance and equity among MCC users was also investigated. According to simulation testing, the suggested approach has the potential to significantly improve the device efficiency of MCC users. The delayed performance effect of CSI is crucial in C-RAN, and our suggested technique can reduce this effect, particularly in large delays and mobility scenarios. Further study on virtualizing the wireless network is ongoing in the given scenario.

REFERENCES

1. S. Bhaumik, S. P. Chandrabose, M. K. Jataprolu, G. Kumar, A. Muralidhar, P. Polakos, V. Srinivasan, and T. Woo, —CloudIQ: A framework for processing base stations in a data center,|| in Proc. ACM Mobicom'12, (Istanbul, Turkey), 2012.
2. China Mobile Research Institute, —C-RAN: the road towards green RAN,|| tech. rep. <http://labs.chinamobile.com/>, accessed: 2013- 07-18.
3. O. S.-H. Park, and Simeone, O. Sahin, and S. Shamai, —Robust and efficient distributed compression for cloud radio access networks,|| IEEE Trans. Veh. Tech., vol. 62, no. 2, pp. 692–703, Feb. 2013.
4. Y. Cai, F. R. Yu, and S. Bu, —Cloud computing meets mobile wireless communications in next generation cellular networks,|| IEEE Network, vol. 28, pp. 54–59, Nov. 2014.
5. S. Bu, F. R. Yu, Y. Cai, and P. Liu, —When the smart grid meets energy-efficient communications: Green wireless cellular networks powered by the smart grid,|| IEEE Trans. Wireless Commun., vol. 11, pp. 3014–3024, Aug. 2012.





Dhawalesswar Rao et al.

6. H. Balakrishnan, V. N. Padmanabhan, S. Seshan, and R. H. Katz, —A comparison of mechanisms for improving TCP performance over wireless links, || IEEE/ACM Trans. Netw., vol. 5, pp. 756–769, Dec. 1997.
7. C. Luo, F. R. Yu, H. Ji, and V. C. M. Leung, —Cross-layer design for TCP performance improvement in cognitive radio networks, || IEEE Trans. Veh. Tech., vol. 59, no. 5, pp. 2485–2495, 2010.
8. N. H. Tran, C. S. Hong, and S. Lee, —Cross-layer design of congestion control and power control in fast-fading wireless networks, || IEEE Trans. Parallel and Dist. Systems, vol. 24, pp. 260–274, Feb. 2013.
9. G. Wang and T. S. E. Ng, —The impact of virtualization on network performance of Amazon EC2 data center, || in Proc. IEEE INFOCOM'10, (San Diego, CA), Mar. 2010.
10. 3rd Generation Partnership Project, —Reply LS to R3-070527/R1-071242 on Backhaul (X2 interface) Delay, || tech. rep., 3rd Generation Partnership Project, 2007.
11. D. J. Love, R. W. Heath, V. K. Lau, D. Gesbert, B. D. Rao, and M. Andrews, —An overview of limited feedback in wireless communication systems, || IEEE J. Sel. Areas Commun., vol. 26, pp. 1341–1365, Oct. 2008.
12. S. Bu, F. R. Yu, and H. Yanikomeroglu, —Interference-aware energy-efficient resource allocation for heterogeneous networks with incomplete channel state information, || IEEE Trans. Veh. Tech., online, 2015. doi: 10.1109/TVT.2014.2325823.
13. R. Xie, F. R. Yu, and H. Ji, —Dynamic resource allocation for heterogeneous services in cognitive radio networks with imperfect channel sensing, || IEEE Trans. Veh. Tech., vol. 61, pp. 770–780, Feb. 2012.
14. A. Goldsmith, M. Effros, R. Koetter, M. Medard, A. Ozdaglar, and L. Zheng, —Beyond Shannon: the quest for fundamental performance limits of wireless ad hoc networks, || IEEE Comm. Mag., vol. 49, pp. 195 –205, May 2011.
15. A. Goldsmith et al., —Breaking Spectrum Gridlock with Cognitive Radios: An Information Theoretic Perspective, || IEEE Proc., vol. 97, May 2009, pp. 894–914.
16. Denoncourt, J. (2020). Companies and UN 2030 sustainable development goal 9 industry, innovation and infrastructure. *Journal of Corporate law studies*, 20(1), 199-235.

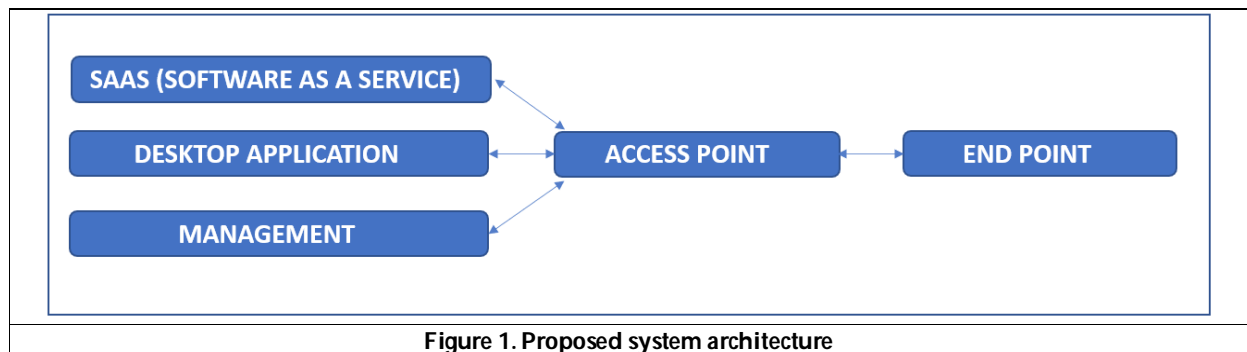


Figure 1. Proposed system architecture





Exploring Implementation of Bioinformatics Computational Spectrum by High Performance Reconfigurable FPGA based Accelerators

Jayakishan Meher*

Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Jayakishan Meher

Centurion University of Technology and Management,
Odisha, India

Email: jk_meher@yahoo.co.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Recently an exponential progress of biological datasets generated due to genome projects has been observed. Bioinformatics computational spectrum has made substantial efforts in genomics research to drive biological discovery. Advanced computational methods are indispensable for analysis of high dimensional biological datasets. The speed of computation of such large-scale data requires hardware accelerators in Biocomputing applications. The execution of such problems can be accelerated by either designing efficient algorithmic or using high performance computing architectures. Out of several hardware configurations like Graphics Processing Unit (GPU), ASIC, FPGA and multi-core processors, FPGAs have emerged as improved reprogrammability computing accelerators that can implement huge parallelized section of computational algorithms. Several Biocomputing applications with huge data are being implemented in FPGA reconfigurable computing platforms, In this paper, we present a survey of real-time implementation of hardware accelerators for Biocomputing applications.

Keywords: Digital signal processing, FPGA, reconfigurable, ASIC, SoC, Bioinformatics, parallel processing.

INTRODUCTION

Bioinformatics plays significant roles in biomedical applications. The analysis of genomic data helps in determination of disease prediction and pharmacogenomics. Bioinformatics emphasizes on data mining and its applications [1]. Recently an exponential progress of biological datasets generated due to genome projects has been observed. Bioinformatics computational spectrum has made considerable devotion in genomics research to drive biological discovery [2]. The software used for data processing of biocomputing applications is very slow because they run in operating systems environment. Signal processing and computational intelligence methods are increasingly used in bioinformatics research [3]. Digital signal processing methods are faster to analyse these data. In



**Jayakishan Meher**

the present trend, architecture implementation of DSP is extended from telecommunication systems, image processing, video processing applications, multimedia systems and computer networks to implementation of complex mathematical procedures for Bioinformatics data analysis. Though use of reprogrammable microprocessors has its own importance; hardware implementation of computational algorithms is essential. Developments in integrated circuits have provided high-speed digital ICs available in ASICs, FPGAs and SoC to implement the computational algorithms in hardware [4]. Hence it is encouraging to solve Biocomputing problems by designing advanced algorithm or implementing in efficient architectures. FPGA has appeared as improved reprogrammability hardware accelerators that can implement huge parallelized section of computational algorithms [5]. In this paper, we present a review of real time implementation of hardware accelerators for Biocomputing applications.

Bioinformatics Computational Spectrum

Bioinformatics deals with many computational tools and resources to handle life sciences datasets by transformed to a quantitative information rich society. It consists of large scale heterogeneous data of biomacromolecules such as DNA and aminoacid sequence, protein multidimensional structures, gene expression data and uncovers the hidden information and pattern [6]. Fortunately the DNA and Protein sequences are digital in nature. These sequences can be represented in numerical sequence by substituting nucleotide sequence and amino acid sequences by their physicochemical properties. Now these numerical sequences can be analyzed by computational algorithms. The several computational problems in Bioinformatics are gene prediction, sequence comparison, protein structure prediction, microarray data analysis, drug discovery and design, drug toxicity prediction, molecular modelling, molecular docking, molecular dynamics, motif prediction, metal binding prediction, transmembrane protein analysis etc [7]. Further the protein molecules are available in structural form. These data can be analysed by many graphical tools and visualisation tools. The various computational methods used in bioinformatics data analysis are DSP tools such as FFT, digital filter, wavelet transform, statistical methods such as linear discriminant analysis, factor analysis, PCA, computational intelligence algorithms like machine learning, particle swarm optimization, genetic algorithms, support vector machine, image processing etc [8]. Developments in ICs have resulted in high-performance and high-speed digital circuit available in ASICs, FPGAs and SoC to implement the computational algorithms in hardware [9]. All these method are subjected to use in bioinformatics problems and need to be implemented in FPGA reconfigurable architecture. The computational spectrum of Bioinformatics is shown in figure 1.

FPGA-Based Reconfigurable Architecture for Bioinformatics

Many bioinformatics applications are explored to get benefits of high performance reconfigurable computing platforms. The rapid growth of Bioinformatics databases has created a challenge of processing speed for traditional processor. The analysis of these data with the help of computer software degrades the processing speed because they are running in operating system environment. Hence the operations can be accelerated utilizing the computing architectures. Such computing architectures include superscalar processors, parallel and pipelined processing architecture systems and implementations of algorithms in hardware. Advances in integrated circuits have provided digital circuitries such as FPGAs, ASICs and SoC that enable us for implementing complex algorithms in hardware and perform high-speed operation [4]. Such huge computation can be addressed by reconfiguring huge parallelized accelerator to attain improved performance. The high density data-rich biomedical problems are formulated by computational techniques and its efficient algorithm is implemented in real time hardware architecture. But the most widely used hardware reprogrammable platform is the FPGA. FPGA has emerged as a high-performance computing accelerator that is capable of implementing massively computational algorithms [5]. The reprogrammability feature of FPGA allows much algorithm-specific computing architecture to be implemented using the same hardware resource. This setup provides the developer flexibility in design before going to actual implementation. Several Biocomputing applications such as algorithms on sequence comparison, multiple sequence alignment, gene predictions etc mapped in FPGA are presented here.



**Jayakishan Meher****Sequence Comparison Algorithms**

Various algorithms relating to alignment of sequence are being accelerated in FPGA. Fernandez and co-authors implemented a design for straight comparison of a running sequence as reference and a fixed sequence of short read [10]. The Aho-Corasick algorithm [11] and hash table [12] have been adopted in FPGA aligners. The implementing the BLAST algorithm on FPGA architecture has been an innovative work in mapping bioinformatics tools on FPGAs [13-16]. Significant work contributed by Muriki et al. [17] and Herbordt et al. [18] towards development of hardware architecture were fully BLAST compliant, that the entire NCBI BLAST can be mapped on FPGAs.

Multiple Sequence Alignment

The homologous biomolecules of three or more sequences can be studied in multiple sequence alignment that determines molecular structure and function information. The T-Coffee and MAFFT algorithms have been implemented on FPGA producing outstanding results [19].

Gene Prediction

Gene prediction is a fundamental aspect in computational molecular biology in which a segment of DNA sequence is repeatedly checked for presence of gene by framing and sliding the along the large sequence data. The decoding of information present in genome leads to gene detection problems. The research has done to design and develop and implement exclusive architectures such as Glimmer algorithm with its advancement denoted as Glimmer HMM. The Interpolated Markov Models has also been used in prediction of gene [13]. Hidden Markov model (HMM) has been integrated with Glimmer algorithm resulting in Glimmer-HMM for improvement in gene identification and designed the required core for Glimmer-HMM implementing the four HMMs of the algorithm on Virtex-5.

RNA and Protein Secondary Structure Prediction

The protein secondary structure prediction based on Predator algorithm has been presented in architecture for parallel implementation of the two initial steps of the algorithm with protein database stored in internal FPGA memory and having six parallel computing modules. The architecture was mapped on a Xilinx Virtex-5 with 30 to 50 times faster than general computer. The Zuker algorithm predicts the secondary structure of RNA sequences. A pipelined architecture in FPGA has been designed, which calculates the matrix coefficients, on a Virtex-5, with the FPGA utilization almost at 100% [20]. Similarly there are several Biocomputing algorithms implemented in FPGA based reconfigurable accelerator. K-means algorithm for clustering Microarray gene expression data has been implemented in FPGA for five k-mean cores on Xilinx Virtex4 XC4VLX25 FPGA and achieved about 51.7x speed-up in contrast to a software model with speed 206.8x [21]. Molecular Dynamics tool helps for study of properties of molecular particles and its simulation has been implemented in FPGA accelerator using C-based OpenCL and achieved over 4.6 times of speed-up compared to microprocessor-based system [22]. AutoDock tool performs molecular docking for drug identification which is implemented in FPGA-based acceleration and achieved a $\times 10$ -40 speedup over a 3.2 GHz processor [23].

Comparison and Result Analysis

FPGA reconfigurable architecture is a promising technology widely used in simulation and synthesis of Bioinformatics algorithms for sequence alignment, multiple sequence alignment, gene prediction, protein structure prediction etc. Several computational algorithms are being synthesized in FPGA Spartan 3E and Vertex-5 using Xilinx software. The representative algorithms implemented in FPGA based reconfigurable hardware accelerator for different Bioinformatics problems are represented in table 1. The speedup achieved for sequence analysis for different hardware accelerators are represented in table 2.

CONCLUSIONS

It is seen that real time implementation of biocomputing applications in FPGA based high performance reconfigurable platform is the current trend of computing. In this paper we presented bioinformatics computational



**Jayakishan Meher**

spectrum requires efficient hardware accelerator computing systems. A comprehensive range of bioinformatics algorithms has been shown to have improved execution times on FPGA system. We noticed that performance of FPGA is better than those of other computing systems that can address the future challenges associated with exponential growth of biological data. However, a substantial design effort remains for system level development to promote the use of FPGA among the life sciences community.

REFERENCES

1. Xin Liang, Wen Zhu, Zhibin Lv and Quan Zou, "Molecular Computing and Bioinformatics", *Molecules*, 24, 2358, (2019), pp 1-7.
2. W.J.S. Diniz and F. Canduri, "Bioinformatics: an overview and its applications", *Genetics and Molecular Research* 16 (1), (2017).
3. P.P. Vaidyanathan and B.J. Yoon, "The role of signal processing concepts in genomics and proteomics," *Journal of the Franklin Institute*, vol. 341, (2004), pp. 111-135.
4. Khaled Benkrid, "High Performance Reconfigurable Computing: From Applications to Hardware", *IAENG International Journal of Computer Science*, 35:1, (2008).
5. Grigorios Chrysos, Euripides Sotiriades, Christos Rousopoulos, Kostas Pramataris, Ioannis Papaefstathiou, Apostolos Dollas, George Petihakis and Jacques Lagnel, "Reconfiguring the Bioinformatics Computational Spectrum: Challenges and Opportunities of FPGA-Based Bioinformatics Acceleration Platforms", *Hardware Acceleration in Computational Biology*, (2014), pp62-73.
6. Khalid Raza, "Application of data mining in bioinformatics", *Indian Journal of Computer Science and Engineering*, Vol 1 No 2, (2012), pp. 114-118.
7. Achuthsankar S Nair, "Computational Biology & Bioinformatics: A Gentle Overview", *Communications of the Computer Society of India*, (2007). Pp. 1-13.
8. Zainab Alansari, Nor Badrul Anuar, Amirrudin Kamsin, Safeeullah Soomro and Mohammad Riyaz Belgaum, "Computational Intelligence Tools and Databases in Bioinformatics", 4th IEEE International Conference on Engineering Technologies and Applied Sciences (ICETAS), Bahrain. IEEE, 2017. Papadopoulos, I. Kirmitzoglou, V. J. Promponas, and T. Theocharides, "FPGA-based hardware acceleration for local complexity analysis of massive genomic data", *The VLSI J.*, vol. 46, no. 3, (2013) pp. 230–239.
9. E. Fernandez, "Exploration of Short Reads Genome Mapping in Hardware," in 2010 International Conference on Field Programmable Logic and Applications, (2010), pp.360–363.
10. Y.S.Dandass, "Accelerating String Set Matching in FPGA Hardware for Bioinformatics Research", *BMC Bioinformatics*, vol. 9, no.1, (2008), pp. 197.
11. Y. Chen et al., "An FPGA Aligner for Short Read Mapping," in 22nd International Conference on Field Programmable Logic and Applications, (2012), pp. 511–514.
12. G. Chrysos et al., "Opportunities from the use of FPGAs as platforms for bioinformatics algorithms," in Proceeding. 12th IEEE International Conference. Bioinformatics. Bioengineering. (BIBE), (2012), pp. 559-565.
13. Sotiriades and A. Dollas, "A general reconfigurable architecture for the BLAST algorithm," *J. VLSI Signal Processing Syst. Signal, Image, Video Technol.*, vol. 48, no. 3, pp. 189–208, (2007).
14. K. Muriki, K. Underwood, and R. Sass, "RC-BLAST: Towards an open source hardware implementation," in Proc. Int. Workshop on High Performance Computat. Biol., (2005).
15. M. Herbordt, J. Model, Y. Gu, B. Sukhwani, and T. VanCourt, "Single pass, BLAST-like, approximate string matching on FPGAs," in Proc. 14th Annu. IEEE Symp. Field-Programmable Custom Comput. Machines, (2006), pp. 217–226.
16. K. Muriki, K. Underwood, and R. Sass, "RC-BLAST: Towards an open source hardware implementation," in Proc. Int. Workshop on High Performance Computat. Biol., (2005).
17. M. Herbordt, J. Model, Y. Gu, B. Sukhwani and T. VanCourt, "Single pass, BLAST-like, approximate string matching on FPGAs," in proc. 14th Annual IEEE Symp. Field Programmable Custom Comput. Machines, (2006), pp. 217-226.





Jayakishan Meher

18. K. Katoh, K. Kuma, H. Toh, T. Miyata, MAFFT version 5: improvement in accuracy of multiple sequence alignment. *Nucleic Acids Research*, vol 33, pp. 511-518, (2005).
19. M. Smerdis, P. Dagritzikos, G. Chrysos, E. Sotirades, A. Dollas, "Reconfigurable Systems for the Zuker and the Predator Algorithms for Secondary Structure Prediction of Genetic Data", In the proceedings of Field Programmable Logic (FPL), (2010).
20. M. Hanaa. Hussain, Khaled Benkrid, Huseyin Seker, Ahmet T. Erdogan, "FPGA Implementation of K-means Algorithm for Bioinformatics Application: An Accelerated Approach to Clustering Microarray Data", NASA/ESA conference on adaptive hardware and systems, (2011), pp. 248-255.
21. H. M. Waidyasooriya, M. Hariyama and K. Kasahara, "An FPGA Accelerator for Molecular Dynamics Simulation Using OpenCL", International Journal of Networked and Distributed Computing, Vol. 5, No. 1, (2017), pp. 52–61.
22. Imre Pechan and Béla Fehér, Attila Bérces, "FPGA-Based Acceleration of the AutoDock Molecular Docking Software", Conference on Ph.D. Research in Microelectronics and Electronics (PRIME), 2010

Table 1. FPGA based Bioinformatics algorithm.

| Bioinformatics Computational Spectrum | Computational Algorithms implemented in FPGA |
|--|--|
| Sequence alignment | BLAST, CAST |
| Multiple sequence alignment | T-Coffee, MAFFT |
| Phylogenetic Tree Construction | RAxML |
| Gene Prediction | Glimmer, GlimmerHMM, Digital filter |
| RNA and Protein Secondary Structure Prediction | Predator, Zuker algorithm |
| Clustering Microarray Data | K-means Algorithm |
| Molecular Dynamics | C-based OpenCL |
| Molecular Docking | Docking algorithm |

Table 2: Speedups achieved for sequence analysis for different hardware accelerators

| Sequence Alignments | Speedup over Serial Implementation | | |
|---------------------|------------------------------------|-----|------------|
| | FPGA | GPU | Multicores |
| PSA | 100 | 70 | 22000 |
| MSA | 13 | 7 | NA |
| BLAST | NA | 16 | NA |

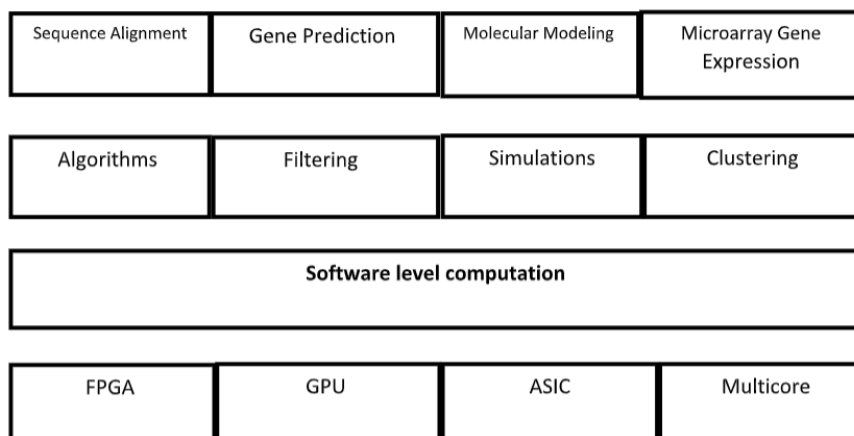


Figure 1. Computational Spectrum of bioinformatics algorithms





A Comprehensive Review: Diosmin

Deenathayalan Uvarajan¹ and Brindha Durairaj^{2*}

¹Research Scholar, Department of Biochemistry, PSG College of Arts and Science, Coimbatore, Tamil Nadu, India.

²Department of Biochemistry, PSG College of Arts and Science, Coimbatore, Tamil Nadu, India.

Received: 30 Mar 2022

Revised: 15 Apr 2022

Accepted: 23 May 2022

*Address for Correspondence

Brindha Durairaj

Department of Biochemistry,
PSG College of Arts and Science,
Coimbatore, Tamil Nadu, India.
Email: brindhavenkatesh6@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Diosmin is a citrus flavone glycoside present in different citrus fruits, and the chemical nature of this flavone is 3',5,7-trihydroxy-4'-methoxy flavone-7-aminoglycoside. This Diosmin is used as an oral flavonoid drug Micronised Purified Flavonoid Fraction (MPFF) [Daflon® 500mg] with the combinations of Diosmin (90%) and Hesperidin (10%). Also, Diosmin was identified as a venous guarding agent to reduce chronic venous insufficiencies, varicose veins and haemorrhoids. Nowadays, the pharmaceutical and chemical industries are isolating the Hesperidin from citrus and converting them into Diosmin. The role of Hesperidin and Diosmin is very crucial in different chronic diseases like carcinoma, hypertension, diabetics. With the extensive research, the structure and mode of actions of Hesperidin are revealed as much, but in Diosmin, there are not enough studies that are not going to understand their roles. Hence this paper will help to summarise the position and ongoing research knowledge about Diosmin.

Keywords: Diosmin, Daflon, Flavonoids, Citrus fruits, Chronic diseases

INTRODUCTION

The known fruits such as oranges, lemons, limes, grapefruits and mangoes are citrus fruits in the family of Rutaceae. These fruits' organoleptic and commercial properties reveal the pharmacological benefits of the citrus fruits field [1]. Citrus fruits are essential sources of Vitamin C, Macronutrients, potassium, magnesium, copper and pantothenic acid [2]. Secondary metabolites are also known as phytochemicals that are not important for the plant's survival but vital in the plant growth that exhibits pharmacological activity. Citrus fruits include several secondary metabolites like flavonoids, alkaloids, limonoids and phenolic acids. The biological activities of these active compounds help enhance human health, anti-oxidative, anti-cancer, anti-inflammatory, neuroprotective and cardioprotective properties [3].



**Deenathayalan Uvarajan and Brindha Durairaj**

Plant flavonoids are a large group of chemical components that exhibits very similar phenolic compounds. Flavonoids are derived from the phenylpropanoid metabolism and shikimic acid pathway (Stafford et al., 1990). Due to their physiological, pharmacological, and health benefits, flavonoids have been recognised as a crucial component in metabolism. Since 1990 the interest in flavonoids has led to exciting research with 13,000 articles and books handling various aspects field [4]. Free radical scavenging and antioxidant property of flavonoids decrease the risk of various chronic diseases [5].

Diosmin is a type of flavonoid, and this flavonoid is obtained from hesperidin dehydrogenation. In 1925 Diosmin was first discovered in *Scrophularia nodosa*, and their pharmaceutical action was identified in 1969. Previous reports suggest that Diosmin is a non-toxic drug for various chronic disorders (i.e. Diabetes). This flavonoid also reveals its anti-radical, anti-inflammatory and antimutagenic properties [6]. With the help of micronised formulation, Diosmin is used as a clinical drug. Later the oral administration of Diosmin is adequately hydrolysed by the intestinal enzymes into diosmetin, aglycone, which is absorbed into the haematopoietic system. The micronisation particles enhanced the absorption capability of this Diosmin at a diameter <2µm. Converted Diosmetins are significantly degraded into phenolic acids or conjugated glycine derivatives which are majorly excreted in the urine.

Diosmin is used as a vascular protective agent to increase the venous tone, enhance lymphatic circulation, and prevent microcirculation from inflammation and apoptosis [7]. Diosmin also reduces the expression of endothelial adhesion molecules, inhibiting the leukocytes migration and activation to the capillary level. The release of inflammatory factors such as free radicals and prostaglandins are hampered by this action [8]. This review reveals the use of flavonoids in the health and pharmaceutical industries. Mainly, Diosmin provides several health benefits and biological activities.

Chemical Nature

Diosmin is a disaccharide component that consists of diosmetin moiety replaced through glycosidic linkage by 6-O-(alpha-L-rhamnopyranosyl)-beta-D-glucopyranosyl residue at the seven positions. The average molecular weight of Diosmin is 608.5447 with the chemical formula $C_{28}H_{32}O_{15}$. Diosmin is an analogue of hesperidin, and a double bond between C-C in the C- ring atom makes the Diosmin different.

Diosmin is mainly isolated from the citrus plants. It is a glycoflavone, so various nitrogen utilising plants are producing the Diosmins by shikimic acid pathway. Citrus plants such as limes, grapefruits, oranges, and pineapple include this compound in higher amounts.

Hesperidin  **Diosmin**

The natural occurrence of Diosmin is shallow in citrus plants. In recent years pharmaceutical use of Diosmin has been enhanced extensively; therefore, synthetic methods developed to synthesise Diosmin. The main component of Diosmin synthesis is Hesperidin because of its structural similarities. By engaging N- Bromosuccinamide, acetyl hesperidin is brominated by the benzoyl peroxide in the presence of chloroform with a yield of 44%⁹. Another research supported that the work of Diosmin is 66%, in the presence of pyridine and iodine at 100°C sodium hydroxide molecules are treated with Hesperidin. Thanh Nguyen *et al.* reported the green synthesis of Diosmin [10]. The low availability of Diosmin enhanced several synthesis methods by using Hesperidin.

Pharmacological Effects

In current medical situations, Diosmins are used to treat chronic venous diseases, lymphedema and varicose vein [11]. The therapeutic action of Diosmin is enhanced by inhibition and metabolism of noradrenaline in the venous walls. Reduction in noradrenalin levels results in reduced elasticity and membrane permeability [12]. These actions made this Diosmin anti-inflammatory, antimutagenic and accessible radical scavenging properties by inhibiting the entry of free radicals. It lowers blood pressure and lipid peroxidases. The availability of nitric oxide was enhanced, thereby it reducing hypertension in the venous walls.



**Deenathayalan Uvarajan and Brindha Durairaj****Diabetes**

Diabetes Mellitus(DM) is a chronic metabolic disorder identified by insufficient insulin secretion or insulin receptors impairment that enhances hyperglycemia. DM is also caused by deficiencies in the carbohydrate, fat and protein metabolism field [13]. Polyuria, polydipsia and polyphagia are the classic symptoms of DM developed during the hyperglycaemia condition [14]. In this regard, β pancreatic cell functions are affected by hyperglycaemia [15]. Macro and microvascular diseases are developed during the prolonged glucose level increase. Therefore appropriate medications are needed to control the blood glucose level. At present several hypoglycaemic agents are diploid to treat DM [16]. Despite benefiting from these drugs, it also reduces specific side effects such as hypertension, hyperglycemic coma [17]. Hence lesser side effects and cost-effective drugs are needed for the effective treatment of DM. Nowadays, combination drug therapies are preferred better than single-drug therapy. So herbal medicines are recommended for combinational drug therapy due to their bioavailability [18]. Diosmin is a glycoflavonoid that plays a vital role to control these glucose levels. Recent studies suggested that Diosmin have excellent hyperglycaemic properties with cost-effective treatments [19]. Several reports are available about diosmin'santi glycaemic activity which are listed below.

Hyperglycaemia disturbs the non-enzymatic binding between glucose and proteins, produces advanced glycation end products (AGEs) [22]. AGEs cause Intracellular oxidation via glycol, which is turned from glucose followed by one amino one deoxyglucose to 3 deoxyglucose degradation, glyceraldehyde fragmentation. More free radicals are generated by these reactive products when it reacts with an amino group of intracellular and extracellular protein [23]. Due to the lone pair, electrons of free radicals can quickly react with DNA, RNA, and proteins of the beta cells, leading to cell death or apoptosis [24]. These free radicals also enhance the level of several inflammatory cytokines present in the beta cells. Nuclear factor-kB(NF-kB) is an essential inflammatory cytokine that plays a vital role in DM pathogenesis. Due to the over expression of NF- kB, it stimulates other cytokines such as IL-6, TNF alpha. Diosmin significantly inhibits the expression of the NF-kB pathway by downregulating the oxidative stress and pro-inflammatory cytokines generation [25].

Diosmin as a hepatoprotective agent,

Chronic liver cirrhosis causes a high rate of morbidity and mortality in humans. Due to the bile duct obstruction, the bile salts are accumulated in the liver stimulate the specific pathway of inflammatory responses leads to liver injury. Those injuries are the primary cause of liver cirrhosis and failure [26]. Recent researches highlighted that liver injury is caused by the oxidants/ antioxidants imbalance, stimulation of inflammatory response, hepatic stellate cells (HSC) activation and depletion of extracellular matrix proteins [27]. The major inflammatory signalling pathway in liver cirrhosis are P38 Mitogen-Activated Protein Kinase (P_{38} - MAPK) and NF- kB signalling pathway. NF- kB translocates into the nucleus and activates many inflammatory genes during the stress conditions like TNF alpha and inducible nitric oxide synthase (iNOS) [28]. Therefore the hepatoprotective agents needed are increased to reduce inflammation and oxidative stress. Previous studies reported that Diosmin could downregulate the TNF alpha and NF- kB expressions [29]. In this way, Diosmin inhibits the translocation of NF- kB. Thereby the expression of other genes is downregulated. Although Diosmin also acts as an antioxidant because of their flavonoid nature, the production of free radicals is also inhibited. Lahouel et al., revealed that the Diosmin having the capability to inhibit the GSH depletion in the liver [30].

Role of Diosmin in Neuroprotection,

Recent research suggests that Diosmin can be used to treat various chronic diseases. In this way, Diosmin can be used to treat neurodegenerative diseases such as Alzheimer's and Brain injury [31]. The Diosmin maintains enhanced antioxidants enzyme activity and neuroinflammatory levels, preventing neurodegeneration and cerebral ischemic [32]. The discharge of sensory signals from hippocampal region neurons is coordinated with a cognitive process. Due to the accumulation of amyloid precursors and neurofibrillary tangles, these electric signals are interrupted, leading to neurodegeneration. Recent studies reveal that Diosmin can reduce amyloid-beta oligomers and the hyperphosphorylation of tau proteins. Flavonoid properties of Diosmin also decrease the neuroinflammation level and cognitive impairment through JAK/ STAT 3 signalling pathway [33].



**Deenathayalan Uvarajan and Brindha Durairaj**

JAK/STAT 3 signalling pathway mainly involves inflammation, cell survival, development, proliferation, differentiation and development. Diosmin reduces the DNA fragmentation in the cerebral region and enhances the cell survival rate by up regulating the Bcl-2 protein and down regulating the Bax [34]. Another study exhibited that Diosmin can reduce the TNF alpha expression in NF- kB signalling pathway [35]. Sarah et al., 2018 demonstrated that Diosmin might ameliorate cognitive impairment by protecting the cholinergic system [36]. Following table describes the works carried out in diosmin as a neuroprotective agent.

Anti-ulcerative agent

Modern lifestyle and alcohol consumption increased the risk of gastric mucosal lesions involving gastric ulcer, gastritis and gastric carcinoma [39]. Gastric mucosal damage is caused by the increased level of myeloperoxidase (MPO) due to the invasion of gastric tissues by neutrophils [40]. The active neutrophils regulate inflammatory responses, leading to the NF-kB activation and translocation followed by the activation of inflammatory cytokines. The primary reason for this activation is free radicals such as reduced glutathione and glutathione peroxidase. In current situations, several anti-ulcerative drugs are available, but most of them act as proton pump inhibitors and H2 receptor antagonists with adverse side effects [41]. Hence the research was conducted to find out the Diosmin efficacy against gastric ulcers and found that Diosmin has greater effectiveness than other ulcerative drugs. In this research, they revealed the Diosmin action against the gastric ulcer. It down-regulates the NF- kB activation and proinflammatory cytokines, although it inhibits the myeloperoxidase activation, preventing gastric mucosal damage [42].

Cardioprotective properties

Cardiovascular diseases are characterised as a heterogeneous group of disorders that damages the blood vessels and heart. The most important one in cardiovascular diseases is myocardial infarction (MI). Death of the heart muscle segment is known as myocardial infarction, which also affects blood flow in the blood vessels. A massive amount of several free radicals are generated during the myocardial infarction like hydrogen peroxide and hydroxyl radical [43]. Mitochondria is the central hub of cellular reactive oxygen species (ROS). Oxidative phosphorylation and energy productions are taking place in the mitochondria. Also, for cardiac muscle contraction, adenosine triphosphate synthesis, electron transport chain are essential processes in mitochondria. During myocardial infarction, the above critical methods are limited. Due to the excessive oxidative stress, mitochondrial damage was caused at the time of the myocardial infarction. Hence mitochondria are the targets for ROS. Previous reports suggested that antioxidants play a crucial role in various chronic diseases. Thus Diosmin is used to reduce the above free radicals and act as a cardioprotective agent [44]. Queenthy et al., reported that Diosmin having the ability to reduce the activity of HMG CoA reductase in hyperlipidemia [45]. Further findings reveals that the Diosmin reduced the cardiac arthemias by enhancing coronary microvascular function [46] and it also decreases the interleukin-1, interleukin-6, Tumor necrosis factor alpha(TNF- α), caspase 3 and 9 [47].

CONCLUSION

Among several classes of flavonoids, Diosmin is improving day by day due to their bioavailability and practical health benefits in neuroinflammation, inflammation in a blood vessel, microbial and cardiovascular diseases. Depending on its physiochemical and structural properties, Diosmin can target various chronic disorders by alone or combinational therapy. Due to their poor solubility, absorption and distribution, Diosmin can make any therapeutic activity and nanotechnology. The molecular weight, structure, solubility, pH sensitivity makes the Diosmin the best therapeutic agent. Nowadays combinational drug Diosmin (Daflon 500mg) is used for various diseases because of its higher absorption rate. Recent researches suggest that Diosmin may be capable of making nanodrugs. This review helps more investigations on Diosmin to explore its new findings with different aspects.





ACKNOWLEDGEMENT

The authors are grateful to DST- FIST and the Management, PSG College of Arts and Science College, Tamil-Nadu, India, for providing all the facilities to carry out this work.

REFERENCES

1. García-Salas P, Gómez-Caravaca AM, Arráez-Román D, et al. Influence of technological processes on phenolic compounds, organic acids, furanic derivatives, and antioxidant activity of whole-lemon powder. *Food Chemistry*. 2013;141(2):869-878. doi:10.1016/j.foodchem.2013.02.124
2. Economos Christine, Clay WD. Nutritional and health benefits of citrus fruits. *Food, Nutrition and Agriculture - FAO*. 1999;24:11-18.
3. Lv X, Zhao S, Ning Z, et al. Citrus fruits as a treasure trove of active natural metabolites that potentially provide benefits for human health. *Chemistry Central Journal*. 2015;9(1):1-14. doi:10.1186/s13065-015-0145-9
4. Gattuso G, Barreca D, Gargiulli C, Leuzzi U, Caristi C. Flavonoid composition of citrus juices. *Molecules*. 2007;12(8):1641-1673. doi:10.3390/12081641
5. Kris-Etherton PM, Lefevre M, Beecher GR, Gross MD, Keen CL, Etherton TD. Bioactive compounds in nutrition and health-research methodologies for establishing biological function: The antioxidant and anti-inflammatory effects of flavonoids on atherosclerosis. *Annual Review of Nutrition*. 2004;24:511-538. doi:10.1146/annurev.nutr.23.011702.073237
6. Lyseng-williamson K a, Perry CM, Allegra C, et al. A Review of its Use in Chronic Venous Insufficiency , Venous Ulcers and Haemorrhoids1. Lyseng-williamson K a, Perry CM, Allegra C, Angiologia S, Giovanni OS, Bergan J, et al. A Review of its Use in Chronic Venous Insufficiency , Venous Ulcers and Haemorrh. 2003;63(1):71-100.
7. Hitzenberger G. [Therapeutic effectiveness of flavonoids illustrated by daflon 500 mg]. *Wiener medizinische Wochenschrift (1946)*. 1997;147(18):409-412.
8. Nicolaides AN, Struckman JR. The pharmacodynamic and clinical activities of Daflon 500 mg: Therapeutic effect of micronization. *Phlebology*. 1994;9(SUPPL. 1):7-9. doi:10.1177/0268355594009001s04
9. Cremades L. (12) United States Patent. 2020;2.
10. Nguyen VT, Huynh TKC, Nguyen TD, Hoang TKD. Oxidation of hesperidin into diosmin using ionic liquids. *Organic Communications*. 2019;12(2):101-108. doi:10.25135/acg.oc.57.19.04.1242
11. Li C, Du GH. Diosmin. *Natural Small Molecule Drugs from Plants*. 2018;9(3):65-70. doi:10.1007/978-981-10-8022-7_10
12. Of I, From D. ISOLATION OF DIOSMIN FROM PLANTS. 1996;29(10):707-709.
13. Akcilar R, Turgut S, Caner V, et al. The effects of apelin treatment on a rat model of type 2 diabetes. *Advances in Medical Sciences*. 2015;60(1):94-100. doi:10.1016/j.advms.2014.11.001
14. Palsamy P, Subramanian S. Modulatory effects of resveratrol on attenuating the key enzymes activities of carbohydrate metabolism in streptozotocin-nicotinamide-induced diabetic rats. *Chemico-Biological Interactions*. 2009;179(2-3):356-362. doi:10.1016/j.cbi.2008.11.008
15. Gerich JE. Clinical significance, pathogenesis, and management of postprandial hyperglycemia. *Archives of Internal Medicine*. 2003;163(11):1306-1316. doi:10.1001/archinte.163.11.1306
16. Delventhal R, Kiely A, Carlson JR. Electrophysiological recording from Drosophila labellar taste sensilla. *Journal of Visualized Experiments*. 2014;(84):1-8. doi:10.3791/51355
17. Fu J, Fu J, Yuan J, et al. Anti-diabetic activities of Acanthopanax senticosus polysaccharide (ASP) in combination with metformin. *International Journal of Biological Macromolecules*. 2012;50(3):619-623. doi:10.1016/j.ijbiomac.2012.01.034
18. Epping J, Laibach N. An underutilized orphan tuber crop—Chinese yam : a review. *Planta*. 2020;252(4):1-19. doi:10.1007/s00425-020-03458-3
19. Srinivasan S, Pari L. Ameliorative effect of diosmin, a citrus flavonoid against streptozotocin-nicotinamide generated oxidative stress induced diabetic rats. *Chemico-Biological Interactions*. 2012;195(1):43-51. doi:10.1016/j.cbi.2011.10.003



**Deenathayalan Uvarajan and Brindha Durairaj**

20. Hsu CC, Lin MH, Cheng JT, Wu MC. Diosmin, a citrus nutrient, activates imidazoline receptors to alleviate blood glucose and lipids in type 1-like diabetic rats. *Nutrients*. 2017;9(7). doi:10.3390/nu9070684
21. Liu WY, Liou SS, Hong TY, Liu IM. The benefits of the citrus flavonoid diosmin on human retinal pigment epithelial cells under high-glucose conditions. *Molecules*. 2017;22(12). doi:10.3390/molecules22122251
22. Palsamy P, Subramanian S. Resveratrol protects diabetic kidney by attenuating hyperglycemia-mediated oxidative stress and renal inflammatory cytokines via Nrf2-Keap1 signaling. *Biochimica et Biophysica Acta - Molecular Basis of Disease*. 2011;1812(7):719-731. doi:10.1016/j.bbadis.2011.03.008
23. Ahmed AJ, Majeed SR, Obaid HM. Biochemistry and molecular cell biology of diabetic complications. *Systematic Reviews in Pharmacy*. 2020;11(11):850-860. doi:10.31838/srp.2020.11.124
24. Hensley K, Floyd RA. Reactive oxygen species and protein oxidation in aging: A look back, a look ahead. *Archives of Biochemistry and Biophysics*. 2002;397(2):377-383. doi:10.1006/abbi.2001.2630
25. Ahmed S, Mundhe N, Borgohain M, et al. Diosmin Modulates the NF- κ B Signal Transduction Pathways and Downregulation of Various Oxidative Stress Markers in Alloxan-Induced Diabetic Nephropathy. *Inflammation*. 2016;39(5):1783-1797. doi:10.1007/s10753-016-0413-4
26. Tomur A, Kanter M, Gurel A, Erboga M. The efficiency of CAPE on retardation of hepatic fibrosis in biliary obstructed rats. *Journal of Molecular Histology*. 2011;42(5):451-458. doi:10.1007/s10735-011-9350-6
27. Colares JR, Schemitt EG, Hartmann RM, et al. Antioxidant and anti-inflammatory action of melatonin in an experimental model of secondary biliary cirrhosis induced by bile duct ligation. *World Journal of Gastroenterology*. 2016;22(40):8918-8928. doi:10.3748/wjg.v22.i40.8918
28. Hoffmann A, Baltimore D. Circuitry of nuclear factor κ B signaling. *Immunological Reviews*. 2006;210:171-186. doi:10.1111/j.0105-2896.2006.00375.x
29. Imam F, Al-Harbi NO, Al-Harbi MM, et al. Diosmin downregulates the expression of T cell receptors, pro-inflammatory cytokines and NF- κ B activation against LPS-induced acute lung injury in mice. *Pharmacological Research*. 2015;102:1-11. doi:10.1016/j.phrs.2015.09.001
30. Lahouel M, Boulkour S, Segueni N, Fillastre JP. Effet protecteur des flavonoïdes contre la toxicité de la vinblastine, du cyclophosphamide et du paracétamol par inhibition de la peroxydation lipidique et augmentation du glutathion hépatique. *Pathologie Biologie*. 2004;52(6):314-322. doi:10.1016/j.patbio.2004.01.001
31. Mirshekar MA, Fanaei H, Keikhaei F, Javan FS. Diosmin improved cognitive deficit and amplified brain electrical activity in the rat model of traumatic brain injury. *Biomedicine and Pharmacotherapy*. 2017;93:1220-1229. doi:10.1016/j.biopha.2017.07.014
32. Liu X, Zhang X, Zhang J, et al. Diosmin protects against cerebral ischemia/reperfusion injury through activating JAK2/STAT3 signal pathway in mice. *Neuroscience*. 2014;268:318-327. doi:10.1016/j.neuroscience.2014.03.032
33. Joon Yau Leong Ranjith Ramasamy ASP. 乳鼠心肌提取 HHS Public Access. *Physiology & behavior*. 2017;176(5):139-148. doi:10.1016/j.jneuroim.2016.08.018. Diosmin
34. Bergan JJ, Schmid-Schönbein GW, Takase S. Therapeutic approach to chronic venous insufficiency and its complications: Place of Daflon® 500 mg. *Angiology*. 2001;52(8 SUPPL. 1):43-47. doi:10.1177/0003319701052001s06
35. Dholakiya SL, Benzeroual KE. Protective effect of diosmin on LPS-induced apoptosis in PC12 cells and inhibition of TNF- α expression. *Toxicology in Vitro*. 2011;25(5):1039-1044. doi:10.1016/j.tiv.2011.04.003
36. Shabani S, Mirshekar MA. Diosmin is neuroprotective in a rat model of scopolamine-induced cognitive impairment. *Biomedicine and Pharmacotherapy*. 2018;108(April):1376-1383. doi:10.1016/j.biopha.2018.09.127
37. Tong N, Zhang Z, Gong Y, Yin L, Wu X. Diosmin protects rat retina from ischemia/reperfusion injury. *Journal of Ocular Pharmacology and Therapeutics*. 2012;28(5):459-466. doi:10.1089/jop.2011.0218
38. 8265410.
39. Franke A, Teyssen S, Singer M V. Alcohol-related diseases of the esophagus and stomach. *Digestive Diseases*. 2006;23(3-4):204-213. doi:10.1159/000090167
40. Wallace JL, Keenan CM, Granger DN. Gastric ulceration induced by nonsteroidal anti-inflammatory drugs is a neutrophil-dependent process. *American Journal of Physiology - Gastrointestinal and Liver Physiology*. 1990;259(3 22-3). doi:10.1152/ajpgi.1990.259.3.g462





Deenathayalan Uvarajan and Brindha Durairaj

41. Halabi MF, Shakir RM, Bardi DA, et al. Gastroprotective activity of ethyl-4-[(3,5-di-tert-butyl-2-hydroxybenzylidene) amino]benzoate against ethanol-induced gastric mucosal ulcer in rats. *PLoS ONE*. 2014;9(5):14-16. doi:10.1371/journal.pone.0095908
42. Arab HH, Salama SA, Omar HA, Arafa ESA, Maghrabi IA. Diosmin protects against ethanol-induced gastric injury in rats: Novel anti-ulcer actions. *PLoS ONE*. 2015;10(3):1-21. doi:10.1371/journal.pone.0122417
43. Rajadurai M, StanelyMainzen Prince P. Preventive effect of naringin on isoproterenol-induced cardiotoxicity in Wistar rats: an in vivo and in vitro study. *Toxicology*. 2007;232(3):216-225. doi:10.1016/j.tox.2007.01.006
44. Sharmila Queenthy S, StanelyMainzen Prince P, John B. Diosmin Prevents Isoproterenol-Induced Heart Mitochondrial Oxidative Stress in Rats. *Cardiovascular Toxicology*. 2018;18(2):120-130. doi:10.1007/s12012-017-9422-2
45. Queenthy SS, John B. Diosmin exhibits anti-hyperlipidemic effects in isoproterenol induced myocardial infarcted rats. *European Journal of Pharmacology*. 2013;718(1-3):213-218. doi:10.1016/j.ejphar.2013.08.031
46. de Almeida GKM, Jesus ICG de, Mesquita T, et al. Post-ischemic reperfusion with diosmin attenuates myocardial injury through a nitric oxidase synthase-dependent mechanism. *Life Sciences*. 2020;258. doi:10.1016/j.lfs.2020.118188
47. Ali TM, Abo-Salem OM, el Esawy BH, el Askary A. The Potential Protective Effects of Diosmin on Streptozotocin-Induced Diabetic Cardiomyopathy in Rats. *American Journal of the Medical Sciences*. 2020;359(1):32-41. doi:10.1016/j.amjms.2019.10.005.

Table I Anti-Diabetic Properties of Diosmin

| Targets | Organisms | Results | References |
|------------------------|-----------------------------------|--|------------|
| Imidazoline receptors | Male Sprague Dwale Rats | Increased the secretion of beta β -endorphin | 20 |
| Human retinal pigments | Human retinal cell line (ARPE-19) | Decreased the expression levels of proinflammatory cytokines | 21 |

Table II Reports Available for Diosmin as a Neuroprotective Agent

| Targets | Organisms | Results | References |
|---|------------------|--|------------|
| Retina | Male Wistar Rats | Regulated oxidative parameters | 37 |
| NOX4(NADPH oxidase 4) and its sub units | Male Wistar Rats | Suppressed the expression of NOX4 and oxidative stress | 38 |

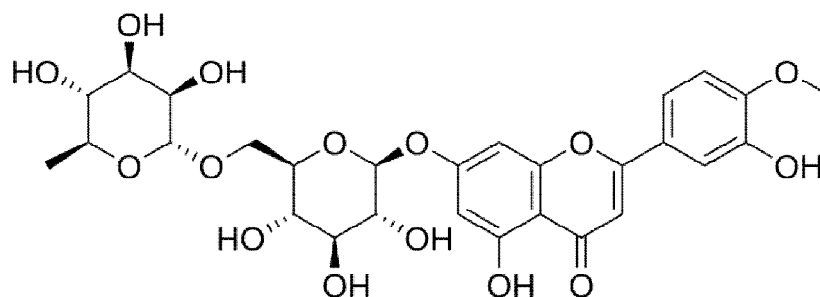


Fig I Chemical structure of Diosmin





An Efficient Monte Carlo for PET Imaging Simulation

Pabamane Dalej¹, P. K. Rath^{1*}, M. Swain¹, M. Mishra² and N. N. Deshmukh³

¹Centurion University of Technology and Management, Odisha, India.

²Saraswati Institute of IT & Management, VikashGroup of Institutatation, Bhawanipatna, Kalahandi - 766001

³School of Sciences, P PSavani University, Kosamba, Surat, Gujarat, India.

Received: 04 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

P. K. Rath

Centurion University of Technology and Management,
Odisha, India.

Email: prasanta.rath@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Medical imaging such as x-ray, MRI, PET (positron emission tomography) scan is an important diagnostic tool for various diseases and biochemical studies. Like x-ray which gives a transmitted image to see the bones PET provides a 2d image to locate the position of various conditions of trauma, cancer, heart problems and disorders related with brain. Normally a PET scan uses a radioactive active tracer. Most often injected into the vein within hand or arm. The tracer will mix with the blood stream and flow to the different parts of the body including the effected part which has a higher levels of metabolic or biochemical activity, which often pinpoints the location of the disease. The tracers are mostly ¹⁸F which emits beta particles. Those are annihilates and produces photons which are normally detected and the affected area are pin pointed. The main part of PET scan is the beta source, detection system and the image reconstruction technique. Here in this paper we have discussed the third point the image reconstruction method using a Monte Carlo technique.

Keywords: Histogram, 2d map, pseudo random number, efficiency

INTRODUCTION

Positron Emission Tomography (PET) is a imaging technique using nuclear physics into reality. This PET normally used to study and diagnose the metabolic activity and special type of diseases. This uses a positron emitting radionuclide normally ¹⁸F. The scan can be visualized and also quantitative result can be inferred. The nuclei which are proton reach normally undergo beta decay to come to stability line. Electron capture is also another mechanism but PET scan uses the decay of nuclei only through beta not EC. PET scan uses a radioactive element ¹⁸F which is a beta (positron) emitters. Once this radioactive element are mixed with blood through injection they move to different parts of the body and then the positron are vanish after striking the electron and produces two gamma ray of each





Pabamane Dalei et al.,

having energy 511 KeV. This is called annihilation gamma ray. These gamma ray moves in opposite direction and detected by the gamma camera (gamma detector). Once the two gamma are detected in coincidence a line of positron source can be reconstruct and accordingly all the image of the samples are crated. Coincidence detection of the gamma rays means the two gamma ray can be detected by the detector with same time or the time gap between them is very narrow. The coincidence detection of the back to back gamma ray is the key point of the PET image reconstruction.

SIMULATION AND RESULT

One of the main part of the PET [1] is the gamma detectors. The detectors are made of crystals which have high atomic numbers and densities; for example, bismuth germinate (BGO) Two detectors are said to be “in coincidence” when the events are detected by camera at almost the same time in both detectors. The detectors detects the coincidence events but this does not provide the image. Image can be constructed from the signals using special software (image reconstruction software). The image is a basically a 2d heat map which indicates the activity at different parts. The effects part mostly consume more blood flow from the others showing a high density points in the 2d map.

The radioactive tracer is normally randomly distributed in the blood flow and specially the emission of gamma occurs in random direction. So the randomness is the must for any simulation related to PET imaging. We have adopted Monte carol based simulation which generated the probability of events within the blood vein by using a sudo random number generators [2-3]. This generates the random number with zero repeating for one million events. For the simulation purpose a small experimental situation has been considered by taking a vein having length 30 mm and diameter 10 micrometer. Since the tracer mix with the blood randomly and then flow with the blood. Two different situation has been considered. Case-1 the random numbers were generated and thrown such that those which will fall within the vein has been considered for simulation. Bellow figure explains the situations.

Fig.1 (a) A 2d map [4] of the events generated by Case-I (see text for detail). One can see that more events are concentrated at centers and there are many location where the tracers are very less which is not a good situation for simulation because it has been assumed that the traces has been mixed with blood randomly and also the emission of gamma points are random in nature. [b] The same as (a) but for the Case-II. This provided more uniform distribution of the tracers inside the vein and also with higher statistics. Fig.1(a) shows the 2d map of this. By considering this approach only ~10% of the total events are falling within the vein as the solid angle of throw is very high. So a second method has been adopted. Case-II - all the random number having random location has been mixed with the blood within the vein and considered the source of gamma points. Fig.1 (b) shows the case -II which indicates more uniform distribution of the tracer which provided the higher statistics compared to Case-I.

CONCLUSION

From the above simulation one can see that Case-I can be considered as more closer approximation of practical operation but not effective one as the non-uniform distribution of the tracer is there and statistics is also less which makes the PET image not clear. Whereas Case-II is faster and provided more statistics which makes the image better as the uniformity in the distribution is there. So we considered this as effective generators for simulations.

ACKNOWLEDGMENT

The author express his gratitude to CUTM, PKD for the full support and also the author is very much thank full to Summer internship program of CUTM-PKD.





REFERENCES

1. Bailey DL, Townsend DW, Valk PE, Maysy MN (2005). *Positron Emission Tomography: Basic Sciences*. Secaucus, NJ: Springer-Verlag. ISBN 978-1-85233-798-8
2. Marsaglia, George; Zaman, Arif (1993). "The KISS generator". Technical Report, Department of Statistics, Florida State University, Tallahassee, FL, USA.
3. gfortran v 7.4 intrinsic random number generator. https://gcc.gnu.org/onlinedocs/gfortran/RANDOM_005fNUMBER.html
4. gnuplot demo script: heatmaps.dem (sourceforge.net)

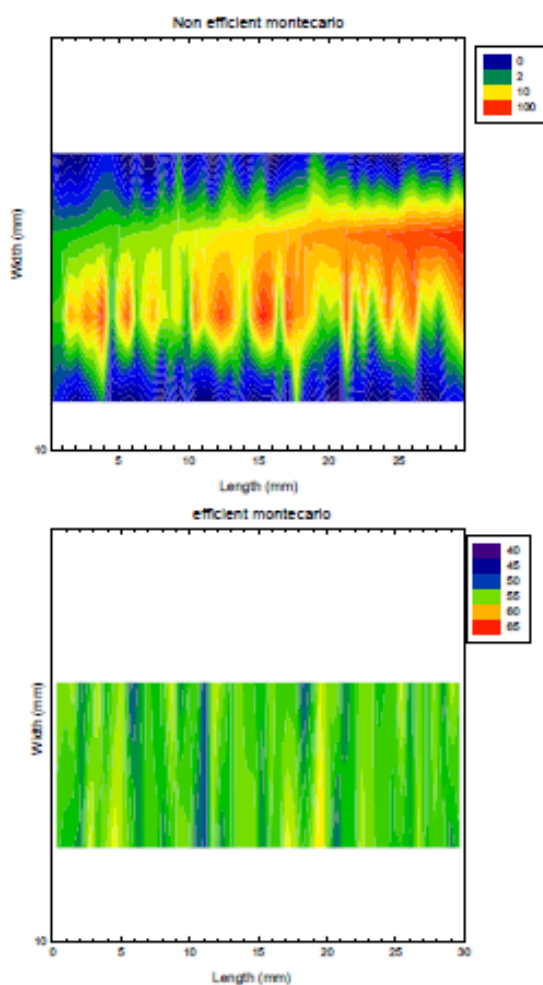


Fig 1 and 2





Liquid-Wall Mass Transfer in an Electrochemical Cell Having Conical Entry with an Immersed Single Sphere

U.S.N. Babu Bheemiseti¹, M.Vijay², G.V.S. Sarma³ and K.V. Ramesh^{3*}

¹Rajiv Gandhi RECS Polytechnic, Kasimkota – 531031, India

²Centurion University of Technology and Management, Odisha, India.

³Department of Chemical Engineering, Andhra University, Visakhapatnam-530003, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

K.V. Ramesh

Department of Chemical Engineering,

Andhra University,

Visakhapatnam-530003, India.

Email: kvramesh69@yahoo.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Investigation have been carried out experimentally to study the effect of single sphere along with conical entry on wall-to-liquid mass transfer coefficient in an electrochemical cell with homogeneous flow. The electrolyte was an equimolar solution of potassium ferricyanide and potassium ferrocyanide of 0.01N with 0.5 N sodium hydroxide as indifferent electrolyte. The reaction considered was the reduction of ferricyanide ion. The mass transfer coefficient was computed from the measured limiting current. It was found that the mass transfer coefficient increased with increasing liquid velocity and sphere diameter. Fluctuating behaviour of mass transfer coefficient was observed along the axial direction. Significant influence of the sphere location was observed on mass transfer coefficient. The entire experimental data on mass transfer coefficient have been correlated in terms of Colburn j-factor and Reynolds number.

Keywords: Mass transfer coefficient, limiting current, turbulent promoter, augmentation.

INTRODUCTION

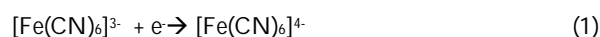
Vertical cylindrical columns are essential units in every chemical process industry. The inlet connections to these columns are generally given by conical shells. Hence there is a necessity of understanding the behavior of heat and mass transfer phenomena in these cylindrical columns with conical inlets. Also to increase heat and mass transfer rates, passive augmentation techniques are usually employed. Augmentation in these case occurs due to reduction in the resistance film thickness as an obvious result of modifying the flow path. Appreciable improvement in mass transfer coefficients were obtained in homogeneous flow in cylindrical conduits in the presence of promoter internals such as hemispheres[1], angled discs[2], twisted tapes[3], helical tape on a rod [4] and string of discs[5] etc. The





Babu Bheemiseti et al.,

sphere as a displaced promoter internal was found to be effective in mass transfer rate enhancement and several investigations have been reported in this direction [6-8]. However, investigations employing a sphere internal or enhancement of mass transfer rates in cylindrical conduits with conical inlet were found to be scarce [9]. In view of these observations the present work has been taken up. An electrochemical method has been considered for obtaining mass transfer coefficients. The liquid phase used was a fluid electrolyte of ferri-ferro redox system. Reduction of ferricyanide ion is carried out in the present experiment as per the following electrochemical reaction equation.



Mass transfer coefficient is calculated from measured limiting current using the equation

$$k_L = \frac{i_L}{nFAC_0} \quad (2)$$

In the present work the effects of flow rate of liquid, location of sphere and sphere diameter on mass transfer coefficient is investigated. An attempt has been made to develop generalized correlations through empirical modeling using dimensionless groups involving pertinent dynamic and geometric variables. The ranges of variables covered are compiled in Table.1.

EXPERIMENTAL

The schematic diagram of the experimental set-up used in the present studies was shown in Fig.1. The fluid electrolyte is prepared by adding calculated amounts of the chemicals to the distilled water. The concentrations of these chemicals in the electrolytes solution is ascertained using standard methods [10]. The electrolyte is taken in feed tank. Circulation of the electrolyte through the experimental unit was carried out with the help of pump and regulation of flow rate is made with valves arranged in the piping network. Flow rate is measured using calibrated rotameter.

The test section was a hollow cylindrical conduit with an inner diameter of 6.73 cm. The height of this section is 60 cm. Point electrodes were provided in such a way that one end of these electrodes was fixed even with the inner surface of the test section. Electrodes, 16 in number were arranged along the length of the test section at equal intervals. Each electrode has a diameter of 3.42 mm. The inlet to this test section is of conical shape with bottom inlet having a diameter of 2.54 cm. The measurement of the limiting current is carried out as per the procedure listed in detail by Harvind Kumar et al[11]. Metered fluid electrolyte is admitted into the conical section at the bottom. A single sphere mounted on a cylindrical rod essentially acted as a promoter element. This rod was fixed at the top side of the column structure.

RESULTS AND DISCUSSION

The experimental data obtained in the present investigation have been analyzed graphically in relation to various dynamic and geometric variables. Fig.2 gives the data of the present study plotted as mass transfer coefficient (k_L) against liquid velocity (U_L) for three cases of homogeneous flow through: (i) a conduit of circular cross section (Plot A), (ii) a conduit of circular cross section with conical entry (plot B), and (iii) the present experimental data obtained in a conduit of circular cross section with conical entry in the presence of a sphere on rod at a height of 20 cm (Plot C). The magnitudes of improvements over homogeneous pipe flow with conical entry with and without sphere promoter, obtained in the present experiment were shown in plots B and C. Plot A gives the data predicted from Lin et al [12] for the case of pipe flow with circular cross section. Whereas plot B shows the data obtained in the cylindrical electrochemical cell with conical entry. These data are found to be in good agreement with that of Ashok



**Babu Bheemiseti et al.,**

Kumar[13]. By placing a single sphere on a concentric rod, in the present study, the mass transfer coefficient data were obtained and plotted as shown in plot C. Plots A and B shows the improvements in mass transfer coefficient due to conical entry were upto 5 times on lower liquid velocity end and upto 2.5 times on higher liquid velocity end. The reason for this massive enhancement may be attributed to the generation of swirl flow in the test section. The swirl caused severe turbulence in the test section leading to reduced thickness of the resistance film. Reduction of thickness yielded lower values of mass transfer rates. Addition of single sphere on a rod, which acted as turbulent promoter in the present case resulted in additional turbulence which led to further reduction of the boundary layer thickness. Therefore, one can expect that higher values of mass transfer coefficient would result in this case. The experimental data shown in Plot C confirmed the same. A close examination of plots B and C shows that the improvements in mass transfer coefficient due to turbulence promoter, were upto 2 times on lower liquid velocity end and upto 1.2 times on higher liquid velocity end. Similarly, plots A and C shows the improvements in mass transfer coefficient over homogeneous flow, were upto 17 fold on lower liquid velocity end and upto 7 fold higher liquid velocity end. These observations indicate that the presence of present promoter element is definitely advantageous as it enhances turbulence resulting in increased mass transfer coefficient.

Longitudinal variation

Fig.3 shows the limiting current data obtained in the present experiment in the presence of single sphere depicting the variation in the longitudinal direction. The liquid velocity maintained was 0.0703 m/s and the sphere diameter was 4 cm. The sphere was placed even with the plane corresponding to the first electrode. This means, the maximum diameter of the sphere falls on this plane. One can now expect that the maximum value of limiting current density would be obtained at the electrode which is arranged even with this plane. Since the sphere acts as a bluff body, it can be anticipated that the limiting current would be fluctuating at all other electrodes as one travels along the axial direction away from the sphere. The trends seen in this figure are as per these expectations.

Effect of longitudinal distance of sphere element

Fig.4 shows the mass transfer coefficient data plotted against axial length for variation of placement of sphere element. The liquid velocity was maintained at 0.0328 m/s and the diameter of the sphere element is taken as 4 cm. The placement of the sphere element is varied from 0 cm to 50 cm. In all these cases the maximum diameter of the sphere is arranged in even with the respective electrode. A close examination of the plots of this figure reveals that the bottom most electrode has shown highest value of mass transfer coefficient, and all remaining electrodes yielded more or less uniform value for every case that is considered. Also, for the case of placement of sphere in line with first electrode, nearly highest value of mass transfer coefficient was realized at each electrode along the longitudinal direction.

Effect of liquid velocity

Fig.5 shows the mass transfer coefficient plotted against axial distance for varied liquid velocities when sphere dia was taken as 4 cm and height maintained at 10 cm. It can be seen from the plots of this figure that maximum mass transfer coefficient could be obtained corresponding to a liquid velocity of 0.178 m/s. In the present case the contribution to the turbulence is from conical entry, liquid velocity, diameter of sphere and location of the sphere. When others are fixed, it is only the liquid velocity that varies. As one can understand that the turbulent intensity varies with increase in liquid velocity. Hence one can anticipate that maximum mass transfer coefficient could be realized for the highest liquid velocity. The same observation has been seen from the graph also.

Effect of sphere diameter

Fig.6 shows the mass transfer coefficient data plotted against liquid velocity for three different sphere diameters. A close examination of the plots of this figure reveals that the mass transfer coefficient increased with increase in sphere diameter. As the sphere diameter increases the flow area available for the liquid would be less and hence the local liquid velocity would be higher. This leads to the reduction of the resistance film thickness hence higher values of mass transfer coefficient would be realized with increase in sphere diameter. The same observation could also be seen from the inset fig. 6a also.





Babu Bheemiseti et al.,

Correlation

It has been observed from the literature that many investigators have correlated their data in wall-liquid mass transfer studies in the $j_D - N_{Re}$ format of equations. So, the authors also made an effort to correlate the entire data obtained in the present study in terms of the $j_D - N_{Re}$ format and obtained the following equation by regression analysis:

$$j_d = 6.022N_{Re}^{-0.665} \left(\frac{d_b}{D_c} \right)^{0.51} \left(\frac{H}{H_{max}} \right)^{-0.05} \quad (3)$$

Average deviation = 6.742%

Standard deviation = 8.162%

By defining $Y_1 = j_d \left(\frac{d_b}{D_c} \right)^{-0.51} \left(\frac{H}{H_{max}} \right)^{0.05}$ (4)

a correlation plot has been drawn between Y_1 and N_{Re} and shown in Fig.7.

CONCLUSIONS

The present investigation is carried out to study the influence of conical entry and single sphere insert promoter element on wall-liquid mass transfer coefficient in an electrochemical cell of circular cross section with conical entry. The following conclusions were observed from this study:

- (i) A maximum of 17 fold augmentation in mass transfer coefficient is obtained in the present experiment with conical entrance along with single sphere internal, when compared against the plain pipe data.
- (ii) The mass transfer coefficient exhibited fluctuations along the longitudinal direction.
- (iii) Significant variation in mass transfer coefficient is observed with the distance of the sphere placed in the axial direction.
- (iv) Mass transfer coefficient increased with increase in liquid velocity and sphere diameter.

A correlation in $j_D - N_{Re}$ format has been obtained which is useful for predicting mass transfer coefficient.

Notation

| | | |
|-------|---------------------------|-------|
| k_L | Mass transfer coefficient | [m/s] |
| i_L | Limiting current | [mA] |
| U_L | Liquid velocity | [m/s] |
| j_D | Mass transfer factor | [-] |
| d_b | Sphere diameter | [m] |
| D_c | Diameter of column | [m] |
| H | Longitudinal distance | [m] |

REFERENCES

1. G.V.S.K. Reddy, M.S.N. Murty, B.Srinivas, and K.V. Ramesh, "Liquid-wall mass transfer in homogeneous flow with coaxially placed string of hemispheres", Journal of The Institution of Engineers (India): Series E, Vol. 95, No. 2, 2014, pp. 69-74.
2. B. NiranjanaRao, B.S.G. Ramaprasad, M.S.N. Murty, and K.V. Ramesh, "Mass transfer at the confining wall of an electrochemical cell in the presence of angled disc promoter", American Journal of Heat and Mass Transfer, Vol. 1, No. 3, 2014, pp. 113-129.





Babu Bheemiseti et al.,

3. B.S. Subramanyam, M.S.N. Murty, B. Surendra Babu, and K.V. Ramesh, "Mass transfer at the confining wall of an electrochemical cell in the presence of twisted tapes", The IUP Journal of Chemical Engineering, Vol. 3, No. 1, 2011, pp. 23-34.
4. V. Sujatha, C. Bhaskara Sarma, and G.J.V. Jagannadha Raju, "Performance of helical tape promoter in fluidized beds", ChemEng Processing, Vol. 36, 1997, pp. 67.
5. P. Venkateswarlu, T. Gopichand, and G.J.V. Jagannadha Raju, "Increased Mass Transfer in a circular column in the presence of Disc Promoter", Journal of Energy, Heat and Mass Transfer, Vol. 22, 200, pp.195-203.
6. T.S. Sitaraman, "Augmentation of mass transfer by coaxial string of spheres as internal in tubes and fluidized beds", Ph.D. thesis, University of Madras, Madras, India, 1977.
7. P. Rohini Kumar, K. Ashok Kumar, P. Venkateswarlu, and K.V. Ramesh, "Wall-to-bulk mass transfer in cocurrent upflow bubble column with coaxially placed string of spheres", Am. J. Heat Mass Transfer, Vol.3, No. 4, 2016, pp. 225-237.
8. P. Rohini Kumar, B. Niranjana Rao, P. Venkateswarlu, and K.V. Ramesh, "Wall-to-bed mass transfer in a three phase fluidized bed with coaxially placed string of spheres internal", Materials Today Proceedings, Vol. 5, 2018, pp. 470-476.
9. C. Bhaskara Sarma, K. Ashok Kumar, R. Bhavani, G.V.S. Sarma, K.V. Ramesh, "Mass transfer in the presence of single sphere in an electrochemical cell with conical entry", Paper No. RACE 2020-009-IHMT-3, Presented in the conference RACE, Osmania University, Hyderabad, India, 2020.
10. J. Mendham, R.C. Denney, J.D. Barnes, and M.J.K. Thomas, "Vogel's textbook of quantitative chemical analysis", 6/e, Pearson Education, New Delhi, 2007.
11. R. Harvind Kumar, K.V. Ramesh, G.V.S. Sarma, and G.M.J. Raju, "Mass transfer at the confining wall of helically coiled circular tubes in the absence and presence of packed solids", International Communications in Heat and Mass Transfer, Vol. 38, 2011, pp. 319-323.
12. C.S. Lin, E.B. Denton, H.S. Gaskill, and C.L. Putan, "Diffusion controlled electrode reactions", Ind. Eng. Chem., Vol. 43, 1951, pp. 2136-2143.
13. K. Ashok Kumar, "Liquid-wall mass transfer in non-conventional flow systems", Ph.D. thesis, Andhra University, Visakhapatnam, 2021.

Table.1: Range of variables covered in the present study

| S.No. | Parameters studied | Minimum | Maximum |
|-------|--|---------|---------|
| 1 | Flow rate of liquid ($Q_L \times 10^3$), m ³ /s | 0.0328 | 0.178 |
| 2 | Diameter of the sphere (d_b), mm | 0.03 | 0.05 |
| 3 | Location of the sphere, (H), cm | 0 | 50.0 |





Babu Bheemiseti et al.,

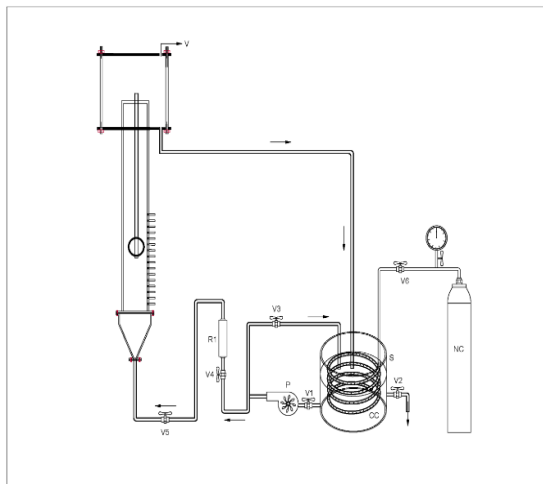


Fig.1. Schematic diagram of experimental unit

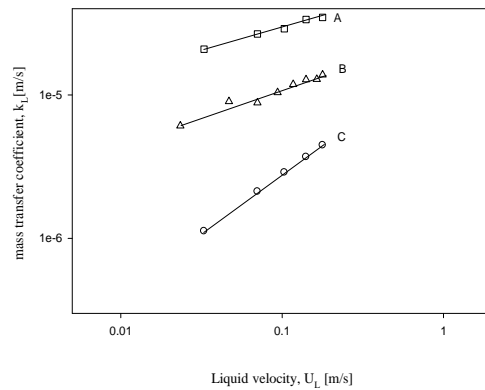


Fig.2. Augmentation of mass transfer coefficient. H = 20 cm; $d_b = 4$ cm.

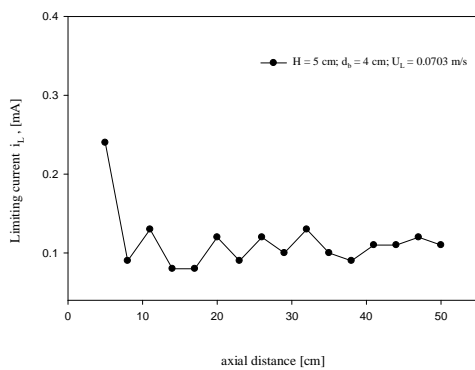


Fig.3. Variation in limiting current with distance

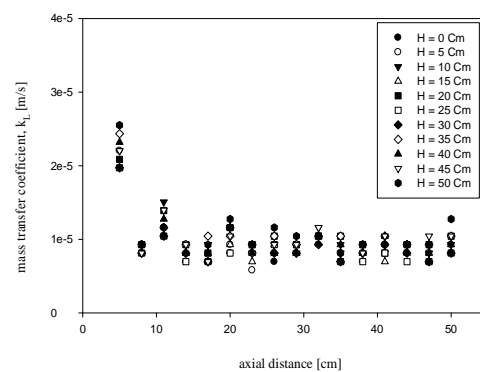


Fig.4. Variation in mass transfer coefficient with distance for sphere dia = 4 cm and $U_L = 0.0328$ m/s

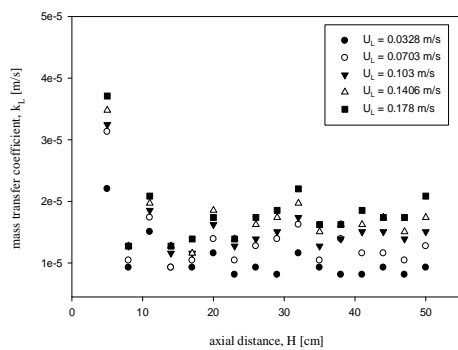


Fig.5. Variation in mass transfer coefficient with axial distance for sphere dia = 4 cm and height = 10 cm

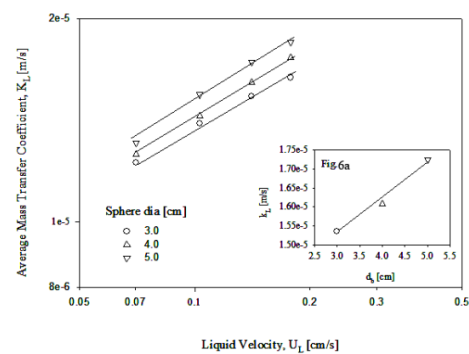


Fig.6. Variation in avg mass transfer coefficient with liquid velocity; at H = 20 cm





Babu Bheemiseti et al.,

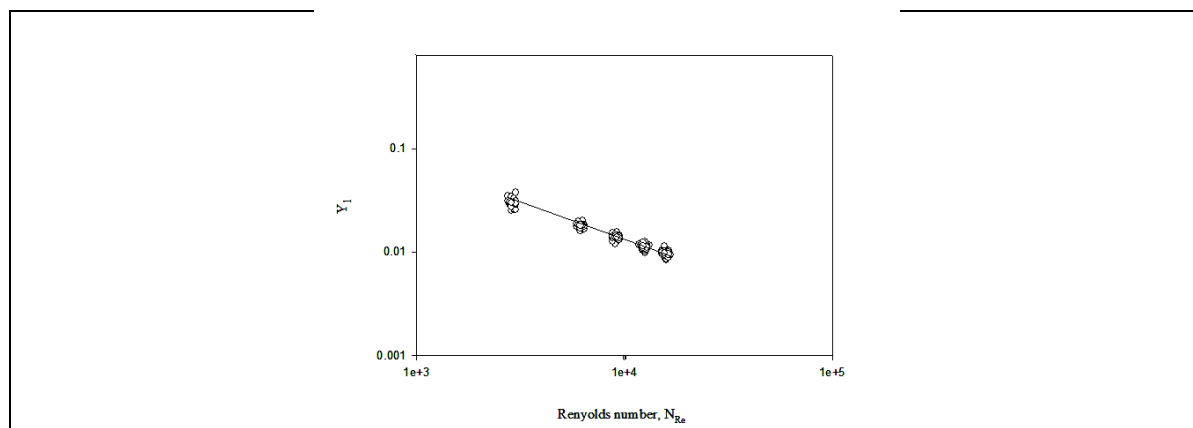


Fig.7. Correlation plot in accordance with eqn.(3)





Effect of Double Cone Element on Mass Transfer in an Electrochemical Cell with Conical Entry

M.Vijay^{1*}, U.S.N. Babu Bheemiseti², G.V.S. Sarma³ and K.V. Ramesh³

¹Centurion University of Technology and Management, Odisha, India.

²Rajiv Gandhi RECS Polytechnic, Kasimkota – 531031, India

³Department of Chemical Engineering, Andhra University, Visakhapatnam-530003, India

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

M.Vijay

Centurion University of Technology and Management,
Odisha, India.

Email: vijay.meditana@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Limiting current measurements made at the copper electrodes fixed flush with the inner surface of the outer cylinder of an electrochemical cell facilitated the computation of the mass transfer coefficients in the present study. The investigations have been carried out experimentally to study the effect of a single double cone element along with conical entry on wall-to-liquid mass transfer coefficient in an electrochemical cell with homogeneous flow. The electrolyte was an equimolar solution of potassium ferricyanide and potassium ferrocyanide of 0.01 N with 0.5 N sodium hydroxide as indifferent electrolyte. The reaction considered was the reduction of ferricyanide ion. It was found that the mass transfer coefficient increased with increasing liquid velocity and double cone diameter. Fluctuating behavior of mass transfer coefficient was observed along the axial direction. Significant influence of the double cone location was observed on mass transfer coefficient. The entire experimental data have been correlated in terms of Coulburn J-factor and Reynolds number.

Keywords: Mass transfer coefficient, limiting current, internal promoter, doublecone.

INTRODUCTION

The crucial units in every chemical process industry are vertical cylindrical columns. Conical shells are normally employed to give the inlet connections to those cylindrical columns. So, understanding the heat and mass transfer phenomenon in the cylindrical columns that are using conical inlets is necessary. To increase the heat and mass transfer rates, the passive augmentation techniques are employed which reduce the resistance film thickness by modifying the flow path. Magnitudes of improvements in mass transfer coefficients were obtained in homogeneous flow in the presence of promoter internals and specifically double cone as a displaced promoter internal was found to be effective in mass transfer rate enhancement and hence several investigations have been reported in this

42731

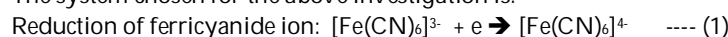




Vijay et al.

direction [1-3]. In all these investigations, the mass transfer between the column wall and the flowing liquid electrolyte has been measured using limiting current technique. However, the use of immersed double cone element along with conical entrance to obtain enhancement in mass transfer rates in electrochemical cells was scarcely investigated. In view of this, an attempt is made to study the effect of an immersed double cone assembly in homogeneous flow with conical entry. The electrochemical system employed for the present investigation belonged to the ferricyanide-ferrocyanide redox system in the presence of sodium hydroxide as indifferent electrolyte. The electrochemical reaction chosen for the present study is the reduction of ferricyanide ion.

The system chosen for the above investigation is:



The mass transfer coefficients were evaluated from the following equation:

$$k_L = \frac{i_L}{nAFC_0} \quad \dots (2)$$

An attempt has also been made to develop generalized correlations through empirical modelling using dimensionless groups involving pertinent dynamic and geometric variables.

Experimental

The schematic diagram of the experimental set-up used in the present studies was shown in Fig.1. About 50 liters of equimolar solution of potassium ferrocyanide and potassium ferricyanide of about 0.01 N and 0.5 N of sodium hydroxide were prepared from analytical grade reagents using distilled water of 5 $\mu\text{S}/\text{cm}$ specification and these were used as the electrolyte. The solution was deaerated using nitrogen prior to recirculation through the test section. The electrolyte from the storage tank was metered and circulated through the test section. Flow rate has measured using calibrated rotameter. The entrance section was made of a copper shaped in conical form with a maximum inner diameter of 6.73 cm which is in contact with test section and minimum diameter of 2.54 cm which is connected to the pipe inlet. The inlet provided at the bottom of the entrance conical section facilitates the flow of the metered fluid electrolyte. A single double cone element mounted on a cylindrical rod essentially acted as a promoter element. The test section, which served as the electrochemical cell, was made of smooth perspex tube of 6.73 cm inner diameter and 0.6 m height. The inner wall of the test section was provided with copper point electrodes of diameter 3.42 mm. The point electrodes 16 in number were machined to the size out of 4 mm diameter copper rod. One end of these electrodes was fixed flush with the surface of the inner wall of the test section while the other end projected outward served as terminal for connecting the electrodes to the external circuit. The exit section was also of the same diameter as A and B with its open end into the atmosphere. Open end was provided such that fluid electrolyte from the test section was drawn from the bottom of the exit section (D). The measurement of limiting current was made in the lines similar to those reported earlier in the studies on ionic mass transfer [4, 5].

RESULTS AND DISCUSSION

The experimental data obtained in the present investigation have been analyzed graphically in relation to various dynamic and geometric variables. Fig.2 gives the data of the present study plotted as limiting current density (i_a) against liquid velocity (U_L) for three cases: (i) homogeneous flow in circular conduct [5], (Plot A); (ii) homogeneous liquid flow through empty column with conical entry [6], (plotB); and (iii) the present experimental data of homogeneous liquid flow with conical entry in the presence of a double cone on rod at a height of 20 cm, (Plot C). The magnitudes of improvements over homogeneous circular flow obtained in the present experiment were shown in plots B and C. Plot A gives the data predicted from Lin et al [5] for the case of pipe flow with circular cross section. Whereas plot B shows the data obtained in the cylindrical electrochemical cell with conical entry. These data are found to be in good agreement with that of Ashok Kumar[6]. By placing a single double cone element on a concentric rod in the present study, the limiting current density data were obtained and plotted as shown in plot C. Plots A and B shows the improvements in limiting current density, i_a due to conical entry were upto 5 times on lower liquid velocity end and upto 2.5 times on higher liquid velocity end. The reason for this massive enhancement may



**Vijay et al.**

be attributed to the generation of swirl flow in the test section. The swirl caused severe turbulence in the test section leading to reduced thickness of the resistance film. Reduction of thickness yielded lower values of mass transfer rates. Addition of single sphere on a rod, which acted as turbulent promoter in the present case resulted in additional turbulence which led to further reduction of the boundary layer thickness. Therefore, one can expect that higher values of mass transfer coefficient would result in this case. The experimental data shown in Plot C confirmed the same. A close examination of plots B and C shows that the improvements in limiting current density, i_{d} due to turbulence promoter, were upto 2 times on lower liquid velocity end and upto 1.2 times on higher liquid velocity end. Similarly, plots A and C shows the improvements in limiting current density over homogeneous flow, were upto 17 fold on lower liquid velocity end and upto 7 fold higher liquid velocity end. These observations indicate that the presence of present promoter element is definitely advantageous as it enhances turbulence resulting in increased limiting current density, i_{d} .

Longitudinal Variation

Fig.3 shows the limiting current data obtained in the present experiment in the presence of single sphere depicting the variation in the longitudinal direction. The liquid velocity maintained was 0.0703 m/s and the double cone diameter was 4 cm. The double cone was placed even with the plane corresponding to the first electrode. This means, the maximum diameter of the double falls on this plane. One can now expect that the maximum value of limiting current density would be obtained at the electrode which is arranged even with this plane. Since the double cone acts as an obstruction to flow, it can be anticipated that the limiting current would be fluctuating at all other electrodes as one travels along the axial direction away from the sphere. The trends seen in this figure are as per these expectations.

Effect Of Longitudinal Distance Of Double Element

Fig.4 shows the mass transfer data plotted against axial length for variation of placement of double cone element. The liquid velocity was maintained at 0.0328 m/s and the diameter of the double cone element is taken as 4 cm. The placement of the double cone element is varied from 0 cm to 50 cm. In all these cases the maximum diameter of the double cone is arranged in even with the respective electrode. A close examination of the plots of this figure reveals the following observations:

- i. Whatever may be the location of the double cone element, the maximum value of mass transfer coefficient was found to obtain for the location of 0 cm almost at every electrode.
- ii. The first electrode has shown highest value of mass transfer coefficient, and all remaining electrodes yielded more or less uniform value

Effect Of Liquid Velocity

Fig.5 shows the mass transfer coefficient plotted against distance for varied liquid velocities when doublecone dia was taken as 4 cm and height maintained at 10 cm. It can be seen from the plots of the figure that maximum mass transfer coefficient could be obtained corresponding to a liquid velocity of 0.178 m/s (38 lpm). In the present case the contribution to the turbulence is from conical entry, liquid velocity, diameter of doublecone and height of the doublecone. When others are fixed, it is only the liquid velocity that varies. As one can understand that the turbulent intensity varies with increase in liquid velocity. Hence one can anticipate that maximum mass transfer coefficient could be realized for the highest liquid velocity. The same observation has been seen from the graph also.

Effect of Doublecone Diameter

Fig.6 shows the mass transfer coefficient data plotted against liquid velocity for three different doublecone diameters. A close examination of the plots of this figure reveals that the mass transfer coefficient increased with increase in doublecone diameter. As the doublecone diameter increases the flow area available for the liquid would be less and hence the local liquid velocity would be higher. This leads to the reduction of the resistance film





Vijay et al.

thickness hence higher values of mass transfer coefficient would be realized with increase in doublecone diameter. The same observation could also be seen from the inset fig. 6a also.

Correlation

It has been observed from the literature that many investigators have correlated their data in wall-liquid mass transfer studies in the $j_D - Re$ format of equations. So, the author also made an effort to correlate the entire data obtained in the present study in terms of the $j_D - Re$ format and obtained the following equation by regression analysis:

$$j_D = 6.022Re^{-0.665} \left(\frac{d_b}{D_c}\right)^{0.51} \left(\frac{H}{H_{max}}\right)^{-0.05} \quad \dots(3)$$

Average deviation = 6.742%

Standard deviation = 8.162%

The correlation plot according to equation (3) has been plotted and shown in Fig.7 by plotting Y_1 on y-axis and Re on x-axis. Y_1 is defined as

$$Y_1 = j_D \left(\frac{d_b}{D_c}\right)^{-0.51} \left(\frac{H}{H_{max}}\right)^{0.05}$$

CONCLUSIONS

The present investigation is carried out to study the influence of conical entry and single doublecone insert promoter element on wall-liquid mass transfer coefficient in an electrochemical cell with conical entry. The following conclusions were observed from this study:

- (i) A maximum of 17-fold augmentation in mass transfer coefficient is obtained in the present experiment with conical entrance along with doublecone element, when compared against the plain pipe data.
- (ii) The mass transfer coefficient exhibited fluctuations along the longitudinal direction.
- (iii) Significant variation in mass transfer coefficient is observed with the distance of the doublecone placed in the axial direction.
- (iv) Mass transfer coefficient increased with increase in liquid velocity and doublecone diameter.
- (v) A correlation in $j_D - Re$ format has been obtained which is useful for predicting mass transfer coefficient.

Nomenclature

| | | |
|----------------|---|------------------------|
| A | = area of the reacting surface | [m ²] |
| C ₀ | = concentration of reacting ion (Fe ²⁺ or Fe ³⁺) | [kmol/m ³] |
| E | = applied potential | [V] |
| F | = Faraday constant | [C] |
| i | = current | [A] |
| i_L | = limiting current | [A] |
| k_L | = mass transfer coefficient | [m/s] |
| n | = number of electrons released or consumed during the reaction | [-] |
| U _L | = superficial liquid velocity | [m/s] |

REFERENCES

1. S. Sarveswara Rao, "Studies on ionic mass transfer with co-axially placed cones on a rod (CPCR internal) in homogeneous fluid and fluidized beds", Ph.D Thesis, Andhra University, Visakhapatnam (1983).





Vijay et al.

2. M.Vijay, G. V. S. K. Reddy,D.V.S.L.Deepthi, K.V. Ramesh, "Mass transfer in an electrochemical reactor in the presence of a string of doublecones with gas-liquid flow systems", JP Journal of Heat and Mass Transfer, 17(1), 47-57 (2019).
3. M. Vijay, G. V. S. K. Reddy, M. Kusuma, K.V.Ramesh, "Wall-to-bed mass transfer in a three-phasefluidized bed electrochemical reactor with an internal", JP Journal of Heat and Mass Transfer, 17(2), 399-409 (2019).
4. R. Harvind Kumar, K.V. Ramesh, G.V.S. Sarma, G.M.J. Raju, "Mass transfer at the confining wall of helically coiled circular tubes in the absence and presence of packed solids", International Communications in Heat and Mass Transfer, 38, 319-323 (2011).
5. C.S. Lin, E.B.Denton, H. S.Gaskill and G. L.Putnan, "Diffusion controlled electrodeReactions", Ind. Eng. Chem., 43(9), 2136-2143(1951).
6. K.Ashok Kumar, "Liquid-wall mass transfer in non- flow systems", Ph.D thesis, A.U, Visakhapatnam, (2021).

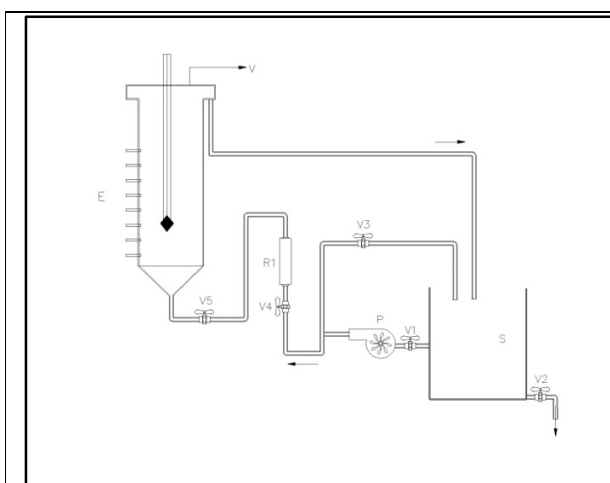


Fig.1. Schematic diagram of experimental unit

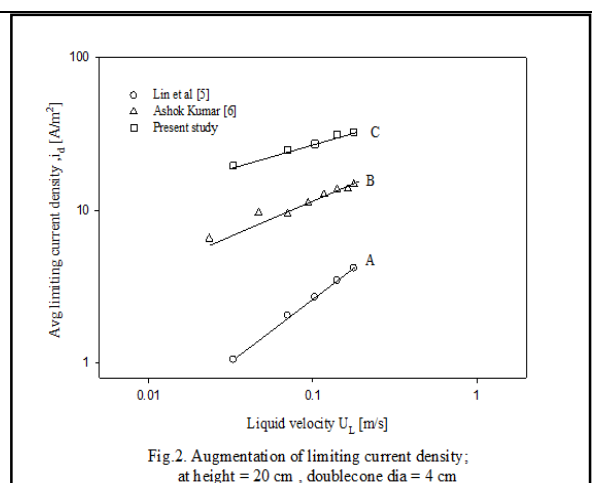


Fig. 2. Augmentation of limiting current density; at height = 20 cm , doublecone dia = 4 cm

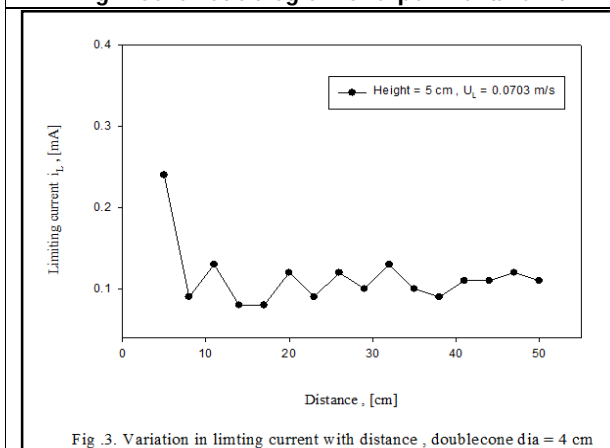


Fig .3. Variation in limiting current with distance , doublecone dia = 4 cm

Fig.3. Variation in limiting current with distance

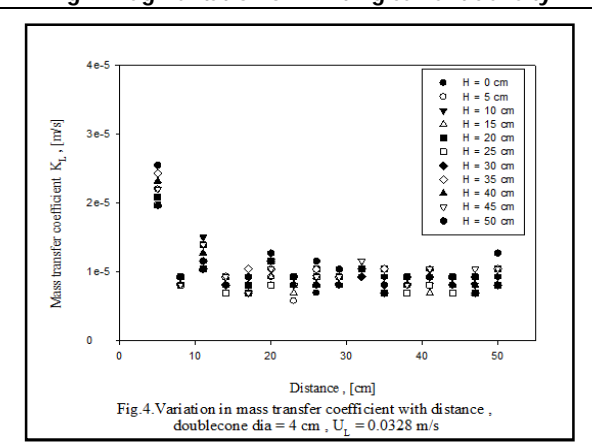


Fig.4.Variation in mass transfer coefficient with distance , doublecone dia = 4 cm , $U_L = 0.0328$ m/s

Fig.4. Variation in mass transfer co efficient with distance





Vijay et al.

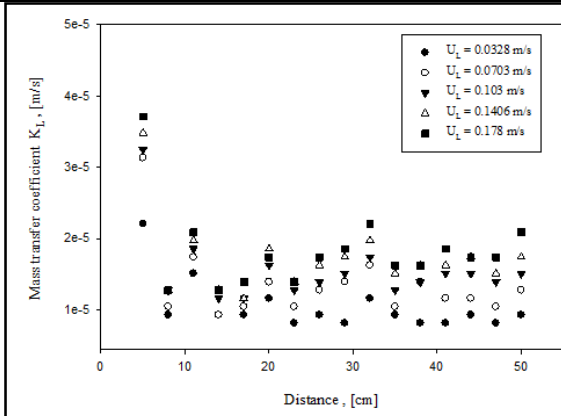


Fig.5. Variation in mass transfer coefficient with distance, doublecone dia = 4 cm, height = 10 cm

Fig.5. Variation in mass transfer coefficient with distance, double cone

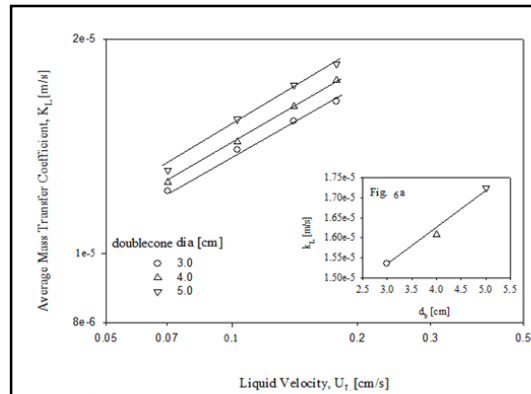


Fig. 6. Variation in Avg mass transfer coefficient with liquid velocity, doublecone height = 20 cm

Fig.6, Variation in Avg mass transfer coefficient with liquid velocity, doublecone height = 20 cm

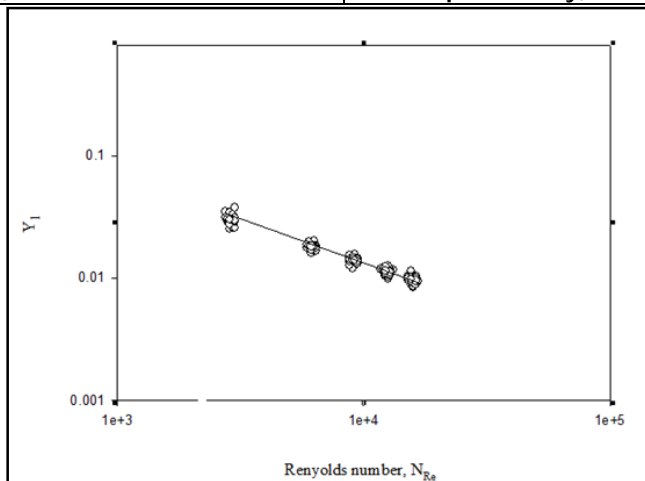


Fig. 7 . Variation in Y_1 with Reynolds number, N_{Re}

Fig.7 Variation in Y_1 with Reynolds number N_{Re}





The Role of Text Summarization in Automatic Sentences Selection for Generating Valid Multiple-Choice Questions

Dhawaleswar Rao CH*

Department of Computer Science and Engineering, Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Dhawaleswar Rao CH

Department of Computer Science and Engineering
Centurion University of Technology and Management
Odisha, India
Email: dhawaleswarrao@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Traditional education will not be able to match the expectations and needs of a Smart City; it will require more advanced kinds of education such as active learning, ICT education, and so on. Multiple choice questions (MCQs) are useful in educational evaluation and active learning, both of which are crucial aspects of Smart City education. MCQs are useful for assessing comprehension of well-defined ideas. A small percentage of a text's sentences include well-defined concepts or information that may be posed as a multiple-choice question. To prepare multiple choice questions manually or mechanically, these informative statements must first be discovered. The volume of text data from various sources has increased dramatically in recent years. This volume of content is a valuable source of information and expertise that must be neatly summarised for usage. The two automated description approaches are extraction and abstraction. To recognise the most relevant phrases in a document or document collection, extractive text summarization uses the idea of sentence salience. The presence of particular significant words or resemblance to a pseudo-sentence centroid are usually used to determine salience.

Keywords: Automatic question generation, Quality Education, Education for sustainability, Learning opportunities, Literacy skills

INTRODUCTION

According to UN SDG (United Nations Sustainable Development Goals), since 2000, there has been a gradual enhancement in universal primary education and also in the literacy rates [19]. People are overwhelmed by the tremendous amount of knowledge and documents available online, thanks to the Internet's rapid expansion. The increasing availability of documents has necessitated much study in the field of automated text summarization. "A



**Dhawaleswar Rao et al.**

text constructed from one or more texts communicating key features in the original text(s), not more than half of the original text(s), and frequently much less than the original text" [1]. With the expansion of online publication, a large number of internet users, and the rapid growth of e-government, the necessity for text summary has developed. Due to the fast growth of information and communication technology, a huge number of electronic documents are now available online, making it difficult for users to find essential information [13, 11]. Furthermore, the internet has generated large text collections on a variety of themes. The redundancy of open on-line texts can be explained in this way. Users may overlook crucial and fascinating articles because they are bored of reading a big volume of texts. As a result, in this century, a robust book list architecture is now necessary. These strategies will condense nuances into a more concise, reasonable depiction based on several archives [10, 36, 4, 32]. Plagiarism detection is important in a variety of applications, including file management, copyright protection, and plagiarism prevention. Current protocols assume that the contents of files stored on a server may be accessed directly. More practical applications, such as detecting plagiarised materials across two conferences with sensitive submissions, are limited by this approach. Plagiarism can take several forms, including duplicating the entire text or sections of it, rewording the same content in new words, borrowing ideas from others, or referring to erroneous or non-existent sources.

The task of creating a brief and fluent description while keeping the major information and significance of the material is known as automatic text summary. In recent years, a slew of automated text summarising algorithms have been created and widely used in a variety of fields. For example, search engines create snippets as document previews [2]. Other examples are news websites that produce succinct explanations of news concerns in the form of headlines to encourage searching or extractive knowledge techniques [3, 17]. Automatic text summarization is problematic because, when we humans summarise a piece of text, we usually read it completely to increase our understanding before writing an analysis highlighting the major points. Because computers lack human understanding and the capacity to speak language, automated text evaluation is a tough and time-consuming task. Automatic text summarization has been a popular topic since the 1950s. The summarization of scientific publications has been prominent research in recent years.

Related Work

Separating the outlines into extracts and abstracts summarization is possible. The abstract summary formed by reformulating sentences from the information text is distinctive, as is the removal of phrases from the source text [12, 14]. The summarising method may also be divided into two types: traditional and question-based. Summarization based on an inquiry yields findings that are typically relevant to client requirements, with a general importance of the report content introduced as overall document content [28]. To summarise, Goldstein [15] listed a number of metrics, including construct, kind, purpose, number of summarised documents, document length, user objective, genre, presentation, source language, and quality. The preprocessing stage in the main technique is to reduce the dimensionality of the depiction space, and typically includes stop-word removal, case collapsing, and stemming [29]. The concept of a reference summary is important because, when we consider its temperament, the capability of computerised rundown age methods can be objectively tested using standard data recovery accuracy and review processes. Extrinsic or exterior plagiarism detection and intrinsic or internal plagiarism detection are the two most common automated plagiarism detection approaches. Extrinsic plagiarism detection looks for plagiarism in a corpus connection to one or more source documents. The goal of this work is to leverage the computer's capacity to search a corpus for similar papers and retrieve documents that may be plagiarised. Intrinsic plagiarism detection examines occurrences of plagiarism in isolation, looking for potentially suspect materials. We'll discuss the success of several category-based summaries depending on the elements that determine the type of summarising.

Single Document And Multi-Document

These are the two main types of summarising, which differ depending on the number of records [18, 21, 19, 22, 28]. When a document is too extensive to consider reading through in detail, or when a customer is in a hurry to get a





Dhawaleswar Rao et al.

quick overview of its contents, a summary of the report in question looks to be really beneficial. As a result, single record structure is a prominent research topic.

Extractive Summarization And Abstractive Summarization

Extract summaries are constructed by selecting a few key lines from the original material and arranging them in an extractive outline structure [24, 22, 20, 25, 30]. The length of a representation is determined by the pressure rate. It's a simple yet effective text summarising technique. Sentences are given some saliency scores in the papers, and then the most deeply scored sentences are picked to convey the description.

Supervised And Unsupervised

Training data is necessary in a supervised system for extracting important material from documents [26, 23, 31, 22]. Large amounts of tagged or annotated data are used in the learning processes. These structures are explored at the sentence level as a two-class classification issue, with positive samples referring to sentences in the summary and negative samples referring to sentences not in the summary. In contrast, unsupervised systems do not require any training data [22, 33].

Internet Based Summarization

On the internet, users now have access to a wealth of information. Every year, the number of web pages on the internet doubles. Some search engines, such as Google Quick, Alta Vista, and others, assist users in finding information, but they provide a list of a significant number of web pages for a single query [27, 34, 30].

E-Mail Based

E-mail summarization is a common type of overview in which e-mail communications are summarised. E-mail has become a popular method of communication due to its quick delivery and low cost. Emails continue to arrive in the inbox as a result of the email overload problem, and a significant amount of time is spent reading, processing, and archiving the incoming emails [37].

METHODOLOGY

Experimental Design

The techniques used to design the system's primary components are now addressed. The system is divided into numerous modules, each of which employs a variety of methodologies, which are listed below. Long phrases may be challenging for students to comprehend or memorise. Multiple facts are frequently found in complex and compound phrases. One FIB or MCQ question, on the other hand, usually deals with a single fact. As a result, concise statements are preferable from a questioning standpoint as well. As a result, the system breaks down difficult and convoluted statements into simple ones. Analyzing the dependence parse structure of the sentences is used to convert them. A text's sentences do not all include a problematic fact. The goal of this stage is to find phrases that may be used to build questions. These phrases are given a lot of weight. In this arena, names are extremely important. One or more names appear in the majority of the informative sentences. If a statement contains a name, it is more likely to contain a fact. As a result, this is the major criterion for sentence selection. However, the presence of a named thing in a sentence alone does not imply that the statement is suspect. As a result, extra checks are carried out to ensure successful phrase selection. The mechanism for calculating sentence similarity is depicted in Figure 1 as a high-level process. For the selection of informative sentences, two alternative methodologies were applied.

Evaluation Of The Proposed Mobile Application

We are now assessing the performance of the proposed learning application's constituent modules. We use the manual evaluation method for this activity. In the section under "Experimental Setup for System Evaluation," we discussed the study's evaluation technique. The specifics of the evaluation are discussed in the next section.





Dhawaleswar Rao et al.

Evaluation Metrics

Based on the type of information, different evaluation metrics were used. The accuracy of term identification is measured using the F-measure [14]. The harmonic mean of accuracy and recall (Eq. 3) is the F-measure or F1 score. Precision is the fraction of the relevant terms identified (Eq. 1). The recall is the fraction of relevant terms over the total amount of relevant terms (Eq. 2) that have been identified. The F-measure was also used to assess the identification of instrument names and the names of scientists. We use the percentage accuracy for evaluating scientist-invention and abbreviation-expansion pairs.

$$\text{Precision} = \frac{\text{Number of correctly retrieved terms}}{\text{Total number of terms retrieved by the system}} \quad (1)$$

$$\text{Recall} = \frac{\text{Number of correctly retrieved terms}}{\text{Total number of available terms in the documents}} \quad (2)$$

$$F_1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (3)$$

A t-test is employed. Gosset is a character in the film Gosset (1908). Various measures have been used to represent performance shown in Figure 2. The mean score, standard deviation, t-value, and p-value are all examples of these terms. The t-value is defined as the ratio of the difference between two groups to the difference between groups. A higher t-value suggests that there is a greater difference between the groups. A lower t-value indicates that the groups are quite similar. A t-value of x, for example, indicates that the groups are x times as diverse as they are within each other. The p-value is the likelihood that the results happened by coincidence. It is expressed as a decimal number between 0 and 1. A low p-value is a positive sign that the outcome did not happen by coincidence.

CONCLUSION AND FUTURE WORK

We have proposed a computer-assisted learning platform in this work that helps weak students prepare for their exams effectively. The suggested method identifies dubious sentences, offers a basic and concise description, runs a trial test, analyzes student replies, and indicates the areas where the student is unsure. These system characteristics act as a remedial instructor, guiding pupils in a variety of ways.

REFERENCES

1. Keesstra, S. D., Bouma, J., Wallinga, J., Tittonell, P., Smith, P., Cerdà, A., ... & Fresco, L. O. (2016). The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals. *Soil*, 2(2), 111-128.
2. D. R. Radev, E. Hovy, and K. McKeown, "Introduction to the special issue on summarization," *Computational linguistics*, vol. 28, no. 4, pp. 399-408, 2002.
3. Turpin, Y. Tsegay, D. Hawking, and H. E. Williams, "Fast generation of result snippets in web search," in *Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval*, 2007, pp. 127-134.
4. E. D. Trippe, J. B. Aguilar, Y. H. Yan, M. V. Nural, J. A. Brady, M. Assefi, S. Safaei, M. Allahyari, S. Pouriyeh, M. R. Galinski et al., "A vision for health informatics: Introducing the sked framework. an extensible architecture for scientific knowledge extraction from data," *arXiv preprint arXiv:1706.07992*, 2017.
5. J. L. Neto, A. A. Freitas, and C. A. Kaestner, "Automatic text summarization using a machine learning approach," in *Brazilian symposium on artificial intelligence*. Springer, 2002, pp. 205-215.
6. G. Erkan and D. R. Radev, "Lexrank: Graph-based lexical centrality as salience in text summarization," *Journal of artificial intelligence research*, vol. 22, pp. 457-479, 2004.





Dhawaleswar Rao et al.

7. E. Lloret and M. Palomar, "Text summarisation in progress: a literature review," *Artificial Intelligence Review*, vol. 37, no. 1, pp. 1–41, 2012.
8. Nenkova and K. McKeown, "A survey of text summarization techniques," in *Mining text data*. Springer, 2012, pp. 43–76.
9. K. S. Jones, "Automatic summarising: The state of the art," *Information Processing & Management*, vol. 43, no. 6, pp. 1449–1481, 2007.
10. K. SPARCK-JONES, "Automatic summarizing: Factors and directions," in "advances in automatic text summarization," *Evaluations*, pp. 6–7, 1999.
11. C. C. Yang and F. L. Wang, "Hierarchical summarization of large documents," *Journal of the American Society for Information Science and Technology*, vol. 59, no. 6, pp. 887–902, 2008.
12. K. Raveendra and R. Vinothkanna, "Hybrid ant colony optimization model for image retrieval using scale-invariant feature transform local descriptor," *Computers & Electrical Engineering*, vol. 74, pp. 281–291, 2019.
13. D. Raman, B. Bezawada, T. Rajinikanth, and S. Sathyanarayan, "Static program behavior tracing for program similarity quantification," in *Proceedings of the first international conference on computational intelligence and informatics*. Springer, 2017, pp. 321–330.
14. G. Sucharitha and R. K. Senapati, "Shape based image retrieval using lower order zernike moments," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 7, no. 3, pp. 1651–1660, 2017.
15. R. CHANGALA and D. RAJESWARA RAO, "A survey on development of pattern evolving model for discovery of patterns in text mining using data mining techniques." *Journal of Theoretical & Applied Information Technology*, vol. 95, no. 16, 2017.
16. J. Goldstein, "Automatic text summarization of multiple documents," pp.1-30, 1999.
17. K. Nikhath and K. Subrahmanyam, "Feature selection, optimization and clustering strategies of text documents." *International Journal of Electrical & Computer Engineering (2088-8708)*, vol. 9, no. 2, 2019.
18. S. Inthiyaz, B. Madhav, and P. Kishore, "Flower segmentation with level sets evolution controlled by colour, texture and shape features," *Cogent Engineering*, vol. 4, no. 1, p. 1323572, 2017.
19. K. Sarkar, "Syntactic trimming of extracted sentences for improving extractive multi-document summarization," *Journal of Computing*, vol. 2, no. 7, pp. 177–184, 2010.
20. D. M. Zajic, B. J. Dorr, and J. Lin, "Single-document and multidocument summarization techniques for email threads using sentence compression," *Information Processing & Management*, vol. 44, no. 4, pp. 1600–1610, 2008.
21. C. D. Manning, H. Schütze, and P. Raghavan, *Introduction to information retrieval*. Cambridge University press, 2008.
22. J. Carbonell and J. Goldstein, "The use of mmr, diversity-based reranking for reordering documents and producing summaries," in *Proceedings of the 21st annual international ACM SIGIR conference on Research and development in information retrieval*, 1998, pp. 335–336.
23. M. A. Fattah and F. Ren, "Ga, mr, ffn, pnn and gmm based models for automatic text summarization," *Computer Speech & Language*, vol. 23, no. 1, pp. 126–144, 2009.
24. Y. Ouyang, W. Li, S. Li, and Q. Lu, "Applying regression models to query-focused multi-document summarization," *Information Processing & Management*, vol. 47, no. 2, pp. 227–237, 2011.
25. Y. Ko and J. Seo, "An effective sentence-extraction technique using contextual information and statistical approaches for text summarization," *Pattern Recognition Letters*, vol. 29, no. 9, pp. 1366–1371, 2008.
26. C.-Y. Lin and E. Hovy, "The automated acquisition of topic signatures for text summarization," in *COLING 2000 Volume 1: The 18th International Conference on Computational Linguistics*, 2000.
27. M. Tsytsarau and T. Palpanas, "Survey on mining subjective data on the web," *Data Mining and Knowledge Discovery*, vol. 24, no. 3, pp. 478–514, 2012.
28. D. R. Radev, W. Fan, and Z. Zhang, "Webinence: A personalized web-based multi-document summarization and recommendation system," in *NAACL Workshop on Automatic Summarization*. Citeseer, 2001.
29. D. B. Dasari, and K. V. G. Rao, "Context similarity strategy for text data plagiarism detection," *International Journal of Engineering and Technology (IAE)*, 7(2), 14-17, 2018.
30. D. B. Dasari, and K. Venu Gopala Rao, "Semantic relevance scale for text data plagiarism detection", *Journal of Advanced Research in Dynamical and Control Systems*, 10(1 Special Issue), 811-819, 2018.





Dhawaleswar Rao et al.

31. V. Deepika. Rao, M. K., and N. Kiranmai, "Tokenization of news feed articles based on their similarity using machine learning techniques", Journal of Advanced Research in Dynamical and Control Systems, 10(2), 252-256, N. 2018.
32. K.V. Durga Rajesh, G. A. Krishna, A.K. Teja, K. Vivek, and B.K. Radha, "An effective similarity-based sheep flock heredity algorithm to anticipate number of cells", Journal of Advanced Research in Dynamical and Control Systems, 2017, 2720-2726, 2018.
33. S. Kolli, and M. Sreedevi, "Adaptive clustering approach to handle multi similarity index for uncertain categorical data streams", Journal of Advanced Research in Dynamical and Control Systems, 10(4 Special Issue), 1401-1408, 2018.
34. K.K. Praveen, V.N. Mandhala, S. Vempati, and S.R. Peram, "Finding author similarity by clustering probabilistic LSA factors in INDIAN english authors poetry", International Journal of Engineering and Technology (UAE), 7, 1096-1099, 2018.
35. K. Raveendra, T. Karthikeyan, R. Vinothkanna, and P.V.N. Reddy, "A novel logo-based document retrieval using hybrid fuzzy based CSA", International Journal of Innovative Technology and Exploring Engineering, 8(5), 255-258, 2019.
36. N. Priya, and M. Sreedevi, "A novel similarity based contextual bug localization model for unstructured textual bug reports", Journal of Advanced Research in Dynamical and Control Systems, 9(Special Issue 18), 21-34, 2017.
37. P. Lakshmi and D.R.Rajeswara, "Literature survey on text classification: A review", Journal of Advanced Research in Dynamical and Control Systems, 9(Special Issue 12), 2270-2280, 2017.
38. S. Corston-Oliver, E. Ringger, M. Gamon, and R. Campbell, "Task-focused summarization of email", In Text Summarization Branches Out, pp. 43-50, 2004.

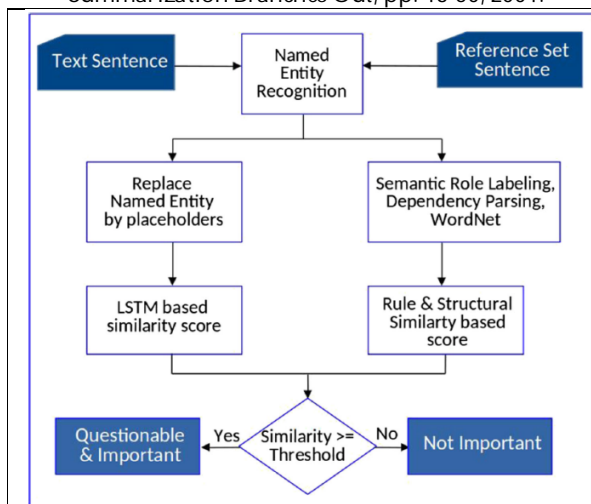


Figure 1 For the selection of informative sentences, two alternative methodologies were applied.

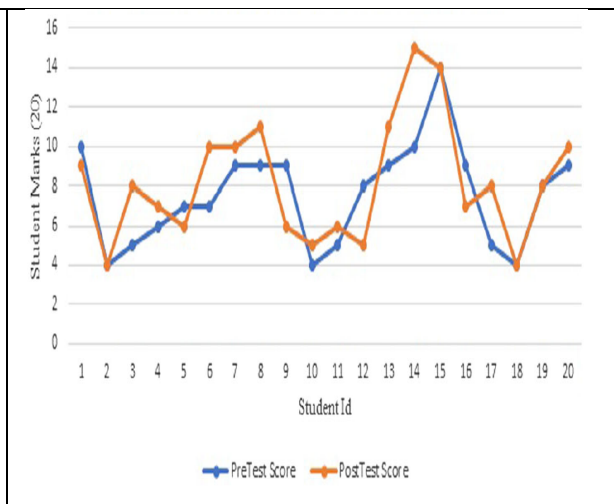


Figure 2 Various measures have been used to represent performance





A Monte Carlo Technique to Study the Distribution of ^{18}F for PET

P. Palaka¹, P. K. Rath^{1*}, P. Padhy¹, M. Swain¹, M. Mishra² and N. N. Deshmukh³

¹Centurion University of Technology and Management, Odisha, India.

²Saraswati Institute of IT & Management, VikashGroup of Institution, Bhawanipatna, Kalahandi - 766001

³School of Sciences, P PSavani University, Kosamba, Surat, Gujarat, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

P. K. Rath

Centurion University of Technology and Management,
Odisha, India.

Email: prasanta.rath@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A positron emission tomography (PET) scan is an imaging test that has a wide application in medical diagnostics. Diagnosis which are not possible through X-ray and other method can be done through PET specially to study the biochemical function of different tissues and organs. Normally a PET scan uses a radioactive active element ^{18}F which is a beta emitter for the process. To study much detail how a PET-image will be collected it is important to understand the imaging process through simulation which reduces the cause of exposure to radioactive substance. Since the radioactive is a random process and the distribution of ^{18}F in blood is random it is important to include the randomness in the simulation. In this paper a Monte Carlo based technique has been applied for random distribution of radioactive element and performed the simulation.

Keywords: Random number, pseudo random number, efficiency

INTRODUCTION

Computer is very essential in present days. Since starting from any technological application to medical imaging computer is the must and also to study the performance and improvement in any imaging devices need's simulation through high power computers. People working with computers often speaks about RN (random number). The (RN) have lot of application starting from the uses in defense signal processing for radar, remote control of signal, codes encryption etc. This makes the Random numbers is very important for application and also it's generator. There are many ways to produce these random numbers. there are midpoint formula and many more to make the RN but out of many Monte Carlo based simulations uses these pseudo random number generators for many model predictions and the probability of different outcomes in a process that cannot easily be predicted using normal numerical methods. A Monte Carlo simulation can be used to tackle a range of problems in virtually every field such as finance, engineering, supply chain, and science. It is also referred to as a multiple probability



**Palakaet al.,**

simulation. Many stochastic process such as radioactivity, jitter of electronic, frequency of oscillator [1-2] uses the random numbers for the generation of physical Situations. In the present case we have used to simulate the situation of distribution of ^{18}F in a small blood vein which can be under go PET imaging in later stages.

SIMULATION AND RESULT

A Monte Carlo based model simulation has been done using pseudo random number generators which generates the random number between 0 and 1 with zero reparation within one million events. There are varieties of RN generators such as RNG1, RNG2, RNG3&RNG4[3-4]. We have taken an examples as follows. Let a small vein having 30 mm length and 10 micrometer wide (radius is 5 micrometer) since the PET imaging can also be applicable to Brain and micro vein and tissues, so we have considered the hard task. we have generated the pseudo random number between 0-50 mm and picked up the random number which lye within the wall of the veins. For our case we have generated 3100 events randomly distributed but by picking up randomly which will lye within the wall of the vein considering the radioactive element mix with the blood randomly and flow. We got a 10% event are within the wall. The image shown in Fig1 (a). The events within the vein is very less for a good imaging since the 2d map will require a good statistics. so we adopted another method, we have thrown 3100 independent events randomly and then we picked up these considering all are within the wall of the vein . Here in the second case we considered that a different approach rather than throwing and picking within the wall, we considered that the all ^{18}F has mixed with the blood randomly and their motion is random . which has been shown on Fig.1(b).The corresponding 1D histogram has also shown in Fig.2 (a) and Fig.2 (b). One can see from Fig.2& Fig.1 that the throwing event and picking up is not an efficient way but this is a genuine way which consumes more time and more events will require for the process. This makes the simulation slower and the image quality will be not good whereas as the 2nd method (random mixing with blood all ^{18}F and flowing randomly) looks an efficient way as the statistics will be more and the simulation will be faster.

CONCLUSION

From the above calculation and simulation one can see that the most effective way to do the simulation is the second mechanics where it has considered that all the ^{18}F has mixed randomly with the blood and flowed. The first approximation looks more realities i.e. the picking up events which lye within the vein boundary but The second one is more preferable for computer simulation point of view as it will increase the statistics , make the simulation faster and the image quality sharper.

ACKNOWLEDGMENT

The author express his gratitude to CUTM, PKD for the full support during the preparation of manuscript which is aout come of summer internship work. In addition the author is very much thank full to all the collaborators.

REFERENCES

1. Nicholas Metropolis &S. Ulam, " *The Montecarlo method*", Journal of the American Statistical Association 44(247), 335–341 (1949)
2. M. J. Applegate, O. Thomas, J. F. Dynes, Z. L. Yuan, D. A. Ritchie, and A. J. Shields" Efficient and robust quantum random number generation by photon number detection" Appl. Phys. Lett. 107, 071106 (2015); <https://doi.org/10.1063/1.4928732>
3. J. F. Dynes, Z. L. Yuan, A. W. Sharpe and A. J. Shields, " *A high speed post processing free, quantum random number generator* " Appl. Phys. Lett. 93, 031109 (2008); <https://doi.org/10.1063/1.2961000>
4. Marsaglia, George; Zaman, Arif (1993). " *The KISS generator*". Technical Report, Department of Statistics, Florida State University, Tallahassee, FL, USA.





Palakaet al.,

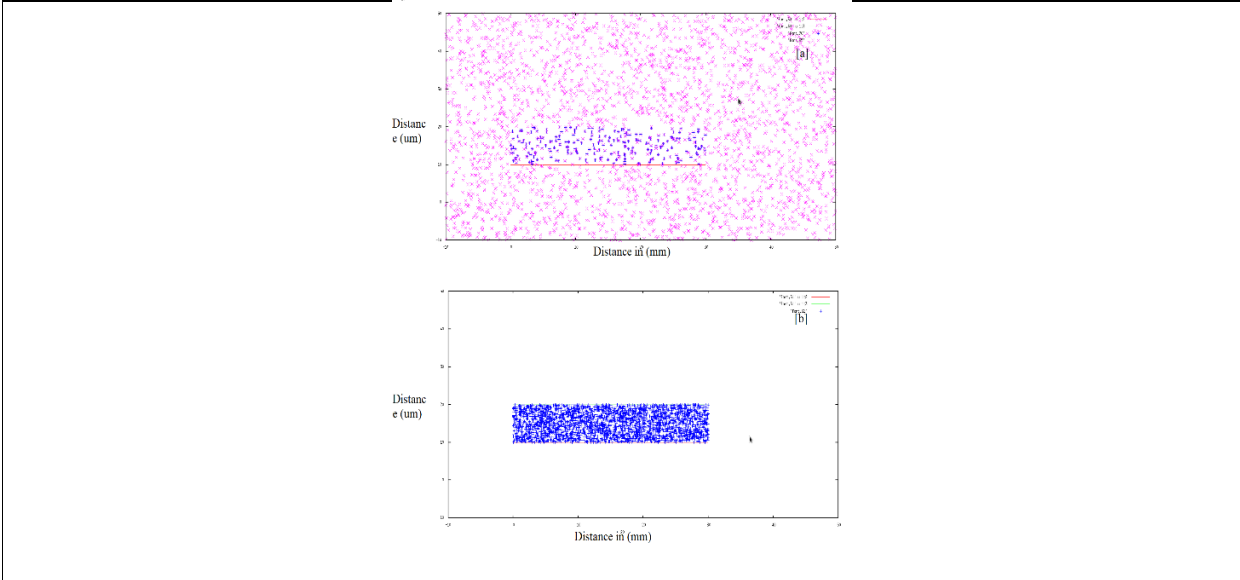


Fig.1 (a): The event (radioactive substance) are distributed randomly including the vein lines. Than the events which were fall within the vein can have only accepted and reaming were rejected . **[b]** The opposite of (a). All the events were generated randomly within the vein and were assumed randomly distributed inside the vein. One can see the density (^{18}F) is different in both the cases even if it is the same vein.

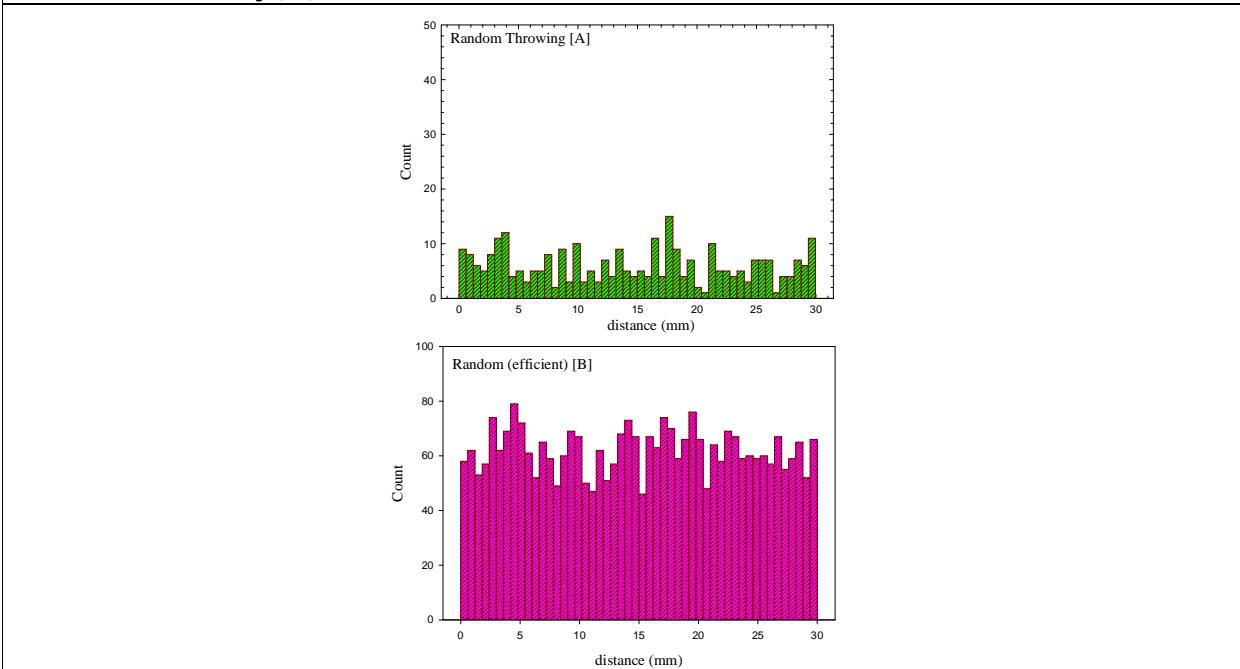


Fig.2 (A): The 1d histogram of the events (radioactive substance) which are within the vein but picked up by method first (see text for detail) which are also picked from Fig.1 (a). **[B]** The 1d histogram of the events (radioactive substance) which are within the vein but picked up by method Second (see text for detail) which has relation with Fig.1 (b). One can see the flat and more events in second distribution compared to first indicates the uniformity and availability of more ^{18}F . The second approach involving simulations will be much appropriated.





Biodiversity-An Important Element for Human Life

Chitrasena Padhy¹*,Kalee Prasanna Pattanayak², M. Devender Reddy³ and Rabindra Kumar Raj⁴

¹Assistant Professor, M S Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India

²Assistant Professor, School of Management, Centurion University of Technology and Management, Odisha, India.

³Professor, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India.

⁴Professor, Siksha 'O' Anusandhan (Deemed University), Bhubaneswar, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Chitrasena Padhy

Assistant Professor,
M S Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Odisha, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Biodiversity refers to the variety of animals, plants, fungi, and even microbes like bacteria that can cause up our natural environment. Every one of those species and organisms, like just a complex web, function together within ecosystems to maintain equilibrium and sustain life. Human civilizations are unable to thrive in unhealthful surroundings. Fish, meat, crops, timber, and fibres such as cotton and silk are among the items consumed by people. Living organisms govern the environments on which crops rely. We are, especially as the human population rises and natural areas are destroyed to make room for agricultural, residential, and industrial development. Often, forest felling is the first step. Many individuals feel that biodiversity has intrinsic value, which means that all species have worth and a right to live regardless as to whether or not they serve humans. Biodiversity guarantees that nature, the biosphere, and life on earth stay diversified. It is quite environmentally friendly. If life on this planet did not exist, it would perish. The cornerstone of world food and nutrition security is biodiversity. Given the fact the millions of species work together to offer us with a diverse range of fruits, vegetables, and animal products that are important for a healthy, well-balanced nutrition, they are currently in grave danger. In health care, traditional medicine continues to play an essential role. Plants are harvested for therapeutic reasons from both wild and cultivated populations. In addition to survival, many communities depend on natural goods derived from ecosystems for medicinal and cultural purposes. Biodiverse ecosystems safeguard us against natural calamities like floods and storms, as well as filtering and renewing our



**Chitrasena Padhy et al.,**

soils. Biodiversity is really important for the environment. The importance of biodiversity in an environment is clear. Natural disasters cannot destroy an environment if biodiversity is preserved.

Keywords: Biodiversity, ecosystem, diversity, biosphere, traditional medicines

INTRODUCTION

The variety of ecosystems, natural resources, species, and genes found around the world or in a particular environment is referred to as biodiversity. It is essential for everyone since it brings benefits that maintain our economic system running smoothly. It is required for ecological systems such as pollinating, climate management, flood mitigation, nutrient retention, and food, fuel, fibre, and medicine production (European Environment Agency, 2020)[1]. Biodiversity refers to the diversity of animals, plants, fungi, and even microorganisms such as bacteria that cause up our natural world. Every species and organism in an ecosystem works with each other to keep the balance and sustain life. Biodiversity supplies everything humans need to survive in the wild, including food, safe drinking water, medicine, and shelter (Hancock, 2022)[2]. Biodiversity, or may be the diversity of life on Earth, is defined as the variance among living organisms induced by a multitude of factors such as species diversity, species diversity in species, and ecological diversity. Biodiversity encompasses not just Earth's millions of species, and also genetic variations and characteristics within species (such as crop varieties), as well as the different kinds of aquatic and terrestrial environments that human societies depend on, such as coastal regions, forests, wetlands, pastures, mountain ranges, and deserts. (Convention on Biological Diversity, 2018) [3]. In Geneva, UN biodiversity talks began to work out a worldwide agreement for greater environmental protection. Almost 200 nations are expected to sign a global framework this year to conserve nature from human devastation by the middle of the century, with a crucial goal of protecting 30% of the planet by 2030 (Phys.org, 2022) [4].

Loss of Biodiversity

Healthy ecosystems are essential to human cultures. Fish, meat, crops, timber, and fibres such as cotton and silk are among the items consumed by people. Living organisms govern the environments on which crops rely. Trees and other plants take in carbon and release oxygen through photosynthesis. They are removing around 27% of what human industry and agriculture emits in the process (The Economist, 2021)[5]. Predicting and managing the effects of global change on species and ecosystems is a huge adjustment for ecology. Many species' phenology is changing as a result of climate change across the planet. Recent reductions in farmland biodiversity, mostly due to agricultural intensification, pose a danger to rural cultural values. Multiple environmental forces, such as temperature change and water colour, will pose a hazard to aquatic systems in the future. Significant evidence has developed in recent years indicating arctic and alpine landscapes are undergoing dramatic changes in plant community structure (Lund University, 2021)[6].

In their daily lives, people rely on biodiversity. People's health is eventually reliant on ecosystems products and services such as clean water, food, and fuel, which are all essential for human health and productive lifestyles. Biodiversity loss can have major direct health consequences for humans if ecosystem services are no longer able to meet social needs. Changing ecosystem services have an indirect effect on livelihoods, earnings, local movement of people, and political unrest in rare situations (WHO, 2015)[7]. Climate change, global warming, increased insect pest and disease infestation in crops, farmers' exposure to continuous pesticide usage, commodity price volatility, and crop losses due to natural disasters including drought, floods, and cyclones are all harming farmers' mental health. (Padhy et al, 2020)[8].

Wild places are removed to make space for agricultural, housing, and industrial development as the human population expands. Forest felling is often the first step, with 30 million hectares - nearly the size of the United Kingdom and Ireland - destroyed worldwide in 2016. Other key challenges include poaching and excessive food hunting. More than 300 animal species are being eaten to extinction, spanning from chimpanzees to large mammals



**Chitrasena Padhy et al.,**

to bats. Orcas and dolphins are also victims of pollution, with long-lived commercial contaminants causing substantial harm. Global commerce has exacerbated the problem: amphibians have seen one of the worst population declines of any species as a result of a fungal disease spread globally by the pet trade.(Carrington, 2018)[9].Farmers are experiencing increased levels of stress, anxieties, despair, sleep disturbances, emotional instability, drastic weight changes, substance misuse, and feelings of failure as a result of changes in environment. (Padhy et al, 2020)[10].

Importance of Biodiversity(Morton and Hill, 2014) [11]

Biodiversity benefits us for a multitude of reasons. Many individuals feel that biodiversity has inherent worth, which means that every species has significance and a right to live whether or not something benefits humans. In their biodiversity book, they underline five important values that individuals put on biodiversity

1. Biodiversity helps us in many ways economically as it provides raw materials for consumption and industry. Biodiversity is vital to the livelihoods of farmers, fishermen, and forest workers.
2. Because it supplies oxygen, clean air and water, plant pollination, insect control, wastewater treatment, and a number of other functions, biodiversity is essential for ecosystems to function properly.
3. Many recreational activities including as bird viewing, hiking, camping, and fishing, rely on our unique biodiversity. The tourism business in our country is strongly reliant on biodiversity..
4. Through expressions of identity, morality, and aesthetic appreciation, Australian culture is inextricably linked to biodiversity. Indigenous Australians have deep religious convictions about plants and animals, which has ultimately led to deep links with biodiversity and a sense of social responsibility for it.
5. Biodiversity is a vast repository of biological information that enhances our understanding of nature and its origins.

Nature's diversity, biosphere, richness, and life on Earth are all maintained via biodiversity. It is really beneficial to the environment. Life on Earth would perish if it didn't exist. Biodiversity is often seen to be helpful and desirable since it contributes to community stability and higher output (Minni, 2022)[12]

Five ways biodiversity supports economies and enhances wellbeing (Quinney, 2020) [13]**The importance of biodiversity for human health and food security**

Biodiversity is the foundation of global nutrition and food security. Regardless of the fact that millions of species collaborate to offer us with a diverse range of vegetables, fruits, and animal foods that are important for a healthy, well-balanced diet, they are now becoming increasingly threatened.

Biodiversity assists fight diseases

Human health has been related to higher levels of biodiversity. For starters, plants are essential for the creation of medications. For example, rainforest plants are used in 25% of modern medications, whereas natural or synthetic chemicals inspired by nature are used in 70% of cancer therapies. This implies we lose out on a potential new medication every time a species goes extinct.

Biodiversity helps for business

According to the World Economic Forum's annual Nature Risk Rising Report, more than half of the world's GDP (\$44 trillion) is reliant on nature. The rapid biodiversity loss has put many enterprises in jeopardy.Natural-materials-based pharmaceuticals are expected to generate \$75 billion in annual revenue, while natural marvels like coral reefs are crucial for food and tourism.

Biodiversity provides livelihoods

Every year, ecological systems are valued \$125 trillion to humanity. Three out of every four jobs need the usage of water, and the agriculture industry employs more than 60% of the world's working poor. Forests provide a source of income for about 1.6 billion people in the Global South.



**Chitrasena Padhy et al.,****Biodiversity protects us**

We are able to exist on this planet because of biodiversity. Biodiverse ecosystems protect us from natural calamities like floods and storms while also purifying our systems and renewing our soils. Healthy biodiversity provides natural services such as water resource preservation, soil development and protection, nutrient storage and recycling, pollutant breakdown and absorption, contribution to climatic stability, ecosystem management, and restoration from unexpected events (Shah, 2014) [14]. Food, medicinal treatment, decorative flora, future resources, gene diversity, species variety, and ecological diversity are all given. It offers societal benefits including research, education, and monitoring, as well as recreational and tourism possibilities and cultural values. In healthcare coverage, traditional medicine remains to play an essential role. Traditional medicines are used by 60% of the world's population, and they are widely integrated into public health services in many nations. Medicinal plants are the most often used therapeutic option in both conventional and complementary medicine all over the world. Plants are gathered from both wild and cultivated populations for medicinal purposes. In addition to subsistence, many communities rely on natural goods derived from ecosystem for medicinal and cultural purposes (WHO, 2015) [7]. Sustainable agriculture further enhances biodiversity in the region by providing a natural and healthy habitat for a range of species to thrive in (Padhy, 2015) [15].

CONCLUSION

Biodiversity indicates the diversity of all living organisms, including plant, animal and bacteria, the genetic data and ecosystems they produce. Genetic variation, diversity of species and ecological diversity are the three levels of biodiversity that are commonly examined (Australian museum, 2020) [16]. People are putting more strain on the world than before, consuming and using more things than before, and risk upsetting ecological equilibrium and wiping off species. (WWF, 2020) [17]. Climate change, according to leading scientists, is causing an increase in extreme weather occurrences. Global temperatures are rising as a result of climate change. Plants' capacity to get and utilise moisture is hampered by higher temperatures (Padhy and Pattanayak, 2020) [18]. Healthy ecosystems purify our waters, cleanse our air, manage our soil, control our climates, reuse nutrients, and provide us with food. They provide raw materials to the pharmaceutical industry and other industries. They are the foundation of all civilizations and the source of our economy's vitality (Wilson et al., 2010) [19]. It is required to strengthen resilience and adaptive capacity to climate hazards and natural disasters in all countries (Envision2030, Goal 13) [20].

REFERENCES

1. European Environment Agency, 2020, <https://www.eea.europa.eu/themes/biodiversity/intro#:~:text=Biodiversity%20is%20the%20name%20given,sustain%20our%20economies%20and%20societies>.
2. Hancock L., WWF, 2022, What is biodiversity? <https://www.worldwildlife.org/pages/what-is-biodiversity#:~:text=Biodiversity%20is%20all%20the%20different,maintain%20balance%20and%20support%20life>.
3. Convention on biological diversity, 2018, Biodiversity is essential for sustainable development and well-being, <https://www.cbd.int/article/biodiversityforSDGs>
4. Phys.org, 2022, UN launches biodiversity talks on deal to protect nature, <https://phys.org/news/2022-03-biodiversity-nature.html>
5. The Economist, 2021, Loss of biodiversity poses as great a risk to humanity as climate change, <https://www.economist.com/technology-quarterly/2021/06/15/loss-of-biodiversity-poses-as-great-a-risk-to-humanity-as-climate-change>
6. Lund University, 2021, Conservation of biodiversity and maintenance of ecosystem services, <https://www.becc.lu.se/research/conservation-biodiversity-and-maintenance-ecosystem-services>.
7. WHO, 2015, Biodiversity and health, <https://www.who.int/news-room/fact-sheets/detail/biodiversity-and-health>
8. Padhy C, Raju P S, Raj R K, 2020, Psychological Challenges of Farmers and Remedial Measures, Indian Journal of Natural Sciences, 10(60): 24134-24138.





ChitrasenaPadhyet al.,

9. Carrington D, 2018, What is biodiversity and why does it matter to us? <https://www.theguardian.com/news/2018/mar/12/what-is-biodiversity-and-why-does-it-matter-to-us>
10. Padhy C, Raju P S, Pattanayak K P, 2020, Assessment of Mental Health and Psychological Counseling for Farmers, International Journal of Advances in Agricultural Science and Technology, Vol.7 Issue.11, November-2020, pg. 55-59
11. Morton SR & Hill R(2014). What is biodiversity, and why is it important? In: Morton SR Sheppard AW & Lonsdale WM(eds), *Biodiversity: Science and Solutions for Australia*, CSIRO Publishing, Collingwood, Melbourne, 1-12.
12. Minni M, 2022, Biodiversity Significance-Definition, Functions, <https://www.embibe.com/exams/importance-of-biodiversity/>.
13. Quinney M, 5 reasons why biodiversity matters-to human health, the economy and your wellbeing, <https://www.weforum.org/agenda/2020/05/5-reasons-why-biodiversity-matters-human-health-economies-business-wellbeing-coronavirus-covid19-animals-nature-ecosystems/>
14. Shah A, 2014, Why is biodiversity important? Who cares? <https://www.globalissues.org/article/170/why-is-biodiversity-important-who-cares#Ahealthybiodiversityoffersmanynaturalservices>
15. Padhy C., 2015, Agriculture for Meeting the Demand of Future Generation and Sustainability: An Interpretative Study, International Journal of Engineering Technology, Management and Applied Sciences, 3(11): 16-21.
16. Australian.museum, 2020, What is biodiversity? <https://australian.museum/learn/science/biodiversity/what>
17. WWF, 2020, What is biodiversity? Why it's under threat and why it matters? <https://www.worldwildlife.org/pages/what-is-biodiversity>.
18. Padhy C, Pattanayak K P, 2020, Global warming and its effect on agriculture, The Pharma Innovation Journal, 9(6): 259-261.
19. Wilson E O, Chivian E., Bernstein A, Why do we need to protect biodiversity?https://ec.europa.eu/environment/nature/biodiversity/intro/index_en.htm
20. Envision2030, Goal 13: Take urgent action to combat climate change and its impacts, <https://www.un.org/development/desa/disabilities/envision2030-goal13.html>.





Synthesis, Characterization and Crystal Structure of New Macrocyclic ring 3,7,10-tritosyl-3,7,10-triaza-1,5(2,6)-dipyridinacycloundecaphane

Rabindra Nath Pradhan*

Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Rabindra Nath Pradhan

Centurion University of Technology and Management,
Odisha, India

Email: Rabindranath.pradhan@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Synthesis of a macrocyclic compound is a great challenge in the field of synthetic chemistry. A macrocyclic tri-tosylate compound (**L**) was designed and synthesized by using different types of chemical reactions. NMR, Mass, Uv-Vis spectroscopy confirmed that the synthesized compound was formed in pure form. The single crystal X-ray diffraction measurements reveal that the compound (**L**) is macrocyclic with tri-tosylate group attached to the three nitrogen atoms of the macrocyclic backbone.

Keywords: Synthesis, macrocyclic tri-tosylate compound, NMR, Mass, Uv-Vis, The single crystal X-ray

INTRODUCTION

Last 40 years the synthesis of macrocyclic compounds have been largely used in supramolecular chemistry to interact the guest molecule and macrocycles. Large number of articles were published to study the new methods for synthesis and structural properties of macrocyclic compounds. The great challenge for synthesis of macrocyclic compounds were, multi steps synthesis, low yield, low solubility, difficulties in purifications and different open chain intermediates. The cyclic compound may contains saturated backbone or unsaturated backbone. Macrocyclic compounds also contains the aliphatic or aromatic rings with different hetero atoms like nitrogen, oxygen and Sulphur. Most of the macrocyclic compounds were showing optical active properties, inclusion properties, [1] chiro-optical properties [2,3] gelation properties. The macrocyclic compounds were very good selective for complexing with different metal ions [4,5]. The different metal binding macrocyclic compounds were showing good catalytical properties, [6,7] medicinal properties. Most of the complexes were used for mimic of different biological enzymes. In this article we have designed a new macrocyclic compound 3, 7, 10 - tritosyl - 3, 7, 10 - triaza -1, 5(2,6)-dipyridinacycloundecaphane and to explore the synthesis of the compound by standard synthetic methodology. The synthesized compound is characterized by different spectroscopic techniques. Further the structure of the compound was confirmed by using single crystal X-ray diffraction.



**Rabindra Nath Pradhan**

METHODOLOGY

All the chemicals and solvents were taken from commercial sources. The chemicals and solvents are purified using standard laboratory methods. The melting point of the compound was taken using BUCHI M-500 instrument. Uv-Vis spectra was recorded using Agilent Cary 60 UV-Vis Spectrophotometer. ¹H and ¹³C NMR spectra were recorded on JEOL ECS 400 spectrometers. The crystal structure was evaluated by using Bruker Kappa APEX II instrument.

RESULTS AND DISCUSSIONS

Compound **L** involved the Synthesis of **(1)**(Scheme 1) which was synthesized from commercially available dipicolinic acid, which was esterified in presence of conc. H₂SO₄ followed by reduction in presence of NaBH₄ to obtain pyridine-2,6-diyl dimethanol by using published procedure,[8,9]. The asymmetric(6-(bromomethyl)pyridin-2-yl)methanol was then synthesized with aqueous HBr by using the published literature procedure.¹⁰ Further reaction with *p*-toluene sulphonamide in acetone solvent using K₂CO₃ as a base to form N,N-Bis[[6-(hydroxymethyl)pyridine-2yl]methyl]-*p*-tosylamide which was brominating in presence of PBr₃ to form compound **1**.

Synthesis of 3,7,10-tritosyl-3,7,10-triaza-1,5(2,6)-dipyridinacycloundecaphane

The toluenesulfonyl protected of ethylenediamine(0.65 g, 2.75 mmol) was taken in a 50 ml round bottom flask with anhydrous K₂CO₃ (0.75 g, 5.58mmol) and added 15 ml of dry DMF and heated to 80 °C. Compound **1** (1.5 g, 2.58mmol) was taken in a 25 ml of conical flask with 10 ml dry DMF and dropwise added in reaction mixture over 1 h. Then the reaction was continued for 12 h at 40 °C. After cooling the total reaction mixture transferred into 50 ml of water in a beaker. The resulting slurry was collected by vacuum filtration and the pure compound was obtained by using chromatography techniques (SiO₂. C₆H₁₂/EtOAc = 3:1) to give the wanted product as white solid (1.25 g, 60% yield).

Characterization of Compound (1)

The compound was characterized by different spectroscopic techniques, such as NMR, Mass, IR and Uv-Vis. mp 172-174.5 °C. ¹H NMR (Fig. 1) (400 MHz, CDCl₃, ppm): δ= 2.48 (s, 9H), 2.89 (s, 4H), 4.20 (s, 4H), 4.40 (s, 4H), 7.08 (d, 2H), 7.34 (m, 4H), 7.40 (m, 6H), 7.68 (d, 4H), 7.78 (d, 2H). ¹³C NMR (ppm, CDCl₃): 154.3, 154.3, 143.7, 142.9, 136.9, 135.8, 134.9, 129.7, 129.6, 126.8, 126.6, 121.9, 120.8, 54.7, 53.8, 44.1, 20.7. ESI-MS m/z: calcd for C₃₇H₄₀N₅O₆S₃⁺, 746.21 ([MH]⁺), Found: 746.22 ([MH]⁺). Uv-Vis spectroscopy (Fig. 2) showed that the highest absorption of the compound was at 262 nm due to presence of aromatic groups.

Crystal structure of Compound L

The crystal structure of **L** was evaluated by diffraction data from a Bruker Kappa APEX II Charge-Coupled Device at 110.0 (2) K by using Mo-K α radiation ($\lambda = 0.71073 \text{ \AA}$) and APEX2 software package. Image was solved with the software SAINT-Plus and absorption correction was performed using the empirical method implemented in SADABS [11]. Structure refinement and crystal parameters are given in Table 1. The refinement of structure was done by using SHELXTL [12] package and anisotropically refined all non-hydrogen atoms. Single crystal of **L** was obtained by slow evaporation of the compound in the mixture of MeOH and CHCl₃ solution. The compound adopted orthorhombic unit cell which contained four asymmetric unit with a space group of P 21 21 21. From the crystal structure it was found that the three tosylate rings are tilted in one direction and two pyridine rings are parallel to each other's but perpendicular to tosylate groups. The two pyridine nitrogen and three macrocyclic nitrogen were in planar fashion (Fig. 3). The six tosylate oxygens were also parallel to the pyridine rings.





Rabindra Nath Pradhan

CONCLUSIONS

A new macrocyclic tri-tosylate 3,7,10-tritosyl-3,7,10-triaza-1,5(2,6)-dipyridinacyclo-undecaphane compound have been designed and successfully synthesized in pure form by using standard chemical reactions and methodology. The synthesized compound was characterized by using different spectroscopic techniques such as NMR, Mass, Uv-Vis and single crystal diffraction. The X-ray diffraction confirm that the compound was in cyclic and crystalize in orthorhombic unit cell with a space group of P 21 21 21. This synthesis paves the way for design of new macrocyclic compound and their synthesis.

REFERENCES

- Ji, X.; Ahmed, M.; Long, L.; Khashab, N. M.; Huang, F.; Sessler, J. L. Adhesive supramolecular polymeric materials constructed from macrocycle-based host-guest interactions. *Chem. Soc. Rev.* **2019**, *48*, 2682-2697.
- Homberg, A.; Lacour, J. From reactive carbenes to chiral polyether macrocycles in two steps – synthesis and applications made easy? *Chemical Science* **2020**, *11*, 6362-6369.
- Borisova, N. E.; Reshetova, M. D.; Ustynyuk, Y. A. Metal-Free Methods in the Synthesis of Macrocyclic Schiff Bases. *Chem. Rev.* **2007**, *107*, 46-79.
- Xia, D.; Wang, P.; Ji, X.; Khashab, N. M.; Sessler, J. L.; Huang, F. Functional Supramolecular Polymeric Networks: The Marriage of Covalent Polymers and Macrocycle-Based Host-Guest Interactions. *Chem. Rev.* **2020**, *120*, 6070-6123.
- Curtis, N. F. Compounds of amine-imine macrocycles: Syntheses and structures of compounds of azamacrocycles with amine-β-imine ring segments. *Inorg. Chim. Acta* **2021**, *527*, 120164.
- He, Q.; Vargas-Zúñiga, G. I.; Kim, S. H.; Kim, S. K.; Sessler, J. L. Macrocycles as Ion Pair Receptors. *Chem. Rev.* **2019**, *119*, 9753-9835.
- Chaudhry, M. T.; Akine, S.; MacLachlan, M. J. Contemporary macrocycles for discrete polymetallic complexes: precise control over structure and function. *Chem. Soc. Rev.* **2021**, *50*, 10713-10732.
- Adam, C.; Beele, B. B.; Geist, A.; Mullich, U.; Kaden, P.; Panak, P. J. NMR and TRLFS studies of Ln(iii) and An(iii) C5-BPP complexes. *Chemical Science* **2015**, *6*, 1548-1561.
- Su, H.; Wu, C.; Zhu, J.; Miao, T.; Wang, D.; Xia, C.; Zhao, X.; Gong, Q.; Song, B.; Ai, H. Rigid Mn(ii) chelate as efficient MRI contrast agent for vascular imaging. *Dalton transactions* **2012**, *41*, 14480-14483.
- Nolan, C.; Gunnlaugsson, T. Improved synthesis of a C3-symmetrical pyridinophane. *Tetrahedron Lett.* **2008**, *49*, 1993-1996.
- Crystal data package. *APEX2 and SAINT, Bruker AXS Inc., Madison, WI* **2004**.
- Sheldrick, G. M. A short history of SHELX. *Acta crystallographica. Section A, Foundations of crystallography* **2008**, *64*, 112-22.

Table 1: Crystal Data And Structure Refinement Details.

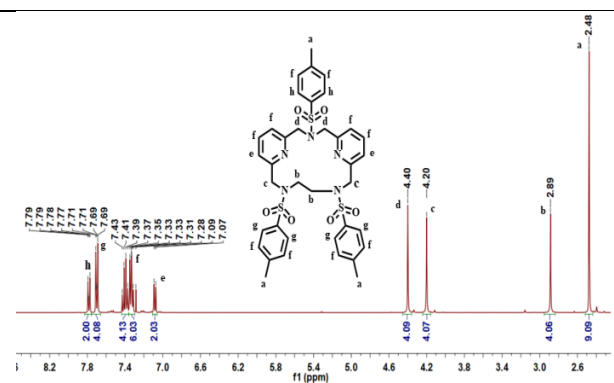
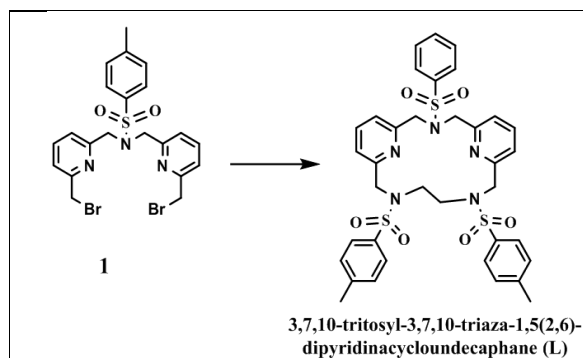
| Parameters | L |
|--|---|
| Empirical formula | C ₃₇ H ₃₉ N ₅ O ₆ S ₃ |
| Formula weight | 745.91 |
| Temperature (K) | 110(2) |
| Wavelength (Å) | 0.71073 |
| Crystal system, space gr. | Orthorhombic ,P 21 21 21 |
| Unit cell dimensions | a = 10.698(2)Å, α = 90.0° b = 11.630(3)Å, β = 90.0° c = 28.634(6)Å, γ = 90.0° |
| Volume (Å ³) | 3562.7(14) |
| Z, Calculated density (g/cm ³) | 4, 1.391 |





Rabindra Nath Pradhan

| | |
|--|---|
| Absorption coefficient (mm ⁻¹) | 0.263 |
| F(000) | 1568 |
| Crystal size (mm ³) | 0.4 x 0.3 x 0.2 |
| Theta range for data collection | 2.256 to 28.353° |
| Limiting indices | -14 ≤ h ≤ 13, -15 ≤ k ≤ 15, -36 ≤ l ≤ 37 |
| Reflections collected / unique | 152881 / 8159 [R(int) = 0.1896] |
| Completeness to theta | 99.9 % |
| Absorption correction | Empirical |
| Refinement method | Full-matrix least-squares on F ² |
| Data / parameters | 8159 / 464 |
| Goodness-of-fit on F ² | 1.021 |
| Final R indices [I > 2σ (I)] | R1 = 0.0536, wR2 = 0.1096 |
| R indices (all data) | R1 = 0.1161, wR2 = 0.1269 |
| Largest diff. peak and hole (e.Å ⁻³) | 0.602 and -0.477 |



Scheme 1: Synthesis of macrocyclic compound L

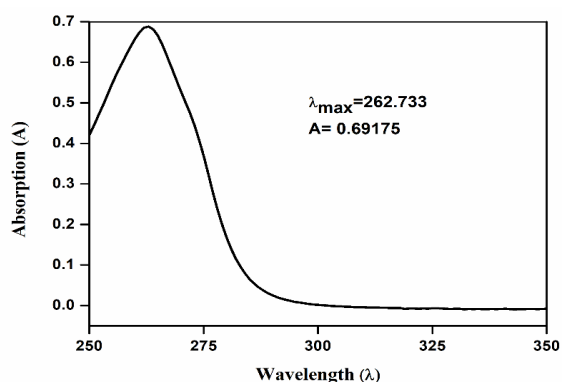


Fig 2. UV-Vis spectra of L in methanol.

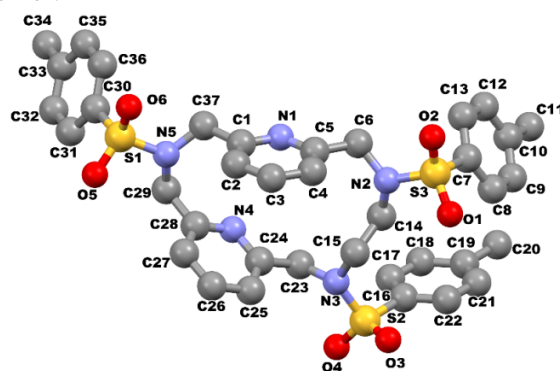
Fig 1. ¹H NMR spectrum of macrocyclic compound L in CDCl₃

Fig 3. X-ray crystal structural of the macrocyclic compound L





Measuring the Perception and Effectiveness of Digital Marketing amongst the Marketing Professionals, an Exploratory Study in Odisha.

Brijlal Mallik^{1*} Kalee Prasanna Pattanayak¹, and Dasarathi Sahu²

¹Asst.Professor, School of Management, Centurion University, Paralakhemundi, Odisha, India

²Reader, Dept. of Bus. Admn, Utkal University, Vani Vihar, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Brijlal Mallik

Asst. Professor

(School of Management, Centurion University)

Gajapati, Paralakhemundi,

R Sitapur, Odisha-761200



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of this exploratory research is to present the perceptions towards Digital Marketing in Odisha. This issue has rarely been addressed by the academicians and researchers in Odisha and elsewhere. This study used digital marketing parameters to measure the awareness and effectiveness of digital marketing among marketing professionals in Odisha. 200 marketing professionals in the city of Bhubaneswar and Cuttack participated in this academic exercise. Data was analyzed in many ways, a) through descriptive statistics b) summarizing the data using factor analysis. Four major perception groups were emerged from the analysis i.e., a) Sceptical b) Enthusiast c) Utilitarian and d) Parsimonious. The result suggests that professionals in Odisha are more skeptical towards digital marketing tools and concepts. They do not fully understand the benefits of digital marketing in terms of growth and cost effectiveness. Finally, the limitations of the studies and findings are presented in study.

Keywords: SEO, Google Analytics, META tags, Blogs, Social Media

INTRODUCTION

MDGs to SDGs: (Millennium Development Goals to Strategic Development Goals is the new slogan of UNO(United Nations Organizations) and therefore transforming the physical world to digital/virtual world of communication, and accessibility of information for the marginalizes section of worlds' population is the only way forward. Inclusiveness – Clear focus on 'leaving no one behind and reaching the furthest behind first



**Brijlal Mallik et al.**

Measurability – Clear emphasis on monitoring, evaluation and accountability, and the metrics - high-quality, up-to-date and reliable data. There are not many studies conducted in Odisha in the area of digital marketing. This concept is rapidly emerging as a new concept which is aggressively adopted internationally for marketing success. In today's time, social media channels such as *Face book*, *Twitter*, *Google* and other social media firms have successfully transformed the attitudes and perceptions of consumers and in the end helped revolutionized many businesses. This was done through measurable vast network of customers with trustworthy data with real-time feedback of customer experiences. It is much more convenient for businesses to conduct surveys online with a purpose to get relevant information from targeted groups and analyzing the results based on their responses. Potential customers can look for reviews and recommendations to make informed decisions about buying a product or using the service. On the other hand, businesses can use the exercise to take action on relevant feedback from customers in meeting their needs more accurately. Change is constant and with time new ideas are accepted and adopted. In order to make the decision to understand the advantage of online marketing, advantages must be highlighted for industry players to realize its power.

LITERATURE REVIEW

The purpose of doing research in the area of digital marketing is because it seem huge, intimidating and foreign. Businesses are looking for clearer picture to start but do not know where and how to start doing digital marketing. In today's time, social media channels such as Face book, Twitter, Google and other social media firms have successfully transformed the attitudes and perceptions of consumers and in the end helped revolutionized many businesses. This was done through measurable vast network of customers with trust worthy data with real-time feedback of customer experiences. It is much more convenient for businesses to conduct surveys online with a purpose to get relevant information from targeted groups and analyzing the results based on their responses. Potential customers can look for reviews and recommendations to make informed decisions about buying a product or using the service. On the other hand, businesses can use the exercise to take action on relevant feedback from customers in meeting their needs more accurately. Digital marketing is the use of technologies to help marketing activities in order to improve customer knowledge by matching their needs (Chaffey, 2013). Marketing has been around for a long time. Business owners felt the need to spread the word about their products or services through newspapers and word of mouth. Digital marketing on the other end is becoming popular because it utilizes mass media devices like television, radio and the Internet. The most common digital marketing tool used today is Search Engine Optimization (SEO). Its role is to maximize the way search engines like Google find your website.

Evolution Of Digital Marketing In The World Vis-A-Vi India, Some Facts And Literature

The world of digital media is changing at a phenomenal pace. Its constantly evolving technologies, and the way people are using them, are transforming not just how we access our information, but how we interact and communicate with one another on a global scale. It's also changing the way we choose and buy our products and services. People are embracing digital technology to communicate in ways that would have been inconceivable just a few short years ago.

Most of the scholars have defined Marketing as an innovative practice adopted by the business organisations in order to execute the study of customer in reference with-

What customers want?

How this can be produced?

What will be the sound pricing of this need satisfying bundle?

Which place will be convenient for both seller and buyer?

How the satisfaction is released from the merchandise sold?

Coviello, Milley and Marcolin defines e-Marketing as "*Using the internet and other interactive technologies to create and mediate dialogue between the firm and identified customers*", different researchers have pointed out the Digital Marketing and expansion of Online Banking Services in different horizons, while at the same time the expansion of both is



**Brijlal Mallik et al.**

parallel and simultaneous. For the analysis of cost structure related with the Traditional and Electronic expenditure, we have taken implementation techniques of ABC (Activity Based Costing). The study concludes that the used and implementation of Digital Marketing provides companies an edge over the expenditure which appears as the additional revenue for the company. It is also evident from the study that the appropriate decrease in the transaction cost for companies after electronic channels was relatively higher than that of the traditional channels. Siam (2006) found the profitability of Jordanian Banks was affected by the Electronic Banking services, the study tried to investigate the reasons behind provision of Electronic Banking Services through the internet and their impact on Banking Services as a whole.

Some Facts about Indian Market Economy

People and demographics

- 1,166m people (estimate 2009)
- Urban population: 29%
- Age structure 0-14 years: 31.1% 15-64 years: 63.6% 65 years and over: 5.3%
- Literacy 61% age 15 and over can read and write Male 73.4% / female 47.8%

Industry

- High economic growth rate
- Pockets of high development, but large wealth divide
- Telecommunications infrastructure challenges remain
- Strong software industry
- Strong media and entertainments industry
- Strong outsourced services industry

Internet usage

- Internet access growth started accelerating in 2002
- Use data is skewed massively towards specific demographics
- Email has become an important business tool
- The web is proving itself as both an entertainment and business media platform
- There is a strong home-grown content industry, complemented by a strong IT sector

METHODOLOGY

Sampling: The sample comprising marketing professional in Bhubaneswar, ODISHA. Bhubaneswar is the biggest city in Odisha in terms of business presence and commercial activity which is why it was considered for this study. Hundreds of managers were surveyed in Bhubaneswar working in different organizations from media, FMCG, Pharmaceuticals, airlines, automobiles, petrochemicals and education. The final sample size was random 200 in which 93% are Men and 17% are Women from the city of Bhubaneswar.

Research Instrument: This study uses Wilska's (2003) instrument to measure perceptions of professional. All measures adapted use five-point likert scales. Various non-statistical validity checks were made prior to the questionnaire's actual implementation.

Firstly; all of these constructs were adopted from earlier studies providing acceptably reliable and valid measures. Secondly; these measures had acceptable reliability figures mostly stated in terms of Cronbach's alpha above 0.5. They have reported a reasonable internal consistency among the items; Cronbach alpha > 0.50 (Wilska, 2003). Finally these measures were processed in a systematic manner in the earlier stages of the research project. In addition to these steps, pre-testing of the questionnaire was also performed.

Data Collection: The strategy of using advertising agencies and their clients' worked really well in terms of questionnaire administration and provided a suitable environment necessary for target participant's involvement, motivation and convenience. All questionnaires were properly filled and 100% response rate was achieved.

Analysis



**Brijlal Mallik et al.**

The data was analyzed into ways a) descriptive statistics b) factors analysis.

Descriptive Analysis

The result from the study indicates that majority of the participants have a perception that digital marketing is a new mix for promotion but also have a negative perception that digital marketing can be misleading and is not useful for word of mouth (WOM) (See Table 1) Perceptions towards digital marketing tools and their effectiveness, it was found that mobile phone in terms of SMS and MMS having the highest value followed by online videos, google ranking, website content, YouTube and Facebook. All these tools are considered most important for implementing digital marketing practices. Surprisingly, In-depth understanding of technical tools of digital marketing such as Webinars, pay-per-clicks, Google analytics, Blogs and META tags scored low indicating lack of application of these tools and their understanding. (See Table 2)

Factor Analysis of Perceptions towards Digital Marketing

The data was analyzed in a number of stages. Firstly, exploratory factor analysis was used to determine the factor structure of items related to marketing professional perception towards digital marketing. Secondly, summated score was calculated for resultant digital marketing factors and finally individual differences were measured for marketing professional mindset factors. Factor analysis was conducted for the digital marketing perception mindset scale using a multi-step process which includes three steps; (a) extracting the factors; (b) labeling the factors; c) creating summated scales and examining the descriptive statistics.

Analysis of 12 items related to the digital marketing perception scale, using the maximum

Likelihood method of extraction with direct oblimin rotation, yielded, a four-factor solution, to which various criteria were then applied for refinement. Initially, the solution was examined to determine whether all the factors satisfied the Kaiser criterion (eigenvalues (1) and they did. All the items loading on each separate factor were found to cohere to some degree, and therefore they were included in their respective factors. The above analysis resulted in a final four-factor solution, comprising 12 items, all with communality values greater than 0.3. (See Table 3)

Factor 1 was labelled as '*Sceptical*'. This group is more sceptical about the importance and benefits of digital marketing. They agree up to certain extent that digital marketing is useful tool for promotional but on the other hand they also think that digital marketing also leads to privacy and misleading of information issues. They have the highest mean value of 2.54 and standard deviation of 0.74.

Factor 2 was labelled as '*Enthusiast*'. These professionals have been defined as enthusiast with digital marketing concepts and excited to include them for marketing success. They have a view that digital marketing is useful for creating marketing opportunities and have a positive outlook. They have the lowest mean value of 1.85 and standard deviation of 0.39.

Factor 3 was labelled as '*Utilitarian*'. It reflects persons who are most utilitarian in nature and more usage oriented. They use digital marketing services in their routine matters and it is something for them having important in their marketing professional job. The analysis shows that they are the keen user of digital marketing and they are keen on using them as utility in their professional marketing job. They are more concerned about the utility or usefulness of digital marketing concept and tools. They have the third highest mean value of 1.89 and standard deviation of 0.40.

Factor 4 was labelled as '*Parsimonious*'. It reflects a marketing professional who considers that digital marketing is important in terms of cost saving but also gives high importance for growth. They have the second highest mean value of 2.31 and standard deviation of 0.72.

RESULTS AND FINDINGS OF THE STUDY

The result suggests that professionals in Odisha are more sceptical towards digital marketing tools and concepts. They do not fully understand the benefits of digital marketing in terms of growth and cost effectiveness. Parsimonious group is more in favour of cost factors of digital marketing and considers it an important tool for





Brijlal Mallik et al.

growth. This segment of marketing professionals is using the digital marketing strategies and reflects new knowledge and training of professional in Odisha.

CONCLUSIONS

This survey examined the perception towards digital marketing of marketing professionals in Odisha. Although, digital marketing tools and concepts are taking over traditional methods of marketing internationally, it is still a new field for professionals operating in Odisha. According to this survey, professionals are sceptical about the usage and benefits of digital marketing and have been classified as Sceptical. They do consider it as an important tool for promotion but at the same time concerned about the issues of privacy and misleading of information of digital marketing. SMS and MMS are considered as the most important tool for conducting digital marketing which shows lack of understanding and in-depth usage of digital marketing tools by marketing professionals in Odisha.

REFERENCES

1. AJ Parsons, M Zeisser, R Waitman, "Organizing for digital marketing", McKinsey Quarterly, 1996
2. Boyd, D. M. & Ellison, N. B. 2007. "Social Network Sites: Definition, History and Scholarship", Journal of ComputerMediated Communication 13 (1), 210-230.
3. G. Reza Kiani, (1998) "Marketing opportunities in the digital world", Internet Research, Vol. 8 Iss: 2, pp.185 – 194.
4. YS Wang, TI Tang, JE Tang, "An instrument for measuring customer satisfaction toward web sites that market digital products and services", Journal of Electronic Commerce
1. Research, VOL. 2, NO. 3, 2001
5. A Sundararajan, Leonard N., "Pricing Digital Marketing: Information, Risk Sharing and Performance", Stern School of Business Working NYU, 2003
6. DC Edelman , "Four ways to get more value from digital marketing", McKinsey Quarterly, 2010
7. YB Song, "Proof That Online Advertising Works", Atlas Institute, Seattle, WA, Digital Marketing Insight, 2001.
8. J Chandler Pepelnjak, "Measuring ROI beyond the last ad", Atlas Institute, Digital
2. Marketing Insight, 2008.
9. A Munshi, MSS MUNSHI, "Digital marketing: A new buzz word", International Journal of Business Economics & Management Research, Vol.2 Issue 7, July 2012.
10. Thompson S.H. Teo, "Usage and effectiveness of online marketing tools among Business-to-Consumer (B2C) firms in Singapore", International Journal of InformationManagement, Volume 25, Issue 3, June Pages 203–213, 2005.
11. Mort, Gillian Sullivan; Drennan, Judy, "Mobile digital technology: Emerging issue formarketing", The Journal of Database Marketing", Volume 10, Number 1, 1 September 2002 , pp. 9-23.
12. Rick Ferguson, "Word of mouth and viral marketing: taking the temperature of the hottest trends in marketing", Journal of Consumer Marketing, Vol. 25 Iss: 3, pp.179 – 182, 2008.
13. Dickinger, Astrid, "An investigation and conceptual model of SMS marketing", System Sciences, Proceedings of the 37th Annual Hawaii International Conference, 5-8 Jan, 2004.
14. Nina Koiso-Kanttila, "Digital Content Marketing: A Literature Synthesis", Journal of Marketing Management, Volume 20, Issue 1-2, pg-45-65, 2004.
15. Michael Trusov, Randolph E. Bucklin, Koen Pauwels (2009). Effects of Word-of-Mouth Versus Traditional Marketing: Findings from an Internet Social Networking Site. Journal of Marketing: Vol. 73, No.5, pp.90-102.
16. Glynn Mangold, David Faulds, "Social media: The new hybrid element of the promotion mix", Business Horizons, Volume 52, Issue 4, , Pages 357–365, July–August 2009.
17. Hanna, Rohm, Crittenden, "We're all connected: The power of the social media
3. ecosystem", Business Horizons, Volume 54, Issue 3, Pages 265–273, May–June 2011.
18. Guoying Zhang, Alan J. Dubinsky, Yong Tan, "Impact of Blogs on Sales Revenue", International Journal of Virtual Communities and Social Networking, Vol.3, Pg 60-74, Aug-2013.





Brijlal Mallik et al.

19. Roland Helm, Michael Möller, Oliver Mauroner, Daniel Conrad, "The effects of a lack of social recognition on online communication behavior", *Computers in Human Behavior* Vol29, pg 1065-1077, 2013.
20. Pai, P, Arnott. DC, "User adoption of social networking sites: Eliciting uses and gratifications through a means-end approach", *Computers in Human Behavior*, Volume 29, Issue 3, Pages 1039–1053, May 2013.

Table 1 Perceptions towards digital marketing

| Perceptions | M | SD |
|--|------|------|
| Digital Marketing | | |
| ... is a new avenue for promotion mix. | 2.59 | .816 |
| ... may provide content not in line with our believes. | 2.59 | .816 |
| ... can be misleading. | 2.51 | .750 |
| ... rewrites contents for privacy issues. | 2.50 | .750 |
| ... accelerates revenue growth. | 2.31 | .726 |
| ... has low investment. | 2.31 | .726 |
| ... provides customer's participation. | 1.91 | .455 |
| ... generates immediate response from customers. | 1.91 | .455 |
| ... attracts attention very quickly | 1.86 | .426 |
| ... is much more measurable. | 1.85 | .398 |
| ... creates marketing opportunities. | 1.85 | .398 |
| ... useful for word of mouth (WOM). | 1.85 | .398 |

Table 2 Perceptions towards digital marketing tools and their effectiveness

| Digital Marketing Tools | M | SD |
|--------------------------------|------|------|
| Mobile Phone – MMS | 4.28 | .450 |
| Mobile Phone – SMS | 4.28 | .450 |
| Online Videos | 4.28 | .450 |
| SEO - Google Rankings | 4.28 | .450 |
| SEO - Keywords Tags | 4.28 | .450 |
| Website Contents | 4.28 | .450 |
| Youtube | 4.28 | .450 |
| Social Media – Facebook | 4.03 | .412 |
| Social Media – linkedIn | 4.03 | .412 |
| Social Media –Twitter | 4.03 | .412 |
| Webinars | 2.84 | .943 |
| Pay-per-click | 2.83 | .941 |
| Google Analytics | 2.31 | .726 |
| Inlinks | 2.31 | .726 |
| Blogs | 1.85 | .398 |
| E-Newsletters | 1.85 | .398 |
| SEO - Title Tags | 1.25 | .431 |
| SEO - META Tags / descriptions | 1.25 | .431 |

Table 3 Factorising to find out the most relevant Items

| Factors | Sceptical | Enthusiast | Utilitarian | Parsimonious |
|-------------------|-----------|------------|-------------|--------------|
| Items | | | | |
| M | 2.54 | 1.85 | 1.89 | 2.31 |
| SD | 0.74 | 0.39 | 0.40 | 0.72 |
| Digital marketing | | | | |





Brijlal Mallik et al.

| | | | | |
|--|------|------|------|------|
| ... is a new avenue for promotion mix. | 0.95 | | | |
| ... may provide content not in line with our believes. | 0.95 | | | |
| ... rewrites contents for privacy issues. | 0.94 | | | |
| ... can be misleading. | 0.93 | | | |
| ... is much more measurable. | | 0.95 | | |
| ... creates marketing opportunities. | | 0.95 | | |
| ... useful for word of mouth (WOM). | | 0.95 | | |
| ... provides customer's participation. | | | 0.92 | |
| ... generates immediate response from customers. | | | 0.92 | |
| ... attracts attention very quickly | | | 0.72 | |
| ... has low investment. | | | | 0.98 |
| ... accelerates revenue growth. | | | | 0.98 |





Challenges and Strategies for Effective Leadership in 21st Century

Chitrasena Padhy¹, M. Devender Reddy², Rabindra Kumar Raj³, Kaley Prasanna Pattanayak⁴

¹Assistant Professor, M S Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India

²Professor, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India.

³Professor, Siksha 'O' Anusandhan (Deemed University), Bhubaneswar, Odisha, India

⁴ Assistant Professor , School of Management, Centurion University of Technology and Management, Odisha, India.

Received: 07 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Chitrasena Padhy

Assistant Professor,
M S Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Paralakhemundi, Dist.-Gajapati, Odisha, India
Email: chitrasenapadhy@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Good leadership in the 21st century demands a complex and broad set of talents, including the driving ability for corporate objectives, cooperate with people, establish effective groups, and be technologically proficient, to name a few. Effective communication, problem-solving abilities, interpersonal skills, human relations skills, teamwork, good judgment and perseverance, and the capacity to create organizational capacities are all skills that leaders in the twenty-first century must have. Managers and leaders who acquire a modern attitude in order to deal with unique challenges are referred to be 21st century leaders. To overcome these challenges, purposeful trainings may be used to build leadership behaviour, talents, and attributes. These skills will allow leaders and managers to adopt the leadership style necessary to address today's leadership challenges. The most effective executives share one trait: they know how to keep their employees engaged. Members of the team if not engaged with their jobs may leave the firm. The world now possesses never-before-seen potential and capabilities for improving global human well-being. Leadership is critical for taking advantage of the opportunities and overcoming the complex difficulties that humanity faces today. Empathy is just the ability to comprehend and care for others. Empathetic leadership produces partnerships in which leaders actually understand and care about their followers' well-being and development. Artificial intelligence, drones, nanotechnology, solar energy, biotechnology, 3D printing, quantum computing, and other emerging technologies have an influence on everyone. Managers and executives must be aware of forthcoming developments, grasp their





Chitrasena Padhy et al.

ramifications, and consider how these problems might be utilised for themselves if businesses wish to stay ahead. It helps leaders to make more accurate predictions and create new ideas that consider future technology.

Keywords: Leadership, teamwork, attitude, empathy, predictions, challenges

INTRODUCTION

A leader's actions and decisions have a considerable impact on how a company works and flourishes. Some individuals believe that a good leader initiates the best in others and assists them in realising their full potential. People argue that a successful leader empowers others to achieve their maximum potential (Hosalikar, 2021). Managers and executives who adopt a modern attitude in order to deal with unique issues are referred to be 21st century leaders. This approach is focused on leadership behaviours, abilities, and attributes that can be learned and practised with rigorous research and training. These abilities will enable leaders and managers to develop a leadership style that is required to meet today's leadership problems (Krauthammer.com, 2022). The most effective leaders share one trait: they manage to keep their employees motivated. If team members feel disengaged, they might leave the company (Goleman, 2004). Over the previous two decades, leadership has changed away from authoritarian to collaborative fostering more teamwork, productivity, innovation, and creativity. The new method of working has enabled firms to innovate and be more creative, which is critical for gaining a competitive edge (Marsh, 2020). **It is necessary to enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries particularly in developing countries (Envision2030, Goal 9: Industry, Innovation and Infrastructure).**

Challenges for the leaders

Artificial intelligence, drones, nanotechnology, solar energy, biotechnology, 3D printing, quantum computing, and other emerging technologies have an influence on everyone. Managers and executives must be aware of forthcoming developments, grasp their ramifications, and consider how these problems might be utilized for themselves if businesses wish to stay ahead. It helps leaders to make more accurate predictions and create new ideas that consider future technology. For example, Elon Musk does not consider what we, or technology, can achieve right now; instead, he considers the capabilities of these technologies in five years and builds solutions that are matched with those capabilities (Nopp, 2020). Entrepreneurs must acquire entrepreneurial skills in order to meet the needs of the twenty-first century. Entrepreneurs, policymakers, administrative agencies, and educational institutions, including higher education, have a responsibility to assist in the development of skills acquisition by current and aspiring entrepreneurs (Pattanayak and Padhy, 2020). **Today, the globe has never-before-seen potential and abilities for promoting global human wellbeing and welfare. Leadership is desperately needed to take opportunities and tackle the multi-faceted difficulties that mankind faces today. These difficulties highlight the pressing need to project a unified global vision, win international support and multi-stakeholder commitment, improve institutional performance, and organise global society for successful action (Jacobs et al, 2019).**

Strategies

Understanding what is involved, taking stock of where you are, establishing a coalition of the willing, becoming clear on the need, and planning the strategy are the five leadership movements to get to 21st century management (Denning, 2020). In their lifetimes, leaders will have an impact on at least 250 individuals (Kehler, 2010). What people say and do, as well as how they work, have an impact on others. Empathy is just the ability to comprehend and care for others. It is not necessary for a leader to acquire the feelings of his or her employees or to attempt to please everyone. It simply implies that while making a choice, you should take into account the sentiments of your employees as well as other aspects. Empathetic leadership produces partnerships in which leaders actually understand and care about their followers' well-being and development (Wim, 2011). Personal presence, high levels of self-awareness, and the capacity to recognise the good and negative consequences of repetitive behaviours are





Chitrasena Padhy et al.

nine critical abilities that a 21st century leader must acquire. Clear fundamental principles that govern their actions and decisions, a clear and compelling vision that others can join, and facilitative abilities to ensure that all voices in the debate and cooperation are heard and appreciated. Spiritual practise, capacity to perceive and hear others, and a practical grasp of systems and how change occurs (Gransberry, 2018).

Seven leadership trends in 21st century (Hollon, 2011)

- 1. Investments in leadership development must be prioritized by organizations.**
- 2. Organizations must establish and implement a leadership plan as well as a strategy for leadership development.**
- 3. Leadership skills must be updated.**
- 4. Global leadership is required.**
- 5. Technological savvy is essential for effective leadership.**
- 6. Leadership development is increasingly aimed at all types of leaders.**
- 7. Leadership development should be viewed as a continual process instead of being considered as one-time event.**

The internal leadership challenges to face are remaining humble, having too little confidence, combating fear, following through, dealing with stress and anxiety, staying motivated, avoiding exhaustion, being sensitive, keeping your team inspired and motivated, developing, coaching and mentoring your employees, continuing to develop your own skills, guiding change, making difficult decisions, keeping everyone is on the same page, managing conflict, delivering bad news (Initiativeone.com, 2020).

Ten evolutionary leadership skills needed in the 21st century (Claremont Lincoln University, 2021)

Authenticity is Valuable.

Consider Holistic Leadership.

Emotional Intelligence should be improved.

Use networking opportunities to find good examples to learn from.

Start with yourself if you're ready to pivot.

Take advantage of remote leadership

Six key skills will make young professionals more effective leaders, ready to drive positive change(Poulsen, 2020)

Self-awareness

Learning mindset

Deep listening

Conflict management

Influencing without authority

Reframing

More importantly, those that believe in something, are willing to participate, and are passionate must be sought out in order to inspire innovation inside an organisation. Innovation leadership is defined as the ability to stimulate creative activity in yourself and others during times of creativity, invention, uncertainty, ambiguity, and risk (Gliddon et al., 2020)..

Authenticity, optimism, and emotional intelligence are essential qualities for success (Masterson, 2020).

Five qualities for leading business in the 21st century (Quist, 2019)

- 1. Make an effort to connect with your humanity.**
- 2. Maintain your authenticity;**
- 3. Appoint individuals who are better at their jobs than you are.**
- 4. Allow for calculated risk-taking.**
- 5. Do not feel the pressure to know it all**

Successful leadership in the twenty-first century demands a complex and broad set of talents, including the ability to drive for corporate objectives, cooperate with people, establish effective groups, and be technologically savvy, to



**Chitrasena Padhy et al.**

name a few. Leaders in the twenty-first century must also have enhanced cognitive abilities, including effective communication, problem solving, interpersonal skills, human relations skills, teamwork, decisiveness and perseverance, and the capacity to create organisational capacities (Sheikh, 2016). Do not fake it until you make it, put your heart into it, integrity counts, honour your responsibility to serve others, create a culture of inclusion, get the big picture, satisfy your internal customer, become a coach/mentor, work hard and play hard are ten ways that leaders can set a tone of integrity and professionalism for business success (Bourgeois, 2019). When leaders are able to communicate effectively, their message is more likely to be heard. The greatest method to keep a team engaged and productive is to speak with them on a frequent basis. Leaders should be able to express their feelings and opinions to others. Whether at a team meeting, by mail, or over the phone, communication should never cease. Becoming eloquent enough for others to comprehend without being perplexed and having strong listening skills are examples of effective communication abilities (Agrawal, 2021). The Purposeful Leadership Initiative was established by the University of Redlands to discover and positively affect today's leadership styles, skills, and methods. Educational opportunities, research, and community outreach are all part of the new programme (University Communications Staff, 2018).

CONCLUSION

An effective leader must be able to communicate openly. The first is a willingness to welcome new ideas or change. Change is an unavoidable aspect of life, and the leader must be willing to embrace it. Life comes to an end when change comes to an end. Recognizing and adjusting to change is an important component of leadership (Legas, 2015). Digital advancements can help emerging nations overcome global poverty and poverty in rural regions more quickly (Padhy *et al.*, 2022). Digitalization, the requirement for rapid speed and agility, upstart competitors, and a more diverse and demanding workforce all demand more from leaders. To flourish in the new digital economy, organisations must enable leaders to adapt their methods of functioning (Ready *et al.*, 2020).

REFERENCES

1. Agrawal, P, 2021, 9 Traits Every 21st-Century Leaders Needs, <https://www.entrepreneur.com/article/365376>
2. Bourgeois, T., 2019, Leading in the 21st Century: 10 Things You Must Know to Succeed, <https://www.amanet.org/articles/leading-in-the-21st-century-10-things-you-must-know-to-succeed/>
3. Claremont Lincoln University, 2021, Ten evolutionary leadership skills needed in the 21st century, <https://www.claremontlincoln.edu/news/10-evolutionary-leadership-skills-needed-in-the-21st-century/>
4. Denning, S., 2020, Your Leadership Moves To Get To 21st Century Management, <https://www.forbes.com/sites/stevedenning/2020/12/20/your-five-leadership-moves-to-get-to-21-century-management/?sh=70200f161897>
5. Envision2030, Goal 9: Industry, Innovation and Infrastructure, <https://www.un.org/development/desa/disabilities/envision2030.html>.
6. Gliddon, D., Rothwell, W., Innovation Leadership, 1st ed. Routledge: 2020, DOI: 10.4324/9781315178219.
7. Goleman, D., 2004 What makes a leader. Harvard Business Review, January. [Accessed: 6 October 2015] Available from hbr. org/2004/01/what-makes-a-leader <https://www.cose.org/en/Mind-Your-Business/Leadership-Development/21st-Century-Leadership-9-Skills-You-Must-Master>
8. Gransberry, M G., 2018, 21st Century Leadership: 9 Skills You Must Master,
9. Hollon, J., 2011, Leadership Development : 7 Key trends for the 21st Century, <https://www.tlnt.com/leadership-development-7-key-trends-for-the-21st-century/>
10. Hosalikar, S., 2021, What does it mean to be a leader in the 21st Century? <https://www.mygreatlearning.com/blog/what-does-it-mean-to-be-a-leader-in-the-21st-century/>
11. Initiativeone.com, 2020, 21 Leadership challenges and how to overcome them, <https://www.initiativeone.com/insights/blog/leadership-challenges/>





Chitrasena Padhy et al.

12. Jacobs, G., Passigli, D K., Chikvaide, D, 2019, Global Leadership in the 21st Century, <http://www.cadmusjournal.org/article/volume-3/issue-6/global-leadership-21st-century>
13. Kehler, KJ. 2010, Nine principles for effective leadership. Power to change business. [Accessed: 6 October 2015] Available from powertochange.com/discover/world/effectivaleadership
14. Krauthammer.com, 2022, What is 21st century leadership? The new skills every manager needs and how to develop them fast, <https://blog.krauthammer.com/21st-century-leadership>.
15. Legas, A., 2015, Qualities of Effective Leadership and its impact on good governance, <https://www.abysinia.com/blog-posts/item/1473-qualities-of-effective-leadership-and-its-impact-on-good-governance>
16. Marsh, E., 2020, How leadership has changed: 2000 versus 2020, <https://www.t-three.com/thinking-space/blog/leadership-2000-2020>
17. Masterson, A., 2020, What it takes to be a great leader in the 21st century, <https://www.irishtimes.com/business/work/what-it-takes-to-be-a-great-leader-in-the-21st-century-1.3365951>
18. Nopp, S., 2020, The leadership mindset of the 21st century, <https://blog.openexo.com/the-unclear-linkage-between-purpose-profit-maximisation-and-solving-global-challenges-0>
19. Padhy, C., Reddy, M D, Raj, R K., Pattanayak, K P., 2022, Role of Digital Technology in Agriculture, 13(71): 40287-40290.
20. Pattanayak, K P and Padhy, C., 2020, Entrepreneurial Skills and Competencies in the 21st Century for Business Growth – A Review, *Shodh Sarita*, 7(28): 84-89.
21. Poulsen, S., 2020, Six skills young leaders need for the 21st century, <https://www.thnk.org/blog/6-skills-young-leaders-need-for-the-21st-century/>
22. Quist, L., 2019, Five qualities for leading business in the 21st century, <https://knowledge.insead.edu/blog/insead-blog/five-qualities-for-leading-business-in-the-21st-century-13011>.
23. Ready, D A., Cohen, C, Kiron, D., Pring, B., 2020, The New Leadership Playbook for the Digital Age, <https://sloanreview.mit.edu/projects/the-new-leadership-playbook-for-the-digital-age/>
24. Sheikh, S, 2016, 7 Keys to Effective Leadership in the 21st Century, <https://www.noormii.com/articles/6953-7-keys-to-effective-leadership-in-the-21st-century>
25. **University Communications Staff, University of Redlands, 2018**, New program addresses needs and challenges of 21st century leaders, <https://www.redlands.edu/bulldog-blog/2018/october-2018/new-program-addresses-needs-and-challenges-of-21st-century-leaders/>
26. Wim, 2011, Empathy in leadership, 17 March. [Accessed: 6 October 2015] Available from emotion.alintelligence.tv/empathy-in-leadership





Risk and Return Analysis of Bombay Stock Exchanges

Pramod Kumar Patjoshi*

Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Pramod Kumar Patjoshi

Centurion University of Technology and Management,
Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Stock market is one of the vital indicators for economic development in a country. Different companies stocks use to trade in the stock market which involves both risk and return. The investors invest in the stock market with an expected return in the future. The actual returns of different stocks differ from expected return due to volatility in the stock market. When the volatility of the stock market is high the risk involves in the investment goes high. There is no fixed return and risk in the stock market. So trading in stock market is very risky for investors. It requires proper analysis of risk and return. Therefore the primary objective of this research is risk and returns analysis of major indices of Bombay Stock Exchange. The risk and return have analyzed by considering the daily closing value of sample indices. The study is centered on secondary data. The data for the study has been composed from the BSE website over a period of 10 years from January 1, 2020 to December 31, 2021. For achieving the above objective in addition to test the hypothesis, various methods like correlation, descriptive statistics and t test have been employed. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth.

Keywords: Keywords: Risk, Return, Bombay Stock, Exchange, Correlation, t test.

INTRODUCTION

Stock market is one of the vital indicators for economic development in a country. Different companies stocks use to trade in the stock market which involves both risk and return. The investors invest in the stock market with an expected return in the future. The actual returns of different stocks differ from expected return due to volatility in the stock market. When the volatility of the stock market is high the risk involves in the investment goes high. There is no fixed return and risk in the stock market. So trading in stock market is very risky for investors. It requires proper analysis of risk and return. So in the competitive world researchers are also doing the analysis of volatile stock market. This research will be help for investors to get more return from their investment. Bombay Stock Exchange (BSE) and National Stock exchange (NSE) are the two most important stock exchanges in Indian stock market (Patjoshi, 2020).





Pramod Kumar Patjoshi

LITERATURE REVIEW

Vikkraman and Varadharajan (2009), analysed that return can be maximised by properly analysing the risk. They have taken beta and other statistical model for the analysis. On the other hand Patjoshi (2011) analysed volatility in Indian stock market by taking various indices of BSE and NSE. However Nicholas and Nicholas (2011) studied in European stock market. They tried to find out the deviation of volatility in the crises period. They found that most of the stocks show negative and statistically insignificant leverage belongings. While Ratna (2013) has analysed the risk return by considering IT stocks and banking Stocks for the analysis. The result suggested holding the stock for a longer period of time to get good amount of return. Similarly Setiawan *et.al*, (2013) have taken Syariah stocks and orthodoxy stocks for the analysis. They have taken risk and return into consideration. They did not find any significant relation between risk and weekly return. On the other hand Ansar *et.al* (2014), have used "A-Y Model" for their study. They tried to find the performance of bullish and bearish market by analysing risk and return of different portfolios. While Sharma *et.al*, (2012) analysed the risk return trade-off between the stocks of South Asia Stock exchanges. They found that in South Asian countries high returns and rational risk are complicated. Similarly Shanmugasundram and Benedict (2013) analysed the risk and return of sectoral indices and Nifty. They used t-test and ANOVA for the study. Again Swarna Lakshmi, (2013) found the volatility pattern in different sectoral indices of Indian stock market. Autoregressive Conditional Heteroskedasticity (ARCH) an econometric model is used for the study. Eleven different sectoral indices have been taken for the period of 2008 to 2012. The result shows that the volatility was very high in reality sector and it was lowest in banking sector for the said period.

Patjoshi and Tanty (2016) analysed the stock market volatility in BSE and NSE of India While Gahan, Mantri, Parida and Sanyal (2012) analysed the volatility pattern in Indian stock market for both pre and post derivative period. They have taken daily closing return value of BSE Sensex and NSE Nifty for the period from 1992 to 2012 and 1995 to 2012. They have calculated volatility by taking the different structure of volatility such as perseverance, irregularity etc. for both pre and post derivative period. They found that the volatility of post derivative period is lesser than pre derivative period. They also found that the current news has more influence in the volatility in the post derivative period than the pre derivative period. Alternatively Patjoshi (2016) investigated the issue and challenges faced by the Indian Stock Market Similarly Patjoshi (2016) has done the research in Indian stock market. He has taken Sensex and banking stocks indices to find the risk and return for the analysis. Similarly; Patjoshi and Tanty (2017) scrutinizes the volatility of 30 companies of BSE SENSEX. They have taken daily return into consideration to find the volatility. Patjoshi and Mishra (2021) measured the volatility and have taken as initiative to focus on measuring the effect of volatility in crude oil prices on share prices of major petroleum companies in the Indian stock market.

Likewise, Patjoshi and Tripathy (2020) studied the investment alternatives for the people and their preferences towards investments of rural investors from the Barang Block, Odisha, India. Similarly, Patjoshi, Nandini and Tripathy (2020) studied the relationship between Sensex and selected international stock market using different tools of correlation and regression. While, Patjoshi and Mishra (2021) measure the volatility in crude oil prices and its impact of share prices of major petroleum companies in the Indian Stock Market. Patjoshi (2020) studied the risk and return of biotechnology companies share and also the impact of these shares return on Sensex in Bombay stock market. Similarly, Patjoshi and Tripathy (2020) studied the awareness of mutual funds and investors perception of investors towards investment in Indian mutual funds

Objectives of The Study

- a. To study the risks and returns comprise of major indices of Bombay Stock Market.
- b. To analyse the comparative risks & returns of BSE 30 and sample indices of Bombay Stock Market.

Hypothesis of The Study

Ho: There is no significant difference between returns of BSE 30 and major indices of BSE.



**Pramod Kumar Patjoshi****Methodology and Tests Used in the Study**

In this major indices of Bombay Stock Market have been used to examine the risk return trade off. The sample indices are BSE 30, BSE 100, BSE 200 and BSE 500. The risks and returns have examined by using the daily closing value all the sample indices. The study is based on secondary data. The data for the analysis has taken from the BSE website over a period of 2 years from January 1, 2020 to December 31, 2021. For satisfying the above objectives and for testing hypothesis, different methods like correlation, descriptive statistics and t test have been adopted in the study.

Risk and Return Analysis of Major Indices of Bombay Stock Exchange

Table-1 indicates the results of descriptive statistics of daily market returns of major indices of Bombay Stock Exchange from January 1, 2020 to December 31, 2021. It has depicted in the table -1 that average daily returns of all sample indices i.e, BSE 30, BSE 100, BSE, 200 and BSE 500 displayed positive returns. The average daily returns recorded highest of 0.0835 for BSE 500, however it recorded lowest of 0.0689 for BSE 30. Thus from the above certainly recommend that average daily return of BSE 30 has performed and provided lower return than that of all other sample indices returns over the study period. In the case of the standard deviation of BSE 30 is uppermost as compare to all sample indices returns. Therefore BSE 30 involves higher risk than that of all other indices returns, while BSE 500 return involves lower risk among all the sample indices as the standard deviation of BSE 500 recorded lowest of 1.5082 during the study period. The daily returns have fluctuated between -14.1017 to 8.5947, -13.8806 to 8.1427, -13.8278 to 7.8046 and -13.7891 to 7.4933 for BSE 30, BSE 100, BSE 200, BSE 500 respectively for the study period. The daily returns distribution of all sample indices are found to be negatively skewed.

Correlation between Major Indices of Bombay Stock Exchange

The Table-2 explains the correlation matrix for daily returns of major indices of Bombay Stock Exchange from January 1, 2020 to December 31, 2021. Table-2 shows the correlation between average daily return of major indices of Bombay stock exchange. It can found from above table that the entire sample indices of Bombay Stock Exchange average daily returns are highly correlated among them.

Analysis of t-Test: Paired of BSE 30 and BSE 100

Table 3 shows the t test result of BSE 30 and BSE 100 from January 1, 2020 to December 31, 2021. The t test results reflects that BSE 30 has shown lower return as compared to that of the BSE 100; leading to the conclusion that BSE 30 has not performed better and provided lower returns. Conversely, higher variance for BSE 30 daily returns as compared to BSE 100 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9936 signifies positive correlation between both the indices. The p-value of 0.3182, which is more than 0.05, indicates that there is no significant difference in the daily returns of BSE 30 and BSE 100 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of BSE 30 and sample indices of BSE) is accepted.

Analysis of t-Test: Paired of BSE 30 and BSE 200

Table 4 shows the t test result of BSE 30 and BSE 200 from January 1, 2020 to December 31, 2021. The t test results reflects that BSE 30 has shown lower return as compared to that of the BSE 200; leading to the conclusion that BSE 30 has not performed better and provided lower returns. Conversely, higher variance for BSE 30 daily returns as compared to BSE 200 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9887 signifies positive correlation between both the indices. The p-value of 1.6479, which is more than 0.05, indicates that there is no significant difference in the daily returns of BSE 30 and BSE 200 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of BSE 30 and sample indices of BSE) is accepted.



**Pramod Kumar Patjoshi****Analysis of t-Test: Paired of BSE 30 and BSE 500**

Table 5 shows the t test result of BSE 30 and BSE 500 from January 1, 2020 to December 31, 2021. The t test results reflects that BSE 30 has shown lower return as compared to that of the BSE 500; leading to the conclusion that BSE 30 has not performed better and provided lower returns. Conversely, higher variance for BSE 30 daily returns as compared to BSE 500 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9839 signifies positive correlation between both the indices. The p-value of 0.1361, which is more than 0.05, indicates that there is no significant difference in the daily returns of BSE 30 and BSE 500 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of BSE 30 and sample indices of BSE) is accepted.

CONCLUSION

All the sample indices have displayed positive returns. By comparing different sample indices, it found that BSE 30 has not performed well than that of all sample indices return over the study period. In the circumstance of the standard deviation of BSE 30 has higher standard deviation as compared to all sample indices. Consequently it designates that investment in BSE 30 involves higher risk than that of all other indices returns. The average daily return of BSE 30 is positively correlated with all sample indices' average daily returns. It has found from the t test that there is no significant difference between returns of BSE 30 and sample indices; therefore the null hypothesis (there is no significant difference between returns of BSE 30 and sample indices of BSE) is accepted. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth..

REFERENCES

1. Ansar Mahmood *et.al*, (2014). A risk-return based model to measure the performance of portfolio management. Management Science Letters, 4.
2. Shanmugasundram, G. and Benedict, D. J. (2013). "Volatility of the Indian sectoral indices-A study with reference to national stock exchange," International Journal of Marketing, Financial Services & Management Research, vol. 2, no. 8, pp. 1-11..
3. Lakshmi P. S. (2013). "Volatility patterns in various sectoral indices in Indian stock market," Global Journal of Management and Business Studies, vol. 3, no. 8, pp. 879-886..
4. Patjoshi, P.K. (2016). "Indian Stock Market – Practices, Issues and Challenges" Innovative Professional Science & IT, Vol.3 (1), January, pp. 28-37.
5. Patjoshi, P.K. (2016). "Stability of the day of the week effect in return and in volatility evidence from Bombay Stock Market" Journal of Management Research and Analysis, 166-170.
6. Patjoshi, P.K. and Tanty, G. (2016) "A Study on Stock Market Volatility Pattern of BSE and NSE in India" Asian Journal of Management, vol.7 (3):, July - September, pp.1-8.
7. Patjoshi, P.K. (2016) , "Comparative Risk Return Analysis of Bombay Stock Market with Selected Banking Stocks in India", IRA-International Journal of Management & Social Sciences, vol. 4 (1), pp. 193-200.
8. Patjoshi, P.K. and Tanty, G. (2017). "An Empirical Analysis on Volatility Pattern of Bombay Stock Exchange (BSE)" Siddhant- Vol. 17(2), April-June, pp. 114-122.
9. Patjoshi, P.K. and Nandini, G. (2020). Stock Market Anomaly: Day of the Week Effect in Bombay Stock Exchange with the Application of GARCH Model, International Journal of Innovative Technology and Exploring Engineerin2244-49.g, Volume-9 Issue-5,
10. Patjoshi, P. K. and Nandini, G. (2020), "Comparative Risk and Return Analysis of Bombay Stock Exchanges and Steel Sector in India", Gedrag&Organisatie Review., vol-33, no-2, 2020, pp.795-802.
11. Patjoshi, P. K. (2020), "Volatility Pattern of the Cement Companies in Indian Stock Market", Gedrag&Organisatie Review., vol-33, no-2, 2020, pp. 2944- 2951





Pramod Kumar Patjoshi

12. Patjoshi, P. K. and Tripathy, P. R. (2020) Investment Alternatives And Preferences Of Rural Investors: A Case Study Of Barang Block, Odisha, India, Journal of critical, 7 (19), 5565-5571
13. Patjoshi, P. K. (2020), Empirical Risk and Return Analysis Of biotechnology Companies in Bombay Stock Market, ShodhSarita, 7(28), 77-83
14. Patjoshi and Tripathy (2020) Study on Awareness and Perception of Investors Towards Indian Mutual Fund, GEDRAG & ORGANISATIE REVIEW, 33(2), 2976-85
15. Patjoshi, P. K. Nandini, G. and Tripathy, P. R. (2021) Examining Associations between Sensex and Selected International Stock Market, Annals of the Romanian Society for Cell Biology, , 25 (4), 10285 - 10290
16. Patjoshi, P. K. and Mishra, S. (2021), Measurement of Effect of Volatility in Crude Oil Prices on Share Prices of Major Petroleum Companies in the Indian Stock Market, Natural Volatiles & Essential Oils 8(5): 11613-11622
17. Setiawan, C. (2013). Syariah and Conventional Stocks Performance of Public Companies Listed on Indonesia Stock Exchange. Journal of Accounting, Finance and Economics, 3(1), 51 – 64.
18. Sharma, G. D. *et.al*, (2012). Rewards and Risks in Stock Markets: A Case of South Asia. The International Journal of Applied Economics and Finance, 6(2), 37-52.
19. Sinha, R. (2013). An Analysis of Risk and Return in Equity Investment in Banking Sector. International Journal of Current Research, 5(8), 2336-2338.
20. Vikkraman P & Varadharajan P. (2009). Study on Risk & Return analysis of Automobile industry in India (2004-2007): Journal of Contemporary Research in Management, 5(7), 35-40

Table-1 Descriptive Statistics of the Daily Returns of Major Indices of Bombay Stock Exchange

| Particulars | BSE 30 | BSE 100 | BSE 200 | BSE 500 |
|--------------------|----------|----------|----------|----------|
| Mean | 0.0689 | 0.0729 | 0.0788 | 0.0835 |
| Standard Deviation | 1.6089 | 1.5519 | 1.5261 | 1.5082 |
| Kurtosis | 17.4921 | 18.2587 | 18.9073 | 19.3539 |
| Skewness | -1.7670 | -1.9599 | -2.0826 | -2.2045 |
| Minimum | -14.1017 | -13.8806 | -13.8278 | -13.7891 |
| Maximum | 8.5947 | 8.1427 | 7.8046 | 7.4933 |

Table-2 Correlation of BSE 30 and Different Major Indices of Bombay Stock Exchange

| Particulars | BSE 30 | BSE 100 | BSE 200 | BSE 500 |
|-------------|--------|---------|---------|---------|
| BSE 30 | 1.0000 | | | |
| BSE 100 | 0.9936 | 1.0000 | | |
| BSE 200 | 0.9887 | 0.9989 | 1.0000 | |
| BSE 500 | 0.9839 | 0.9966 | 0.9992 | 1.0000 |

Table 3 t-Test: Paired of BSE 30 and BSE 100

| Particulars | BSE 30 | BSE 100 |
|---------------------|---------|---------|
| Mean | 0.0689 | 0.0729 |
| Variance | 2.5885 | 2.4085 |
| Pearson Correlation | 0.9936 | |
| t Stat | -0.4730 | |
| P(T<=t) one-tail | 0.3182 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.6364 | |
| t Critical two-tail | 1.9647 | |





Pramod Kumar Patjoshi

Table 4 t-Test: Paired of BSE 30 and BSE 200

| Particulars | BSE 30 | BSE 200 |
|---------------------|---------|---------|
| Mean | 0.0689 | 0.0788 |
| Variance | 2.5885 | 2.3290 |
| Pearson Correlation | 0.9887 | |
| t Stat | -0.8898 | |
| P(T<=t) one-tail | 0.1870 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.3740 | |
| t Critical two-tail | 1.9647 | |

Table 5 t-Test: Paired of BSE 30 and BSE 500

| Particulars | BSE 30 | BSE 500 |
|---------------------|---------|---------|
| Mean | 0.0689 | 0.0835 |
| Variance | 2.5885 | 2.2748 |
| Pearson Correlation | 0.9839 | |
| t Stat | -1.0993 | |
| P(T<=t) one-tail | 0.1361 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.2722 | |
| t Critical two-tail | 1.9647 | |





Antibacterial Properties of Rosemary (*Rosmarinus officinalis* L.) Essential Oil: A Short Account

Rosy Mallik*

Department of Chemistry, School of Applied Science, Centurion University of Technology and Management Paralakhemundi, Odisha-761211, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Rosy Mallik

Department of Chemistry,
School of Applied Science,
Centurion University of Technology and Management Paralakhemundi,
Odisha-761211, India.
Email: rosy.mallik@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Many plant species contain a complex mixture of volatile and aromatic compounds which are sources of various bioactive compounds. These volatile components when extracted are known as essential oils. The bioactive compounds are known to exhibit a range of activities such as antioxidant, antimicrobial, antifungal and free radical scavenging properties to name a few. Rosemary essential oil has been studied for its various medicinal properties. This paper presents a concise review of different activities of rosemary essential oil.

Keywords: Rosemary, *Rosmarinus officinalis* L., Essential oil, bioactivity, antioxidant, antifungal, antibacterial. SDG 3

INTRODUCTION

Originally grown in southern Europe, Rosemary (*Rosmarinus officinalis* L.) is a spice herb now cultivated worldwide. Fresh and dried rosemary is commonly used as a spice in cooking and seasoning whereas its essential oil is used as a flavouring agent in food processing. Rosemary has a long history of different usage in different cultures apart from culinary applications. Greeks wore rosemary wreaths on head and believed that it increases brain and memory power. In many European cultures fresh rosemary sprigs are worn in weddings. In middle ages, people burnt rosemary twigs to cleanse and disinfect the surroundings. Though those traditions were followed without much scientific reasoning at the time, modern day scientific studies have provided the underlying scientific logic to those traditions. Analyses and study of rosemary components have revealed that the presence of essential oils and tannins in fact produce aromatic smoke upon burning which has purifying and disinfectant properties.



**Rosy Mallik**

Most common applications of rosemary are found in traditional medicine, aromatherapy, perfumery and flavouring industries.

Components in rosemary leaves

The major components that are present in rosemary are α -pinene, camphor, 1, 8- cineol, borneol and bornyl acetate (Figure 1). Apart from these major components, rosemary also contains other terpenoids, sesqui-terpenoids and volatile phenolic components to a small extent (Figure 2).

Antibacterial properties of rosemary extract

Extracts of rosemary obtained from various extraction methods have been investigated for their biological activities. It has been found from experimental studies that rosemary extracts exhibit a broad range of biological activities against bacteria, microbes, fungi and have comparable effects as other phytoextracts. There are various mechanisms by which the essential oils can inhibit bacterial growth. Hydrophobicity of essential oils can partition the lipids of bacterial cell wall and makes them permeable. The phenolic compounds present in essential oils change the permeability of microbial cell wall. P. Kwiatkowski *et al.* compared the activity of rosemary oil (*R. officinalis L.*), with carawayoil (*C. carvil.*) and fennel oil (*F. vulgareMill.*) against gram positive bacteria *S. aureus* (DSMZ 346) and Gram-negative bacteria *E. coli* (DSMZ 1576)[1]. In their study, they found that rosemary oil inhibited the growth of *S. aureus* bacteria at a concentration of 0.5% (5 mg/g) and inhibited the growth of *E. coli*. bacteria at a concentration of 2% (20 mg/g). Fennel had shown bacterial growth inhibition at exactly same concentrations whereas caraway oil had a little better effect which exhibited bacterial growth inhibition of *S. aureus* bacteria and *E. coli*. bacteria at concentrations 1mg/g and 10 mg/g respectively.

Y. Fu *et al.* investigated the antibacterial activity of rosemary essential oil with the help of AFM (Atomic Force Microscopy). Rosemary essential oil was found to be effective against Propioni bacterium acnes, an anaerobic gram negative bacterium with a minimum inhibition concentration of 0.56mg/ml [2]. The cell wall of the bacterium was reduced drastically within 8 hours of rosemary oil application. A similar study was conducted by Y. Jiang *et al.* where effect of rosemary essential oil on three Gram-positive and 3 Gram-negative bacterial strains was monitored by AFM. The activity of essential oil was compared with activities of isolated major components 1, 8-cineole and α -pinene and found to have better antibacterial effect than the individual compounds [3]. The study revealed that superior activity of rosemary essential oil as a whole can be due to the bioactive minor compounds present in it which make significant contribution towards biological activity of the oil.

Yujie Fu *et al.* used rosemary essential oil (REO) in combination with clove essential oil (CEO) for enhanced antibacterial activity[3]. They tested the mixtures of REO and CEO in various ratios against gram positive and gram negative bacteria. The compositions of the essential oils were essential for antibacterial activity and clove oil was found to be more potent than rosemary oil for the bacterial strains. Interestingly additive antimicrobial effects could be seen for combinations of the two essential oils against *S. epidermidis*, *S.aureus*, *B. subtilis*, *E. coli*, *P.vulgaris* and *P. aeruginosa*. For *Candida albicans*, a synergistic effect of the combined oil mixture was noticed whereas the effect was antagonistic for *Aspergillus niger*. These observations were found for the combination of CEO and REO at ratios 1:5, 1:7 and 1:9. The higher percentage of eugenol in clove oil has been accounted for its antibacterial activity (Table 1). The research group of M. Viuda-Martos studied the antibacterial activity of rosemary with various other spices such as thyme, sage, cumin, clove and oregano [4]. At higher concentrations (25%, 50% and 100%) rosemary showed better and significant activity against *S. xylosus*, *S. carnosus*, *E. gergoviae*, *L. curvatus*, *E. ammigenus*, and *L. sakei*. as compared to other spices.

O.O. Okoh *et al.* performed a comparative study of antibacterial activities of rosemary extracts obtained in different extraction methods. They used hydrodistillation method and microwave assisted solvent free extraction method to obtain rosemary extracts. It is well documented that essential oils obtained from different extraction methods vary in their chemical compositions which also change the biological activities. They studied both gram positive and gram



**Rosy Mallik**

negative bacteria and found that the essential oil obtained from microwave extraction method in a solvent free condition had better activity as compared to the oil obtained by hydrodistillation method [5]. The outcome can be explained from the fact that there are more oxygenated compounds present in the essential oil obtained from microwave extraction method than the oil obtained by hydro-distillation method. Oxygenated compounds are known to be responsible for antibacterial activities of essential oils [6]. E. Issabeagloo *et al.* reported the antibacterial effect of rosemary essential oil against fourteen clinical isolates of Staphylococcus and Methicillin Resistant *S. aureus*. They observed better antibacterial activity of the rosemary essential oil against Gram positive bacteria than Gram-negative bacteria. They also found out that essential oils having highest amount of camphor, borneol, and verbenone exhibited best antibacterial activity [7].

Essential oils obtained from enzyme assisted extraction of rosemary and Thyme were tested for their antibacterial activity by K. Hoshniet al. Cellulase and hemicellulase were used for pretreatment of thyme and rosemary and the yields were improved considerably. For rosemary oil pre-treatment with cellulase increased the yield by 5%, pre-treatment with hemicellulase increased the yield by 50% and a combination of cellulase/hemicellulase increased the yield by 20%. [8]. The essential oils were tested for their antibacterial activity against *S. agalactiae*; *S. aureus* and *E. faecium* (Gram-positive bacteria); *E. coli* and *S. typhimurium* (Gram-negative bacteria). The essential oil obtained from hemicellulase pre-treatment was more active towards Gram-negative bacteria. Varied activities of rosemary essential oil towards different bacteria can be attributed to the variety of components present in it. For example, a combination of α -pinene and 1, 8-cineole present in rosemary essential oil enhance the effect against *S. typhimurium*. whereas camphor does not have any such effect on this particular strain. However, 1, 8-cineole rich essential oil has been found to have reduced antibacterial activity towards *S. aureus*. [9].

M. Sienkiewicz *et al.* studied the antibacterial activity of rosemary essential oils against clinical resistant strains of *Escherichia coli* and gram positive extended-spectrum β -lactamase bacteria and compared with basil essential oil. The average MIC values were found to be ranging from 18.25 $\mu\text{L/mL}$ to 19.5 $\mu\text{L/mL}$ for many of the bacterial strains [10]. Antibacterial and antioxidant effects of rosemary essential oils were studied by A. M. Ojeda-Sana against Gram-positive bacteria *Staphylococcus aureus* (ATCC 25923), *E. faecalis* (ATCC 29212), and Gram-negative bacteria, *E. coli* (ATCC 35218), and *Klebsiella pneumoniae*. The extracts rich in α -pinene has higher antibacterial activity against *S. aureus* (MIC value 10 $\mu\text{L/mL}$), *E. faecalis* (MIC value 26 $\mu\text{L/mL}$), and *K. pneumoniae* (MIC value 20 $\mu\text{L/mL}$), than the extract rich in myrcene whereas both α -pinene and myrcene rich extracts were equally effective towards *E. coli* (MIC value 14 $\mu\text{L/mL}$) [11].

Another comparative activity study of rosemary oil and clove oil (*Syzygium aromaticum*) was performed by B. H. Abdullah *et al.* against different strains of multidrug resistant bacteria. The essential oils, obtained by hydrodistillation method were tested against drug resistant bacterial strains of *S. aureus*, *E. faecalis*, *A. baumannii* and *P. aeruginosa*. Both rosemary and clove essential oils showed inhibitory effects against the above organisms, though clove had higher activity as compared to rosemary essential oils. Consistent with earlier studies of M. Viuda-Martos, in this study also rosemary was found to be effective at higher concentration (10% v/v).

CONCLUSION

Rosemary has been an essential condiment in various cuisines especially the Mediterranean recipes. Its aromatic profile has also been exploited in cosmetics, aromatherapy and perfumery as well. However, robust scientific exploration of rosemary essential oil and its components has gained interest rather recently. Presence of terpenoids and phenolic compounds in various proportions in the rosemary essential oil has shown interesting bioactive properties. Due to its significant antibacterial effect, rosemary essential oil can be used as natural antibacterial agent which can be used as an alternative for synthetic counterparts. Most importantly, it is also effective towards drug resistant bacterial strains as well. As shown in various studies, different components have different effects on the bacterial growth inhibition of different strains of bacteria, it will be interesting to see if the essential oils can be





Rosy Mallik

enriched with particular components to produce tailor-made antibacterial agents and replace the existing artificial antibacterial agents as a natural and safer alternative which in turn will provide a sustainable way for good health and overall well-being.

REFERENCES

1. P. Kwiatkowski, S. Giedrys-Kalemba, M. Mizieleńska, A. Bartkowiak Antibacterial activity of rosemary, caraway and fennel essential oils *Herba Pol*2015; 61(4): 31-39.
2. Y. Fu, Y. Zu, L. Chen, T. Efferth, H. Liang, Z. Liu, W. Liu Investigation of antibacterial activity of rosemary essential oil against *Propionibacterium acnes* with Atomic Force Microscopy *Planta Med*2007, 73, 1275-1280.
3. Y. Jiang, N. Wu, Yu-Jie Fu, W. Wang, M. Luo, C-J. Zhao, Y-G Zu, X-L Liu Chemical composition and antimicrobial activity of the essential oil of Rosemary *Environmental Toxicology and Pharmacology* 2011, 32, 63-68.
4. Y. Fu, Y-G. Zu, L-Y. Chen, X-G. Shi, Z. Wang, S. Sun, T. Efferth Antimicrobial Activity of Clove and Rosemary Essential Oils Alone and in Combination *Phytother. Res.* 2007, 21, 989–994.
5. M. Viuda-Martos, Y. Ruiz-Navajas, J. Fernandez-Lopez, J. A. Perez-Avarez Antibacterial activity of different essential oils obtained from spices widely used in Mediterranean diet *International Journal of Food Science and Technology*2008, 43, 526–531.
6. O.O. Okoh, A.P. Sadimenko, A.J. Afolayan Comparative evaluation of the antibacterial activities of the essential oils of *Rosmarinus officinalis* L. obtained by hydrodistillation and solvent free microwave extraction methods *Food Chemistry*2010, 120, 308–312.
7. F. Deba, T. D. Xuan, M. Yasuda, S. Tawatu Chemical composition and antioxidant, antibacterial and antifungal activities of the essential oils from *Bidens pilosa* Linn. Var. *Radiata*. *Food Control*2008, 19, 346–352.
8. E. Issabeagloo, P. Kermandadeh, M. Taghizadieh, R. Foroughi Antimicrobial effects of rosemary (*Rosmarinus officinalis* L.) essential oils against *Staphylococcus* spp *African Journal of Microbiology Research*2012, 6(23), 5039-5042.
9. K. Hosni, I. Hasseni, H. Chaabane, M. Jemli, S. Dallali, H. Sebei, H. Casabianca Enzyme-assisted extraction of essential oils from thyme (*Thymus capitatus* L.) and rosemary (*Rosmarinus officinalis* L.): Impact on yield, chemical composition and antimicrobial activity *Industrial Crops and Products*2013, 47, 291– 299.
10. M.J.Jordan, V.L.Maria, C.Rota, S.Loran, J.A. Sotomayor, Effect of bioclimatic area on the essential oil composition and antibacterial activity of *Rosmarinus officinalis* L. *Food Control*2013, 30, 463–468.
11. M. Sienkiewicz, M. Łysakowska, M. Pastuszka, W. Bienias, E. Kowalczyk The potential of use basil and rosemary essential oils as effective antibacterial agents *Molecules* 2013, 18, 9334-9351.
12. M. Ojeda-Sana, C. M. van Baren, M. A. Elechosa, M. A. Juárez, S. Moreno New insights into antibacterial and antioxidant activities of rosemary essential oils and their main components *Food Control*2013, 31, 189-195.
13. H. Abdullah, S. F. Hatem, W. Jumaa A Comparative Study of the Antibacterial Activity of Clove and Rosemary Essential Oils on Multidrug Resistant Bacteria *UK Journal of Pharmaceutical and Biosciences*2015, 3(1), 18-22.

Table 1: Compositions of CEO and REO

| Clove essential oil (CEO) | | Rosemary essential oil (REO) | |
|---|-----------|------------------------------|----------|
| eugenol | (68.52%), | 1, 8-cineole | (27.23%) |
| □-caryophyllene | (19.00%) | ●-pinene | (19.43%) |
| 2-methoxy-4-[2-propenyl] phenol acetate | (10.15%) | camphor | (14.26%) |
| | | camphene | (11.52%) |
| | | □- caryophyllene | (2.41%) |
| | | bornyl acetate | (1.13%). |
| | | borneol | (3.17%) |





Rosy Mallik

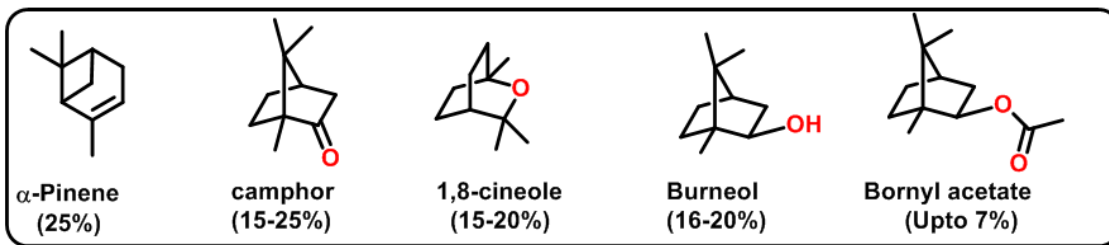


Figure 1: Major components in rosemary and their percentages

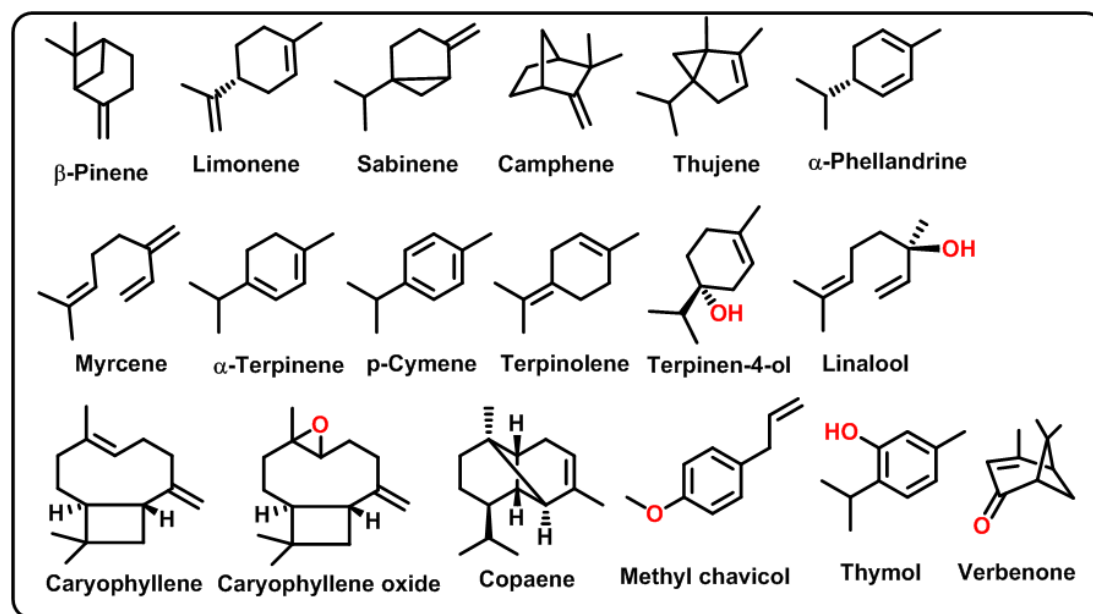


Figure 2: Minor components in rosemary





Secure Data De-duplication for Cloud Data Storage

Megha Shrivastava¹, Neeraj Shrivastava^{2*} and Vaishali Gupta³

¹Assistant Professor of Mathematics, Medicaps University, Indore, MP, India.

²Associate Professor, IPS Academy, Institute of Engineering and Science, CSE, Indore, MP, India.

³Assistant Professor, IPS Academy, Institute of Engineering and Science, CSE, Indore, MP, India.

Received: 14 Mar 2022

Revised: 15 Apr 2022

Accepted: 17 May 2022

*Address for Correspondence

Neeraj Shrivastava

Department of Computer Science & Engineering,
IPSA Institute of Engineering and Science Indore,
Madhya Pradesh, India Pin 452012
Email: neeraj0209@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Cloud computing is defying a champion among the foremost hard problems: i.e. information. Users are interacting with the cloud thus high traffic on cloud servers exist. In addition, of that for improving the availability and scalability of cloud data, the replicas are maintained on the server. These replicas are the duplicate of actual data, by which the storage overhead of the cloud servers increased. For the issue of security, privacy and data storage a new lightweight model is implemented. In this model, the text files are used for experimentation. The information encoded by Tiger hash generation algorithm and 3-DES algorithm. That information is additionally utilized with the hash generation algorithm utilizing the SHA1 algorithm. Presently a specific block of information is checked by the access information in the binary hash tree if the information exists then information is copy and need not transfer generally, the information is transferred to the server. The framework is actualized utilizing JAVA innovation in nearby measuring the framework execution. The results show the strategies implemented playing out a beneficial operation on contrasting and the customary system.

Keywords: Cloud Storage, Cryptographic Data, Data Deduplication.

INTRODUCTION

Now a day the cloud becomes an essential mechanism for any organization. Cloud computing includes cloud storage model which managed, maintained and backed up data. It has many focal points in like manner the record, which is secured in the cloud that can be gotten to at whatever point from wherever, however, we should have the web get to. Cloud storage can be characterized as "store information online in the cloud". It gives the facility of unwavering quality, openness, fast deployment etc [14]. Private, public and hybrid are three models in cloud-based storage. Public cloud storage profit offers multi-tenant storage. Private storage service is a dedicated & protected. The





Megha Shrivastava et al.

firewall also exists over there. Private cloud and public cloud storage service together make a hybrid cloud. Whenever the data is stored by a user, multiple replicas created at several places i.e. the same file stored at the several places by the different users it increases storage complexity. Data deduplication procedure assumes an unmistakable part in cloud computing. This is the technique which removes the duplicate data in the cloud. Jin Li, et al., [12] proposed a convergent encryption technique and data encrypted before outsourcing. They used duplicate check tokens; those are created by the private cloud server with keys. Every file attached a unique file token. Nimgire Reshma, et al., [2] proposed hybrid cloud architecture design duplicate checks in which duplicate check document tokens are created with the private key by the private cloud server. S. A. Telkar & Dr. M z Shaikh [3] developed a prototype, which performs client-side deduplication for security, storing & sharing data using the hybrid cloud.

Related Work

Triple DES (Triple data encryption standard) and RSA(Rivest-Shamir-Adleman) [17]

Triple DES is a symmetric block cipher and uses 56, 112 or 168 bits key length and 64 bits block size. In three-DES, the three-instance iteration is implemented to boom the encryption level and average time. It gets a secret 168-bit key, which is isolated into three 56 bit keys. RSA is an asymmetric block cipher and uses 2600 bits key length. It consumes more time. Asymmetric algorithms like RSA etc are slower than that of symmetric algorithms. It is the least secure algorithm as compared to 3des.

Comparison of MD5 and SHA/SHA-1 [18]

Problem and Solution

Managing data securely is of prior importance in cloud computing. The security includes the cryptography techniques to implement with the data on the cloud. Therefore, for the feature of accessibility and data availability i.e. anytime anywhere we can access the data providing a new solution which must be provided by the cloud. In this experimental work fig. 1, the text data is considered for work. The user selects a text file from their local file system for uploading to the cloud storage in which user select file is input to the implemented system. The text files are not always found in a similar size. Thus, some we extract the features from the text file. Firstly the input text file is read by the system separately to make and compute features from the files. Additionally, the original data is kept separate for further process. The content of the file is used in next process. After reading the contents of the input file special characters (" ", ".", ";", "@", "!") From the file are removing and then stop words (this, that, is, am, are and others) are removed from the content. In this context first, the frequency of each word in the file is computed. For computing the frequency of the word the following formula is used.

$$\text{Word frequency} = \frac{\text{total occurrence of the word}}{\text{total words}}$$

After computing the word's frequency the entire data or content remaining is sorted according to the computed frequency. Additionally, on those words are selected which are having a higher frequency for identifying the domain information. For making the regular size of data in this system or experiment is 50 features are selected. It is assumed that some amount of data and their features are existing on the server. Therefore the current file based features are compared with the existing list of features for domain identification. After identifying the domain of data it is considered the file is treated as the domain. Thus, it is labeled with the domain name as their domain indexing. After labeling of the file is encrypted for storing on the server. The original file which is provided as input to the system is encrypted in this phase. During the encryption process first, the hash key is generated using the tiger hash generation algorithm. That produces 512 bits of key block but the 3DES is not accepting such length of key thus the last bits of the tiger hash algorithm is discarded. Remaining 168 bits are used with the 3DES algorithm to encrypt the file. The encrypted file is used in next phase of the process. The encrypted file is used in this phase than the data is split in a fixed size of blocks. In this experiment, the 512 bits of data block is considered. That is not fixed it depends on the designer to create their own size. Each block of the file is not utilized with this phase of data processing. Here the individual block is treated with the SHA1 to generate the hash for the block data. The tree uses binary manner for mounting each block of data. Each block of data is mounted on the tree using the binary manner. Additionally,





Megha Shrivastava et al.

before constructing the tree, the block hashes are compared with the existing binary tree leaf nodes for finding the duplicate data. If the data is found in any leaf node the tree is not constructed further and only a mapping for that file is created. After validating the file availability the file is stored in the server space and for searching the similar files on the storage the tree is used for making fast access of data.

EXPERIMENTAL RESULT AND DISCUSSION

Time Complexity

Time consumption is the amount of time required to learn the given patterns from the storage using the selected algorithm. Fig. 2, initially, data size is small then the performance is linear thereafter time complexity is gaining high whenever we increase the input data file. Proposed approach consumes less time while traditional RSA taking more to process the algorithm

Space Complexity

The comparative memory consumption of both the algorithms namely Base method of RSA technique versus implemented method using triple DES of data security is given in fig 3.

Conclusion and Future Work

The projected work is meant to produce a secure information deduplication over encrypted cloud information for user information privacy. In this research work, we developed a privacy-preserving model to secure data deduplication for enhancing security for cloud data storage. These generated results of the Privacy preserving system and their performance parameters demonstrate the proposed technique is secure and efficient for a public cloud. It is secure and adaptable for different cloud storage services. The proposed work of privacy preserving for cloud data storage which is ensured to secure data deduplication in a secure access is implemented successfully. Additionally, the system performance with the cryptography implementation of the system is also acquired adaptable performance. Therefore, in the future, the proposed work considering this scheme can be further enhanced by uploading very large data and can do compression on those data. Also, enhance the Quality of Service (QoS).

REFERENCES

1. Hur, J., Koo, D., Shin, Y., and Kang, K.: Secure data deduplication with dynamic ownership management in cloud storage (Extended Abstract). In: IEEE International Conference on Data Engineering. San Diego, CA, USA, 69-70(2017).
2. Reshma, N., Snehal, K., Tejas, T., and Bhandari, G.M.: Deduplication & secure authorized data using hybrid cloud. In: Imperial Journal of Interdisciplinary Research, 2(6), 415-419(2016).
3. Telkar, S.A., and Shaikh, M.Z.: Secured and efficient cloud storage data deduplication system. In: International Journal of Advanced Research in Computer and communication Engineering, 5(1), 301-304(2016).
4. N.S., R., N. Gopal, G., and G.S.: A novel scheme for authenticated secured de-duplication with identity based encryption in cloud. In: International Conference on Information Science. Kochi, India, 228-232(2016).
5. Yao, X., Lin, Y., Liu, Q., and Zhang, Y.: A Secure Hierarchical Deduplication System in Cloud Storage. In: IEEE/ACM 24th International Symposium on Quality of Service (IWQoS). Beijing, China, 1-10(2016).
6. Hur, J., Koo, D., Shin, Y., and Kang, K.: Secure data deduplication with dynamic ownership management in cloud storage. In: IEEE International Conference on Data Engineering. San Diego, CA, USA, 3113 - 3125(2016).
7. Li, J.; Li, J.; Xie, D.; and Cai, Z.: Secure Auditing and Deduplication Data in Cloud. In: IEEE Transactions on Computers, 65(8), 2386 – 2396(2015).
8. Al-Sagar1, Z.S., Saleh, M.S., and Sameen, A.Z.: Optimizing the cloud storage by data deduplication : A Study. In: International Research Journal of Engineering and technology (IRJET), 2(9), 2524-2527(2015).





Megha Shrivastava et al.

9. Kaaniche, N., and Laurent, M.: A secure client side deduplication scheme in cloud storage environments. In: 6th International Conference on New Technologies, Mobility and Security (NTMS). Dubai, United Arab Emirates, 1-7(2015).
10. Nandini, J., and Reddy, R.N.: Implementation of hybrid cloud approach for secure authorized deduplication. In: International Research Journal of Engineering and technology (IRJET), 2(3), 1297-1306(2015).
11. Li, J., Chen, X., Li, M., Li, J., Lee, P.P.C., and Lou, W.: Secure deduplication with efficient and reliable convergent key management. In: IEEE Transactions on Parallel and Distributed Systems, 25(6), 1615 – 1625(2014).
12. Jin Li, Y.K. Li, X.C., Patrick P. C. Lee, W.L.: Hybrid cloud approach for secure authorized deduplication. In: IEEE Transactions on Parallel and Distributed Systems, 26(5), 1206-1216(2014).
13. Puzio, P., Molva, R., Onen, M., and Loureiro, S.: ClouDedup: Secure deduplication with encrypted data for cloud storage. In: IEEE 5th International Conference on Cloud Computing Technology and Science (Cloud-Com). Bristol, UK, 363-370(2013).
14. Cloud Storage and there types, from <http://searchcloudstorage.techtarget.com/definition/cloud-storage>, Last accessed, 2017/6/10
15. Explain Deduplication, from http://www.webopedia.com/term/d/data_deduplication.html. Last accessed, 2017/6/10
16. How deduplication works, from <http://www.computerworld.com/article/2474479/data-center/data-deduplication-in-the-cloud-explained-part-one.html>, Last accessed, 2017/6/15
17. Triple DES, from https://www.tutorialspoint.com/cryptography/triple_des.htm. Last accessed, 2017/6/22.
18. Difference between MD-5 and SHA-1, from <http://lnxsysadm.blogspot.in/2010/12/what-is-difference-between-md5-and-sha.html>. Last accessed, 2017/6/16.

Table 1. Comparison of different methods in hashing

| Factors | MD5 | SHA/SHA-1 |
|------------|--------------------------------|---|
| Key length | 128 bit/16 byte digest | 160 bit/20 byte digest |
| Speed | Faster than SHA | Slower than MD5 |
| Cost | Cheaper to Compute | Not cheaper than MD5 |
| Security | Less secure as compared to SHA | More secure and stronger against brute force attack |

| | |
|---|--|
| Input: input file F, Database storage S | |
| Output: Remove duplicate data | |
| Process: | |
| 1. | R = readInputFile(F) |
| 2. | DF _n = ComputeFeatures(R) |
| 3. | for(i = 1; i ≤ n; i + +) |
| a. | Domain = ComputeSimilarDomain(DF _i , S) |
| 4. | End for |
| 5. | Domain.AddFileIndex(F) |
| 6. | K = Tiger.GetHash(F) |
| 7. | E = TDES.Encrypt(F,K) |
| 8. | SP _m = File.split(E, 512) |
| 9. | for(j = 1; j ≤ m; j + +) |
| a. | H _j = SHA1.generateHash(SP _j) |
| b. | if (Tree.contains(H _j)) |
| i. | rejectUpload(SP _j) |
| c. | else |





Megha Shrivastava et al.

| | |
|----|------------------------------|
| i. | uploadFile(SP _j) |
| d. | end if |
| e. | end for |

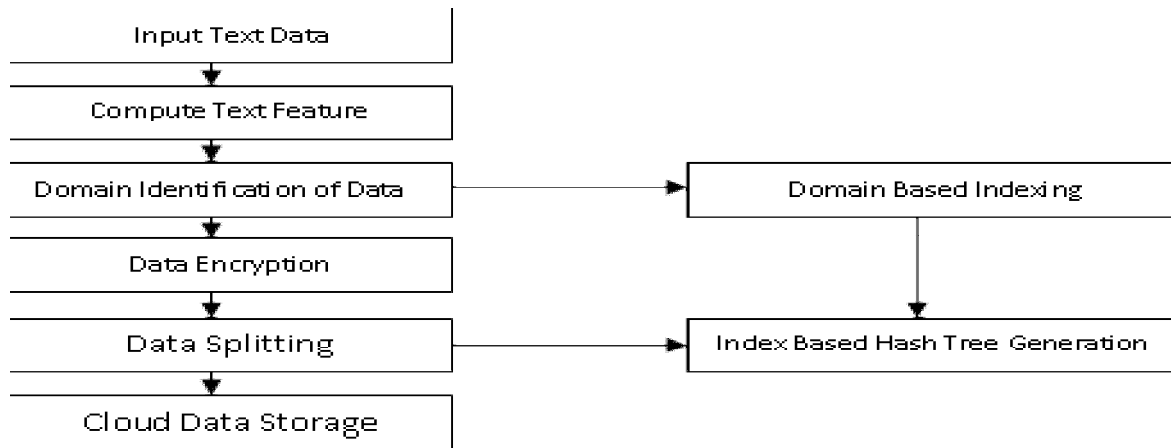


Figure: 1 Proposed Model

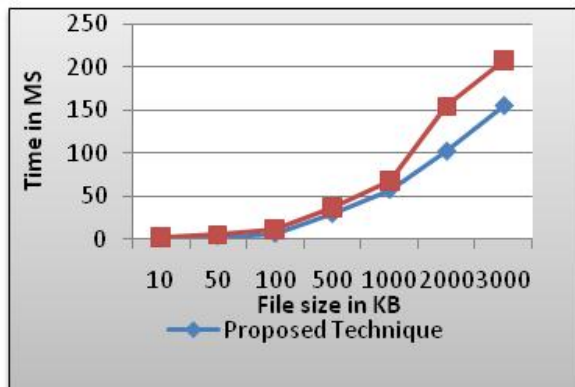


Figure 2 Time Complexity

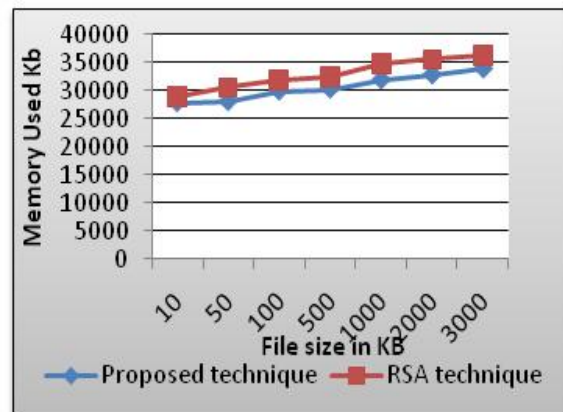


Fig. 3 Space Complexity





Oxidative Removal of Loperamide from Aqueous System: A Kinetic and Mechanistic Approach

Syed Y.H*

Department of Chemistry, Kohinoor Arts, Commerce & Science College Khuldabad, Dist. Aurangabad 431101

Received: 15 Apr 2022

Revised: 03 May 2022

Accepted: 24 May 2022

*Address for Correspondence

Syed Y.H.

Department of Chemistry,
Kohinoor Arts, Commerce & Science College
Khuldabad, Dist. Aurangabad 431101
Email: sdyusufchem@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The kinetic study of oxidation of loperamide with potassium dichromate in acid medium using UV Visible Spectrophotometer was investigated in temperature range of 298K to 318K. The observed reaction rate was first order with respect to loperamide and potassium dichromate. The rate was found to be not depending on concentration of sulphuric acid. The reaction product is found to be loperamide N-oxide and stoichiometry was recorded as one mole of potassium dichromate is required for oxidizing three moles of loperamide. On the basis of results obtained appropriate mechanism was proposed and enthalpy, entropy and Gibbs free energy calculated.

Keywords: Aqueous, Kinetics, Mechanism, Oxidation, Pharmaceuticals

INTRODUCTION

In many countries including India, there is increased availability and affordability of medical treatment which led to an increased production and consumption of different classes of pharmaceuticals. Nowadays, a number of pharmaceuticals have been reported to be potentially toxic substances which are found in more concentrations in the environment and consumption of medical treatment. [1][2] The pharmaceuticals are removed from the aqueous system through physical processes and biological processes. The efficiency of the removal of pharmaceuticals varies, depending upon the treatment process involved. A number of studies have confirmed conventional biological methods not being effective enough to provide for the complete removal of residual pharmaceuticals in wastewaters [3][4][5][6][7]. The chemical oxidation using different oxidizing agents is another process which gives satisfactory removal of pharmaceuticals from aqueous systems. In this study loperamide is oxidized using potassium dichromate in acid medium in the temperature range of 298K to 318K using UV Visible Spectrophotometer through kinetic and mechanistic approach. Loperamide is a pharmaceutical compound generally used to treat diarrhea. It slows



**Syed**

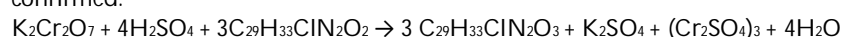
intestinal motility and affects water and electrolyte movement through the bowel and inhibits peristaltic activity by a direct effect on circular and longitudinal muscles of the intestinal wall. It prolongs the transit time of intestinal contents, reduces fecal volume, increases fecal viscosity and bulk density, and diminishes loss of fluid and electrolytes. It is a medicine used to treat effectively number of types of diarrhea. It includes control of acute nonspecific diarrhea, mild traveller's diarrhea, irritable bowel syndrome, chronic diarrhea due to bowel resection and chronic diarrhea secondary to inflammatory bowel disease.

MATERIALS & METHODS

All the chemicals are of analytical grade of purity supplied by local company. The stock solution of potassium dichromate was obtained by dissolving a known weight of it in double distilled water. The standard solution of loperamide was freshly prepared with double distilled water. The oxidation of loperamide by potassium dichromate was followed under pseudo-first order conditions where concentration of loperamide was excess over concentration of dichromate at 298K [8]. The reaction was initiated by mixing the required quantities of solutions of substrate and reagents with sulphuric acid. The unreacted dichromate was analyzed spectrophotometrically.

Stoichiometry and Product Analysis

Different reaction mixtures containing different concentrations of loperamide with excess concentrations of potassium dichromate in sulphuric acid were kept for 4-5 days for completion of reaction. The unreacted potassium dichromate was determined spectrophotometrically at 520nm. The stoichiometry of the reaction was found that one mole of potassium dichromate is consumed for oxidation of three moles of loperamide. Hence following equation is confirmed.



The reaction product was confirmed by using reaction mixture containing 0.1 mol dm⁻³, 0.2 mol dm⁻³ potassium dichromate and 0.1 mol dm⁻³ sulphuric acid. The reaction mixture was allowed to stand for 4-5 days for completion of the reaction. The reaction mixture was extracted with ether. The ether layer was neutralized using sodium bicarbonate and washed with distilled water. The ether layer was evaporated and dried to get product. The product was identified as loperamide N-oxide (C₂₉H₃₃ClN₂O₃). It is confirmed by spot tests [9].

RESULTS & DISCUSSIONS

To study the effect of concentration change of loperamide, potassium dichromate and sulphuric acid on oxidation at room temperature using UV-Visible spectrophotometer different concentrations of these substances were used and results were analyzed to calculate kinetic parameters.

Effect Of Loperamide Concentration

In this study the concentration of loperamide was varied from 1x10⁻² to 6 x 10⁻²mol dm⁻³ keeping all other conditions constant. Figure 1 represents plot of concentration of loperamide versus k_{obs}. The rate constant was found to be increasing with increase in concentration of loperamide with other conditions remaining constant indicating first order rate of the reaction[10].

Effect Of Oxidant Concentration

Concentration of oxidant i.e. potassium dichromate was varied from 1x10⁻³ to 6x10⁻³mol dm⁻³ keeping all other conditions constant. The k_{obs} values showed a sharp increase with the increase in concentration of potassium dichromate. The plot of log concentration of potassium dichromate versus log k_{obs} gives a straight line indicating first order dependence of the rate of the reaction on concentration of potassium dichromate.





Syed

Effect Of Temperature

Variation of temperature change on the rate of oxidation of loperamide was studied by conducting kinetic runs at different temperatures ranging from 298K, 303K, 308K, 313K and 318K keeping all other experimental conditions constant i.e. [LPM], [PD] and [H⁺]. The result shows increase in rate of reaction with the increase in temperature. From the linear Arrhenius plots of logk versus 1/T activation parameters were calculated and tabulated in table 4.

Effect of acid concentration

The oxidation of loperamide with potassium dichromate was studied with different concentrations of sulphuric acid keeping all other conditions of the reaction constant. There is no significant change in the rate constant with increasing sulphuric acid concentrations i.e. rate of the reaction is not depending on concentration of acid.

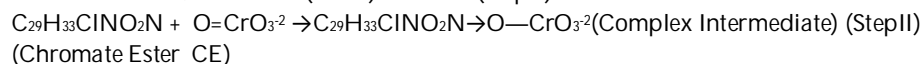
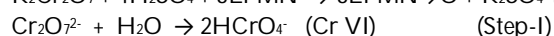
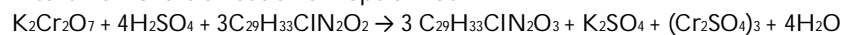
Free radical test

In the reaction mixture aqueous solution of acrylonitrile was added. It does not show initiation of polymerization reaction including non-involvement of free radical in the reaction sequences [11][12].

Effect of salts added

Different salts were added to study the effect of salt on the rate of oxidation of loperamide with potassium dichromate. Sodium chloride (NaCl), potassium chloride (KCl), potassium bromide (KBr) and magnesium chloride (MgCl₂) these salts were added to the oxidation reaction at 298K. It is found that the added salt has no effect on the rate of oxidation of loperamide and so there is no interaction of charged species during the reaction.

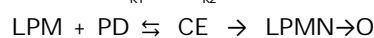
Mechanism of the oxidation of Loperamide:



Scheme- 1

The probable rate equation for the above reaction mechanism can be expressed as follows

$$-\frac{d[Cr_2O_7^{2-}]}{dt} = -\frac{d[CrO_4^{2-}]}{dt} = k_2 [CE]$$



We can apply steady state approximation to CE

$$\frac{d[CE]}{dt} = 0 = k_1[LPM][PD] - k_{-1}[CE] - k_2[CE]$$

$$[CE] = \frac{k_1}{k_{-1} + k_2} [LPM][PD]$$

The overall rate is the rate of formation of LPMN→O

$$\text{Rate} = \frac{d[LPMN \rightarrow O]}{dt} = k_2 [CE] = \frac{k_1 k_2}{k_{-1} + k_2} [LPM][PD]$$

Since k₋₁ is much smaller than k₂, k₋₁ << k₂ neglecting k₋₁ in the above equation, rate equation is reduced to

$$\text{Rate} = k_1[LPM][PD]$$





Syed

CONCLUSION

The most reasonable reaction mechanism which is suggested in scheme-1 has a fast intermediate formation between the substrate and the kinetically active chromate. It gets decomposed in the rate determining step to give rise to the final product. The kinetic study of oxidation of loperamide with potassium dichromate shows that loperamide undergoes oxidation in acid medium in which the nitrogen of piperidine part of the loperamide molecule which is sterically less hindered undergoes oxidation to yield loperamide-N-oxide as the main product. The rate of the reaction is first order with respect to substrate and oxidant but it is not depending on the concentration of acid. In the reaction the chromium(VI) exists in acid media as chromic acid H_2CrO_4 . It is indicated in the first step in scheme-1 [13] [14]. The negative value of entropy of activation indicates formation of rigid transition state. It can be concluded from kinetic data the overall mechanistic sequence described is consistent with product and scheme-1.

ACKNOWLEDGEMENT

The author is thankful to Principal Kohinoor Arts, Commerce & Science College Khuldabad, Dist Aurangabad for giving permission to carry out research work in the laboratory.

Conflict of Interest: The author does not have any conflict of interest

REFERENCES

1. Singh, P., Rani, B. and Maheshwari, R., 2011. Pharmaceutical pollution: A short communication. International Journal of Pharmacy and Biological Sciences (ISSN:2230-7605) 1 (2), 26-30.
2. Albrecht, R.J., 2012. Pharmaceuticals in the environment: Looking to green governance for a remedy. Journal of Energy and Environmental Law, 182-203.
3. Ternes, T.A. and Hirsch, R., 2000. Occurrence and behavior of x-ray contrast media in sewage facilities and the aquatic environment. Environmental Science and Technology 34, 2741-2748.
4. Kimura, K., Hara, H. and Watanabe, Y., 2005. Removal of pharmaceutical compounds by submerged membrane bioreactors (MBRs). Desalination 178, 135-140.
5. Vieno, N.M. Tuhkanen, T. and Kronberg, L., 2005. Seasonal variation in the occurrence of pharmaceuticals in effluents from a sewage treatment plant and in the recipient water. Environmental Science and Technology 39, 8220-8226.
6. Suarez, S., Carballa, M., Omil, F. and Lema, J., 2008. How are pharmaceutical and personal care products (PPCPs) removed from urban wastewaters? Reviews in Environmental Science and Biotechnology 7, 125-138.
7. Hollender, J., Zimmermann, S.G., Koepke, S., Krauss, M., McArdell, C.S., Ort, C., Singer, H., von Gunten, U. and Siegrist, H., 2009. Elimination of organic micropollutants in a municipal wastewater treatment plant upgraded with a full-scale post-ozonation followed by sand filtration. Environmental Science and Technology 43(20), 7862-7869.
8. Wiberg K.B., Oxidation in organic chemistry, Academic Press, London and New York, 1965.
9. F. Feigl, Spot tests in organic analysis, Elsevier, New York, NY, USA, 1957.
10. Joseph; Basheer K.M, Radhakrishnan Nair T.D., "Effects of substituents on the kinetics of the oxidation of benzyl chloride using acid dichromate, Asian J. Chem., 2007, 19(6): 4733-4738.
11. Vogel, A.I, Text book of practical organic chemistry, Longman, London, 1967.
12. Laidler K. Chemical Kinetics, McGraw Hill, New York, USA, 1965.
13. Bailey N, Carrington A, Lott KAK, Symons MCR "Structure and reactivity of the oxyanions of transition metals". Part VIII. Acidities and spectra of protonated oxyanions. J Chem Soc, 1960: 290-297.
14. Sasake Y Equilibrium studies on polyanions. 9. The first steps of acidification of chromate ion in 3M $Na(ClO_4)$ Medium at 25°C. Acta Chem Scand, 1962;16: 719-734.





Syed

Table 1: [LPM] mol dm⁻³ and k_{obs}

| | | | | | | |
|---|------|------|------|------|------|------|
| [LPM] mol dm ⁻³ | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 |
| k _{obs} X 10 ⁻⁴ s ⁻¹ | 5.0 | 5.5 | 6.1 | 6.6 | 6.9 | 7.3 |

Table 2: [PDF] mol dm⁻³ and k_{obs}

| | | | | | | |
|---|-------|-------|-------|-------|-------|-------|
| [PD] mol dm ⁻³ | 0.001 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 |
| k _{obs} X 10 ⁻⁴ s ⁻¹ | 4.9 | 5.4 | 5.8 | 6.3 | 6.9 | 7.5 |

Table 3: log k_{obs} at different temperatures

| | | | | | |
|---|-----|-----|-----|-----|-----|
| Temperature K | 298 | 303 | 308 | 313 | 318 |
| k _{obs} X 10 ⁻⁴ s ⁻¹ | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 |

Table 4: Activation Parameters

| | | | | |
|-----------------------|----------------------------|----------------------------|--|---------------------------|
| Activation Parameters | E _a | ΔH | ΔS | ΔG |
| | 14.106 kJmol ⁻¹ | 11.503 kJmol ⁻¹ | -270.81 JK ⁻¹ mol ⁻¹ | 96.28 kJmol ⁻¹ |

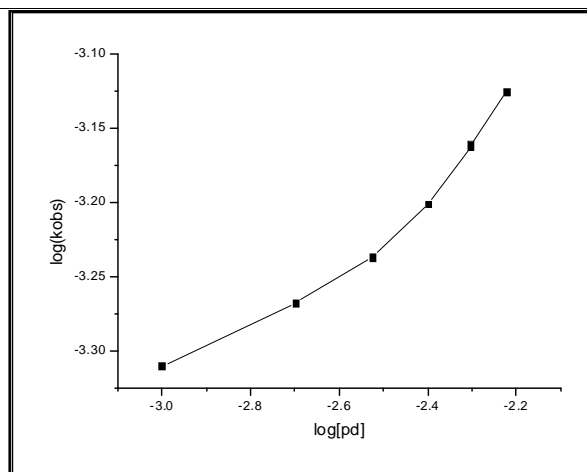
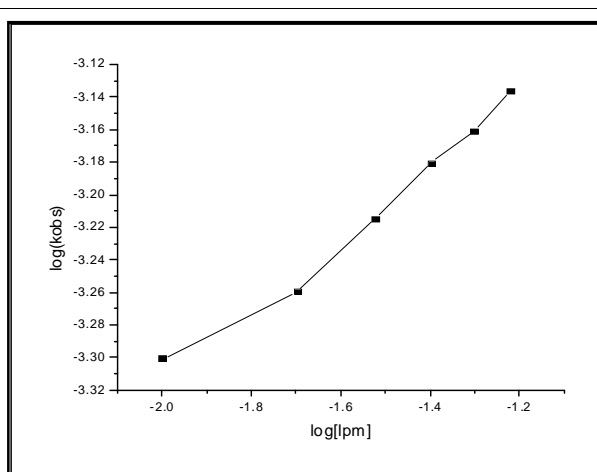


Figure 1: Plot of log(k_{obs}) vs log[lpm]

Figure 2: Plot of log(k_{obs}) vs log[pd]

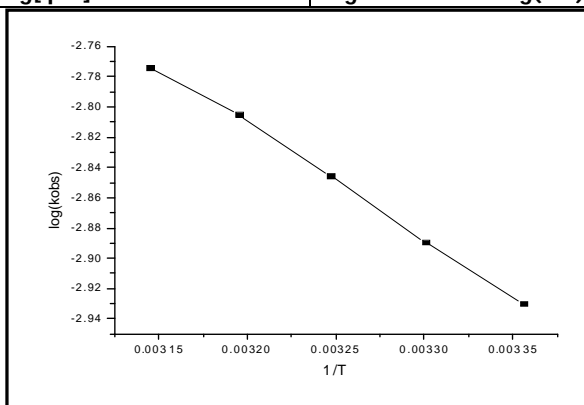


Figure 3: Plot of log(k_{obs}) vs 1/T





Design of Effective Double Loop Controllers for PV System Fed Negative Output Boost Converter

S. Vijai Ananth^{1*} and S. Singaravelu²

¹Research Scholar, Department of Electrical and Electronics Engineering, Annamalai University, Tamil Nadu, India

²Professor, Department of Electrical and Electronics Engineering, Annamalai University, Tamil Nadu, India

Received: 14 Apr 2022

Revised: 03 May 2022

Accepted: 25 May 2022

*Address for Correspondence

S. Singaravelu

Professor,

Department of Electrical and Electronics Engineering,

Annamalai University,

Tamilnadu, India

Email: ganapss@yahoo.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The sun's fluctuating strength and weather conditions still have an impact on solar power. A significant voltage difference will also have a negative impact on loads and the power grid. The Super-Lift Luo-Converter (SLLC) has a high voltage transfer gain, as well as other advantages like as improved efficiency, a simple structure, and low cost. The output voltage of a Double Loop Controllers (DLCs) can be made to track a reference value very precisely. As a result, a solar panel power system is constructed in this article with help of a Negative Output Boost Converter (NOBC) with feedback-loop control to achieve the appropriate DC output voltage. A NOBC is one topology of SLLC. Here, DLCs consists of Fuzzy Logic Controller (FLC)/Proportional Integral (PI) control act as outer loop control for output voltage regulation whereas Proportional (P) is perform as inner loop current controller for regulating the inductor of the NOBC at different irradiation. To ensure that the produced system satisfied the design criteria under various operating situations, a MATLAB/Simulink simulation was used. The final output voltage was found to be stable, indicating that the proposed solar panel system could successfully improve output voltage stability.

Keywords: DC-DC Conversion, Luo Converters, Double Loop Controllers, Fuzzy Logic Controllers, Proportional Integral Controller, Proportional Controller.





INTRODUCTION

The usage of renewable energy has become a hot topic in most countries throughout the world due to the rapid depletion of fossil energy resources and environmental concerns [1][2]. Solar and wind energy have previously been produced and put to use on a significant scale in a range of applications [3]. As a result, the focus of this study is on a solar panel system investigation. Solar panels, despite being one of the most popular renewable energy sources, have a significant drawback. That is, a solar panel's output is unsteady as a result of fluctuating sunshine and weather conditions, resulting in varying output voltage [4]. Unstable voltage is unacceptable, whether for loads or the electrical grid. To fix this problem, you'll need a good and dependable control module. Furthermore, to reach the needed high output voltage, DC-DC converters are widely utilised in solar panel systems. As a result, in a solar panel system, a DC-DC converter with closed-loop control is a good choice for producing a stable output DC voltage at a desired voltage level [5]. Fundamental converters, such as the Boost and Buck converters, on the other hand, cannot be employed in high-power applications and have significant disadvantages. Conversion techniques have advanced rapidly in recent years, and there are numerous DC-DC converter topologies available. The most common of them is the Super-Lift Luo Converter (SLLC), which has a very high voltage transfer gain. In this article, Negative Output Boost Converter (NOBC) is selected for study [9]. A NOBC is one of the topology of SLLC. The classical linear controllers design for various DC-DC converters was reported [6-7]. However, the classical controllers are not able to regulate the output of the same converter during large irradiation of solar panels. Therefore, non-linear controller is best choice for these issues. Fuzzy Logic Controller (FLC) is a kind of non-linear controller [8]. The fuzzy rules are framed based on converters performance without mathematical modelling which is one the merit of FLC. The goal of this study is to use the MATLAB/Simulink software platform to develop a solar-panel power system that uses the NOBC in conjunction with Double Loop Controllers (DLCs) to achieve the necessary output voltage and inductor current at varied sun irradiation. Here FLC is used as outer voltage loop, while P controller is applied as inner current loop for NOBC with solar system as input.

Design of Solar System Fed NOBC

After all of the blocks were pre-prepared, the system was completely designed for simulation. The system includes four major components, as shown in Fig. 1:

Solar Cell Modeling

A solar panel, a NOBC, a load, and DLCs. Each component is described in detail in the sections below.

Fig. 2 shows the modelling of PV cell. The output of the current source is proportional to the amount of light falling on the cell (photo current ($I_{pv, cell}$)). As a result, the modelling process for this solar cell will be designed using the (1)

$$I = I_{pv,CELL} - I_{diode} = I_{pv,CELL} - I_{o,CELL} \left[\exp\left(\frac{q*V}{\alpha*k*T}\right) - 1 \right] \quad (1)$$

Where,

$I_{pv,CELL}$, is the current generated by the incident light.

I_{diode} , is the Shockley diode equation. $I_{o,CELL}$ (A) is the reverse saturation or leakage current of the diode [A].

q is the electron charge [1.60217646 x 10⁻¹⁹ C].

K is the Boltzmann constant [1.3806503 x10⁻²³ J/K]. T [K] is the temperature of the p-n junction.

α is the diode ideality constant which lies between 1 and 2 for mono crystalline silicon. According to Equation (1), the elementary PV does not represent the I-V characteristic of real-time PV arrays. Practical modules, which are made up of many connected PV cells, necessitate the addition of additional parameters R_s and R_p , which are then substituted in (1) and expressed as (2)





Vijai Ananth and Singaravelu

$$I = I_{pv,CELL} - I_{o,CELL} \left[\exp\left(\frac{V + R_s * I}{V_t * \alpha}\right) - 1 \right] - \frac{V + R_s * I}{R_p} \tag{2}$$

According to equation, the light-generated current of the module depends linearly on solar irradiation and is also influenced by temperature (3)

$$I_{pv} = (I_{pv,n} + K_I \Delta T) \frac{G}{G_n} \tag{3}$$

Where K_I is the I_{sc} temperature coefficient, G is the irradiance (W/m²), and G_n is the irradiance under typical operating conditions. The temperature dependence of diode saturation current I_o can be expressed as (4)

$$I_o = I_{o,n} \left(\frac{T_n}{T}\right)^3 \exp\left[\frac{q * E_g}{\alpha * K} \left(\frac{1}{T_n} - \frac{1}{T}\right)\right] \tag{4}$$

Operation NOBC

The NOBC power circuit diagram is shown in Fig. 3(a). Source voltage V_{in} , capacitor C_1 , input inductor L_1 , power switch (n-channel MOSFET) Q , freewheeling diodes D_1 , and load resistance R are the components. The NOBC power switch Q may be controlled to provide efficient voltage step-up capability. All of the components are assumed to be in perfect working order, and the NOBC runs in CCM mode. To study the operation of the NOBC circuit, it can be divided into two stages: switch-on and switch-off. Figures 3 (b) and (c) show the NOBC's two operation intervals [9]. When the Q is turned on in stage 1, the V_{in} charges the capacitor C_1 , increasing the current via the inductor i_{L1} . The corresponding circuit of NOBC in stage 1 operation is shown in Fig. 1(b) (b). In stage 2, when Q is turned off, i_{L1} falls with a voltage of $-(V_{C1} - V_{in})$. The current i_{L1} is carried by the freewheeling diode D_1 . The corresponding circuit of NOBC in stage 2 operation is shown in Fig.1 (c) [9]. The voltage transfer gain is

$$G = \frac{V_o}{V_{in}} = \frac{1}{1-d} - 1 \tag{5}$$

Modeling of NOBC

The inductor current i_{L1} and the capacitor voltage V_{C1} ($= V_o$) are the state variables of NOBC, respectively x_1 and x_2 . The state space equation can be engraved as when the Q is in the ON position (Fig. 3 (b)).

$$\begin{cases} \frac{di_{L1}}{dt} = \frac{V_{in}}{L_1} \\ \frac{dV_{C1}}{dt} = \frac{V_{C1}}{C_1 R} - \frac{V_{in}}{RC_1} \end{cases} \text{ Switch ON (6)}$$

In the same way, when the Q is turned off (Fig.3 (c)), the state space equation can be written as

$$\begin{cases} \frac{di_{L1}}{dt} = \frac{V_{in}}{L_1} - \frac{V_{C1}}{L_1} \\ \frac{dV_{C1}}{dt} = \frac{i_{L1}}{C_1} + \frac{V_{in}}{RC_1} - \frac{V_{C1}}{RC_1} \end{cases} \text{ Switch OFF (7)}$$





Vijai Ananth and Singaravelu

With state variables i_{L1} and V_{C1} , the state-space average modelling of the analogous circuit of NOBC is given by

$$\begin{bmatrix} \dot{i}_{L1} \\ \dot{V}_{C1} \end{bmatrix} = \begin{bmatrix} 0 & -\frac{1-d}{L_1} \\ \frac{1-d}{C_1} & -\frac{1}{RC_1} \end{bmatrix} \begin{bmatrix} i_{L1} \\ V_{C1} \end{bmatrix} + \begin{bmatrix} \frac{1}{L_1} \\ \frac{1-2d}{RC_1} \end{bmatrix} V_{in} \tag{8}$$

Where d is switch's switching duty cycle.

$$A = \begin{bmatrix} 0 & -\frac{1-d}{L_1} \\ \frac{1-d}{C_1} & -\frac{1}{RC_1} \end{bmatrix}, \quad B = \begin{bmatrix} \frac{1}{L_1} \\ \frac{1-2d}{RC_1} \end{bmatrix} \tag{9}$$

Where, A and B are averaged system state space matrices. Tables 1. show the specifications of the designed system.

Design of Effective DLCS

The input voltage from the solar panel varies since the amount of sunshine varies and the weather is unpredictable. The solar panel's rated voltage is 12 volts, although it can range from 12 volts minus 20% to 12 volts plus 20%. A closed-loop control for the NOBC is required to achieve a consistent output DC voltage. DLCs are an excellent solution to achieve the criteria while also providing a quick dynamic response [9]. For inner current loop control, a proportional (P) controller is employed, and for outer voltage loop control, a proportional-integral (PI) controller and FLC are used to make the output voltage closely track a reference value. To generate the PWM wave that will be used to control the IGBT, the triangular wave comparison method is used. As a result, the duty cycle d of the NOBC is controlled. d does not need to be pre-set because this is an automatic control. The DLCs' block schematics are illustrated in Fig.4.

Design of PI Controller

In NOBC, a P/PI controller is chosen to provide better output voltage regulation. The DC output voltage is sensed and compared to the reference Output voltage to generate an error signal. The P/PI controllers use this error signal to keep the output voltage constant and reduce the steady-state error. The proportional gain (K_p) and integral times (T_i) of the P/PI controllers are obtained using the Zeigler – Nichols tuning method [10-11].

NOBC Transfer Function (T.F) model is,

$$T.F = \frac{-334.3 s + 8.433e7}{s^2 + 667.7 s + 2.093e7} \tag{10}$$

The characteristics equation with proportional control (K) of (10) is expressed

$$S^2 + (666.72 - 333.33K)s + (K8.33 e^7 + 2.0833e^7) = 0 \tag{11}$$

The routh array of equation (11) is

$$S^2: 1K8.33 e^7 + 2.083e^7$$

$$S^1: 666.72 - 333.33K$$

$$S^0: K8.333 e^7 + 2.0833e^7$$





Vijai Ananth and Singaravelu

The range of K for stability from this routh array is $K > 0$, $K < -0.34$, $(667.7-334.3K) > 0$, $K > 2$, $0 < K < 2$. As a result, the ultimate critical gain $K_{cr} = 2$. When $K=2$, the imaginary roots since the S1 row are both 0. The corresponding auxiliary equation is as follows:

$$S^2 + (16.66 + 2.0833) e^T = 0 \quad (12)$$

as well as their corresponding roots $= 13527.7$ rad/sec and $P_{cr} = 2 * \pi = 84954.26$. The NOBC reaches the expected steady state with few oscillations after tuning the controller with this method, with the ultimate gain for stability being $K_{cr} = 0.0211$ and the corresponding ultimate period being $P_{cr} = 0.001222$ s. The values of $K_p = K_{cr}/2 = 0.013205$ and $T_i = P_{cr}/2 = 0.001333$ s are determined using this method.

Design of FLC

The FLC main purpose is to control the output voltage of the NOBC, and it is also placed outside of the control loop [8]. The FLC's entering (inputs) and leaving (outputs) parameters are depicted in Figs. 5 (a), (b) and (c). The NOBC output voltage error (e) and its corresponding change in output voltage error (ce) are fed into the FLC, and the output (o) is produced i_{ref} . For feasibility, the statistical ranges of the FLC's e, ce, and o can be identical, as shown in Figs. 5 (a), (b) and (c), and their corresponding fuzzy sets are [NB, NM, NS, Z, PS, PM, PB], where PS (positive small), PM (positive medium), PB (positive big), NB (negative big), NS (negative small), and Z (zero), respectively. As e and ce, trapezoidal membership functions are used (refer Fig.3). The FLC rules are written with this converter behaviour in mind. This design contains 49 rules, which are catalogued in Table 2. Following that, the weighted average method (one of the defuzzification methods) is used to complete the FLC design. Fig. 6 depicts the three-dimensional surface view of FLCs such as e, ce, and o.

Simulation Study

The simulation analysis of the NOBC with DLCs is discussed in this section. The parameters of the same model utilised in this study are listed in Table I. Figs 7(a)-7(d) show MATLAB/Simulink models of NOBC with DLCs. The simulated V_o , I_{L1} , and V_{in} of NOBC with P cum PI control when the input voltage step is changed from 12V to 18V and 12V to 06V are shown in Figs. 8 and 9. These findings clearly show that during V_{in} changes, V_o of NOBC with controller produced peak overshoots of -8V and a settling time of 0.04 s. The output current and input current or PV current, of the NOBC with P cum PI control during line fluctuation from 12V to 18V is shown in Fig. 10. The simulated results were found to be quite close to the theoretical values recoded in Table I. For load resistance adjustments from 50 ohm to 30 ohm and 50 ohm to 70 ohm, Fig. 11 shows the simulated V_o and I_o of NOBC with P cum PI control. These findings clearly show that during load changes, V_o of NOBC with controller produced peak overshoots of -6V and a settling time of 0.04 s. The simulated V_o and V_{in} of NOBC with P cum FLC for input voltage steps of 12V to 18V and 12V to 06V are shown in Fig. 12. In the input voltage changes, these findings clearly show that V_o of NOBC with controller has zero peak overshoots and null settling time. For load resistance changes from 50 ohm to 30 ohm and 50 ohm to 70 ohm, Fig. 13 shows the simulated V_o and I_o of NOBC with P cum FLC. In the input voltage changes, these findings clearly show that V_o of NOBC with controller has zero peak overshoots and null settling time. For an input voltage change from 12 V to 06 V, Fig.14 shows the simulated efficiency, input power, and output power of NOBC with P cum FLC and P cum PI control. These findings show that NOBC with P cum FLC has 96.6 percent efficiency over P cum PI control, which has 96.06 percent efficiency. Table 3 shows the time domain specs of NOBC with controllers. The developed FLC cum PI control has superior performance when compared to the P cum PI control, as shown in the Table 3.

CONCLUSION

This paper looked into the use of NOBC in a solar panel system. This study's utilisation of the NOBC with P cum FLC/PI controller was a highlight. The author sought to fix the issue of the solar panel's changing output voltage, as indicated at the introduction. To achieve their goal, the authors designed a solar panel system that used a NOBC with a DLCs to convert the voltage from the solar panel into the required more voltage and stabilize the V_o . All of





Vijai Ananth and Singaravelu

the design requirements were met, indicating that the design was successful, according to the simulation findings. The author also noticed that the inductance and capacitance values used in the simulation had a significant impact on the results. If L1 is set too high or C1 is set too low for the NOBC, it will take longer to maintain a constant output voltage. This design has a lot of application potential. Solar energy, first and foremost, has become a worldwide hotspot. As a result, it is inextricably related to the expanding renewable energy trend. Second, while solar power has a bright future, it does have some disadvantages. The design presented in this study can assist in obtaining a stable V_o from a solar panel system, allowing solar energy to be more effectively utilised. It also has a number of new features, such as NOBC and closed-loop control. As a result, some industrial companies may see this concept and use it for their solar panel farm applications.

ACKNOWLEDGMENT

The authors gratefully acknowledge the support and facilities provided by the authorities of the Annamalai University, Annamalainagar, Tamilnadu and India to carry out this research work.

REFERENCES

1. Sumedha R.G. Weliwaththage, Udara S.P.R. Arachchige "Solar Energy Technology" JRTE, Vol 1, Iss 3, July 2020 ISSN 2714-1837.
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems" John Wiley & Sons, Inc, 2004.
3. Paul A. Lynn, Electricity from Sunlight: An Introduction to Photovoltaic. UK: John Wiley & Sons, 2010.
4. Falk Antony, Christian Dürschner, and Karl-Heinz Remmers, Photovoltaics for Professionals. London: Earthscan, 2007.
5. F.L. Luo F.L and Hong Ye, Essential DC–DC converters, New York: CRC Press & Taylor & Francis Group, 2006.
6. K. Ramash Kumar and S. Jeevananthan, "PI Control for Positive Output Elementary Super Lift Luo Converter," World Academy of Science, Engineering and Technology, vol. 63, pp. 732-737, 2010
7. K. Ramash Kumar, S. Jeevananthan, "Analysis, Design and Implementation Of Hysteresis modulation sliding mode controller for negative output elementary boost converter", Journal of Electric Power Components and Systems, 40:3, 292-311, 2012.
8. K. Ramash Kumar, N.Arunkumar, T.S. Sivakumaran, "Implementation of Non-Linear Controller for Contemporary DC-DC converters," International Journal on Electrical Engineering and Informatics, Vol.11, Iss.4, December 2019, pp.622-637.
9. Luo, F. L., and Ye, H., "Negative output cascade boost converters," IEE Proc. Elect. Power Appl., Vol. 151, No. 5, pp. 590–606, September 2004.
10. Comines, P., and Munro, N., "PID controllers: Recent tuning methods and design to specification," IEEE Proc. Control Theory Appl., Vol. 149, No. 1, pp. 46–53, January 2002.
11. Middlebrook, R., and Cuk, S., "A general unified approach to modeling switching-converter power stages," Int. J. Electron., Vol. 42, No. 6, pp. 521–550, June 1977.

Table 1 Specifications of the NOBC

| Parameters name | Symbol | Value |
|-----------------------------|----------|-------------|
| Input Voltage (PV voltage) | V_{IN} | 12V |
| Output Voltage | V_o | -36V |
| Inductor | L1 | 100 μ H |
| Capacitors | C1, Co | 30 μ F |
| Nominal switching frequency | f | 100kHz |
| Load resistance | R | 50 Ω |
| Output power | Po | 25.922W |





Vijai Ananth and Singaravelu

| | | |
|--|----------------|-----------------|
| Input power | P_{in} | 28.236W |
| Average input current | I_{in} | 2.2833A |
| Efficiency | η | 94.62% |
| Average output current | I_o | -0.72 A |
| Duty ratio | d | 0.75 |
| Peak to Peak Inductor Current Ripple | Δ_{iL1} | 25% of I_{in} |
| Peak to Peak Output Capacitor Ripple Voltage | ΔV_o | -0.12V |

Table 2 Fuzzy Rule Base Table Of NOBC

| ece | NB | NM | NS | Z | PS | PM | PB |
|-----|----|----|----|----|----|----|----|
| NB | NB | PB | NB | PB | NM | PS | PS |
| NM | PM | PS | PM | NB | NS | Z | PS |
| NS | PM | PM | PM | PS | PS | PS | PM |
| Z | NB | NM | NS | PS | PS | PM | PB |
| PS | NM | NS | Z | NS | NS | NM | NB |
| PM | NS | Z | PS | PM | PM | PS | PS |
| PB | Z | PS | NM | NB | PB | PB | PB |

Output (o): NB=-1; NM= -0.65356; NS= -0.33334; Z=0; PB= 1; PM 0.65356; PS= 0.33334.

Table 3: Simulated Numerical Time Domain Specifications Analysis Of NOBC with DLCS

| Startup-Region | Line Variations | | | | | | Load Variations | | | |
|------------------|-----------------|----------|------------------------------|----------|-----------------------------|----------|-----------------------------------|----------|-----------------------------------|----------|
| | M_p | $T_s(s)$ | $V_{in}=12V \text{ to } 18V$ | | $V_{in}=12V \text{ to } 6V$ | | $R=50\Omega \text{ to } 30\Omega$ | | $R=50\Omega \text{ to } 70\Omega$ | |
| | | | M_p | $T_s(s)$ | M_p | $T_s(s)$ | M_p | $T_s(s)$ | M_p | $T_s(s)$ |
| P cum FLC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P cum PI control | 0 | 0.04 | -8v | 0.04 | -8v | 0.04 | -6v | 0.04 | -6v | 0.04 |

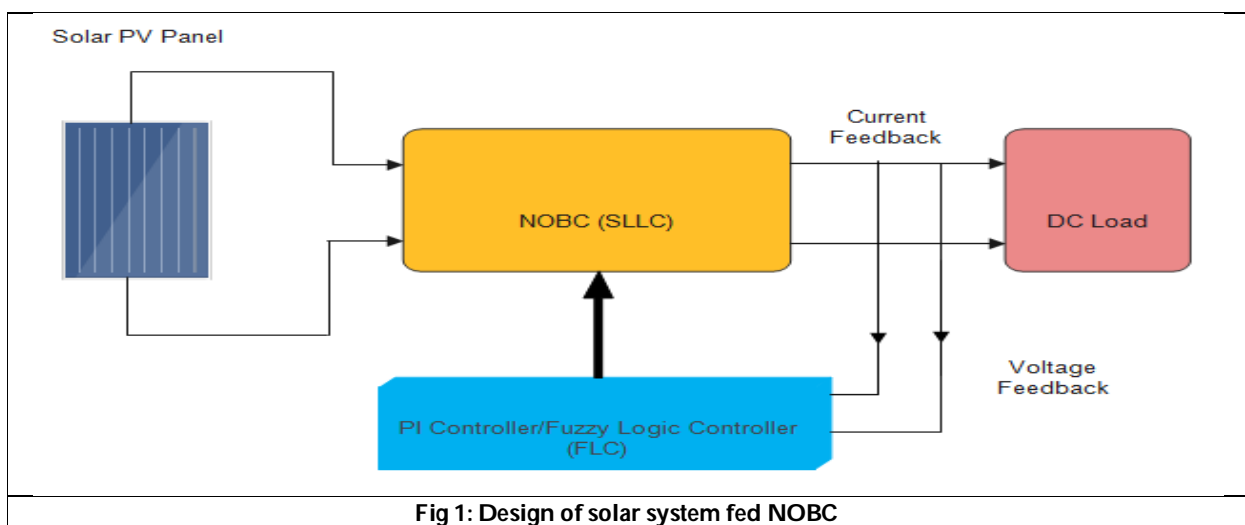


Fig 1: Design of solar system fed NOBC





Vijai Ananth and Singaravelu

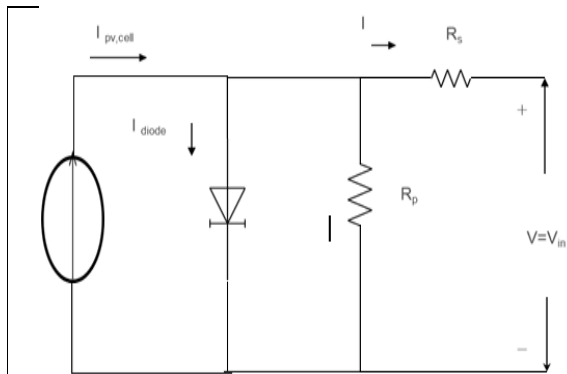
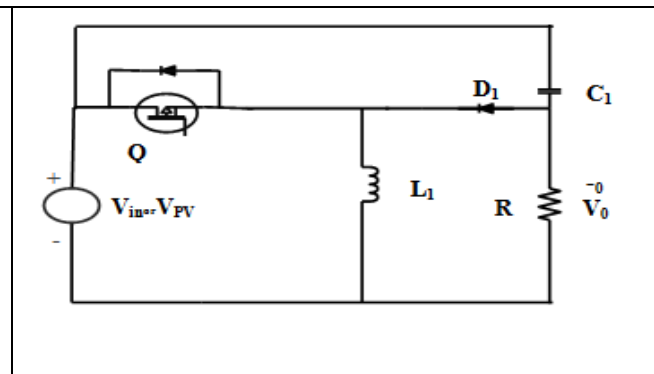
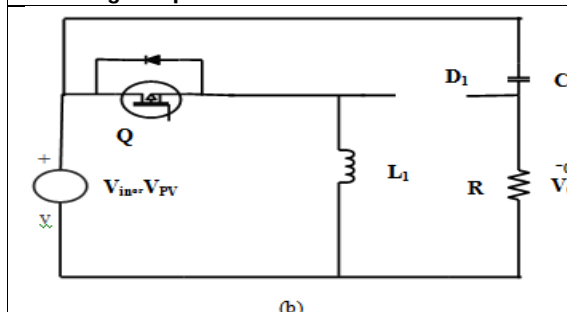


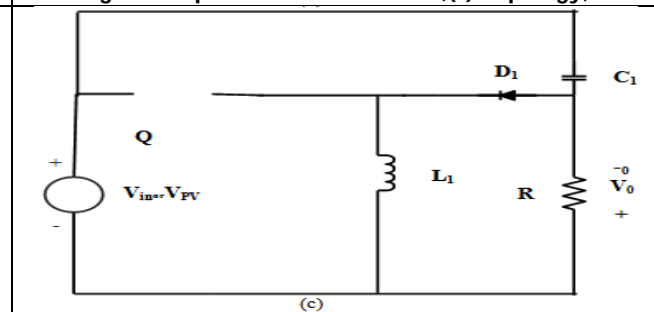
Fig 2: Equivalent circuit model of PV cell



(a)



(b)



(c)

Fig 3: The power circuit of NOBC, (b) Equivalent circuit during stage 1 operation, (c)Equivalent circuit during stage 2 operation

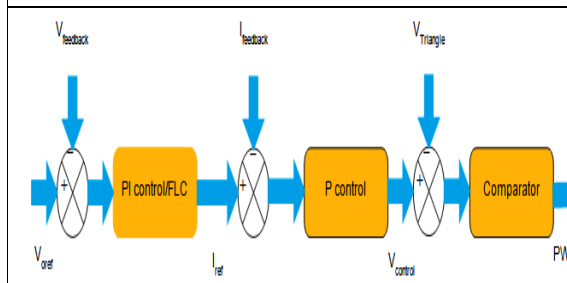


Fig 4: Design structure of DLCs for NOBC with solar system as input source

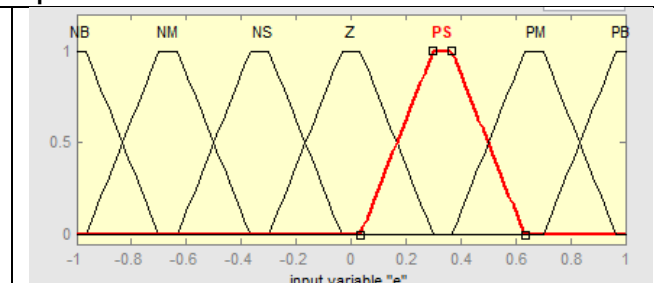


Fig 5: Membership's functions of FLC, (a) error (e)

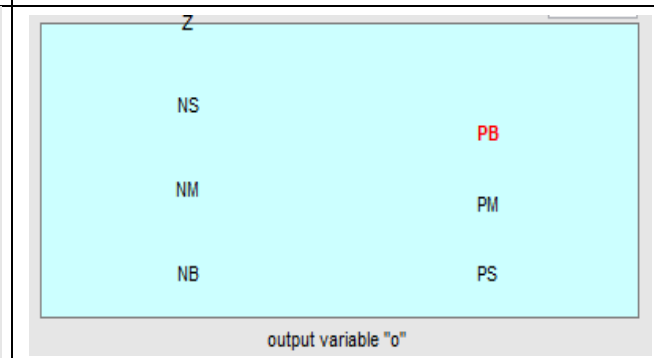
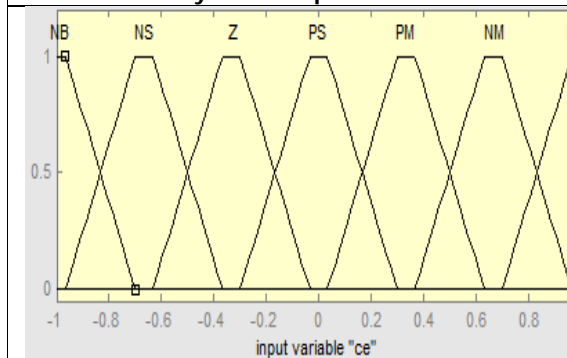


Fig 5: Membership's functions of FLC, (b) change in error (ce), and (c) output (o)





Vijai Ananth and Singaravelu

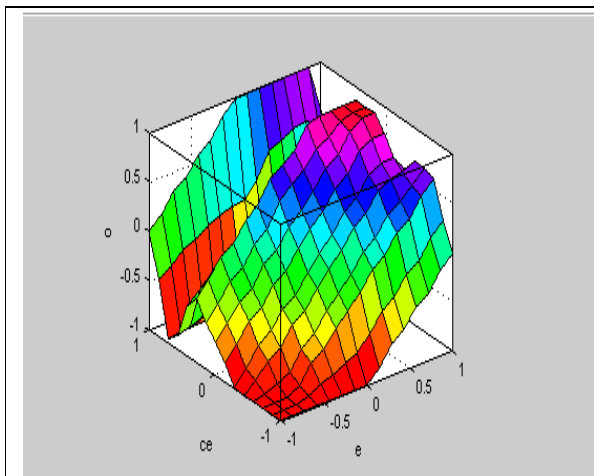


Fig 6: Graphical three-dimensional (e, ce and o) surface view of membership's functions of FLC

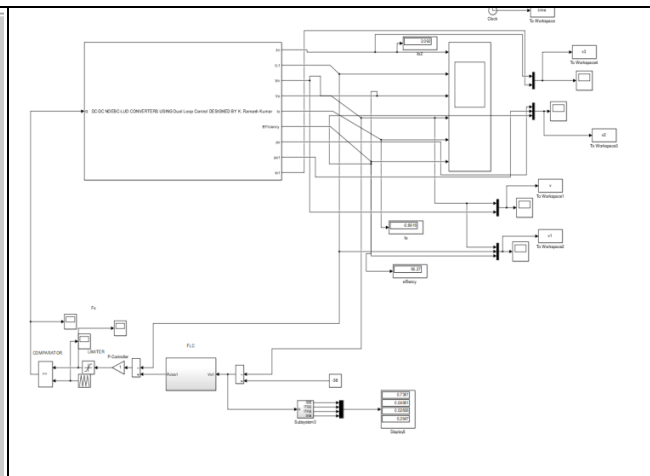


Fig 7: MATLAB/Simulink models of NOBC with DLCs, (a) P cum FLC

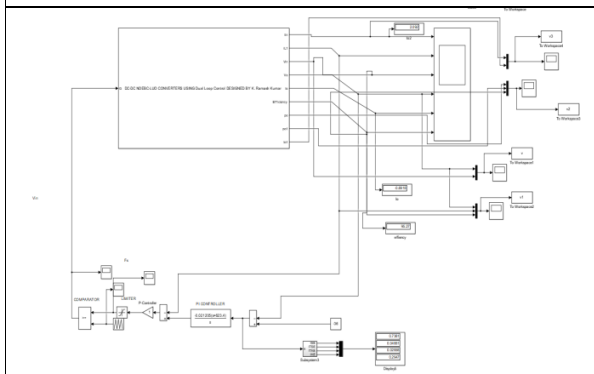


Fig 7: MATLAB/Simulink models of NOBC with DLCs, (b) P cum PI control

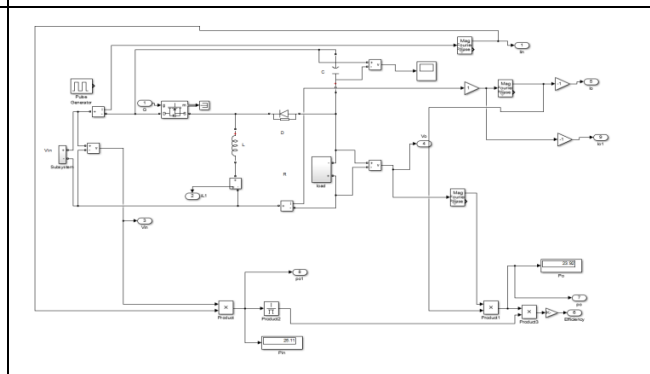


Fig 7: MATLAB/Simulink models of NOBC with DLCs, (c) Zoomed NOEB and

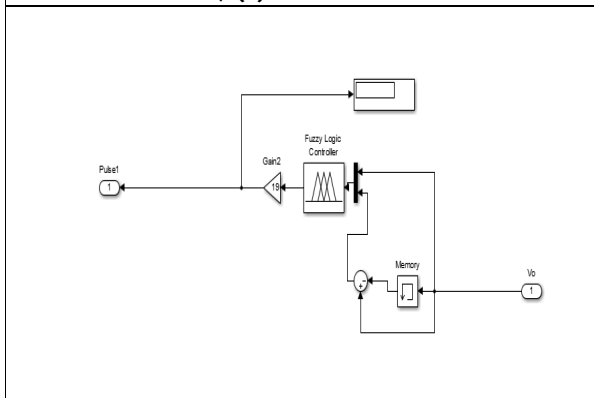


Fig 7: MATLAB/Simulink models of NOBC with DLCs(d) Zoomed FLC

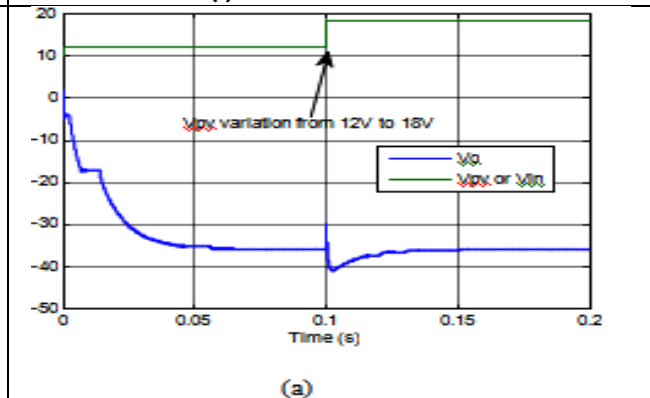
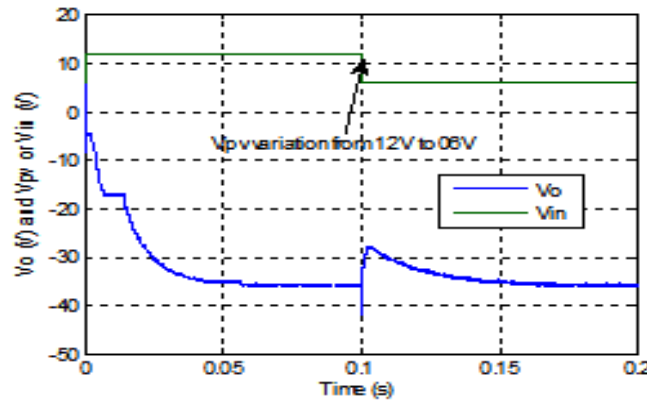


Fig 8: Simulated V_o responses of NOBC with DLCs (P cum PI control), (a) for input voltage changes from 12V to 18V





Vijai Ananth and Singaravelu



(b)

Fig 8: Simulated V_o responses of NOBC with DLCs (P cum PI control) (b) for input voltage change from 12V to 06V

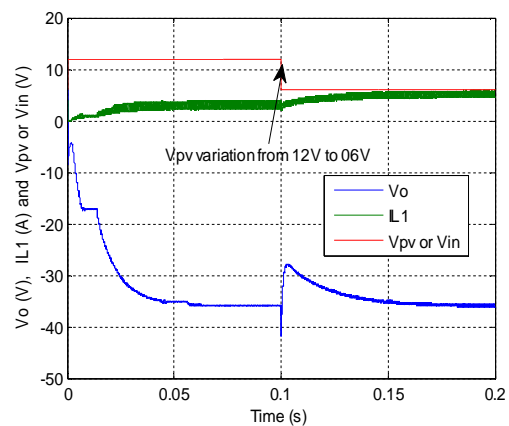
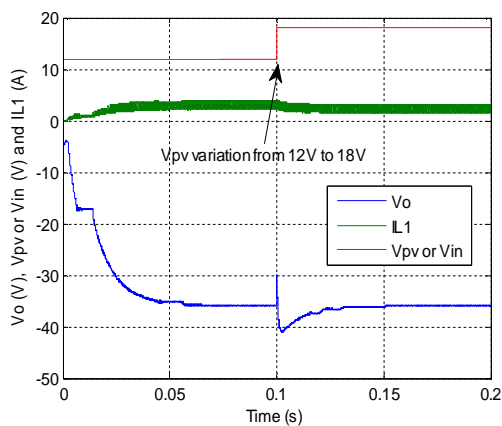


Fig 9: Simulated V_o and I_{L1} responses of NOBC with DLC (P cum PI control), (a) for input voltage changes from 12V to 18V, (b) for input voltage change from 12V to 06V

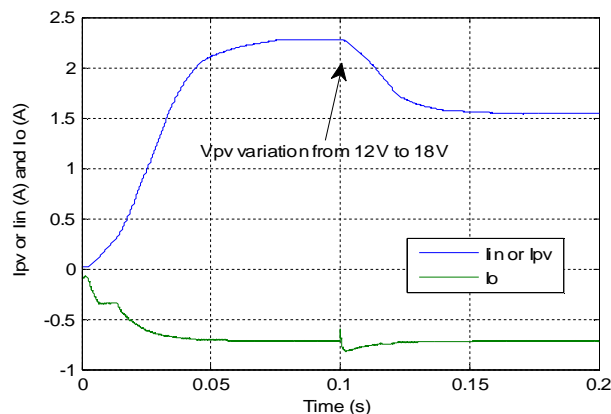


Fig 10: Simulated I_o and I_{pv} responses of NOBC with DLC (P cum PI control) for input voltage changes from 12V to 18V





Vijai Ananthand Singaravelu

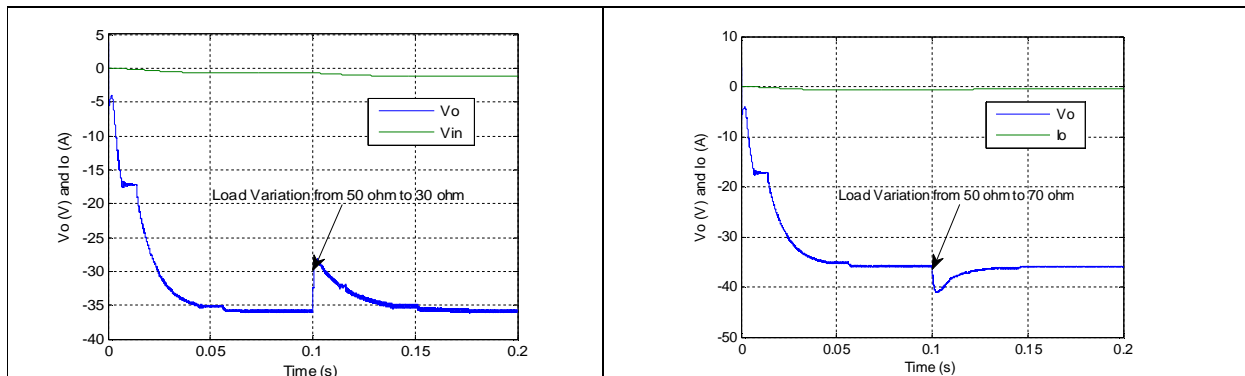


Fig 11: Simulated V_o responses of NOBC with DLCs (P cum PI control), (a) for load resistance changes from 50 ohm to 30 ohm, (b) for load resistance changes from 50 ohm to 70 ohm

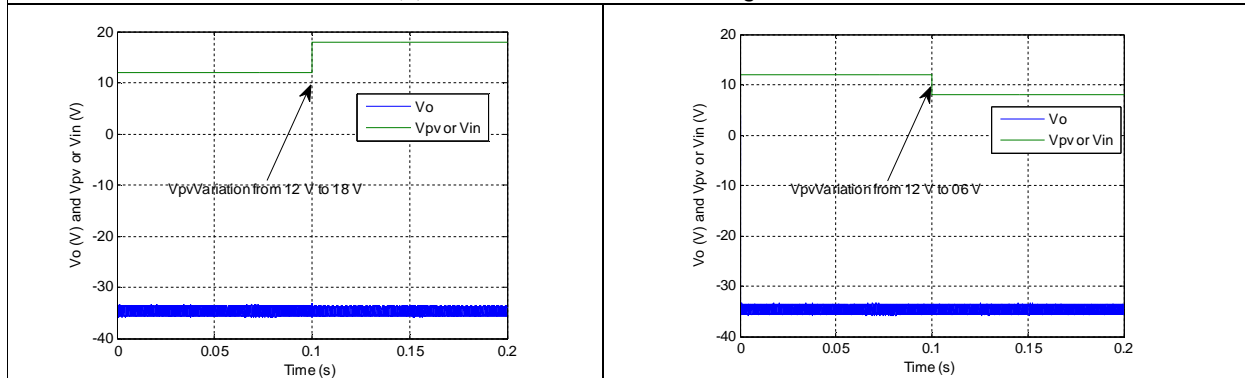


Fig 12: Simulated V_o responses of NOBC with DLCs (P cum FLC), (a) for input voltage changes from 12V to 18V, (b) for input voltage change from 12V to 6V

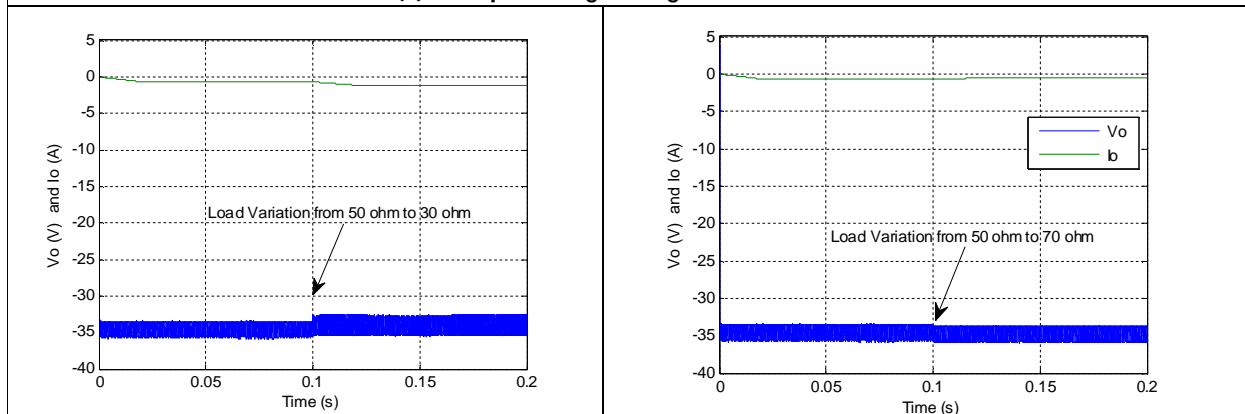


Fig 13: Simulated V_o responses of NOBC with DLCs (P cum FLC), (a) for load resistance changes from 50 ohm to 30 ohm, (b) for load resistance changes from 50 ohm to 70 ohm





Vijai Ananth and Singaravelu

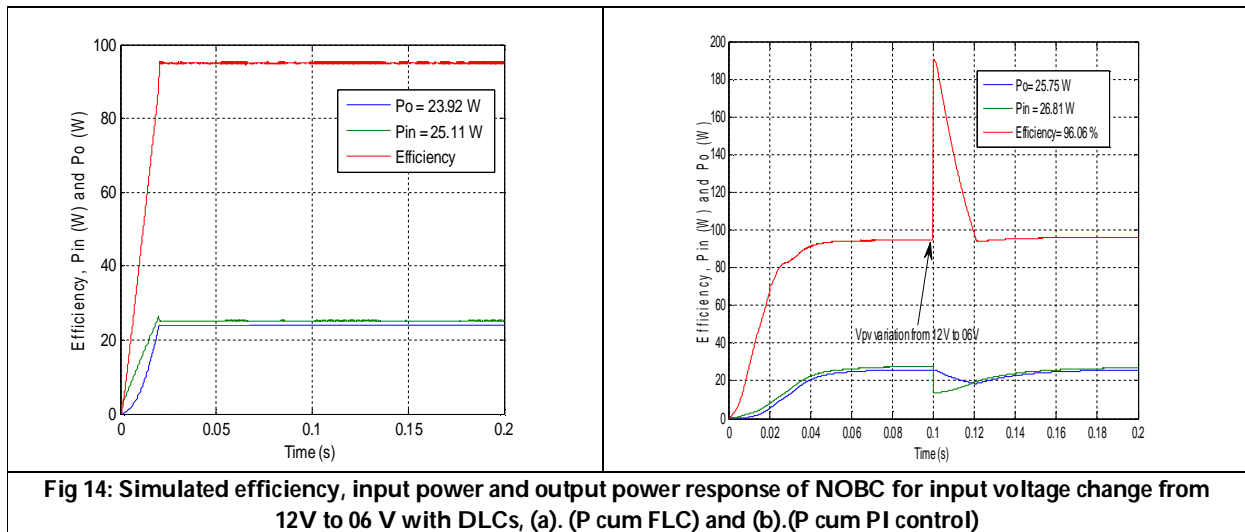


Fig 14: Simulated efficiency, input power and output power response of NOBC for input voltage change from 12V to 06 V with DLCs, (a). (P cum FLC) and (b). (P cum PI control)





Sources of Stress and Emotional Intelligence among the Rural Engineering College Faculties

M.Gowrisankar^{1*} and S.Sivagnana Bharathi²

¹Principal and Research Supervisor Ayyan Thiruvalluvar College of Arts and Science, Coimbatore, Tamil Nadu, India.

²Research Scholar, Ph.D. in Management, Maharaja Arts and Science College, Coimbatore, Tamil Nadu, India.

Received: 03 Apr 2022

Revised: 03 May 2022

Accepted: 25 May 2022

*Address for Correspondence

M.Gowrisankar

Principal and Research Supervisor

Ayyan Thiruvalluvar College of Arts and Science,

Coimbatore, Tamil Nadu, India.

Email: asiagowri47988@gmail.com.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The pandemic situation changed the education systems in terms of online and the schools, colleges, and other educational institutions are shifting to online education. The perception of education changed due to the lockdown. Moreover, while schools resume, the workspace will be reduced to encourage social distancing. Thus, the digital education sector has a bright future ahead. The main benefit of online education is that it can be scaled effortlessly. Indian government permits universities to provide an online education degree which reshapes the education system worldwide. By 2026, the Indian market for online education is expected to be worth \$ 8.6 billion. The rapid emergence of online education in India is due to the widespread accessibility of the internet. The usage of the internet in India has increased by 128 million between 2019 and 2020. For the very first time, rural India exceeds the number of urban in terms of internet users.

Keywords: Emotional Intelligence, Stress, Engineering College

INTRODUCTION

Covid-19 is a contagious disease that has just recently been found. This kind of disease spreads from person to person primarily through respiratory droplets when people are in close proximity to one another. As a result, the closer distance can cause a covid-19 infection. This is because the World Health Organization (WHO) has taken precautions to decrease the risk of infection, such as avoiding crowded places, residing at home, and keeping a safe distance from others. Since March 2020, the covid-19 pandemic has impacted the global educational system, notably



**Gowrisankar and Sivagnana Bharathi**

the complete teaching sectors, resulting in mass quarantines around the world. This approach has evolved into a solution for maintaining the continuity of teaching and learning while also providing psychological protection. As a result, students no longer receive face-to-face instruction but instead have access to a variety of teaching modalities used by universities. This research is based on engineering college student's perception of online teaching methods. Because of the necessity to provide a suitable learning environment for students, universities, schools, and colleges have begun to implement online teaching systems that combine internet access with traditional teaching methods.

REVIEW OF LITERATURE

The review of the research literature allows better awareness for both empirical and theoretical aspects which is necessary for the study. According to Hodges et al. (2020), teachers of all sorts of experiences must create and conduct their classes from home, with all the logistical challenges that entail technological obstacles that imply, and often without sufficient technical assistance. Lokanath Mishraa and Tussah Gupta (2020), the authors suggested that their study of online teaching methods reveals various forms of online teaching modes used throughout the COVID-19. The intention of this investigation is to find out how students and teachers feel about online teaching and learning lecture. Pravat Kumar Jena (2020), the authors reveal that the government of India has taken measures to encourage online learning throughout the Covid-19, as well as numerous online platforms used by educational institutions throughout the session. Some of the advantages and drawback of online teaching highlights the recommendations for improvement. Anggrainingsih.R et al (2020), the authors have come up with the most effective influential factors from both the learner and instructor viewpoints. Instructors' point of view along with course quality, technical support is an important thriving component. Lack of engagement is one of the determining success elements from the perspective of students.

Thurmond et al (2019), in this study diversified methods are used to assess the effectiveness of online teaching conducted through the various methods and process of learners are to be corrected or get improved their skills towards achieve better performance. According to Stephanie J. Blackmon and Claire Major (2018), the purpose of this study was to investigate what problems students faced when taking online courses. This is done to improve perseverance and retention. The goal of this research is to look into students' experiences in these online courses by combining available evidence. Lovertt, M., et al (2018), the authors describe that the online Educational action plan is to measure the success of the statistics course in speeding up students learning. The Open Learning Initiative (OLI) statistics helps to learn a full semester's worth of resources in half of that time and performed as well as or better than students learning from conventional more than an entire semester. VK John et al (2017) analyzed information from students who had completed an eLearning programme at a Thai university to create an inferential research model, demonstrating that there is a substantial association between learner satisfaction and behavioral intention to utilize eLearning. WS Chen and colleagues (2016), the author suggested various assessment approaches which stimulate learners to showcase their best efforts at various levels of the evaluation process according to the findings of this study. As a result, online educational activities are more serious and successful. The authors suggest that learners will be demotivated to continue their studies if their perception is poor. Al-Rahimi et al (2016), the author exposes the concept of measuring the efficiency of employing E-Learning at the University of Technology Malaysia by utilizing an application that has an impact on the effectiveness of e-learning. Perceived satisfaction, intention to use eLearning, and self-efficacy are some of the elements that have been identified to connect with online learning efficiency.

Objectives of the Study

To study the level of "Source of Stress" and "Emotional Intelligence" among the Rural Engineering College Facultiesat Coimbatore.





MATERIALS AND METHODS

The research is descriptive research in nature, where the descriptive research helps to measure and report in detail a situation or relationship of the specific variables occur in the sample. The primary data and secondary data have been considered for the study. The secondary data was collected to support the literature and theory. The structured questionnaire (research instrumentation) was used to collect the primary data.

Structured Questionnaire (Research Instrumentation)

The questionnaire for the survey about the "Sources of Stress" & "Emotional Intelligence".

Sources of Stress – It has nine variables like environment and facilities, administration, colleagues, regulations and policy, teaching difficulties, perception of teachers on students, attitude of parents, work and personal circumstances.

Emotional Intelligence- It has two dimensions namely inter personal composite and intra personal composite.

Inter Personal Composite- It has two dimensions namely self-perception (*self-regard, self-actualization and emotional self-awareness*) and self-expression (*emotional expression, assertiveness and independence*). Intra Personal composite- It has three variables which includes *intra personal relationship, empathy and social responsibility*. These variables are measured using the standard measurement scale (Five-point scale of Likert) ranging from "5" = Strongly Agree, "4" = Agree, "3" = Moderate, "2" = Disagree and "1" = Strongly Disagree.

Sampling

The researcher has selected engineering colleges affiliated to Anna University in Tamil Nadu has been selected as the population of the study. There are Totally 4 University Department Campuses (CEG/MIT/ ACT/SAP Campuses), presently; Anna University has 13 Constituent Colleges, 3 Regional Campuses at Tirunelveli, Madurai and Coimbatore and 593 Affiliated Colleges (Government, Government Aided and Self-Financing Colleges) ("Annual Report – Directorate of Technical Education Tamil Nadu, 2021). So, there are 610 engineering colleges and university in Tamil Nadu. The samples are the faculties working in all the engineering colleges and university in all the departments has been identified as the sample frame work. The total number of working in all the engineering colleges and university in all the departments is not exactly available, so the researcher considered the population to be infinite. The researcher gave around 800 Questionnaire to all the engineering colleges and university (i.e. on an Average certain Colleges 2 questionnaire and remaining colleges one questionnaire were distributed). The online questionnaire survey method was used to collect the data. According to Demorgan's table, for infinite population, 784 samples is required with 95 % of confidence level and 3.5 % of confidence interval for the collecting the data. The researcher gave around 800 Questionnaire to all the engineering colleges and university and received back 787 Questionnaire. The remaining questionnaires were found to be biased.

Data Analysis

The collected data were analysed using Statistical Package for Social Sciences (SPSS), Statistics for Windows, Version 20.0; The measures of central tendency (mean) and measures of dispersion (standard deviation) was used to analyse the result.

RESULTS

The result of the study have been analysed using the measures of central tendency (mean) and measures of dispersion (standard deviation). The mean and standard deviation satisfy the objective (*to study the level of "source of stress" and "emotional intelligence" among the rural engineering college faculties at Coimbatore*).

Measures of Central Tendency (Mean) & Measures of Dispersion (Standard Deviation)

The table and graph show the result mean & standard deviation for the dimensions like "source of stress" and "emotional intelligence" and their internal variables. the results are as follows; The sources of stress are found to be high among all the aspects like perception of teachers on students, attitude of parents, work, teaching difficulties,





Gowrisankar and Sivagnana Bharathi

school environment and facilities, regulations and policy, personal circumstances, colleagues and administration. The mean value ranges from 3.75 to 2.90. Being the variables are negative, the respondent agrees with all the variables stating that they are facing stress in all above mentioned variables. The emotional intelligence among the respondents is found that they are not able to handle or balance the situations prevailing in their work place. This means that the respondents are getting disturbed semantically and not able to handle the circumstances in better way.

CONCLUSION

In developing countries, the effectiveness of online education approaches varies. It is necessary to research acceptable pedagogy and platform for various classes of engineering college students. Internet bandwidth is constrained due to smaller number of connection points, and the internet data are too costly while comparing to the income level of the people and also the limiting accessibility and affordability. Further analysis and examination of powerful pedagogy for e-teaching and e-learning is a research field. Accessibility and usability of edifying technologies for all learners from all socio-economic groups has been identified as a challenge, with the educational tool creators focusing on personalization and elucidation. It is evenly required to arbitrate at the guiding principle. Adapting the comprehensive and user-friendly tools to make e-teaching as more inspired, exploratory and interactive is another field of research and development. This will help in preparing the e-education system challenges in future. The teachers and students/learners should be taught how to use diverse e-educational tools as a result of the COVID-19 outbreak.

REFERENCES

1. Charles Hodges, Stephanie Moore, Barb Lockee, Torrey Trust and Aaron Bond, (2020). The Difference between Emergency Remote Teaching and Online Learning, Why IT matters to Higher Education Educause Review.
2. Lokanath Mishra, Tushar Gupta B, Abha Shree B, (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic, International Journal of Educational Research Open, pp 1-25.
3. M. Sampath Nagi, Vijayakanthan. S and Arasuraja. G, "Service Quality towards Retail Stores Across Coimbatore District", Indian Journal of Natural Sciences, Vol. 12, No. 70, Pp. 38370 – 38374.
4. Pravat Kumar Jena (2020). Online learning during lockdown period for covid-19 in India, International Journal of Multidisciplinary Educational Research (IJMER), 9(5), pp 82-92.
5. Stephanie J. Blackmon and Claire Major (2012). Student experiences in Online courses, The Quarterly review of distance education, 13(2), pp 77-85
6. Marsha Lovett, Oded Meyer, Candace Thille (2018). The Open Learning Initiative: Measuring the effectiveness of the OLI Statistics Course in accelerating student learning, Journal of Interactive Media in education, 1, pp 1-18.
7. M. Sampath Nagi, M. Kannan and P. Ramasubramaniam, "Challenging Scenario Faced by Exporters of Garment Industry", Indian Journal of Natural Sciences, Vol. 12, No. 70, Pp. 38728 – 38734.
8. M. Sampath Nagi and K. Prakash (2021), "Client Satisfaction Towards Transportation and Logistics Services Providers, Tamil Nadu", Global Journal for Research Analysis, Vol. 10, No. 07, Pp. 01 – 03.
9. M. Sampath Nagi and D. Sathish Kumar, (2021), "Perception of the Farmers towards the Quality of Service Provided By Co-Operative Banks", Indian Journal of Natural Sciences, Vol. 12, No. 66, Pp. 30725 – 30732.

Mean & Standard Deviation - "Source of Stress"

| Variables | N | Mean | Sd | Mean Rank |
|------------------------------------|-----|------|-------|-----------|
| Perception of Teachers on Students | 787 | 3.75 | 0.461 | 1 |
| Attitude of Parents | 787 | 3.71 | 0.477 | 2 |
| Work | 787 | 3.53 | 0.534 | 3 |
| Teaching Difficulties | 787 | 3.45 | 0.614 | 4 |





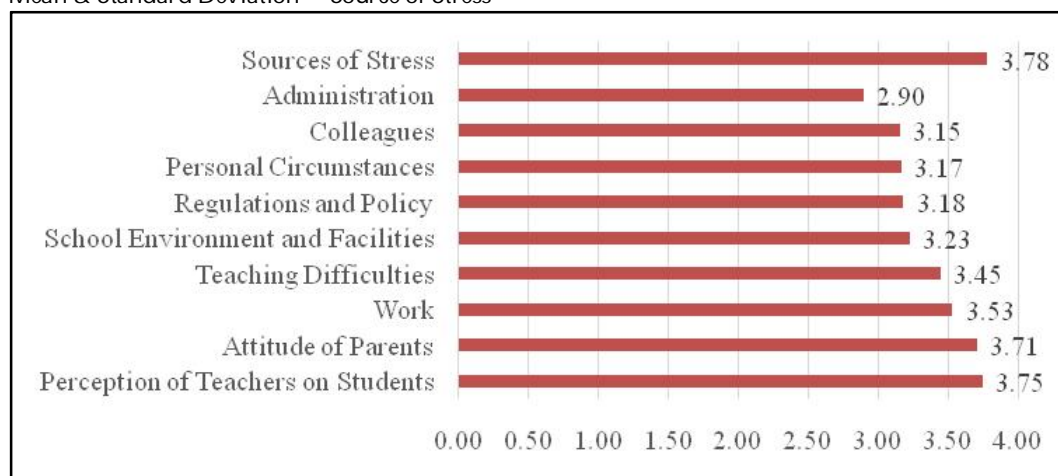
Gowrisankar and Sivagnana Bharathi

| | | | | |
|-----------------------------------|-----|------|-------|---|
| School Environment and Facilities | 787 | 3.23 | 0.604 | 5 |
| Regulations and Policy | 787 | 3.18 | 0.415 | 6 |
| Personal Circumstances | 787 | 3.17 | 0.540 | 7 |
| Colleagues | 787 | 3.15 | 0.809 | 8 |
| Administration | 787 | 2.90 | 0.643 | 9 |
| Mena Score - Source of Stress | 787 | 3.78 | 0.456 | |
| <i>N – Number of Respondents</i> | | | | |
| <i>Sd - Standard Deviation</i> | | | | |

Mean & Standard Deviation - "Emotional Intelligence"

| Dimensions | Variables | N | Mean | Sd |
|----------------------------------|----------------------------|-----|------|-------|
| Self-Perception | Self-Regard | 787 | 3.45 | 0.498 |
| | Self-Actualisation | 787 | 2.32 | 0.465 |
| | Emotional Self Awareness | 787 | 1.68 | 0.465 |
| | Mena Score | 787 | 2.45 | 0.498 |
| Self-Expression | Emotional Expression | 787 | 1.84 | 0.370 |
| | Assertiveness | 787 | 2.24 | 0.429 |
| | Independence | 787 | 1.52 | 0.500 |
| | Mena Score | 787 | 1.96 | 0.185 |
| Inter - Personal Composite | Self-Perception | 787 | 2.45 | 0.498 |
| | Self-Expression | 787 | 1.96 | 0.185 |
| | Mena Score | 787 | 1.90 | 0.299 |
| Intra – Personal Composite | Interpersonal Relationship | 787 | 4.73 | 0.443 |
| | Empathy | 787 | 2.36 | 0.479 |
| | Social Responsibility | 787 | 1.67 | 0.472 |
| | Mena Score | 787 | 2.91 | 0.290 |
| Emotional Intelligence | Inter - Personal Composite | 787 | 1.90 | 0.299 |
| | Intra – Personal Composite | 787 | 2.91 | 0.290 |
| | Mena Score | 787 | 2.46 | 0.499 |
| <i>N – Number of Respondents</i> | | | | |
| <i>Sd - Standard Deviation</i> | | | | |

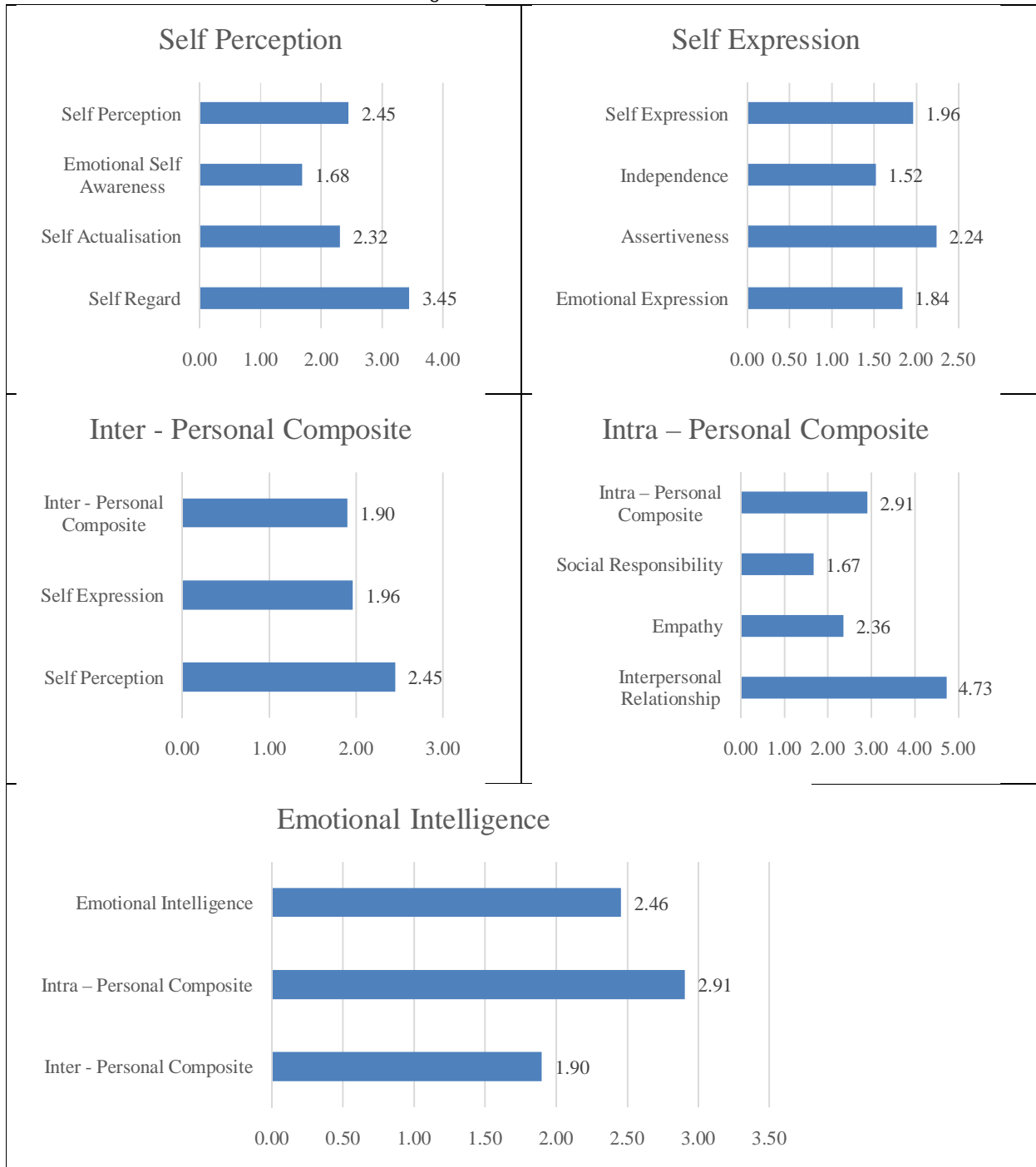
Mean & Standard Deviation - "Source of Stress"





Gowrisankar and Sivagnana Bharathi

Mean & Standard Deviation - "Emotional Intelligence"





Scientific Validation of Siddha Polyherbal Formulation, Tulasi Oil for Its Antioxidant Properties – an *In vitro* Assessment

S. Yavanarani¹, R. Selvakumar^{2*}, M. Sathiyabama³ and D. Sivasankari⁴

¹Siddha Physician, Yavanarani Siddha Clinic, Pillaiyarpalayam, Kanchipuram, Tamilnadu, India – 631501

²Siddha Physician, Siddha Government Hospital, Tiruttani, Tiruvallur, Tamilnadu, India – 631209.

³Siddha Physician, Panruti, Cuddalore, Tamil Nadu, India – 607106.

⁴PG student, Department of Paediatrics, Govt Siddha Medical College, Chennai – 600106, Tamil Nadu, India.

Received: 15 Apr 2022

Revised: 02 May 2022

Accepted: 25 May 2022

*Address for Correspondence

R. Selvakumar

Siddha Government Hospital,

Tiruttani, Tiruvallur,

Tamilnadu, India - 631209

Email: dr.selvakumar7@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Siddha system is one of the traditional medicine systems serving constant service to humanity for over 5000 years in combating diseases and in sustaining physical, mental and moral health. Siddha classical texts have numerous polyherbal formulations one among them is Tulasi oil. The objective of the current study was to ascertain the antioxidant potential of Siddha polyherbal formulation of Tulasi oil (SPHTO) in various *in vitro* experimental methods like scavenging DPPH radical, H₂O₂ radical, SOD radicals, ABTS radical and Lipid peroxidization using appropriate assay systems compared to synthetic antioxidants. Total phenolic and flavonoid contents were evaluated using the Folin-Ciocalteu method and AICl₃ test, respectively. The results showed that the SPHTO accumulated considerably higher phenolic and flavonoid contents. The strong inhibitions of free radicals were caused by the SPHTO in dose dependent manner. Thus, the Siddha polyherbal formulation of Tulasi oil could be considered as a potential source of natural antioxidants.

Keywords: Siddha, polyherbal formulation, Tulasi oil, phenols, flavanoids, antioxidant.

INTRODUCTION

Free radicals usually referred to as reactive oxygen species (ROS), are a unit elementary to any biochemical process and an essential part of aerobic life and metabolism [1]. During normal physiologic condition, ROS are continuously



**Yavanarani et al.**

produced in the aerobic cells and removed by endogenous antioxidant defense mechanism of the cell. But, under pathologic condition the balance between ROS and antioxidant defense mechanism is lost. When ROS production is superior to the detoxification ability of the cell, unusually formed ROS manifests wide range of harms to DNA, proteins, lipids etc. and provoke as a mediator of pro-inflammatory and carcinogenic dealings such as hepatic cell cirrhosis, tenderness, ASVD, glycemia, sarcoma, neurodegenerative disease, renal toxicity and also the aging process [2, 3].

Antioxidants are necessary to supplement the natural antioxidant protects the body to cure these diseases. Though, the synthetic antioxidants might be unsafe in sometimes, hence, more consideration is being paid to investigating for natural antioxidants from herbs to diminish the oxidative damages [4]. In recent days, there is an increasing awareness in finding free radical scavenging phytochemicals, because they can suppress the generation of free radical reactions and defend the human body from disorders. The most resourceful components seem to be phenolic and flavonoids compounds of various medicinal plant raw materials, particularly in herbs, seeds, leaf, root and fruits. The metal-chelating capabilities and radical- scavenging properties of medicinal plant parts have enabled phenolic compounds to be thought of as effective free radical scavengers and inhibitors of lipid peroxidation [5]. Vegetables, spinaches, nuts, and fruits are the rich sources of antioxidants, such as vitamin A, C, E, carotenoids, polyphenolic compounds and flavonoids, which prevent free radical damage, reducing risk of chronic diseases such as cardiovascular diseases, especially atherosclerosis and cancer [6].

Thulasi oil is a siddha polyherbal formulation prescribed in the management of childhood asthma. It possesses the medicinal properties like good expectorant, analgesic, anti-allergic, antidiabetic agent, anti inflammatory, antioxidant, antidote, anti-pyritic, carminative and antimicrobial agent [7]. The oil contains various phytoconstituents i.e., Eugenol, Naphthalene, Oleic acid and Ricinoleic acid derivatives which possess the actions of broncho dialator, anti-inflammatory, anti-tussive, anti-asthmatics, anti-oxidant, anti-viral, antibiotics etc [8]. Since not much research had been done to evaluate the biological activity of the Tulasi Oil, the aim of the present study was to assess the *invitro* antioxidant activity in terms of scavenging DPPH radical, H₂O₂ radical, SOD radicals, ABTS radical and lipid peroxidization.

MATERIALS AND METHODS

Preparation of Drug

The ingredients; *Ricinus communis* (352 ml), *Ocimum sanctum* (160 ml), *O. Prostratum* (160 ml), *O. canum* (160 ml), *Taxus buccata* (160 ml), *Aegle marmelos* (160 ml), *Allium cepa* (160 ml), *Zingiber officinale* (8g), *Piper longum* (8g), *Piper nigrum* (8g) were powdered separately and mixed well together then taken in a tightly closed container. This powder was mixed with honey (160 ml) [7]. The medicine will be prepared in Gunapadam lab of National Institute of Siddha after proper purification. All the ingredients mentioned in the formulation are purified as per the direction described in the Siddha literature. 352ml of *Ricinus communis* oil was mixed with the juice of 160 ml of *Ocimum sanctum*, *O. prostratum*, *O. canum*, *Taxus buccata*, *Aegle marmelos*, *Allium cepa* in a mud vessel. 8gms of dried ginger, long pepper, black pepper were fried them and make them in fine powder and this powder was mixed with 160ml of honey and heat it till muster form appears and filter it. The filtrate was mixed with TO and stored in clean and dry glass container [3].

Phytochemical Analysis

Total Phenol and Flavanoid Content [9]

100 µl of SPHTO was mixed with 2.0 ml of 2% Na₂CO₃ and allowed to stand for 2 min at room temperature. After incubation, 100 µl of 50% Folin Ciocalteu's phenol reagent was added and the reaction mixture was mixed thoroughly and allowed to stand for 30 min at room temperature in the dark. Absorbance of all the sample solutions was measured at 720 nm using spectrophotometer. For flavonoid content estimation, 250 µl of 5% NaNO₂ solution was added to 0.5 ml of the SPHTO along with 150 µl of 10% AlCl₃.H₂O solution. After 5 min, 0.5 ml of 1M NaOH

42807



**Yavanarani et al.**

solution was added and then the total volume was made up of 2.5 ml with ionized distilled water and the absorbance was read 510 nm. All the experiment was conducted in three replicates.

Total DPPH Assay [10]

Two ml of 50, 100, 200 and 400 µg/ml concentrations of SPHTO were mixed with two ml of 0.16 mM methanolic DPPH solution and the mixture was vortexed for 1 min and then left to stand at room temperature for 30 min in the dark. The absorbance of all the sample solutions was measured at 517 nm. The varied concentrations in the range of 50 to 400 µg/ml were taken for standard also ran at same time. The control was tested without standard and test samples. The scavenging effect (%) was calculated by using the formulae:

Scavenging effect (%) = $[1 - (A_{\text{sample}} - A_{\text{sample blank}}) / A_{\text{control}}] \times 100$

Hydrogen Peroxide Radical Scavenging Assay [11]

A solution of hydrogen peroxide (H₂O₂, 10 mM) was prepared in phosphate buffer (0.1 M, pH 7.4). 3.4 ml of phosphate buffer was mixed with 0.6 ml of H₂O₂ solution (0.6 ml, 43 mM) and 1.0 ml of SPHTO at a concentration of 50, 100, 200 and 400 µg/ml was added on the above solution. The absorbance value of the reaction mixture was recorded at 230 nm after 10 minutes incubation at room temperature. Blank solution contains sodium phosphate buffer without H₂O₂. Ascorbic acid (50 to 400 µg/ml) was used as the standard. Control solution containing buffer and H₂O₂ were taken. The percentage of H₂O₂ scavenging was calculated using the following equation: Scavenging effect (%): control - test/ control x 100

Superoxide Dismutase Radical Scavenging Activity [12]

The assay mixture contained 1.2 ml of sodium pyrophosphate buffer, 0.1 ml of PMS, 0.3 ml of NBT, 0.2 ml of enzyme preparation at a concentration of 50, 100, 200 and 400 µg/ml of SPHTO and water. There action was initiated by the addition of 0.2 ml of NADH. The mixture was incubated at 30 for 90 seconds and arrested by the addition of 1.0 ml of glacial acetic acid. There action mixture was then shaken with 4 ml of n-butanol, allowed to stand for 10 minutes and centrifuged. The intensity of the chromogen in the butanol layer was measured at 560 nm in a spectrophotometer. Control tube was also measured containing only reagents. Scavenging activity (%) was calculated using the equation: Scavenging effect (%): control- test/ control X 100

ABTS Radical Scavenging [13]

ABTS radical cation was generated by mixing 20mM ABTS solution with 70mM potassium peroxodisulphate and allowing it to stand in dark at room temperature for 24 hours before use. 0.6 ml of SPHTO at a concentration of 50, 100, 200 and 400 µg/ml were mixed with 0.45 ml of ABTS reagent and absorbance of these solutions was measured at 734 nm after 10 min of incubation Trolox at the concentration of 50, 100, 200 and 400 µg/ml was used as a reference compound. The absorbance was read at 745nm in a spectrophotometer and the per cent inhibition was calculated using the formula; % scavenging activity = control - test/ control x 100

Lipid Peroxidation by Egg Yolk Method [14]

Egg homogenate (0.5 ml, 10% in distilled water, v/v) and 0.1 ml of SPHTO at a concentration of 50, 100, 200 and 400 µg/ml were mixed separately in a test tube and the volume was made up to 1 ml, by adding distilled water. Finally, 0.05 ml FeSO₄ (0.07 M) was added to the above mixture to induce lipid peroxidation and incubated for 30 min. Subsequently, 1.5 ml of 20% acetic acid and 1.5 ml of 0.8% TBA (w/v) in 1.1% sodium dodecyl sulfate (SDS) and 0.05 ml 20% TCA was added, vortexed and then heated in a boiling water bath for 60 min. After cooling, 5.0 ml of butanol was added to each tube and centrifuged at 3000 rpm for 10 min. The absorbance of the organic upper layer was measured at 532 nm. Control tube was also measured containing only reagents. Scavenging activity (%) was calculated using the equation: % scavenging activity = control - test/ control x 100. All results are expressed as Mean ± SD





RESULT AND DISCUSSIONS

Total Phenol and flavonoid Content

The different concentration of SPHTO was found to contain the highest amount of phenols and flavonoid. Phenols and flavonoid contents of the test sample were found to decrease in the following order: 400 µg/ml > 200 µg/ml > 100 µg/ml > 500 µg/ml (Figure-1 and 2). Phenolic compounds are known as powerful chain breaking antioxidant due to their redox properties, hydrogen donors and singlet oxygen quencher [15]. Flavonoids are capable of effectively scavenging the reactive O₂ species because of their phenolic hydroxyl groups and so they are potent antioxidants [16]. Thus, from the results it can be concluded that the tested Tulasi oil contains the important phenolics and flavonoids bioactives in them.

Antioxidant Activity

Total DPPH Assay

In this assay, all the tested SPHTO samples showed high DPPH radical scavenging capacities. The present study indicates DPPH scavenging activity for Tulasi oil as 23.32± 0.27 to 80.81±0.66 (Fig. 3), which is high level that of Tulasi oil in the present study. Antioxidants can transfer either an electron or a hydrogen atom to DPPH, thus neutralizing its free radical character [17]. DPPH test, which is based on the ability of DPPH, a stable free radical, to decolorize in the presence of antioxidants, is a direct and reliable method for determining radical scavenging action [18].

Hydrogen Peroxide Radical Scavenging Assay

The potential of SPHTO to scavenging hydrogen peroxide is demonstrated in Fig 4. The 400 µg/ml of SPHTO exhibited the high scavenging activity (72.25%) compared to other concentrations. The scavenging of H₂O₂ by Tulasi oil may be due to the phenol donating electrons to H₂O₂, thereby reducing it to water. The SPHTO was capable of scavenging H₂O₂ in a concentration dependent manner [14].

Superoxide dismutase radical scavenging activity

From the Fig 5, the SPHTO's concentration of 400 µg/ml has registered the highest SOD scavenging activity (80.41%) compared to other concentrations tested. Superoxide dismutase is an essential enzyme in the antioxidant defense system. SOD converts superoxide anion to hydrogen peroxide, reducing its toxic effects. The percentage of superoxide inhibition by SOD by polyphenols represents that and may reduce cell damage [19]. This study shows that increasing the concentration of SPHTO maximizes the inhibitory activity of SOD.

ABTS Radical Scavenging

Fig 6 was shown the SPHTO's scavenging capacity against ABTS was compared with that of BHT and/or ascorbic acid and percentage inhibition was calculated. This study reported that the 400 µg/ml of SPHTO had the highest scavenging potential (80.45%) compared with its counterpart at other concentrations. The presence of phenolic compounds in the tulasi oil may inhibit the potassium persulfate activity and hence diminished the production of ABTS [20].

Lipid per oxidation by egg yolk method

In this study, Fig 7 was represented that all concentrations of SPHTO were able to prevent the formation of MDA in a dose-dependent manner. However the maximum anti-lipid peroxidation activity was reported in the concentration tried 400 µg/ml of SPHTO (80.21%). This assay showed that the SPHTO might suppress the reactive radical species from damaging biomolecules such as lipoprotein, DNA, amino acids, sugar and proteins in living organisms and food systems [21].





Yavananani et al.

CONCLUSION

All of the experiments undertaken in the current study are based on crude oil and are considered preliminary and require more advanced research to reach concrete conclusions about the results of this study. Based on this research finding, it is necessary to reveal that SPHTO is an effective siddha medicine as it unveiled good scavenging potential amongst studied concentrations. To summarise, these results provides that Siddha polyherbal formulation of Tulasi oil (SPHTO) is an admirable source for more investigation of individual phenol and flavonoid compounds, *in vivo* antioxidant activity, and the various antioxidant mechanisms, as well as a most promising candidate from which specific antioxidant bioactive products could be developed. As a result, in order to filter out bioactive substances, substantial research should be conducted as soon as possible.

REFERENCES

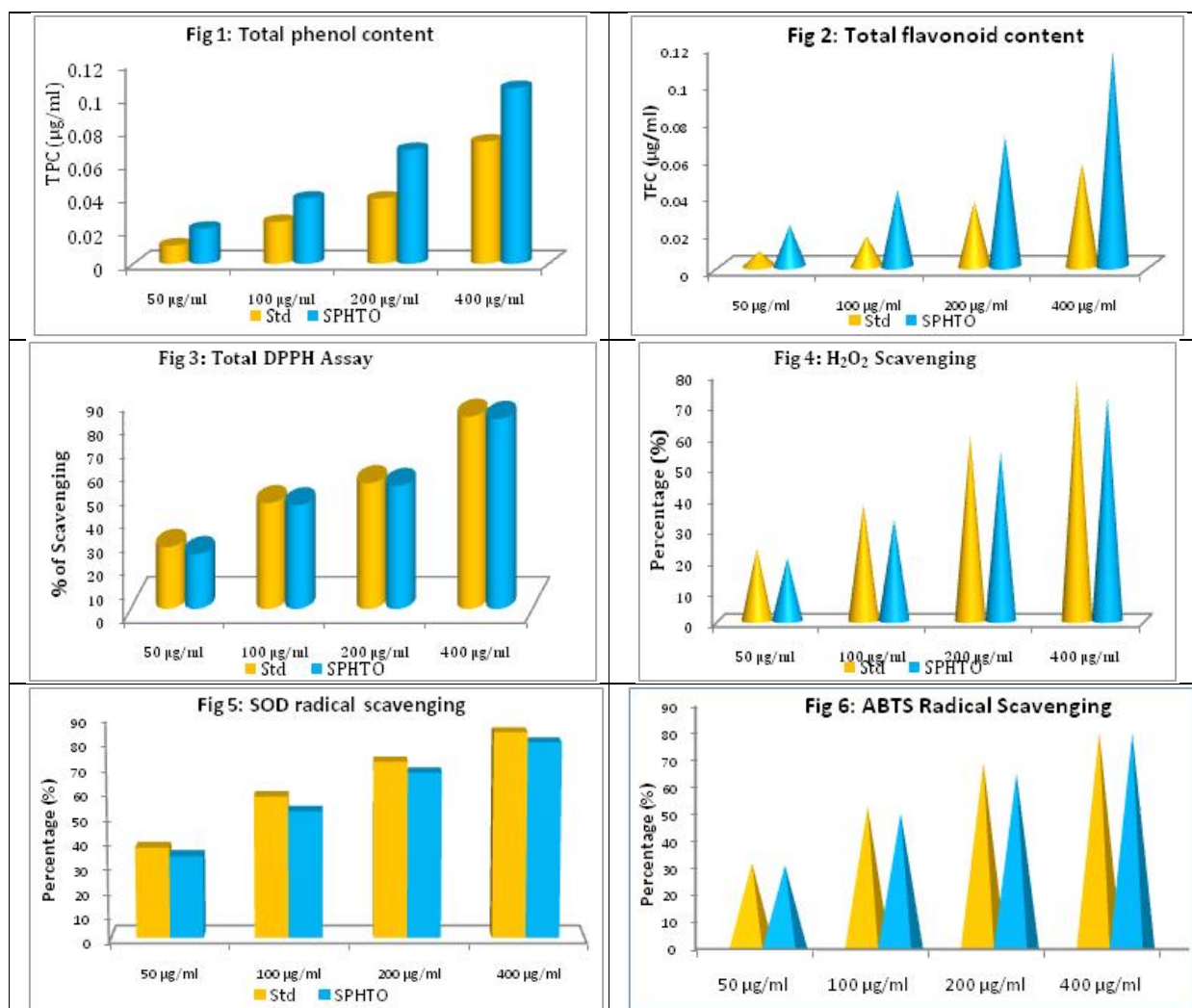
1. Tiwari AK. Imbalance in antioxidant defense and human diseases: multiple approach of natural antioxidants therapy. *Curr Sci* 2001;81:1179-1187.
2. Kowaltowski, AJ, Vercesi AE. Mitochondrial damage induced by conditions of oxidative stress. *Free radical biology and medicine* 1999;26:463–471.
3. Yamaguchi F, Saito M, Ariga T, Yoshimura Y, Nakazawa H. Free radical scavenging activity of garcinol from *Garcinia indica* fruit rind. *Journal of agricultural and food chemistry* 2000;48:2320–2325.
4. Christen Y. Oxidative stress and Alzheimer disease. *Am J Clin Nutr* 2000;71: 621–629.
5. Cao G, Sofic E, Prior RL. Antioxidant capacity of tea and common vegetables. *J Agric Food Chem* 1996;44:3426-3431.
6. Ames BN. Dietary carcinogens and anticarcinogens. Oxygen radicals and degenerative diseases. *Science* 1983;221:1256-1264.
7. Yavananani S, Sathiyabama M, Mirunaleni P, Suresh K, Meenakshi Sundaram M, Banumathi V. Therapeutic effectiveness of Siddha formulation Thulasi Ennai: A Review. *Int J Curr Res Chem Pharm Sci.* 2021;8(4):9-15.
8. Yavananani S, Mirunaleni P, Sathiyabama M, Suresh K, Meenakshi Sundaram M, Banumathi V. GCMS analysis of Thulasi ennai – A Siddha polyherbal formulation. *Int J Adv Multidiscip Res.* 2018;5(7):65-69.
9. Swetha S, Anuradha V, Yogananth N, Syed Ali M. GCMS analysis and *invitro* enzyme inhibitory effect of different solvent extracts of *Garcinia cambogia* fruit. *World journal of pharmaceutical research* 2018;7(5):1636-1650.
10. Selvi R, Yogananth N, Syed Ali M, Anuradha V. *In vitro* antioxidant and free radical scavenging activity of crude extract of *Solanum nigrum* L. *International journal of scientific research and review* 2018;7(3):153-163.
11. Swaminathan R, SyedAli M, Anuradha V, Abinaya R, Ananthalakshmi JS, Yogananth N. Antioxidant potential of fucose isolated from the marine macroalgae *Padina gymnospora*. *Biosc Biotech Res Comm* 2021;14(3): 1302-08
12. Chitra J, Syed Ali M, Anuradha V, Yogananth N, Asrar M. Chromatographic analysis of *Rhizophora mucronata* bark- based on antioxidant and free radical scavenging potential. *European journal of biomedical and pharmaceutical science* 2018;5(3):771-781.
13. Chitra J, Syed Ali M, Anuradha V, Yogananth, N. Screening of phytochemical constituents and anti- bacterial activity of fractionated leaf extract and anti-oxidant capacity of the crude extract of *Sesuvium Portulacastrum* leaf from backwaters of Muthukadu Lake, Chennai. *International journal of environmental health and technology* 2018;1(2):62-66.
14. Asbin Mary X, Syed Ali M, Anuradha V, Yogananth N, Antioxidant and free radical scavenging activity of crude extract of *Rhizophora mucronata* leaves. *International journal of environmental and health* 2017;1(1):22-29.
15. Rice-Evans CA, Miller NJ, Bolwell PG, Bramley PM, Pridham JB. The relative antioxidant activities of plant-derived polyphenolic flavonoids, *Free radical research* 1995;22(4):375–383.
16. Cao G, Sofic E, Prior RL. Antioxidant and prooxidant behavior of flavonoids: structure-activity relationships. *Free Rad Biol Med* 1997;22:749–60.





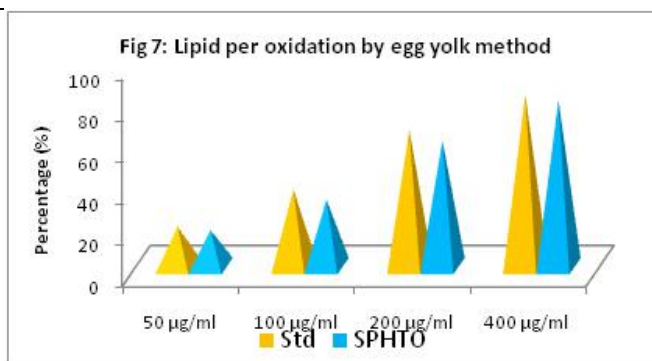
Yavanarani et al.

17. Pan Y, Wang K, Huang S, Wang H, Mu X, He C. et al. Antioxidant activity of microwave-assisted extract of Longan (*Dimocarpus longum* Lour.) peel. Food chemistry 2008;106:1264-1270.
18. Raquibul Hasan SM, Mokarram Hossain MD, Raushanara A, Mariam J, Ehsanul Hoque Mazumder MD, Shafiqur R. DPPH free radical scavenging activity of some Bangladesh medicinal plants. Journal of medicinal plant research 2009;3(1):875-879.
19. Nanfack P, Biapa N, Pieme C, Moor VA, Moukette B, Ngogang Y. The *in vitro* antisickling and antioxidant effects of aqueous extracts *Zanthoxylum heitzii* on sickle cell disorder. BMC Complement Alternat Med 2013;13:162.
20. Jamuna S, Paulsamy S, Karhtika K. Screening of *in vitro* antioxidant activity of methanolic leaf and root extracts of *Hypochoeris radicata* L (Asteraceae). J Appl Pharm Sci 2012;12: 149-154
21. Adithya ES, Lakshmi MS, Hephzibah P. *In vitro* antioxidant, anti-lipid peroxidation activities and HPLC analysis of methanol extracts from bark and stem of *Mahonia leschenaultia* Takeda. Asian J Plant Sci Res 2013;3:116–126.





Yavaranani et al.





An Extensive Review on Nanoparticulate Drug Delivery System and Its Toxicity

Vigneshwar.M^{1*}, Deepika Sree.R², Kalaivani.K², Kirankumar.S² and Harikrishnan N³

¹Assistant Professor, Department of Pharmaceutics, Faculty of Pharmacy, Dr.MGR Educational and Research Institute, Chennai, Tamil Nadu, India .

²Student, Faculty of Pharmacy, Dr.MGR Educational and Research Institute, Chennai, Tamil Nadu, India

³Professor and Principal, Faculty of Pharmacy, Dr.MGR Educational and Research Institute, Chennai, Tamil Nadu, India.

Received: 04 Apr 2022

Revised: 28 Apr 2022

Accepted: 24 May 2022

*Address for Correspondence

M.Vigneshwar,

Assistant professor,

Faculty of pharmacy,

Dr.MGR Educational and Research Institute,

Chennai, Tamilnadu, India.

Email: Vigneshwar.pharm@drmgrdu.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The nanoparticle are ruling the research world for the past two decades in almost all fields of science and technology. It is mainly because of their good stability, less size and better penetration etc. Pharmaceutical field is one such area in which the nano-particulate drug delivery is inevitable. Almost all the drugs which are ineligible for conventional dosage form are converted into one or other form of novel Nano-delivery system. Nano in drug delivery enables high cell specificity, better internalization, modified delivery, and reduced toxicity. Hence while formulating a nano-delivery system, knowledge about the drug, formulation methods and polymers are very essential to make an optimized formulation. This work provides key information about the nanoparticles its formulation, polymers, evaluation and Marketed preparation. It also speaks about the nano-toxicity and various methods to determine the toxicity effects so as to enable a brief idea to the researchers.

Keywords: Nanoparticles, Nano-toxicity, Cell surface selectivity, Nanoparticle kinetics and Biodegradable polymers.

INTRODUCTION

Nano particles are defined as ultra-fine particles of matter which has the size range between 1-100nm in diameter [1]. A large fraction of nanoparticles lies within a few atomic diameters from its surface, being a lot smaller than the

42813



**Vigneshwar et al.**

frequency of visible light 400-700nm nanoparticles cannot be seen with ordinary optical microscope, requiring the use of microscope with laser. Nanoparticle observation and size measurements was first done in 20th century by Richard Adolf Zsigmondy. First reported nanoparticles were based on non- biodegradable polymeric system that is polyacrylamide polymethylmethacrylate, by Birrenbach and Speiser in 1976. Nanoparticles are nanosized colloidal structure composed of synthetic or semi- synthetic polymers size range 10-100nm. Due to their wide range of superiority they are employed in various area in pharmaceutical industry.

In Targeted Drug Delivery

The drug is dissolved, entrapped, encapsulated, or attached to a nanoparticle matrix. Particle size affects the resistance imposed by physiological barrier in the body. To overcome the resistance, nanoparticles enable effective medication delivery to diverse areas of the body [2]. Nanoparticles can help with medication delivery by increasing the water solubility of poorly soluble medicines and increasing bioavailability for coordinated drug release as well as specific drug targeting. The surface characteristics of nanoparticles can be adjusted for targeted medication delivery of proteins, small molecules, peptides, and nucleic acids loaded nanoparticles are not recognized by the immune system to specific types of tissues [3]. Drug toxicity can be decreased and drug distribution can be made more efficient by targeting nano drug carriers. Nano carriers have the ability to distribute biotechnical medications across many anatomical ends of the body, such as the blood brain barrier (BBB) [4].

Properties

- They have huge specific surface areas.
- They are highly mobile in the free state, eg: silica nanoparticles
- They may exhibit quantum effect ⁷.
- Elastic modulus, hardness, stress and strain, adhesion is the mechanical nature of nanoparticles
- Enhanced toughness, lubrication and wear resistance, energy absorbing, particle agglomeration are the coating properties of nanocomposite.

Preparation

The suitable method for preparing nanoparticles is determined by the physicochemical property of polymer and drug loaded capacity. The following are the most common nanoparticle preparation methods:

Solvent evaporation:

Most of the nanoparticles were prepared by this method. In this procedure, there are two steps. The polymer solution must be first emulsified in an aqueous phase. In second step evaporation of polymer solution takes place, and nanospheres are created by causing polymer precipitation. Ultracentrifugation is used to collect nanoparticles, which are then washed in distilled water to eliminate any free drugs or residue before being lyophilized for conservation. Solvent evaporation is also known as high-pressure emulsification. To remove organic solvent, this procedure entails homogenization under high pressure and extensive stirring. The size can be modified by altering the stirring rate, organic and aqueous phase viscosity, temperature, type, and amount of dispersing agent. PLA, Poly (-hydroxybutyrate) (PHB)²², Poly (caprolactone) (PCL)²³, PLGA²⁴, cellulose acetate phthalate²⁵, and EC²⁶ are among the polymers employed in this approach [8].

Emulsification/Solvent Diffusion

A modified form of the solvent evaporation procedure is emulsification/solvent diffusion. The polymer is dissolved in a polar organic solvent and mixed with aqueous solutions. With the addition of water and stabilizer, emulsification proceeds quickly [9]. The encapsulating polymer is dissolved in a partly miscible with water solvent, such as propylene carbonate or benzyl alcohol, and the original thermodynamic equilibrium of both liquids saturated with water must be maintained. Following that, the polymer-water saturated solvent phase is emulsified in an aqueous solution containing a stabilizer, resulting in solvent diffusion to the outer phase and the arrangement of nanospheres or nano capsules based on the oil-to polymer proportion. At last, the solvent is eliminated by



**Vigneshwar et al.**

dissipation or filtration as per its edge of boiling point. However, there are significant disadvantages in this method including the large amount of water that must be removed from the suspension and reduced encapsulation efficiency during emulsification due to water soluble drug leakage in the saturated-aqueous exterior phase. This technique produced drug-laden nano particles such as cyclosporine (cy-A-); filled sodium glycolate nanoparticles, meso tetra (hydroxyphenyl) porphyrin-loaded PLGA nano particles, and doxorubicin-loaded PLGA nanoparticle [10].

Ionic Gelation Method:

The ionic gelation process is employed to make alginate nanoparticles. The ionotropic gelation of polyanion with calcium chloride was followed by polycationic crosslinking to produce alginate–chitosan nanoparticles in a two-step approach. Much research has been done on the preparation of nanoparticles using biodegradable hydrophilic polymers such as chitosan, sodium alginate, and gelatin. Calvo and colleagues developed an ionic gelation method for manufacturing hydrophilic chitosan nanoparticles. The approach uses two aqueous phases, one of which includes the polymer chitosan and the other of which contains sodium tripolyphosphate, a polyanion. In this process, the positively charged amino group of chitosan interacts with the negatively charged tri polyphosphate to generate nanometer-sized coacervates [11]. Coacervates are formed when two aqueous phases interact electrostatically, whereas ionic interaction circumstances at ambient temperature result in a change from liquid to gel due to ionic gelation.

Advantages

The advantages of nanoparticles as drug carrier is numerous, some of the important advantages are given

- High stability
- Longer shelf life
- High carrier capacity
- Feasibility of both hydrophilic and hydrophobic substances
- Limited side effects
- Longer drug circulation time
- Lower cytotoxicity
- Improving drug bioavailability
- Enhancing drug permeability and retention in tumour tissue (EPR)
- Controlled and sustained drug release
- Lower clearance rate and smaller volume of distribution

Disadvantages

Even though the advantages are high there are certain short comings in nano-particulate drug delivery like

- Drug burst release by erosion mechanism
- Lack of wide clinical studies
- Low drug payload for hydrophilic drugs
- Drug expulsion
- Reticulo-endothelial system (RES) clearance for synthetic^{12 13 14}.

Applications of nanoparticles:

Nano-medicine has enormous potential in terms of improving human diseases detection and treatment. The utilization of microbes in the creation of nanoparticles is an eco-friendly method [15]. Nanotechnology has the potential to change a wide range of biotechnological instruments, making them more affordable, tailored, safer, portable, and easier to deliver.





Timed Release of Drug

To avoid nonspecific toxicity, the medicine must remain encapsulated in the particle until it attaches to the target [16]. Nanoparticles can be used in targeted medication delivery at the site of disease, resulting in a number of significant effects, including:

Improved drug bioavailability,

Drugs that are targeted to a certain place

To increase the absorption of medicines that are poorly soluble.

Nano-materials have been used to successfully synthesize chemotherapeutic drugs such as dexamethasone, doxorubicin 5-fluorouracil, and paclitaxel

Cell Specificity and Internalization

Enhancement of cell selectivity by conjugating fluorescent or radio labelled antibodies to carbon nanotubes [17]. Surface-functionalized carbon nanotubes can be used to produce internalization within mammalian cells [18].

In Drug Delivery

The delivery of medications, heat, light, or other factors to certain types of cells (such as cancer cells) in the form of nanoparticles. Nanoparticles have been created to attract disease cells, allowing for direct therapy of specific cells. This technology will not only reduce harm to healthy cells in the body, but it will also allow for earlier illness detection. Another method for treating cancer cells is to administer chemotherapeutic medications to the cells while also applying heat to them. FOR EXAMPLE: Researchers connect gold nano-rods to DNA strand, which operate as a scaffold holding the nano-rod and the delivered medicine together. When infrared light illuminates the cancer tumour, the gold nano-rod absorbs it and converts it to heat. Heat causes the chemotherapy medicine to be released, which aids in the destruction of cancer cells [19].

In Diagonisis

Nanotubes improve the efficiency of diagnostic procedures. This functionalization characteristic which has a high length-to diameter aspect ratio allows for a high surface-to-volume ratio, and aids in creating high performance biosensors [20]. Because of Consider physical properties that are additional carbon-neutral medication delivery and diagnostic systems, The High thermal physicochemical characteristics conductivity, a well-organized structure with a high aspect ratio excellent electrical resistance, ultra-light weight, metallic Conductivity, high mechanical strength are all examples of semi metallic behaviour [21].

Characterization of Nanoparticles

Nanoparticle characterization is dependent on measuring parameters such as morphology, particle size, surface hydrophobicity, and surface charge. Transmission electron microscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy (AFM) are advanced techniques for measuring particle size, morphology, and particle size distribution, respectively. The surface charge of nanoparticles altogether affects the polymer's physical stability and efficiency. Therefore, the zeta potential technique is broadly utilized as an indirect method of estimating the surface charge of nanoparticles. It can likewise be utilized to evaluate the surface hydrophobicity and nature of materials encapsulated inside nano capsules or covered onto their surface. Several techniques, such as high-performance liquid chromatography (HPLC) or ultraviolet (UV) spectroscopy, have been used to determine drug loading and drug release. The HPLC method is used to determine the nanoparticle conjugated drug's loading capacity, which can be communicated as moles of medication per mg of polymer, mg of drug per mg of polymer, or as a rate comparative with the polymer.





Vigneshwar et al.

Evaluation Parameter of Nanoparticles

Particle size:

Particle size and its distribution is important characteristics in nanoparticles as they play a major role in distribution, pharmacology activity, toxicity and targeting to specific sites. Advanced methods to determine the particle size of nanoparticles is by photon correlation spectroscopy or dynamic light scattering, scanning electron microscopy.

Particle shape:

Particle shape of nanoparticle dosage form like suspension can also be determined by scanning electron microscopy (SEM) [22]. In order to form the solid particles these nano-suspension were subjected to lyophilization.

Yield of nanoparticles:

Percentage yield = Amount of particle / Amount of drug + Polymer * (100)

Drug content / Surface Entrapment / Drug Entrapment

Percentage drug entrapment = $W-w/W$ * (100)

Zeta Potential:

Zeta potential is a potential difference existing between the surface of a solid particle immersed in a conducting liquid and the bulk of the liquid. The surface charge of the nanoparticles is usually measured by zeta potential.

Differential scanning calorimetry (DSC):

It is used to determine the nature of crystalline within nanoparticles through the measurement of glass and melting point temperature and their associated enthalpies [23].

Atomic force microscopy (AFM):

It offers an ultra-high resolution in particle size measurement and is based on a physical scanning of sample at sub-micron level using a probe tip at atomic scale. AFE provides the most accurate description of size and shape distribution and requires non mathematical treatment.

Drug Localization And Drug Release

An important factor of nanoparticles as carries for drug delivery is to understand the way and level to which the therapeutics molecules are released. Release profile studies are carried out by encapsulation efficiency determination experiments, in which a time interval is measure to determine the release mechanism [24]. Several strategies for determining the in vitro release pattern of the encapsulated substance from nanoparticles have been described, Which includes the following:

Compartment diffusion cells with artificial or biological membrane

Stirring chased by centrifugation

Ultrafiltration or centrifugal filtration method

Diffusion through dialysis bag

Reverse dialysis bag method

Generally, drug release studies are carried out using centrifugation and controlled stirring. However, because the study is lengthy and there are technical difficulties in removing nanoparticles from the release buffer, the dialysis method is frequently preferred. The most common mechanisms for drug release from nanoparticles are:

Detachment of API attached to the outer layer,

Diffusion through the polymer matrix,

Membrane controlled diffusion,

Erosion of nanoparticles matrix,

A combination of diffusion and erosion process [25].

A biexponential formula could be used to evaluate the kinetics of nanocarrier release patterns.

$$C = A e^{-\alpha t} + B e^{-\beta t}$$



**Vigneshwar et al.**

Where C represents drug levels inside nanocarriers t represents time, A and B are constants that depend on matrix properties (A represents diffusion control matrices and B represents erosion control matrices), and alpha, beta are rate constants that can be estimated using semi-logarithmic plots. The drug's overall release pattern is determined by its inherent solubility, diffusion through the matrix, and biodegradation. To evaluate drug release from nanoparticles, lyophilize, weigh, and re-suspend in buffer, then incubate at 37 °C with slight stirring in a water bath. At predetermined intervals (between 15 and 60 minutes), with the same amount of new buffer being replaced to keep sink conditions constant. To calculate overtime drug release, quantify the drug by measuring the absorbance with spectrometry or HPLC. As a control, always use drug-free nanoparticles. The type of polymer matrix employed and the type of nanocarriers generated have a big impact on the drug release pattern. Furthermore, release profiles might be changed to prevent burst releases, but the burst effect could be used to deliver an initial loading dose if needed. The fact that the drug is loaded into the SLN, it is not always evenly solubilized in the lipid matrix and can be found in various regions of the particles as well as associated structures including micelles, liposomes, and drug nanocrystals. Unfortunately, release investigations are carried out in a variety of techniques, including centrifugation and dialysis, making it impossible to compare the results. The use of a dialysis membrane, for example, is a frequently used approach; however, the dialysis bag can sometimes limit diffusion and/or interact with medication molecules [27]. A dialysis bag is filled with the nanoparticle suspension and hermetically sealed. Immerse adequately sealed bags in a suitable dissolving fluid at 37°C with gentle stirring. The samples are taken at regular intervals, centrifuged, and tested for drug content against a blank using a suitable analytical method. The pattern of release changes depending on the conditions of release (sink or non-sink conditions, release medium etc) [28].

Toxicity Of Nanoparticles

Nanoparticles physiochemical properties impact how they cooperate with cells and, therefore, their overall potential toxicity. Understanding these properties could lead to the making of more secure nanoparticles. Recent research has started to recognize properties that make some nanoparticles more toxic than others. In principle, molecule size should contribute to cytotoxicity. Smaller nanoparticles have a larger specific surface area (SSA) and in this way more accessible surface region to connect with cellular parts such as nucleic acids, proteins, fatty acids, and carbohydrates when compared to larger nanoparticles of the same mass. Due to its smaller size, it is bound to enter the cell and cause cell harm. Toxicity was found to be a component of both size and SSA in some nanoparticles. Particles below 10 or above 30 nm produced similar levels of Reactive oxygen species per surface area. However, the production of reactive oxygen species per unit surface area increased dramatically as particle size increased from 10 to 30 nm. This data sheds light on the complex relationship between nanoparticle properties and nanotoxicity.

The toxicity of nanoparticles is determined by a number of factors, according to toxicological data:

Effect of dose and exposure time: The molar concentration of Nanoparticles (NPs) in the nearby media multiplied by the exposure period determines the number of nanoparticles that reach the cells [28].

Effects of aggregation and concentration: There are numerous findings on the toxicity of NPs at various concentrations that are contradictory.

Aggregation helps by increasing the concentration of nanoparticles. Because most NP aggregates are micro meter-sized, a large number of aggregated NPs may not penetrate cells, losing their toxicity [29].

The effect of particle size: The toxicity of NPs is proportional to their size. eg, Compared to Ag⁺ ions and Ag NPs with larger diameters (20–100 nm), Ag NPs with a diameter of less than 10 nm have a greater ability to infiltrate and disrupt cellular processes in many organisms [30].

The effect of particle shape: Toxicity levels are also affected by shape. Shape-dependent toxicity occurs in NPs, meaning that toxicity levels vary depending on the aspect ratio. For eg,

Amorphous TiO₂ was found to create more ROS than anatase or rutile of similar size, with rutile TiO₂ producing the least measure of ROS. Amorphous TiO₂ is probably going to have more surface defects, and hence more active sites capable of producing ROS.

Even though the particles are similar in size and chemical make-up, the anatase form of TiO was significantly more toxic to PC12 cells than the rutile form. The effect of crystal structure: NPs may have variable cellular absorption, oxidative processes, and subcellular localisation depending on their crystal structure [31].

For example, the toxicity of the two crystalline polymorphs of TiO₂ (rutile and anatase) differs. Rutile NPs (200 nm) cause DNA damage in the dark via oxidation, whereas anatase NPs (200 nm) do not cause DNA damage in the



**Vigneshwar et al.**

dark [32]. The effect of surface functionalization: Particle surface charge was determined by point-of-zero charge (PZC). Surface characteristics of NPs have been found to have significant effects on translocation and subsequent oxidation processes [33,34,35]. Effect of pre-exposure: shorter exposure times or pre-exposure to lower NP concentrations can boost cellular phagocytic activity [36]. The human body adapts to NPs to some extent as a result of this preexposure [37].

CONCLUSION

Nanoparticles are important in several dosage form in recent years, Nanoparticle technologies have enormous potential, as they can transform poorly soluble, poorly absorbed, and labile physiologically active substances into potentially deliverable particles. The morphology, on the other hand, can be controlled the method of preparation. Because of their small size, NPs have a vast surface area, making them a good choice for a variety of applications. Furthermore, toxicology and various application of nanoparticles are detailed. Though NPs are beneficial for a variety of applications, they can pose some health risks due to their uncontrolled usage and discharge into the natural environment. Nanotechnology's application in medicine, specifically drug delivery, is expected to grow substantially. Nanoparticles have been used in pharmaceutical research for to lower drug toxicity and side effects. In near future the complete takeover of nanoparticle drug delivery over the conventional dosage form will make the rational treatment protocols.

REFERENCES

1. Cristina Buzea, Ivan Pacheco, Kevin Robbie., Nanomaterials and Nanoparticles: Sources and Toxicity, *Biointerphases*, 2: MR17–MR71, 2007.
2. Paul JA, Borm and Wolfgang Kreyling., Toxicological Hazards of Inhaled Nanoparticles- Potential Implications for Drug Delivery., *J Nano sci Nanotech*, 4(6):1-11, 2004
3. Mohsen J, Zahra B., Protein nanoparticle: A unique system as drug delivery vehicles, *African Journal of Biotechnology*, 25:4926-4934, 2008.
4. Rawat M, Singh D, Saraf S, Nanocarriers: Promising Vehicle for Bioactive Drugs. *Biol. Pharm. Bull.* 2006, 29(9):1790-1798.
5. Asha Rani PV, Low Kah Mun G, Hande MP, Valiyaveetil S, Cytotoxicity and genotoxicity of silver nanoparticles in human cells. *ACS Nano*, 3, 279–290, 2009.
6. Abouelmagd SA, Meng F, Kim BK, Hyun H, Yeo Y, Tannic acid-mediated surface functionalization of polymeric nanoparticles. *ACS Biomater. Sci. Eng.* 6b00497, 2016.
7. Ali S, Khan I, Khan SA, Sohail S, Ahmed R, Rehman A, Ansari MS, Morsy MA, Electrocatalytic performance of Ni Pt core-shell nanoparticles supported on carbon nanotubes for methanol oxidation reaction. *J. Electro anal. Chem.*, 795, 17–25, 2017.
8. Jaiswal J, Gupta SK, Kreuter J., Preparation of biodegradable cyclosporine nanoparticles by high pressure emulsification solvent evaporation process., *J Control Release*, 96:1692-1778,, 2004.
9. Soppinath KS, Aminabhavi TM, Kulkurni AR, Rudzinski WE., Biodegradable polymeric nanoparticles as drug delivery devices., *J Control Release*, 70:1-20, 2001.
10. Tice TR, Gille GM., Preparation of injectable Controlled release microcapsules by solvent evaporation process., *J Control Release*, 1985.
11. Allemann E, Gurny R, Doekler E., Drug-loaded nanoparticles preparation methods and drug targeting issues., *Eur J Pharm Bio pharm.*, 39:173-91,, 1993.
12. El-shabouri MH., Positively charged nano particles for improving the oral bioavailability of cyclosporine-A., *Int J Pharm.*, 249:101-8, 2002.
13. Vargas A, Pegaz B, Devefve E, Konan Kouakou Y, Lange N, Ballini JP., Improved photodynamic activity of porphyrin loaded into nano particles: an in vivo evaluation using chick embryos., *Int J Pharm.*, 286: 131- 45, 2004.





Vigneshwar et al.

14. 14.Yoo HS, Oh JE, Lee KH, Park TG., Biodegradable nanoparticles containing PLGA conjugates for sustained release., *Pharm Res.*,16: 1114-8,,1999.
15. 15.Fessi H,Puisieux F,Devissaguet JP, Ammoury N, Benita S., Nano capsule formation by interfacial deposition following solvent displacement., *Int J Pharm.*, 55: R1-R4,, 1989.
16. 16.Chorny, Michael et al. "Lipophilic drug loaded nanospheres prepared by nanoprecipitation: effect of formulation variables on size, drug recovery and release kinetics." *Journal of controlled release: official journal of the Controlled Release Society* 83, 3: 389-400, 2002.
17. Calvo P, Remunan- C,Vila- JL, Alonso MJ., Novel hydrophilic chitosanpolyethylene oxide nanoparticles as protein carriers., *J Appl Polymer Sci.*,63: 125-132, 1997.
18. 18.Ubrich N, Bouillot P, Pellerin C,Hoffman M, Maincent P., Preparation and characterization of propranolol hydrochloride nanoparticles: A comparative study., *J Control release.*,291-300,2004.
19. 19.Catarina PR,Ronald JN, Antonio JR., Nano capsulation: Method of preparation of drug –loaded polymeric nanoparticles. *Nanotech Bio med.*,2:8-21, 2006.
20. Singh SS, Fenniri H, Singh B., Nanotechnology based drug delivery systems. *J Occup Med Toxicol.*, 2: 16, 2007.
21. McDevitt MR, Chattopadhyay D, Kappel BJ, Jaggi JS, Schiffman SR, C Antczak C., Tumor targeting with antibody-functionalized, radiolabeled carbon nanotubes., *J Nucl Med.*,48: 1180–9,2007.
22. 22.Bodmeier R, Chen H., Indomethacin polymeric nanosuspensions prepared by micro fluidization., *J Control Release.*, 12:223-33,1990.
23. Takeuchi H Yamamoto Y., Mucoadhesive nanoparticulate system for peptide drug delivery. *Adv Drug Del Rev.*,47: 39-54, 2001.
24. Zhang Z, Yang X, Zhang Y, Zeng B, Wang S,Zhu T., Delivery of telomerase reverse transcriptase small interfering RNA in complex with positively charged single-walled carbon nanotubes suppresses tumor growth., *Clin Cancer Res.*, 12: 4933–9,, 2006.
25. 25.Thakral S, Mehta RM., Fullerenes: an introduction and overview of their biological properties, *Ind J Pharm Sci.*, 68:13–9,2006.
26. 26.Wim H, Jong D, Paul JA, Drug delivery and nanoparticles: Applications and hazards., *Int J Nanomed.*, 3(2): 133–149, 2008.
27. 27.Cuimiao Z, Chunxia Li, Shanshan Huang, Zhiyao Hou, Ziyong Cheng, Piaoping Yang, Chong Peng, Jun Lin., Self-activated luminescent and mesoporous strontium hydroxyapatite nanorods for drug delivery., *Biomaterials.*, 31(12): 3374-83, 2010.
28. 28.Tahara K, Sakai T, Yamamoto H, Takeuchi H, Hirashima N, Kawashima Y, *Int. J. Pharm.*,Article Download PDF View Record in Scopus [32] 382 pp.,198-204,2009.
29. Nassimi M,Schleh C, Lauenstein H.D, Hussein R, Hoymann H.G, Koch W et al. *Eur. J. Pharm. Bio pharm.*, Article Download PDF View Record in Scopus [33] 75 pp., 107-116,2010.
30. Davoren M, Herzog E, Casey A, Cottineau B, Chambers G, Byrne H.J et al. *Toxicol, In Vitro*, 21 Article Download PDF View Record in Scopus [34] pp., 438-448,2007.
31. Schipper M.L,Nakayama-Ratchford N, Davis C.R, Kam N.W, Chu P, Liu Z et al. *Nat. Nano technol.*, 3 View PDF Cross Ref View Record in Scopus [35] pp., 216-221,2008.
32. 32Mitchell L.A, Gao J, Wal R.V, Gigliotti A, Burchiel S.W,McDonald J.D,*Toxicol. Sci.*, 100 pp., 203-214,2007.
33. 33.Tahara K, Sakai T, Yamamoto H, Takeuchi H, Hirashima N, Kawashima Y, *Int. J. Pharm.*, Article Download PDF View Record in Scopus [32] 382pp., 198-204,2009.
34. 34.Nassimi M, Schleh C, Lauenstein H.D, Hussein R, Hoymann H.G, Koch W et al.*Eur. J. Pharm. Bio pharm.*, Article Download PDF View Record in Scopus [33] 75 pp., 107-116,2010.
35. 35.Davoren M, Herzog E, Casey A, Cottineau B, Chambers G, Byrne H.J, et al. *Toxicol. In Vitro*, Article Download PDF View Record in Scopus [34] 21 pp. 438-448,2007.
36. Schipper M.L, Nakayama-Ratchford N, Davis C.R, Kam N.W, Chu P, Liu Z et al. *Nat. Nano technol.*, 3 pp. 216-221,2008.
37. Mitchell L.A, Gao J, Wal R.V, Gigliotti A, Burchiel S.W, JMcDonald J.D, *Toxicol. Sci.*, 100 pp. 203-214,2007.



Vigneshwar *et al.***Table-1 Types Of Nanoparticles And Their Applications**

| TYPES OF NANOPARTICLES | APPLICATION |
|----------------------------|--|
| Lipid nanoparticles | Medication delivery and RNA release in cancer therapy ⁵ |
| Vesicular systems | Delivery of various active compounds including protein and peptides, insulin |
| Polymeric nanoparticles | Stimuli responsive cargo delivery, nanocomposites, tissue engineering ⁶ |
| Metallic nanoparticles | To synthesize metal-based biopolymer composites |
| Carbon based nanoparticles | Delivery of therapeutics, biomedical imaging, chemophoto thermal therapy |

Table:2 Polymers Used In The Preparation Of Nanoparticles:

| Biodegradable | Non-biodegradable |
|--|------------------------------|
| WATER SOLUBLE | |
| Albumin | Polymethylvinyl ether/maleic |
| Gelatin | Polyamidoamines (PAMAM) |
| Poly malic acid (PMA) | Gantrez |
| Poly vinyl pyrrolidone(PVP) | Poly glutamic acid (PGA) |
| Poly vinyl alcohol(PVA) | Polypropylene (PP) |
| WATER INSOLUBLE | |
| Poly lactic acid (PLA) | Eudragit |
| Poly glycolic acid (PGA) | Polymethyl methacrylate's |
| Poly lactide-co-glycolide (PLGA), polyalkyl cyanoacrylates | Polyortho ester (POE) |
| Poly-ε-caprolactone (PCL), Poly lactide-cocaprolactone (PLC) | Polystyrene |
| Alginate acid/ alginates, chitosan and chitin derivatives | Poly ethylene terephthalate |

Table: 3 Review Of Key Nanoformulations In Last Decades:

| DRUG | POLYMER | PREPARATION METHOD | % EE | DRUG EFFECT/ ACTIVITY | REFERENCE |
|--------------------|-------------------------------------|-----------------------------|--------|-------------------------|--|
| Flutamide | Chitosan | Ionic gelation technique | 75.2% | Anti-androgenic | Adlin.J <i>et al</i> (2009) |
| Lamivudine | Eudragit RS 100 | Nanoprecipitation method | 70.83% | Anti-viral agent | Tamizhrasi S <i>et al</i> (2009) |
| Carvedilol | Eudragit E 100 | Nanoprecipitation method | 91% | Anti-hypertensive drug | Selvakumar kalimuthu <i>et al</i> (2009) |
| Losartan potassium | Ethyl cellulose | Ionic gelation method | 87.5% | Anti-hypertensive agent | Amar singh <i>et al</i> (2011) |
| Capecitabine | Tripolyphosphate, chitosan | Ionic gelation method | 86.4% | Anti-cancer therapy | Latha.S <i>et al</i> (2012) |
| Isoniazid | Poly ε caprolactone | Ultrasonication technique | 69.72% | Anti-hypertensive agent | Atanu Kumar Behera (2012) |
| Curcumin | Polycatocol, poly vinyl pyrrolidine | Freeze drying | 76.2% | Cancer therapy | Murali Mohan Yallapu <i>et al</i> (2012) |
| Moxifloxacin HCL | Eudragit RL 100 | Solvent displacement method | 80% | Anti-bacterial activity | Srinivas P <i>et al</i> (2012) |
| | | | | | |





Vigneshwar et al.

| | | | | | |
|--------------------------------|--|--|--------|-------------------------------------|---------------------------------------|
| Pioglitazone | Carboxy methyl cellulose | Coacervation | 77.5% | Type 2 diabetes | Bindu Madhavi Boddupalli et al (2013) |
| Glipizide | Polyvinyl alcohol | Emulsification – solvent evaporation technique | 95.66% | Anti-diabetic drug | Amolkumar Lokhande et al (2013) |
| Betamethasone sodium phosphate | Chitosan | Ionotropic gelation technique | 64.29% | Macular edema | Mohamed Ali Attia Shafie et al (2013) |
| Clopidogrel | Polyvinyl alcohol, polyvinyl pyrrolidone | Anti – solvent precipitation method | 83% | Anti-platelet drug | Zainab E Jassim et al (2014) |
| Artemisinin HCL | Poly (E – Caprolactone) | Solvent evaporation method | 99% | Anti-malarial drug | Gupta et al (2014) |
| Dorzolamide hydrochloride | Eudragit | Quasi-emulsion solvent diffusion technique | 89.5% | Anti-glucoma | Azza A Hasan et al (2014) |
| Sunitinib | Chitosan | Ionic crosslinking method | 98.03% | Anti-cancer drug | Jayapal John Joseph et al (2015) |
| Fenretinide | PEG, PLGA | Solvent evaporation technique | 92.6 % | Anti-cancer drug | Richard A Graves (2015) |
| Moxifloxacin | Gelatin | Desolvation technique | 57% | Anti-bacterial drug | Alok Mahor et al (2016) |
| Miconazole | Cremaform RH40 | Hot homogenization | 90.2% | Broad spectrum anti-fungal | Bader Mubarak Aljaeid et al (2016) |
| Labetalol | Chitosan, ethylcellulose | Nanoprecipitation | 83.47% | Anti-hypertensive drug | Surendranath Betala et al (2018) |
| N-acetyl cysteine | PLGA | Nanoprecipitation method | 0.4% | Anti-oxidant drug | Ruth Iancheros et al (2018) |
| Fenofibrate | Eudragit L-100 | Precipitation technique | 92.43% | Anti-lipidemic drug | Shelake SS et al (2018) |
| Carvedilol | HPMC, Gelation | Nanoprecipitation method | 74.2% | Anti-hypertensive drug | Surendranath Betala et al (2018) |
| Erlotinib | Chitosan | Ionic gelation, spray drying | 43% | Anti-cancer drug | Parijat et al (2019) |
| Allopurinol | Chitosan, TPP | Chemical co-precipitation method | 52.56% | Hyper-uricemic nephropathy | Gurpreet Kandav et al (2019) |
| Simvastatin | Hydrogel | Nanoprecipitation method | 97.25% | Wound healing (anti-lipidemic drug) | Usama Farghaly Aly et al (2019) |





Vigneshwar et al.

| | | | | | |
|-------------------|-----------|------------------------|---------|------------------|----------------------------|
| Ondan Setron HCL | Eudragit | Nanoprecipitation | 78.45% | Anti-emetic drug | Amjed H Noor et al (2020) |
| Ropinirole | Chitosan | Ionic gelation method | 61.42 % | Dopamine agonist | Anudeep Balla et al (2020) |
| N-acetyl cysteine | PLGA, PVA | Double emulsion method | 55.46% | Anti-bacterial | Vishal puri et al (2022) |

Table:4 Marketed Available Product As Nano-Formulation:

| Product | Therapeutic agent | Nanotechnology | Therapeutic use | Route of administration |
|-----------|-------------------|-----------------------------|--------------------------|-------------------------|
| Abraxane | Paclitaxel | Albumin-bound nanoparticles | Metastatic breast cancer | Intravenous |
| AmBisome | Amphotericin B | Lipid-based nanoparticles | Anti-fungal agent | Intravenous |
| Avinza | Morphine sulphate | Nanocrystal | Psycho-stimulant | Oral |
| Danazol | Danocrine | Nanocrystals | Angioedema | Oral |
| Emend | Aprepitant | Nanocrystals | Anti-emetic | Intravenous |
| Invega | Paliperidone | Nanosuspension | Schizophrenia | intramuscular |
| Megace es | Megestrol Acetate | Nanocrystals | Appetite stimulant | Oral |
| Pacliall | Paclitaxel | Nanoparticles | Lung cancer | Intravenous |
| Rapamune | Sirolimus | Nanocrystals | Immuno-suppressant | Oral |
| Tricor | Fenofibrate | Nanocrystal particles | Anti-lipidemic | Oral |

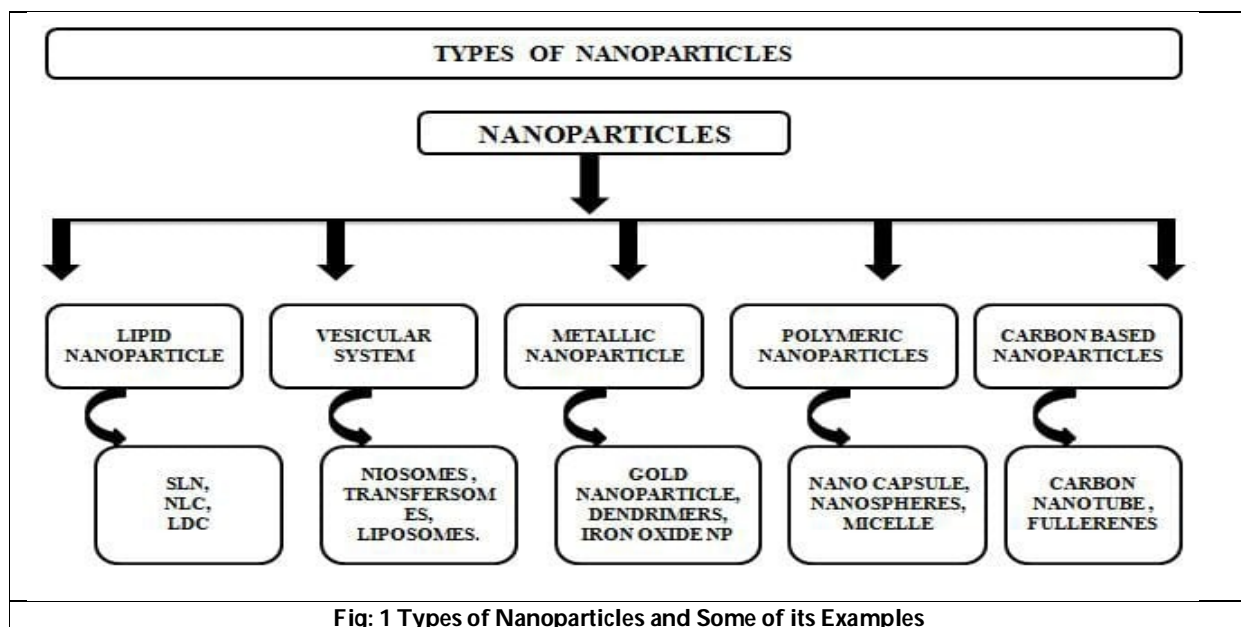
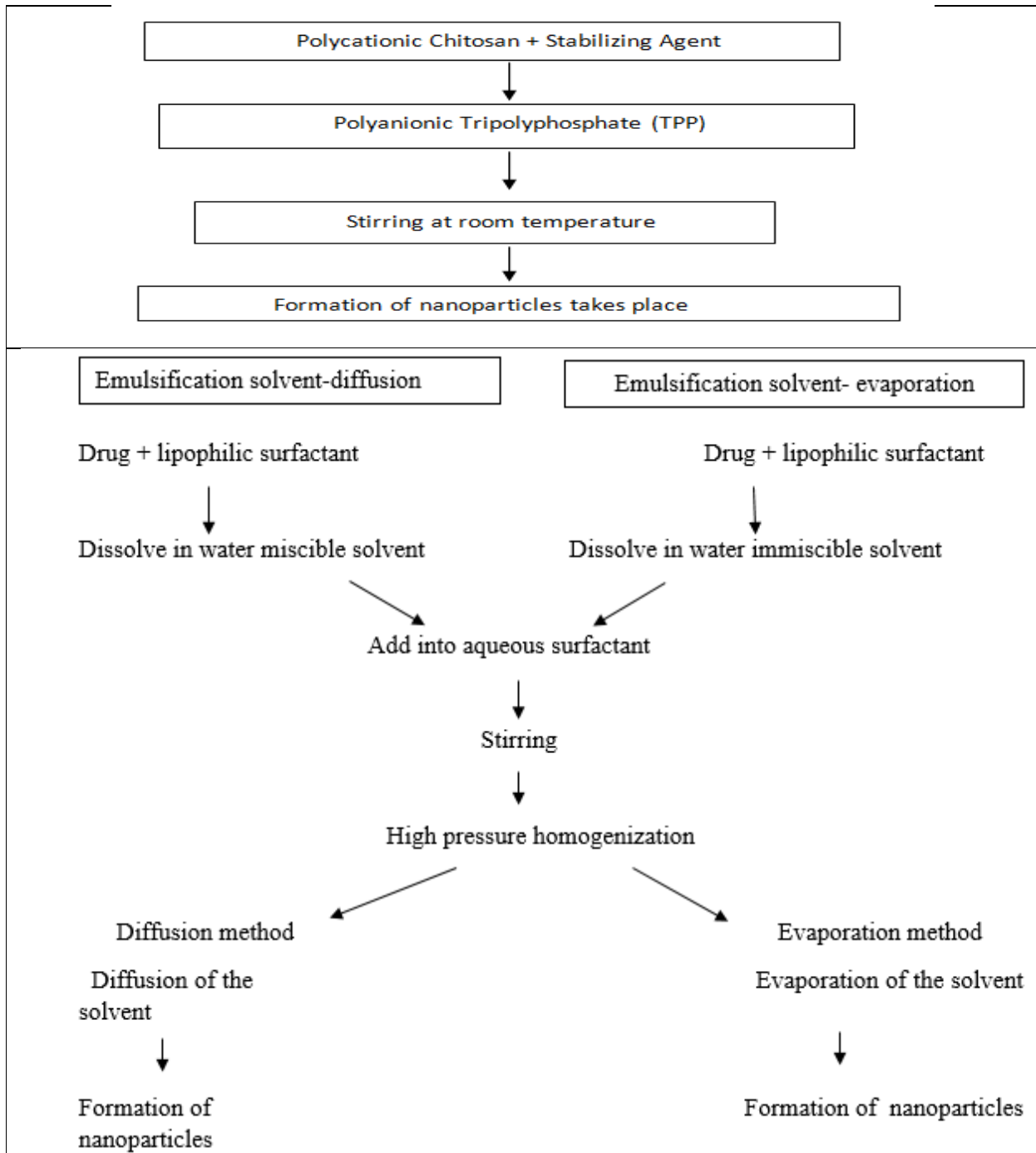


Fig: 1 Types of Nanoparticles and Some of its Examples





Vigneshwar et al.





Effect of Yogic Practices on Selected Biochemical Variables among Obese Adult Women

T.Sujatha¹, R. Elangovan²,

¹PhD Scholar(Part-Time) in Yoga, FYST, Meenakshi Academy of Higher Education and Research, No.12, Vembuliamman Koil Street, West K.K.Nagar, Chennai-78, Tamil Nadu, India.

²Professor & Head, Faculty of Yoga Sciences and Therapy, Meenakshi Academy of Higher Education and Research, No.12, Vembuliamman Koil Street, West K.K.Nagar, Chennai-78, Tamil Nadu, India.

Received: 14 Apr 2022

Revised: 02 May 2022

Accepted: 25 May 2022

*Address for Correspondence

T.Sujatha

PhD Scholar(Part-Time) in Yoga,
FYST, Meenakshi Academy of Higher Education and Research,
No.12, Vembuliamman Koil Street,
West K.K.Nagar, Chennai-78, Tamil Nadu, India
Email: sujatha.yogaworks@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Group trial(Random) was intended to investigate if yoga practises had an influence on certain risk variables in obese women. A random sample design was used to divide 30 obese adult women in Chennai, India, into two groups, each with a different age range. Participants in each of the two experimental groups totaled fifteen (15). This research required an eight-week training session. Six days a week, for up to an hour and a half, members of the experimental group A practised yoga during morning. Rest group was active with day routines. For both groups, tests(before/after) were administered in the training. Analysis of Covariance (ANCOVA) was performed to determine the statistical significance within two groups of participants. Degree of confidence was set at 0.05. There was a significant difference in biochemical indicators such as fasting blood sugar and HbA1c between group-1 and group-2 of obese adult women who participated in yoga activities. One study on obese adult women found that yoga practises improved biochemical measures including fasting blood sugar and HbA1c (which fell) as compared to Group B. As a result, the 0.05 level of confidence in the hypothesis presented above was accepted.

Keywords: Yogic practices, Fasting blood sugar, HbA1c, Adult women, Obesity.





INTRODUCTION

Motivation for Research

Women playing a very important role in the society, She becoming ill and inefficient not only impact her as an individual but also impact the Family and as a whole the Society. Hence Women being healthy is of utmost important. As Obesity is one of the primary reasons which induces lot of other complication in a Women, curbing the root cause of the women health issue is the motivation for this research A woman's role in the home is absolutely vital. In order for a kid to grow up to be a well-rounded individual, the mother or mother figure in the home performs an essential role. The mother's role extends beyond providing food and clothes to include nurturing the child's emotional and psychological well-being. Today, regardless of the nature of the job, women may be found in any business on the planet. At least theoretically, women have equal opportunity in the workplace. It has become more common for women to have a significant part in the financial and emotional well-being of their families. For women who is playing the prominent role in the Family and the societal life, the maintenance of Health becomes a crucial factor. One of the major issues faced by the women in the current era is the Obesity. Obesity has a detrimental influence on women's health in a variety of ways. Obese or overweight women have inclination to diabetes and coronary heart disease. Low back discomfort and knee osteoarthritis are more common in obese women. As a result of obesity, contraception and fertility are negatively affected. Obesity in pregnant women has been associated to an increased risk of caesarean section and other high-risk obstetric problems. Pregnancy outcomes are negatively impacted by maternal obesity (increased risk of neonatal mortality and malformations). Overweight mothers have a decreased desire for nursing, a decreased rate of starting, a decreased length of breastfeeding. Cultural factors may impact the connection between obesity and depression in women. Obese women are more likely to get endometrial cancer, cervical cancer, breast cancer, and maybe ovarian cancer.

Symptoms of Adult Obesity

It may seem small at first, but weight gain may soon turn into a major medical problem if it isn't addressed. Among the most noticeable signs and symptoms are a decline in quality of life, difficulty sleeping, excessive sweetening, respiratory difficulties, fatigue, skin problems, psychological problems, and physical pain.

Adult Obesity's Causes and Complication

Causes:-

Lifestyle – A Healthy behaviours with regular physical activity and healthy eating needs to be practised. The sedentary life style and the junk food invasion has contributed to a great extent on the increase in obesity

Genetics - The body's genes tell it how to react to changes in its environment. Several gene changes may make people hungrier and eat more, which can lead to obesity.

Diseases and drugs: Some diseases, like Hormone issues, can cause people to gain weight or become obese. Steroids and some antidepressants can also make you gain weight.

Complications

People who are obese are more likely to get many serious diseases and health conditions than people who are a healthy weight.

- Less time on earth, and less quality of life
- Elevated blood pressure (hypertension)
- Diabetes type 2
- LDL cholesterol is high and HDL cholesterol is low
- Diseases of the heart, brain, and gallbladder
- Arthritis
- Sleep apnea
- Mental disorders like clinical depression, anxiety, and other mental illnesses
- Pain in the body and trouble getting around





Sujatha and Elangovan

Solutions for Being Fat

- There is no one easy way to stop the growing number of people who are overweight. It's a hard problem, so there needs to be more than one way to solve it. Policymakers, state and local organisations, business and community leaders, school, childcare, and health care professionals, and individuals all need to work together to create an environment that supports a healthy lifestyle.
- You can't get and stay at a healthy weight by making short-term changes to your diet. Instead, you need a lifestyle that includes healthy eating and regular exercise.
- Regular exercise like running, swimming etc
- Regular yoga practise and a healthy diet might help you lose weight.
- Different effect on obesity are witnessed because of practice of yoga, which, unlike other methods of weight loss, is designed to last. Fat buildup that is out of control

Problem Statement

The study's goal was to examine the impact of yoga practises on several biochemical markers in obese adult women.

Hypotheses

It was predicted that the yoga practises of obese adult women will have a substantial impact on biochemical variables such as fasting blood sugar and haemoglobin A1c in group 1 compared to control group 2.

The Importance of the Research.

Certain biochemical indicators, such as fasting blood sugar, HbA1c, among obese adult women, were thought to be associated to the control group 2 because of the yoga practise in the first group.

Design for Experimentation

Pre- and post-tests were conducted as part of the study's true random group experimental design.

Purpose of the Investigation

The study's purpose was to see if some biochemical markers like fasting blood sugar and haemoglobin A1c differed significantly among obese adult women.

Delimitations

- Only obese adult females were included in the research.
- There were only a few participants from outside of the city of Chennai in this study.
- The participants were all between the ages of 25 and 35.
- Only yogic practises were included as an independent variable in the study.
- As a dependent variable, the study was confined to fasting blood sugar and HbA1c.

Limitations

- The subject's way of life was not taken into consideration. • There was little consideration for the other procedures done by the participants.
- It was not taken into account throughout training that the subject's job and daily routine were not taken into account.
- It was not taken into account external aspects such as food habits, life-styles, socioeconomic level, and motivation.
- There were no considerations given to the use of medication by the individuals.

METHODOLOGY

In order to conduct the random group experimental study, a total of 90 individuals were enrolled, 50 were scanned, and 30 obese adult women aged 25 to 35 from Chennai City were selected at random using a "simple random group sampling technique". Subjects are kept equal size of 15 into two groups. It took eight weeks to conduct this study.



**Sujatha and Elangovan**

An hour of yoga were performed six days a week by participants in experimental group 1. There were no changes to regulation in Group-2.

Surya Namaskar, Kapalbhathi, SukshmaViyayama and Surya Namskar are the yogic practises provided to students in group I. Among a limited group of people, the variations in fasting blood sugar and haemoglobin A1c between the beginning and end of the study were attributed to yoga practises. HbA1c, a Lab Test, was used to test fasting blood sugar levels. Pre- and post-tests were administered to all participants in advance to and following the testing. The results were assessed using the ANCOVA test, which measures co-variance. A 0.05 level of confidence was used for the significance test.

RESULTS AND DISCUSSIONS

Analysis of Covariance (ANCOVA) was used to determine the relevant difference between the two groups before and after the training period, with a confidence level of 0.05. In the following tables, you can see the results.

Results On Fasting Blood Sugar

Using ANCOVA the statistical test, significance of the differences in variables were obtained from two groups before and after the training session. Table I shows the results of an ANCOVA analysis on fasting blood sugar between the Yogic Practices and the Control Group. For fasting blood sugar, the F-ratio value of 52.87* was higher than the table value of 4.20. This shows that the post-test and adjusted post-test means of the yogic practises group are different from those of the control group when it comes to fasting blood sugar. The above conclusions can also be backed up by what experts Yadav Rashmi *et al* (2016). Figure1. shows the ordered modified means on fasting blood sugar to better illustrate the study findings.

Results on HbA1c

ANCOVA was used to examine the statistical significance in variables obtained from two groups before and after the training session. Table I shows the results of an ANCOVA analysis on HbA1c between yogic practises and a control group. In the case of HbA1c, the actual F – ratio (267.48*) was higher than the expected table value (4.20). This shows that the post-test and adjusted post-test averages of yogic practises group 1 were significantly different from the control group 2 on HbA1c. Furthermore, the conclusions of specialists ThindHerpreet *et al.* might be backed up by the results of this study (2017). The bar diagram in Figure 2 illustrates the orderly modified means on HbA1c in order to assist understand the results of this investigation.

HYPOTHESIS DISCUSSION

It was predicted that the yoga practises of obese adult women would have a substantial impact on some biochemical variables such as fasting blood sugar and haemoglobin A1c in group 1 compared to control group 2. Yogic exercises had a substantial impact on fasting blood sugar (Decreased) and HbA1c (Decreased) compared to obese adult women in the control group.

CONCLUSION

Yoga has been shown to reduce fasting blood sugar and HbA1c levels in obese adult women. Obese people might also benefit from the health benefits of yogic activities.





Sujatha and Elangovan

REFERENCES

1. Yadav, Rashmi *et al.* "Effect of a Short-Term Yoga-Based Lifestyle Intervention on Health-Related Quality of Life in Overweight and Obese Subjects." *Journal of alternative and complementary medicine (New York, N.Y.)* vol. 22,6 (2016): 443-9. doi:10.1089/acm.2015.0268
2. Thind, Herpreet *et al.* "The effects of yoga among adults with type 2 diabetes: A systematic review and meta-analysis." *Preventive medicine* vol. 105 (2017): 116-126. doi:10.1016/j.ypmed.2017.08.017
3. Krishna Raman (2006), "A Matter of Health", Chennai, East West Books Pvt.Ltd.PP.24.
4. Swami SatyanandaSaraswathi (2009), "Asana PranayamaMudraBandha", Bihar, Yoga Publications Trust. PP.197-362
5. www.lifeclinic.com
6. https://www.rightdiagnosis.com/artic/niddk_statistics_related_to_overweight_and_obesity_niddk.htm
7. https://www.rightdiagnosis.com/artic/understanding_adult_obesity_niddk.htm
8. <https://www.knowledgeidea.com/role-of-women-in-society/>
9. www.shodhganga.com

Table – I ANCOVA ANALYSIS ONFASTING BLOOD SUGAR (Scores in mg/dl)

| | Group 1 | Group 2 | Source of Variance | Sum of Squares | Degrees of Freedom | Mean Squares | Obtained F ratio |
|-------------------------|---------|---------|--------------------|----------------|--------------------|--------------|------------------|
| Pre Test Mean | 117.93 | 118.93 | Between | 7.50 | 1 | 7.50 | 11.49 |
| | | | Within | 2413.87 | 28 | 86.21 | |
| Post Test Mean | 95.33 | 115.80 | Between | 3141.63 | 1 | 3141.63 | 52.87* |
| | | | Within | 1663.73 | 28 | 59.42 | |
| Adjusted Post Test Mean | 95.70 | 115.43 | Between | 2908.80 | 1 | 2908.80 | 235.71* |
| | | | Within | 333.20 | 27 | 12.34 | |
| Mean difference | 22.60 | 3.13 | | | | | |

*Significant at 0.05 confidence level. With 4.20 & 4.21 as f table scores

Table – II THE MEANS OF GROUPS ONHbA1c(Scores in numeric)

| | Group 1 | Group 2 | Source of Variance | Sum of Squares | Degrees of Freedom | Mean Squares | Obtained F ratio |
|-------------------------|---------|---------|--------------------|----------------|--------------------|--------------|------------------|
| Pre Test Mean | 7.77 | 7.82 | Between | 0.02 | 1 | 0.02 | 7.23 |
| | | | Within | 4.32 | 28 | 0.15 | |
| Post Test Mean | 6.09 | 7.69 | Between | 19.36 | 1 | 19.36 | 267.48* |
| | | | Within | 2.03 | 28 | 0.07 | |
| Adjusted Post Test Mean | 6.10 | 7.68 | Between | 18.57 | 1 | 18.57 | 696.5* |
| | | | Within | 0.72 | 27 | 0.03 | |
| Mean difference | 1.68 | 0.13 | | | | | |

*Significant at 0.05 LOC. Critical F Value for sample size/degree of freedom is 4.20 & 4.21.





Sujatha and Elangovan

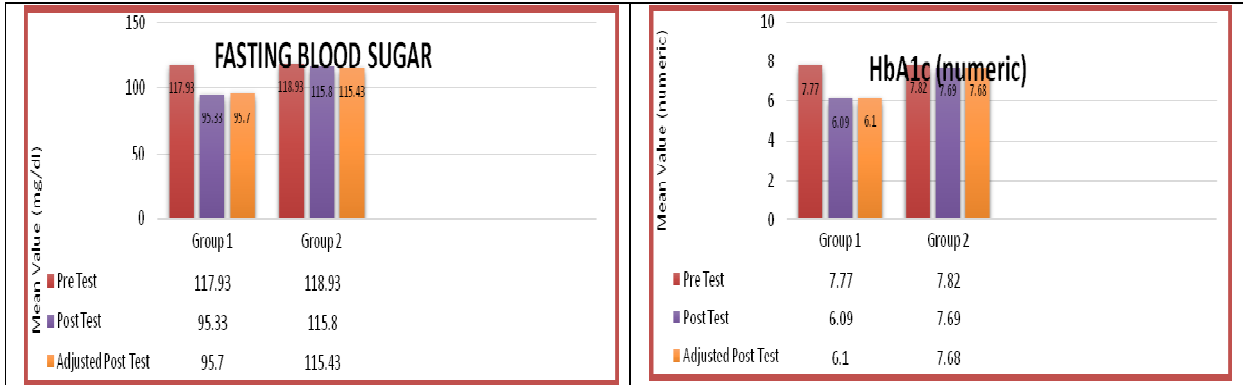


Figure1. BAR DIAGRAM ON FASTING BLOOD SUGAR (Scores in mg/dl) *Significant at 0.05 LOC.

Figure-2BAR DIAGRAM ON HbA1c (Scores in numeric) *Significant at 0.05 LOC.





South Beach Diet

S. Sivakrishnan* and G. Veeramani

Assistant Professor, Department of Pharmacy, FEAT, Annamalai University, Annamalai Nagar, Tamil Nadu, India.

Received: 08 Apr 2021

Revised: 28 Apr 2022

Accepted: 25 May 2022

*Address for Correspondence

S. Sivakrishnan

Assistant Professor,
Department of Pharmacy, FEAT,
Annamalai University,
AnnamalaiNagar, Tamil Nadu



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

There are thousands of diets. Some are for weight loss, while others are for weight gain, cholesterol reduction, longevity, and other reasons. A diet is a set of eating and drinking guidelines intended to aid weight loss or the adoption of a healthier lifestyle. A modified low-carbohydrate diet is commonly referred to as the South Beach diet [SBD]. The SBD is strong in protein and healthy fats and low in carbohydrates. But not low carb. The diet has three phases in which the quantity of carbs increases while the proportion of fats and proteins decreases. The diet includes lean meats, veggies, and "healthy" (mainly monounsaturated) fats. The SBD may produce some healthy improvements while promoting weight loss. Healthy carbohydrate and fat sources include whole grains, unsaturated fats, vegetables, and fruits, which have been shown to benefit health. For example, a low-carbohydrate diet rich in healthy fats may help decrease cholesterol.

Keywords: Carbohydrates, Health, South beach diet, Nutrisystem, Lifestyle

INTRODUCTION

There are healthy carbs and fats on the SBD, as well as bad carbs and fats. The trick to losing weight is to pick the finest of each. Non-starchy veggies, fish, eggs, full-fat dairy, protein like chicken and turkey, whole grains, and nuts are also good options. In comparison to the usual American diet, SBD is lower in carbohydrates and higher in protein and healthy fats. [1,2] The SBD is a fad diet created by Arthur Agatston and popularised by a best-selling book published in 2003. [3,4] It emphasises consuming low-glycemic-index foods and divides carbohydrates and fats into "good" and "bad" categories. It, like other fad diets [5] may have parts that are widely accepted as healthy, but it promises health benefits that aren't supported up by data or strong science. [6] The SBD is a well-known weight-loss



**Sivakrishnan and Veeramani**

plan that has been the talk of the town for more than a decade. It is a diet plan that is known for its minimal calorie intake. This diet plan has been shown to help people lose weight quickly while also improving their heart health.

History

Celebrity cardiologist Arthur Agatston and Marie Almon, former chief dietician at Mount Sinai Medical Center in Miami Beach, developed the SBD in the mid-1990s. [7,8] The SBD was dubbed after the South Beach neighbourhood in Miami Beach, which is close to Agatston's practise. [9] Agatston devised the diet for his own patients. The Atkins diet, unlike the American Heart Association's low-fat, high-carbohydrate diet, helped Agatston's patients lose weight. Agatston used medical studies to create a diet regimen that prioritised lean protein and fibre while categorising fats and carbohydrates as healthy or bad. [10] It was created to help people reduce their risk of heart disease, but it quickly became a weight-loss diet. Dr. Agatston created the diet after noticing that many low-fat, high-carb diets failed to help people lose weight. The diet isn't low-carb. Instead, it focuses on choosing the right carbs. Healthy fats like olive oil and lean protein sources are examples of whole grains. It advises avoiding certain carbs with a high GI. It consists refined CHO, like white sugar. These foods are quickly digested, causing blood sugar spikes. These foods provide short-term satisfaction. They'll be hungry soon. Wholegrain foods with unprocessed carbohydrates have a lower GI. These foods take longer to digest and release energy. This prevents blood sugar surges and keeps you fuller longer. They won't be hungry for a while. This diet focuses on carbs, protein, and fat balance. More importantly, you should eat excellent carbs, protein, and lipids. Sugary foods including baked goods, candies, and soft drinks are forbidden. In this case, the diet may be difficult to follow. The diet contains three phases in which the percentage of carbs increases while the proportions of fat and protein decrease. The diet includes lean meats, veggies, and "healthy" (mainly monounsaturated) fats. Agatston wrote the first book on the plan, The SBD, which came out in April 2003. [11] Around 8 million copies were printed by 2004. In total, 3 million copies of the SBD Good Fats/Good Carbs Guide and 1.75 million of the SBD Cookbook were sold. Former US President Bill Clinton reportedly tried it in 2004. [12] The SBD Supercharged, co-authored by Agatston and exercise physiology professor Joseph Signorile, contained an interval training regimen. This diet and exercise book is likely to be successful, according to an Academy of Nutrition and Dietetics review. A 20-minute daily exercise regimen is a realistic and affordable way to get fit. [13]. Agatston co-owner SBD Enterprises LLC, which owns the "South Beach Diet" trademark. [14,15] To buy SBD for \$15 million in December 2015. Nutrisystem announced it would introduce new South Beach products in 2017 and sell them in stores and online. [16] South Beach introduced a keto-friendly diet in December 2018. [17]

Purpose

The SBD's goal is to adjust your food balance to promote weight loss and a healthy lifestyle. The SBD promotes a healthy lifestyle regardless of weight loss goals. You may choose the SBD if:

- ✓ Enjoy the diet's meal choices.
- ✓ Want to lose weight by limiting certain carbs and fats
- ✓ Want to alter your overall eating habits
- ✓ Want a lifelong diet
- ✓ Like the SBD cookbooks and diet meals,

A diet should be discussed with a doctor or dietician, especially if you have any health issues.

Diet details

According to the SBD's website, it's a lifetime nutrient-dense, fibre-rich diet. Complex carbs are found in entire foods like fruits and vegetables. Simple carbs are sugar, syrup, and baked goods. Dietary fats are also discussed in the SBD, with an emphasis on monounsaturated fats. The SBD supports fruits, vegetables, fibre, and whole grains.

Carbohydrates

Not as low as a strict low-carb diet, but lower than a usual eating plan. A typical diet provides 45–65% of daily calories from carbs. On a 2,000-calorie diet, this translates to 225-325 grammes of carbs per day. In the last





Sivakrishnan and Veeramani

maintenance phase of the SBD, you can get up to 28% of your daily calories from carbs, or 140 grams. A severe low-carb diet may limit your carb intake to 20-100 grams per day. The South Beach keto diet limits carbs to 40 grams in phase 1 and 50 grams in phase 2.

Exercise

With time, the SBD has evolved to include exercise as part of a healthy lifestyle. Exercising regularly is recommended as part of the SBD.

SBD Phases

There are three phases to this programme. Foods to avoid in each phase The SBD contains three phases: kick-starting weight loss, achieving goal weight, and maintaining optimum weight. [18,19]

Phase 1 [kick-starting the weight-loss process]: This two-week phase is designed to help you lose weight by curbing the sugar and refined carb cravings. Just stay away from almost all carbohydrates. Individuals are not permitted to consume juice or alcohol. During phase 1, eat three meals a day of lean protein, such as shellfish, skinless poultry, lean beef, and soy products. Unsaturated fats can be found in avocados, almonds, and seeds. Most people lose 8–13 pounds (3.5–6 kg) throughout this time.

Phase 2 [Achieving the target weight]: This phase starts on day 15 and lasts for as long as you need it. This is a period of maintenance. You can begin reintroducing foods that were previously restricted, such as whole-grain breads, pasta, brown rice, fruits, and more vegetables. Stay in this period if you want to lose weight. You should drop 1–2 pounds (0.5–1 kg) per week during this time.

Phase 3 [Adopting a lifestyle]: This is a lifelong maintenance phase. You keep using the lifestyle lessons from the previous phases. You can eat everything in moderation. Although the phase-2 criteria should be followed, occasional pleasures are allowed and no foods are completely off-limits at this time. Dr. Agatston advises returning to phase 1 for one to two weeks if you overindulge and gain weight. Dr. Agatston advocates frequent exercise and gives a three-phase fitness regimen to go along with the food stages. The SBD contains three dietary periods [20]. Table 2 lists things to avoid during the SBD's three phases.

A Sample SBD Plan

Sample days on the diet

Table 3 shows sample meal plans for phases 1 and 2 of the SBD to give you an idea of a normal day. [21] There are hundreds of recipes available for all three phases of the SBD, including many with ingredients that are cheap, tasty and easy to find.

Benefits

The SBD has many advantages, including:

- ✓ It aids in hunger-free weight loss.
- ✓ Diets high in protein and low in carbs have been found to help people lose weight.
- ✓ Its protein content helps increase metabolic rate. Protein decreases hunger and keeps you full. So, you eat less food.
- ✓ It has nutritious carbs that are gradually added to the diet. For some people, this helps them lose weight and stay on track with their diet.
- ✓ It includes high intake of fatty fish and other foods like leafy greens and cruciferous vegetables that act as an anti-inflammatory action.
- ✓ It also advises eating eggs, almonds, seeds, extra virgin olive oil, and other foods to protect heart-health.
- ✓ The SBD may lead to weight loss while also improving the health. It has been proven that a long-term dietary plan high in nutritional carbs and lipids, such as whole grains, unsaturated fats, vegetables, and fruits, promotes health. A low-carbohydrate, high-fat diet, for example, may help lower cholesterol. [22]



**Sivakrishnan and Veeramani****Side Effects and Drawbacks**

To be clear, the SBD is low-carb and low-fat. The diet emphasises ketosis, especially in Phase 1. Sugar deficiency causes ketones to build up in the body. It might cause dehydration, dizziness, heart palpitations, fatigue and irritability. Diabetes, migraines, and fluid loss are connected to this diet. Salt deficiency causes cramps and weariness. Kidney disease can lead to serious health issues. Intake of high protein diet may damage renal function. Phase Two, with a more balanced diet, frequently alleviates these adverse effects. Despite this, the SBD has some flaws. The main issue is that it may be excessively rigorous on fat amounts and kinds. It also allows omega-6 fatty acids-rich soybean and safflower oils. While eating enough omega-6 fats is important, most people get way too much. Anti-inflammatory omega-3 lipids found in fatty fish like salmon, sardines, and mackerel are likely lacking in the Western diet. High omega-6 versus omega-3 fat intake linked to inflammation, heart disease, and other health concerns. This is because butter and coconut oil are heavy in saturated fat. For obese persons, coconut oil has been related to weight loss, reduced abdominal fat, and improved heart health. Also, most meta-analyses found no link between saturated fat and heart disease. Unsaturated fats are less likely to cause heart disease than saturated fats. Saturated fat may be better for the heart than eating less processed fat and more omega-3-rich seafood. [23-26]

ACKNOWLEDGMENT

Nil

Conflict Of Interest

Nil

Financial Support

Nil

Ethics Statement

Nil

CONCLUSION

The SBD is a well-known diet. Phases of the diet are: lean protein, nutrient-dense carbs, and healthy fats. This diet incorporates daily exercise. The SBD is a low-carbohydrate diet. Raw foods are also emphasised. It's full of veggies and fibre. However, it allows the use of vegetable oil, which is harmful to health. Overall, the SBD is a healthy way to lose weight.

REFERENCES

1. Agatston, Arthur. The South Beach Diet: The Delicious, Doctor-designed, Fool proof Plan for Fast and Healthy Weight Loss. New York:Rodale Press, 2003.
2. Katherine Marengo LDN, R.D., Nutrition — Written by Yvette Brazier on February 18, 2019. What is the South Beach Diet? Medical News Today.
3. "People to watch". Nature Medicine. **12** (1): 29. 2006. doi:10.1038/nm0106-29. ISSN 1078-8956. S2CID 26068107. James Hill wants Americans to shed pounds. But instead of promoting any one fad diet, he embraces most--Atkins, South Beach, grapefruit-only--as relatively effective ways to lose weight; Goff SL, Foody JM, Inzucchi S, Katz D, Mayne ST, Krumholz HM (July 2006).
4. "Brief Report: nutrition and weight loss information in a popular diet book: is it fact, fiction, or something in between?". Journal of General Internal Medicine. 21 (7): 769–74. doi:10.1111/j.1525-1497.2006.00501.x. PMC 1924692. PMID 16808780.





Sivakrishnan and Veeramani

5. DeBruyne L, Pinna K, Whitney E (2011). "Chapter 7: Nutrition in practice – fad diets". Nutrition and Diet Therapy (8th ed.). Cengage Learning. p. 209. ISBN 978-1-133-71550-4.
6. "Sizing up South Beach. It makes some good points, but The South Beach Diet has problems typical of diet books: lack of proof and some dubious claims". Harvard Health Letters. 29 (1): 5. November 2003. PMID 14633496.
7. Bijlefeld M, Zoumaris SK (2014). Celebrity Doctors. Encyclopedia of Diet Fads: Understanding Science and Society (2nd ed.). ABC-CLIO. pp. 127–128. ISBN 978-1-61069-760-6.
8. Allison Adato (26 April 2004). "Life's a South Beach". People.[https://in.search.yahoo.com/search?fr=mcafee&type=E211IN826G0&p=9.+Allison+Adato+\(26+April+2004\).+%22Life%27s+a+South+Beach%22.+People](https://in.search.yahoo.com/search?fr=mcafee&type=E211IN826G0&p=9.+Allison+Adato+(26+April+2004).+%22Life%27s+a+South+Beach%22.+People).
9. Alex Witchel (14 April 2004). "Doctor Wants 'South Beach' To Mean Hearts, Not Bikinis". The New York Times.[https://in.search.yahoo.com/search?fr=mcafee&type=E211IN826G0&p=10.+Alex+Witchel+\(14+April+2004\).+%22Doctor+Wants+%27South+Beach%27+To+Mean+Hearts%2C+Not+Bikinis%22.+The+New+York+Times](https://in.search.yahoo.com/search?fr=mcafee&type=E211IN826G0&p=10.+Alex+Witchel+(14+April+2004).+%22Doctor+Wants+%27South+Beach%27+To+Mean+Hearts%2C+Not+Bikinis%22.+The+New+York+Times).
10. Diet Wars – Interview with Author Agatston, Author of the South Beach Diet. Frontline. 8 August 2004.<https://in.search.yahoo.com/search?fr=mcafee&type=E211IN826G0&p=%22Diet+Wars+%E2%80%93+Interview+With+Author+Agatston%2C+Author+of+the+South+Beach+Diet%22.+Frontline.+8+August+2004>.
11. Jefferey A. Trachtenberg (30 June 2004). "Diet Book Found Novel Ways to Get to Top – and Stay". The Wall Street Journal.
12. Philip Sherwell (3 October 2010). "Bill Clinton's new diet: nothing but beans, vegetables and fruit to combat heart disease". The Daily Telegraph.
13. Dawn Jackson Blatner for the Academy of Nutrition and Dietetics. Book Review: The South Beach Diet Super Charged Beckerman, Josh (18 December 2015).
14. Beckerman, Josh (18 December 2015). "Nutrisystem Buys South Beach Diet Brand". Wall Street Journal
15. "SBD–Trademark of Agatston, Arthur S. – Registration Number 3213757 – Serial Number 76548397". Justia. Retrieved 16 December 2016.
16. "Nutrisystem 10K for FY 2015". SEC EDGAR. 31 December 2015.
17. Miller, Korin (17 December 2018). "The South Beach Diet Just Launched a New Keto Program That Sounds Pretty Awesome". Women's Health. Retrieved 27 November 2019.<https://www.mayoclinic.org/healthy-lifestyle/weight-loss/in-depth/south-beach-diet/art-20048491>
18. The South Beach Diet: What Do You Do & How Does it Work. THE PALM: Get Tips & Recipes. <https://palm.southbeachdiet.com/all-new-south-beach-diet/>
19. Megan Ayala. Last Updated: November 28, 2020. South Beach Diet Phase 1, 2, 3: Food List, Meal Plan, & Menu PDF
20. John P. Cunha, DO, FACOEP. What Kind of Food Do You Eat on The South Beach Diet?. HEALTHY LIVING CENTER TOPIC GUIDE. Reviewed on 11/11/2020. https://www.emedicinehealth.com/south_beach_diet_low_carb_food_list/article_em.htm.
21. Franziska Spritzler, South Beach Diet Review and Beginner's Guide, Healthline. Found here: <https://www.healthline.com/nutrition/south-beach-diet>
22. South Beach Diet, U.S. News & World Report. Found here: <https://health.usnews.com/best-diet/south-beach-diet>
23. South Beach Diet. Mayo Foundation for Medical Education and Research (MFMER). <https://www.mayoclinic.org/healthy-lifestyle/weight-loss/in-depth/south-beach-diet/art-20048491>
24. Abel, Lee. "Somewhere on South Beach." The Journal of the Arkansas Medical Journal. (February, 2004): 255–256.
25. Center for Science in the Public Interest. "Weighing the Diet Books (Cover Story)." Nutrition Action Healthletter. (January/February, 2004):3–8.
26. Goodnough, Abby. "New Doctor, New Diet, but Still No Cookies." New York Times. (October 7, 2003): F1.





Sivakrishnan and Veeramani

Table 1: Foods to include in SBD

| Phase -1 Foods to include | |
|---|---|
| The following guidelines are from The SBD Supercharged. The SBD website may have various rules. | |
| Lean protein | Although amounts aren't regulated, the plan advises eating slowly and returning for seconds if hungry. <ul style="list-style-type: none"> – Skinless chicken and turkey breast – Beef, lamb, veal, and game. – Fish and shellfish – Turkey bacon and pepperoni – Eggs and egg whites – Soy-based meat substitutes – Dairy products such as hard cheese and ricotta – 2 cups (473 ml) of buttermilk, low-fat milk, plain or Greek yoghurt, kefir, or soy milk daily. |
| Non-starchy vegetables | 4 1/2 cups daily minimum. The only veggies that are prohibited are beets and most winter squashes. |
| Legumes | Unless otherwise specified, limit to 1/3–1/2 cup cooked daily. <ul style="list-style-type: none"> – Beans such as kidney, pinto, navy, and garbanzo. – Peas such as split and black-eyed – Lentils – Tofu with soybeans – 1/4 cup hummus |
| Nuts and seeds | 1 ounce (28 g) per day. <ul style="list-style-type: none"> – Other nuts like almonds, pecans, pistachios, and walnuts – 2 tbsp nut butter – Flax, chia, sesame, pumpkin, and other seeds |
| Oils and fats | 2 tbsp of oil per day. Encourage monounsaturated oils. <ul style="list-style-type: none"> – Monounsaturated oils include olive, canola, macadamia, and avocado. – Corn, flaxseed, grapeseed, peanut, safflower, sesame, and soybean oils |
| Alternative fat choices | 2 tbsp healthy oil per serving <ul style="list-style-type: none"> – Avocado, 2/3 of a fruit. – 2 tbsp trans-fat-free margarine – 2 tbsp low-fat mayonnaise – 1 tbsp regular mayonnaise – 2 tbsp salad dressing with less than 3 g sugar – 20–30 olives, depending on size |
| Sweet treats | Limit intake to 100 calories or fewer. <ul style="list-style-type: none"> – sugar-free or unsweetened cocoa – Sugar-free jellies and gelatin – sweetener-free treats or gum – Artificial sweeteners and sugar alcohols like xylitol and erythritol |
| Condiments | Unless otherwise specified, these foods are unlimited. <ul style="list-style-type: none"> – Broth – Herbs, spices, lemon juice, or salsa – All vinegars, except balsamic, 1 tbsp. – 1/4 cup light coconut milk (59 ml) – 1 1/2 tsp soy sauce, steak sauce, or miso (7 ml). – 1 tbsp cream, whole milk, or half-and-half – 2 tbsp sour cream or cream cheese |





Sivakrishnan and Veeramani

| | |
|---|--|
| | <ul style="list-style-type: none"> – 2 tbsp light whipped topping |
| Beverages | <p>Consume these beverages in unlimited quantities, but do so in moderation</p> <ul style="list-style-type: none"> – Coffee, caffeinated or not, – Tea, normal or decaffeinated, – Sugarless soda – Dietary sweeteners – Tomato or veggie juice |
| <p>Phases 2 and 3: Foods to include</p> <p>Starting with one serving of fruit and whole grains or starchy vegetables every day for the first week, phase 2 gradually introduces higher-carb items.</p> <p>Once phase 2 is over, you can eat three portions of fruit and four servings of whole grains and starchy vegetables. A small amount of alcohol is permitted, but only light beer and dry wine.</p> <p>After reaching your ideal weight, you enter phase three, maintenance. During this phase, generally follow phase 2's standards. No item is absolutely off-limits, so you can include "treat" meals periodically.</p> | |
| Fruits | <p>1–3 servings daily, except for dates, figs, pineapple, raisins, and melons.</p> <p>1 small piece of fruit, 1/2 grapefruit, or 3/4 cup (about 115 grams) of berries, grapes.</p> |
| Whole grains and starchy vegetables | <p>1–4 servings per day.</p> <ul style="list-style-type: none"> – Peas – Rutabaga – Sweet potatoes and yams – Turnips – 3/4 cup winter squash – Whole-grain hot cereal – 1 cup whole-grain cold cereal – Wheat bread – Brown or wild rice – Pasta, quinoa, couscous or farro – 1 cup Taro – 3 cups of popcorn max. – 1/2 small whole-grain bagel – 1/2 pita bread only. – One small corn or wheat tortilla. |
| Alcohol | <p>A daily glass of dry wine or light beer is permitted.</p> <ul style="list-style-type: none"> – 12 oz. light beer (355 ml). – 4 oz. red or white wine (118 ml). |

Table 2: Foods to avoid in SBD

| | |
|-------------------------|---|
| Phase 1: Foods to avoid | <p>Phase 1 excludes items heavy in fat and carbohydrates, such as fruits and grains. These are:</p> <ul style="list-style-type: none"> – Fatty meat and poultry – Butter and coconut oil – Whole milk – Foods containing refined sugar – Honey, maple syrup and agave nectar – Grains – Fruits and juice – Beets, carrots, corn, turnips, yams, peas, white potatoes and winter squash – Alcohol |
|-------------------------|---|





Sivakrishnan and Veeramani

| | |
|---------------------------------------|--|
| <p>Phases 2 and 3: Foods to avoid</p> | <p>Phase 2 of the SBD opposes fatty meats, saturated fats, and sugary meals. Avoid:</p> <ul style="list-style-type: none"> – Fatty meat and poultry – Butter and coconut oil – Whole milk – refined flour or sugar – Honey, maple syrup, agave nectar – Fruit juice – White potatoes, beets and corn – Dates, figs, pineapple, raisins and watermelon – Besides light beer and dry wine |
|---------------------------------------|--|

Table 3: Sample meal plans for phase 1 and phase 2

| Phase 1 Sample Day | |
|---------------------------|--|
| Breakfast | 3 eggs and 1 cup of kale cooked with 1 tsp of olive oil. |
| Snack | 1 oz (28 g) string cheese topped with bell pepper slices |
| Lunch: | Salad with roasted salmon and asparagus with mustard vinaigrette |
| Snack | 2 tsp peanut butter on celery sticks |
| Dinner | Broccoli and lean steak |
| Phase 2 Sample Day | |
| Breakfast | Quick and easy peanut butter oatmeal |
| Snack | 1 cup cucumber slices with 1/4 cup hummus |
| Lunch | Salad of chicken with apples and walnuts |
| Snack | Cherry tomatoes and cottage cheese |
| Dinner | 1/3 cup guacamole on chicken fajitas |





Economic Status of Rural Vijayapur District Migrants in Goa State

Mahantesh Radderatti^{1*} and Mahesh G Nayak²

¹Assistant Professor, Department of Geography, Govt. First Grade College, Rabakavi-Banahatti, Karnataka, India.

²Assistant Professor, Department of Geography, Karnatak University, Dharwad, Karnataka, India.

Received: 10 Apr 2021

Revised: 28 Apr 2022

Accepted: 25 May 2022

*Address for Correspondence

Mahantesh Radderatti

Assistant Professor,
Department of Geography, Govt. First Grade College,
Rabakavi-Banahatti, Bagalkote



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Migration is a geographic and a continuous process that brings a drastic change in the demography of any place or region. It is a product of economic, social, cultural, political and environmental factor of which economic factor dominates the flow of migration. Generally, the Permanent and Seasonal migrants exhibit a variation in their economic status. In the present study, economic status observed in the rural Vijayapur district moving to Goa State has been assessed by using 400 (275 Permanent migrants – Male 223 and Female 52 and 125- Male 95 and Female 30 Seasonal migrants) samples collected randomly in different places of Goa State by using questionnaire method during 2015 and 2016. Simple statistical techniques were adopted - percentages, averages and bar graphs. Economic Status can be identified by analyzing the thirteen parameters i.e., Occupation, Monthly Income, Monthly Expenditure, Monthly Savings, Possession of amenities, Immovable and Moveable Property, Nature and Type of House, Rent, Facilities in Houses, Money remittance and Purpose of sending money, Nature of Employment and Working hours. The study shows that 37 % permanent migrants fall into the moderate income groups while 74 % were seasonal migrants belonging to Low income groups. Another interesting finding is Seasonal migrant labourers own Mobile followed by Fan and Non-stick stove while Permanent migrant labourers possess Mobile followed by Fan, TV and LPG Gas.

Keywords: Migration, Occupation, Permanent Migrant labourer, Seasonal Migrant Labourer

INTRODUCTION

Migration is a geographic and a continuous process that brings a drastic change in the demography of any place or region. It is the human desire to seek employment and livelihood is at the core of the migration-development nexus. The recent 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in September 2015, provides for a strong link between decent work and migration in Sustainable Development Goal

42839



**Mahantesh Radderatti Mahesh G Nayak**

(SDG) 8 on promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. It contains targets: "Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment." Migration is a product of economic, social, cultural, political and environmental factor of which economic factor dominates the flow of migration. Of migration types, the Permanent and Seasonal migrants exhibit a variation in the migrants' economic status. As per the 2011 Census, India had 45.6 crore migrants in 2011 (38% of the population) compared to 31.5 crore migrants in 2001 (31% of the population). Between 2001 and 2011, population grew by 18% and the number of migrants increased by 45%. Studies on internal migration have indicated a decline in population mobility up to 1990's (Srivastava, 1998, Bhagat, 2009). Conversely, the post reform period confirms an increase in internal population movement. In 2011, 99% of total migration was internal and immigrants (international migrants) comprised 1%. Interaction of various factors in the course of development can not only accentuate the pace of mobility but would lead to emergence of new migration patterns. Migration and factors affecting the migration patterns studied by Devi and Sudarsan (2021) found the economic factors that dominate in both push and pull factors further social factors -choice of destination- reflects the growing importance of networks in certain forms of employment. Similarly Debnath and Nayak (2020) viewed recurring drought as one of the most important reasons forcing the rural people of this region to migrate out and the area experiences the highest out migration rate in West Bengal. Further, seasonal migration was the last option as a strategy to combat the drought. Bala (2017) highlighted the Push factors are poverty, lack of work opportunities, unemployment and underdevelopment, poor economic condition, lack of opportunities, exhaustion of natural resources and natural calamities, scarcity of cultivated land, inequitable land distribution, low agricultural productivity etc., Pull factors attract migrant to an area (area of destination), like, employment and higher education opportunities, higher wages facilities, better working condition.

Bhagat (2016) identified the reasons for the decline in male mobility are: insufficient job creation during the last two decades, a stagnation of job opportunities in the organized sector, rising commutation of workers, and the employment guarantee scheme initiated in rural areas. Increased female migration could be the result of increased marriage and family associated migration. Further, Keshri & Bhagat 2013 reported that temporary migration is seven times larger than permanent migration, and is largely a rural phenomenon dominated by rural to urban migration. A regional pattern in temporary labour migration is evident in the low-income Central and North Indian states. Low economic, educational and social status significantly induces temporary labour migration in contrast to permanent labour migration. As such, temporary labour migration appears to be a survival strategy of the rural poor in India. Shyam *et al* (2011) found that Majority (57 percent) of the respondents were youth engaged in fishing activities in Kerala. Chinmay Tumble (2011) concluded that domestic remittances from Goans accounted for 40 per cent of international remittance flow. Aim of the study: The above research works were instrumental in motivating to work on the Economic status observed in the migrants of rural Vijayapur district moving to Goa State has been assessed.

DATA & METHODOLOGY

The study has been assessed by using 400 (275 Permanent migrants – Male 223 and Female 52 and 125- Male 95 and Female 30 Seasonal migrants). Samples were collected randomly in different places of Goa State by using questionnaire method during 2015 and 2016. Simple statistical techniques were adopted - percentages, averages and bar graphs.

RESULTS AND DISCUSSION

Thirteen Economic factors were analyzed i.e., Occupation, Monthly Income, Monthly Expenditure, Monthly Savings, Possession of amenities, Immovable and Moveable Property, Nature and Type of House, Rent, Facilities in Houses, Moneyremittance and Purpose of sending money, Nature of Employment and Working hours.



**Mahantesh Radderatti Mahesh G Nayak**

Table 1 shows that 96 respondents (34.91%) were permanent migrant labourers and 89 (71.20%) of seasonal labour migrants were working in private sector followed by 94(34.18%) in permanent and 13(10.40%) in seasonal migrant labourers were self-employed, 66(24.00%) in permanent and 20(16.00%) in seasonal migrant labourers were working on contract basis and only 19(6.91%) of permanent migrant labour and 3(6.40%) of seasonal labour migrants were working in government sector.

Table 2 shows that from Rural Vijaypur, 119 respondents (43.27%) were permanent and 98 (78.40%) of seasonal migrants labourers income was between Rs1000 - 5000 per month. This low income group suggests the migrants to move to a better destination which will pay them high returns. Their earnings are sufficient to meet their essential needs such as food, cloth, shelter, and housing facilities, but the quality of fulfilling the needs significantly differs. Table 3 indicates that more than 50% of permanent migrant labourers and more than 80% of seasonal migrants labourers' income was between Rs 5000 -15000 per month. Source of their income is routine work and very less from agriculture and allied works followed by businesses. At their native place, more than 50% of permanent migrant labourers and more than 77% of seasonal migrant labourers expenditure was between Rs 1000 –Rs. 5000 per month. Overall, the table indicates that both income and expenditure are well- balanced (Table 4).

Table 5 provides details during post migration scenario that more than 50% of permanent migrant labourers and around 40% of seasonal migrants labourers whose expenditure was between Rs 5000 -10,000 per month. Seasonal migrants are 62 percent fall in the expenditure group of 1000 to 5000. Permanent migrant labourers earn less and spent more but seasonal migrants labourers are earn more and spent less and save money for future requirements. Moreover, they bring all grocery materials from their native and every month they return to their native to bring the materials. Whereas the permanent migrant labourer had to spend buy all the livelihood material from Goa and hence their expenditure is more than few people who earned less but spent more, lead to increased burden among the migrant labourers. At their native place, most people were unemployed and some of them have less earnings only few migrant labourers saved money (Table 6). From table 7, it is inferred that 104 (37.82%) permanent migrant labourers saved money between Rs.5001 – 10000 while 77 (61.60%) of seasonal migrant labourers saved money between Rs 1000 – 5000. This is due to the seasonal migrant labourers income was less as compared to permanent migrant labourers.

It is observed from Table 9 that majority of respondents ie 271(98.55%) permanent migrant labourers and 122 (97.60%) seasonal migrant labourers had mobile in their house as mobile connectivity is an essential mode of communication. Similarly, 241(87.64%) permanent migrant labourers and 39(31.20%) seasonal migrant labourers had fans in their home as to combat high humidity. About 150(54.55%) permanent migrant labourers and 2(1.60%) seasonal migrant labourers have sewing machine in their house. Here, permanent migrant labourer used to have tailoring as a job and provided tailoring classes to the locals as observed in Zauri nagar. Table 9 indicates that among the migrant labourers about 96 (34.91%) were permanent migrant labourers and 84 (67.20%) seasonal migrant labourers. They confirmed that money remitted by the migrants improved the living standards at their natives.

Table 10 shows that 127 (46.20%) permanent migrant labourers and 4 (3.20%) seasonal migrant labourers owned building. Possession of two wheelers by permanent migrants was high than the seasonal as 105 (38.20%) permanent and 4(3.20%) seasonal migrant labourers owned two-wheeler for transportation purposes. Only 19(6.90%) permanent and 4(3.20%) seasonal migrant labourers owned four-wheeler in their house. Only 8(2.90%) permanent migrant labourers and 2(1.60%) seasonal migrant labourers owned a ten-wheeler. In addition, livestock like hen, sheep, buffaloes, Goats and cow were in less percent among the households. Majority of 151(54.91%) permanent and 4(3.20%) seasonal migrant labourers had their own house. Most of the seasonal migrants stayed in a hut/temporary tent, etc. without any safety walls. Table 12 shows that 123 (45.09%) permanent and 121 (96.20%) seasonal migrant labourers did not own a house and stayed in rented houses. Majority of the houses were provided and constructed by the government under housing schemes like Dr. B. R. Ambedkar Nivasa Yojane, Basava Vasathi Yojane and Indira Awas Yojane and Nanna Mane (Affordable Housing for low income groups). Majority of houses permanent





Mahantesh Radderatti Mahesh G Nayak

migrants lived in roofing tiled houses 97 (35 percent) and bungalow /flat 92 (33 percent) Seasonal migrants stayed in sheds 61 (49 percent), huts 33 (36 percent) and roofing tiled 26 (21 percent).

Majority 83 (66.94%) of permanent migrant labourers have paid the rent between Rs. 500 – 1500. 93 (76.86%) of seasonal migrant labourers paid the rent between Rs.100–1000. Permanent migrant labourers had earned money more as compared to seasonal (Table 13). Various facilities were enjoyed by migrants 225 (81.82%) of permanent and 58 (46.40%) of seasonal migrant labourers had drinking water facility. Majority of 245 (89.09%) of permanent and 62 (65.60%) of seasonal migrant labourers have electricity facility in their house. About 144 (52.36%) of permanent and 6 (4.80%) of seasonal migrant labourers have toilet facility. Majority migrant labourers did not have toilet facility in their home. They used open field for defecation creating an unhealthy environment. About 214 (77.82%) of permanent and 42 (33.60%) of seasonal migrant labourers have a bathroom. About 102 (37.09%) of permanent and only 2 (1.60%) of seasonal migrant labourers have furniture. Overall, seasonal migrant labourers house had no basic facilities- water connection, toilet, bathroom and furniture. Earned money was either spent or sent to family and other relatives who are at native place. Table 15 suggests that among the migrant labourers about 97 (35.27%) permanent and 84 (67.20%) seasonal migrant labourers had remitted the money to his family members. Majority of 69 (71.13%) of permanent and 51 (60.71%) of seasonal migrant labourers sent money between Rs. 100- 2000 to their house. 20% of permanent and seasonal migrant labourers have sent more than 4000 Rs money to their house.

CONCLUSION

In nutshell, the analysis of sixteen parameters showing economic status is discussed along with substantial findings. Seasonal migrants are engaged in tertiary economic activities while permanent migrants are occupied in primary activities. During pre-migration conditions, Majority of both types of migrants are earning between Rs. 1000 to Rs. 5000 monthly. During post migration conditions, slightly different as permanent migrants whose income groups belong are between Rs. 5000 to Rs.20000 while during seasonal the income groups are from Rs. 5000 to Rs. 15000. Maximum number of migrants are employed in Private sector. Permanent migrants own mobiles, fan and gas while seasonal migrants possessed mobile fan and non-stick stove. They own their own building and 2-wheeler.

REFERENCES

1. <https://www.ilo.org/global/topics/labour-migration/policy-areas/migration-and-development/lang-en/index.html>
2. Srivastava, R.S. (1998). Migration and the labour market in India. *Indian Journal of Labour Economics*, 41 (4).
3. Bhagat, R.B. (2009) Internal Migration in India: Are the Underclass More Mobile? 26th IUSSP General Population Conference, Marrakech, 27 September-2 October 2009.
4. Bhagat (2016) Internal migration in India: are the underclass more mobile? *India Migrations Reader*, 132-150, 2016
5. P. S. Devi & P. K. Sudarsan, 2021. "Determinants of Migration to Goa, India: A Gravity Model Analysis," *The Indian Journal of Labour Economics*, Springer; *The Indian Society of Labour Economics (ISLE)*, vol. 64(2), pages 485-498
6. Manoj Debnath & Debendra Kumar Nayak (2020) Assessing drought-induced temporary migration as an adaptation strategy: evidence from rural India, *Migration and Development*, DOI: 10.1080/21632324.2020.1797458
7. Kunal Keshri & Ram B. Bhagat (2013), Socioeconomic Determinants Of Temporary Labour Migration In India, *Asian Population Studies*, 9:2, 175- 195, DOI: 10.1080/17441730.2013.797294
8. Bala, Anju (2017) Migration in India: Causes and consequences, *International Journal of Advanced Educational Research*, Vol. 2; Issue 4; July 2017; Page No. 54-56, ISSN: 2455-6157
9. Tumble Chinmay (2012) Migration persistence across twentieth century India, *Migration and Development*, 1:1, 87-112, DOI: 10.1080/21632324.2012.716225





Mahantesh Radderatti Mahesh G Nayak

10. Tumble, Chinmay, Remittances in India: Facts & Issues (December 22, 2011). IIM Bangalore Research Paper No. 331, SSRN: <https://ssrn.com/abstract=2122689> or <http://dx.doi.org/10.2139/ssrn.2122689>
11. Shyam, S Salim and Kripa, V and Zacharia, P U and Mohan, Anjana and Ambrose, T V and Manjurani (2014), *Vulnerability assessment of coastal fisher households in Kerala: A climate change perspective*. Indian Journal of Fisheries, 61 (4). pp. 99-104

Table 1: Distribution of migrant labourers based on Nature of Employment

| Nature of Employment | Nature of Migration | | | | Total | Percent |
|----------------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Government | 19 | 6.91 | 3 | 2.40 | 22 | 5.50 |
| Private | 96 | 34.91 | 89 | 71.20 | 185 | 46.25 |
| Self | 94 | 34.18 | 13 | 10.40 | 107 | 26.75 |
| Contract based | 66 | 24.00 | 20 | 16.00 | 86 | 21.50 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 2: Distribution of migrant labourers based on monthly Income (Pre-migration)

| Income | Nature of Migration | | | | Total | Percent |
|-----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 119 | 43.27 | 98 | 78.40 | 217 | 54.25 |
| Rs. 5001-10000 | 43 | 15.64 | 5 | 4.00 | 48 | 12.00 |
| Rs. 10001-15000 | 9 | 3.27 | 1 | 0.80 | 10 | 2.50 |
| Rs. 15001-20000 | 2 | 0.73 | 0 | 0.00 | 2 | 0.50 |
| Not Applicable | 102 | 37.09 | 21 | 16.80 | 123 | 30.75 |

Table 3: Flow of migrant labourers according to monthly Income (Post-migration)

| Income | Nature of Migration | | | | Total | Percent |
|-----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 3 | 1.09 | 1 | 0.80 | 4 | 1.00 |
| Rs. 5001-10000 | 46 | 16.73 | 67 | 53.60 | 113 | 28.25 |
| Rs. 10001-15000 | 101 | 36.73 | 47 | 37.60 | 148 | 37.00 |
| Rs. 15001-20000 | 63 | 22.91 | 8 | 6.40 | 71 | 17.75 |
| Rs. 20001-25000 | 22 | 8.00 | 1 | 0.80 | 23 | 5.75 |
| Rs.25001-30000 | 19 | 6.91 | 0 | 0.00 | 19 | 4.75 |
| Rs. 30001-35000 | 10 | 3.64 | 1 | 0.80 | 11 | 2.75 |
| >Rs. 35000 | 10 | 3.64 | 0 | 0.00 | 10 | 2.50 |
| Not Applicable | 1 | 0.36 | 0 | 0.00 | 1 | 0.25 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 4: Flow of migrant labourers based on monthly expenditure (Pre-migration)

| Expenditure | Nature of Migration | | | | Total | Percent |
|-----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 141 | 51.27 | 96 | 76.80 | 237 | 59.25 |
| Rs. 5001-10000 | 26 | 9.45 | 3 | 2.40 | 29 | 7.25 |
| Rs. 10001-15000 | 3 | 1.09 | 0 | 0.00 | 3 | 0.75 |
| Rs.25001 Above | 2 | 0.73 | 0 | 0.00 | 2 | 0.50 |
| Not Applicable | 103 | 37.45 | 26 | 20.80 | 129 | 32.25 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |





Mahantesh Radderatti Mahesh G Nayak

Table 5. Flow of migrant labourers based on monthly Expenditure (Post-migration)

| Expenditure | Nature of Migration | | | | Total | Percent |
|-----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 63 | 22.91 | 62 | 49.60 | 125 | 31.25 |
| Rs. 5001-10000 | 139 | 50.55 | 55 | 44.00 | 194 | 48.50 |
| Rs. 10001-15000 | 57 | 20.73 | 6 | 4.80 | 63 | 15.75 |
| rs. 15001-20000 | 10 | 3.64 | 2 | 1.60 | 12 | 3.00 |
| Rs. 20001-25000 | 3 | 1.09 | 0 | 0.00 | 3 | 0.75 |
| Rs.25001 Above | 2 | 0.73 | 0 | 0.00 | 2 | 0.50 |
| Not Applicable | 1 | 0.36 | 0 | 0.00 | 1 | 0.25 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 6: Flow of migrant labourers based on monthly savings (Pre-migration)

| Savings | Nature of Migration | | | | Total | Percent |
|-----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 30 | 10.91 | 4 | 3.20 | 34 | 8.50 |
| Rs. 5001-10000 | 2 | 0.73 | 0 | 0.00 | 2 | 0.50 |
| Rs. 10001-15000 | 2 | 0.73 | 0 | 0.00 | 2 | 0.50 |
| Not Applicable | 241 | 87.64 | 121 | 96.80 | 362 | 90.50 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 7: Flow of migrant labourers based on monthly savings (Post-migration)

| Savings | Nature of Migration | | | | Total | Percent |
|----------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 1000-5000 | 78 | 28.36 | 77 | 61.60 | 155 | 38.75 |
| Rs. 5001-10000 | 104 | 37.82 | 20 | 16.00 | 124 | 31.00 |
| Rs.10001-15000 | 34 | 12.36 | 3 | 2.40 | 37 | 9.25 |
| Rs.15001-20000 | 16 | 5.82 | 0 | 0.00 | 16 | 4.00 |
| Not Applicable | 43 | 15.64 | 25 | 20.00 | 68 | 17.00 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 8: Distribution of migrant labourers based to possession of amenities

| Savings | Nature of Migration | | | | Total | Percent |
|-----------------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Gas | 231 | 84.00 | 19 | 15.20 | 250 | 62.50 |
| AC | 22 | 8.00 | 1 | 0.80 | 23 | 5.75 |
| Water Heater | 109 | 39.64 | 4 | 3.20 | 113 | 28.25 |
| TV | 232 | 84.36 | 17 | 13.60 | 249 | 62.25 |
| VCD/DVD Player | 85 | 30.91 | 3 | 2.40 | 88 | 22.00 |
| Refrigerator | 87 | 31.64 | 4 | 3.20 | 91 | 22.75 |
| Nonstick Stove | 83 | 30.18 | 31 | 24.80 | 114 | 28.50 |
| Mobile | 271 | 98.55 | 122 | 97.60 | 393 | 98.25 |
| Landline Connection | 18 | 6.55 | 0 | 0.00 | 18 | 4.50 |
| Computer | 26 | 9.45 | 0 | 0.00 | 26 | 6.50 |
| Broad band Connection | 8 | 2.91 | 0 | 0.00 | 8 | 2.00 |
| Radio | 33 | 12.00 | 3 | 2.40 | 36 | 9.00 |
| Fans | 241 | 87.64 | 39 | 31.20 | 280 | 70.00 |
| Sewing Machine | 150 | 54.55 | 2 | 1.60 | 152 | 38.00 |





Mahantesh Radderatti Mahesh G Nayak

Table 9: Has the money remitted by you improved the living standard your family?

| | Nature of Migration | | | | Total | Percent |
|-------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Yes | 96 | 34.91 | 84 | 67.20 | 180 | 45.00 |
| No | 179 | 65.09 | 41 | 32.80 | 220 | 55.00 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 | 100.00 |

Table 10: Flow of migrant labourers based on Immoveable and moveable Property

| Immoveable Property | Nature of Migration | | | | Total |
|---------------------|---------------------|---------|----------|---------|-------|
| | Permanent | Percent | Seasonal | Percent | |
| Building | 127 | 46.2 | 4 | 3.20 | 131 |
| Moveable Property | | | | | |
| Two wheeler | 105 | 38.2 | 4 | 3.20 | 109 |
| Four Wheeler | 19 | 6.9 | 1 | 0.80 | 20 |
| Ten Wheeler | 8 | 2.9 | 2 | 1.60 | 10 |
| Livestock's | | | | | |
| Buffalos | 3 | 1.1 | 0 | 0.00 | 3 |
| Cows | 1 | 0.4 | 0 | 0.00 | 1 |
| Goats | 1 | 0.4 | 1 | 0.80 | 2 |
| Ships | 1 | 0.4 | 0 | 0.00 | 1 |
| Hens | 1 | 0.4 | 1 | 0.80 | 2 |

Table 11: Movement of migrant labourers based on Nature of House.

| Nature of House | Nature of Migration | | | | Total |
|-----------------|---------------------|---------|----------|---------|-------|
| | Permanent | Percent | Seasonal | Percent | |
| Own | 151 | 54.91 | 4 | 3.20 | 155 |
| Rented | 124 | 45.09 | 121 | 96.80 | 245 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 |

Table 12: Distribution of migrant labourers based on the Type of House.

| Type of House | Nature of Migration | | | | Total |
|---------------|---------------------|---------|----------|---------|-------|
| | Permanent | Percent | Seasonal | Percent | |
| Hut | 19 | 6.91 | 33 | 26.40 | 52 |
| Bungalow/Flat | 92 | 33.45 | 5 | 4.00 | 97 |
| Shed | 67 | 24.36 | 61 | 48.80 | 128 |
| Roofing tiled | 97 | 35.27 | 26 | 20.80 | 123 |
| Total | 275 | 100.00 | 125 | 100.00 | 400 |

Table 13: Movement of migrant labourers based on house rent

| If rented how much you pay? | Nature of Migration | | | | Total | Percent |
|-----------------------------|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs.100-500 | 11 | 8.87 | 37 | 30.58 | 48 | 19.59 |
| Rs. 500-1000 | 34 | 27.42 | 56 | 46.28 | 90 | 36.73 |
| Rs. 1000-1500 | 49 | 39.52 | 25 | 20.66 | 74 | 30.20 |
| Rs. 1500 and above | 30 | 24.19 | 3 | 2.48 | 33 | 13.47 |
| Total | 124 | 100.00 | 121 | 100.00 | 245 | 100.00 |





Mahantesh Radderatti Mahesh G Nayak

Table 14: Distribution of migrant labourers based on Facilities in Houses.

| Facilities inHouses | Permanent | Percent | Seasonal | Percent | Total | Percent |
|---------------------|-----------|---------|----------|---------|-------|---------|
| Piped Water | 225 | 81.82 | 58 | 46.40 | 283 | 70.75 |
| Electricity | 245 | 89.09 | 82 | 65.60 | 327 | 81.75 |
| Toilet | 144 | 52.36 | 6 | 4.80 | 150 | 37.5 |
| Bath Room | 214 | 77.82 | 42 | 33.60 | 256 | 64 |
| Furniture | 102 | 37.09 | 2 | 1.60 | 104 | 26 |

Table 15: Flow of migrant labourers based on remittance money to the family.

| Do you remit money to your family? | Nature of Migration | | | |
|------------------------------------|---------------------|---------|----------|---------|
| | Permanent | Percent | Seasonal | Percent |
| Yes | 97 | 35.27 | 84 | 67.20 |
| No | 178 | 64.73 | 41 | 32.80 |
| Total | 275 | 100.00 | 125 | 100.00 |

Table 16: Flow of labourers based on proportion of money do you send to house

| If yes what is the proportion of money do you send to house? | Nature of Migration | | | | Total | Percent |
|--|---------------------|---------|----------|---------|-------|---------|
| | Permanent | Percent | Seasonal | Percent | | |
| Rs. 100-1000 | 37 | 38.14 | 24 | 28.57 | 61 | 33.70 |
| Rs. 1001-2000 | 32 | 32.99 | 27 | 32.14 | 59 | 32.60 |
| Rs. 2001-3000 | 5 | 5.15 | 9 | 10.71 | 14 | 7.73 |
| Rs. 3001-4000 | 4 | 4.12 | 4 | 4.76 | 8 | 4.42 |
| >Rs. 4000 | 19 | 19.59 | 20 | 23.81 | 39 | 21.55 |
| Total | 97 | 100.00 | 84 | 100.00 | 181 | 100.00 |





Measuring Socioeconomic Development Progress in India in the Pre-Covid Era

Edith Jacob¹ and Shilpi Gupta^{2*}

¹Research Scholar, Department of Economics, Manipal University Jaipur, Jaipur, Rajasthan-303007, India.

²Associate Professor, Department of Economics, Manipal University Jaipur, Jaipur, Rajasthan- 303007, India.

Received: 01 May 2022

Revised: 17 May 2022

Accepted: 26 May 2022

*Address for Correspondence

Shilpi Gupta

Associate Professor,

Department of Economics,

Manipal University Jaipur,

Jaipur, Rajasthan- 303007, India.

Email: Shilpi.gupta@jaipur.manipal.edu



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The purpose of this paper is to measure the socioeconomic development progress in India during the period 2001-2019 on the basis of 12 selected indicators. The study uses principal component analysis to create the composite index of socio-economic development. The result shows an increasing trend in the Socioeconomic Development Index. The study's findings also suggest that the socio-economic development, in India has been improving each year but the curve gets flatter after 2015. Stagnation in the process of development is also a point of concern. India needs to uphold the level of Socio-economic development in the post-Covid Era too and move on a path towards an upward trajectory.

Keywords: Socio-economic development, economic development, Social Development, Principal Component Analysis, Pre-Covid Era

INTRODUCTION

Socio-economic development is a multidimensional and complex phenomenon that has a significant role to play in Human Welfare. Socio-economic development is vital for the overall development of a state or a country. Development should not just be in monetary terms but also terms of standard of living and uplifting even the mindsets of its people towards a sustainable lifestyle. The study of development has been a centre of attraction for a lot of economist right from Adam Smith to Marx and Keynes. Time and again, we have seen Governments investing in social schemes, but the gestation period has been long or even an ongoing process. Development in today's context needs to be an approach beyond the monetary aspect along with being sustainable.



**Edith Jacob and Shilpi Gupta**

Seers (1972) defined the concept of development in terms of creating the conditions for the realization of human personality. Social development is also directly related to the development of peace freedom, stability and security. Gunnar Myrdal (1972) points out that development requires upward movement of the entire social system. Development means reduction in poverty, unemployment and inequality. Bilance (1997) says the concept of social development is the promotion of sustainable society that is worthy of human dignity by empowering the marginalized group, men, Women, to undertake their own development, to improve their social and economic position and to acquire their rightful place in the society. Andrews (1973) draws our attention to the fact that increasing the per capita GNP does not automatically lead to balanced social development and general improvement of the quality of life of the people.

Sen (1981) points out an interesting fact that socio-economic development may also be influenced by the nature of government intervention. According to HDR (1990) social development should create an enabling environment for people to live long, healthy and creative lives. Sen (1996) said that Economic Growth helps in reducing scarcity and to improve the capabilities and the quality of life of ordinary people. Economic growth has not substantially helped the poor and the vulnerable to eject themselves out from the vicious circle of poverty. This study aims at measuring the socio-economic progress of India since 2000 using 12 indicators. Apart from the usual indicators used for measuring social development like, Health and Education, this study uses 12 indicators that can give a better picture of people's lifestyle and well being.

MATERIALS AND METHODS

The data is collected for a time period of 2000 to 2019. During the 2000s, the millennium development goals were signed with the targets to be achieved by 2015. This study attempts to capture the picture of socio-economic development during that time frame when such a thought process was initiated among the developing countries. Several authors have used various methods to create a composite index of development. Many of the researchers have also used the methodology given by the UNDP to construct the composite index. Variables selected in this study are the ones which could give a picture of both social as well as economic well being of the people. Rather than taking a large number of variables, this study has narrowed down to 12 variables as follows:

Per capita availability of edible oil (kg) per year

Oil plays an important part as far as the lives of Indians are concerned. It is a part of the staple diet of the entire population. Adequate availability of edible oil to individuals indicate how well off they are financially and their social living standards.

Per capita availability of sugar (kg) per year

Sugar is another substance of daily use which goes from simple drinks like coffee/tea to major dessert delicacies and sweets. The per capita availability of sugar gives us a picture of people's lifestyles and food habits.

Per capita availability of total cloth (meters) per year

Cloth is also one of the basic needs of an individual. An individual with better living standards will be able to fulfill their clothing requirements.

Per capita availability of tea (grams) per year

Tea is a beverage that has been a part of people's lives for ages, especially in India. Tea is the world's most-consumed drink after water. Tea is also a source of livelihood for many in India. Hence, it is one of the components of an individual's essential well-being both economically and socially.

Per capita availability of coffee (grams) per year

Coffee is another beverage that plays a vital role in people's lives and is also a source of livelihood for many. An individual leading an everyday life with adequate resources will be a part of the coffee consuming community.





Edith Jacob and Shilpi Gupta

Availability of electricity per capita (kwh) per day

Availability of Electricity is also an indicator of both social as well as economic development of a country. A country on the path to economic growth will need an increased amount of electricity. Various sectors can generate income, contributing to the better living standards of an individual.

Per capita availability of milk (grams) per day

Milk is another substance that adds nutritional value to people's life. It serves as a raw material for umpteen numbers of dairy products. Milk plays a vital role in the economic and social aspects of the people and the country.

Per capita availability of cereals and pulses (grams) per day

Cereals and pulses are also involved in the staple diet of the people. If an individual is doing economically well, cereals and pulses would be a part of his daily life to enhance health and social well being.

Infant mortality rate

Infant mortality rates have always been used as an indicator of the condition of health in a country. It projects the health infrastructure and resources available to the people of a country.

School enrolment, primary (% gross)

This ratio is an indicator of education at the initial level. Education has been mentioned as a fundamental right of children in the constitution and plays a vital role in human resource development. Higher enrollment levels would lead to better prospects for the country.

School enrolment, secondary, female (% gross)

Enrolment at the secondary level of females is a significant variable in the context of India. It's an indicator of gender equality and equal opportunity.

School enrolment, secondary male (% gross)

Enrolment at the secondary level for males has been considered, as it gives a picture of trends in male education concerning that of females. Primary education is a must to strive for a better society.

RESEARCH METHODOLOGY

A wide variety of multivariate statistical techniques are available to derive a composite index from the selected set of variables. In social sciences, generally, variables are correlated. In such a scenario where the variables show a good amount of correlation, the technique of dimension reduction is used. This would help to summarize the whole set of information into a manageable form without much loss of information from the actual data collected (Chatfield & Collins, 1980). In principal component analysis, a set of variables are transformed into a new set of uncorrelated variables called principal components. The objective of this method is to find out a few components that account for maximum variation in the actual data set. This study uses the methodology of Principal Component Analysis in order to create a composite index of socio-economic development.

Analysis

The variables selected are assumed to be of equal importance and were scaled using the standardization procedure. A correlation matrix is obtained, which was analyzed. Using the correlation matrix, the study of variations explained by the variables is enabled. In addition, the socio-economic index has been compiled by taking the first principal component score (Table 1) as it explains the maximum variation in the data. It was observed in the analysis that, per capita consumption of edible oil and sugar has the highest loading in both the principal components, followed by the other variables. According to the KMO and Bartlett test (Table 3), all the selected variables are adequate with a 100% level of significance. It is observed from the scree plot (fig 1) that the per capita consumption variables are the most



**Edith Jacob and Shilpi Gupta**

determining factors for the socio-economic development in India. The values obtained for the composite index show an increasing trend in the SDI (Fig 2), the values are constantly increasing with an exception in the years 2010-11, 2014-15 and 2015-16 where the values have come down. After 2016 the curve gets flatter depicting that there has not been much improvement in the level of Socio-economic development.

CONCLUSION

It is important that Socio-economic development should translate into better sustainable living standards and well being of the people rather than just translating into good numbers on graphs. Though there is a continuous improvement in the level of Socio-economic Development but it is also a point of concern that the development has become stagnant in the years after 2015. A dip in the value during the year 2010-11 shows the after effects of the 2008 global meltdown but after 2015 it has seen a lot of political as well as structural changes and reforms. 2016 is when demonetization happened in India and it had immensely affected people both economically and socially. The Socio-economic condition seems to have retarded thereafter, thus posing a challenge to the government. Lot of economic packages and corporate reforms have taken the limelight in the past years but the target groups that is the bottom of the pyramid is left out with not really much impactful policies and reforms. Socio-economic development is the well being of the common man and not just businesses and corporate. Hence it is high time that the government focuses on issues like labor wages in the organized and unorganized sectors, farmers and uplifting the downtrodden and the poor. Arrival of Covid-19 has further worsened the situation and it is very important to invest on the overall development of the country than just the economic aspect.

REFERENCES

1. Naresh Kumar, (2017) "Measurement of social development: evidence from India", International Journal of Social Economics, Vol. 44 Issue: 9, pp.1211-1230, <https://doi.org/10.1108/IJSE-01-2016-0001>
2. Andrews, F.M. (1973)., "Social indicators and socio-economic development", The Journal of Developing Areas.
3. Banerjee, K. (2010)., "Social development index 2010", Social Development Report 2010, Council for Social Development.
4. Bilance (1997)., "A world in balance – Balance stands for social development", policy paper, Balance, Oegstgeest.
5. HDR (1990)., "Human development report", United Nations Development Program.
6. Ray, A.K. (1989)., "On the measurement of certain aspects of social development. Measurement of Social Development: An International Comparison. <https://www.jstor.org/stable/27734602>
7. Reserve Bank of India (2014)., Handbook of Statistics on the Indian Economy 2013-14.
8. Seers D (1972) What are we trying to Measure?, The Journal of Development Studies, 8:3, 21-36, DOI: 10.1080/00220387208421410
9. Diener, E. and Suh, E. (1997), "Measuring quality of life: economic, social and subjective indicators", Social Indicators Research.
10. Hicks, N. and Streeten, P. (1979), "Indicators of development: the search for a basic needs yardstick", World Development.
11. Sen, A.K. (1981), "Public action and the quality of life in developing countries".
12. Sen, A.K. (1996), "Radical needs and moderate reforms".
13. Rosegrant, Mark (2016), "Climate change and agricultural policy options". IFPRI Policy brief November 2016.
14. United Nations (1961), "International definition and measurement of levels of living: an interim guide.
15. Streeten, P. and Burki, S.J. (1978), "Basic needs: some issues" UNESCO (1976), The Use of Socio-Economic Indicators in Development Planning, UNESCO Press.





Edith Jacob and Shilpi Gupta

Table 1: Principal Component matrix

| Component Matrix ^a | | |
|--|-----------|-------|
| | Component | |
| | 1 | 2 |
| Eol | .981 | .024 |
| Sug | .917 | .138 |
| Clo | .828 | -.346 |
| Tea | .978 | -.067 |
| Coff | .990 | .042 |
| Ele | .977 | .071 |
| Mil | .968 | .020 |
| Cnp | .204 | .939 |
| Imr | -.997 | -.020 |
| Pgr | .776 | -.235 |
| Sgf | .992 | .036 |
| Sgm | .989 | .008 |
| Extraction Method: Principal Component Analysis. | | |
| a. 2 components extracted. | | |

Table 2: PCA EXTRACTED

| KMO and Bartlett's Test | | |
|--|--------------------|---------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .784 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 482.171 |
| | Df | 66 |
| | Sig. | .000 |

Table 3: Social Development index as per author's own calculation.

| Year | Socio-economic Development Index (SDI) |
|---------|--|
| 2000-01 | 0.22 |
| 2001-02 | 0.21 |
| 2002-03 | 0.27 |
| 2003-04 | 0.30 |
| 2004-05 | 0.37 |
| 2005-06 | 0.37 |
| 2006-07 | 0.44 |
| 2007-08 | 0.49 |
| 2008-09 | 0.52 |
| 2009-10 | 0.54 |
| 2010-11 | 0.53 |
| 2011-12 | 0.62 |
| 2012-13 | 0.64 |
| 2013-14 | 0.70 |
| 2014-15 | 0.67 |
| 2015-16 | 0.61 |
| 2016-17 | 0.67 |
| 2017-18 | 0.68 |
| 2018-19 | 0.68 |





Edith Jacob and Shilpi Gupta

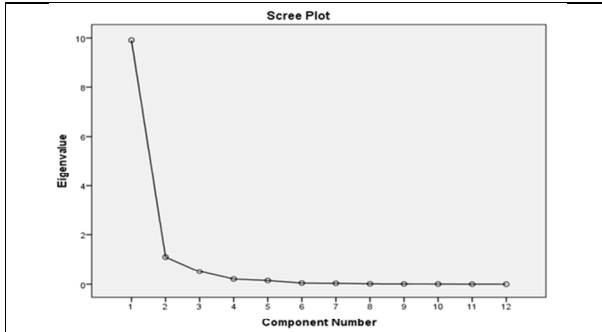


Figure 1: Strong Determined Factors Through PCA

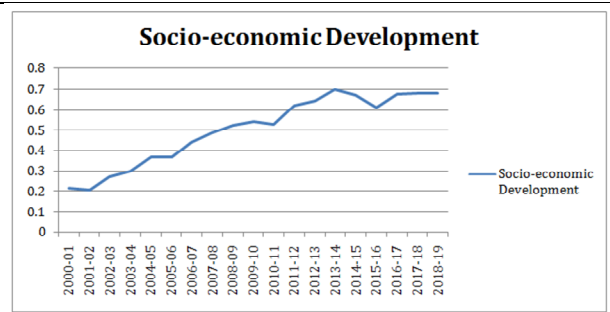


Figure 2: Socio-economic development index(SDI) as per author's calculation based on PCA





CFD Analysis of Octacopter using 3D Experience

Ashok Mishra¹, Preeti Kumari Das¹, G.Akhila¹, S,jai Sankar¹, Sujit Mishra¹ and Mukundjee Pandey^{2*}

¹School of Applied Science, Centurion University of Technology and Management, Odisha, India.

²Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Mukundjee Pandey

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India

Email: mukundjee.pandey@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The employment of octacopter drones for any form of aerial task is already a possibility. This drone design, as the name implies, has eight propellers. So long, helicopters have been the proprietors of the sky, performing all types of aerial labour. Large corporations and organisations are starting to put effort and money into improving multirotor drones in order to compete with helicopters. Drones give economic and operational benefits, among other things. In this paper, we will draw a clear understanding of analyzing the octacopter using CFD techniques along with the 3DEXPERINCE SOFTWARE for performing our simulation tasks and for a detailed study of the drag and lift force changes when octacopter is subjected to certain velocity and temperature when it moves forward and upward direction.

Keywords: CFD, octacopter, Drag force, Lift force

INTRODUCTION

There are various applications of drone like spraying of pesticides [1]. The exposure of individuals towards the harmful pesticides and fertilizers can lead to various diseases [2]. Also, drones can be used in wars where unmanned vehicles are extremely desired and loss of pilots can lead to deprivation of resources [3]. CFD tools plays a better role in the simulation of drones as it helps in the prediction of its performances in the simulated environment [4]. There is different other system engineering software where the controlled behavior of drones can be investigated [5]. It is also required to investigate the rotation required to deliver the lift forces for a particular design of propeller [6]. The vertical take-off and landing conditions can be simulated with CFD tools, and this helps to predict no crash conditions [7]. The structural analysis of drones structures and frames are important to predict the build quality and



**Ashok Mishra et al.**

further modifications [8]. The aerodynamic efficiency of the drone can be improved and is one of the major factors for the determination of its performance [9].

Model Description

The imported model as shown in Fig.1 is an assembly of the components of the octocopter. It consists of frame, Motor or Rotor, ESC (Electronic speed controls), Flight controller, 8 propellers, Battery, Charger. The free stream velocity that the octocopter sees is 33.5m/s. We will be modelling the environment around the octocopter using a virtual wind tunnel with a velocity inlet less than free stream velocity and a pressure outlet sufficiently downstream of the octocopter set as atmospheric pressure. The key outputs from the analysis will be the drag force and lift force.

METHODOLOGY

The first step in the analysis operation is the importing the model into the CATIA part design application. Then we have clicked into the fluid scenario creation app from the 3D compass which can be seen on the left side of the top corner of the software. There using V+R button we can search for the fluid scenario creation application. It will result in the opening of the new interface namely Simulia fluid scenario creation, this name will appear just after the 3D EXPERIENCE name on the screen. This indicates that we have successfully switched to the scenario window and everything set for beginning our work.

After switching to the fluid scenario creation app the assistant panel will appear. Then we have clicked on the model option to assign a finite element model. From the command section of model, fluid domain has been selected where the complete model is selected as part and just after this an exterior bounding box is given as it is an external flow. One wetted surface of drone is taken as region where as all faces are selected as surface selection. In fluid section air is picked from material palette. Just after assigning the fluid section the model option on the assistant will turn green, it shows that all the things are properly assigned to the model in terms of the fluid domain along with fluid section. Now the sst k-omega turbulence model is selected with enabled temperature effects and maximum number of iterations given in steady state step. Just after assigning physical properties the boundary conditions are assigned in which the velocity inlet, pressure outlet, and symmetry boundary conditions are taken. After this we have given the output requests for velocity inlet, pressure outlet and symmetry. After this switched in to the mesh creation window. Mesh generation is a subdivision of a continuous geometric space into discrete geometric cells. From the mesh command section, we selected the Hexa-Dominant-Mesh and given the maximum and minimum size. After that clicked on simulate option.

RESULT AND ANALYSIS

The Simulation of the octocopter has been carried out in the 3DEXperience using 2 number of cases (case 1: - octocopter moving forward, case 2: - octocopter moving upward) with the value of velocities varying from 2m/s to 100m/s with a value gap of 2m/s between two subsequent values of velocity and the temperature values are kept constant i.e. 300 K. In this paper the snapshots of results of Velocity vector, gauge pressure and temperature distribution contour plots with values have been provided In Fig 1,2,3 & 4 respectively at 2m/s Velocity in both forward and upward direction.

Case1: - Contour Plots When The Octocopter Moves In A Forward Direction

In Fig.2 of velocity contour plot different colors shows that different ranges are plotted for velocity. The value of velocity ranging from 0 m/s to 2.58 m/s. The remaining part shows the moderate velocity. Fig. 3 shows that the distribution of temperature on the whole body, for this case it is noted that the value and impact of temperature remains uniform across the whole body. The highest and lowest value is same 300kDeg. In Fig. 4 of gauge pressure plot different colors shows that different ranges are plotted for gauge pressure. Red color shows that the maximum



**Ashok Mishra et al.**

range of gauge pressure that is 2.42 N/m². Blue color shows that the minimum range of gauge pressure that is -2.93 N/m². Remaining part shows the moderate gauge pressure.

Case2: - Contour Plots When The Octacopter Moves In Upward Direction

In Fig. 5 of velocity contour plot different colors shows that different ranges are plotted for velocity. The value of velocity ranging from 0 m/s to 2.87 m/s. The remaining part shows the moderate velocity. In Fig. 6 of gauge pressure plot different colors shows that different ranges are plotted for gauge pressure. Red color shows that the maximum range of gauge pressure that is 2.82 N/m². Blue color shows that the minimum range of gauge pressure that is -4.08 N/m². Fig. 7 shows that the distribution of temperature on the whole body, for this case it is noted that the value and impact of temperature remains uniform across the whole body. The highest and lowest value is same 300kDeg. Fig. 8 represents the graph of drag force Vs inlet velocity (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for drag force. Then it is concluded that with the increase of the velocity drag force also increases. Fig. 9 represents the graph of lift force Vs inlet velocity (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for lift force. Then it is concluded that with the increase of the velocity lift force also increases. Fig. 10 represents the graph of mean velocity(m/s) Vs inlet velocity (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for mean velocity. Then I concluded that with the increase of the velocity mean velocity also increases. Fig. 11 represents the graph of mean pressure(N/m²) Vs inlet velocity (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for mean pressure. Then I concluded that with the increase of the velocity mean pressure is decreases. Graphical plots when the octacopter moving upward direction Fig. 12 represents the graph of drag force Vs inlet velocity of air (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity of air and y-axis for drag force. Then I concluded that with the increase of the velocity drag force also increases. Fig. 13 represents the graph of lift force Vs inlet velocity (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for lift force. Then I concluded that with the increase of the velocity lift force also increases. Fig. 14 represents the graph of mean velocity(m/s) Vs inlet velocity of air (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for mean velocity. Then I concluded that with the increase of the velocity mean velocity also increases. Fig. 15 represents the graph of mean pressure(N/m²) Vs inlet velocity of air (2m/s to 100m/s). In this graph I gave x-axis for inlet velocity and y-axis for mean pressure. Then I concluded that with the increase of the velocity mean pressure is decreases.

CONCLUSION

In this study, CFD simulation method is followed to analyse the aerodynamic behavior and performance of an octacopter. Different contour plots are analysed to find out the physical distributions around the Octacopter. Lift is created by deflecting a flow of air and drag is generated on the body in various ways. Lift is produced by diverting a flow of air, whereas drag is produced on the body in a variety of methods. To keep the drone afloat, lift directly opposes its weight. Lift rises as the drone speeds up until its force equals its weight. When the balance between weight and lift is reached, the drone is propelled upward. While every portion of the drone produces lift, the wings generate the majority of the lift used by the drone. It is concluded that with the increase of the velocity, temperature, lift force and drag force increases but the gauge pressure and absolute pressure decreases.

REFERENCES

1. Shah et al.(2018). Development of UAV Octocopter Based on Pesticides Spraying System. *University of Wah Journal of Science and Technology*, 2, 13-17.
2. Oluwaseun et al.(2022). Design And Construction of Octocopter Agricultural Drone. *IRE Journals*, 6 (9), 2456-8880.
3. Atmaca et al.(2019). CFD Analysis of Unmanned Aerial Vehicles (UAV) Moving in Flocks. *ACTA PHYSICA POLONICA A*, 135, 694-696.
4. Thibault et al.(2017). CFD Simulation of a Quad-Rotor UAV with Rotors in Motion Explicitly Modeled Using an LBM Approach with Adaptive Refinement. *American Institute of Aeronautics and Astronautics*. 1-16.





Ashok Mishra et al.

5. Oscarson. (2015). Design, Modeling and Control of an Octocopter. *Degree project, in optimization and systems theory, second level.*
6. Ahmad et al.(2020). Flow and structural analysis of a quadcopter UAV. *International Journal of Advanced Research in Engineering and Technology*, 11(8), 880-888.
7. Yemle et al.(2019). Design & Analysis of Multi-Frame for Octo & Quad Copter Drones. *International Research Journal of Engineering and Technology*, 6(6),2935-2939.
8. Minh et al.(2021). Design, Analysis and Simulation of V-frame Octocopter. *International Conference of Intelligent Unmanned Systems.*
9. Zhu et al.(2020). Design and assessment of octocopter drones with improved aerodynamic efficiency and performance. *Aerospace Science and Technology*, 106, 106206.



Fig. 1 Cad model of drone in Catia

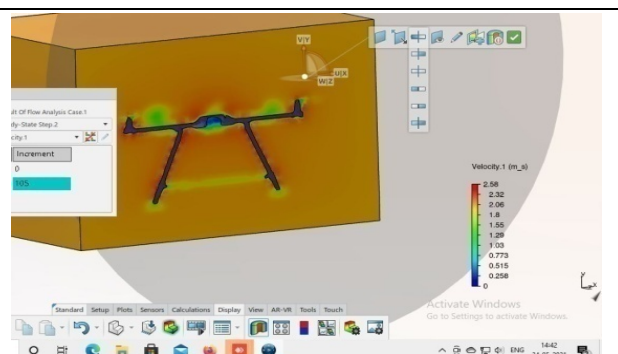


Fig.2 Velocity contour of drone in forward motion



Fig. 3 Temperature contour of drone of forward motion

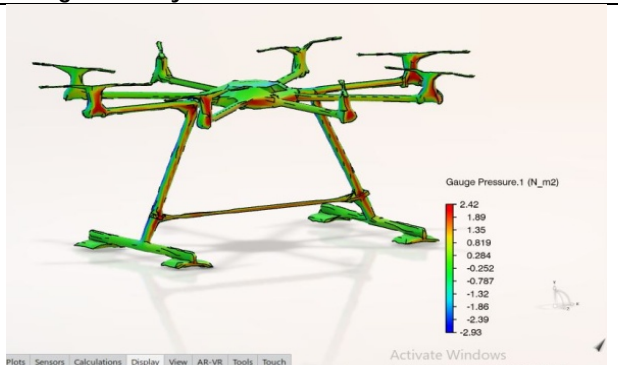


Fig. 4 Pressure Contour Of Drone In Forward Motion

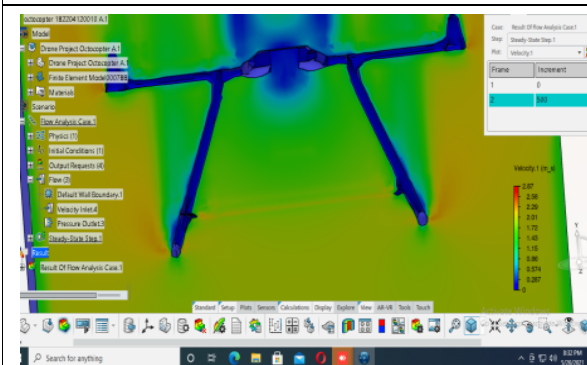


Fig. 5 Velocity contour of drone in upward motion

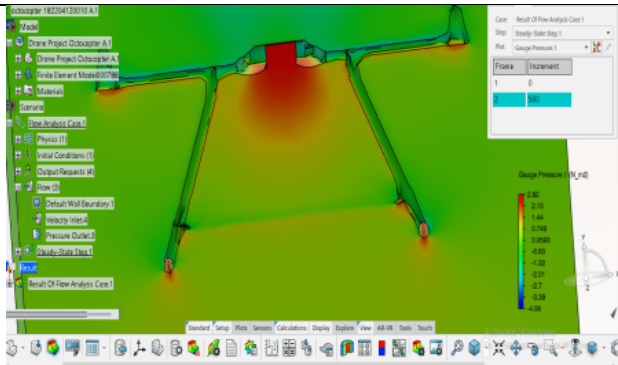


Fig. 6 Pressure contour of drone in upward motion





Ashok Mishra et al.

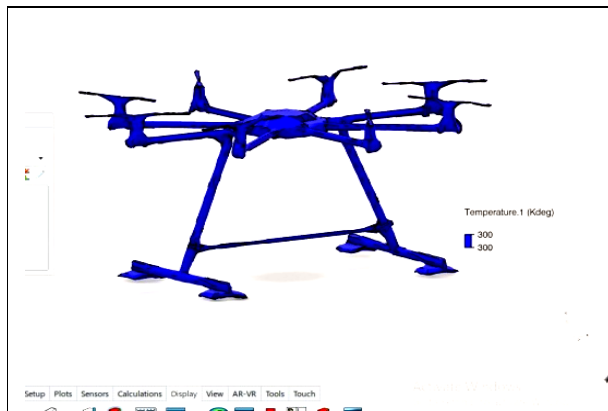


Fig. 7 Temperature contour of drone in upward motion

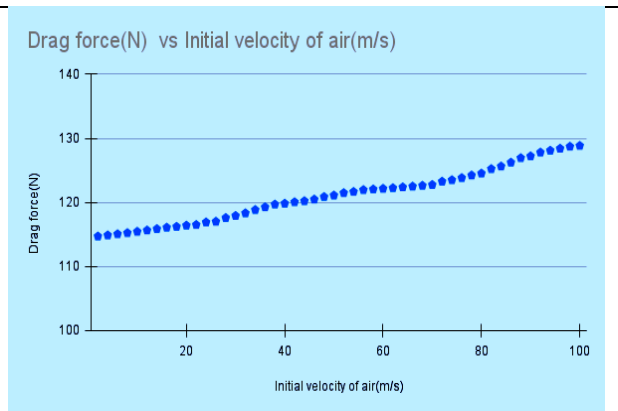


Fig. 8 Drag force vs velocity of air

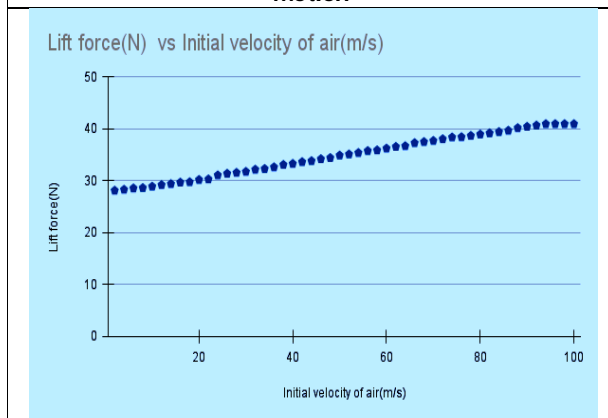


Fig. 9 Lift force vs velocity of air

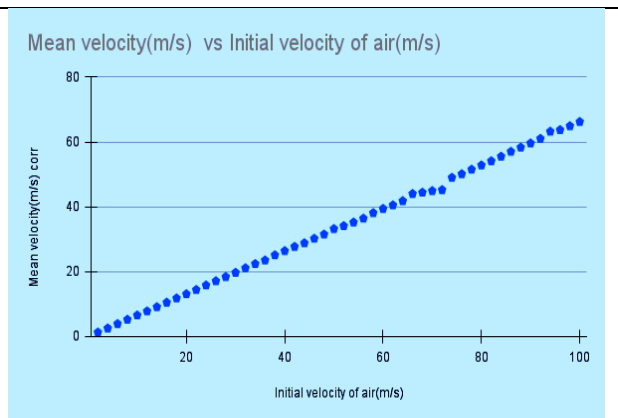


Fig. 10 Mean velocity vs velocity of air

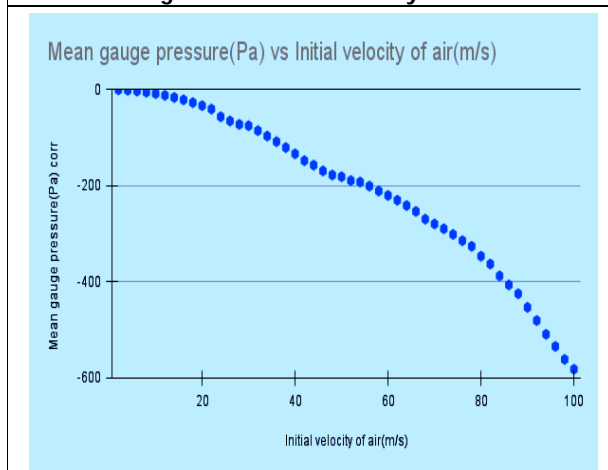


Fig. 11 Mean gauge pressure vs velocity of air

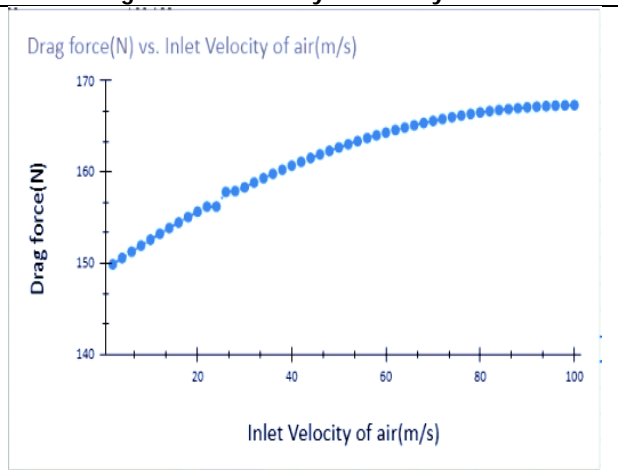


Fig. 12 Drag force Vs inlet velocity





Ashok Mishra et al.

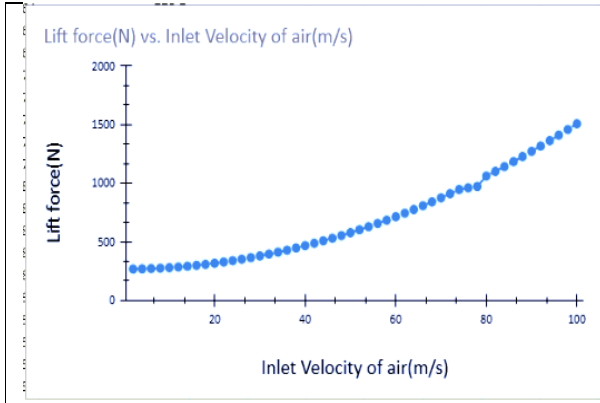


Fig. 13 Lift force Vs velocity inlet

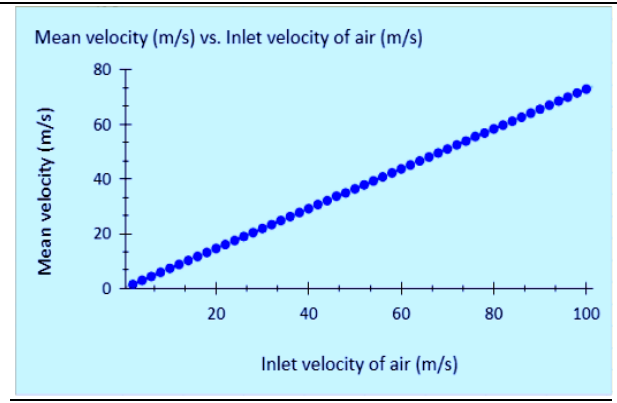


Fig. 14 Mean velocity Vs Inlet velocity of air

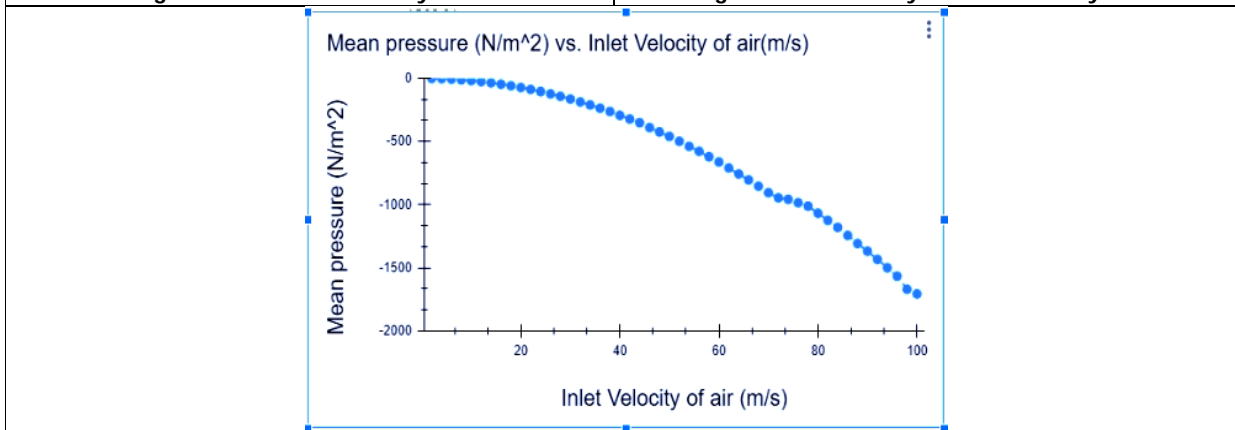


Fig. 15 Mean pressure Vs Inlet velocity of air





ARC Welding Parameter Selection using Taguchi

Sudeep Kumar Singh* and A. M. Mohanty

Mechanical Engineering Department, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Sudeep Kumar Singh

Mechanical Engineering Department,
Centurion University of Technology and Management,
Odisha, India.

Email: sudeep.singh@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The movement of flagging boundaries in association processes has stayed a pivotal reach out because of the energy-serious action of welding processes. Low paper debasement steel is the most broadly welded accessible in the business. The Practice Tinny Arc Welding (MMAW) of delicate steel is generally notable among all welding strategies, as it offers a minimal expense medication, tracks down wide use in underlying make, rebuilding and upkeep. The streaming think about centers choosing qualified MMAW boundaries for welding merciful balance, alluring into thought noises and normal type as the determinant factors. The trials led were molded utilizing Minitab 18 programming. The cross over pliable size, conjunct hardness and the effect power of the joined analyzer. Arranged Neural Meshing is used for preparing the material utilizing data gained from the trials did. The relapse partner was applied in Matlab R2019a to determine the connection between the sign and lead factors to extraordinarily uphold foresee the ideal blend of joint info boundaries.

Keywords: Arc Welding; Mild Steel; Artificial Neural Network; Taguchi; Energy consumption.

INTRODUCTION

Shielded Metal Arc Welding (SMAW) of Temperate Brace (MS) finds school wide coating in structural frames, pipelines, visually artistic designs, and ameliorate due to its richly ductility and weld ability properties [1, 2, 3]. Welding relic the most widely adoptive connection transmute in the manufacture despite its shrilling energy-intensive conception. The option of prim welding parameters is rattling historic in a multi-input multi-output nation similar welding [4, 5]. The mechanistic properties of welded joints mostly depend on treat parameters old in the manufacturing walk [6]. The welder mostly focuses on the grade aspects of the produced joints and pays lesser work to the jumbo impact on the resources exhausted same cigarette caliber, pct of rework/rejection, and life exhausted [7].



**Sudeep Kumar Singh and Mohanty**

Nation consumption is one among umpteen factors trusty for the perverse environmental personalty generated from welding procedure, nurture the essential for characterization of the SMAW affect considering sustainability aspects [3, 8]. Thusly the interpret document intends to line a relationship between the foursome powerful sign parameters and the four product parameters

LITERATURE SURVEY

Adnan *et al.* [4] carried out Economist Analysis to maturate uncomfortable sign parameters of the GMAW welding cognition. They mature three contrary ANN models for signaling, out turn parameter prediction and classifying products. ANN was also employed for work the effects of deliver parameters in laser welding of AA5754 aluminum devalue [9]. Two parameters welding speed and shielding gas were heterogeneous, and the optimization nation was implemented using an Excel add-in named Neuronic Tools. In yet another thoughtfulness, authors formed two assorted ANN models one for sorting of imperfect products and others for prevision of input parameters [5]. Welding processes change a short environmental someone for which improvement of key welding parameters is rattling portion of analyze [8]. Flow, emf and welding motion are considered for analysis. Welding of dissimilar metals involving Al impureness and unblemished steel has been premeditated using the laser-arc welding skillfulness [10]. Taguchi is utilized for studying the opinion of varied welding parameters to get optimum parameters of matriculate form in SMAW [11]. TIG welding parameter has been optimized using greeting ascend methodology (RSM), eccentric flower organization on gentle poise [12], and organisation wildcat optimizer [13] on commanding posture low mixture 15CDV6 steel. RSM has also been adoptive for optimizing GMAW parameters for welding Gentle Brace IS:2062 [14]. Authors [15] bed shell welding using Resistance Strike Welding. RPLNN and GA individual been used involving ternion inputs and two salutation parameters. Reseda quality considering tensile properties and microstructure were analyzed supported on land arrangement using an arc assisted trait laser welding of Al-Mg devalue [16]. Tensile and combat properties in multi-pass SMAW human been investigated by Saxena *et al.* for determining the persuade of welding consumables in ArmoX 500T impureness [17]. Mechanical properties and microstructure of MS welded parts under varied afoot were analyzed using the E7016 electrode [1]. The maximal tensile power was obtained at 75A with nonaged welding defects. Sheets of assorted thicknesses welded using SMAW and GMAW were investigated for judgment a new set of welding parameters for structural mark steel welding [6]. The main aim of the rife explore utilize is to learning the influence of varying signaling parameters on the signaling lineament of the clannish. The arrangement of the paper is as follows. The experimental methodology is explained in section 3. The next section discusses the outcomes of the experimental and test results. The fifth section discusses the application of ANN for welding parameter selection. The sixth section presents conclusions obtained from the analysis and also provides directions for future scope.

METHODOLOGY

The strategy followed in the current work can be divided into different sections of which, arc welding, testing for obtaining output data, and selection of input parameters to the welding process based on influential responses of welding are important. Arc welding of Mild Steel considering energy consumption has been considered in the present investigation. The strategy followed in the current investigation is presented pictorially in figure no 1. Mild steel plates of different thicknesses 3mm, 5mm, and 10mm (three levels) were utilized in the welding process. The welding parameters, current, joint gap, and face width were also varied during the experiment. The input parameters considered in the investigation include the welding parameters and the plate thicknesses. The output parameters considered are Ultimate Tensile Strength (UTS), impact energy (Izod), Rockwell hardness, and energy consumption. The input parameters (factors) involved in the study are presented in table no 1. Mild steel procured in flat form was first cut to a rectangular shape with length 200 mm and width 100 mm. One longitudinal edge of each plate was beveled to produce a double V-groove butt joint. The including angle of the V-shaped joint is 60° for all the plates used. The chemical composition of the plates was tested using XRF spectrometer, and the obtained values are tabulated in table no 2. The data presented in the table displays close conformance in terms of composition for both



**Sudeep Kumar Singh and Mohanty**

the workpiece and filler metals. The filler rod used in the welding process is 3.15 mm in diameter Superweld E6013 manufactured by ESAB. The XRF samples for both material types were prepared by grinding on a surface grinder. The plates were cleaned properly using solvent to remove all dirt, rust present on the surface of the material to be welded. It is followed by welding the plates using process parameters obtained from TAGUCHI orthogonal array design presented in table no 3.

The Welding Process

Similar to the raw material of three different thickness values, the input current has also been varied into the same number of current values and adopted for the experiments; 100, 110, and 120 amperes. The remaining two input variables adopted are root gap and face width. Three different values were considered for both the variables as 0, 1 and 2mm. All the varying parameters are taken together, including the plate thickness values, makes the total number of factors involved in the experimental design as four. The number of levels for each factor is three. Thus if the full factorial design of experiments were to be considered, the total number of experiments would become 27. To reduce the number of experiments, Taguchi Design of Experiment (DoE) method was adopted. Using L9 Taguchi orthogonal array design adopting a four-factor and three-level experimental approach, the total number of experimental runs were reduced to 9. The experimental design adopted for the experiments is presented in table no 3.

The welding process was carried out by using RS400 a Thyristorised MMA welding machine manufactured by ESAB India Ltd. The machine is equipped with 50 Hz 3-phase power supply with an input voltage of 415 volts and 27-ampere current. The welding runs were carried out using the AC power supply. A 3-phase power analyser, model no DPATT-3Bi, manufactured by Uma Electronics Enterprises, Jaipur India, was used for measuring the instantaneous power consumption values during the arc welding process. A three-phase four-wire connection was used in the process of measurement. Table no 3 presents the four factors and the values of the three levels of process parameters adopted in the experimental runs. It displays the values of different process parameters used in the welding process. Four different parameters; welding current, plate thickness, root gap, and face width are used for designing nine number of experiments in total. The welding speed was considered constant throughout the experiment. The plates of 3 mm thickness were welded using a single pass of welding, but multiple runs were necessary for plates with 5 mm and 10 mm thickness. The former was welded with two passes, and for the later three number of welding, passes were used. In total, nine number of welding joints were produced and processed further for preparing test samples for tensile, Rockwell and Izod impact tests to be conducted further. The details of the test procedure and results have been explained in the next section.

Post-weld Testing

The welded steel plates were cleaned to remove the slag deposited during welding by using a chipping hammer and wire brush. Tensile, hardness, and Izod test specimens were extracted from the welded plates of different thicknesses with the respective dimensions, presented in figure-2.

Welding beads were removed by grinding operation from the welded surface for both the tests.

The tensile test was conducted on a Universal Testing machine manufactured by Blue Star Engineering & Electronics Ltd., having a maximum capacity of 1000kN. The test specimens were made to undergo the tensile testing procedure, and the Ultimate Tensile Strength values for each test specimen were noted. The average value of HRB was calculated after measuring hardness values at two different points on the weld bead surface. The samples prepared for the Izod test were carried out using Impact test machine and values of energy absorbed before failure for individual specimen were recorded. The values of UTS, HRB, and Energy absorbed has been presented in table no. 3 under respective columns. Figure no. 3 displays phases of sample preparation for different tests after conducting the tensile, Rockwell, and Izod tests. The figure nos. 4 (a) displays the Impact testing machine, and 4 (b) depicts the Rockwell hardness testing machine used for the experimentation.





Sudeep Kumar Singh and Mohanty

Parameter selection using ANN

Neural networks find a wide application and recognized as efficient solvers of non-linear problems. Successful applications have been reported in literature containing real-world problems. Thus ANN has been selected for finding optimum input parameters for SMAW in the present study. The architecture for the employed neural net is presented in figure no 5. An Artificial Neural Network was modeled for training using the data collected from the conducted experiments. The Bayesian Regularization backpropagation method is used for the construction of the network. This method is generally used for difficult, small, and noisy datasets. In the current construction, the data set is small and prone to noise in the measured value; thus, the application of Bayesian Regularization fits our requirement. 'trainbr' learning function is used in the Matlab R2019a platform. The network takes 70% of data for training, 15% for validation, and 15% for testing. The ANN model developed in this study involves an input layer, one hidden layer, and one output layer. The input layer consists of 4 neurons; each neuron corresponding to individual input parameters and the output layer containing 4 neurons, representing one output parameter each. The hidden layer employs 50 neurons. The most promising network architecture is based on the trial and error method for which many trials have been conducted to arrive at the best combination. The performance of the network has been discussed in detail in the conclusion section.

CONCLUSION

The new energy involves quadruplet input and tetrad sign variables for SMAW welding of structural ablaunt mild brace. The lineament of the welding has been tried by measure UTS of the welded cooperative by applying concern in the thwartwise itinerary, activity the touch energy intent by the conjoint before nonstarter, hardness on the beadwork appear, and also the land exhausted for associated thinking. The sign and signal were fed into an ANN meshing fitly fashioned for the purport. The shapely system is susceptible of selecting all the foursome parameters similar liveliness exhausted, UTS hardness, and effect vitality. This create can be outstretched to opposite welding methods. Else polar variables not reasoned in the tell work may be wise as futurity search cro.

REFERENCES

1. Faqih, Imam & Ma'arif, Syamsul & Sukarjo, Heribertus. (2019). The Effect of Current Variation on MMA Welding to Mechanical Properties and Microstructure of Mild Steel.
2. Ahmed, A.N., Noor, C.M., Allawi, M.F. and El-Shafie, A., 2018. RBF-NN-based model for prediction of weld bead geometry in Shielded Metal Arc Welding (SMAW). *Neural Computing and Applications*, 29(3), pp.889-899.
3. Alkahla, I. and Pervaiz, S., 2017, September. Sustainability assessment of shielded metal arc welding (SMAW) process. In *IOP conference series: materials science and engineering* (Vol. 244, No. 1, p. 012001). IOP Publishing.
4. Aktepe, A., Ersöz, S. and Lüy, M., 2014. Welding process optimization with artificial neural network applications. *Neural Network World*, 24(6), p.655-670.
5. Aktepe, A., Ersöz, S. and Lüy, M., 2012, September. Backpropagation neural network applications for a welding process control problem. In *International Conference on Engineering Applications of Neural Networks* (pp. 172-182). Springer, Berlin, Heidelberg.
6. Khamari, B.K., Dash, S.S., Karak, S.K. and Biswal, B.B., 2019. Effect of welding parameters on mechanical and microstructural properties of GMAW and SMAW mild steel joints. *Ironmaking & Steelmaking*, pp.1-8.
7. Singh, S.K., Samal, B.K., Pradhan, S.R., Ojha, S.R., Saffin, M.D. and Mohanty, A.M., 2019, August. Sustainable Analysis of TIG Parameters for Welding Aluminum Alloy Considering Joint Gap and Welding Current. In *International Conference on Application of Robotics in Industry using Advanced Mechanisms* (pp. 316-323). Springer, Cham.
8. Vimal, K.E.K., Vinodh, S. and Raja, A., 2017. Optimization of process parameters of SMAW process using NN-FGRA from the sustainability view point. *Journal of Intelligent Manufacturing*, 28(6), pp.1459-1480.
9. Casalino, G., Facchini, F., Mortello, M. and Mummolo, G., 2016. ANN modelling to optimize manufacturing processes: The case of laser welding. *IFAC-PapersOnLine*, 49(12), pp.378-383.





Sudeep Kumar Singh and Mohanty

10. Gao, M., Chen, C., Mei, S., Wang, L. and Zeng, X., 2014. Parameter optimization and mechanism of laser-arc hybrid welding of dissimilar Al alloy and stainless steel. *The International Journal of Advanced Manufacturing Technology*, 74(1-4), pp.199-208.
11. Arifin, A., Gunawan, A.M., Yani, I., Pratiwi, D.K., Yanis, M. and Sani, K.A., 2019. Optimization of Angular Distortion on Weld Joints Using Taguchi Approach. *Jurnal Kejuruteraan*, 31(1), pp.19-23.
12. Srivastava, S., Kumar, S. and Garg, R.K., A multi-objective optimisation of TIG welding parameters using response surface methodology, In press.
13. Skariya, P.D., Satheesh, M. and Dhas, J.E.R., 2018. Optimizing parameters of TIG welding process using grey wolf optimization concerning 15CDV6 steel. *Evolutionary Intelligence*, 11(1-2), pp.89-100.
14. Srivastava, S. and Garg, R.K., 2017. Process parameter optimization of gas metal arc welding on IS: 2062 mild steel using response surface methodology. *Journal of Manufacturing Processes*, 25, pp.296-305.
15. Azizi, A., Barenji, A., Barenji, R. and Hashemipour, M., 2016. Modeling mechanical properties of FSW thick pure copper plates and optimizing it utilizing artificial intelligence techniques. *Sensor Netw Data Commun*, 5(142), p.2.
16. Leo, P., Renna, G., Casalino, G. and Olabi, A.G., 2015. Effect of power distribution on the weld quality during hybrid laser welding of an Al-Mg alloy. *Optics & Laser Technology*, 73, pp.118-126.
17. Saxena, A., Kumaraswamy, A., Reddy, G.M. and Madhu, V., 2018. Influence of welding consumables on tensile and impact properties of multi-pass SMAW Armax 500T steel joints vis-a-vis base metal. *Defence technology*, 14(3), pp.188-195.

Table 1. Different values for the input variables.

| Sl. No | Factors | Level1 | Level2 | Level3 |
|--------|-----------------|--------|--------|--------|
| 1 | Current | 100A | 110A | 120A |
| 2 | Plate thickness | 3mm | 5mm | 10mm |
| 3 | Root gap | 0mm | 1mm | 2mm |
| 4 | Face width | 0mm | 1mm | 2mm |

Table 2. Material composition.

| Sl. No. | Base material | Si | Mn | S | P | Fe |
|---------|------------------|-------|-------|-------|-------|--------|
| 1 | Mild steel plate | 0.720 | 0.709 | 0.132 | 0.029 | 96.840 |
| 2 | Electrode E6013 | 1.451 | 0.437 | 0.125 | 0.034 | 96.115 |

Table 3. Experimental values in the investigation.

| Sl. No. | Current (A) | Plate thickness (mm) | Root gap (mm) | Face width (mm) | Power (kW) | UTS (MPa) | Hardness (HRB) | Impact energy (J) |
|---------|-------------|----------------------|---------------|-----------------|------------|-----------|----------------|-------------------|
| 1 | 100 | 3 | 0 | 0 | 4.73 | 481 | 76.4 | 60 |
| 2 | 100 | 5 | 1 | 1 | 4.52 | 411 | 77.25 | 62 |
| 3 | 100 | 10 | 2 | 2 | 5.32 | 305 | 83.9 | 74 |
| 4 | 110 | 3 | 1 | 2 | 4.59 | 295 | 78.1 | 50 |
| 5 | 110 | 5 | 2 | 0 | 5.52 | 501 | 78.6 | 52 |
| 6 | 110 | 10 | 0 | 1 | 5.14 | 406 | 85.55 | 160 |
| 7 | 120 | 3 | 2 | 1 | 5.88 | 458 | 80.6 | 52 |
| 8 | 120 | 5 | 0 | 2 | 6.59 | 362 | 84.05 | 112 |
| 9 | 120 | 10 | 1 | 0 | 5.89 | 329 | 82.65 | 110 |





Sudeep Kumar Singh and Mohanty

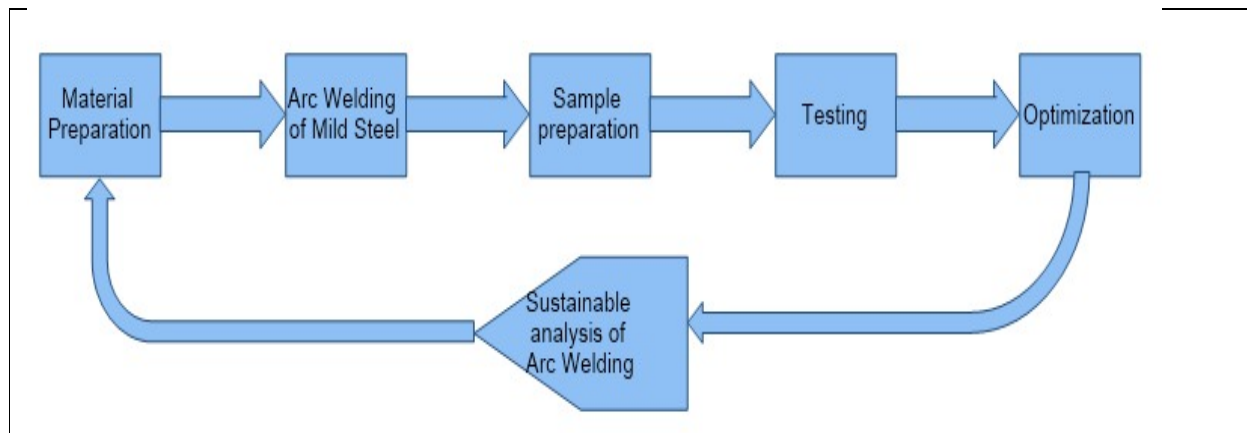


Fig. 1. Experimental methodology

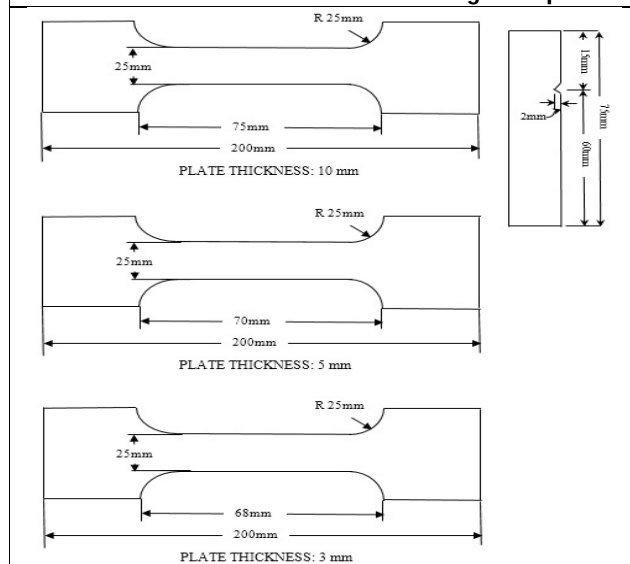


Fig. 2. Schematic diagrams of (a) Tensile Test specimen; (b) Izod specimen

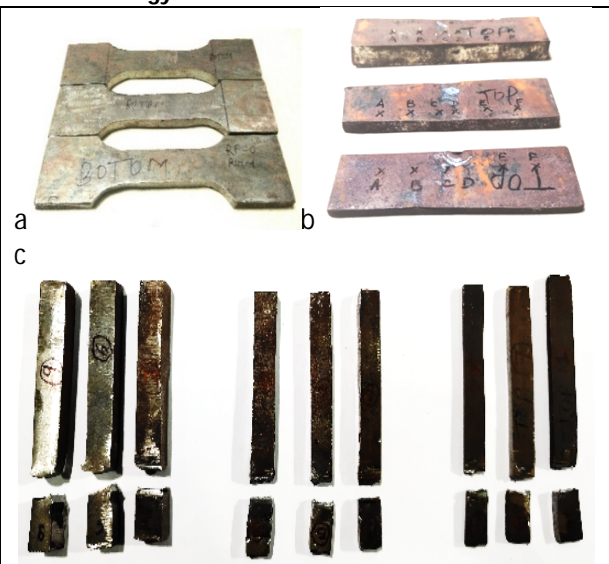


Fig. 3. Pictorial representations of (a) Tensile Test; (b) Hardness; (c) Izod Specimens

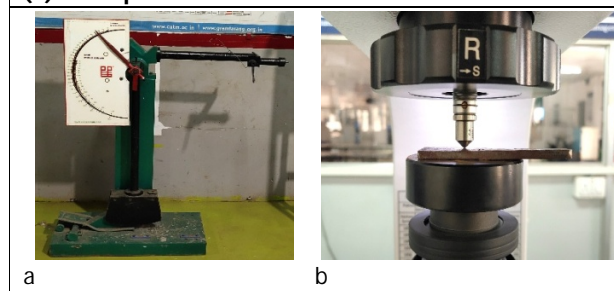


Fig. 4. (a) Impact testing machine; (b) Rockwell hardness testing machine

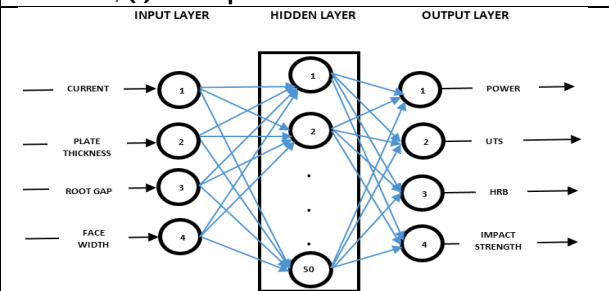


Fig. 5. ANN architecture





Sudeep Kumar Singh and Mohanty

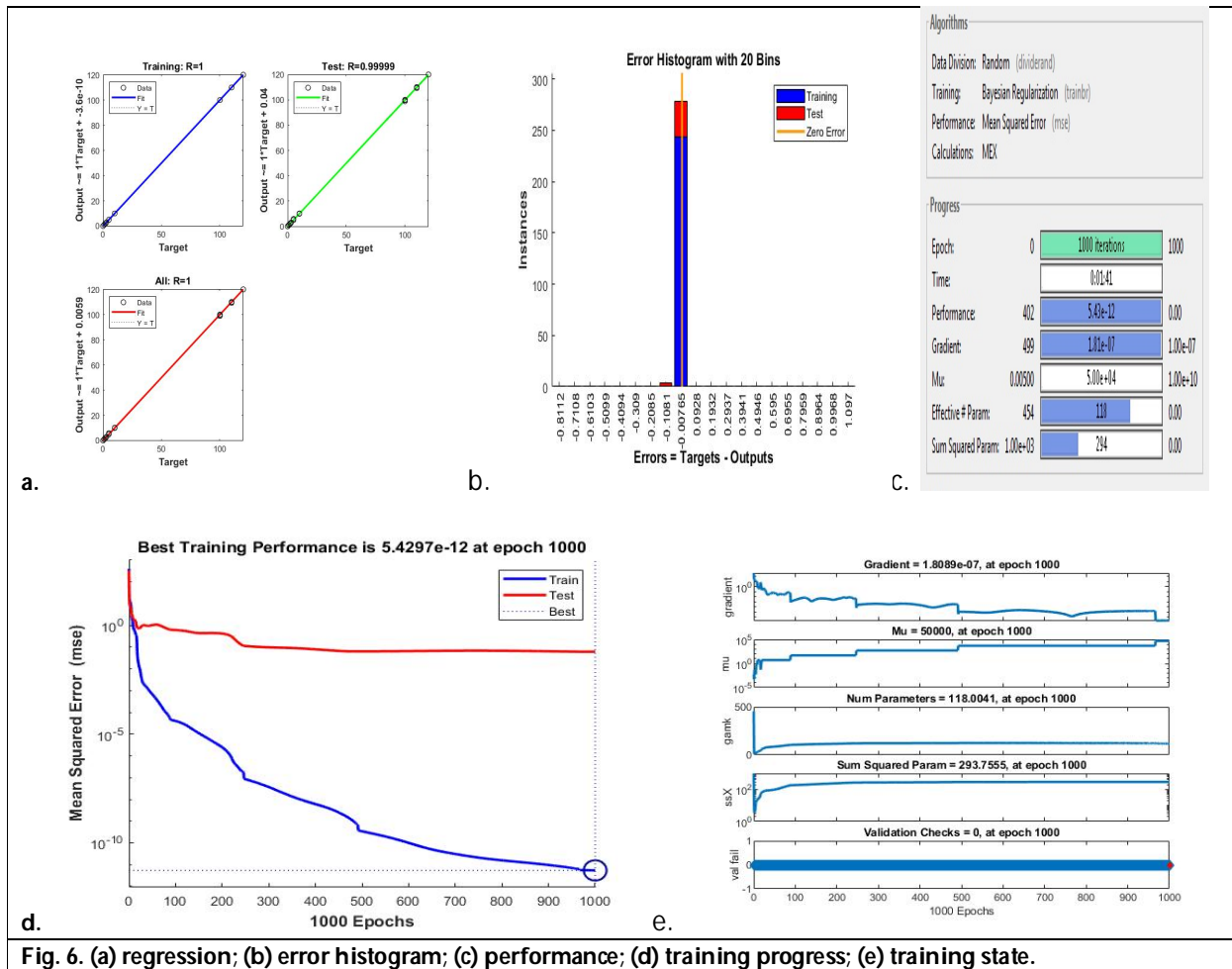


Fig. 6. (a) regression; (b) error histogram; (c) performance; (d) training progress; (e) training state.





Simulation of a Solar operated Agri Pesticide Sprayer using PVSYST Software

Debashree Debadatta Behera*

Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India

Received: 04 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Debashree Debadatta Behera

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Accesses to modern energy services are necessary for improved health and agricultural productivity (UNDP, 2001). In the present paper a smart agri pesticide sprayer was developed which was operated by solar power. It was efficient as compared to conventional sprayer (operated by diesel fuel) and required less time for spraying larger area and also reduced back pain. The main components are solar panel, charge controller, battery, DC pump, and nozzle with sprayer and further the entire system was analyzed by PV syst software.

Keywords: Smart agri pesticide sprayer, PV syst, PV panel

INTRODUCTION

All of the world's problems can be solved with energy. It contributes to the human and economic growth of any area, state, or country. In today's world, energy access is a prevalent issue. Access to clean energy can aid in the development of rural tribal communities. "Electrification is linked to a range of development improvements, such as increasing in income, generating employment, and achieving better health and education" (Barron and Torero, 2017; Chakravorty *et al.* 2016). In recent era, the demand of electricity has raised drastically. In order to overcome that smart agri sprayer had fabricated which consist of 1.Solar panel, battery, charge controller, DC pump, and sprayer. It is easy to install, operate and maintain and diesel was not required. The present development of sprayer has following objectives.It is operated by clean energy which is pollution free and maintenance cost is less.

LITERATURE REVIEW





Debashree Debadatta Behera

S. charvani *et al* [1] developed a sprayer which was operated by solar Panel, battery and pump. R.Joshua *et al* [2] developed a sprayer for discharging pesticide and it was operated by DC motor. Harshit Jain *et al* [3] E. Zahab *et al* [4] designed solar water pumping system which consists of three speed controller and MPPT device for charging and discharging battery. Nithin Vasanth *et al* [5] had done experimental work on solar powered sprayer and all data had been submitted through GSM. Yallappa D *et al* [6] developed multipurpose solar operated sprayer. Kohle [7] had done experimental work solar water pumping by using manual tracking system.

Diagram of Spraying System

Analysis by using PVSYST software

By considering simulation parameter such as geographical data of Bhubaneswar, Odisha location, system parameters (sizing of solar panel and battery), used energy, performance ratio, loss of head were obtained. In the figure 2 it has been shown below

RESULTS AND DISCUSSIONS

Power Conversion Efficiency of the Panel

$\eta = \text{Maximum power} / \text{Minimum power} = \text{output power} / \text{input power}$ Where,

Under STD condition

Irradiance = 1000 W/m²

Area of solar cell = 0.4m x 0.4m

Input power = 160 W

Output power = $V_{oc} \times I_{sc} \times FF$

$V_{oc} = 21.5$, $I_{sc} = \text{Short circuit current} = 1.29$

File factor (FF)

The output in the solar panel is not 100%. So it is the resistance in the solar panel. $FF = \text{loss due to file factor} = (V_{oc} - I_n) / (V_{oc} + 0.72) / (V_{oc} + 1)$. $FF = 81.7\%$

Output power = open circuit voltage x short circuit current x Fill factor = 22.6 W

$\eta = \text{output power} / \text{input power} = 14\%$ which power conversion efficiency

$\eta = (\rho \times g \times Q \times Hm) / (V_{oc} \times I_{sc}) = 0.36 = 36\%$

CONCLUSION

From the experiment it was found that maximum discharge rate at outlet of DC pump was 4.3 Liter per minute by taking Solar panel(20W),battery (12V,7.2Ah), charge controller (12V,10A), DC Pump (12V,4.2 LPM).It was cost effective as compared electric operated pump. It can used for multipurpose such as charging mobile and operating LED light. Due to battery back it can be used in night or in cloudy weather.

REFERENCES

1. S.Charvani, K.Sowmya, M.Malathi , P.Rajani4, K.Saibaba“Design and fabrication of a solar sprayer”, International Journal of science Technology and Management, 6(2017), pp.589-596.
2. R. Joshua, V. Vasu and P. Vincent. “Solar Sprayer - An Agriculture Implement”, International Journal of Sustainable Agriculture, 2(2010), pp.16-19.
3. Harshit Jain,Nikunj Gangrade, Sumit Paul, Harshal Gangrade, Jishnu Ghosh, “Design and fabrication of solar pesticide sprayer”, IJARIE, 4(2018), P.1715-1727.
4. Essam E. Aboul Zahaba, Aziza M.Zakib and Mohamed M.El-SotouhyDesign and control of a Standalone PV water pumping system. Journal of Electrical system and Information Technology, 2017, pp.322-337.





Debashree Debadatta Behera

5. Vasanath N., Akash G., Srikanth KR., Pavan, S, TN and Sinha R. Solar Powered Automatic Pesticide Sprayer. Internal Conference on Energy, Communication, Data Analytic and Soft Computing, 2017, pp. 3438-3440.
6. Yallapa, D., Vijaykumar P., Veerangouda M., and Sushilendra. Development and Evaluation of Solar powered Sprayer with Multipurpose Application. Global Humanitarian Technology Conference, 2016, pp. 1-5.
7. Kolhe M, Joshi J.C, and Kothari D. P. Performance Analysis of a Direct Coupled Photovoltaic Water-Pumping system. IEEE Transactions on Energy Conversion, 2004, pp.613-618.

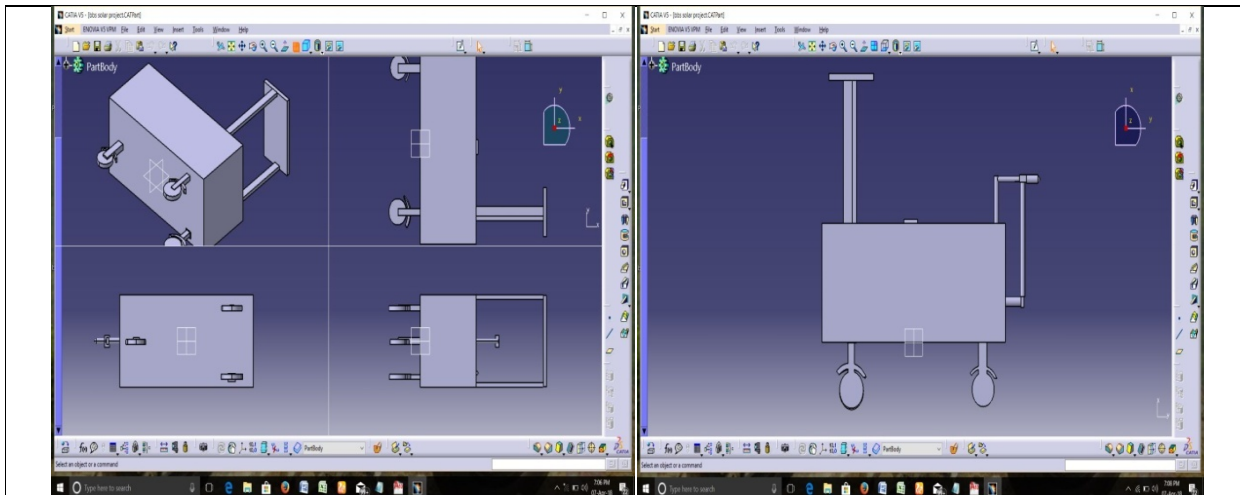


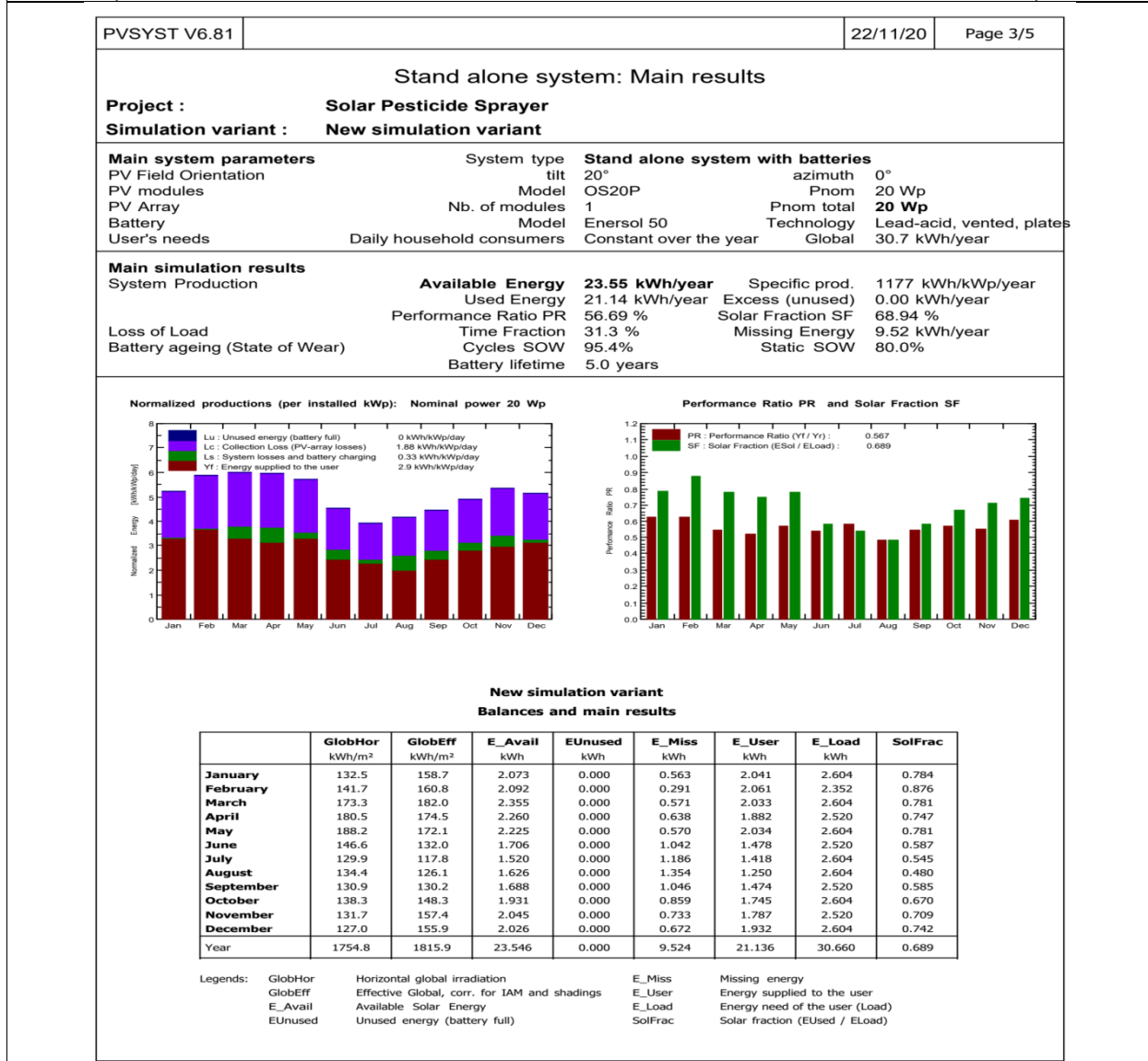
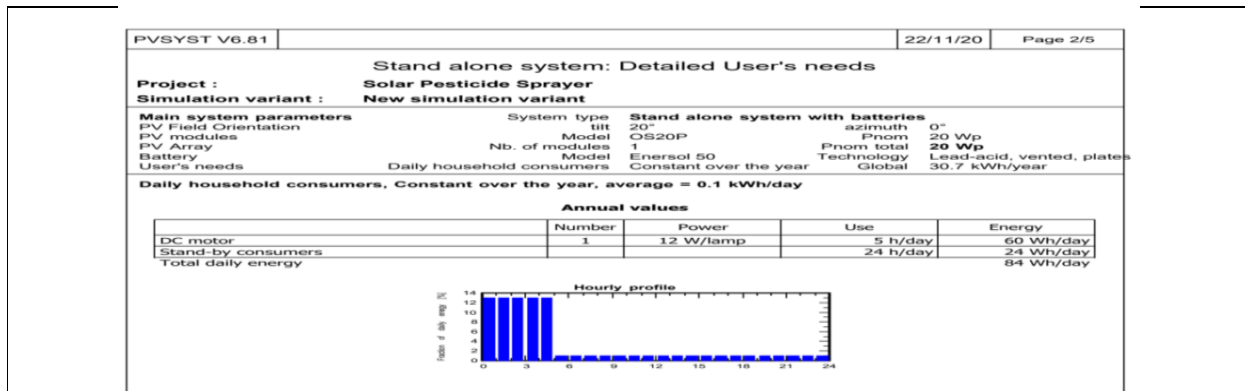
Figure 1. Modeling of spraying system by Catia Software

| | | | |
|--|--------------------|--|------------------------------|
| PVSYS V6.81 | | 22/11/20 | Page 1/5 |
| Stand alone system: Simulation parameters | | | |
| Project : Solar Pesticide Sprayer | | | |
| Geographical Site | | Jatani | |
| Situation | | Latitude | 20.16° N |
| Time defined as | | Legal Time | Time zone UT+5.5 |
| | | Albedo | 0.20 |
| | | Country | India |
| | | Longitude | 85.71° E |
| | | Altitude | 33 m |
| Meteo data: Jatani Meteorom 7.2 (1981-2010), Sat=100% - Synthetic | | | |
| Simulation variant : New simulation variant | | | |
| Simulation date 22/11/20 12h36 | | | |
| Simulation parameters | | Stand alone system with batteries | |
| Collector Plane Orientation | | System type | Tilt |
| Models used | | 20° | Azimuth 0° |
| User's needs : | | Transposition | Perez |
| Daily household consumers average | | Diffuse | Perez, Meteorom |
| | | Constant over the year | 0.1 kWh/Day |
| PV Array Characteristics | | | |
| PV module | | System type | Stand alone system |
| Original PVsyst database | Si-poly | Model | Enersol 50 |
| Number of PV modules | 1 | Manufacturer | Exide Classic |
| Total number of PV modules | 1 | Nb. of units | 1 |
| Array global power | 20 Wp | Nominal Capacity | 37 Ah |
| Array operating characteristics (50°C) | 18 V | Stored energy | 0.4 kWh |
| Total area | 0.2 m ² | Temperature | Fixed (20°C) |
| | | Discharging min. SOC | 20.0 % |
| | | Temperature | Fixed (20°C) |
| | | Model | Universal direct controller |
| | | Technology | Series |
| System Parameter | | Temp coeff. | -5.0 mV/°C/elem. |
| Battery | | Threshold commands as | |
| Battery Pack Characteristics | | Charging | SOC = 0.92 / 0.75 |
| Nb. of units | | Discharging | SOC = 0.20 / 0.45 |
| Voltage | | | i.e. approx. 13.3 / 12.4 V |
| Discharging min. SOC | | | i.e. approx. 11.6 / 12.1 V |
| Temperature | | | |
| Controller | | | |
| Battery Management control | | | |
| PV Array loss factors | | | |
| Thermal Loss factor | | Uc (const) | 20.0 W/m ² K |
| Wiring Ohmic Loss | | Global array res. | 250 mOhm |
| Serie Diode Loss | | Voltage Drop | 0.7 V |
| Module Quality Loss | | Uv (wind) | 0.0 W/m ² K / m/s |
| Strings Mismatch loss | | Loss Fraction | 1.5 % at STC |
| Incidence effect (IAM): Fresnel AR coating, n(glass)=1.526, n(AR)=1.290 | | Loss Fraction | 3.8 % at STC |
| | | Loss Fraction | -0.8 % |
| | | Loss Fraction | 2.5 % (fixed voltage) |
| | | Loss Fraction | 0.10 % |
| | | | |
| 0° | 30° | 50° | 70° |
| 1.000 | 0.999 | 0.987 | 0.962 |
| | | | 75° |
| | | | 0.892 |
| | | | 80° |
| | | | 0.816 |
| | | | 85° |
| | | | 0.681 |
| | | | 90° |
| | | | 0.440 |
| | | | 0.000 |





Debashree Debadatta Behera





Debashree Debadatta Behera

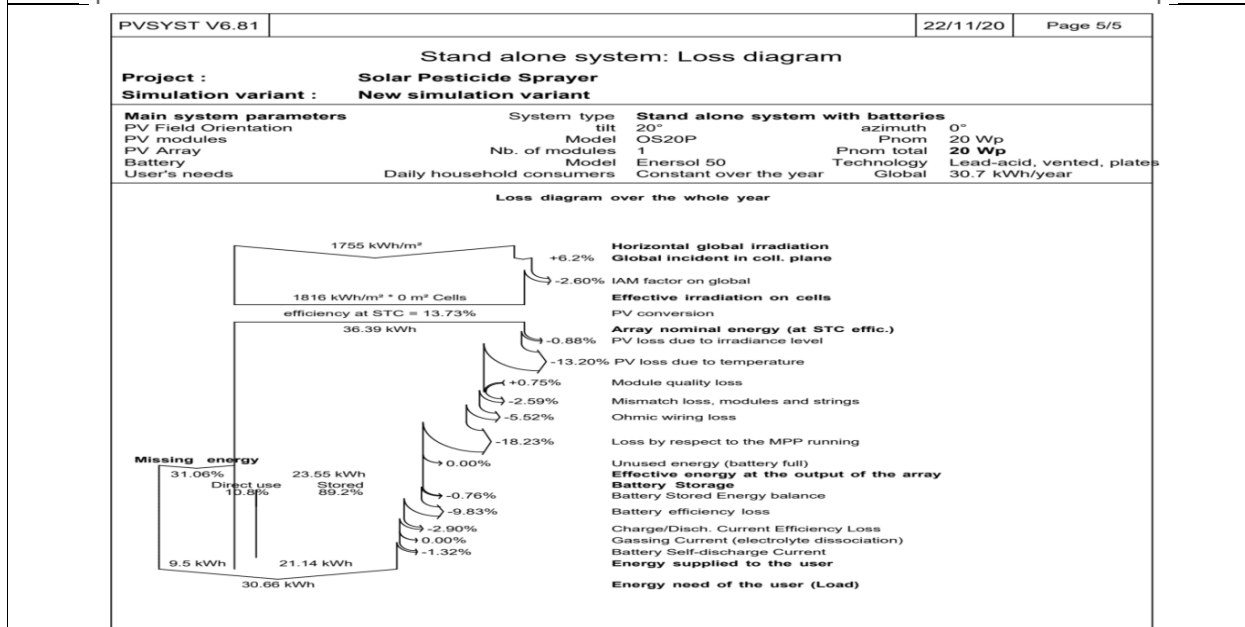
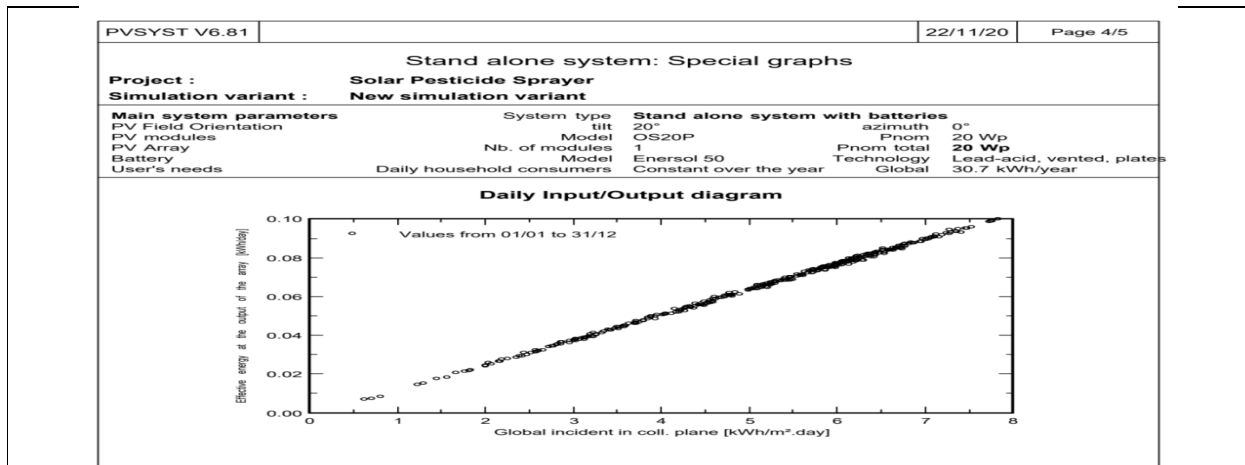


Figure 2. Analysis report by using PVSYSY software



Figure 3. Testing operation





Analysis of Roughness Coefficient in Meandering Channels by using ANN

Saine S. Dash¹ and Kishanjit K. Khatua^{2*}

¹Department of Civil Engineering, Centurion University of Technology and Management, Odisha, India

²Department of Civil Engineering, NIT Rourkela, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Kishanjit K. Khatua

Department of Civil Engineering,

NIT Rourkela, India

Email: kkkhatua@yahoo.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

An attempt has been made to predict Roughness Coefficient Manning's n by using three independent parameters such as Aspect Ratio (δ), Sinuosity (S_r) and Bed Slope of the channel (S_o). The prediction modeling was done by using Data Based Model otherwise called Black Box Model. For this purpose as sample Multi-Layer Perceptron (MLP) from Artificial Neural Network (ANN) architecture has been used. For the acquirement of data experiments have been conducted for different combinations of input parameters i.e. Aspect Ratio (δ), Sinuosity (S_r) and Slope (S_o). A total of 5 different combinations of input parameters have produced different values for the ANN model. The model has performed at satisfactory level by showing as $R^2=0.87$ value of before predicted and original data.

Keywords: meandering channel, Aspect Ratio, Sinuosity, Slope.

INTRODUCTION

Water is possibly the most vital and necessary natural resource available for mankind. It reaches on land in the form of precipitation and returns to the sea by means of river channels. Rivers are a natural aspect of our landscape and form an integral part of the water cycle. By default it has the effects of magnificence and the historic essence of a settlement. Rivers are always ingenious to the livelihood settled on its banks and cause of attraction for almost every civilization. Important benefits gives from rivers such as, water for household consumption, irrigation and industry, sustainable energy, convenient transportation links, and valuable wild-life habitat. By the nature river channels adequately convey the water back to the sea but sometimes, under conditions of high rainfall and large flow rates, the river channel may overtop its banks and flow onto the flood plain with possible danger to life and property. Recently, increasing



**Brijlal Mallik et al.**

environmental awareness has led to the reversal of this trend, and in some cases to their introduction of meanders and bends in previously straightened lengths of river. Natural channels are rarely straight and man-made channel, but now required to comply with more stringent environmental standard, will be so less and less. Therefore, hydraulics engineer's needs for a reliable design guide that embrace the concept of meandering channels. Previously, the hydraulics model study of such channels gives basic information on the flow pattern and velocity distribution found there but do not give enough data of sufficient compressive and reliable value of Roughness on a general picture of flow mechanism. For prediction of roughness coefficient in meandering channel, it depends upon some parameters such as Slope of channels, sinuosity and aspect ratio of channels. To overcome such limitations many models are developed. So, a simple but reliable prediction method for estimating Roughness of meandering channel is highly desirable for field engineers. Therefore, an easily implementable technique in the field like ANN has been developed. In this study, prediction of Roughness coefficient through ANN is tried. For prediction of Roughness Coefficient in a Meandering channel a MLP algorithm of ANN was used. [1] Simulated the equation developed by Cool brook-White through Neuro-fuzzy model. Also [2] used ANN to predict the friction factor in a smooth open channel. For pipe flow, ANN was also used for prediction of friction factor by [3].

METHODOLOGY

Experimental Investigation

For investigation in meandering channels, experimental setup was built in Fluid Mechanics and Hydraulics Laboratory of NIT Rourkela. A meandering channel having trapezoidal meandering channel (bottom width 0.33m, depth 0.065m and side slope 1:1) with constructed with Perspex sheet of 6mm/10mm thickness having Manning's n value=0.01. It was built inside a steel tilting flume of around 15m length as shown in Fig.1. All observations are recorded along a meandering path in bend apex of channels. Series of pitot-tubes with moving bridge arrangement are made to measure the velocity at different points of the flow passage of the channel. The measurements are taken at different reaches along the meander path for every section. Similar readings are taken for different discharge and different flow depths at steady state conditions.

By the help of centrifugal pump (15Hp) the required amount of water is supplied to the flume from an underground sump via an overhead tank. A movable bridge (approx. 1.2m width and 4m long) was provided across the flume in both axes over the channel area so that each location on the plan of meandering channel could be accessed for taking measurements. The broad parameters of this channel such as aspect ratio of main channel (δ), width ratio (α) was kept constants for all different sinuous channels. In all the experimental channels, the flow has been maintained uniform i.e., the water surface is parallel to bed of channel. This simplified approach has been tried to achieve which is also in line with the experimental work [5]. This stage of flow is considered at normal depth, which can carry a particular flow only under steady and uniform conditions. All the observations are recorded at the central bend apex of the meandering channel. Point velocities were measured along verticals spread across the main channel to cover the width of entire cross section. Measurements are taken from left edge to the right edge of the main channel in the direction of flow. The lateral spacing of the grid points has been taken as 4cm on either side of the centerline.

Longitudinal velocity distribution in the meandering channel at bend apex gives contours points that are skewed with curvature. From the experiment it is observed that contours with more velocity were getting gradually increasingly at the inner bank to outer bank at the bend apex of meandering channel. In all cases of depth, the maximum velocity occurred at the inner wall in the bend entrance where the radius of curvature is the minimum and negative pressure gradient occurs from outer bank. Similar reports are also seen for deep channels of [6] and [7] the distribution of longitudinal velocity as erratic.

Soft Computing Technique (ANN)

ANN is widely applied now a day for classification, identification, control, diagnostics, recognition, etc. An ANN is an information processing paradigm that is stimulated by the way biological nervous systems, such as the brain,





Brijlal Mallik et al.

process information. Basically, a neural network (NN) is composed of a set of nodes and each node is connected to the others via a set of links. Information is transmitted from the input to the output cells depending on the strength of the links. Usually, NN operate in two phases. The first phase is a learning phase where each of the nodes and links adjust their strength to match with the desired output. A learning algorithm is in charge of this process. When the learning phase is complete, the NN is ready to recognize the incoming information and to work as a pattern recognition system.

ANNs can be created using software run on computers programmers are written and constructed so that the basic architecture and functional characteristics of the biological neuron matrix found in the human brain is replicated mathematically. This structure combines in vast numbers to create the human brain structure. The human brain demonstrates prodigious ability to learn suitable responses to the myriad of different stimuli. The knowledge/information stored within the neuron matrix enables the brain to deliberately replicate the desired response to a certain stimulus because, during a lifetime of trial and error, the optimal responses to various stimuli have been learnt, remembered (stored) and subsequently retrieved. The most implemented ANN to date with this form of configuration (where the nodes are arranged in layers) is known generically as a Multi-Layer Perceptron (MLP). Here, attempts to train a special type of Artificial Neural Network (ANN), Multi-Layer Perceptron (MLP), to approximate the observed complex multi-variate functional relationship between Global F^* and the 3 key parameters. Such as Aspect Ratio, Sinuosity, Slope.

$$F^* = f(\delta, S_r, S_o)$$

All the parameters were converted into a non-dimensional form so that results from different scale models could be realistically compared. When data is gathered from a set of experiments and analysed, it often exhibits a complex functional relationship between the independent signals (input parameters) and dependent signals (target parameters). The combination of input and target parameters is known as the training pair. The output generated when the input parameters from a training pair are presented to the first ANN configuration chosen by designer. A training algorithm must be used to adjust the weights and biases in the ANN architecture to minimize the error between the output and target values.

DISCUSSION AND RESULT

In this present work, an efficient technique is used for analysis for prediction of Roughness Coefficient for meandering channels. Roughness coefficient means Manning's n varies each depth of flow. It means Manning's n depends on some parameters such as Aspect ratio, Sinuosity, Slope of channel. ANN was applied to predict roughness coefficients in terms of Manning's n . Here the MLP technique was applied for analysis the model where the dependencies of roughness coefficient on different independent parameters are related. At first, the variation of the non-dimensional variables in relation to Manning's n are plotted and the best fit curve are obtained. The functional relationships which are providing the maximum coefficient of determination are fixed for each dependency parameter with Manning's n through the ANN. Independent parameters considered in the present work as Aspect ratio, Slope and Sinuosity. The dependency of roughness and the best functional relationships have been found out from the experimental data sets as well as from the global data sets exist in the literatures. Through ANN validation has been used around 15% of data sets, and then finally test has occurred and gives results which are given in fig 3. And in Fig 4 gives details of ANN Predicted verses with Actual which gives good results. Here Regression Coefficient $R^2 = .87$.

CONCLUSIONS

The following conclusions can be presented in this work

- 1 An experimental investigation has been carried out to measure the velocity at different points of bend apex of a meandering channel for a given discharge to analyse the effect of velocity distribution.





Brijlal Mallik et al.

- 2 From the contour, it is observed that at the bend apex of the meandering channel the velocity distribution variation occurred more at the inner wall and at the outer walls are very less.
- 3 Manning's n is found to be dependent upon many non-dimensional parameters such as Aspect Ratio, Sinuosity, Slope and the experimental Investigation has been carried out to found out it.
- 3 A MLP model is proposed for accurate estimation of Manning's n in meandering channel by taking consideration of experimental data.
- 4 The regression plots for different methods show that the ANN model is fitted with amazing accuracy whereas the coefficient of determination is obtained as 0.87. ANN model holds the Roughness prediction with minimal error i.e. less than 10 %.

ACKNOWLEDGMENT

The authors wish to acknowledge thankfully the support received by the fourth author from DST India, under grant no. SR/S3/MERC/066/2008 for conducting experimental research works.

REFERENCES

1. Walid HS, and Shyam SS, An artificial neural network for non-iterative calculation of the friction factor in pipeline flow. *Comput Electron Agriculture*, 21, pp.219–28, 1998.
2. Bigil A, and Altun H., Investigation of flow resistance in smooth open channels using artificial neural network. *Flow Measurement and Instrumentation*, 19, pp.404-8, 2008.
3. Fadare DA, and OfidheU., Artificial neural network model for prediction of friction factor in pipe flow, *J. Expert Sys. App.*, 36(2), pp.1142-1154. w 2009.
4. Das KM and Kishor N., Adaptive fuzzy model identification to predict the heat transfer coefficient in pool boiling of distilled water., *J applied science research*, 5(6), pp.662-70,2009.
5. Khatua KK, Patra KC, and Mohanty P., Stage-Discharge Prediction for Straight and Smooth Compound Channels with Wide Floodplains *J. Hydr. Engg.*, ASCE, 2011,
6. Shiono, K., Muto, Y., Knight, D.W. & Hyde, A.F.L., "Energy Losses due to Secondary Flow and Turbulence in Meandering Channels with Overbank Flow," *Journal of Hydraulic Research, IAHR*, vol. 37, no. 5, pp. 641-664, 1999.
7. Khatua K.K., Patra K.C., Nayak P., "Meandering effect for evaluation of roughness coefficients in open channel flow," *Sixth International Conf. on River Basin Management, WIT Transactions on Ecology and the Environment*, ISSN 1743-3541, CMEM, WIT Press., 146(6):213-227, 2012.
8. Cowan W. L., Estimating Hydraulic roughness Coefficients, *Agric. Engrg*, 37, 473-475, 1956.
9. Ikeda S., Parker G. and Kimura Y., Stable Width and Depth of Straight Gravel Rivers With heterogeneous Bed Materials, *Water Resources Research*, Vol. 24, No. 5, pp. 713-722, May, 1988.
10. Mohanty, P.K., Dash, S.S. and Khatua, K.K., Flow Investigations in a Wide Meandering Compound Channel. *International Journal of Hydraulic Engineering*, 1(6) 83-94, 2012.
11. Patra, K.C., Kar, S. K. and Bhattacharya A. K., Flow and Velocity Distribution in Meandering Compound Channels, *Jour. of Hydraulic Engg.*, ASCE, 130 (5), 398, 2004.
12. Patra, K.C., and Khatua, K. K., Energy loss and discharge estimation in two stage meandering and straight compound channel, *EWRI of ASCE and IIT Kanpur*, 2006,
13. Saine S. Dash, K.K.Khatua, P.K.Mohanty, Energy loss for a highly Meandering open Channel Flow Res. *J. Engineering Sci.*, Vol. 2(4), 22-27, April-2013.
14. Saine S. Dash, K.K.Khatua, P.K.Mohanty, "Factors influencing the prediction of resistance in a meandering channel," *International Journal of Scientific & Engineering Research*, Volume 4, Issue 5, May-2013.
15. Toebes G. H., Sooky A. A., Hydraulics of Meandering Rivers with Floodplains, *Journal of Waterways and Harbours Div.*, ASCE, Vol. 93, 1967.





Brijlal Mallik et al.



Fig. 1 Photograph of the Experimental Channel

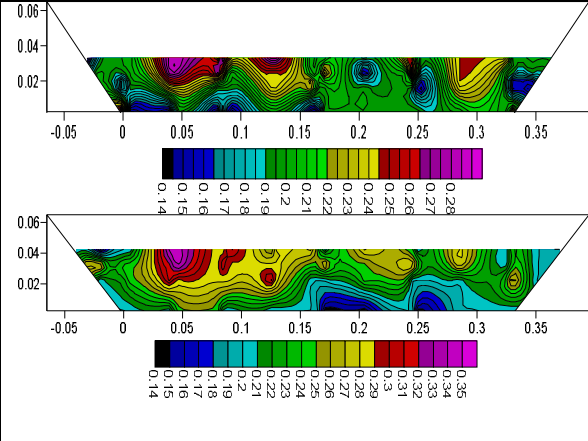


Fig. 2 longitudinal Velocity Distribution of Meandering Channels

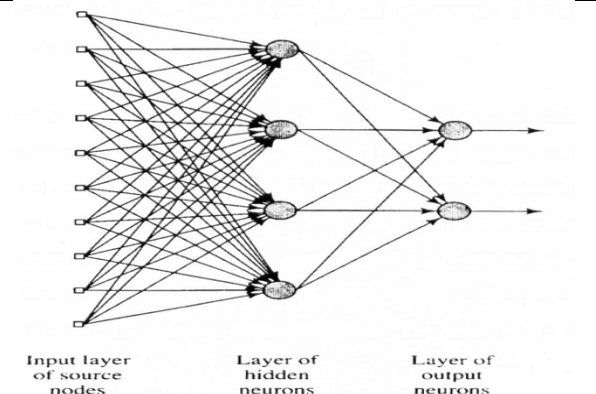


Fig.3 Multi-Layer Perception

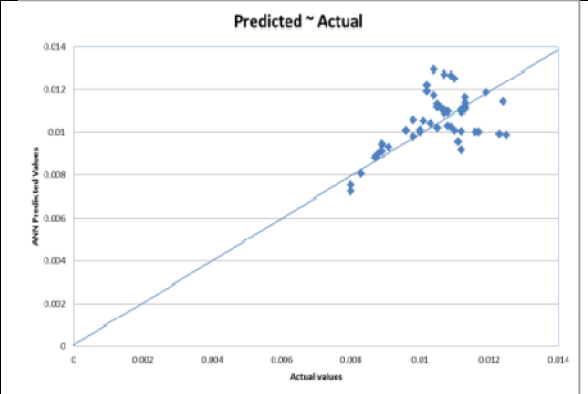


Fig 4 Correlation plot of ANN predicted values vs. Actual Values of Manning's n

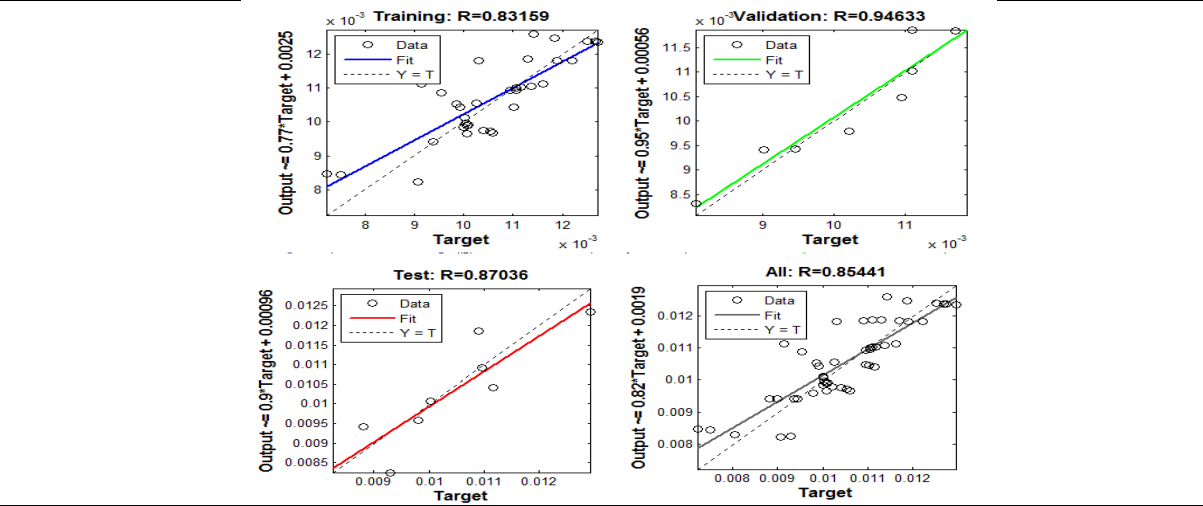


Fig: 3 Correlation plot of Actual vs. Output predicted Manning's n using the MLP: (a) training data (b) validation data (c) test data (d) all data sets





Analyzing the Quadcopter Drone using 3D Experience

Sujit Mishra¹, Rashmita Swain², Rohit Kumar Senapati², Ashok Mishra² and Mukundjee Pandey^{1*}

¹Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India.

²School of Applied Science, Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Mukundjee Pandey

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: mukundjee.pandey@cutm.ac.in]



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A quadcopter, sometimes known as a quadrotor, is a four-rotor aircraft. Although quads helicopters and convertiplanes have been flown experimentally for many years, the configuration remained a mystery until the emergence of the contemporary UAV or drone. In general, quadcopters feature two rotors spinning clockwise (CW) and two counterclockwise (CCW). The remote controller can control these. These drones' applications are not restricted to the military realm; rather, they serve a large section of the economy with improved mechanisms and outstanding capabilities. In this study article, we will provide detailed information on evaluating the quadcopter drone utilising CFD methodologies and the 3D EXPERIENCE PLATFORM, where we completed our simulation.

Keywords: Analysis of the quadcopter drone, Drag force vs Lift force, velocity distribution

INTRODUCTION

The performance of drones is based on the results of structural and CFD analysis of commercial tools [1]. Structural simulations are performed to check whether the model is rigid enough or not to bear the fluctuating loads [2]. Also, the dynamic analysis of drones is important and can lead to its stability [3]. Thrust produced by each propeller is important to determine the overall lift force developed by the drone [4]. The vibration analysis of drone is also very important to check its stability [5]. CFD commercial tools were used to determine the aerodynamics of flow patterns around the drone [6]. In order to determine the feasibility of the drones, the CFD and structural simulations were performed [7,8]. Structural analysis can be performed to know the total deformation of the structures under various loads [9]. But the drone can withstand small deformations without violating any safety limit [10].



**Sujit Mishra et al.**

METHODOLOGY

Here, it has been chosen 3D EXPERIENCE platform for our simulation according to our compatibility. This platform makes it easier and helps us to complete the simulation in a better way. The simulation is carried out using Fluid Scenario Creation App. First, the quadcopter model from the GRABCAD is imported. Then we have to click on the V+R in the compass which appears on the top left corner and checked into Fluid Scenario Creation app. Now a new tab will be created. The name will appear just after the 3D EXPERIENCE name on the screen. From the assistant it has been chosen MODEL to create a finite element model. Then FLUID DOMAIN from the command section has been selected. From the command section select FLUID SECTION and in editor choose air as material. Then PHYSICS behavior from the assistant and from command section choose PHYSICS BEHAVIOUR, in the editor choose SST K-omega as turbulence model and toggle on the temperature effects to get the plot of temperature. Steady state step from command section is chosen with 2000 as maximum iteration.

RESULT AND DISCUSSION

The simulation of the quadcopter drone has been carried out with 50 number of cases in forward direction with the value of velocities varying by 2m/s between subsequent values are provided. The temperature given is constant i.e 300 K. In this paper the snapshots of contour plots of velocity, pressure, temperature contour plots and the streamlines are shown. Fig. 1 represents the velocity contour plot of the quadcopter drone moving in forward direction and the velocity varies from 0m/s to 2.55 m/s. the velocity is maximum at the top. Fig. 2 represents the velocity vector contour plot of the quadcopter drone moving in forward direction and the velocity varies from 0m/s to 2.69m/s. Fig. 3 represents the gauge pressure contour plot of the quadcopter drone moving in forward direction and the pressure varies from -2.43m/s to 1.23m/s. From Fig. 4 it can be seen that the drag force also increases with increase in the inlet velocity of the drone. From Fig. 5 it can be seen that the mean velocity also increases with increase in the inlet velocity of the drone. From the Fig. 6 it can be seen that the mean gauge pressure decreases with increase in the inlet velocity of the drone. From the Fig. 7 it can see that the lift force increases with increase in the inlet velocity of the drone. From the Fig. 8 it can be seen that the absolute pressure slightly decreases with increase in the inlet velocity of the drone.

CONCLUSION

The aerodynamics of quadcopter plays an important role in the performance evaluation of it in terms of lift and drag. Also, velocity and pressure profiles help in the determination of aerodynamics of the quadcopter.

REFERENCES

1. Mahen *et al.* (2014). Design And Development Of Amphibious Quadcopter. *International Journal of Mechanical And Production Engineering*,2, 30-34.
2. Al-zoghyet *al.* (2019).CFD Analysis of Quadcopter. The 4th International under-Graduate Research Conference, IUGRC 2019,1-4.
3. Thomas *et al.* (2016). Design And Analysis Of A Quadcopter Using Catia. *International Journal of Scientific & Engineering Research*,7,140-156.
4. Kuantama *et al.* (2016). Quadcopter Body Frame Model And Analysis *Annals Of The University Of Oradea,Fascicle of Management and Technological Engineering*,1,71-74.
5. Bhandariet *al.* (2019). Design and Vibration Characteristics Analysis of Quadcopter Body Frame. *International Journal of Applied Engineering Research*,14,66-70.
6. Ahmad *et al.* (2020). Flow And Structural Analysis Of A Quadcopter Uav. *International Journal of Advanced Research in Engineering and Technology*,11,880-888.





Sujit Mishra et al.

7. Pathak *et al.* (2017). Computational Fluid Dynamics And Structural Analysis Of Quadcopter Frame Ss-1and Comparison With X-Frame. International Journal of Research in Engineering and Technology,6,52-58.
8. Yemle *et al.* (2019). Design & Analysis of Multi-Frame for Octo & Quad Copter Drones. International Research Journal of Engineering and Technology,6,2935-2939.
9. Javir *et al.* (2015). Design, Analysis And Fabrication Of Quadcopter. Journal of Advance Research in Mechanical and Civil Engineering,2,15-23.
10. Ahmad *et al.* (2020). Modeling and Analysis of Quadcopter F450 Frame. International Conference on Contemporary Computing and Applications (IC3A),1-6.

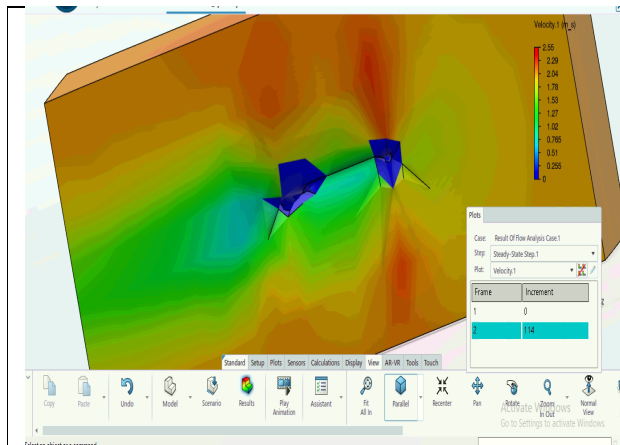


Fig. 1 Velocity contour of quadcopter

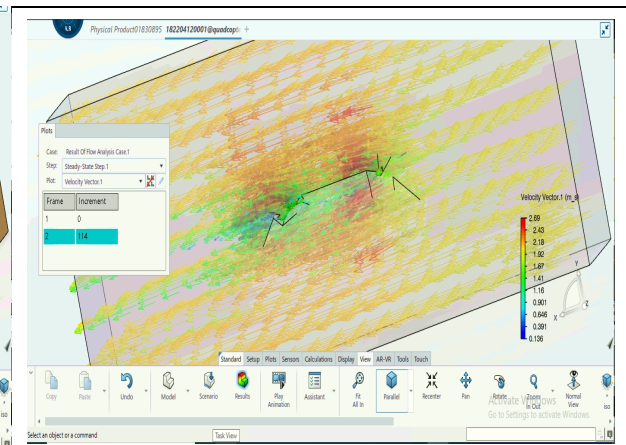


Fig. 2 Velocity vector of quadcopter

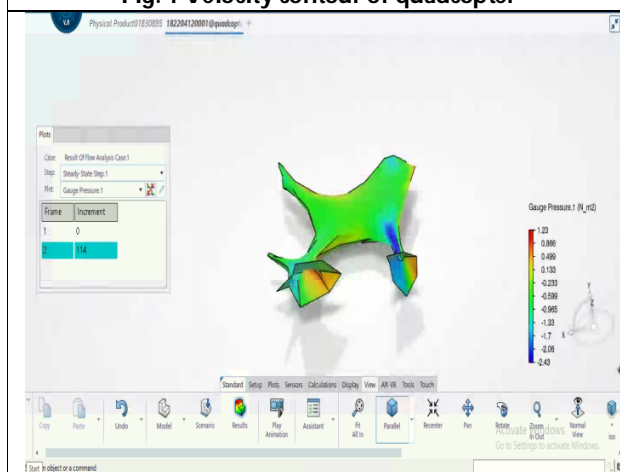


Fig. 3 Gauge pressure of quadcopter

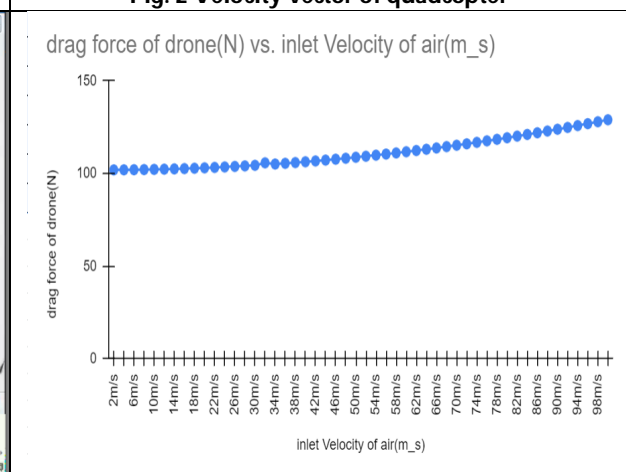


Fig. 4 Drag force vs velocity of air





Sujit Mishra et al.

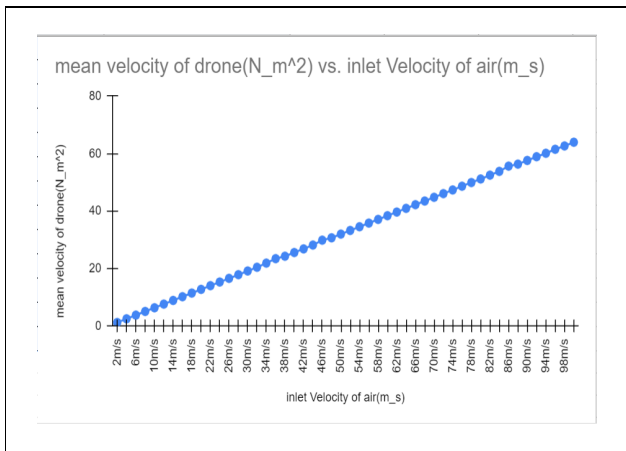


Fig. 5 Mean velocity vs velocity of air

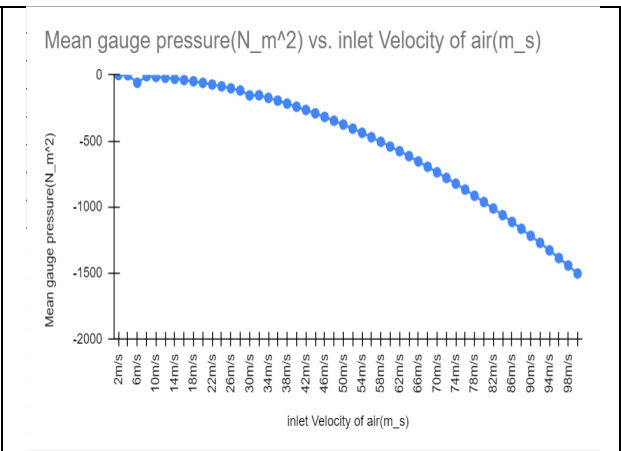


Fig. 6 Mean gauge pressure vs velocity of air

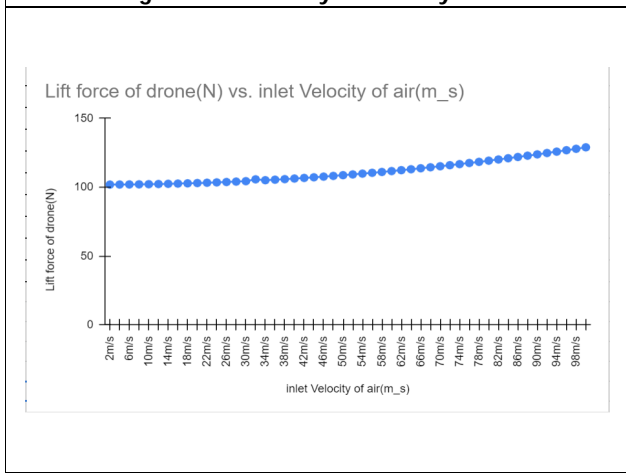


Fig. 7 Mean gauge pressure vs velocity of air

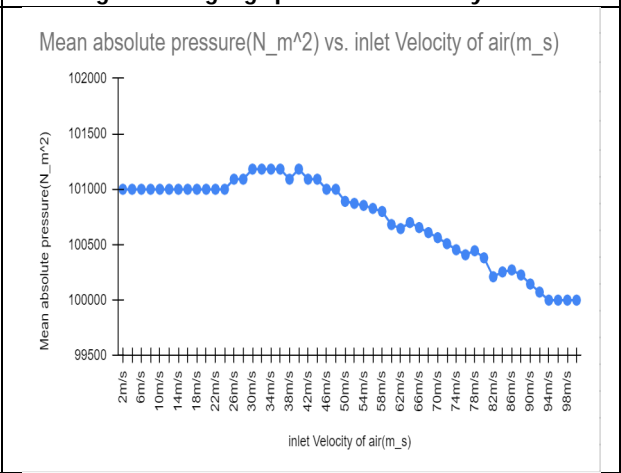


Fig. 8 Mean absolute pressure vs velocity of air





Performance Testing of a Solar Box Type Cooker

Debashree Debadatta Behera*

Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Debashree Debadatta Behera¹
Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Generally in Rural area, people cook foods by using conventional methods such as Chulha which produces lots of smoke. This results respiratory problem. The present research objective is to develop a solar operated box type of solar cooker as an alternative and cleaned energy solution for rural area. The main component of this cooker is a folding type reflector made up of Aluminium (highly glazing material) which transmits all radiation and focus into the cooking chamber. There were six numbers of reflector integrated and focuses incident radiation individually to one point so that heating effect was increased. It is light weight and can be easily handled. The maximum temperature found as 1000C and cooking power and standard cooking power were calculated as 17.5 W and 17.09W respectively which are sufficient enough for cooking.

Keywords: Sustainable, Reflector, cooking device, cooking power, glazing material

INTRODUCTION

Due to increasing population, better living standard, growth of urbanization, the global energy demand is increasing. At the present situation, due to less reservation of fossil fuel as per environment concern, the renewable energy is made for substantial contribution to the future domestic and industrial economies. Due to unavailability of electricity and conventional cook stoves (which causes health problem), the present research aims for alternative cleaned technology in rural development. S. Geddam *et al.* [1] designed a box type of solar cooker in which he had taken some design parameter, optical efficiency and heat capacity. By taking characteristic graphs he had compared with predicted values and compared values. By using finned type cooking vessel, the time has been reduced. J. Folaranmi *et al.* [2] designed a double glazed type solar with proper dimension. The standard cooking power also estimated. Z. Ademe *et al.* [3] designed a box type cooker with glazing wiper mechanism. He had calculated standard cooking power and cumulative efficiency. The simulation was done to calculate inner wall temperature distribution.





Debashree Debadatta Behera

G.Palanikumar *et al.* [4] designed a natural box type cooker with fuzzy technique. The overall efficiency was found 15.4%. M.Balakrishnan *et al.* [5] had designed a solar cooker which is parabolic type used for generate steam. H. Terres *et al.* [6] had developed a cooker with internal reflector. A temperature sensor and solar meter were used to measure temperature and solar radiation data. L.B. Sosa *et al* [7] presented a project of rural solar cookers which was an initiative for reducing the consumption of timber fuels as well as reducing respiratory disease.

Experimental Set Up

The figure 1 shows the experimental set up of solar cooker which consists of folding type of reflector, transparent or cover plate and absorbing plate. There were six numbers of reflectors made up of Aluminium materials (glazing type, 3 mm thickness) integrated with each other and fixed on the top of the cooker. The main reason of taking number of reflectors in order to achieve as much as incident radiation to focus on one point. The transparent plate made up of tempered glass was used to transmit the all the incident radiation to absorbing plate. The interior area of the cooker was black painted as well as absorbing plate in order to absorb maximum radiation convert into heat. The box was made slope with and angle of 20° and was faced towards south direction. At the bottom of cooker glass wool having 1 inch was provided for reducing heat loss and acting as an insulator. The cooker had bottom dimension of 16 Inch×16 Inch, front dimension 16×8.5 Inches, back dimensions 16× 12.5 Inches, glass dimensions 16×16 Inches, dimension of reflector was 17.5 ×19.75 Inches.

RESULT AND DISCUSSION

The performance of solar cooker can be tested by placing it in open area where maximum solar radiation was available and without shadow effect. The cooker was faced due south throughout the day. With in regular interval of time the temperature was measured with the help of temperature sensor which was fixed within the cooker. At the same time solar radiation was measured with the help of Lux meter. For testing purpose the water was taken. The cooking power can be calculated by using the formula= $M_{\text{water}} \times C_{\text{water}} \times (T_2 - T_1) / \text{time interval taken}$

Given $C_{\text{water}} = 4.2 \text{ J/g}^\circ\text{C}$ or 4179.6 J/KgK

Putting $T_2 = 100^\circ\text{C}$ and $T_1 = 95^\circ\text{C}$, $M_{\text{water}} = 1 \text{ Litre}$,

Cooking power was calculated as 17.5 W

Similarly standard cooking power was calculated as by multiplying standard intensity of solar light = 700 W/m^2

$[M_{\text{water}} \times C_{\text{water}} \times (T_2 - T_1) \times 700 \text{ W/m}^2] / \text{time interval taken} \times g$, where $g = 9.8 \text{ m/s}^2$

Standard cooking power found = 17.09 W

CONCLUSION

The present experimental investigation is to use the box type solar cooker, an alternative solution for conventional method of cooking. The cooker is light weight and easily handled and it has one folding type reflector. In the experimental study the highest temperature found 100°C which is sufficient enough for boiling water or cooking food. The design of cooker can be modified by using of two numbers of cover plates in order to increase efficiency for future scope. And it can be used in night purpose by implementing storage devices.

REFERENCES

1. Sunil Geddami, G. Kumaravel Dinesh, Thirugnanasambandam Sivasankar, "Determination of thermal performance of a box type solar cooker", *Solar Energy*, vol. 113, (2015), pp.324–331.
2. Joshua Folaranmi, "Performance Evaluation of a Double-Glazed Box-Type Solar Oven with Reflector", *Journal of Renewable Energy*, 2013, pp.1-8.
3. Zeleke Ademe and Sameer Hameer, "Design, construction and performance evaluation of a Box type solar cooker with a glazing wiper mechanism", *AIMS Energy*, vol.6, (2018), pp.146-169.





Debashree Debadatta Behera

4. G. Palanikumar, S. Shanmugan, ChithambaramVengatesanand Periyasami Selvaraju, "Evaluation of fuzzy inference in box type solar cooking food image of thermal effect", Environmental and Sustainability Indicators, vol.1-2, (2019),pp.1-10.
5. M. Balakrishnan, A. Claude and D. R. Arun Kumar, "Engineering, design and fabrication of a solar cooker with parabolic concentrator for heating, drying and cooking purposes", Archives of Applied Science Research, vol.4,(2012), pp. 1636-1649.
6. HilarioTerres, Arturo Lizardi, RaymundoLópez, Mabel Vaca and Sandra Chávez, "Mathematical Model to Study Solar Cookers Box-Type with Internal Reflectors", Energy Procedia,vol.57(2014), pp. 1583 – 1592.
7. Luis Bernardo LópezSosaa, Mauricio González Avilésa, Dante González Péreza and YuritzSolísGutiérreza, "Rural Solar Cookers, an alternative to reduce the timber resource extraction through the use of renewable energy sources: technology transfer and monitoring project", Energy Procedia, vol. 57 (2014) 1593 – 1602

The Table 1 Represents The Testing Data Of Cooker In A Sunny Day.

| Si no | Timing (AM/PM) | Temperature in 0c | Intensity of solar radiation in LUX |
|-------|----------------|-------------------|-------------------------------------|
| 1 | 09:30AM | 85 | 71400 |
| 2 | 10:40 AM | 90 | 71900 |
| 3 | 11:00 AM | 95 | 72500 |
| 4 | 12:20PM | 100 | 80900 |
| 5 | 1:00 PM | 100 | 73600 |
| 6 | 2:20 PM | 60 | 53600 |
| 7 | 3:30 PM | 50 | 12300 |
| 8 | 4:00 PM | 50 | 12000 |

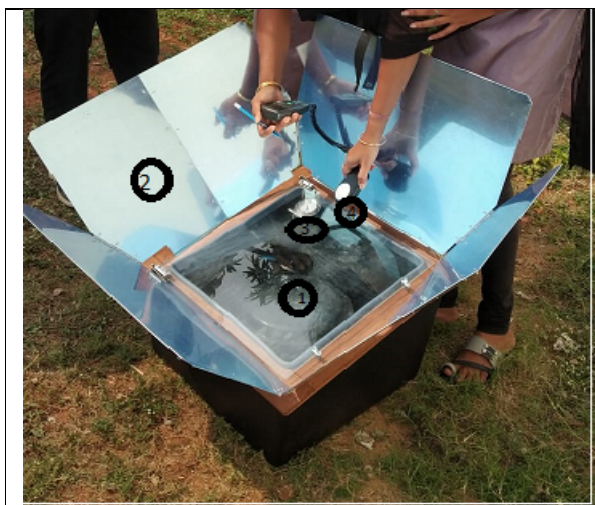


Figure 1. Experimental st up of Solar box type of cooke. (1). Transparent or cover plate, (2) Reflector(4 numbers), (3).Temperature sensor, (4) Lux meter.



Figure 2 . The interior part of the cooking chamber painted black.





Fragility Analysis of Regular and Irregular Steel Frame Buildings by Probabilistic Seismic Analysis

Bhagyashree Jena, Punendu Gajendra Mohapatra, Deepak Kumar Sahu*, Bibhuti Bhusan Mukharjee

M. Tech graduate, BPUT, Rourkela, Odisha

M. Tech graduate, BPUT, Rourkela, Odisha

Asst. Prof., Department of Civil Engineering, Centurion University Of Technology and Management, Odisha, India

Ph.D., BPUT, Rourkela, Odisha

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Deepak Kumar Sahu

Asst. Professor,

Department of Civil Engineering,

Centurion University of Technology and Management,

Odisha, India

Email: deepaksahu3269@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The seismic exposition of structures with irregular mass, stiffness and strength along the height might be altogether un-equal in relation to that of regular structures. Configuration codes of OpenSees programming restrict development seismic design of such structures depend upon the degree of irregularity and site hazard. The sufficiency of fundamental mode properties for the evaluation of vertical irregularity is investigated here. Further, this inspection is useful to check the relationship among regular and vertical irregularity pointers and the seismic danger. Seismic risks of chosen vertical irregular structures in terms of fragility curve and drift are introduced.

Keywords: OpenSees, vertical irregularity, fundamental mode properties, seismic response.

INTRODUCTION

It is a very big challenge in today's plot to construct quaky resistant building. Unreliability elaborated and behavioural learning plays an essential role for all civil engineering structures. Present-time establishment dictate the designer to organize the structures which are asymmetrical in scheme and altitude. The structural engineer faces many challenges while constructing such non-uniform buildings are deposited in lofty quivering region. To determine the internal forces, stresses and deformations of the structural system by applying various loads the physical laws can be applied and mathematical equations to predict its responses and behaviours by the help of



**Bhagyashree Jena et al.**

structural analysis process. Earth tremor are the most uncertain and destructive hazard among all familiar tragedy, which are very tough to rescue over engineering belongings and existence, against it. The seismic presentation of the constructed territory has been carried out through the growth of numerous systematic plans of action to overcome these issues. Arrangement is extremely much principal for quality seismic production of the building. Due to lack of knowledge and poor configuration wide varieties of damages was noticed during past earthquakes across the world. By the help of latest software aid, models can be studied having regular and irregular structure under the result of earthquake filling. The effects of earthquake in regular and irregular bare frame of steel buildings have been examined by using the Finite Element Analysis software such as OpenSees and SAP2000. Steel composition building is a kind of fabrication assemble from concoct ingot, essentially steel for twain its interior maintenance and its outermost substance. Steel framework is handed-down for the parallel beams and the perpendicular pillars and they are pivoted jointly through a welding operation or strong bolts and rivets. In bare frame design neglecting the masonry loads. Bare frame allows more flexibility and power compare to the open one storey, because in open one story there is no infill at ground floor.

At the design stage, the prediction of responses of steel bare frame with certainty is tough to predict because of its non-linearity and uncertainty associated with the input parameters. Further, fragility analysis can be useful in determination of performance of the structure which has been significantly influenced by structural properties and loading conditions. In the current investigation, fragility analysis has been performed for the steel bare frame using OpenSees software to access various structural random variables. Moreover, the impact on the structural response of a building with alternation of the selected variables can be found out based on Tornado Diagram Analysis method. Further, the influence of probability of exceedance of damage for the selected frames is presented in this study.

LITERATURE REVIEW

A detailed review of existing studies has been carried out to comprehend the subject and to identify the current status of the exploration in this area. Review of literature related to current investigation has been presented as follows to access the major outcomes in this area. Kenna (1997) executed the packed pliancy component in the OpenSees computational structure. A crack guideline was consolidated in the adjusted Ibarra-Krawinkler crumbling model permitted demonstrating of solidarity and solidity disintegration and break prompting the total cutting off a steel pillar to-segment association because of cyclic stacking. Mazzoni *et al.* (2006) built up a phenomenological model of top-and-situated point post-tensioned associations were created in OpenSees and along these lines checked utilizing earlier investigations. A model structure, which hadself-centering moment resisting frames as its horizontal power opposing framework, was chosen. Utilizing the presented phenomenological representation of the post tension association, a 2D model for the self centering- moment resisting frame was developed. Ghosh (2008) detailed that park-Ang harm list was viewed as perhaps the most practical proportions of primary damage. One of strategy to break down the level of harm got by structure is known as harm list. Damage list was examined and acquainted as a device with measure the harm on the structure that tormented by quake and communicated in explicit scale. Bojorquez *et al.* (2010) presented a power damage record for numerous- level of opportunity steel structures. Their replica was created by supplementing the outcomes got by test and logical examination on steel outline components in regard to the dispersion of plastic request on a few steel outlines. Chung *et al.* (2010) expressed the ground movements in general resound elevated structures whose basic normal periods are over 2s. This perception was affirmed by ongoing full-scale shake table tests that addressed regular skyscraper development in Japan. Earlier mathematical investigations on skyscraper steel structures exposed to extensive stretch long term ground movements likewise affirmed that the common time spans were over 2s. Tarta and Pintea (2012) revealed the nonlinear static system which had become a significant instrument to describe the seismic interest and the presentation of designs. The investigations had been led on a progression of second opposing steel outlines with firmness abnormalities, with various number of stories, planned by EC8(Euro Code) and the Romanian Seismic Design Code for Romania's Vrancea Seismic Area. Jonathan *et al.* (2020) assessed damage list was conversely relative to regular recurrence as the energy expanded. The basic furthest reaches of each of the three diverse storey





Bhagyashree Jena et al.

unconventionally propped outline building happened towards the finish of the patterns of semi-cyclic push over examination. Shah *et al.* (2020) expressed calamity alleviation of the nation required the information of delicacy bends for different run of the mill structures. The selectively seismic interest models for ordinary solidness and mass upright unpredictable structures were created. Steel outlined structures with deck storey open were discovered to be the perpendicular sporadic structure which was the most helpless out of the relative multitude of those vertical structures.

METHODOLOGY

In the current research work, bare frame 4s2b, 6s2b, 8s4b, 10s4b, 12s4b both regular and irregular adopted for fragility analyses, are designed in accordance to zone V with peak ground acceleration of 0.36g as per Bauru of Indian Standards (IS 1893) for medium soil conditions having N- value lies between 10 to 30. Table 1 represents the other detailed parameters considered in designing of the frames. Figure 1(a) to 5(e) represents all the regular and irregular selected steel frames buildings. The characteristic strength of steel, the elastic modulus of steel, length of the column and damping ratio were taken as 393 MPa, 2.1×10^8 kN/m², 3.2 m, and 0.2 m respectively. The current research is related analysis of steel multi-storey framed buildings having both regular and irregular in plan. All the designated building frames have varying bays with uniform bay width 5.2 m and storey height 3.2 m. The dead load was taken as 3.75 kN/m² and live load is 3 kN/ m². Various types of uncertainties associated with material properties of steel are considered. Further, one more source of uncertainty related to the damping is vital in design as it can affect the dynamic response of buildings. Incorporation of the uncertainties associated with potential material and modeling parameters is highly desired in the computational model to provide a naturalistic representation of the responses in a probabilistic judgment. The yield strength of steel, elastic modulus of steel, damping ratio and column length selected as random variables for performing fragility analysis are given in Table 2. Fragility analyses are performed for bare regular and irregular frame by the help of OpenSees software. Further, the random variables are chosen for analysis of the variation in response of a building.

PSDM and Fragility Analysis

The current study adopts as accepted probability-based approach and fragility curves are used to represent the seismic risks. The development of Probabilistic seismic demand models is a very much essential step which is further used to establish the fragility curve of the buildings which is taken for the analysis. The relationship between intensity measure (spectral acceleration) and the engineering demand parameter (displacement) is known to be probabilistic seismic demand model. Moreover, it indicates the probability of certain level of demand for a given intensity measure level. The intensity measure are the values ranging from zero to one in a linear regression value. Probabilistic seismic demand models are created utilizing power-law relapse examination which is appeared below. All the probabilistic seismic demand model graphs are plotted for both regular and irregular steel frames by using the exponential equation i.e.,

$$y = ax^b \quad (1)$$

The value of R^2 , a and b have been deployed from the probabilistic seismic demand models. The values of a and b which have been derived from the models are used to determine the fragility curve of the buildings. The value of R^2 replicates the accuracy of the building's design. The fragility function indicates the probability of exceedance of a chosen engineering demand parameter (EDP) at structural limit state (LS) for a particular ground motion intensity measure (IM). The fragility curves represent the cumulative probability distribution that indicates the probability that a component or system will be damaged to a given damage state or a more severe one, as a function of a particular intensity measure. The SAC- FEMA is a simplified method for the calculation of seismic risk which has been introduced by Cornell *et al.* (2002), is adopted the current investigation for the fragility evaluation. The seismic fragility $F_R(x)$ can be represented in closed form equation.





Bhagyashree Jena et al.

$$P(DS|IM) = \Phi \left(\frac{\ln IM - \ln IM_m}{\beta_{comp}} \right) \quad (2)$$

Where $(\ln IM - \ln IM_m)$ is $(\ln S_D/S_C)$, D is the drift demand, S is the drift capacity, S_D and S_C are the median demand and capacity at the chosen limit state (LS), respectively.

$$\beta_{comp} = \frac{\sqrt{\beta_{d\backslash IM}^2 + \beta_c^2}}{b} \quad (2)$$

The dispersion, $\beta_{d\backslash IM}$ of inter- storey drifts (d_i) from the time history analysis can be calculated as,

Where $a(IM)^b$ represents the mean inter- storey drift and “ N ” is the no. of building models. Dispersion in limit state capacities recommended by different standards and literatures are not in agreement.

$$\beta_{D/IM} = \frac{\sqrt{\sum (\ln(d_i) - \ln(aIM^b))}}{N-2} \quad (3)$$

RESULTS

Fragility analysis

Fragility Curves for $4s2b$, $6s2b$, $8s4b$, $10s4b$ and $12s4b$ are plotted separately for both regular and irregular steel frames for three performance levels (Intermediate Occurrence(IO), Life Safety(LS) and Collapse Prevention(CP)) as shown in figure 6 a to figure 10 c. From the above figures for fragility curves, it can be clearly classified that with increase in PGA in the X- axis, there is also an increase in the P (EDP/PGA) but it can't be determined that they are directly proportional to each other. In $4s2b$ regular vs. irregular bare framed buildings it can be clearly classified that the fragility curve of IBD 's are below the RB 's. In this case it can be considered that the irregular buildings are safer than regular buildings. For $6s2b$ bare framed buildings it can be classified that the fragility curve of regular buildings lies in between the irregular bare framed buildings design i.e., $6s2bIBD2$ is safer as compared to regular buildings but $6s2bIBD1$ is less safe as compared to $6s2b RB$. For $8s4b$ bare framed buildings, it can be observed that the fragility curve of $8s4bIBD3$ lies below the $8s4b$ regular building and the rest models of irregular buildings lies above the regular buildings. This means the $IBD3$ of $8s4b$ is safer than $8s4bRB$ and rest IBD 's are unsafe. In $10s4b$ and $12s4b$ it can be classified that the fragility curve of $10s4b$ and $12s4bIBD$ s lies above the RB 's means all the models of IBD 's are unsafe than the RB 's.

Comparison of Storey vs. Displacement

Storey Drift is defined as the lateral displacement of one level relative to the level above or below. The purpose for this is to find out the result drift per floor. In the present study, x axis represents the maximum drift. and y axis represents the number of floors for a single storey building. Figure 12 and Figure 13 describes about the drift storey ratio for bare framed regular buildings and bare framed irregular buildings respectively. From the respective figures, with every increase in storey for both regular bare framed buildings and irregular bare framed buildings, the drift ratio increases for every rise of floors and with increase in number of storeys the graphs gradually increase. The main motive to do this is to describe about the displacement of each floor for each storey of buildings.

CONCLUSIONS

From the present study, it can be concluded that there is a difference between regular bare framed buildings and irregular bare framed buildings. In some cases, the irregular steel bare framed buildings are safer as compared to regular steel bare framed buildings but some buildings did not meet the expectations. From the following fragility





Bhagyashree Jena et al.

curves $4s2b$ IBD1 is 10-12% safe as compared to $4s2b$ IBD2 and $4s2b$ IBD2 is 13-15% safe as compared to $4s2b$ RB buildings. $6s2b$ IBD1 is 16-19% safe as compared to $6s2b$ RB and $6s2b$ RB is 11-13% safer than $6s2b$ IBD2 buildings. $8s4b$ RB is 4-6% safe as compared to $8s4b$ IBD3, $8s4b$ IBD3 is 2-4% safer than $8s4b$ IBD4 buildings, $8s4b$ IBD4 is 14-17% safe as compared to $8s4b$ IBD2 buildings and $8s4b$ IBD2 is 6-9% safer than $8s4b$ IBD1 buildings. $10s4b$ RB is 8-10% safe as compared to $10s4b$ IBD3, $10s4b$ IBD3 is 3-4% safer than $10s4b$ IBD4 buildings, $10s4b$ IBD4 is 2-3% safer than $10s4b$ IBD1 buildings and $10s4b$ IBD1 is 8-11% safe as compared to $10s4b$ IBD2 buildings. $12s4b$ RB is 9-11% safe as compared to $12s4b$ IBD1, $12s4b$ IBD1 is 4-5% safer than $12s4b$ IBD4 buildings, $12s4b$ IBD4 is 13-14% safer than $12s4b$ IBD3 buildings and $12s4b$ IBD3 is 14-17% safe as compared to $12s4b$ IBD2 buildings. Comparing the graphical images of storey drift ratio between regular and irregular steel frame buildings, the maximum displacement for IBD is 10-15% less as compared to RB. Therefore, IBD can also be designed using steel framed buildings with more mathematical approach and proper calculations. However, maximum building can't be proven safe, but with more mathematical calculation, it can be possible to attain more stability but it does not mean that irregular buildings are unsafe. From the graphs, it can be concluded that though they are not as safe as regular but these irregular buildings are almost safe as the regular buildings.

REFERENCES

1. Bojórquez, E., Reyes-Salazar, A., Terán-Gilmore, A., & Ruiz, S. E. (2010). Energy-based damage index for steel structures. *Steel and Composite Structures*, 10(4), 331-348.
2. Celarec, D., & Dolšek, M. (2013). The impact of modelling uncertainties on the seismic performance assessment of reinforced concrete frame buildings. *Engineering Structures*, 52, 340-354.
3. Chung, A., Kaiser, A., Christensen, C. M., Allen, R., Lawrence, J. F., Cochran, E. S., & Taufer, M. (2014). Rapid earthquake characterization using MEMS accelerometers and volunteer hosts following the M 7.2 Darfield, New Zealand, earthquake. *Bulletin of the Seismological Society of America*, 104(1), 184-192.
4. FEMA 356. Pre-standard and commentary for the seismic rehabilitation of buildings, American Society of Civil Engineers, USA, 2000.
5. FEMA P695. Quantification of Building Seismic Performance Factors, prepared by the Applied Technology Council, Redwood City, California for the Federal Emergency Management Agency, Washington, D.C, 2012.
6. Ghosh, S., Ghosh, S., & Chakraborty, S. (2021). Seismic fragility analysis in the probabilistic performance-based earthquake engineering framework: an overview. *International Journal of Advances in Engineering Sciences and Applied Mathematics*, 13(1), 122-135.
7. HARAN, P. D., Davis, R., & Sarkar, P. (2015). Reliability evaluation of RC frame by two major fragility analysis methods. *phd dissertation*.
8. Haselton, C. B., Whittaker, A. S., Hortacsu, A., Baker, J. W., Bray, J., & Grant, D. N. (2012). Selecting and scaling earthquake ground motions for performing response-history analyses. *In Proceedings of the 15th world conference on earthquake engineering* (4207-4217).
9. IS 1893 Part I. (2002) Indian standard criteria for earthquake resistant design of structures, Bureau of Indian Standards, New Delhi.
10. Jonathan, V., Orientilize, M., & Sentosa, B. O. B. (2020). Numerical study of damage index of 2d steel building with eccentrically braced frame using OPENSEES. *In IOP Conference Series: Materials Science and Engineering* 801(1), 012022.
11. Kenna, Mackie, & Stojadinović, B. (1997). Probabilistic seismic demand model for California highway bridges. *Journal of Bridge Engineering*, 6(6), 468-481.
12. Mander, J. B., Priestley, M. J., & Park, R. (1988). Theoretical stress-strain model for confined concrete. *Journal of structural engineering*, 114(8), 1804-1826.
13. MatLAB. MatLab-Programming software for all kind of problems [online]. < [http:// www.mathworks.com/](http://www.mathworks.com/)>, 2012.
14. Mazzoni, S., McKenna, F., Scott, M. H., & Fenves, G. L. (2006). OpenSees command language manual. *Pacific Earthquake Engineering Research (PEER) Center*, 264, 137-158.





Bhagyashree Jena et al.

15. Shah, F., Khan, M. A., Akhtar, K., Ahmad, N., & Khattak, N. (2020). Vibration analysis of damaged and undamaged steel structure systems: cantilever column and frame. *Earthquake engineering and engineering vibration*, 19(3), 725-737.
16. Tarta, G., & Pintea, A. (2012). Seismic evaluation of multi-storey moment-resisting steel frames with stiffness irregularities using standard and advanced pushover methods. *Procedia Engineering*, 40, 445-450.

Table 1Details of members used

| Members | Configuration used for 4s2b | Configuration used for 6s2b | Configuration used for 8s4b | Configuration used for 10s4b | Configuration used for 12s4b |
|--------------------------|-----------------------------|-----------------------------|--------------------------------|---------------------------------|--------------------------------|
| Beam Size | W12 x 45 | W12 x 45, W16 x 40 | W12 x 26, W14 x 30 | W12 x 26, W14 x 30 | W12 x 26 |
| Column Size | W14 x 500 | W14 x 90, W14 x 605 | W14 x 61, W14 x 311, W14 x 730 | W14 x 193, W14 x 455, W14 x 730 | W10 x 45, W14 x 211, W14 x 730 |
| No of Storey | 4 | 6 | 8 | 10 | 12 |
| No of Bay | 2 | 2 | 4 | 4 | 4 |
| Bay Width(in meter) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| Storey Height (in meter) | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 |

Table 2Details of random variables considered in the seismic risk assessment

| Variables | Symbols | Mean | Cov% | Distribution | Source |
|--------------------------|-----------|-------------------------------------|------|--------------|----------------------------------|
| Yield strength of steel | F_y | 393 MPa | 12 | Lognormal | Seo <i>et al.</i> (2012) |
| Elastic Modulus of steel | E_s | 2.1×10^8 kN/m ² | 5 | Lognormal | Mitropoulou <i>et al.</i> (2011) |
| Length of column | L_{col} | 3.2 m. | 8 | Lognormal | Bal <i>et al.</i> (2008) |
| Global damping ratio | ζ | 2 | 0.8 | Lognormal | Friswell <i>et al.</i> (2000) |

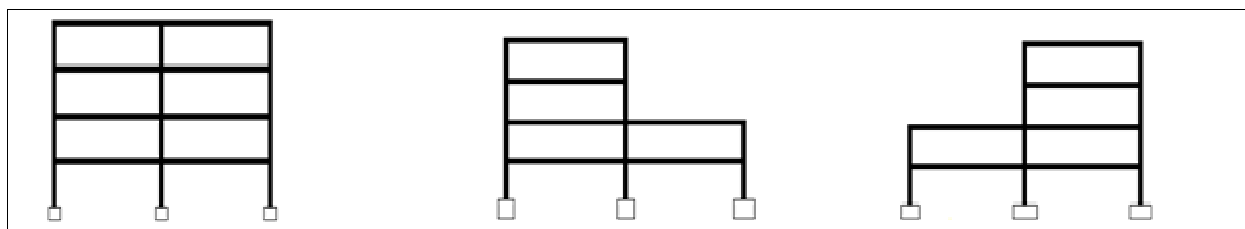


Figure 1 (a-c)Types of 4s2b bare frame regular and irregular buildings (a)4s2b RB (b) 4s2b IBD-1(c)4s2b IBD-2

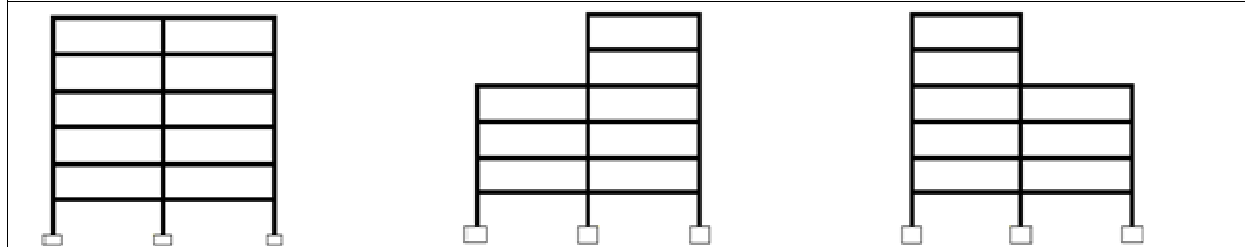


Figure 2 (a-c) Types of 6s2b bare frame regular and irregular buildings (a) 6s2b RB(b)6s2b IBD1(c) 6s2b IBD2





Bhagyashree Jena et al.

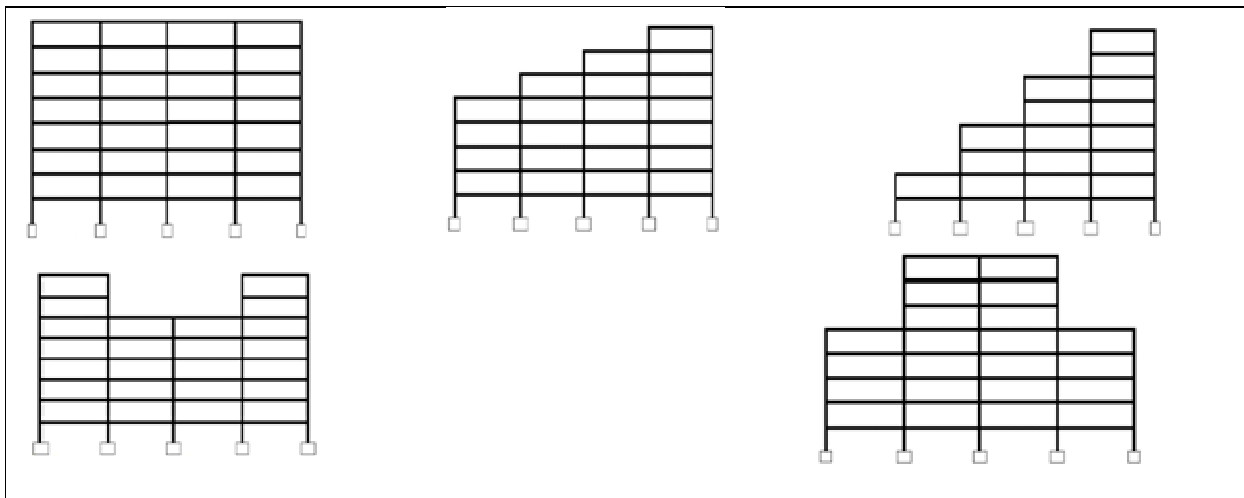


Figure 3 (a-e)Types of 8s4b bare frame regular and irregular buildings (a) 8s4b RB (b) 8s4b IBD1 (c) 8s4b IBD2 (d) 8s4b IBD3 (e) 8s4b IBD4

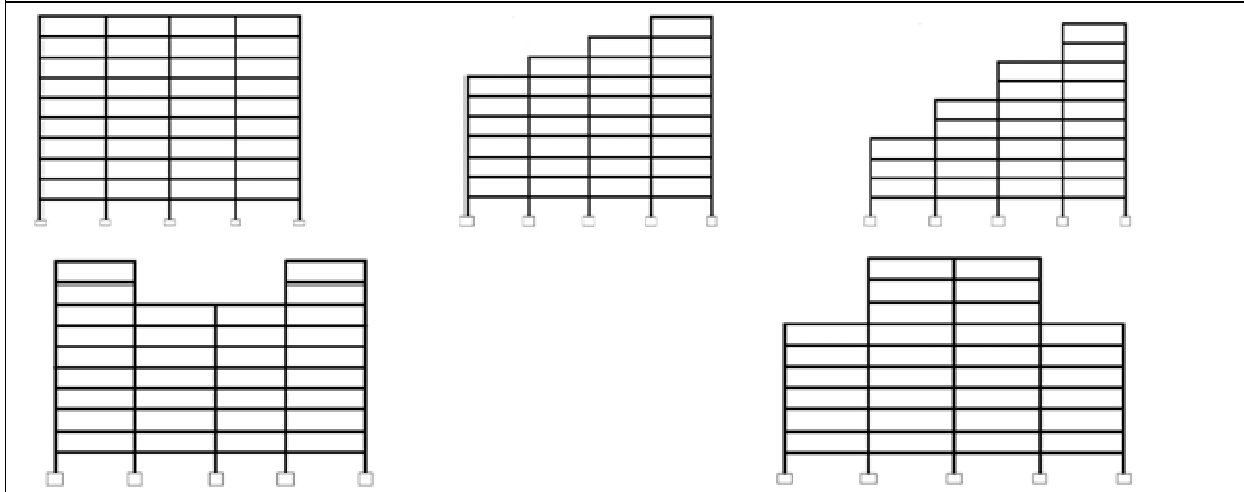
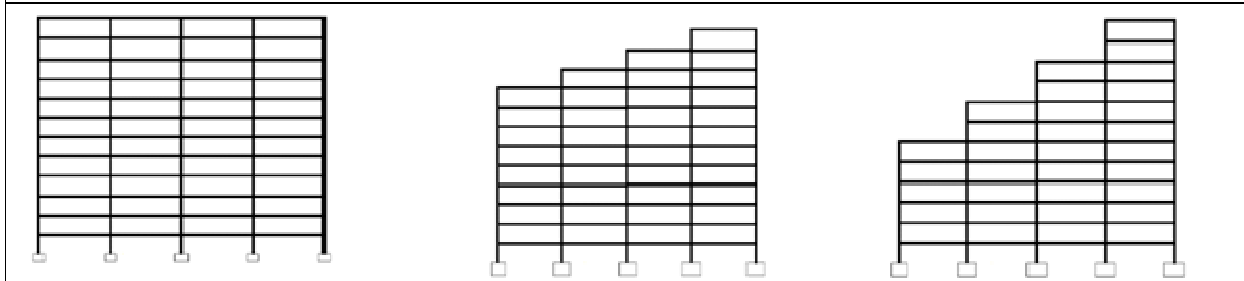


Figure 4(a-e)Types of 10s4b bare frame regular and irregular buildings (a) 10s4b RB (b) 10s4b IBD1 (c) 10s4b IBD-2 (d) 10s4b IBD3 (e) 10s4b IBD4





Bhagyashree Jena et al.



Figure 5(a-e)Types of 12s4b bare frame regular and irregular buildings (a) 12s4b RB(b) 12s4b IBD1 (c) 12s4b IBD2 (d) 12s4b IBD3 (e) 12s4b IBD4

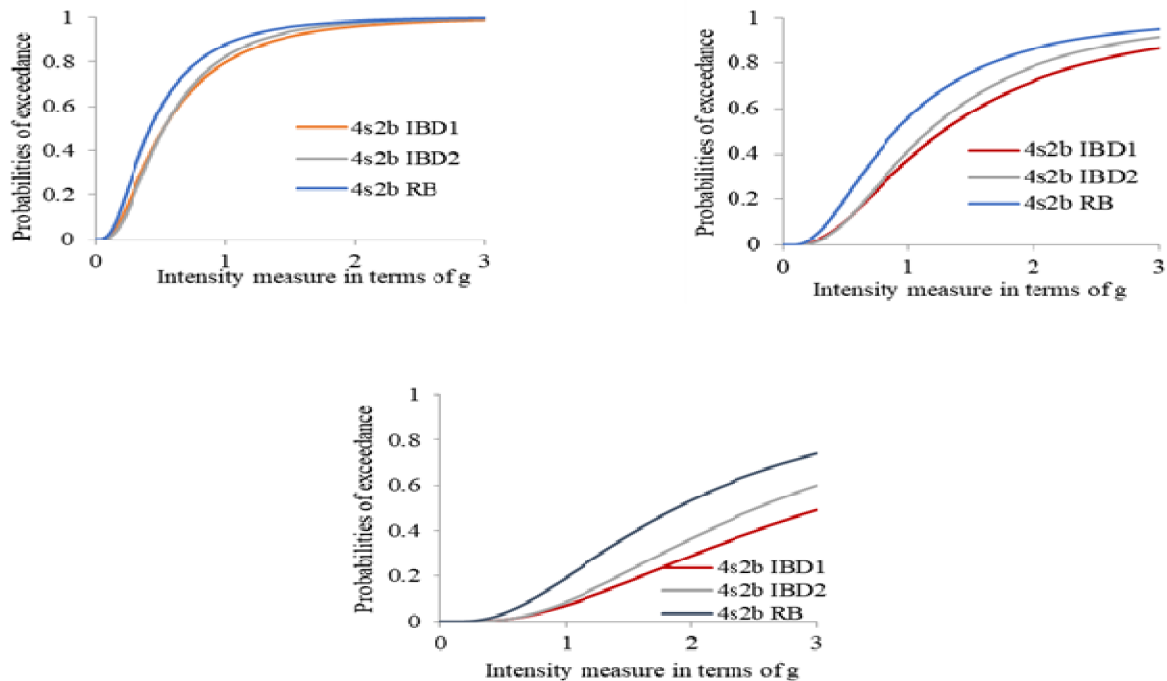


Figure 6(a-c)4S2B Regular vs. Irregular Steel Frame Buildings (a)IO Limit State (b) LS Limit State (c)CP Limit State

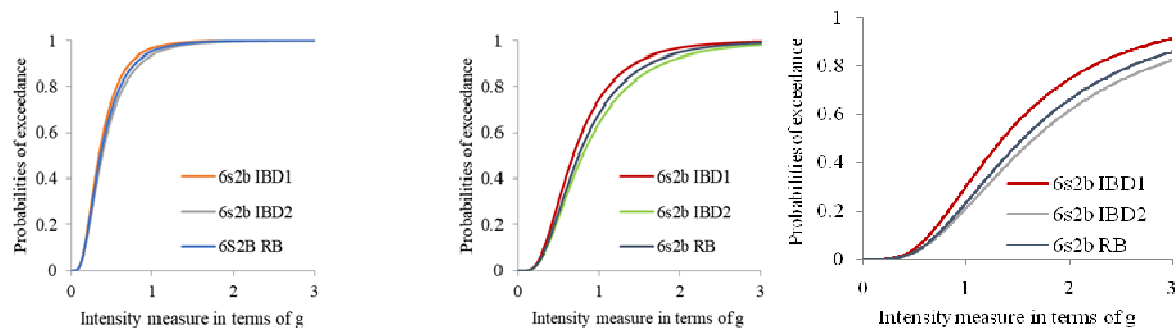


Figure 7(a-c)6S2B Regular vs. Irregular Steel Frame Buildings





Bhagyashree Jena et al.

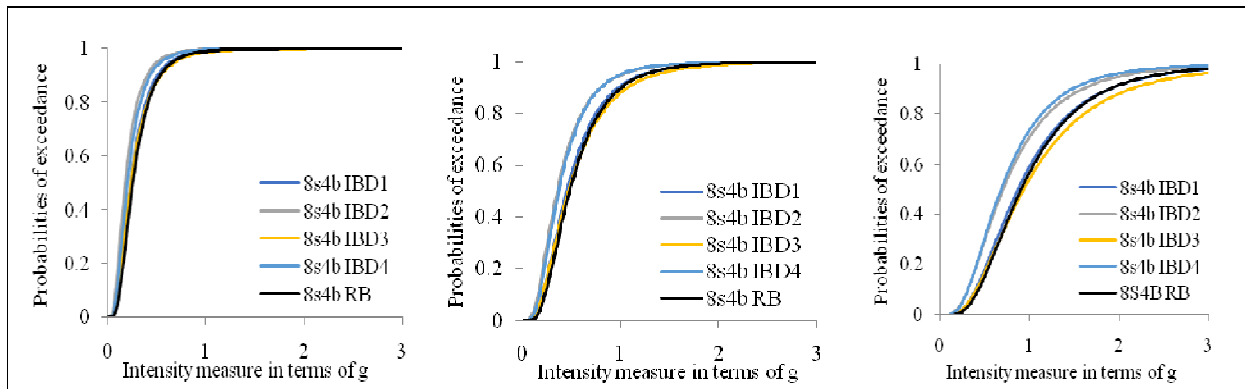


Figure 8(a-c)8S4B Regular vs. Irregular Bare Framed Buildings (a) IO Limit State (b) LS Limit State (c) CP Limit State

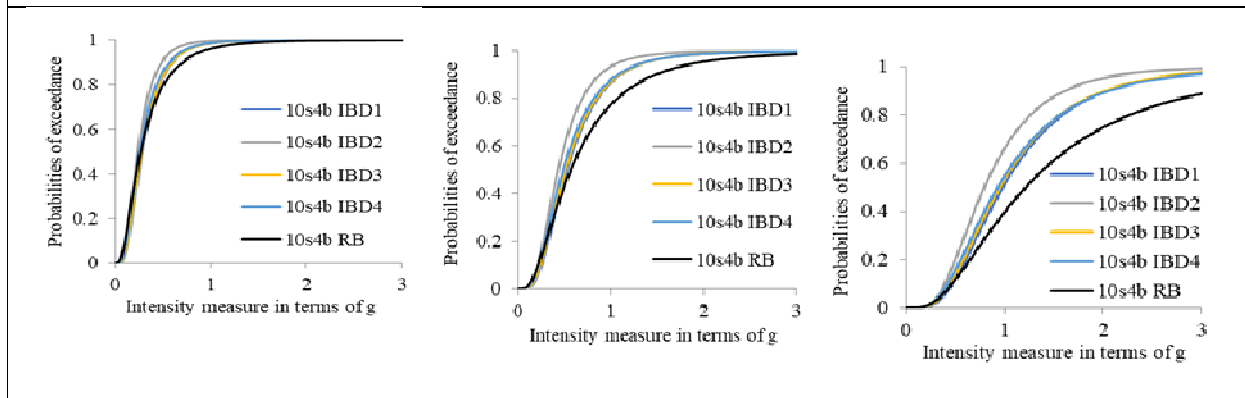
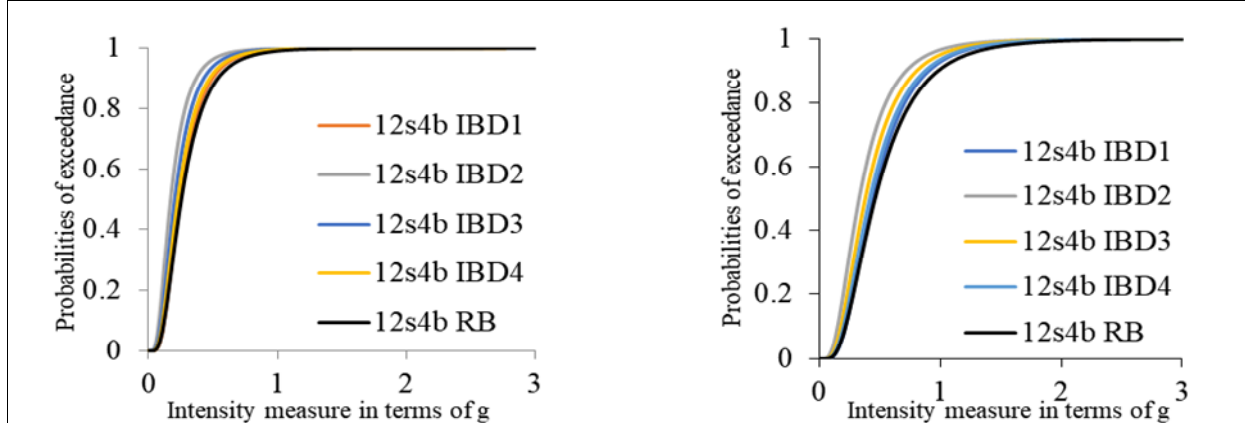


Figure9(a-c)10S4B Regular vs. Irregular Bare Framed Buildings (a)IO Limit State (b)LS Limit State (c)CP Limit State





Bhagyashree Jena et al.

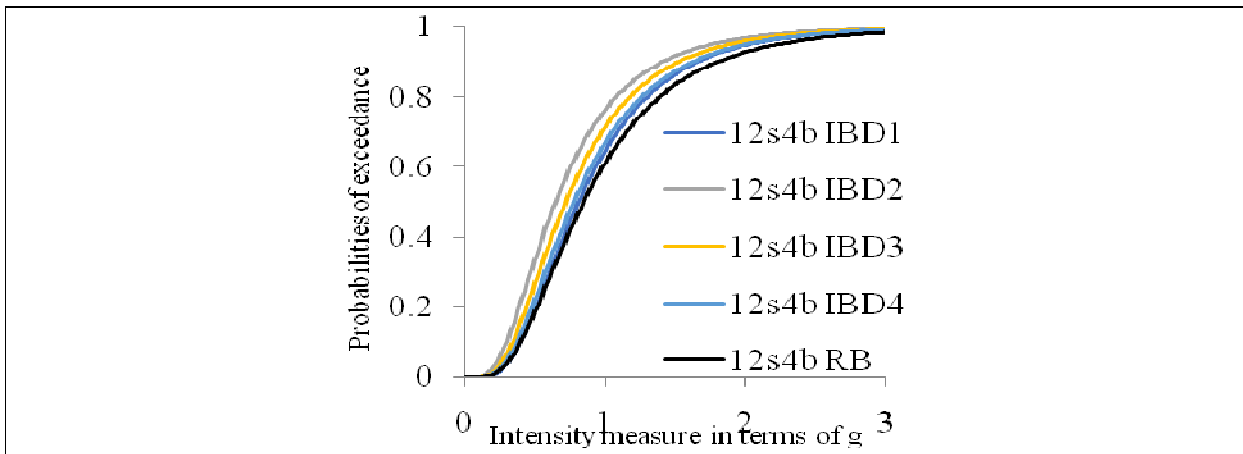


Figure 10(a-c) 12S4B Regular vs. Irregular Bare Framed Buildings (a) IO Limit State (b) LS Limit State (c) CP Limit State

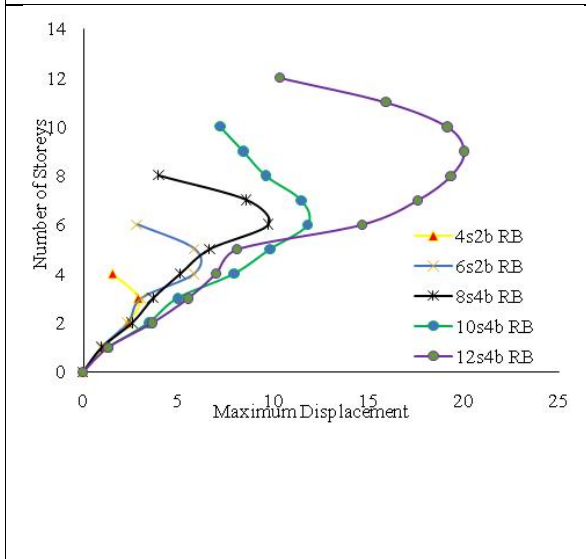


Figure 12 Storey vs. Displacement Graph Regular Bare Framed Buildings

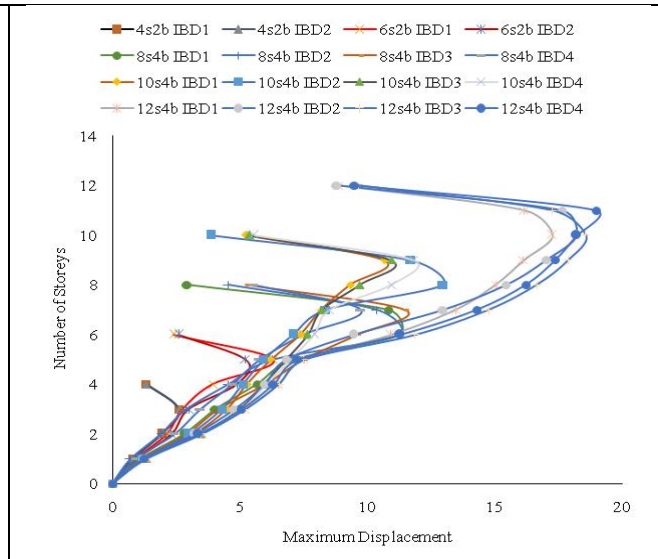


Figure 13 Storey vs. Displacement Graph for Irregular Bare Framed Buildings





CFD Flow Simulations over Ahmed Body Moving in Dusty Fluid Medium

Sujit Mishra, Mukundjee Pandey, Ashok Misra*,

Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ashok Misra

Centurion University of Technology and Management,
Odisha, India

Email: amisra1972@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Majorities of automotive aerodynamic simulation studies are carried out on simplified car models in order to assess flow patterns and their impact on drag forces. Simulations using Computational Fluid Dynamics (CFD) are an excellent technique to model these flow properties, which are highly dependent on the accuracy of the turbulence model used. The present study investigates the drag performance and overall flow characteristics in a 25° slanted Ahmed body in a dusty fluid environment. In the presence of suspended dust particles present in the air, it is found that the overall drag performance of Ahmed body gets attenuated which leads to a better simulation approach than the existing studies.

Keywords: Simplified car, Ahmed Body, Aerodynamics, Dusty fluid

INTRODUCTION

External aerodynamics has a significant effect on several essential components of an automobile, including the vehicle's stability, level of comfort, and amount of gasoline consumed while traveling at highway speeds. The road test gets more complicated, despite being one of the most effective methods for investigating external aerodynamics. While wind tunnel testing is still commonly employed, the development of useful numerical tools is expanding as the cost of numerical simulations continues to decrease. However, the fundamental challenge is that the automotive industry and industrial applications are currently experiencing a lack of robust and accurate computational fluid dynamics (CFD) methodologies. External flows with a large Reynolds number exhibit extremely turbulent behavior in addition to 3D detachment and reattachment phenomena. The capacity of a CFD simulation to effectively simulate these flow parameters is highly dependent on the quality of the turbulence model used. Throughout the decades, the use of reference automobile models (Le Good and Garry, 2004) has served to give designers insight into a vehicle's basic generic flow architecture. Because there have been many studies of individual automobile models, almost all of them use a simplified or general car model because of the following two key reasons. While generic models concentrate on the impact of a specific geometric feature, the insights gained from



**Sujit Mishra et al.**

these models are fundamental and universally accepted as they concentrate on how any geometric model can operate. A second advantage of using a generic benchmark model is that it allows researchers to more easily interact and collaborate, allowing them to make future breakthroughs. Due to these advantages, reference car models are commonly used to research several areas of automobile aerodynamics, including flow characterization, ground modeling, and drag reduction, flow control, acoustic performance, and ventilation design. Most research has concentrated on the Ahmed model, the most well-known universal simplified model established (S. R. Ahmed, 1984), because of its simplified geometry to reproduce some of the bulk essential flow aspects surrounding an actual car model – especially the rear end. The results show that pressure drag generated towards the rear end of the body accounts for nearly 85 percent of body drag, and the wake flow takes the form of vortices depending on the slant angle. (Fares, 2006) predicted the capability and feasibility of a lattice Boltzmann solver over the 25° slant Ahmed model utilising an extended eddy simulation (VLES) framework, but had problems reaching the time steps required for the flow parameters to converge. As a CFD modeling technique, (Guilmineau, 2008) offered a quadratic explicit algebraic stress model (EASM) applied to the Ahmed body with 25° and 35° slant angles. Around the 25° slant Ahmed body, Serre *et al.* (2013) investigated two eddy-resolving modeling techniques: Large Eddy Simulations (LES) and Detached Eddy Simulation (DES) methods. According to their findings, issues arise in their schemes as a result of computational cost and simplicity of execution without compromising the quality of the outcomes. LES modeling has been utilized in a similar study (Aljure *et al.*, 2014) to compare flows and turbulent structures using two types of simplified models.

The Reynolds Averaged Navier–Stokes (RANS) equations are investigated using a second-order upwind scheme over the Ahmed model to yield findings for various flow parameters such as drag force, drag coefficient, turbulent kinetic energy, and wake flow structures (Tientcheu-Nsiewe *et al.*, 2016; Mishra *et al.*, 2017). Furthermore, the Ahmed automobile body gains more from a hybrid RANS-LES model (Ashton *et al.*, 2016) than RANS models in terms of force coefficients and overall flow field. It is worth noting that nearly all of the studies mentioned above emphasized the reliability and accuracy of the numerical turbulence techniques for simulating external flow phenomena in a single-phase fluid medium, specifically clean air. However, in reality, ambient air, used for the aerodynamic experiments in wind tunnel setups, is not only the clear air but also comprises air with suspended particles. Considering the air with suspended particles is not a new concept in CFD analysis, but it is new to handling external aerodynamics studies. Furthermore, some recent research. An extended eddy simulation (VLES) scheme is used to depict the water sprayed particle effects and deposition patterns in the wake regions (Gaylard *et al.*, 2017). Furthermore, the Ahmed model (Mishra *et al.*, 2019) estimates the aerodynamic flow characteristics while taking into account air and sand particles. Due to high sand volume fraction levels, the unstable RANS (URANS) mixture scheme reveals an increase in drag coefficient and turbulent kinetic energy in their analysis.

As a result, the current study employs a k-epsilon turbulent scheme in the 2D Ahmed computational domain to investigate drag performance and overall flow characteristics in a dusty fluid environment. The granular secondary phase interacts with the primary phase of air in dusty fluids, which are two-phase Eulerian treatment-based models. The goal is to use the flow solver ANSYS Fluent v19 to determine the impacts of aerodynamic factors such as drag coefficients and flow features in the wakes region on the 25° slanted Ahmed body when the dusty fluid concentrations are set to 0.1 percent. Furthermore, this information is useful in the development of industrial innovations (SDG 9 and SDG 12)

Geometry Specification

Figure 1 depicts the Ahmed model (S. R. Ahmed, 1984) utilised in the numerical simulations. The pressure drag created at the rear end accounts for the majority of this body's drag. With a separation zone and counter-rotating vortices formed at the slant side margins, the wake structure is quite complex. The separation strength is determined by the slant angle. The rear slant angle was retained at 25° in this case, as a result of which the flow splits in the upstream end of the slant surface and reattaches in the downstream, as observed in the studies (Lienhart and Becker, 2003). The "Ahmed Body" has a length of 1044mm and a height of 288mm. The size of the front nose is fixed.



**Sujit Mishra et al.**

Computational Domain

The simulations for the present research are run on a 2D computational domain. The fluid with suspended particles passed through the Ahmed body model is represented by the computational domain as a rectangular box built-in Ansys fluent, as seen in figure 2. The model is linked to the reference axis (X, Y, Z), point O, as indicated in Figure 1, and ground clearance $G = 50\text{mm}$ is maintained. The Reynolds number $Re = 7.68 \times 10^5$ is determined based on the geometry model's height and the entering velocity, $U = 40\text{ m/s}$. The Reynolds number is the same as in the wind tunnel studies (Lienhart and Becker, 2003), which were performed in a 34% open test section with a 0.4 percent blockage ratio. Table 1 shows the computational domain for Ahmed Body specifications. The current study is being conducted on a 2D computational domain. The computational domain has been led by the boundary conditions, with the edges at the outlet edge set to atmospheric pressure outlet conditions. The no-slip condition has been applied to the remaining edges of the geometry. The turbulence intensity values are limited to 1% based on the experiments and simulations. (S. R. Ahmed, 1984; Khan and Umale, 2014).

Meshing

Using the meshing module in the Ansys Fluent workbench, the computational domain supplied in the previous step is discretized with unstructured 2D triangle elements. The patch conforming meshing technique is the simplest simple method for discretizing the domain. Three varieties of meshing, such as coarse, medium and fine, with maximum element sizes of 32mm, 14mm, and 7mm, were used to conduct the grid independence test.

Grid Independent Test

It is the way to find an optimum grid size for the present simulated problem. The solution will not be impacted after this size, regardless of grid size. Table 3, shows a comparison between the overall elements generated in the different grid systems with the coefficient of drag values. The plot between the Drag Coefficient (C_d) and the Number of elements generated at various meshing is shown in Figure 3. A similar approach has been adopted for the grid independency test (Pandey *et al.*, 2021). It can be clearly understood that increasing the total amount of grid elements increases the drag coefficients at the particular amount of grid elements.

Validation Test

A dusty fluid URANS Realizable k- epsilon turbulence setup uses for validating the present simulation approach that uses the concept of phasic volume fractions, where the volume fractions in the secondary dusty fluid medium are taken as insignificant amounts such that the relative density in simulations generates a similar and equivalent effect that matches the existing single-phase simulations (Guilmineau *et al.* 2018). The grid independence is attained with a satisfactory level with the medium mesh when the drag coefficients are compared to that of the existing results. As a result, the medium mesh is used as the starting point for all subsequent investigations. Table 4 shows a comparison of dusty phase URANS Realizable k-epsilon turbulence models with single URANS Realizable k-epsilon turbulence models drag coefficients results. It is observed that the drag coefficient values in the present simulation analysis make good attainment at the same level of accuracy with medium mesh and hence validate the simulation procedure.

Solver Settings

Before starting the simulations, the solver parameters for the problem of vehicle external flow numerical analysis must be completed. The Computational wind tunnel's intake was labeled "velocity-inlet," while the outflow was labeled "pressure-outlet." The solver settings utilized in the current simulations are listed in Table 5.

DISCUSSION OF RESULTS

The results from dusty-fluid 2D Ahmed body simulations are presented and discussed in this section. The pressure contour plot at the Ahmed body's symmetry plane reveals that the Ahmed body's front nose suffers increased pressure as the total kinetic energy is converted to pressure energy (Stagnation Point). Additionally, as the volume



**Sujit Mishra et al.**

fractions of dusty fluid increase to 0.1 percent, the total pressure increases, as shown in Figure 4. Picture 5 illustrates the velocity contour plots at the symmetry plane of the Ahmed body. As can be seen from the figure, it follows the Bernoulli principle and is, therefore, the inverse of the pressure contour. As the concentration of suspended dust particles in the air increases, the maximum velocity increases to 88.12 m/s at 0.1 percent. The suspended dust attempts to dampen the air velocity, reducing the flow.

Figure 6 depicts the flow structures in the Ahmed body's rear portion. The flow splits at the top edge's centre area and reattaches on the slant for the rear slant angle of 25° (Guilmineau, 2008). Similar flow topologies are predicted when suspended dusty fluid flows are evaluated at both intensity levels. Additionally, the wake generates two anticlockwise eddies with identical generating regions. Figure 7 illustrates the Drag Coefficients found and their comparison to earlier experimental (ERCOFTAC) and single-phase simulation results. As seen in the bar chart, the dusty fluid model simulation accurately predicts the drag coefficient. The accumulated total drag coefficient for suspended dust particles in the air at a volume fraction of 0.1% is around 0.292. The relative error determined from the drag coefficients is shown in Table 6. The maximum relative error, when compared to the current experimental result, is roughly 3.18 percent, while it is approximately 5.80 percent when compared to the simulation findings with a 0.1 percent volume fraction increase in suspended dust particles in the air. This shows that the presence of dust suspended particles in the air has an effect on the aerodynamics flow characteristics, lowering the overall drag coefficient regardless of the body form of the system.

CONCLUSION

The drag performance and overall flow parameters in Ahmed Body moving in a dusty fluid environment have been investigated. The conclusions are highlighted herewith.

- As the volume fractions of suspended dust increase to 0.1 percent, the total pressure over the Ahmed body gets also increase.
- In the presence of suspended dust at 0.1 percent volume fractions, a similar flow topology has been obtained, in which the flow separates from the top edge of the rear slant and reattaches near the middle of the Ahmed body's slant surface.
- When compared to existing experimental data, the highest relative error in overall drag coefficient values in the presence of suspended dust particles in the air is roughly 3.18 percent.
- Turbulence flow simulations in a dusty fluid medium offer a better approximation to aerodynamic experimental wind tunnel results than single-phase turbulence simulations, indicating a more feasible approach for such investigations.

REFERENCES

1. Aljure, D. E. *et al.* (2014) 'Computers & Fluids Flow and turbulent structures around simplified car models', COMPUTERS AND FLUIDS. Elsevier Ltd, 96, pp. 122–135. doi: 10.1016/j.compfluid.2014.03.013.
2. Ashton, N. *et al.* (2016) 'Assessment of RANS and DES methods for realistic automotive models', Computers and Fluids. Elsevier Ltd, 128, pp. 1–15. doi: 10.1016/j.compfluid.2016.01.008.
3. Fares, E. (2006) 'Unsteady flow simulation of the Ahmed reference body using a lattice Boltzmann approach', Computers and Fluids, 35(8–9), pp. 940–950. doi: 10.1016/j.compfluid.2005.04.011.
4. Fluent 6.3.26 users guide (2015), <https://www.Fluent.com>.
5. Gaylard, A. P. *et al.* (2017) 'Simulation of rear surface contamination for a simple bluff body', Journal of Wind Engineering and Industrial Aerodynamics. Elsevier Ltd, 165(February), pp. 13–22. doi: 10.1016/j.jweia.2017.02.019.
6. http://www.ercoftac.org/fileadmin/user_upload/bigfiles/sig15/data_base/index.html.
7. Le Good, G. M. and Garry, K. P. (2004) 'On the use of reference models in automotive aerodynamics', SAE Technical Papers, 2004(724). doi: 10.4271/2004-01-1308.





Sujit Mishra et al.

8. Guilmineau, E. (2008) 'Computational study of flow around a simplified car body', Journal of Wind Engineering and Industrial Aerodynamics, 96(6–7), pp. 1207–1217. doi: 10.1016/j.jweia.2007.06.041.
9. Guilmineau, E., Queutey, P. and Visonneau, M. (2018) 'Assessment of Hybrid LES Formulations for Flow Simulation Around the Ahmed Body', Computers and Fluids. Elsevier Ltd, (January). doi: 10.1016/j.compfluid.2017.01.005.
10. Khan, R. S. and Umale, S. (2014) 'CFD Aerodynamic Analysis of Ahmed Body', 18(7), pp. 301–308.
11. Lienhart, H. and Becker, S. (2003) 'Flow and turbulence structure in the wake of a simplified car model', SAE Technical Papers, pp. 323–330. doi: 10.4271/2003-01-0656.
12. Mishra, S. et al. (2019) 'MULTIPHASE MIXTURE MODEL SIMULATION OVER A SIMPLIFIED CAR', 23(1), pp. 17–24.
13. Pandey, M., Padhi, B. N. and Mishra, I. (2021) 'Performance analysis of a waste heat recovery solar chimney for nocturnal use', Engineering Science and Technology, an International Journal. Karabuk University, 24(1), pp. 1–10. doi: 10.1016/j.jestch.2020.11.009.
14. Mishra, S., Misra, A., Rao, P. S. V. R., Rao, D. N., (2017). Simulation of Aerodynamic Flow Parameters over a Simplified Sedan Car. International Journal of Engineering, Science and Mathematics, 6(8), 1265-1274.
15. S. R. Ahmed, G. R. and G. F. (1984) 'Some Salient Features of the Time -Averaged Ground', 93, pp. 473–503.
16. Serre, E. et al. (2013) 'Computers & Fluids On simulating the turbulent flow around the Ahmed body : A French – German collaborative evaluation of LES and DES', Computers and Fluids. Elsevier Ltd, 78, pp. 10–23. doi: 10.1016/j.compfluid.2011.05.017.
17. Tientcheu-Nsiewe, M. et al. (2016) 'Ahmed body, Wake, Velocity field, Turbulent flow, CFD; Ahmed body, Wake, Velocity field, Turbulent flow, CFD', American Journal of Environmental Engineering, 6(6), pp. 157–163. doi: 10.5923/j.ajee.20160606.01.

Table 1 Computational Domain Specifications for Ahmed Body

| Model | Parameter |
|--|--|
| Dimension | 2D |
| Length of Ahmed Body | 1.044 m |
| Height of Ahmed Body | 0.288 m |
| Rear Slant Angle | 25 Deg |
| Total Length of Computational Domain | 7m |
| Total Height of the Computational Domain | 3m |
| Ground Clearance | 0.05m |
| Reynolds Number | 7.68 x 10 ⁵ , based on height |

Table 2. Setup Details for the Meshing

| Meshing | Type/Parameters |
|-----------------------|---------------------|
| Element Type | Triangles with Hexa |
| First Layer Thickness | 0.0002 m |
| Maximum Layers | 6 |
| Growth Rate | 1.2 |

Table 3 Comparison of different mesh elements with the obtained drag coefficient values

| Mesh No | Mesh Element Size | No. of Elements | Cd |
|---------|-------------------|-----------------|-------|
| Mesh 1 | 32 mm | 65489 | 0.324 |
| Mesh 2 | 14 mm | 212250 | 0.321 |
| Mesh 3 | 7 mm | 876428 | 0.311 |





Sujit Mishra *et al.*

Table 4 Validation of Numerical Simulation Approach with existing Single-phase simulations

| Study | Turbulent Model | Drag coefficient |
|---------------------------------|-----------------|------------------|
| (Khan and Umale, 2014) | Standard k-ε | 0.310 |
| (Guilmineau <i>et al.</i> 2018) | SST-k- ε | 0.307 |
| Present study | Realizable k- ε | 0.311 |

Table 5. Solver setting used for the present simulations

| | |
|-----------------------------|--|
| Solver | Pressure- Based |
| Time | Transient |
| Model | Multi-phase |
| Primary Phase | Air |
| Secondary Phase | Sand-Dust up to 0.1 % Volume Fractions |
| Phase Interactions | Wen-Yu Model |
| Viscous Model | K- ε |
| K-Epsilon Model | Realizable |
| Near-Wall Treatment | Non-Equilibrium Wall Function |
| Turbulence Multiphase Model | Per Phase |

Table 6. Relative error comparison for drag coefficient values

| Experimental , Cd (A) | Simulations, Cd (B) | Dusty- Simulations, Cd (C) | Fluid | Relative Error (%)Between (B) & (C) | Relative Error (%)Between (A) & (C) |
|---------------------------|-----------------------------|----------------------------|-------|-------------------------------------|-------------------------------------|
| 0.283 (S. R. Ahmed, 1984) | 0.31 (Khan and Umale, 2014) | 0.292 | | 5.80 | 3.18 |

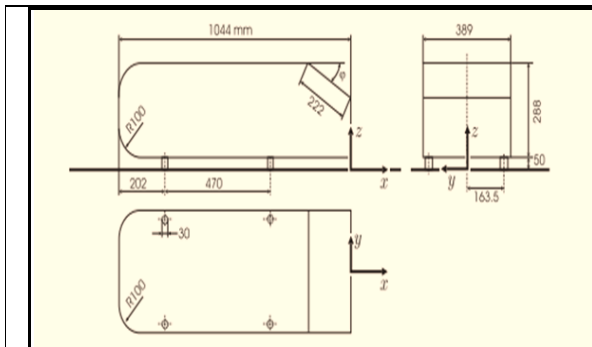


Fig.1 Geometry specification of Ahmed Body.

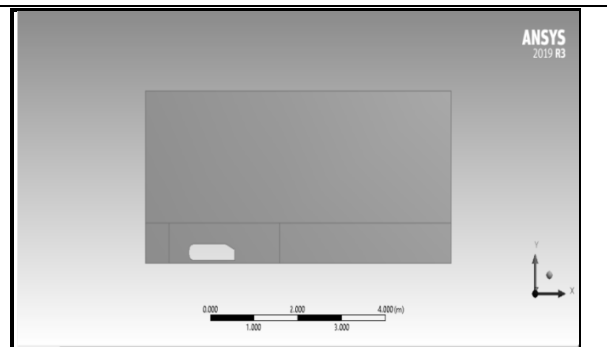


Figure 2. Computational Domain for 2D Ahmed Body

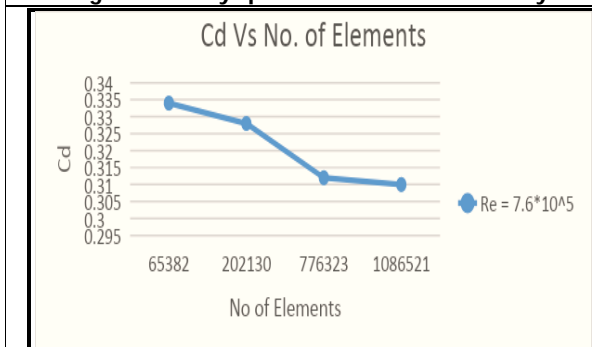


Fig 3 Mesh independency test for Ahmed Body

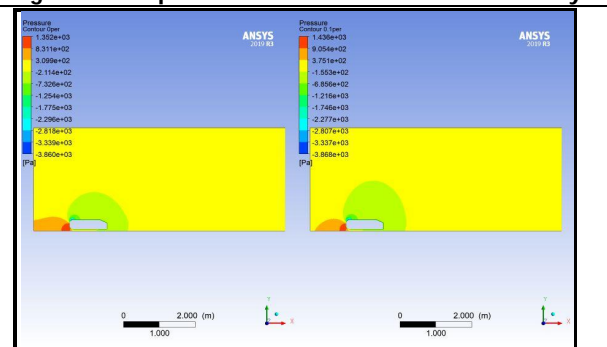


Figure 4. Pressure contour plots compare at 0 and 0.1% volume fractions of suspended dust particles.





Sujit Mishra et al.

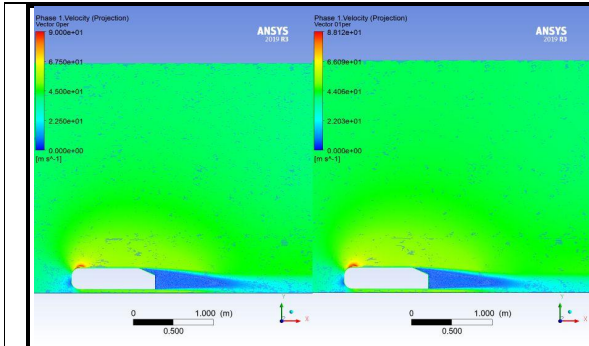


Figure 5. Velocity contour plots comparison at 0 and 0.1% volume fractions of suspended dust particles.

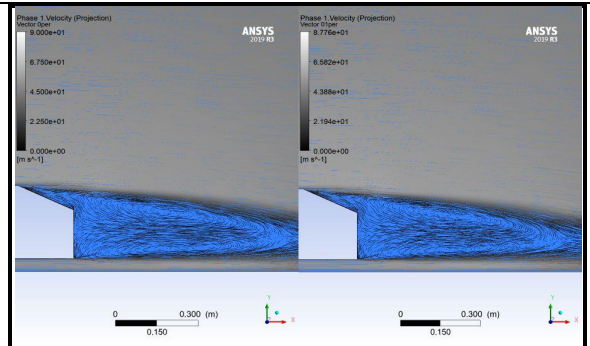


Figure 6. Velocity wakes contour plots comparison at 0 and 0.1% volume fractions of suspended dust particles.

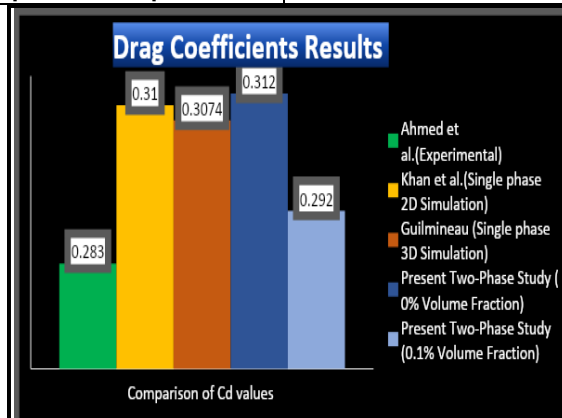


Figure 7. Drag Coefficients comparison of dusty-fluid simulations with existing results





Energy Conscious Parameter Selection in Arc Welding of Mild Steel using ANN

Sudeep Kumar Singh* and A. M. Mohanty

Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, 752050, India

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Sudeep Kumar Singh

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, 752050, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The selection of optimum input parameters in joining processes has a crucial effect on the intended joint quality and source usage, e.g., power. The Manual Metal Arc Welding (MMAW) of mild steel is most well-known among all welding procedures, as it offers low-cost remedy, finds extensive use in structural work, restoration & maintenance. The present study focuses on selecting ideal joint parameters in MMAW of low carbon alloy metal, taking into consideration joint quality power and parameter consumption through the welding operation. All the experiments conducted during the investigation process were designed using Minitab 18 software. The transverse tensile strength of the joints and the effective hardness of the joint region are taken as quality parameters of the welded joint. Measurement of power has been performed utilizing a charged power analyzer. Artificial Neural Network is utilized for training the info acquired from the experiments carried out using Bayesian regularization 'trainbr' learning function. The regression evaluation model was applied in Matlab R2019a to determine a relationship between your input and result variables to greatly help predict the perfect mix of joint input parameters.

Keywords: Arc Welding; Mild Steel; Artificial Neural Network; Taguchi; Energy consumption.

INTRODUCTION

Welding (SMAW) of Mild Steel (MS) has been a widely adopted process, finding extensive application in structural frames, pipelines, visually aesthetic designs, and repair works; due to its high ductility and weldability properties [1, 2, 3]. In spite of its high energy-intensive property, welding remains the most widely adopted joining process. Parameter selection is very important in a multi-input multi-output process like welding [4, 5]. Power consumption is one among many factors responsible for the negative environmental effects generated from welding operations,

42900



**Sudeep Kumar Singh and A. M. Mohanty**

raising the need for characterization of the SMAW process considering sustainability aspects [3, 6]. Thus, understanding the influence of input parameters on the joint quality is essential. The mechanical property of welded joints largely depends on the selected process parameters used in the manufacturing process [7]. Generally, more emphasis is put on the quality aspects of the produced joints rather than the process parameter selection. In practice, the process parameters selected, bears great impact on the resources consumed like energy consumption. Thus, the present study intends to draw a relationship between the three most influential inputs and the four output parameters adopted for investigation.

Adnan et al. [4] carried out Pareto Analysis to find uncontrollable input parameters for the GMAW welding process, developing three ANN models for input, output parameter prediction and classifying products. Laser welding of aluminium alloy AA5754 was also analyzed using ANN, for investigating the effects of process parameters [8]. The optimization process was carried out by varying welding speed and shielding gas, using a developed Excel add-in named "Neural Tools". Authors also developed ANN models for classification of defective products and prediction of the input parameters [5]. Optimization of key welding parameters is also important to mitigate the existing poor environmental image of welding processes. Authors also adopted hybrid neuro-fuzzy approach for optimizing SMAW process parameters focusing on sustainability approach [6]. The crucial welding parameters considered in the investigation are current, voltage and welding speed. Welding of dissimilar metals involving Al alloy and stainless steel has been studied using laser-arc welding technique [9]. Taguchi is used for studying the effect of different welding parameters to get optimum values of angular distortion in SMAW [10]. Central Composite Design applied on TIG welding of mild steel has been optimized using Response Surface Methodology (RSM), [11], ANN [12], and grey wolf optimizer [13] on different materials. In yet another study, RSM has been adopted for optimizing GMAW parameters for welding Mild Steel IS:2062 [14]. Authors [15] have developed model for predicting mechanical and micro structural properties of copper plate using Friction Stir Welding. RPLNN and GA have been used involving three inputs and two response parameters.

Weld quality considering tensile properties and microstructure were analyzed based on power distribution using an arc assisted fiber laser welding of Al-Mg alloy [16]. Tensile and impact properties in multi-pass SMAW have been investigated by Saxena et al. for determining the influence of welding consumables in ArmoX 500T alloy [17]. MS welded parts under varying current was analyzed for mechanical properties and microstructure [1]. The outcome claims the highest tensile strength obtained at 75A with minor welding defects. Sheets of different thicknesses welded using SMAW and GMAW were investigated for finding a new set of welding parameters for structural grade steel welding [7].

The current research work aims to study the influence of key input parameters on the qualitative output of the arc welded joint. The arrangement of the paper is as follows. Next section describes the experimental methodology. The third section discusses test procedure and results. The fourth and the final section presents conclusions obtained from the analysis and also presents directions for future scope.

Experimental Methodology

Arc welding of Mild Steel considering energy consumption has been considered in the present experimental investigation. The material finds tremendous application in structural work and industrial application. The adopted methodology has been pictorially presented in figure no 1. The presented research utilizes raw material in form of plates for the welding process. The input parameters taken as variables are; current, joint gap, face width and the output parameters; power consumed, Ultimate Tensile Strength (UTS), hardness (HRB) and impact energy (Izod). The input parameters (factors) involved in the study are presented in table no 1.

The raw materials were first tested for finding its composition using XRF spectrometer (result presented in table no-2), then was cut to size having length 200 mm and width 100 mm. One longitudinal edge of each plate was beveled to produce a double V-groove butt joint. The including angle between the two plates of the V-shaped joint to be welded is 60° for all the MS plates used. The flux coated stick electrode employed in the welding process was tested



**Sudeep Kumar Singh and A. M. Mohanty**

using XRF spectrometer, and the obtained results presented in table no 2. The data in table no-2 displays close conformance of iron percentage in both the workpiece and filler. The filler rod used in the welding process is 3.15 mm in diameter; Superweld E6013 manufactured by ESAB. The XRF samples for both the types of material were prepared by the help of a surface grinder. The plates were cleaned properly using a solvent to remove dirt, rust, etc. present on the surface of the material to be welded. It is followed by welding the plates using process parameters obtained from TAGUCHI orthogonal array design presented in table no 3. The experiments designed using 4³matrix, where three-factor and four levels of parameters are used.

The Welding Process

The welding process uses four different values of input current for the experiments as 90, 110, 130, and 150 amperes. The remaining two input variables are root gap and face width. The same number of levels were adopted for both the factors as 0, 1, 2 and 3mm. All the varying parameters taken together make the total number of factors involved in the experimental design as three. The number of levels for each factor is four. The total number of experiments calculated becomes 16. All the experiments were conducted using L16 Taguchi orthogonal array design for a three-factor and four-level experimental design. The experimental design adopted for the experiments is presented in table no 3. The welding process was carried out by using RS400, a thyristorised Manual Metal Arc welding machine manufactured by ESAB India Ltd. The machine is equipped with 50 Hz 3-phase power supply with an input voltage of 415 volts and 27 ampere current. All the welding runs were carried out using AC power supply.

A 3-phase power analyser, model no DPATT-3Bi, manufactured by Uma Electronics Enterprises, Jaipur India, was used for measuring the instantaneous power consumption values during the arc welding process. A three-phase four-wire connection was used in the process of power measurement. Table 3 presents the three factors and the values of the four levels of process parameters adopted in the experimental runs. It displays the values of different process parameters used in the welding process. The welding speed was considered constant throughout the experiment. All the mild steel plates involved in the investigation for MMAW are of 10mm thickness. Sixteen number of welding joints were produced and processed further to prepare the test samples for Tensile, Rockwell, and Izod tests to be conducted further down the process. The details of the test procedure and results have been explained in the next section.

Post-weld Testing

The mild steel plates after completion of welding were properly cleaned to remove slag deposited by using chipping hammer and wire brush. Tensile test, Rockwell hardness and Izod test specimens were extracted from the welded plates of 10mm thicknesses in conformance to ASTM E8 standard, presented in figure-2. A Rockwell hardness tester, HR-300, made in Brazil by Mitutoyo was employed for the purpose. Welding beads were removed by grinding from the welded surface before producing the test samples for both the tests. The hardness test was conducted at six different points on the bead face of the welded joints, designated by alphabets, A to F, as shown in fig 3(c). The HRB values at points A and F denote base metal hardness, the values at points B and E for hardness values at HAZ area of both parent metals, and the hardness values at points C and D denote the hardness for the face or cap side of the welded joint. The average hardness value of points C and D only are considered in the current investigation as HAZ and base material analysis does not come under the purview of our research scope.

The tensile test was conducted on a Universal Testing Machine (UTM) manufactured by Blue Star Engineering & Electronics Ltd. India, having a maximum capacity of 1000kN. The test specimens were loaded onto the UTM machine and made to undergo the tensile testing procedure, and the Ultimate Tensile Strength (UTS) values for each test specimen were noted. The samples prepared for Izod test were fitted on an Impact test machine and values of energy absorbed before failure for individual specimens were recorded. The values of UTS and Energy absorbed is presented in table no. 3 under respective columns. Figure no. 3(a) and (b) displays the tensile test samples before and after failure, fig 3(c) displays the hardness test specimen, and fig 3(d) depicts a broken Izod test specimen.



**Sudeep Kumar Singh and A. M. Mohanty****Neural Net modeling**

Neural networks find wide application and recognized as efficient solvers of non-linear problems. Successful applications have been reported in literature containing real-world problems. Following these traits, ANN is utilized to find optimum input parameters for SMAW in the present study. The architecture for the employed neural net is presented in figure no 4.

An Artificial Neural Network was modeled for training using the data collected from the conducted experiments. The bayesian Regularization backpropagation method is used for the construction of the network. This method is generally used for difficult, small and noisy datasets. In the current construction, the data set is small and prone to noise in the measured value mainly due to various reasons including, uncertainties involved in the test procedure. Thus, the application of Bayesian Regularization fits our requirement and 'trainbr' learning function is used in the Matlab R2019a platform. The network takes 70% of input data for training, 15% for validation and 15% for testing. The ANN model developed in this study involves an input layer, one hidden layer, and one output layer. The input layer consists of 3 neurons; each neuron corresponding to individual input parameters and the output layer containing 4 neurons, representing one output parameter each. The hidden layer employs 50 neurons. The most promising network architecture is based on trial and error methods for which many trials have been conducted to arrive at the best combination. The performance of the network has been discussed in detail in the conclusion section

Parameter selection using ANN

Neural networks find a wide application and recognized as efficient solvers of non-linear problems. Successful applications have been reported in literature containing real-world problems. Thus ANN has been selected for finding optimum input parameters for SMAW in the present study. The architecture for the employed neural net is presented in figure no 5.

An Artificial Neural Network was modeled for training using the data collected from the conducted experiments. The bayesian Regularization backpropagation method is used for the construction of the network. This method is generally used for difficult, small and noisy datasets. In the current construction, the data set is small and prone to noise in the measured value; thus, the application of Bayesian Regularization fits our requirement. 'trainbr' learning function is used in the Matlab R2019a platform. The network takes 70% of data for training, 15% for validation and 15% for testing. The ANN model developed in this study involves an input layer, one hidden layer, and one output layer. The input layer consists of 3 neurons; each neuron corresponding to individual input parameters and the output layer containing 4 neurons, representing one output parameter each. The hidden layer employs 50 neurons. The most promising network architecture is based on trial and error method for which many trials have been conducted to arrive at the best combination. The performance of the network has been discussed in detail in the conclusion section.

CONCLUSION

The current work involves three input and four output variables for SMAW welding of structural grade mild steel. The quality of the welding has been tested; measuring UTS of the welded joint by applying load in transverse direction, calculating average Rockwell hardness, and measuring the energy absorbed by the joint before fracture through Izod impact test. The input and output data collected from the test results were fed into an ANN network suitably designed for the purpose. The parameters of the network was chosen by trial and error method. The modeled network is capable of selecting all the three input parameters considered in the present work based on desired output parameters like energy consumed, UTS, hardness and impact energy. The network accuracy is impressive and the results obtained can help reduce the energy wastage in the welding process adopted without compromising the joint quality expressed in terms of tensile strength and impact energy in the present research. This



**Sudeep Kumar Singh and A. M. Mohanty**

work presented is applicable to other welding methods without much modification. Important process parameters not addressed in the present work can be considered as future research scope.

REFERENCES

1. Faqih, Imam & Ma'arif, Syamsul & Sukarjo, Heribertus. (2019). The Effect of Current Variation on MMA Welding to Mechanical Properties and Microstructure of Mild Steel.
2. Ahmed, A.N., Noor, C.M., Allawi, M.F. and El-Shafie, A., 2018. *RBF-NN-based model for prediction of weld bead geometry in Shielded Metal Arc Welding (SMAW)*. Neural Computing and Applications, **29**(3), pp.889-899.
3. Alkahla, I. and Pervaiz, S., 2017, September. *Sustainability assessment of shielded metal arc welding (SMAW) process*. In *IOP conference series: materials science and engineering* (Vol. **244**, No. 1, p. 012001). IOP Publishing.
4. Aktepe, A., Ersöz, S. and Lüy, M., 2014. *Welding process optimization with artificial neural network applications*. Neural Network World, **24**(6), p.655-670.
5. Aktepe, A., Ersöz, S. and Lüy, M., 2012, September. *Backpropagation neural network applications for a welding process control problem*. In International Conference on Engineering Applications of Neural Networks (pp. 172-182). Springer, Berlin, Heidelberg.
6. Vimal, K.E.K., Vinodh, S. and Raja, A., 2017. *Optimization of process parameters of SMAW process using NN-FGRA from the sustainability view point*. Journal of Intelligent Manufacturing, **28**(6), pp.1459-1480.
7. Khamari, B.K., Dash, S.S., Karak, S.K. and Biswal, B.B., 2019. *Effect of welding parameters on mechanical and microstructural properties of GMAW and SMAW mild steel joints*. Ironmaking & Steelmaking, pp.1-8.
8. Casalino, G., Facchini, F., Mortello, M. and Mummolo, G., 2016. *ANN modelling to optimize manufacturing processes: The case of laser welding*. IFAC-PapersOnLine, **49**(12), pp.378-383.
9. Gao, M., Chen, C., Mei, S., Wang, L. and Zeng, X., 2014. *Parameter optimization and mechanism of laser-arc hybrid welding of dissimilar Al alloy and stainless steel*. The International Journal of Advanced Manufacturing Technology, **74**(1-4), pp.199-208.
10. Arifin, A., Gunawan, A.M., Yani, I., Pratiwi, D.K., Yanis, M. and Sani, K.A., 2019. *Optimization of Angular Distortion on Weld Joints Using Taguchi Approach*. Jurnal Kejuruteraan, **31**(1), pp.19-23.
11. Srivastava, S., Kumar, S. and Garg, R.K., A multi-objective optimisation of TIG welding parameters using response surface methodology, In press.
12. Singh, S.K., Samal, B.K., Pradhan, S.R., Ojha, S.R., Saffin, M.D. and Mohanty, A.M., 2019, August. Sustainable Analysis of TIG Parameters for Welding Aluminum Alloy Considering Joint Gap and Welding Current. In *International Conference on Application of Robotics in Industry using Advanced Mechanisms* (pp. 316-323). Springer, Cham.
13. Skariya, P.D., Satheesh, M. and Dhas, J.E.R., 2018. *Optimizing parameters of TIG welding process using grey wolf optimization concerning 15CDV6 steel*. Evolutionary Intelligence, **11**(1-2), pp.89-100.
14. Srivastava, S. and Garg, R.K., 2017. *Process parameter optimization of gas metal arc welding on IS: 2062 mild steel using response surface methodology*. Journal of Manufacturing Processes, **25**, pp.296-305.
15. Azizi, A., Barenji, A., Barenji, R. and Hashemipour, M., 2016. *Modeling mechanical properties of FSW thick pure copper plates and optimizing it utilizing artificial intelligence techniques*. Sensor Netw Data Commun, **5**(142), p.2.
16. Leo, P., Renna, G., Casalino, G. and Olabi, A.G., 2015. *Effect of power distribution on the weld quality during hybrid laser welding of an Al-Mg alloy*. Optics & Laser Technology, **73**, pp.118-126.
17. Saxena, A., Kumaraswamy, A., Reddy, G.M. and Madhu, V., 2018. *Influence of welding consumables on tensile and impact properties of multi-pass SMAW Armax 500T steel joints vis-a-vis base metal*. Defence technology, **14**(3), pp.188-195.





Sudeep Kumar Singh and A. M. Mohanty

Table 1. Input parameters.

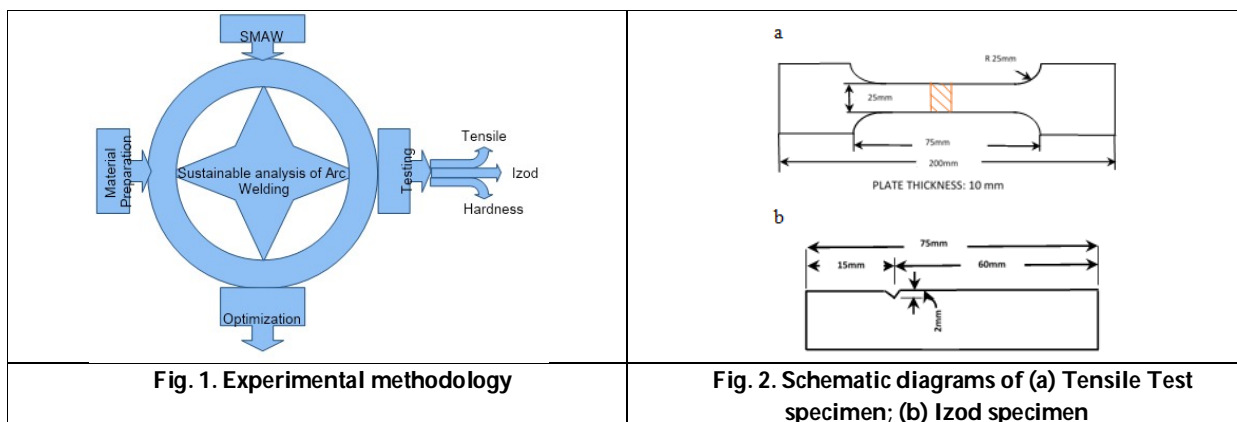
| Sl. No | Factors | Level1 | Level2 | Level3 | Level4 |
|--------|------------|--------|--------|--------|--------|
| 1 | Current | 90A | 110A | 130A | 150A |
| 2 | Root gap | 0 | 1 | 2 | 3 |
| 3 | Face width | 0 | 1 | 2 | 3 |

Table 2. Material composition.

| Sl. No. | Base material | Si | Mn | S | P | Fe |
|---------|------------------|-------|-------|-------|-------|--------|
| 1 | Mild steel plate | 0.340 | 0.533 | 0.100 | 0.059 | 95.102 |
| 2 | Electrode E6013 | 1.451 | 0.437 | 0.125 | 0.034 | 96.115 |

Table 3. Experimental runs with output values.

| Sl. No. | Current (A) | Root gap (mm) | Face width (mm) | Power (kW) | UTS (MPa) | Hardness (HRB) | Impact Energy (Joule) |
|---------|-------------|---------------|-----------------|------------|-----------|----------------|-----------------------|
| 1 | 90 | 0 | 0 | 4.14 | 400 | 73.8 | 42 |
| 2 | 90 | 1 | 1 | 4.32 | 371 | 81.95 | 47 |
| 3 | 90 | 2 | 2 | 4.45 | 472 | 81.05 | 52 |
| 4 | 90 | 3 | 3 | 4.71 | 530 | 83.5 | 58 |
| 5 | 110 | 0 | 1 | 5.03 | 847 | 80.45 | 40 |
| 6 | 110 | 1 | 0 | 5.24 | 643 | 81.15 | 48 |
| 7 | 110 | 2 | 3 | 5.43 | 721 | 81.8 | 44 |
| 8 | 110 | 3 | 2 | 5.71 | 788 | 77.9 | 49 |
| 9 | 130 | 0 | 2 | 6.04 | 632 | 81.15 | 52 |
| 10 | 130 | 1 | 3 | 6.27 | 562 | 85.0 | 60 |
| 11 | 130 | 2 | 0 | 6.45 | 689 | 81.2 | 68 |
| 12 | 130 | 3 | 1 | 6.90 | 736 | 80.95 | 62 |
| 13 | 150 | 0 | 3 | 7.12 | 563 | 79.75 | 38 |
| 14 | 150 | 1 | 2 | 7.35 | 492 | 77 | 44 |
| 15 | 150 | 2 | 1 | 7.48 | 586 | 78.6 | 56 |
| 16 | 150 | 3 | 0 | 7.79 | 643 | 85.25 | 64 |





Sudeep Kumar Singh and A. M. Mohanty

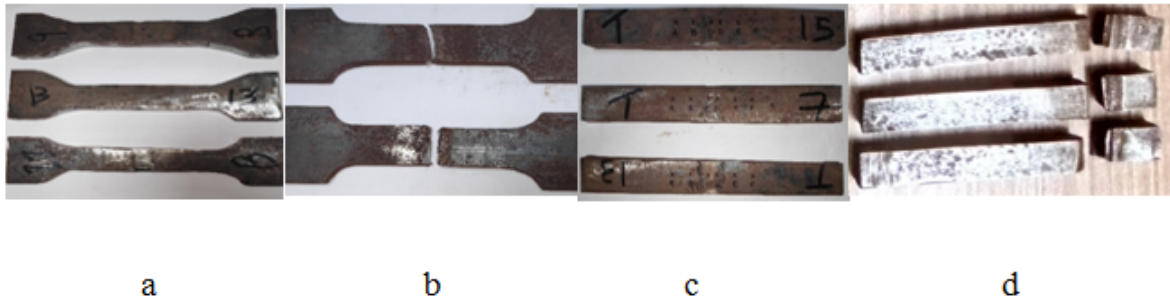


Fig. 3. (a) Tensile specimen before fracture; (b) Tensile specimen after fracture; (c) Rockwell test sample; (d) Izod test sample

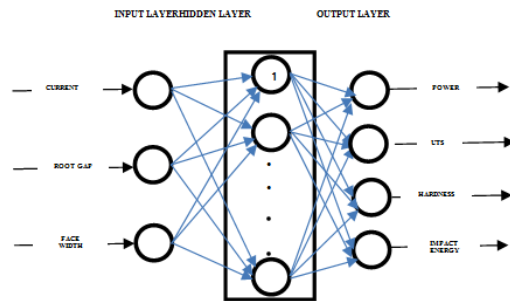


Fig. 4. ANN architecture

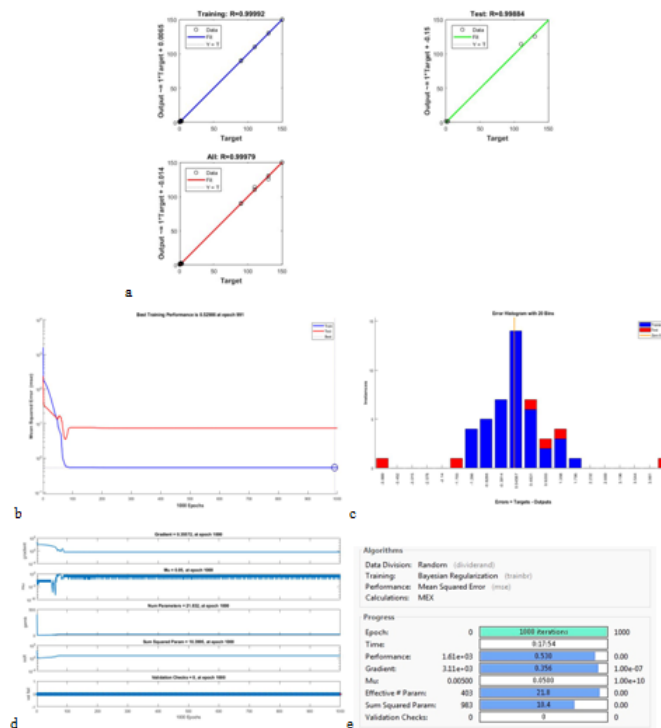


Fig. 5. (a) regression; (b) performance; (c) error histogram; (d) training state; (e) training progress





Design and Fabrication of Glass Fiber / SiC Reinforced Polymer Composite

Prajna Paramita Debata, Prakash Chandra Panda, Akash Kumar Behera and Dojalisa Sahu*

School of Applied Sciences, Centurion University of Technology and Management, Odisha, India

Received: 05 Mar 2022

Revised: 10 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Dojalisa Sahu

School of Applied Sciences,
Centurion University of Technology and Management,
Odisha, India.

E.Mail: dojalisa.sahu@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In recent years, the need for the manufacturing of reliable and innovative components has been increased rapidly. Fiber reinforced polymer (FRP) composite materials have strong candidature for fulfilling these aspects with wide applications in almost all areas of engineering and technology. Glass, carbon, and aramid fibers are being used widely for the production of fiber reinforced polymer composites. The present work deals with the processing and characterization of glass fiber reinforced epoxy composites with silicon carbide (SiC) filler. The composite material samples were fabricated by *Hand-Layup* method. Hand Layup process is one of oldest and cheapest mode of fabrication technique available for FRP products. A fish breeding tank with multiple layouts have been designed and fabricated. FRP products are generally light weight in nature with high fiber to matrix ratio.

Keywords: Hand Layup Method, Fiber Reinforced Plastic (FRP), Glass Fiber, Resin, Fish Breeding Tank, Innovation

INTRODUCTION

Two or more constituent materials are combined to produce a composite material [1-3]. The constituent materials show dissimilarity in their chemical or physical properties but when these are merged together to form a new composite material, it shows distinct properties which differs from the properties of individual elements. In a composite, the individual components retain their identity by showing individual properties and remain separate and distinct. The above attributes allow composites to behave differently from mixtures and solid solutions. Matrix and fiber are the two main component of composite. Matrix is treated as a base material on which the fiber is reinforced to produce the composite. There are some other materials which are included in composite such as additives, fillers, core materials etc. These materials added to obtain unique performance properties of the composite.



**Prajna Paramita Debata et al.,**

Fiber reinforced polymer (FRP) is one type of composite material which is prepared from a polymer matrix which is reinforced with a natural or man-made fiber which has been specially engineered for the purpose. There are different types of fiber materials such as glass, aramid, basalt, carbon or natural fibers which are included in FRP composite materials. Polymer resins (such as polyester, vinyl ester, epoxy or phenolic) are sometimes referred to as plastic. There are various reasons where new material can be favored [1-3]. Typical examples include materials which are less expensive, lighter, stronger or more durable when compared with common materials [3]. More recently researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as robotic materials. Composite materials are generally used for buildings, bridges, and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and countertops [6-8]. They are also being increasingly used in general automotive applications. The most advanced examples perform routinely on spacecraft and aircraft in demanding environments [9-10]. In this work, we have designed and fabricated some glass fiber/SiC reinforced polymer composites for different applications such as the manufacturing of fish breeding tank. Hand lay-up method for preparation of polymer composite is low cost, easily available, easy fabrication methodology for development composite parts for future sustainable industrialization.

MATERIALS AND METHODS

Design of different composite product by CATIA V5 Software

Catia V5 is a CAD system developed by Dassault Systems in 1998, currently widely used in the automotive, aerospace and others industries. CATIA stands for Computer Aided Three-Dimensional Interactive Application. It is much more than a CAD (Computer Aided Design) software package. It is a full software suite which incorporates CAD, CAE (Computer-Aided Engineering) and CAM (Computer-Aided Manufacture) [11-13]. Since it supports multiple stages of product development from conceptualization, design and engineering to manufacturing, it is considered a CAD-software and is sometimes referred to as a 3D Product Lifecycle Management software suite. Like most of its competition it facilitates collaborative engineering through an integrated cloud service and has support to be used across disciplines including surfacing & shape design, electrical, fluid and electronic systems design, mechanical engineering and systems engineering [12, 14-15].

Water Tank has been designed by the use of tools Sketch from Profile Toolbar (CATIA TOOL). For the outer structural purpose, Rib Tool is used. The outer support structure is made to merge with the pre sketch structure for the resultant structure given below. Circular shaped Fish Breeding Tank was designed with a hole at bottom for the outlet and Rib for the outer structural purpose and avoiding sharpen corners for the easy removal of Waste

Chemical Analysis of Component by using BIOVIA Material Studio

BIOVIA Materials Studio is a complete modeling and simulation environment designed to allow researchers in materials science and chemistry to predict and understand the relationships of a material's atomic and molecular structure with its properties and behavior. Using Materials Studio, researchers in many industries are engineering better performing materials of all types, including catalysts, polymers, composites, metals, alloys, pharmaceuticals, batteries and more. BIOVIA modelling and simulation software allows scientists to create better performing, safer and more cost-effective products by connecting the virtual and real worlds to test concepts with minimum risk and lower costs. For the analysis of different mechanical properties of the fiber composite prepared by glass fiber and resins we choose SiC as representation of glass fiber. Epoxy Resin was selected from the library of BIOVIA Material Studio. From the two components, geometric optimization was done for the stability of mixing.

The mechanical property of the material was obtained. Crystal structure and geometric optimization was done to obtain the mechanical properties of silicon so that it can be compared with glass fiber reinforced composite.





Prajna Paramita Debata et al.,

Material required

For fabrication of Glass Fiber Reinforced Products, glass fiber, resin, hardener, filler material was used. Hardener was used for curing of Fiber into Resin matrix. Depending upon the rate of curing the proportion of hardener to resin is changed. A layer of Mansion Wax Polish are required for the easy release of product from its mould. The composite materials used for the present investigation was fabricated by hand layup process.

Hand lay-up is an open molding method suitable for making a wide variety of composites products from very small to very large. Hand lay-up is the simplest composites molding method, offering low cost tooling, simple processing, and a wide range of part sizes. Gel coat is first applied to the mold using a spray gun for a high quality surface. When the gel coat has cured sufficiently, roll stock fiberglass reinforcement is manually placed on the mold. The laminating resin is applied by pouring, brushing, spraying, or using a paint roller. FRP rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air. Subsequent layers of fiberglass reinforcement are added to build laminate thickness. Low density core materials such as end-grain balsa, foam, and honeycomb, are commonly used to stiffen the laminate. This is known as sandwich construction.

Fabrication of Different Product by Glass Fiber/SiC Reinforced Polymer Composite

Rectangular Framed Fish Breeding Tank

Rectangular Fish Breeding Tank was fabricated by *Hand Layup* Process by impregnation of glass fiber onto resin where glass fiber serves as reinforcement and resin as matrix. The total volume capacity of fabricated fish breeding tank is 50000 metric liters

Circular Fish Breeding Tank

Pre-prepared mould was taken for the fabrication of required Circular Fish Breeding Tank. On these mould layer of Mansion wax polish was applied so that it will be released with ease. Two successive layers were applied on the mould. The Fish Breeding Tank was made to release after drying. The Circular Fish Breeding Tank has an approximately volume of 12000 liters as water holding capacity.

Fabrication of Fish Breeding Tank

Designed Specification for Fish Breeding Tank-

1. Tank of Height-2meter, Width-4meter, Length-6meter
2. Approximately Volume-50000Liters
3. Could withstand high Water pressure
4. No sharpen corners to avoid deposition of waste
5. Light weight so that if required Tank can be transported to another site
6. Separate space for Submersible Aeration Pump
7. Inside colour should be Blue to reduce stress on Fishes

Rectangular Framed Fish Breeding Tank

First Glass Fiber Reinforced Composite Sheets were prepared by Hand Layup process. First, mansion polish wax was applied on the wooden plank sheets and on to it layer of glass fiber are spread with mixture of resin mixed with accelerator and catalyst. After drying, another layer of glass fiber is spread with application of resin and kept it for drying. After drying the layer are made to release from the wooden plank surface. The two layered sheets of glass fiber reinforced composite sheets are made in numbers. Then the doubled layered sheets of glass fiber reinforced are made to be fixed to prepare iron case structure. Subsequently, another 4 layers of glass fiber reinforced was applied to it resulting into 6 layers of glass fiber reinforced wall. The prepared layers were kept for drying. After which, colour was applied to prevent the iron frame from rusting. For bottom part of Fish Breeding Tank, 4 layers of a separate circular Glass Fiber sheet was fabricated and attached at the bottom of the tank with required holes for inlet





Prajna Paramita Debata et al.,

and outlet. The above project shows how composite materials show unique properties for different applications [16-17].

CONCLUSION

By *Hand Layup* method, Fish Breeding Tank was prepared. This process is easy, with simple mould requirement, cost effective, and suitable for the development of township enterprises. The production of FRP products is not limited by size and shape, such as; large cruise ships, round roof, sink, etc. It can be joint with other materials (such as: metal, wood, foam, etc.) at the same time. For some of the large products (such as: large can, large roof) can be produced on the spot. Product quality is not as stable as machine made. Because of the difference of the level of operating personnel and the production environmental conditions, the stability of the product quality is average.

REFERENCES

- Hatchett, D. W., & Josowicz, M. (2008). Composites of intrinsically conducting polymers as sensing nanomaterials. *Chemical reviews*, 108(2), 746-769.
- Clyne, T. W., & Hull, D. (2019). *An introduction to composite materials*. Cambridge university press.
- Tsai, S. W., & Hahn, H. T. (2018). *Introduction to composite materials*. Routledge.
- Newnham, R. E. (1986). Composite electroceramics. *Ferroelectrics*, 68(1), 1-32.
- Laws, N. (1973). On the thermostatics of composite materials. *Journal of the Mechanics and Physics of Solids*, 21(1), 9-17.
- Chawla, K. K. (2012). *Composite materials: science and engineering*. Springer Science & Business Media.
- Christensen, R. M. (2012). *Mechanics of composite materials*. Courier Corporation
- Song, M. K., Lin, F. C., Ward, S. E., & Fine, J. P. (2013). Composite variables: when and how. *Nursing research*, 62(1), 45.
- Halpin, J. C., & Finlayson, K. M. (2017). *Primer on composite materials analysis*. Routledge.
- Vinson, J. R., & Chou, T. W. (1975). *Composite materials and their use in structures*.
- Campbell, F. C. (2010). *Structural composite materials*. ASM international.
- Hashin, Z. (1983). *Analysis of composite materials—a survey*.
- Harris, B. (1999). *Engineering composite materials*.
- Mamalis, A. G., Robinson, M., Manolakos, D. E., Demosthenous, G. A., Ioannidis, M. B., & Carruthers, J. (1997). Crashworthy capability of composite material structures. *Composite structures*, 37(2), 109-134.
- Chung, D. D. (2010). *Composite materials: science and applications*. Springer Science & Business Media.
- Palai, A., Panda, N.R., Sahoo, M.R., Sahu, D., (2022) *Journal of Materials Science: Materials in Electronics*, 33, 9599-9615.
- Palai, A., Panda, N.R., Sahu, D. (2021), *Journal of Molecular Structure* 1244, 131245.

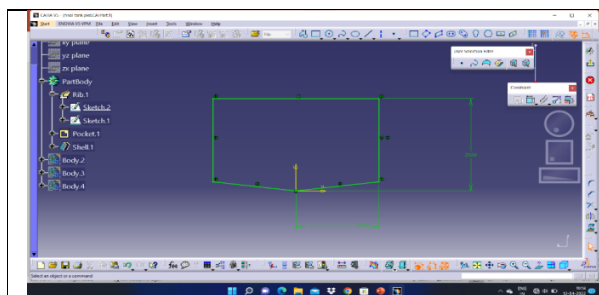


Figure-1: Sketch of rectangular fish breeding tank

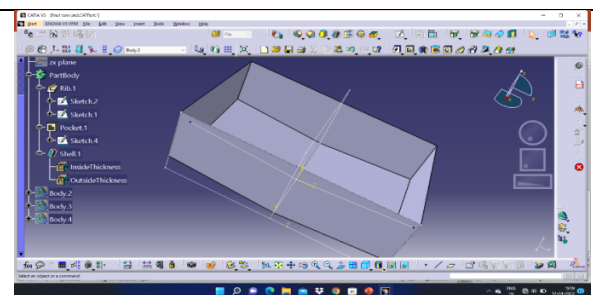


Figure-2: Filling of fish breeding tank.





Prajna Paramita Debata et al.,

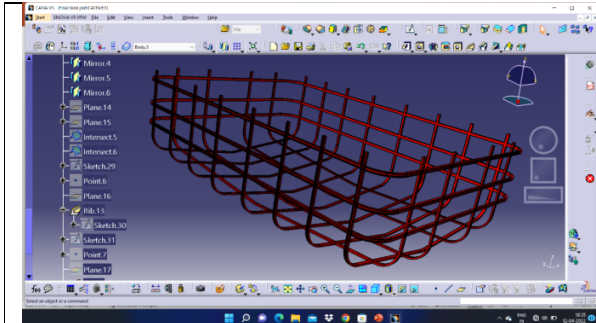


Figure-3: Outer structural part of fish breeding tank

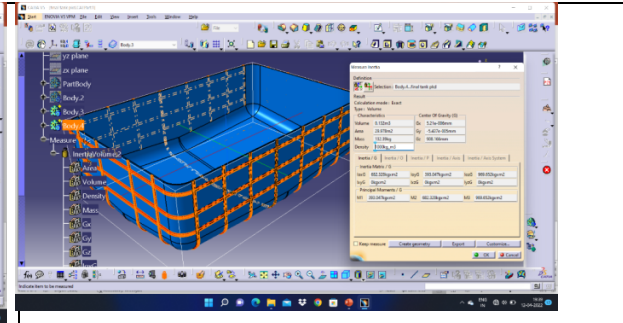


Figure-4: Design of fish breeding tank by CATIA V5

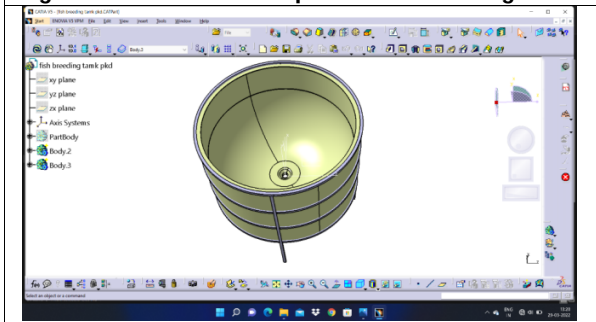


Figure- 5 : Design of circular fish breeding tank by CATIA V5.

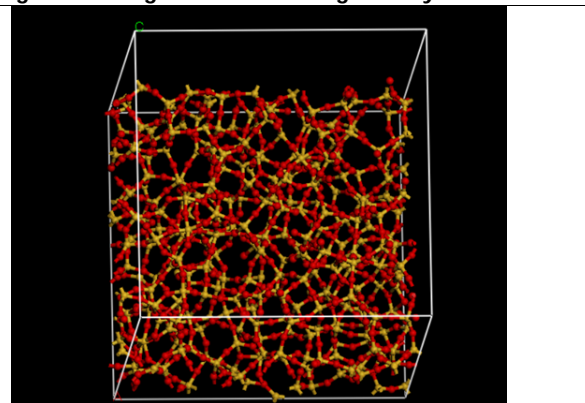


Figure-6: Crystalline Structure of SiC.

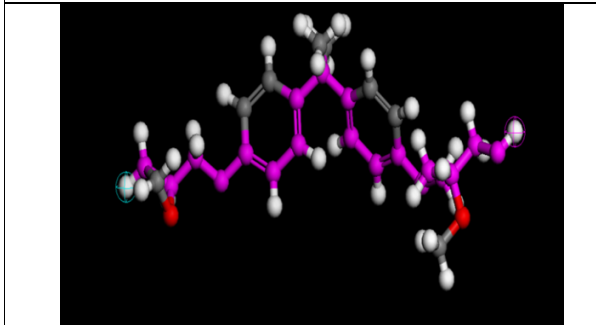


Figure-7: Epoxy Structure

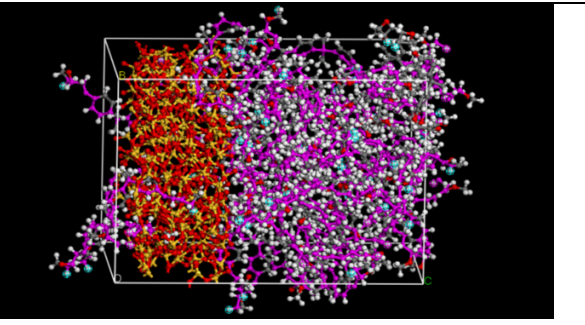
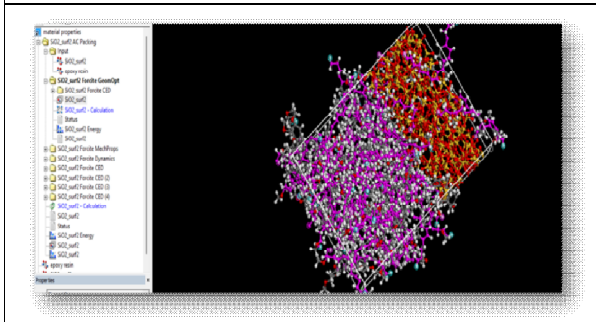


Figure-8: Geometric optimization of the crystal structures.



```

111.1208    220.7768    230.0807    4.0075    21.8810    -12.0024
129.4229    187.0847    148.2274    -9.0112    4.3282    21.7534
26.2288    41.0273    9.1424    2.7624    2.7624    -1.4800
-3.8667    12.8259    0.3285    1.4800    1.4800    68.0120
-----
0.6113    -0.9932    -4.6755    -6.8999    -2.5560    -0.1713
-0.9932    0.3326    -3.3453    -3.3514    -2.3838    1.1807
-4.6755    -3.3514    13.0213    -0.0289    10.7920    1.0482
0.3326    -3.3514    0.7050    18.3428    30.7124    1.2388
-0.1713    1.3967    -1.0482    1.3555    1.4308    14.9992

Elastic compliance constants Sij (1/TPa), Strain-1 = Sij*Stress-j.
-----
S11 = 0.6113    S12 = -0.9932    S13 = -4.6755    S14 = -6.8999    S15 = -2.5560    S16 = -0.1713
S21 = -0.9932    S22 = 0.3326    S23 = -3.3453    S24 = -3.3514    S25 = -2.3838    S26 = 1.1807
S31 = -4.6755    S32 = -3.3514    S33 = 13.0213    S34 = -0.0289    S35 = 10.7920    S36 = 1.0482
S41 = 0.3326    S42 = -3.3514    S43 = 0.7050    S44 = 18.3428    S45 = 30.7124    S46 = 1.2388
S51 = -0.1713    S52 = 1.3967    S53 = -1.0482    S54 = 1.3555    S55 = 1.4308    S56 = 14.9992

Bulk modulus (GPa) = 157.2259    Voigt    156.9008    156.9618
Shear modulus (GPa) = 89.4534    32.4363    60.9458

Compressibility (1/TPa) = 6.4434

Young Modulus (GPa) = Poisson ratios
-----
E11 = 131.2388    nu12 = 0.1502    nu13 = 0.2073
E22 = 293.3881    nu23 = 0.3431    nu24 = 0.3326
-----

velocities of sound (cm/s)
-----
v1 = 6.8381    v2 = 10.9135
v3 = 10.8208    v4 = 10.7286
v5 = 0.7881    v6 = 10.7286

Lame constants (GPa) (assuming material is isotropic)
-----
lambda = 150.1209    mu = 89.4530

Task terminated : Mon Jan 24 16:08:07 2022
Total CPU time used by Fucrite: 1:13:08 hours (4387.596)
Termination status : normal
    
```

Figure-9: Blending of epoxy and SiC





Prajna Paramita Debata et al.,



Figure-10: Rectangular framed fish breeding tank.



Figure-11: Circular Fish Breeding Tank.





5-Axis Milling Parameter Selection for Higher Surface Finish and Reduced Power Consumption

Sudeep Kumar Singh* and A. M. Mohanty

Department of Mechanical Engg., Centurion University of Technology and Management, Odisha, India

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Sudeep Kumar Singh

Department of Mechanical Engg.,

Centurion University of Technology and Management,

Odisha, India.

Email: sudeep.singh@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Energy saving and emanation decrease have become key worldwide procedures in numerous nations under the rising tension from the energy emergency and ecological guidelines. . The milling process requires a milling machine, work piece, fixture, and cutter. The work piece is a piece of pre-shaped material that is secured to the fixture which itself is attached to a platform inside the milling machine. The current research work aims at optimizing milling process variables. The working methodology adopted has been described in the current chapter. The EN-24 has been selected for the present work. EN24T steel is a popular grade of through-hardening alloy steel due to its excellent machinability. To make it workable for machining it was cut from both the ends to give it a flat shape out of the arc-shaped ends, which was necessary to hold the material with proper grip at the bed of CNC machine. 5-axis machining refers to a machine's ability to move a tool or a part in five different axes simultaneously. This data can be useful in predicting optimized values of input parameters based on minimum surface roughness, power consumed and highest MRR.

Keywords: worldwide, machine, MRR, 5-axis.

INTRODUCTION

Energy saving and emanation decrease have become key worldwide procedures in numerous nations under the rising tension from the energy emergency and ecological guidelines. Further developing energy effectiveness and decreasing energy utilization are the mindful concentration for practically all modern cycles, particularly for the assembling business, as it consumes the relative extent of complete modern energy use. For example, energy utilization in assembling in the USA represented around 80% of the modern utilization in 1999, and in 2003, fabricating utilized 85.2 % of the last modern energy use in China [1]. Machining is a material evacuation process that normally includes the cutting of metals utilizing different cutting devices. A cycle is especially helpful because of its high-layered precision, the adaptability of the interaction, and cost-viability in delivering appropriate amounts of parts. Among assembling processes, machining is special in that it very well may be utilized both to make items and



**Sudeep Kumar Singh and A. M. Mohanty**

to complete items. The momentum research work revealed in this paper centers around the determination of ideal machining boundaries; speed, feed and profundity of cut in view of lower surface harshness and power consumed.

Milling Machine

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, workpiece, fixture, and cutter. The workpiece is a piece of pre-shaped material that is secured to the fixture which itself is attached to a platform inside the milling machine. A cutter is a cutting tool with sharp teeth that is also secured in the milling machine and rotates at high speeds. By feeding the workpiece into the rotating cutter, the material is cut away from this workpiece in the form of small chips to create the desired shape. Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three-dimensional surface contours. Parts that are fabricated completely through milling often include components that are used in limited quantities, perhaps for prototypes, such as custom-designed fasteners or brackets. Another application of milling is the fabrication of tooling for other processes. For example, three-dimensional molds are typically milled. Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features to a part whose basic shape has already been formed.

METHODOLOGY

The current research work aims at optimizing milling process variables. The working methodology adopted has been described in the current chapter.

Pre Processing

The raw material has been processed before machining to bring it to a machinable condition so that it can be used on the CNC milling.

Material Selection

The EN-24 has been selected for the present work. EN24T steel is a popular grade of through-hardening alloy steel due to its excellent machinability. It is used in components such as gears, shafts, studs and bolts, its hardness is in the range 248/302 HB. EN24T can be further surface-hardened to create components with enhanced wear resistance by induction or nitriding processing.

Material Cutting

The raw material EN-24 procured was 350mm*135mm*55mm (L*B*H) in dimension. The raw material brought was not perfectly rectangular, it was in the arc shape at both the ends and the surface was not even the same across the areas. To make it workable for machining it was cut from both the ends to give it a flat shape out of the arc-shaped ends, which was necessary to hold the material with proper grip at the bed of CNC machine. Now to cut this material from both the ends available options were looked for, where it was decided to choose the automatic hacksaw machine, because of the high hardness of the material. The material was cut 30mm from each side means total 60mm on the total length of the material to make the ends flat. Now after cutting of the material the current size of the workpiece is 290mm*135mm*55mm (L*B*H) which allowed to hold it properly on the bench vice of the CNC milling bed to do the machining.

XRF Testing

X-ray fluorescence (XRF) spectrometry is an elemental analysis technique with broad applications in science and industry. XRF is based on the principle that individual atoms, when excited by an external energy source, emit X-ray photons of a characteristic energy or wavelength.



**Sudeep Kumar Singh and A. M. Mohanty**

An x-ray beam with enough energy to affect the electrons in the inner shells of the atoms in a sample is created by an x-ray tube inside the handheld analyzer. The x-ray beam is then emitted from the front end of the handheld XRF analyzer.

Hardness Testing

The application of hardness testing helps to test a material's properties, such as strength, ductility and wear resistance, and so helps determine whether material treatment is suitable for the desired purpose. Hardness is the property of a material that enables it to resist plastic deformation, penetration, indentation, and scratching. Therefore, hardness is important from an engineering standpoint because resistance to wear by either friction or erosion by steam, oil, and water generally increases with hardness. The Rockwell hardness number is the difference in depth between the zero reference position and the indent because of the major load. Over thirty different scales are used between Rockwell and Superficial Rockwell hardness testing because of the various choices and combinations of tests, indenters and major loads. For the EN-24 the C scale was found to be the most suitable for getting the desired information regarding the hardness of the material against 150kgf load with diamond type indenter where it was found the result mentioned below:

OBSERVATIONS

Material of Test piece- EN 24

Thickness of test piece- 25mm x 35mm x 8mm

Hardness Scale used- HRC

Minor Load- 150Kgf / N1471

After performing the above tests of XRF and Hardness, the workpiece can now be machined at the CNC milling machine. Both the above tests helped us to find the suitable tool & insert using which we need to machine the workpiece at CNC.

The machining was performed on a 5 axis CNC milling machine, where facing operation was performed at first on the top and bottom surfaces where it was machined it till 0.25mm on each side. The thickness of the material has been removed from both surfaces to make it flat across the total area of the top and bottom sides of the workpiece. Also, it was machined the two sides LH & RH and removed 0.5mm on each side where on total 1mm thickness of material removal has been carried out after which now the workpiece dimension becomes 290mm* 134mm* 50mm (L*B*H). And now the workpiece is ready for the final experiment work to be done.

Experimental Setup

The experimental setup used in the study has been described below section.

Selection of machine & tool

CNC (Computer Numerical Control) machining refers to the process of removing the material with high-speed precision machines that make use of a wide range of cutting tools. 5-axis machining refers to a machine's ability to move a tool or a part in five different axes simultaneously. Basic machining operates on three primary axes: X, Y, and Z; However, a 5-axis CNC machining tool can rotate two additional axes, A and B, which give the cutting tool a multidirectional approach. In the simplest terms, 5-axis machining involves using a CNC to move a part or cutting tool along five different axes simultaneously. This enables the machining of very complex parts. Therefore, most industries use such machines for mass production, which and where the energy can be minimized if we follow the correct process parameter. I performed 45 different experiments for my work using 16mm dia tool holder with Carbide insert (11T308AH725) to get the energy consumption regarding the time at all different specified parameters.

Selection of parameters for main experiment

The critical parameters used in the experiment are speed, feed and depth of cut. The speed range selected for the material was 100, 150 and 200 rpm. The feed value used was 0.1, 0.13 and 0.15mm and depth of cut used was 0.25,



**Sudeep Kumar Singh and A. M. Mohanty**

0.5, 0.75, 1 and 1.25. The output values of surface roughness, MRR and power consumed values were measured from the respective instrument. The parameters used are presented in the table below

Optimization via ANN

Bayesian regularization learning technique was used for training the data. It is a network training function that updates the weight and bias values according to Levenberg-Marquardt optimization. It minimizes a combination of squared errors and then determines the correct combination so as to produce a network that generalizes well.

RESULT AND DISCUSSION

After conducting the CNC milling tests for different speed, feed and depth of cut values, it was found that for the predicted values of speed, feed and depth of cut, the parameter having highest error is below 0.2%. The results obtained from the ANN shows significant agreement with the experimental values. This data can be useful in predicting optimized values of input parameters based on minimum surface roughness, power consumed and highest MRR. A simplified machining strategy based on face milling operations. The tool wear rate was not considered in the experiment. A multi-variable energy optimization was carried out considering the following process parameters (cutting speed, feed rate and radial depth of cut). It was demonstrated that the proper cutting parameters selection can be an effective way for reducing both the consumed energy and the production time. This analysis was carried out in order to analyze the effects on energy oriented process parameters optimization in the next machine tool generation that surely will be equipped with eco-auxiliaries. Since adopted methodology considers the properties of the machine tool and can be quite easily configured, it could be used to analyze, from the energy perspective, different machine tool layouts and design alternatives during the early machine conception. This would surely be the objective of further research studies.

CONCLUSION AND FUTURE SCOPE

The current research work has successfully put deep insight on the relation between the different parameters involved. The ANN algorithm is capable of predicting input parameters for any feasible set of output parameters involved. More experimental investigation on the aforementioned area can bring better results in terms of better correlation between, the input and output parameters. Future scope may include determining the most influencing parameter influencing the surface roughness, MRR and power consumed. Time of machining can be included in the optimization function to ultimately reduce the cost of machining.

REFERENCES

1. Singh, S. K., and A. M. Mohanty. "A Survey of Automated Process Planning Approaches in Machining." *International Journal of Engineering and Management Research (IJEMR)* 8.6 (2018): 81-88.
2. Ye, Yingxin, et al. "A knowledge based intelligent process planning method for controller of computer numerical control machine tools." *Journal of Intelligent Manufacturing* (2018): 1-17.
3. Dambhare, S., S. Deshmukh, and A. Borade. "Machining parameter optimization in turning process for sustainable manufacturing." *International Journal of Industrial Engineering Computations* 6.3 (2015): 327-338.
4. Asiltürk, İlhan, and Harun Akkuş. "Determining the effect of cutting parameters on surface roughness in hard turning using the Taguchi method." *Measurement* 44.9 (2011): 1697-1704.
5. Deng, Zhaohui, et al. "Optimization of process parameters for minimum energy consumption based on cutting specific energy consumption." *Journal of cleaner production* 166 (2017): 1407-1414.
6. Li, Congbo, et al. "A method integrating Taguchi, RSM and MOPSO to CNC machining parameters optimization for energy saving." *Journal of Cleaner Production* 135 (2016): 263-275.
7. Pimenov, Danil Y., et al. "Optimization of Face Milling Parameters Considering Wear and Tool Life of Cutters to Improve the Quality, Cost and Power Consumption." (2018).





Sudeep Kumar Singh and A. M. Mohanty

8. Li, Congbo, et al. "A comprehensive approach to parameters optimization of energy-aware CNC milling." *Journal of Intelligent Manufacturing* (2016): 1-16.
9. Ic, Yusuf Tansel, et al. "Optimisation of cutting parameters for minimizing carbon emission and maximising cutting quality in turning process." *International Journal of Production Research* 56.11 (2018): 4035-4055.
10. Zhou, Guanghui, et al. "Cutting parameter optimization for machining operations considering carbon emissions." *Journal of Cleaner Production* 208 (2019): 937-950.
11. Bi, Z. M., and Lihui Wang. "Optimization of machining processes from the perspective of energy consumption: A case study." *Journal of manufacturing systems* 31.4 (2012): 420-428.
12. Ma, Feng, et al. "An energy consumption optimization strategy for CNC milling." *The International Journal of Advanced Manufacturing Technology* 90.5-8 (2017): 1715-1726.
13. Li, Congbo, et al. "A method integrating Taguchi, RSM and MOPSO to CNC machining parameters optimization for energy saving." *Journal of Cleaner Production* 135 (2016): 263-275.
14. Pimenov, Danil Y., et al. "Optimization of Face Milling Parameters Considering Wear and Tool Life of Cutters to Improve the Quality, Cost and Power Consumption." (2018).
15. Hu, Luoke, et al. "Optimising the machining time, deviation and energy consumption through a multi-objective feature sequencing approach." *Energy conversion and management* 160 (2018): 126-140.
16. Jayal, A. D., et al. "Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels." *CIRP Journal of Manufacturing Science and Technology* 2.3 (2010): 144-152.
17. Wang, S., et al. "A systematic approach of process planning and scheduling optimization for sustainable machining." *Journal of Cleaner Production* 87 (2015): 914-929.
18. Zhou, Guang-hui, et al. "Multi-objective process route optimization considering carbon emissions." *The International Journal of Advanced Manufacturing Technology* 96.1-4 (2018): 1195-1213.
19. Cuixia, Z. H. A. N. G., L. I. U. Conghu, and Z. H. A. O. Xi. "Optimization control method for carbon footprint of machining process." *The International Journal of Advanced Manufacturing Technology* 92.5-8 (2017): 1601-1607.
20. Zhou, Guang-hui, et al. "Multi-objective process route optimization considering carbon emissions." *The International Journal of Advanced Manufacturing Technology* 96.1-4 (2018): 1195-1213.
21. Dong, Zhaorui, Qiong Liu, and Qin Li. "Optimization of Machining Process Planning for Carbon Reduction." *ASME 2018 13th International Manufacturing Science and Engineering Conference*. American Society of Mechanical Engineers, 2018
22. Zhou, Guang-hui, et al. "Multi-objective process route optimization considering carbon emissions." *The International Journal of Advanced Manufacturing Technology* 96.1-4 (2018): 1195-1213.
23. Mori, Masahiko, et al. "A study on energy efficiency improvement for machine tools." *CIRP annals* 60.1 (2011): 145-148.
24. Wu, Zijian, et al. "Energy-efficiency-oriented scheduling in smart manufacturing." *Journal of Ambient Intelligence and Humanized Computing* 10.3 (2019): 969-978.
25. Ye, Yingxin, et al. "A knowledge based intelligent process planning method for controller of computer numerical control machine tools." *Journal of Intelligent Manufacturing* (2018): 1-17.
26. Zhao, G. Y., et al. "Energy consumption in machining: Classification, prediction, and reduction strategy." *Energy* 133 (2017): 142-157

Table 1.

| ROCKWELL HARDNESS | | | |
|--------------------------|-----------------|------------------|---------------------------|
| Method | Total load(Kgf) | Type of Indenter | Hardness Test scales(HRC) |
| ROCKWELL (HR) | 150 | Diamond | 33.8 |
| | 150 | Diamond | 33.6 |
| | 150 | Diamond | 32.8 |
| | 150 | Diamond | 33.7 |
| | 150 | Diamond | 35.8 |





Sudeep Kumar Singh and A. M. Mohanty

Table 2.

| Sl.no | Depth of Cut | FEED/TOOTH | Feed Rate | Cutting Speed | RPM |
|-------|--------------|------------|-------------|---------------|-------------|
| 1 | 0.25 | 0.1 | 397.9624323 | 100 | 1989.812162 |
| 2 | 0.25 | 0.13 | 517.3511621 | 100 | 1989.812162 |
| 3 | 0.25 | 0.15 | 596.9436485 | 100 | 1989.812162 |
| 4 | 0.25 | 0.1 | 596.9436485 | 150 | 2984.718243 |
| 5 | 0.25 | 0.13 | 776.0267431 | 150 | 2984.718243 |
| 6 | 0.25 | 0.15 | 895.4154728 | 150 | 2984.718243 |
| 7 | 0.25 | 0.1 | 795.9248647 | 200 | 3979.624323 |
| 8 | 0.25 | 0.13 | 1034.702324 | 200 | 3979.624323 |
| 9 | 0.25 | 0.15 | 1193.887297 | 200 | 3979.624323 |
| 10 | 0.5 | 0.1 | 397.9624323 | 100 | 1989.812162 |
| 11 | 0.5 | 0.13 | 517.3511621 | 100 | 1989.812162 |
| 12 | 0.5 | 0.15 | 596.9436485 | 100 | 1989.812162 |
| 13 | 0.5 | 0.1 | 596.9436485 | 150 | 2984.718243 |
| 14 | 0.5 | 0.13 | 776.0267431 | 150 | 2984.718243 |
| 15 | 0.5 | 0.15 | 895.4154728 | 150 | 2984.718243 |
| 16 | 0.5 | 0.1 | 795.9248647 | 200 | 3979.624323 |
| 17 | 0.5 | 0.13 | 1034.702324 | 200 | 3979.624323 |
| 18 | 0.5 | 0.15 | 1193.887297 | 200 | 3979.624323 |
| 19 | 0.75 | 0.1 | 397.9624323 | 100 | 1989.812162 |
| 20 | 0.75 | 0.13 | 517.3511621 | 100 | 1989.812162 |
| 21 | 0.75 | 0.15 | 596.9436485 | 100 | 1989.812162 |
| 22 | 0.75 | 0.1 | 596.9436485 | 150 | 2984.718243 |
| 23 | 0.75 | 0.13 | 776.0267431 | 150 | 2984.718243 |
| 24 | 0.75 | 0.15 | 895.4154728 | 150 | 2984.718243 |
| 25 | 0.75 | 0.1 | 795.9248647 | 200 | 3979.624323 |
| 26 | 0.75 | 0.13 | 1034.702324 | 200 | 3979.624323 |
| 27 | 0.75 | 0.15 | 1193.887297 | 200 | 3979.624323 |
| 28 | 1 | 0.1 | 397.9624323 | 100 | 1989.812162 |
| 29 | 1 | 0.13 | 517.3511621 | 100 | 1989.812162 |
| 30 | 1 | 0.15 | 596.9436485 | 100 | 1989.812162 |
| 31 | 1 | 0.1 | 596.9436485 | 150 | 2984.718243 |
| 32 | 1 | 0.13 | 776.0267431 | 150 | 2984.718243 |
| 33 | 1 | 0.15 | 895.4154728 | 150 | 2984.718243 |
| 34 | 1 | 0.1 | 795.9248647 | 200 | 3979.624323 |
| 35 | 1 | 0.13 | 1034.702324 | 200 | 3979.624323 |
| 36 | 1 | 0.15 | 1193.887297 | 200 | 3979.624323 |
| 37 | 1.25 | 0.1 | 397.9624323 | 100 | 1989.812162 |





Sudeep Kumar Singh and A. M. Mohanty

| | | | | | |
|----|------|------|-------------|-----|-------------|
| 38 | 1.25 | 0.13 | 517.3511621 | 100 | 1989.812162 |
| 39 | 1.25 | 0.15 | 596.9436485 | 100 | 1989.812162 |
| 40 | 1.25 | 0.1 | 596.9436485 | 150 | 2984.718243 |
| 41 | 1.25 | 0.13 | 776.0267431 | 150 | 2984.718243 |
| 42 | 1.25 | 0.15 | 895.4154728 | 150 | 2984.718243 |
| 43 | 1.25 | 0.1 | 795.9248647 | 200 | 3979.624323 |
| 44 | 1.25 | 0.13 | 1034.702324 | 200 | 3979.624323 |
| 45 | 1.25 | 0.15 | 1193.887297 | 200 | 3979.624323 |

Table 3.

| SI.No | Time | Current R | Current Y | Current B | line power |
|-------|-------|-----------|-----------|-----------|------------|
| 1 | 30.38 | 10.8 | 9.5 | 11.8 | 7704 |
| 2 | 28.45 | 10.1 | 9.8 | 12.2 | 7704 |
| 3 | 23.65 | 10.3 | 9.5 | 13.2 | 7920 |
| 4 | 25.49 | 10.7 | 9.8 | 14.2 | 8328 |
| 5 | 20.55 | 12.3 | 11.2 | 14.9 | 9216 |
| 6 | 17.99 | 12.3 | 11.3 | 16.5 | 9624 |
| 7 | 21.8 | 12.8 | 11.2 | 16.2 | 9648 |
| 8 | 15.36 | 12.8 | 11.1 | 16.1 | 9600 |
| 9 | 17.17 | 12.8 | 10.8 | 15.8 | 9456 |
| 10 | 34.82 | 12.9 | 11.5 | 16.8 | 9888 |
| 11 | 31.85 | 12.7 | 10.4 | 16.4 | 9480 |
| 12 | 24.46 | 11.4 | 9.1 | 14.2 | 8328 |
| 13 | 23.22 | 11.9 | 9 | 13.7 | 8304 |
| 14 | 15.08 | 11.3 | 9.1 | 13.2 | 8064 |
| 15 | 17.37 | 11.7 | 9.3 | 13.3 | 8232 |
| 16 | 17.95 | 12.6 | 8.6 | 13.9 | 8424 |
| 17 | 14.98 | 12.7 | 8.6 | 13.1 | 8256 |
| 18 | 13.55 | 12.2 | 9.1 | 13.2 | 8280 |
| 19 | 32.05 | 12 | 8.9 | 13.3 | 8208 |
| 20 | 33.44 | 12.2 | 8.7 | 13.6 | 8280 |
| 21 | 23.71 | 11.2 | 9.2 | 15.6 | 8640 |
| 22 | 27.32 | 12.3 | 8.3 | 13.6 | 8208 |
| 23 | 18.83 | 11.9 | 9.1 | 13.2 | 8208 |
| 24 | 17.46 | 11.8 | 9.5 | 13 | 8232 |
| 25 | 18.36 | 11.9 | 9.6 | 13.4 | 8376 |
| 26 | 15 | 13 | 9.2 | 14.2 | 8736 |
| 27 | 7 | 12.5 | 9.3 | 10.3 | 7704 |
| 28 | 19.87 | 11.4 | 8.9 | 13.2 | 8040 |
| 29 | 10.23 | 12.1 | 9.1 | 12.7 | 8136 |
| 30 | 14.15 | 12.2 | 9.2 | 12.6 | 8160 |
| 31 | 14.34 | 12.2 | 9.2 | 13.1 | 8280 |
| 32 | 12.24 | 12.4 | 9.5 | 13.2 | 8424 |
| 33 | 1 | 14.2 | 10.5 | 16.9 | 9984 |
| 34 | 11.03 | 14.4 | 10.6 | 15.9 | 9816 |





Sudeep Kumar Singh and A. M. Mohanty

| | | | | | |
|----|-------|------|------|-------|--------|
| 35 | 6.04 | 14.3 | 10.5 | 15.6 | 9696 |
| 36 | 8.2 | 12.1 | 9.1 | 12.5 | 8088 |
| 37 | 17.51 | 11.5 | 8.8 | 13.7 | 8160 |
| 38 | 13.85 | 12.3 | 9 | 14.2 | 8520 |
| 39 | 13 | 11.9 | 8.8 | 13.1 | 8112 |
| 40 | 14.12 | 14.4 | 11 | 15.6 | 9840 |
| 41 | 15.73 | 12.5 | 8.9 | 14.11 | 8522.4 |
| 42 | 10.59 | 14.3 | 10 | 14.8 | 9384 |
| 43 | 13.1 | 14 | 9.6 | 14.1 | 9048 |
| 44 | 9 | 14.3 | 9.5 | 14 | 9072 |
| 45 | 9.42 | 13.4 | 9.7 | 12.8 | 8616 |

Table 4.

| Sl. No. | Roughness-1 | Roughness-2 | Roughness-3 |
|---------|-------------|-------------|-------------|
| 1 | 0.4999 | 0.47 | 0.569 |
| 2 | 1.08 | 0.882 | 0.663 |
| 3 | 0.8 | 0.598 | 0.73 |
| 4 | 0.544 | 0.891 | 0.913 |
| 5 | 0.643 | 0.633 | 0.64 |
| 6 | 0.634 | 0.607 | 0.516 |
| 7 | 0.971 | 0.715 | 0.612 |
| 8 | 0.87 | 0.738 | 0.748 |
| 9 | 0.648 | 0.58 | 0.535 |
| 10 | 0.971 | 1.01 | 0.982 |
| 11 | 0.72 | 0.696 | 0.681 |
| 12 | 0.487 | 0.56 | 0.581 |
| 13 | 0.516 | 0.614 | 0.545 |
| 14 | 0.801 | 0.807 | 0.81 |
| 15 | 0.624 | 0.68 | 0.737 |
| 16 | 0.511 | 0.459 | 0.457 |
| 17 | 0.271 | 0.442 | 0.455 |
| 18 | 0.616 | 0.616 | 1.05 |
| 19 | 0.991 | 0.94 | 0.655 |
| 20 | 0.79 | 0.786 | 0.776 |
| 21 | 1.44 | 1.43 | 1.42 |
| 22 | 1.02 | 1.04 | 1.08 |
| 23 | 1.32 | 0.947 | 0.943 |
| 24 | 1.53 | 1.51 | 1.44 |
| 25 | 0.664 | 0.674 | 0.675 |





Sudeep Kumar Singh and A. M. Mohanty

| | | | |
|----|--------|--------|--------|
| 26 | 1.5 | 1.59 | 1.6 |
| 27 | 2.25 | 2.24 | 2.26 |
| 28 | 0.945 | 0.971 | 0.959 |
| 29 | 3.93 | 3.93 | 3.97 |
| 30 | 6.75 | 6.82 | 6.62 |
| 31 | 0.185 | 0.125 | 0.0985 |
| 32 | 0.119 | 0.0927 | 0.0458 |
| 33 | 0.1 | 0.173 | 0.0338 |
| 34 | 0.0955 | 0.0591 | 0.0258 |
| 35 | 0.0707 | 0.184 | 0.157 |
| 36 | 0.177 | 0.0229 | 0.158 |
| 37 | 0.0456 | 0.174 | 0.142 |
| 38 | 0.114 | 0.152 | 0.0634 |
| 39 | 0.2 | 0.0452 | 0.11 |
| 40 | 0.0352 | 0.129 | 0.164 |
| 41 | 0.0997 | 0.119 | 0.157 |
| 42 | 0.172 | 0.0422 | 0.0413 |
| 43 | 0.0948 | 0.188 | 0.0533 |
| 44 | 0.191 | 0.0107 | 0.0914 |
| 45 | 0.0303 | 0.0279 | 0.129 |

Table 5.

| Sl.no | Time | Current R | Current Y | Current B | line power |
|-------|-------|-----------|-----------|-----------|------------|
| 1 | 30.38 | 10.8 | 9.5 | 11.8 | 7704 |
| 2 | 28.45 | 10.1 | 9.8 | 12.2 | 7704 |
| 3 | 23.65 | 10.3 | 9.5 | 13.2 | 7920 |
| 4 | 25.49 | 10.7 | 9.8 | 14.2 | 8328 |
| 5 | 20.55 | 12.3 | 11.2 | 14.9 | 9216 |
| 6 | 17.99 | 12.3 | 11.3 | 16.5 | 9624 |
| 7 | 21.8 | 12.8 | 11.2 | 16.2 | 9648 |
| 8 | 15.36 | 12.8 | 11.1 | 16.1 | 9600 |
| 9 | 17.17 | 12.8 | 10.8 | 15.8 | 9456 |
| 10 | 34.82 | 12.9 | 11.5 | 16.8 | 9888 |
| 11 | 31.85 | 12.7 | 10.4 | 16.4 | 9480 |
| 12 | 24.46 | 11.4 | 9.1 | 14.2 | 8328 |
| 13 | 23.22 | 11.9 | 9 | 13.7 | 8304 |
| 14 | 15.08 | 11.3 | 9.1 | 13.2 | 8064 |
| 15 | 17.37 | 11.7 | 9.3 | 13.3 | 8232 |
| 16 | 17.95 | 12.6 | 8.6 | 13.9 | 8424 |
| 17 | 14.98 | 12.7 | 8.6 | 13.1 | 8256 |
| 18 | 13.55 | 12.2 | 9.1 | 13.2 | 8280 |
| 19 | 32.05 | 12 | 8.9 | 13.3 | 8208 |





Sudeep Kumar Singh and A. M. Mohanty

| | | | | | |
|----|-------|------|------|-------|--------|
| 20 | 33.44 | 12.2 | 8.7 | 13.6 | 8280 |
| 21 | 23.71 | 11.2 | 9.2 | 15.6 | 8640 |
| 22 | 27.32 | 12.3 | 8.3 | 13.6 | 8208 |
| 23 | 18.83 | 11.9 | 9.1 | 13.2 | 8208 |
| 24 | 17.46 | 11.8 | 9.5 | 13 | 8232 |
| 25 | 18.36 | 11.9 | 9.6 | 13.4 | 8376 |
| 26 | 15 | 13 | 9.2 | 14.2 | 8736 |
| 27 | 7 | 12.5 | 9.3 | 10.3 | 7704 |
| 28 | 19.87 | 11.4 | 8.9 | 13.2 | 8040 |
| 29 | 10.23 | 12.1 | 9.1 | 12.7 | 8136 |
| 30 | 14.15 | 12.2 | 9.2 | 12.6 | 8160 |
| 31 | 14.34 | 12.2 | 9.2 | 13.1 | 8280 |
| 32 | 12.24 | 12.4 | 9.5 | 13.2 | 8424 |
| 33 | 1 | 14.2 | 10.5 | 16.9 | 9984 |
| 34 | 11.03 | 14.4 | 10.6 | 15.9 | 9816 |
| 35 | 6.04 | 14.3 | 10.5 | 15.6 | 9696 |
| 36 | 8.2 | 12.1 | 9.1 | 12.5 | 8088 |
| 37 | 17.51 | 11.5 | 8.8 | 13.7 | 8160 |
| 38 | 13.85 | 12.3 | 9 | 14.2 | 8520 |
| 39 | 13 | 11.9 | 8.8 | 13.1 | 8112 |
| 40 | 14.12 | 14.4 | 11 | 15.6 | 9840 |
| 41 | 15.73 | 12.5 | 8.9 | 14.11 | 8522.4 |
| 42 | 10.59 | 14.3 | 10 | 14.8 | 9384 |
| 43 | 13.1 | 14 | 9.6 | 14.1 | 9048 |
| 44 | 9 | 14.3 | 9.5 | 14 | 9072 |
| 45 | 9.42 | 13.4 | 9.7 | 12.8 | 8616 |

Table 4.

| Sl. No. | Roughness-1 | Roughness-2 | Roughness-3 |
|---------|-------------|-------------|-------------|
| 1 | 0.4999 | 0.47 | 0.569 |
| 2 | 1.08 | 0.882 | 0.663 |
| 3 | 0.8 | 0.598 | 0.73 |
| 4 | 0.544 | 0.891 | 0.913 |
| 5 | 0.643 | 0.633 | 0.64 |
| 6 | 0.634 | 0.607 | 0.516 |
| 7 | 0.971 | 0.715 | 0.612 |
| 8 | 0.87 | 0.738 | 0.748 |
| 9 | 0.648 | 0.58 | 0.535 |
| 10 | 0.971 | 1.01 | 0.982 |
| 11 | 0.72 | 0.696 | 0.681 |
| 12 | 0.487 | 0.56 | 0.581 |





Sudeep Kumar Singh and A. M. Mohanty

| | | | |
|----|--------|--------|--------|
| 13 | 0.516 | 0.614 | 0.545 |
| 14 | 0.801 | 0.807 | 0.81 |
| 15 | 0.624 | 0.68 | 0.737 |
| 16 | 0.511 | 0.459 | 0.457 |
| 17 | 0.271 | 0.442 | 0.455 |
| 18 | 0.616 | 0.616 | 1.05 |
| 19 | 0.991 | 0.94 | 0.655 |
| 20 | 0.79 | 0.786 | 0.776 |
| 21 | 1.44 | 1.43 | 1.42 |
| 22 | 1.02 | 1.04 | 1.08 |
| 23 | 1.32 | 0.947 | 0.943 |
| 24 | 1.53 | 1.51 | 1.44 |
| 25 | 0.664 | 0.674 | 0.675 |
| 26 | 1.5 | 1.59 | 1.6 |
| 27 | 2.25 | 2.24 | 2.26 |
| 28 | 0.945 | 0.971 | 0.959 |
| 29 | 3.93 | 3.93 | 3.97 |
| 30 | 6.75 | 6.82 | 6.62 |
| 31 | 0.185 | 0.125 | 0.0985 |
| 32 | 0.119 | 0.0927 | 0.0458 |
| 33 | 0.1 | 0.173 | 0.0338 |
| 34 | 0.0955 | 0.0591 | 0.0258 |
| 35 | 0.0707 | 0.184 | 0.157 |
| 36 | 0.177 | 0.0229 | 0.158 |
| 37 | 0.0456 | 0.174 | 0.142 |
| 38 | 0.114 | 0.152 | 0.0634 |
| 39 | 0.2 | 0.0452 | 0.11 |
| 40 | 0.0352 | 0.129 | 0.164 |
| 41 | 0.0997 | 0.119 | 0.157 |
| 42 | 0.172 | 0.0422 | 0.0413 |
| 43 | 0.0948 | 0.188 | 0.0533 |
| 44 | 0.191 | 0.0107 | 0.0914 |
| 45 | 0.0303 | 0.0279 | 0.129 |





Sudeep Kumar Singh and A. M. Mohanty

Table 5. Optimized Data through ANN

| PREDICTED INPUT DATA | | | OBSERVED INPUT DATA | | | ERROR | | | EXPERIMENTAL OUTPUT | | |
|----------------------|----------|--------------|---------------------|------|--------------|--------------|--------------|--------------|---------------------|-------|-------------|
| Speed | Feed | Depth of cut | Speed | Feed | Depth of cut | Speed | Feed | Depth of cut | Surface Roughness | Power | MRR |
| 149.9996 | 0.114568 | 1.074353469 | 150 | 0.1 | 1.25 | 0.000438032 | -0.014567807 | 0.175646531 | 0.1094 | 9840 | 26.42636294 |
| 99.99973 | 0.121168 | 0.327984845 | 100 | 0.1 | 0.25 | 0.00027499 | -0.021168015 | -0.077984845 | 0.512966667 | 7704 | 17.64318631 |
| 149.9996 | 0.1323 | 0.561697623 | 150 | 0.13 | 0.5 | 0.000364145 | -0.002299978 | -0.061697623 | 0.806 | 8064 | 71.08753316 |
| 199.9995 | 0.126713 | 0.194779384 | 200 | 0.15 | 0.25 | 0.000464609 | 0.023286513 | 0.055220616 | 0.587666667 | 9456 | 31.21723937 |
| 149.9997 | 0.13441 | 1.291749524 | 150 | 0.15 | 1.25 | 0.000321994 | 0.015590417 | -0.041749524 | 0.085166667 | 9384 | 35.23484021 |
| 150.0003 | 0.117485 | 0.441260918 | 150 | 0.1 | 0.25 | -0.000323041 | -0.017485062 | -0.191260918 | 0.782666667 | 8328 | 21.02785406 |
| 199.9997 | 0.125491 | 0.729025418 | 200 | 0.15 | 0.75 | 0.00029565 | 0.024509343 | 0.020974582 | 2.25 | 7704 | 13.16944688 |
| 100 | 0.135761 | 0.986670376 | 100 | 0.13 | 1 | -0.00001842 | -0.005761172 | 0.013329624 | 3.943333333 | 8136 | 29.18004085 |
| 100.0014 | 0.140321 | 1.004808598 | 100 | 0.15 | 1 | -0.001367506 | 0.009679136 | -0.004808598 | 6.73 | 8160 | 21.09593376 |
| 99.99996 | 0.130365 | 1.217727135 | 100 | 0.15 | 1.25 | 0.00004153 | 0.01963476 | 0.032272865 | 0.1184 | 8112 | 28.70264064 |



Fig.1. Material Cutting



Fig.2. XRF Testing

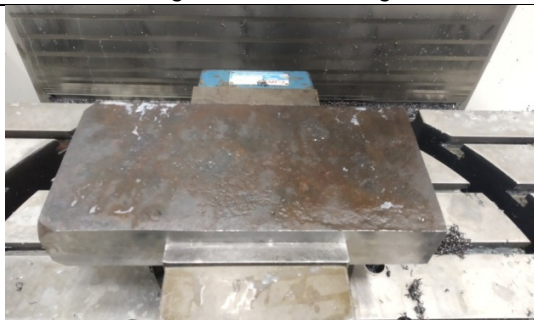


Fig.3. Machining of w/p





Sudeep Kumar Singh and A. M. Mohanty

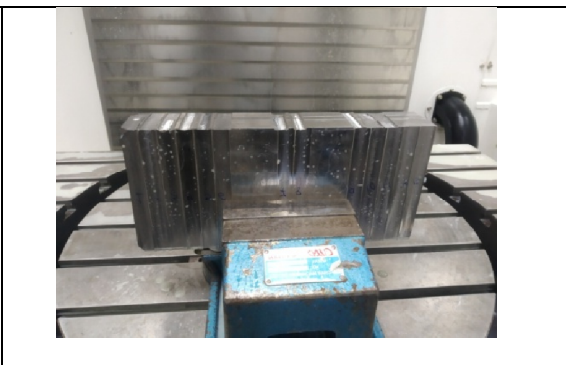
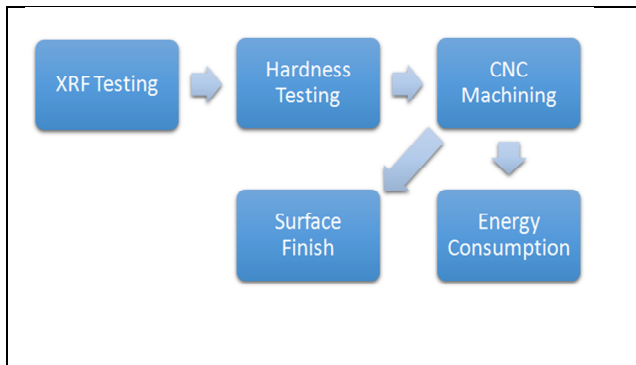


Fig.4. Selection of machine & tool

Fig.5. Selection of machine

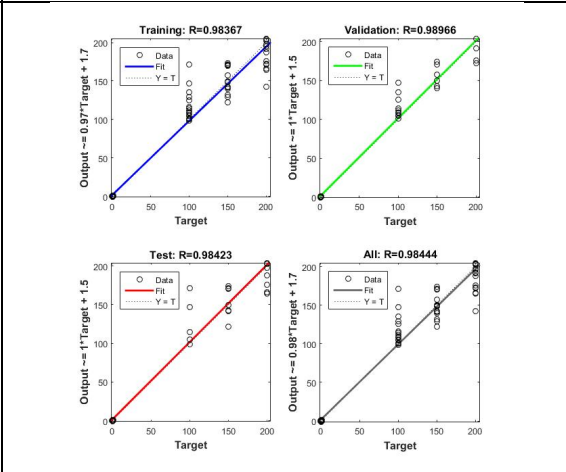


Fig.6 Selection of parameters for main experiment

Fig.7.

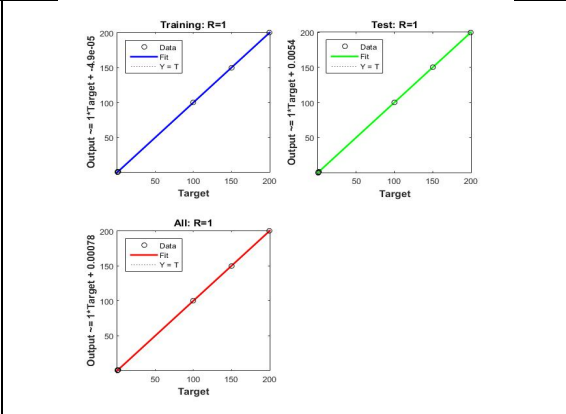
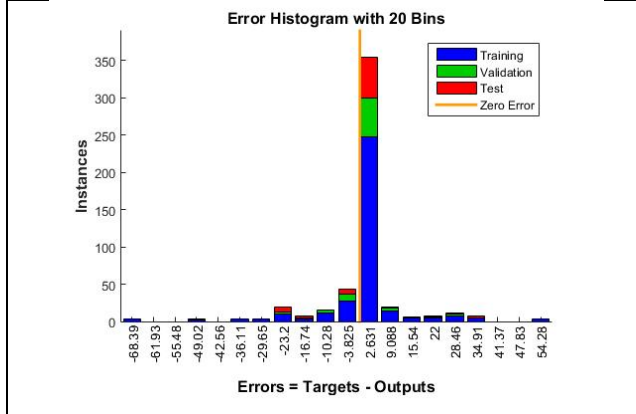


Fig.8.

Fig.9.





Sudeep Kumar Singh and A. M. Mohanty

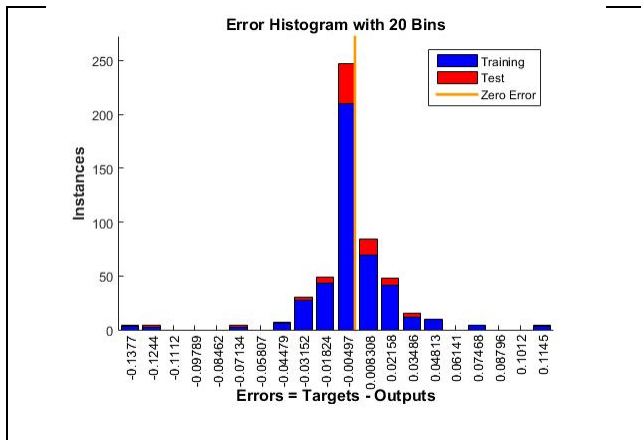


Fig.10.

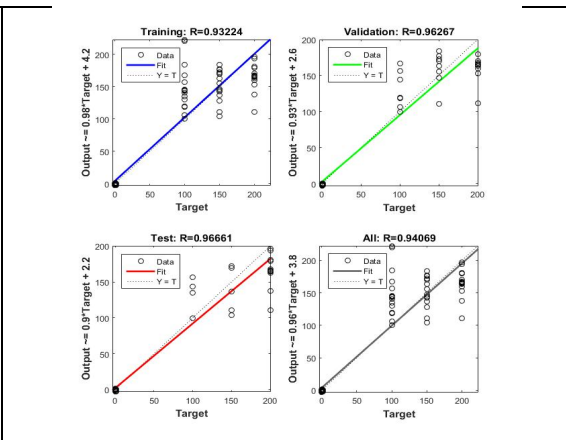


Fig.11

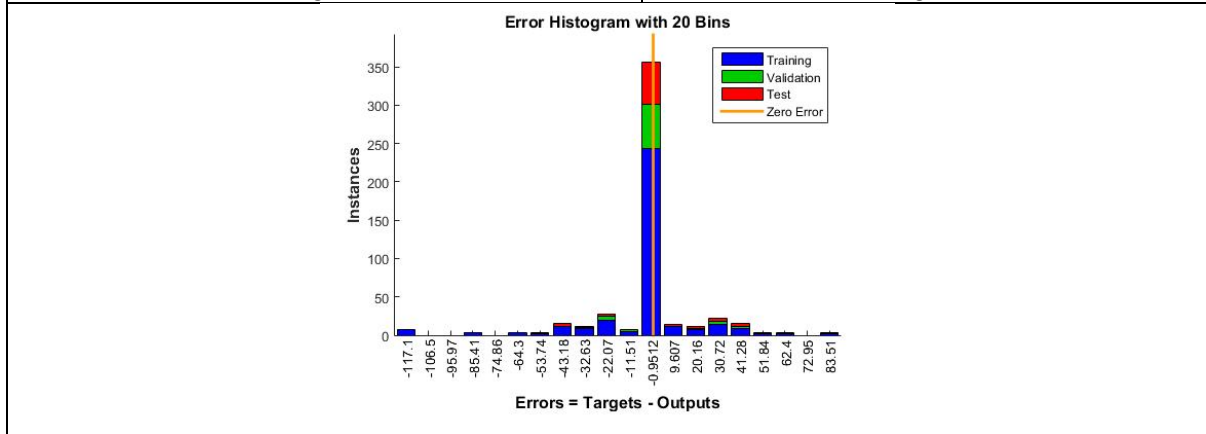


Fig.12.





Risk and Return Analysis of National Stock Exchanges

Pramod Kumar Patjoshi*

Centurion University of Technology and Management, Odisha, India.

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Pramod Kumar Patjoshi

Centurion University of Technology and Management,
Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Stock market is one of the vital indicators for economic development in a country. Different companies stocks use to trade in the stock market which involves both risk and return. The investors invest in the stock market with an expected return in the future. The actual returns of different stocks differ from expected return due to volatility in the stock market. When the volatility of the stock market is high the risk involves in the investment goes high. There is no fixed return and risk in the stock market. So trading in stock market is very risky for investors. It requires proper analysis of risk and return. Therefore the primary objective of this research is risk and returns analysis of major indices of National Stock Exchange. The risk and return have analyzed by considering the daily closing value of major indices. The study is centered on secondary data. The data for the study has been composed from the NSE website over a period of 2 years from January 1, 2020 to December 31, 2021. For achieving the above objective in addition to test the hypothesis, various methods like correlation, descriptive statistics and t test have been employed. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth.

Keywords: Risk, Return, National Stock Exchange, Correlation, t test

INTRODUCTION

Stock market is one of the vital indicators for economic development in a country. Different companies stocks use to trade in the stock market which involves both risk and return. The investors invest in the stock market with an expected return in the future. The actual returns of different stocks differ from expected return due to volatility in the stock market. When the volatility of the stock market is high the risk involves in the investment goes high. There is no fixed return and risk in the stock market. So trading in stock market is very risky for investors. It requires proper analysis of risk and return. So in the competitive world researchers are also doing the analysis of volatile stock market. This research will be help for investors to get more return from their investment. Bombay Stock Exchange (BSE) and National Stock exchange (NSE) are the two most important stock exchanges in Indian stock market (Patjoshi, 2020).





Pramod Kumar Patjoshi

LITERATURE REVIEW

Vikkraman and Varadharajan (2009), analysed that return can be maximised by properly analysing the risk. They have taken beta and other statistical model for the analysis. On the other hand Patjoshi (2011) analysed volatility in Indian stock market by taking various indices of BSE and NSE. However Nicholas and Nicholas (2011) studied in European stock market. They tried to find out the deviation of volatility in the crises period. They found that most of the stocks show negative and statistically insignificant leverage belongings. While Ratna (2013) has analysed the risk return by considering IT stocks and banking Stocks for the analysis. The result suggested holding the stock for a longer period of time to get good amount of return. Similarly Setiawan *et.al*, (2013) have taken Syariah stocks and orthodox stocks for the analysis. They have taken risk and return into consideration. They did not find any significant relation between risk and weekly return.

On the other hand Ansar *et.al*, (2014), have used “A-Y Model” for their study. They tried to find the performance of bullish and bearish market by analysing risk and return of different portfolios. While Sharma *et.al*, (2012) analysed the risk return trade-off between the stocks of South Asia Stock exchanges. They found that in South Asian countries high returns and rational risk are complicated. Similarly Shanmugasundram and Benedict (2013) analysed the risk and return of sectoral indices and Nifty. They used t-test and ANOVA for the study. Again Swarna Lakshmi, (2013) found the volatility pattern in different sectoral indices of Indian stock market. Autoregressive Conditional Heteroskedasticity (ARCH) an econometric model is used for the study. Eleven different sectoral indices have been taken for the period of 2008 to 2012. The result shows that the volatility was very high in reality sector and it was lowest in banking sector for the said period.

Patjoshi and Tanty (2016) analysed the stock market volatility in BSE and NSE of India While Gahan, Mantri, Parida and Sanyal (2012) analysed the volatility pattern in Indian stock market for both pre and post derivative period. They have taken daily closing return value of BSE Sensex and NSE Nifty for the period from 1992 to 2012 and 1995 to 2012. They have calculated volatility by taking the different structure of volatility such as perseverance, irregularity etc. for both pre and post derivative period. They found that the volatility of post derivative period is lesser than pre derivative period. They also found that the current news has more influence in the volatility in the post derivative period than the pre derivative period. Alternatively Patjoshi (2016) investigated the issue and challenges faced by the Indian Stock Market. Similarly Patjoshi (2016) has done the research in Indian stock market. He has taken Sensex and banking stocks indices to find the risk and return for the analysis. Similarly; Patjoshi and Tanty (2017) scrutinizes the volatility of 30 companies of BSE SENSEX. They have taken daily return into consideration to find the volatility. Patjoshi and Mishra (2021) measure the volatility and have taken as initiative to focus on measuring the effect of volatility in crude oil prices on share prices of major petroleum companies in the Indian stock market.

Likewise, Patjoshi and Tripathy (2020) studied the investment alternatives for the people and their preferences towards investments of rural investors from the Barang Block, Odisha, India. Similarly, Patjoshi, Nandini and Tripathy (2020) studied the relationship between Sensex and selected international stock market using different tools of correlation and regression. While, Patjoshi and Mishra (2021) measure the volatility in crude oil prices and its impact of share prices of major petroleum companies in the Indian Stock Market. Patjoshi (2020) studied the risk and return of biotechnology companies share and also the impact of these shares return on Sensex.in Bombay stock market. Similarly, Patjoshi and Tripathy (2020) studied the awareness of mutual funds and investors perception of investors towards investment in Indian mutual funds

Objectives of the Study

- a. To study the risks and returns comprise of major indices of National Stock Exchange.
- b. To analyse the comparative risks & returns of sample indices of National Stock Exchange.





Pramod Kumar Patjoshi

Hypothesis of the Study

Ho: There is no significant difference between returns of NSE 50 and major indices of NSE.

Methodology and Tests Used in the Study

In this major indices of National Stock Exchange have been used to examine the risk return trade off. The sample indices are NSE 50, NSE 100, NSE 200 and NSE 500. The risks and returns have examined by using the daily closing value all the sample indices. The study is based on secondary data. The data for the analysis has taken from the NSE website over a period of 2 years from January 1, 2020 to December 31, 2021. For satisfying the above objectives and for testing hypothesis, different methods like correlation, descriptive statistics and t test have been adopted in the study.

Risk and Return Analysis of Major Indices of National Stock Exchange

Table-1 indicates the results of descriptive statistics of daily market returns of major indices of National Stock Exchange from January 1, 2020 to December 31, 2021. It has depicted in the table -1 that average daily returns of all sample indices i.e NSE 50, NSE 100, NSE, 200 and NSE 500 displayed positive returns. The average daily returns recorded highest of 0.0822 for NSE 500, however it recorded lowest of 0.0697 for NSE 50. Thus from the above certainly recommend that average daily return of NSE 50 has performed and provided lower return than that of all other sample indices returns over the study period. In the case of the standard deviation of NSE 50 is uppermost as compare to all sample indices returns. Therefore NSE 50 involves higher risk than that of all other indices returns, while NSE 500 return involves lower risk among all the sample indices as the standard deviation of NSE 500 recorded lowest of 1.5836 during the study period. The daily returns have fluctuated between -13.9038 to 8.4003, -13.6951 to 8.0907, -13.7440 to 7.8009, -13.7063 to 7.4094 for NSE 50, NSE 100, NSE, 200 and NSE 500 respectively for the study period. The daily returns distribution of all sample indices are found to be negatively skewed.

Correlation between Major Indices of National Stock Exchange

The Table-2 explains the correlation matrix for daily returns of major indices of National Stock Exchange from January 1, 2020 to December 31, 2021. Table-2 shows the correlation between average daily return of major indices of National stock exchange. It can found from above table that the entire sample indices of National Stock Exchange average daily returns are highly correlated among them.

Analysis of t-Test: Paired of NSE 50 and NSE 100

Table 3 shows the t test result of NSE 50 and NSE 100 from January 1, 2020 to December 31, 2021. The t test results reflects that NSE 50 has shown lower return as compared to that of the NSE 100; leading to the conclusion that NSE 50 has not performed better and provided lower returns. Conversely, higher variance for NSE 50 daily returns as compared to NSE 100 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9982 signifies positive correlation between both the indices. The p-value of 0.3727, which is more than 0.05, indicates that there is no significant difference in the daily returns of NSE 50 and NSE 100 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of NSE 50 and sample indices of NSE) is accepted.

Analysis of t-Test: Paired of NSE 50 and NSE 200

Table 4 shows the t test result of NSE 50 and NSE 200 from January 1, 2020 to December 31, 2021. The t test results reflects that NSE 50 has shown lower return as compared to that of the NSE 200; leading to the conclusion that NSE 50 has not performed better and provided lower returns. Conversely, higher variance for NSE 50 daily returns as compared to NSE 200 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9887 signifies positive correlation between both the indices. The p-value of 1.6479, which is more than 0.05, indicates that there is no significant difference in the daily returns of NSE 50 and NSE 200 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of NSE 50 and sample indices of NSE 50) is accepted.



**Pramod Kumar Patjoshi****Analysis of t-Test: Paired of NSE 50 and NSE 500**

Table 5 shows the t test result of NSE 50 and NSE 500 from January 1, 2020 to December 31, 2021. The t test results reflects that NSE 50 has shown lower return as compared to that of the NSE 500; leading to the conclusion that NSE 50 has not performed better and provided lower returns. Conversely, higher variance for NSE 50 daily returns as compared to NSE 500 daily returns undoubtedly specifies that former involves more risky than the latter. Again, the correlation value is 0.9907 signifies positive correlation between both the indices. The p-value of 0.1094, which is more than 0.05, indicates that there is no significant difference in the daily returns of NSE 50 and NSE 500 at 5 percent level of significance. Consequently here the null hypothesis (there is no significant difference between average daily returns of NSE 50 and sample indices of NSE 50) is accepted.

CONCLUSION

All the sample indices have displayed positive returns. By comparing different sample indices, it found that NSE 50 has not performed well than that of all sample indices return over the study period. In the circumstance of the standard deviation of NSE 50 has higher standard deviation as compared to all sample indices. Consequently it designates that investment in NSE 50 involves higher risk than that of all other indices returns. The average daily return of NSE 50 is highly correlated with all sample indices' average daily returns. It has found from the t test that there is no significant difference between returns of NSE 50 and sample indices of NSE; therefore the null hypothesis (there is no significant difference between returns of NSE 50 and sample indices of NSE) is accepted. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth. This paper fulfills sustainable development goals (SDGs) 8: Decent Work and Economic Growth.

REFERENCES

1. Ansar Mahmood *et.al*, (2014). A risk-return based model to measure the performance of portfolio management. Management Science Letters, 4.
2. Shanmugasundram, G. and Benedict, D. J. (2013). "Volatility of the Indian sectoral indices-A study with reference to national stock exchange," International Journal of Marketing, Financial Services & Management Research, vol. 2, no. 8, pp. 1-11..
3. Lakshmi P. S. (2013). "Volatility patterns in various sectoral indices in Indian stock market," Global Journal of Management and Business Studies, vol. 3, no. 8, pp. 879-886..
4. Patjoshi, P.K. (2016). "Indian Stock Market – Practices, Issues and Challenges" Innovative Professional Science & IT, Vol.3 (1), January, pp. 28-37.
5. Patjoshi, P.K. (2016). "Stability of the day of the week effect in return and in volatility evidence from Bombay Stock Market" Journal of Management Research and Analysis, 166-170.
6. Patjoshi, P.K. and Tanty, G. (2016) "A Study on Stock Market Volatility Pattern of BSE and NSE in India" Asian Journal of Management, vol.7 (3):, July - September, pp.1-8.
7. Patjoshi, P.K. (2016) , "Comparative Risk Return Analysis of Bombay Stock Market with Selected Banking Stocks in India", IRA-International Journal of Management & Social Sciences, vol. 4 (1), pp. 193-200.
8. Patjoshi, P.K. and Tanty, G. (2017). "An Empirical Analysis on Volatility Pattern of Bombay Stock Exchange (BSE)" Siddhant- Vol. 17(2), April-June, pp. 114-122.
9. Patjoshi, P.K. and Nandini, G. (2020). Stock Market Anomaly: Day of the Week Effect in Bombay Stock Exchange with the Application of GARCH Model, International Journal of Innovative Technology and Exploring Engineerin2244-49.g, Volume-9 Issue-5,
10. Patjoshi, P. K. and Nandini, G. (2020), "Comparative Risk and Return Analysis of Bombay Stock Exchanges and Steel Sector in India", Gedrag&Organisatie Review., vol-33, no-2, 2020, pp.795-802.
11. Patjoshi, P. K. (2020), "Volatility Pattern of the Cement Companies in Indian Stock Market", Gedrag&Organisatie Review., vol-33, no-2, 2020, pp. 2944- 2951





Pramod Kumar Patjoshi

12. Patjoshi, P. K. and Tripathy, P. R. (2020) Investment Alternatives And Preferences Of Rural Investors: A Case Study Of Barang Block, Odisha, India, Journal of critical, 7 (19), 5565-5571
13. Patjoshi, P. K. (2020), Empirical Risk and Return Analysis Of biotechnology Companies in Bombay Stock Market, ShodhSarita, 7(28), 77-83
14. Patjoshi and Tripathy (2020) Study on Awareness and Perception of Investors Towards Indian Mutual Fund, GEDRAG & ORGANISATIE REVIEW, 33(2), 2976-85
15. Patjoshi, P. K. Nandini, G. and Tripathy, P. R. (2021) Examining Associations between Sensex and Selected International Stock Market, Annals of the Romanian Society for Cell Biology, , 25 (4), 10285 - 10290
16. Patjoshi, P. K. and Mishra, S. (2021), Measurement of Effect of Volatility in Crude Oil Prices on Share Prices of Major Petroleum Companies in the Indian Stock Market, Natural Volatiles & Essential Oils 8(5): 11613-11622
17. Setiawan, C. (2013). Syariah and Conventional Stocks Performance of Public Companies Listed on Indonesia Stock Exchange. Journal of Accounting, Finance and Economics, 3(1), 51 – 64.
18. Sharma, G. D. *et.al*, (2012). Rewards and Risks in Stock Markets: A Case of South Asia. The International Journal of Applied Economics and Finance, 6(2), 37-52.
19. Sinha, R. (2013). An Analysis of Risk and Return in Equity Investment in Banking Sector. International Journal of Current Research, 5(8), 2336-2338.
20. Vikkraman P & Varadharajan P. (2009). Study on Risk & Return analysis of Automobile industry in India (2004-2007): Journal of Contemporary Research in Management, 5(7), 35-40

Table-1 Descriptive Statistics of the Daily Returns of Major Indices of National Stock Exchange

| Particular | NSE 50 | NSE 100 | NSE 200 | NSE 500 |
|--------------------|----------|----------|----------|----------|
| Mean | 0.0697 | 0.0712 | 0.0763 | 0.0822 |
| Standard Deviation | 1.5836 | 1.5424 | 1.5308 | 1.5039 |
| Kurtosis | 17.5171 | 18.0833 | 18.4382 | 19.1680 |
| Skewness | -1.8338 | -1.9460 | -2.0692 | -2.2179 |
| Minimum | -13.9038 | -13.6951 | -13.7440 | -13.7063 |
| Maximum | 8.4003 | 8.0907 | 7.8009 | 7.4094 |

Table-2 Correlation of NSE 50 and Different Major Indices of National Stock Exchange

| Particular | NSE 50 | NSE 100 | NSE 200 | NSE 500 |
|------------|--------|---------|---------|---------|
| NSE 50 | 1.0000 | | | |
| NSE 100 | 0.9982 | 1.0000 | | |
| NSE 200 | 0.9948 | 0.9986 | 1.0000 | |
| NSE 500 | 0.9907 | 0.9958 | 0.9991 | 1.0000 |

Table 3 t-Test: Paired of NSE 50 and NSE 100

| Particular | NSE 50 | NSE 100 |
|---------------------|---------|---------|
| Mean | 0.0697 | 0.0712 |
| Variance | 2.5078 | 2.3791 |
| Pearson Correlation | 0.9982 | |
| t Stat | -0.3250 | |
| P(T<=t) one-tail | 0.3727 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.7453 | |
| t Critical two-tail | 1.9648 | |





Pramod Kumar Patjoshi

Table 4 t-Test: Paired of NSE 50 and NSE 200

| Particular | NSE 50 | NSE 200 |
|---------------------|---------|---------|
| Mean | 0.0697 | 0.0763 |
| Variance | 2.5078 | 2.3434 |
| Pearson Correlation | 0.9948 | |
| t Stat | -0.8779 | |
| P(T<=t) one-tail | 0.1902 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.3804 | |
| t Critical two-tail | 1.9648 | |

Table 5 t-Test: Paired of NSE 50 and NSE 500

| Particulars | NSE 50 | NSE 500 |
|---------------------|---------|---------|
| Mean | 0.0697 | 0.0822 |
| Variance | 2.5078 | 2.2618 |
| Pearson Correlation | 0.9907 | |
| t Stat | -1.2311 | |
| P(T<=t) one-tail | 0.1094 | |
| t Critical one-tail | 1.6479 | |
| P(T<=t) two-tail | 0.2189 | |
| t Critical two-tail | 1.9648 | |





Prediction of Optical Properties of Limonene using Material Studio

Satyanarayan Dhal*

Centurion University of Technology & Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Satyanarayan Dhal

Centurion University of Technology & Management,
Odisha, India.

Email: satyanarayan.dhal@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Limonene is a color-less aliphatic hydrocarbon, the key constituent in the oil of citrus fruit peels [1]. Limonene is further used as the fragrance of oranges, is a flavouring agent in food manufacturing. Optical absorption spectra of solid materials are extremely valuable to be considered earlier for any industrial procedure. We have used DMol module of Material Studio to forecast the optical properties of limonene in the presence of ethanol as a solvent. One major peak having large intensity has been obtained at 7.72 eV the ultraviolet regime. The higher peak may be owing to their secondary and tertiary structure.

Keywords: Limeonene, DMol, Optical, BIOVIA, HOMO, hydrocarbon

INTRODUCTION

Limonene [1,2,3,4] is one of the utmost significant complexes obtained in the essential oils of aromatic plants. The existence of these hydrocarbons in numerous plants could be accredited as it is used as a chemical precursor in the synthesis of monoterpenes. Owing to the capability to be utilized as a medicine, limonene has been widely examined. In this paper, we have attempted to predict the optical properties of limonene using BIOVIA Material Studio[1]. Here, we have utilized the DMol3[1]. module in Material Studio to enhance the geometry optimization using the PBE exchange energy functional of GGA in density functional theory. The disadvantage of the rigidity of the crystal structure here is not allowing to use the force field COMPASS here. We have accomplished energy calculation to obtain the optical absorption spectrum of limonene in vacuum and also in presence of ethanol. This module is designed for 30 lowest excited states with their corresponding energies.

Fig 2 discovered the maximum absorption happens in limonene at a wave number of 57000 cm^{-1} which indicated an energy having 7.0670 eV, due to the larger ability to contribute electrons in the far UV region which corresponds to the secondary and tertiary structure[1]. respectively. We can differentiate various internal chromophoric groups that

42933





Satyanarayan Dhal

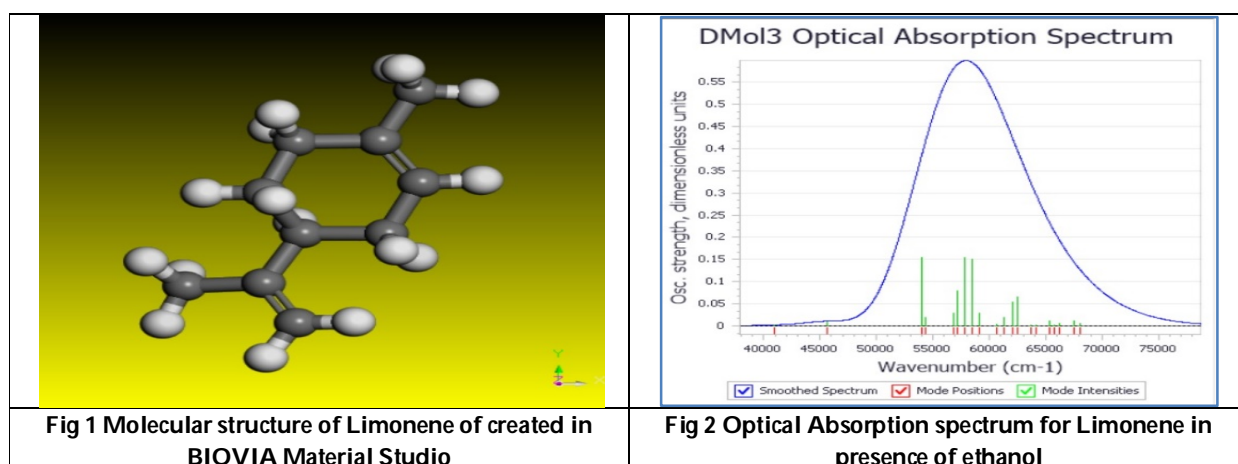
give rise to electronic absorption bands. indicates greater affluence to transfer electrons from the HOMO to LUMO during $n \rightarrow \pi^*$ transition in the presence of vacuum. Almost no change is observed in the modified peak coming in the spectrum due to the solvent presence as ethanol. DMol analysis module permitted for the calculation of the electronic states of the final output structure.

CONCLUSION

Here, we have used BioVIA Material studio with Dmol module to predict the optical absorption spectrum for limonene in presence of ethanol and vacuum. We have obtained one significant peak at 7.7 eV in the ultraviolet regime which corresponds to the tertiary component.

REFERENCES

1. Limonene | C10H16 - PubChem (nih.gov)
2. Thomas, A.F. and Bessiere, Y., 1989. Limonene. Natural Product Reports, 6(3), pp.291-309.
3. Ciriminna, R., Lomeli-Rodriguez, M., Cara, P.D., Lopez-Sanchez, J.A. and Pagliaro, M., 2014. Limonene: a versatile chemical of the bioeconomy. Chemical Communications, 50(97), pp.15288-15296.
4. KARR, L.L. and COATS, J.R., 1988. Insecticidal properties of d-limonene. Journal of Pesticide Science, 13(2), pp.287-290.
5. Crowell, P.L. and Gould, M.N., 1994. Chemoprevention and therapy of cancer by d-limonene. Critical Reviews™ in Oncogenesis, 5(1).
6. Sharma, S., Kumar, P., Chandra, R., Singh, S.P., Mandal, A. and Dondapati, R.S., 2019. Overview of BIOVIA materials studio, LAMMPS, and GROMACS. Molecular Dynamics Simulation of Nanocomposites using BIOVIA Materials Studio, Lammps and Gromacs, Amsterdam, Netherlands: Elsevier, pp.39-100.
7. Ungerer, M.J., Van Sittert, C.G.C.E., van der Westhuizen, D.J. and Krieg, H.M., 2019. Density functional theory study with and without COSMO of H2SO4 reactions in an aqueous environment for metal extraction. Journal of Computational Chemistry, 40(3), pp.591-606.
8. Chaturvedi, S.K., Ahmad, E., Khan, J.M., Alam, P., Ishtikhar, M. and Khan, R.H., 2015. Elucidating the interaction of limonene with bovine serum albumin: a multi-technique approach. Molecular BioSystems, 11(1), pp.307-316.





Spatio-Temporal Morphogenesis Road Network –Tigiria Block, Odisha

T.Pramod Kumar Patro¹, Siba Prasad Mishra^{2*}, Abhishek Mishra³ and Kamal Kumar Barik²

¹Civil Engineering Department, Centurion University of Technology and Management, Odisha, India

²Associate Professor of Civil Engineering Department, Centurion University of Technology and Management, Odisha, India.

³Assistant Engineer, Odisha Space Application Center (ORSAC), Odisha, India

Received: 09 Mar 2022

Revised: 10 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Siba Prasad Mishra

Associate Professor of Civil Engineering Department,
Centurion University of Technology and Management,
Odisha, India.

Email: 2sibamishra@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Road networks are the lifelines of a country in every aspect, whether it may be in the form of developing the country economically or defending the borders. Road networks are a key element for the economic growth of every country. It is essential to develop a strategic and sustained expansion and adequate maintenance of these networks to guarantee quality connections between the various regions of a country. Here in this study the whole process revolves around the change detection of the area in block Tigiria of Cuttack district, by which we can map out the statistics around which the new road plan differs from the past road network in Tigiria block. In the total study, the year of data considered is 2005 and 2022. The change detection majorly focuses over the statistical change in length of the road and the flow of the network throughout the block in the certain period of intervals. As roads change due to change in topography of an area but the change of roads in a particular area changes, the socio economic development in the area. Here the data of 2005 year considered first and with respect to 2005 year. The 2021 plan needs mapping and the change or growth of network is to have be geometrical observation and need plotting accordingly to detect the change.

Keywords: Connectivity.





Pramod Kumar Patro et al.,

INTRODUCTION

Sporadic rising of population has upgraded large villages to urban settlement. History depicts the cosmopolitan cities like Bengaluru, Calcutta, Bhubaneswar, Chandigarh were the evolvement of large villages during 13th –14th century. They have been sprawled to present dimensions. (Biswas et al., 2022 [1]). The modernization in 21st century have increased the network of connectivity and the number of motorized vehicle. One road contended in one village have increased to anastomosis of road network in these newly developed urbans. Role of road infrastructure plays vital role on rural growth to urban areas (van Duijne et al., 2019 [2], Sharma et al., 2022[3]). Odisha, a coastal State, have 6968 km stretch in 2018 of National Highways (NH). About extra 2500 km of SH (State Highways), have identified for upgradation to NH to reach a length of in Odisha to 9493 km, which was 4639km in the year 2014. Good roads shall surge the economy of not only Odisha but also of the nation. The study executed over the Tigiria block in Cuttack district in Odisha, housed parallel to river Mahanadi (Fig 1).

The block encompasses an area of 151 km² (148.04 km² rural and 2.72 km² urban). The Block has population of 74,639, living in 16,519 houses out of which 10.8% people dwell in Urban while rest 89.2% in rural areas (Census 2011[4]). Tigiria PS became a part of Athagarh subdivision in early 1960's with population 35053 (census 1961[5]). Tigiria tehsil has 10GP's comprising of 50 villages and a part to the Athagarh Odisha Assembly constituency. NH 65 is passing through the block connecting Athagarh and Narasinghpur. The panoramic Ansupa sweet water lake attracts tourists round the year. The area lies in the flood plain of the river Mahanadi the area is burgeoning at a faster rate (Fig 2).

Initially, the satellite imagery taken into study, the year of study of satellite imageries are of year 2005 and 2022. The tehsil-authenticated maps was helpful to record the names of the villages in Tigiria block. The village roads of the block considered to map, with the names and type of road. The initial and final year of mapping work gets over. The geometrical part of the digitized roads and their attributes of the road is geometrically calculated. The dimensional analysis of the road network for each year recorded. The new road network with dimensions with the new modified roads highlighted. Finally, comparison of road network with past existing are under comparison and their morphogenesis with geospatial changes investigated, and will show the change in road plan in course of time.

LITERATURE REVIEW

The motor vehicles in India registered in 1951, 1991 and 2011 were 0.3 million, 21.4 million and 142 million respectively (Census 2011[4]; Road transport research wing 2011-12[6]; Solanki et al, 2016[7], Hatab et al, 2021[8]). Development of transport infrastructure in towns only can be the way to achieve safe, resilient and sustainable as per SDG-11. Problems of traffic jamming, environmental pollution, and on road clashes crops up without proper road network in small towns (Tahir et al., 2013[9]; Verma et al., 2021[10]). In 21st century, the nation's urban history have mentioned remarkably in the globe but its sustainability is under Jeopardy. The focussing domain are the green buildings, smart transportation infrastructure and proportionate horizontal and vertical growth under rampant adaptation to Block chain and Cryptocurrency. With 30% growth of small towns (Census towns) from 2001 to 2011 have surged up multi fold the transport infrastructure in India, (Mukhopadhyay et al, 2021[11] Chakrabarti et al., 2021, 2022[12]).

The interconnectivity of the areas by roads in India prone to accidents. The networks need network analysis, cause of crowding, accidents to minimize the manmade on road disasters, Mukherjee S (2020)[14]. Urban mapping need focus on its stability, durability and managing by using digital data and possible to minimize, Kumar et al., (2016)[15]. Anastomosed carriage routes, need a smooth planning design and management otherwise shall result in ensuing road blockage and traffic deadness of the city (Yamin et al., 2003[15], Canterella et al., 2006[15], Das et al, 2019[16], Good speed, et al., 2021[17]). Sprawl of large villages to urban areas and increase of road network have well detection through various maps created by remote sensing (RS) and GIS tools (Bhatta 2010[18]; Sinha 2017[19]; Biswas et al, 2022[1]; Kumar et al, 2016[20]; Chaudhury et al., 2022[21]). The proper progressive planning with an innovative design by considering as an integral part accomplishment of urban traffic management using satellite data and GIS and RS software, (Cantarella et al, 1995[22], Ahamad et al, 2017[23], Scandiffo et al, 2019[24], Vicente et





Pramod Kumar Patro et al.,

al, 2022[25]). Minimum literature is available on in-block connectivity of various blocks of Odisha. Hence, it is high time to audit the road network planning of the census town urban areas, the status of the existing roads, and the management of traffic, in a backward block having less NH and SH linkage in Odisha.

METHODOLOGY

The methodology applied in the present study follows:

- Mapping of AOI (area of interest).
- Tracing and mapping of the year 2005 with statistical design of different types of roads in Tigiria block in Cuttack district, Odisha.
- Tracing and mapping of the road network for the year 2022
- Comparison of new developments, highlight the new plans in the current year. & Geometrical calculation of the design and advancement of the road plan in comparison to the annual plan 2005.

SURVEY/INVESTIGATION/EXPERIMENT/DESIGN

Mapping of AOI (area of interest)

The Cuttack district of Odisha has 298 Km². of area. It is the millennium city of Odisha housed on the bank of the river Mahanadi. The Tigiria is a block (Nuapatna declared Census town) in Cuttack occupying area 129.14Km², Population on 2020 of 73181 (density; 566 people/km²), where the whole process of road network needs enactment. Tigiria has 10 panchayats, 54 revenue villages, and 2 reserve forests. The village list (Revenue), the drainages and their population as per 2011 census is in Fig 2(a), Fig 2(b) and Table 2

The type of roads constructed in Tigiria block comprises of NH, SH, MDR (Major/ODR under PMGSY) and village roads. The status of the roads in 2005 as shown as NH and SH in fig 4(a), PMGSY roads in Fig 4(b), PMGSY and other major and other roads in 4(c) and all the roads of Tigiria block is shown in fig 4(d). The PMGSY road network during 2005 is in Table -3

The tracing of roads downloaded from the satellite imagery of the year 2005 by which different types of roads like district roads, PMGSY roads, and village roads like Pucca / kucchas & footpaths were traced out by digitization by using Arc GIS. The road features are mapped in polyline features from the 45 Zone of Universal Transverse Mercator (UTM) projection. The total road network in Tigiria block in 2005 was 169.05km. The status of 161 numbers of roads connecting various villages of the Tigiria block existing during 2022 is in Table-4.

The tracing of roads is done over the satellite imagery of the year 2022 by which different types of roads like district roads, PMGSY roads, and village roads like Pucca/ kucchas & footpaths are traced out by digitization by using Arc GIS. The improved 76.523km of roads due to PMGSY scheme of GOI in Tigiria block by 2022 w.r.t. year 2005 is in Table 5.

RESULTS AND DISCUSSION

Sprawl of small towns is intrinsic to expansion and modernization. They often oblige as one of the major driver on its overall growth. India have attained its rural-urban conversion at her tipping point. The people, the dwelling, the connectivity and the environment is not growing synchronous to the sprawl. Recent small towns are lacking social, economic and infrastructural planning.





Pramod Kumar Patro et al.,

The transportation system and connectivity the major drivers are worst taken care.

- a. From the above study it is found that in year 2005 the total no. roads present in the block were 183 out of which 2 were major roads (district roads), 20 were PMSGY roads, and 161 were village roads including kuccha, Pucca, and footpaths. In year 2022 it is found that the total no. of roads are 2 major roads, 27 PMGSY roads, and 219 village roads.
- b. From the above comparison and study, it is found that in between the course of years 2005 & 2022 the total road network length increased to 20.064 Kms. under PMGSY scheme by inducing 8 no. of new roads, which can be observed from the above comparison map.
- c. Under the road network of villages, the kuccha, Pucca, and footpaths, it is found that between theyears, 2005 & 2022 increased to 66.009Kms. They were of 45 new roads, which can be observed from the above comparison map.

CONCLUSION

The study has been completed by observing the 18years (2005 and 2022 year) data of Tigiria block, and the statistical analysis of the road network has been plotted in the result section which shows the road network change in between the course of years 2005 & 2022. As the road network has increased the inter connectivity between the villages present in Tigiria, thus it will reduce the time taken to travel from one village to another as well as will increase the efficiency of transportation and will give a boost to the economic development of block Tigiria. The study showed the road network change of different roads like PMGSY & village roads depicting their road network spread dimensionally, which shows that the block Tigiria is developing the modes of transportation, thus enhancing the socio-economic development.

REFERENCES

- 1 Biswas, V., Tripathi, D.K., Kumar, M. (2022). Impact of Sprawl on Development Pattern of Bengaluru City. In: Singh, R.B., Kumar, M., Tripathi, D.K. (eds) Remote Sensing and Geographic Information Systems for Policy Decision Support. 403-419; Advances in Geographical and Environmental Sciences. Springer, Singapore. https://doi.org/10.1007/978-981-16-7731-1_20
- 2 van Duijne, R. J., & Nijman, J. (2019). India's emergent urban formations. *Annals of the American Association of Geographers*, 109(6), 1978-1998.
- 3 Sharma, M., Abhay, R.K. Urban growth and quality of life: inter-district and intra-district analysis of housing in NCT-Delhi, 2001–2011–2020. *GeoJournal* (2022). <https://doi.org/10.1007/s10708-021-10570-8>
- 4 Office of Registrar General and Census Commissioner, Ministry of Home Affairs, GOI, New Delhi. [WWW/censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011](http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011).
- 5 Census of India, (1961), Office of the Registrar General. Indja,(2011), Ministry of Home Affairs, NEW DELHI [online://www.census1961.co.in/district](http://www.census1961.co.in/district) URL:<http://hdl.handle.net/123456789/391>
- 6 Road.Transport Research Wing, Annual report 2011-12. Ch 4; p.21. Ministry of Road Transport and Highways. Government of India. New Delhi; 2012. Back to cited text no. 2
- 7 Solanki HK, Ahamed F, Gupta SK, (2016). Nongkynrih B. Road transport in Urban India: Its implications on health. *Indian J Community Med* 2016;41:16-22
- 8 Hatab, A.A., Ravula, P., Nedumaran, S. et al. Perceptions of the impacts of urban sprawl among urban and peri-urban dwellers of Hyderabad, India: a Latent class clustering analysis. *Environ Dev Sustain* (2021). <https://doi.org/10.1007/s10668-021-01964-2>
- 9 Tahir, M., Hussain, T., Ali, M., 2013, (2013). Road Transport and Environmental Deterioration in India. *Int. J. of Env. Sciences*, 2 (1), 1-11
- 10 Verma, A., Harsha, V. & Subramanian, G.H. Evolution of Urban Transportation Policies in India: A Review and Analysis. *Transp. in Dev. Econ.* 7, 25 (2021). <https://doi.org/10.1007/s40890-021-00136-1>





Pramod Kumar Patro et al.,

- 11 Mukhopadhyay P, Zerah H, Samanta G, Maria A (2016) Understanding India's urban frontier: what is behind the emergence of census towns in India? World Bank Policy Research Working Paper, 7923
- 12 Chakrabarti S, Mukherjee V (2020) Birth of census Towns in India; an economic analysis. South Asian J Macroecon Publ Finance 9(2):139–166
- 13 Mukherjee, D., Mitra, S., (2020). A comprehensive study on identification of risk factors for fatal pedestrian crashes at urban intersections in a developing country. Asian Transport Studies, (6). 100003, <https://doi.org/10.1016/j.eastsj.2020.100003>.
- 14 Yamins, D., Rasmussen, S. & Fogel, D. Growing Urban Roads. Networks and Spatial Economics 3, 69–85 (2003). <https://doi.org/10.1023/A:1022001117715>
- 15 Cantarella, G.E., Vitetta, A. The multi-criteria road network design problem in an urban area. Transportation 33, 567–588 (2006). <https://doi.org/10.1007/s11116-006-7908-z>
- 16 Das, D., Ojha, A.K., Kramsapi, H. et al, (2019). Road network analysis of Guwahati city using GIS. SN Appl. Sci. 1, 906 (2019). <https://doi.org/10.1007/s42452-019-0907-4>
- 17 Goodspeed, R., Pettit, C., Staffans, A., Geertman, S. (2021). Introduction. In: Geertman, S.C.M., Pettit, C., Goodspeed, R., Staffans, A. (eds) Urban Informatics and Future Cities. The Urban Book Series. Springer, Cham. https://doi.org/10.1007/978-3-030-76059-5_1
- 18 Bhatta, B. (2010). Analysis of urban growth and sprawl from remote sensing data. Springer Science & Business Media.
- 19 Sinha SK (2017) Urban sprawl in Gautam Budh Nagar District, Uttar Pradesh. Ann Nat Assoc Geogr India 36(1):89–102
- 20 Kumar, S., Devi, K., Kumar, M., Bhadwal, S., Chauhan, N., Verma, N.K. (2022). Spatio-Temporal Changes in Metropolitan Cities of India: A Comparative Study of Delhi and Mumbai. In: Singh, R.B., Kumar, M., Tripathi, D.K. (eds) Remote Sensing and Geographic Information Systems for Policy Decision Support. Advances in Geographical and Environmental Sciences. Springer, Singapore. https://doi.org/10.1007/978-981-16-7731-1_12
- 21 Chaudhary, V., Buttar, P.K. & Sachan, M.K. Satellite imagery analysis for road segmentation using U-Net architecture. J Supercomput (2022). <https://doi.org/10.1007/s11227-022-04379-6>
- 22 Cantarella, G.E., Sforza, A. (1995). Network Design Models and Methods for Urban Traffic Management. In: Gartner, N.H., Improta, G. (eds) Urban Traffic Networks. Transportation Analysis. 123-153, Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-79641-8_5
- 23 Ahmed S, Ibrahim RF, Hefny HA (2017) GIS based Network Analysis for the Roads Network of the Greater Cairo Area. In: Proceedings of the international conference on applied research in computer science and engineering ICAR'17, vol 2144, no 1 at <http://ceur-ws.org>
- 24 Scandiffio, A.: Mapping spatial quality of slow routes with GIS-based method a comparative assessment of alternative routes. Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci. XLII-2/W15, 1071–1076 (2019)
- 25 Vicente-Gilabert, C., López-Sánchez, M., del Pulgar, M.L.G. (2022). GIS-Based Design for Urban Heritage Routes. In: Ródenas-López, M.A., Calvo-López, J., Salcedo-Galera, M. (eds) Architectural Graphics. EGA 2022. Springer Series in Design and Innovation , vol 21. Springer, Cham. https://doi.org/10.1007/978-3-031-04632-2_13

Table 1. 2022 YEAR ROAD NETWORK PLAN IN TIGIRIA BLOCK

| MAJOR ROAD NETWORK STATISTICS 2005 YEAR | | |
|---|---------------|-------------|
| SL.NO. | ROAD TYPE | LENGTH (KM) |
| 1 | DISTRICT ROAD | 1.715 |
| 2 | DISTRICT ROAD | 12.577 |
| TOTAL ROAD | | 14.292 |





Pramod Kumar Patro et al.,

Table 1: The revenue Village status of the Tigiria block area in Cuttack, Odisha

| SL.NO.. | VILL_CODE | VILL_NAME | DIST_NAME | TEH_NAME | STATE_NAME | TYPE | BLOCKNAME | AREA(SQ.KMS) |
|---------|-----------|----------------------|-----------|----------|------------|---------|-----------|--------------|
| 1 | 308001 | Achalkote-02 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 6.351 |
| 2 | 308002 | Karadapalli-12 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.766 |
| 3 | 308003 | Gokarnakhal-21 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.486 |
| 4 | 308004 | Godijharia-04 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.262 |
| 5 | 308005 | Godarabandha-15 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.468 |
| 6 | 308006 | Tigiria_Nizigarh-10 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 3.29 |
| 7 | 308007 | Nuapatna-20 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.443 |
| 8 | 308008 | Pankal-18 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.601 |
| 9 | 308009 | Panchagan-08 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 6.705 |
| 10 | 308010 | Baneswarpada-13 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.305 |
| 11 | 308011 | Baliput-14 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.431 |
| 12 | 308012 | Viruda-03 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 7.915 |
| 13 | 308013 | Bhejia-16 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 10.592 |
| 14 | 308014 | Jemadeipur-19 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.447 |
| 15 | 308015 | Ramachandrapur-05 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.44 |
| 16 | 308016 | Sesagan-07 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.666 |
| 17 | 308017 | Sudarsanpur-09 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.003 |
| 18 | 308018 | Haridapasi-01 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 4.207 |
| 19 | 308019 | Hariharpur-06 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.24 |
| 20 | 308020 | Kalibiri-37 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.18 |
| 21 | 308021 | Kanthipur-32 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.49 |
| 22 | 308022 | Kumbhiput-43 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.732 |
| 23 | 308023 | Koilikanya-34 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.557 |
| 24 | 308024 | Khandahata-50 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.902 |
| 25 | 308025 | Gadadharpur-27 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.669 |
| 26 | 308026 | Gopinathpur_Sasan-11 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.057 |
| 27 | 308027 | Chasanara-47 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.119 |
| 28 | 308028 | Nandapur-39 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.111 |
| 29 | 308029 | Paikiara-42 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 3.494 |
| 30 | 308030 | Puruna_Tigiria-38 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 4.176 |
| 31 | 308031 | Baulanga-49 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.621 |
| 32 | 308032 | Badanauput-41 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.812 |
| 33 | 308033 | B-Baharbilla-45 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.095 |
| 34 | 308034 | Banamalipur-35 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.954 |
| 35 | 308035 | Basudev_pur-23 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.029 |
| 36 | 308036 | Biriput-17 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.398 |
| 37 | 308037 | Bindhanima-36 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 4.136 |
| 38 | 308038 | Bishnupur-31 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.39 |
| 39 | 308039 | Belanta-24 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.777 |
| 40 | 308040 | Bhogada-22 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.281 |
| 41 | 308041 | Mahuldhip-44 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.92 |
| 42 | 308042 | Manapur-26 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.647 |
| 43 | 308043 | Raghurampur-33 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.543 |
| 44 | 308044 | Sampur-40 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.651 |
| 45 | 308045 | Salijanga-48 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 1.365 |
| 46 | 308046 | Sunthipal-30 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.886 |
| 47 | 308047 | Sampada-46 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.716 |
| 48 | 308048 | Sananauput-28 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.718 |
| 49 | 308049 | Harisaranpur-25 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 0.905 |
| 50 | 308050 | Hatamal-29 | Cuttack | Tigiria | ODISHA | Village | TIGIRIA | 2.506 |
| 51 | | RESERVE FOREST | Cuttack | Tigiria | ODISHA | Forest | TIGIRIA | 6.48 |
| 52 | | RESERVE FOREST | Cuttack | Tigiria | ODISHA | Forest | TIGIRIA | 13.121 |
| 53 | 302136 | Baunshaputa-01 | Cuttack | Banki | ODISHA | Village | BANKI | 3.466 |
| 54 | 302138 | Manipur-03 | Cuttack | Banki | ODISHA | Village | BANKI | 0.262 |
| 55 | 302142 | Tentulia-07 | Cuttack | Banki | ODISHA | Village | BANKI | 1.718 |
| 56 | 302141 | Bandalo- 06 | Cuttack | Banki | ODISHA | Village | BANKI | 1.473 |





Pramod Kumar Patro et al.,

Table 3: The status of the PMGSY road network of the Tigiria Block for the year 2005.

| PMGSY ROAD NETWORK STATISTICS 2005 YEAR | | |
|---|---|-------------|
| SL.NO. | ROAD TYPE | LENGTH (KM) |
| 0 | PWD Road to Sankarpur | 0.237 |
| 1 | PWD Road at19th km to badabhuindal | 0.652 |
| 2 | Raja Athagarh Bidharpur 33km to Narasinghpur Ratapat 59km | 0.346 |
| 3 | Raja Athagarh Narasinghpur PWD Road to Baunsaput | 4.533 |
| 4 | Jenapada Bindhanima road | 11.237 |
| 5 | Bindhanima Khandahata | 7.887 |
| 6 | PWD Road to Tentuliragadi | 0.615 |
| 7 | Bindhanima to Kalibiri | 2.077 |
| 8 | PWD Road to Bheja | 1.034 |
| 9 | PWD Road to Biriput | 1.288 |
| 10 | PWD Road to Karadapalli | 1.671 |
| 11 | Nizigarh to Balipatana | 11.484 |
| 12 | PWD Road to Banewarpada | 0.709 |
| 13 | PWD Road to Nuasasan | 0.933 |
| 14 | Gadadharpur to Manpur | 0.722 |
| 15 | Gadadharpur to Raghurampur | 1.848 |
| 16 | Sudarsanapur to Haridaposhi | 2.135 |
| 17 | PWD Road to Gopinathpur | 2.663 |
| 18 | Sankarpur to Bhapur Dhenkanal Block border | 0.203 |
| 19 | Nuapataa to Gokhankhal | 0.995 |
| 20 | PWD Road to Baliput | 0.530 |
| TOTAL ROAD NETWORK | | 53.798 |

Table 4: The status of the earthen/ Kuccha and Pucca roads in 2022 (Tigiria Block)

| FOOTPATH/KUCCHA/PUCCA ROAD NETWORK STATISTICS 2022 YEAR | | | FOOTPATH/KUCCHA/PUCCA ROAD NETWORK STATISTICS 2022 YEAR | | |
|---|-----------------------|-------------|---|-----------------------|-------------|
| SL.NO. | ROAD TYPE | LENGTH (KM) | SL.NO. | ROAD TYPE | LENGTH (KM) |
| 100 | Village road (Kuchha) | 1.341 | 133 | Village road (Kuchha) | 1.163 |
| 101 | Village road (Kuchha) | 0.435 | 134 | Village road (Kuchha) | 0.795 |
| 102 | Village road (Kuchha) | 0.961 | 135 | Village road (Kuchha) | 0.702 |
| 103 | Village road (Kuchha) | 1.615 | 136 | Village road (Kuchha) | 0.658 |
| 104 | Village road (Kuchha) | 0.972 | 137 | Village road (Kuchha) | 0.320 |
| 105 | Village road (Kuchha) | 0.799 | 138 | Village road (Kuchha) | 0.359 |
| 106 | Village road (Kuchha) | 0.975 | 139 | Village road (Kuchha) | 0.145 |
| 107 | Village road (Kuchha) | 1.573 | 140 | Village road (Kuchha) | 0.898 |
| 108 | Village road (Kuchha) | 1.156 | 141 | Village road (Kuchha) | 0.149 |
| 109 | Village road (Kuchha) | 1.576 | 142 | Village road (Kuchha) | 0.617 |
| 110 | Village road (Kuchha) | 0.661 | 143 | Village road (Kuchha) | 1.306 |
| 111 | Village road (Kuchha) | 0.387 | 144 | Village road (Kuchha) | 0.542 |
| 112 | Village road (Kuchha) | 1.659 | 145 | Village road (Kuchha) | 0.428 |
| 113 | Village road (Kuchha) | 0.513 | 146 | Village road (Kuchha) | 0.765 |
| 114 | Village road (Kuchha) | 1.653 | 147 | Village road (Kuchha) | 0.375 |
| 115 | Village road (Kuchha) | 0.972 | 148 | Village road (Kuchha) | 0.645 |
| 116 | Village road (Kuchha) | 3.332 | 149 | Village road (Kuchha) | 1.529 |
| 117 | Village road (Kuchha) | 0.669 | 150 | Village road (Kuchha) | 0.305 |
| 118 | Village road (Kuchha) | 0.307 | 151 | Village road (Kuchha) | 0.774 |
| 119 | Village road (Kuchha) | 0.867 | 152 | Village road (Kuchha) | 0.399 |
| 120 | Village road (Kuchha) | 1.251 | 153 | Village road (Kuchha) | 0.316 |
| 121 | Village road (Kuchha) | 0.444 | 154 | Village road (Kuchha) | 1.581 |
| 122 | Village road (Kuchha) | 1.046 | 155 | Village road (Kuchha) | 2.122 |
| 123 | Village road (Kuchha) | 2.266 | 156 | Village road (Kuchha) | 0.661 |
| 124 | Village road (Kuchha) | 0.682 | 157 | Village road (Kuchha) | 0.536 |
| 125 | Village road (Kuchha) | 1.580 | 158 | Village road (Kuchha) | 0.483 |
| 126 | Village road (Kuchha) | 0.993 | 159 | Village road (Kuchha) | 0.179 |
| 127 | Village road (Kuchha) | 0.710 | 160 | Village road (Kuchha) | 1.398 |
| 128 | Village road (Kuchha) | 0.782 | 161 | Village road (Kuchha) | 1.403 |
| 129 | Village road (Kuchha) | 1.113 | | | |
| 130 | Village road (Kuchha) | 0.248 | | | |
| 131 | Village road (Kuchha) | 0.884 | | | |
| 132 | Village road (Kuchha) | 0.369 | | | |
| TOTAL ROAD NETWORK | | | #REF! | | |





Pramod Kumar Patro et al.,

Table 5: The PMGSY road network in Tigiria block in Cuttack district for the year 2022

| Sl.no. | Road name | Length (km) |
|--------|---|-------------|
| 1 | PWD Road to Sankarpur | 0.237 |
| 2 | PWD Road at 19th km to badabhuindal | 0.652 |
| 3 | Raja Athagarh Bidharpur 33km to Narasinghpur Ratapat 59km | 0.346 |
| 4 | Raja Athagarh Narasinghpur PWD Road to Baunsaput | 4.533 |
| 5 | Panchagaon to Somapada | 7.313 |
| 6 | Jenapada Bindhanima road | 11.237 |
| 7 | Bindhanima Khandahata | 7.887 |
| 8 | PWD Road to Tentuliragadi | 0.615 |
| 9 | R D Road to Kumbhiput | 0.790 |
| 10 | Tigiria to Chasanara | 5.196 |
| 11 | PWD Road to Basudevpur | 2.072 |
| 12 | Nuapataa to Gokhankhal | 3.968 |
| 13 | Bindhanima to Kalibiri | 2.077 |
| 14 | PWD Road to Bhejia | 1.034 |
| 15 | PWD Road to Biriput | 1.288 |
| 16 | PWD Road to Karadapalli | 1.671 |
| 17 | Nizigarh to Balipatana | 11.484 |
| 18 | PWD Road to Baliput | 1.107 |
| 19 | PWD Road to Baneswarpada | 0.709 |
| 20 | PWD Road to Nuasasan | 0.933 |
| 21 | PWD Road to Belanta | 2.194 |
| 22 | Gadadharpur to Manpur | 0.722 |
| 23 | Gadadharpur to Raghurampur | 1.848 |
| 24 | Sudarsanapur to Haridaposhi | 2.135 |
| 25 | PWD Road to Gopinathpur | 2.663 |
| 26 | Nusadak to Godijharia | 1.611 |
| 27 | Sankarpur to Bhapur Dhenkanal Block border | 0.203 |





Pramod Kumar Patro et al.,

Table 7: The newly added roads in the Tigiria block under PMGSY scheme

| NEWLY ADDED ROADS TO THE BLOCK UNDER PMGSY IN KMS. | | |
|--|-------------------------------------|--------|
| 1 | Nusadak to Godijharia | 1.611 |
| 2 | Panchagaon to Somapada | 7.313 |
| 3 | PWD Road to Sankarpur | 0.237 |
| 4 | PWD Road at 19th km to badabhuindal | 0.652 |
| 5 | PWD Road to Basudevpur | 2.072 |
| 6 | PWD Road to Belanta | 2.194 |
| 7 | R D Road to Kumbhiput | 0.790 |
| 8 | Tigiria to Chasanara | 5.196 |
| TOTAL | | 20.064 |

Table 8: Newly Added Pucca Roads in Kms

| NEWLY ADDED PUCCA ROADS IN KMS. | | |
|---------------------------------|----------------------|--------|
| 1 | Village road (Pucca) | 4.296 |
| 2 | Village road (Pucca) | 0.219 |
| 3 | Village road (Pucca) | 1.326 |
| 4 | Village road (Pucca) | 8.172 |
| 5 | Village road (Pucca) | 0.915 |
| 6 | Village road (Pucca) | 0.983 |
| 7 | Village road (Pucca) | 2.602 |
| 8 | Village road (Pucca) | 1.066 |
| 9 | Village road (Pucca) | 1.659 |
| 10 | Village road (Pucca) | 0.177 |
| 11 | Village road (Pucca) | 2.056 |
| 12 | Village road (Pucca) | 1.217 |
| 13 | Village road (Pucca) | 1.457 |
| 14 | Village road (Pucca) | 2.875 |
| 15 | Village road (Pucca) | 2.032 |
| 16 | Village road (Pucca) | 2.640 |
| 17 | Village road (Pucca) | 2.528 |
| 18 | Village road (Pucca) | 0.429 |
| 19 | Village road (Pucca) | 0.648 |
| 20 | Village road (Pucca) | 0.818 |
| 21 | Village road (Pucca) | 0.364 |
| 22 | Village road (Pucca) | 0.600 |
| 23 | Village road (Pucca) | 3.913 |
| 24 | Village road (Pucca) | 5.551 |
| 25 | Village road (Pucca) | 1.930 |
| 26 | Village road (Pucca) | 1.432 |
| 27 | Village road (Pucca) | 4.044 |
| 28 | Village road (Pucca) | 2.448 |
| 29 | Village road (Pucca) | 0.216 |
| 30 | Village road (Pucca) | 0.643 |
| 31 | Village road (Pucca) | 0.031 |
| 32 | Village road (Pucca) | 1.859 |
| 33 | Village road (Pucca) | 0.354 |
| 34 | Village road (Pucca) | 0.663 |
| 35 | Village road (Pucca) | 0.257 |
| 36 | Village road (Pucca) | 0.748 |
| 37 | Village road (Pucca) | 0.297 |
| 38 | Village road (Pucca) | 0.298 |
| 39 | Village road (Pucca) | 0.161 |
| 40 | Village road (Pucca) | 0.283 |
| 41 | Village road (Pucca) | 0.285 |
| 42 | Village road (Pucca) | 0.277 |
| 43 | Village road (Pucca) | 0.170 |
| 44 | Village road (Pucca) | 0.529 |
| 45 | Village road (Pucca) | 0.539 |
| TOTAL | | 66.009 |





Pramod Kumar Patro et al.,

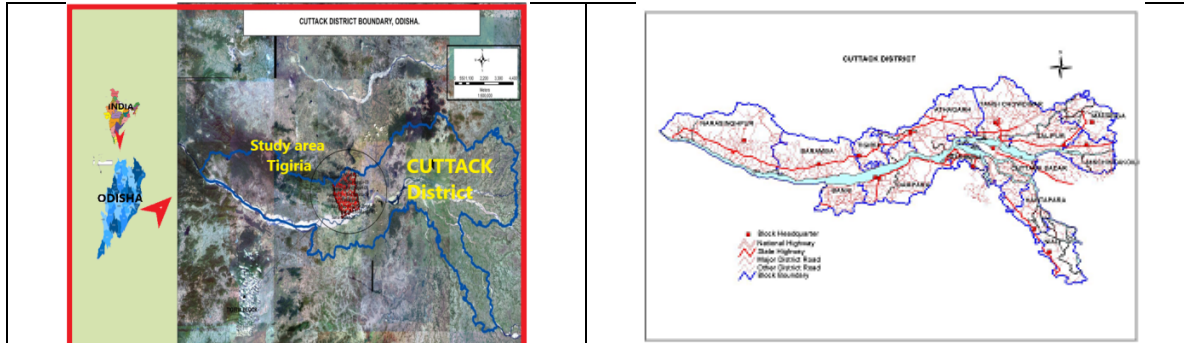


Fig 1: Index map of Study area, the Tigiria Block: Cuttack

Table 2: The Block map of the Cuttack district in Odisha (Source: <https://cdn.s3waas.gov.in/>)

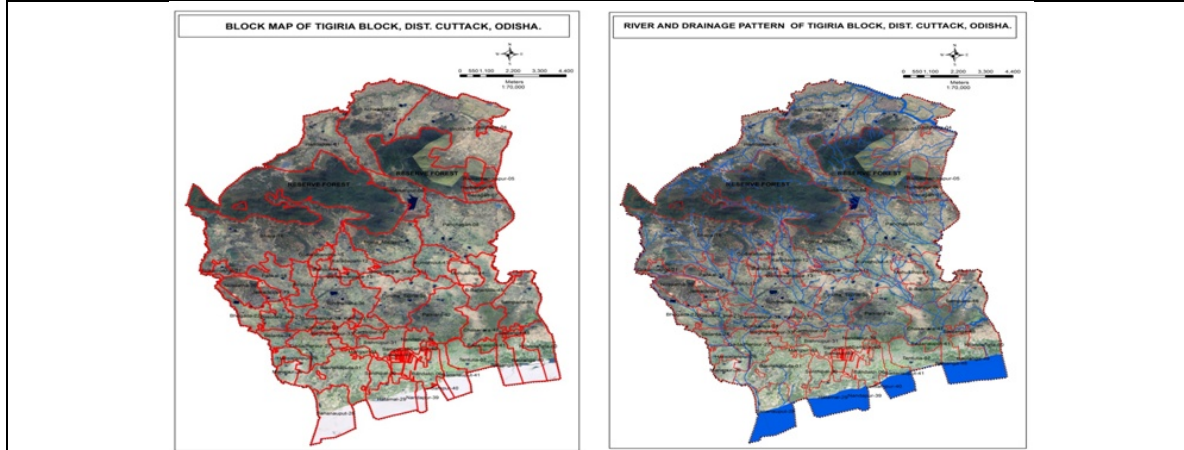


Fig 3(a); (b): The village /basin map of the Tigiria Block in Cuttack dist. (Source: LANDSAT-5)

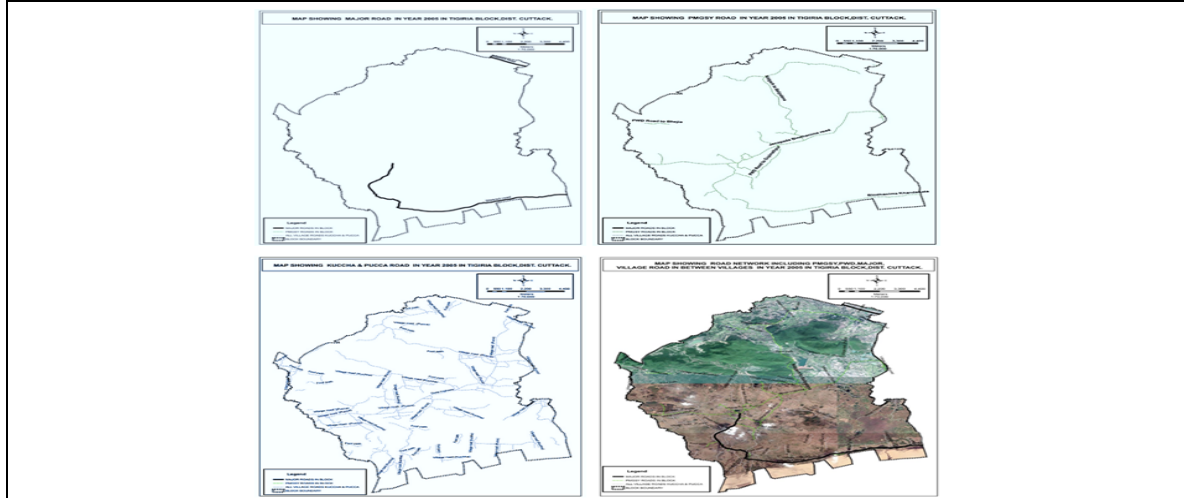


Fig 4: Segregated; Major (Part of NH 65), PMGSY, Pucca, and Total road network of Tigiria block (The year 2005) (Source: ORSAC)





Pramod Kumar Patro et al.,

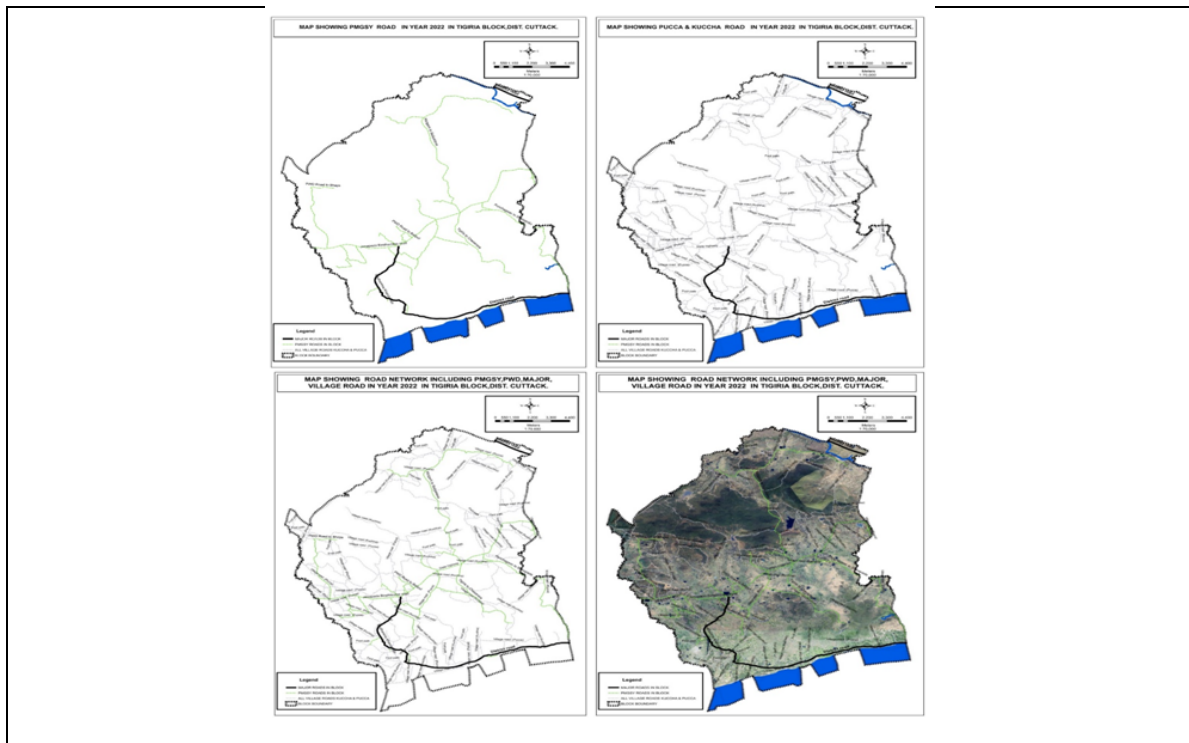


Fig 5 (a), (b), (c), and (d) : The status of major, PMGSY,footpath/ Kuccha and Pucca and total roads in Tigiria Block in the year 2022

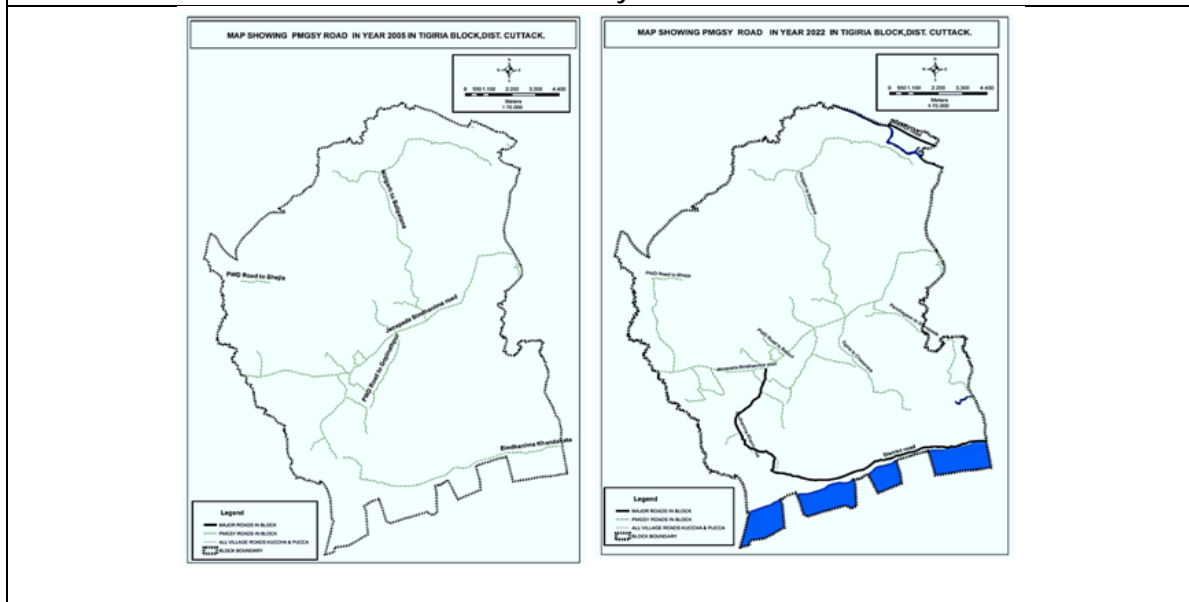


Fig 6 : Change detection in road status between year 2005 and 2022





Pramod Kumar Patro et al.,

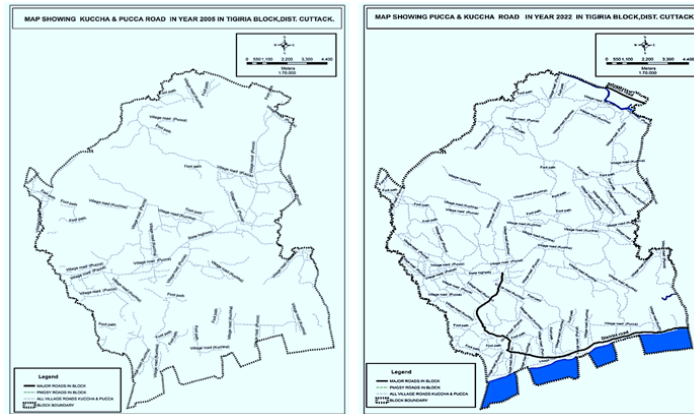


Fig 7: The change detection in maps and figure in roads in tabular form of Tigiria Block; 2005 with respect to 2022

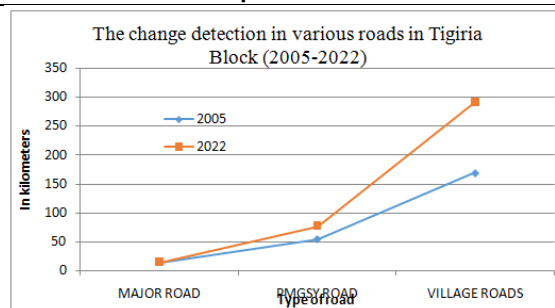


Fig 8: The change detection of various roads in Tigiria block in the years 2005-2022

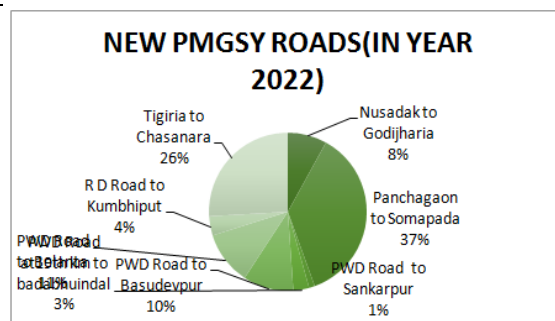


Fig 9: The change detection of PMGSY roads in Tigiria block in the years 2005-2022





Pramod Kumar Patro et al.,

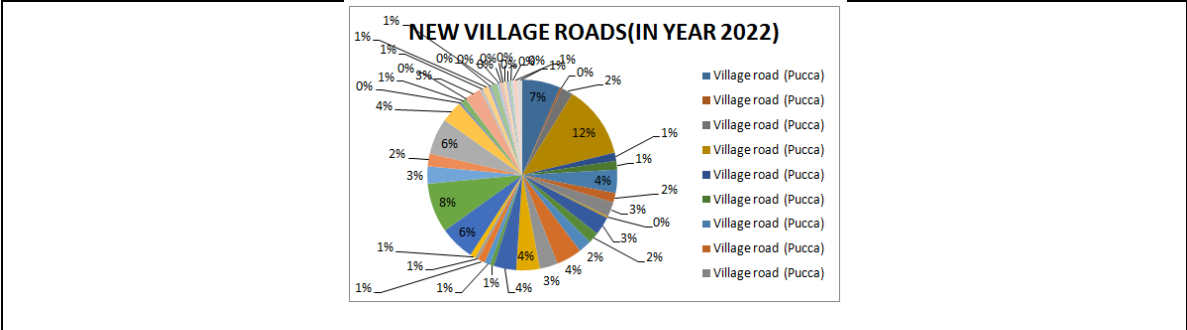


Fig10: The change detection of newly formed roads in Tigiria block in the years 2005-2022





Horticulture Based Agro Forestry Systems

Sutapa Sudipti Pradhan¹, M. Chandra Surya Rao², Arpita Dash¹, Bajjayanti Paikaray¹ and Sabhyata Sambit Samal¹

¹Department of Botany, School of Applied Science, Centurion University of Technology and Management, Odisha, India.

²Department of Horticulture, MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

M. Chandra Surya Rao

Department of Horticulture,
MS Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Odisha-761211, India.
Email: chandra.surya@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Agriculture is one of the prime sectors for the growth of the country like India. The diversification of agriculture sector in number of super specialized discipline out of which agro forestry and horticulture are promising fields for food, wood and sustainable natural resource management. The growing inhabitants forced the expansion in demand not only for food but other goods and services. In current scenario of global warming and climate change interventions in the agriculture sector for enhancing the productivity of farm with integration of agro forestry and horticulture are viable green portions. The convergence of these two disciplines is complementary to each other which can provide larger share in employability with eco-friendly options. The different aspects of agro forestry and horticulture with their thematic areas and employability options are described in details for awakening the people about the scope of the subjects for betterment of society.

Keywords: Agriculture, Agro forestry, Horticulture, Resource, climate, society

INTRODUCTION

Agro forestry is a land use system, integrates trees, crops and/or animals in a way that is scientifically sound, practically feasible, ecologically desirable and socially acceptable by the farmers (Nair, 1979). In other words, Agro forestry can be stated as science and art of judiciously managing agricultural crops with woody perennials (forest and horticultural trees) in a unit piece of land to enhance the productivity and profitability for combined goods and services. In the present market oriented world the dimensions of agro forestry has changed from subsistence to



**Sutapa Sudipti Pradhan et al.**

commercial and ecofriendly with a rider of maintaining balance between ecology and economy. Agro forestry plays a vital role in the Indian economy by way of tangible and intangible benefits. In fact, agro forestry has high potential for simultaneously satisfying three important objectives viz., protecting and stabilizing the ecosystems; producing a high level of output of economic goods; and improving income and basic materials to rural population. It has helped in rehabilitation of degraded lands on one hand and has increased farm productivity on the other.

Why Agro Forestry is the Need of the Time

Mounting human population requires enormous amount of food and wood, which eventually generating intense pressure on cultivable land and forests in India. The rising demand of food is being met by the scientific and modern interventions in the agriculture sector, however the same pace could not achieve in forestry sector. In India, the production potential of trees for wood is restricted to about 0.7 m³/ha/year compared to the world average of about 2.1 m³/ha/year resulted huge gap between the demand and supply. As per national forestry action programme timber requirements of India during 2006 were 82 million m³, whereas, the domestic availability was just 27 million m³, moreover, in last ten years the money spent on import of wood has increased from US\$ 1.0 billion in 2001 to more than \$ 5 billion in 2011. Due to the scarcity of domestic timber resources and rapidly growing demand, wood imports in India have doubled since 2006, in order to meet the country's growing hunger for wood products (RISI, 2013). The rising demand of food and wood products are the basic livelihood needs, can be achieved by increasing the farm and forest area or by raising / enhancing the productivity of land. Land being a restricted resource, expansion of the farm area is not possible however, enhancing the productivity of farm with integration of fast growing trees as agro forestry is the reasonable and realistic alternative of today. The integration of different components in spatial and temporal arrangement with social acceptance can promote the agro forestry (Nair, 1993). Agro forestry is believed to be one of the sensible substitutes, has got the potential to capture land degradation, sequestering carbon and recovers site productivity through interactions among trees, soil, agricultural crops, and livestock, and thus restore environment and enhance the productivity (Avery, 1990). Moreover, it is also recognized that the planting trees outside the forest in the form of agro forestry/farm forestry is the only substitute to meet the goal as required by the national forest policy 1988 for increasing vegetation cover to 33% from the present level of 24.01% (Forest cover 21.23% and Tree Cover 2.78% as per FSI, 2013). National Forest Commission has also stressed the expansion of forestry activities outside the forest area to achieve requisite forest cover (NFC, 2006) which can only be possible through TOF as agro forestry, Farm Forestry and other extension forestry approaches.

Development of Agro Forestry In India

Agro forestry is a new name of existing set of aged old practices retaining multipurpose trees on the agricultural field primarily for fuel and fodder requirement. In India the organized and scientific agro forestry started by the Indian Council of Agriculture Research (ICAR), launching All India Coordinated Research Project on Agro forestry (AICRPAF) during 1983 with 20 centers now reached to 39 centers in ICAR institutes and State Agricultural Universities (SAUs). Further a National Research Centre for Agro forestry (NRCAF) was established by ICAR during 1988 at Jhansi in Central India. On 8th May, 2013, the NRCAF- ICAR, Jhansi has celebrated its silver jubilee and the 8th May is declared as National Agro forestry Day by ICAR, New Delhi. Recently in 2015 the NRCAF, Jhansi has been upgraded to an institute as Central Agro forestry Research Institute (CAFRI). Now India has become the first nation in the world to adopt an exclusive agro forestry policy at National level. At present the research, education and extension in agro forestry in India are being pursued by Ministry of Agriculture, however the role of Ministry of Environment, Forest and Climate Change is equally important as agro forestry is a link subject between agricultural crops and trees. Today, the biggest challenge faced by pulp, paper and match industries in the India is the unavailability of wood based raw material which require establishment of industrial wood plantations.

Checklist Of Tree Species And Major Agricultural Crops Grown In Different Agroforestry Systems**Interactions in Agro-Forestry**

In agro forestry, complementary or competitive effects depends upon



**Sutapa Sudipti Pradhan et al.**

1. Age and size of the trees,
2. Nature of the tree species,
3. Nature of the agricultural crops,
4. Availability of water, nutrients and light etc.

In an intercropping system involving a legume and non-legume, part of the nitrogen fixed in the root nodule of the legume may become available to the non-legume component which is an example of complementarity (Soundararajan and Palaniappan, 1979). Multistoried cropping in coconut and planting shade trees in cocoa and tea plantation uses this principle. In similar manner under agro-forestry system, exploitation of different layers of soil by the root systems of trees and crops may lead better utilization of resources with much less competition. In temporal complementarity, the yield advantages provided by the mixture cannot always be explained by more effective use of growth resources at specific times. Indeed, there are substantial opportunities for temporal complementarity if species make their major demands on available resources at different times, thereby reducing the possibility of competition.

Benefits of Agro Forestry**Enhanced Productivity**

In agro forestry, the potentially higher productivity could be due to the capture of more growth resources *eg.* light or water or due to improved soil fertility. Several studies in different parts of the country suggested that agro forestry is more profitable to farmers than agriculture or forestry for a particular area of land (Tokey, 1997 and Samra *et al.*, 1999). National Research Centre for Agro forestry has been working since 1989 on agri-silviculture system which included 4 varieties of *aonla viz.*, Chakaiya, Kanchan, Krishna and NA 7 as fruit trees, *Leucaena* as multipurpose tree and blackgram as intercrop in rainfed areas. The *Leucaena* was planted on both sides of the fruit trees at 2 m distance. The *aonla* was planted at 10 m x 6 m and 5 m x 6 m spacing but 10 m x 6 m spacing was proved an ideal spacing among these and it was considered for calculating the yield and economics of the system

Enhancing Soil Fertility

The primary objective of soil conservation is to improve / maintain soil fertility. To achieve this, control of erosion, maintenance of organic matter and physical properties, organic matter addition, maintenance of nutrient is necessary. In this way agro forestry system constitute sustainable land use and helps to improve soils in the number of ways. Maintenance and enhancement of soil fertility is vital for global food security and environmental sustainability. Although currently India is self-sufficient in terms of food production, for a population expected to rise further, the country will need to enhance both food production as well as tree biomass. Ecologically sound agro forestry systems such as intercropping and mixed arable-livestock systems can increase the sustainability of agricultural production while reducing on-site and off-site consequences and lead to sustainable agriculture. Alternate land-use systems such as agro forestry, agro-horticultural, agro-pastoral and agro-Silvipastoral are more effective for soil organic matter restoration (Manna, *et al.* 2003).

Soil Conservation

Agro forestry system on arable lands envisage growing of trees and woody perennials on terrace risers, terrace edges, field bunds as intercrops and as alley cropping in the shape of hedge row plantation. Integrating trees on the fields act as natural sump for nutrients from deeper layers of soil, add biofertilizer, conserve moisture and enhance productivity of system. The alley cropping with leguminous trees *viz.*, subabul (*Leucaena leucocephala*) has been most widely used on the field bunds for producing mulch material for moisture conservation and nutrient recycling. Alley cropping with *Leucaena leucocephala* was effective for erosion control on sloping lands up to 30%.

Soil Fertility

With intensified agriculture and reduced fallowing periods, soil fertility has emerged as a key problem in many farming systems throughout the tropics. Another agro forestry practice for improving soil fertility is biomass transfer – the manual transfer of green manure to crops – which increases vegetable yields, extends the harvesting season and



**Sutapa Sudipti Pradhan et al.**

improves the quality of produce. In western Kenya, farmers who treated their vegetable plots with leaves from *Tithonia diversifolia* hedges grown along field boundaries, together with small amounts of phosphorus fertilizer, doubled their returns to labour.

Enhancing Water use Efficiency

There is robust evidence that agro forestry systems have the potential for improving water use efficiency by reducing the unproductive components of the water balance. Examples from (run-off, soil evaporation and drainage) India and elsewhere show that simultaneous agro forestry systems could double rainwater utilization compared to annual cropping systems, mainly due to temporal complementarity and use of run-off in arid monsoon regions. For example, a combination of crops and trees uses the soil water between the hedgerows more efficiently than the sole cropped trees or crops, as water uptake of the trees reached deeper and started earlier after flood irrigation than that of the *Sorghum* crop, whereas the crop could better utilize top soil water. Integration of persistent could better utilize topsoil water perennial species with traditional agriculture also provides satisfactory drainage control to ameliorate existing out breaks of salinity. Agro forestry systems can also be useful for utilization of sewage contaminated wastewater from urban systems.

Microclimate Improvement

The use of trees as shelterbelts in areas that experience high wind or sand movement in well-established example of micro climate improvement that resulted in improved yields. Establishment of micro - shelterbelts in arable lands, by planting tall and fast growing plant species viz., castor on the windward side and shorter crop such as vegetables in the leeward side of tall plants helped to increase the yield of bhendi yield by 41 % and of cowpea by 21 % over the control (Venkateshwaralu, 1993).

Biodiversity Conservation

Over exploitation of natural resources is a major challenge for sustainable production and livelihood security. Deforestation is that major cause which affected the bio-diversity of an ecosystem. Agro forestry with components like trees, agricultural crops, grasses, livestock etc. provides all kinds of life support. However, agro forestry may not entirely reduce the deforestation (Angelsen and Kaimowitz, 2004) but in many cases it acts as an effective buffer to deforestation. Trees in agro forestry system act as a refuse to biodiversity after catastrophic events such as fire (Griffith, 2000). The traditional society of coastal belts and tropics of the country practicing home gardens and sacred groves help in bio- diversity conservation.

Carbon Sequestration

Tree components in agro forestry systems can be significant sink of atmospheric carbon due to their fast growth and high productivity. By including trees in agricultural production systems, agro forestry can, arguably, increase the amount of C stored in lands devoted to agriculture, while still allowing for the growing of food crops (Kursten, 2000). In agro forestry system, tree components are managed, often intensively by pruning or minimizing competition and maximize complementarity. The pruned materials are mostly non- timber products. Such materials are often returned to soil. Besides, the amount of biomass and therefore C that is harvested and exported from the system is relatively low in relation to the productivity of the tree. Therefore, unlike in tree plantations and other mono culture systems, agro forestry seems to have unique advantage in terms of Carbon sequestration.

Opportunities

Agro forestry provides great opportunities to link water conservation with soil conservation. The opportunities offered by agro forestry are it gives diversification and provide opportunity for growth and also mechanism for better equity. It is multifunctional system at the same time and thus, fulfills various demands simultaneously. It generates fresh water harvesting potential and ground water recharge. Agro forestry creates green cover for carbon sequestration And regenerate biomass and nurtures depleted soil.



**Sutapa Sudipti Pradhan et al.****Salient Research Achievements of National Research Centre for Agro forestry, Jhansi Agrihorticulture Programme**

The varietal evaluation of aonla in agri-horticultural system under rainfed condition indicated that after 13 years of plantation aonla yielded maximum 121 kg fruit plant⁻¹ (NA-7) followed by 94 kg plant⁻¹ (Kanchan). However only 37 plants showed bearing out of 63 plants surviving due to rocky sub-terrain.

Hortipasture

In parallel to agrihorticulture system intercropping of fodder grasses along with horticulture trees intensifies the productiveness of the system. The introduction of *Cenchrus ciliaris* with Ber (6m×6m) was very profitable where grass production was the dry grass production was 1.55 t ha⁻¹ year⁻¹ and the fruit, leaf fodder and fuel wood production from ber was 2.77, 1.87, 2.64 t ha⁻¹ year⁻¹ (Tewari et al., 1999).

Fruit Based Multitier Cropping System for Uplands

Fruit based multitier cropping system comprise of planting of fruit trees with large canopies (Mango, Litchi, Aonla, Jack fruit) at a spacing of 10 m x 10 m as main crop, planting of precocious bearing fruit species with dwarf canopy (guava, custard apple, lime, lemon) at a spacing of 5 m x 5m between rows and between plants in the same field as filler crop and growing of inter crops in the inters paces. The system accommodates 100 large size trees and 300 small sized trees per ha. A productivity level of 12.0 tonnes per ha of paddy equivalent yield can be obtained from 10 year old fruit based multitier system under the eastern plateau conditions

Agri-Horticultural / Agri-Horti-Silvicultural System For Eastern Plains

Under Eastern UP conditions, agrisilvihorti culture system has been found to be promising In this system fruit species like aonla, guava and ber are planted in association with Casuarina and Eucalyptus hybrids separately. It has been observed that agricultural crops perform better under casuarinas as based system than eucalyptus based system. Later on due to increase in canopy of tree and fruit species, tuber crops like colocasia and turmeric are cultivated. The casurina based system shows tuber yields of 3 t ha⁻¹ and 1.5 t ha⁻¹ for colocasia and turmeric, respectively (Kumar et al., 2012).

Horticulture Based Agro-Forestry System For Coastal Agro-Eco System

Fruit crop based agro-forestry system is a multi-pronged programme of land use to meet various needs and could be ideal for restoration of ecological balance, improvement in farm income and minimization of soil fertility depletion and loss of soil through erosion. For soil conservation, live bunds of subabul (*Leucaena leucocephala*), *Calliandra calothyrsus*, *Sesbania rostrata*, perennial grasses and legumes together, agave (*Agave americana*) etc. are promising. Combination of papaya with teak and arable crops has been found more productive than growing arable crops alone. The agro-forestry systems have given an additional income of ₹ 4629 to 6576 per year. Fruit crop based agro-forestry systems have given benefit: cost ratio of 11.13 as against 9.48 in arable crops. Average compound income, Net Product Value (NPV) and IRR (Internal Rate of Return) have been highest with arable crops + teak + papaya (Nadagoundar et al., 1993)

CONCLUSION

Mixing of crop species in horticulture based cropping systems lead to a wide range of benefits that can be assessed by short-term (increase in crop yield and quality) and long-term (agro ecosystem sustainability) benefits as well as societal and ecological sustainability (recreation, aesthetics, water and soil quality, enrichment of biodiversity etc.). The horticulture based agroforestry systems not only give additional return to the farm families but also generate additional working days for rural youths in a sustainable manner.





Sutapa Sudipti Pradhan et al.

REFERENCES

1. Avery, M.E., Cannell, M.G.R., Ong, C.K., (Eds) 1990. Biophysical Research for Asian Agroforestry.
2. FSI, 2013. State of Forest Report, Dehradun, India.
3. Griffith DM (2000). Agroforestry: A refuge for tropical biodiversity after fire. Conservation Biology **14**: 325-326.
4. Kursten, E. (2000). Fuelwood production in agroforestry systems for sustainable land use and CO2 mitigation. Ecological Engineering **16**: 69-72.
5. Manna MC, PK Ghosh and CL Acharya, (2003). Sustainable crop production through management of soil organic carbon in semiarid and tropical India. J. Sustain. Agric., 21: 87- 116.
6. Nair, P.K.R. 1979. Intensive multiple cropping with coconuts in India. Verlag Pau Parey, Berlin and
7. Nair, P.K.R.,1993. An Introduction to Agroforestry. Kluwer, Dordrecht, The Netherlands. New York, NY, USA.
8. NFC, 2006. Report on the recommendation of National Forest Commission. MoEF, New Delhi.
9. RISI, 2013. India's Forest Products Industry Outlook. <http://www.risiinfo.com/risi-store/do/product/detail>
10. Samra JS, BL Dhyani and AR Sharma (1999). Problem and prospects of natural resource management in Indian Himalayas- A base paper. Hill and mountain Agro-ecosystem Directorate, NATP, CSWCRTI, Dehradun, 146p.
11. Soundararajan D and SP Palaniappan (1979). Effect of intercropping on growth and yield components of redgram. Indian Journal of Agricultural Research **13**: 127-132.
12. Tewari JC, Bohra MD, Harsh LN (1999). Structure and production function of traditional extensive agroforestry systems and scope of agroforestry in Thar desert. Indian J Agrofor 1(1):81-94.
13. Toky OP (1997). Poplar an economy booster and eco-friendly agroforestry tree. Agroforestry News Letter, NRC for Agroforestry **9**: 2-3.
14. Venkateswarlu J (1993). Problems and prospects in desertification control: Role of Central Arid Zone Research Institute. In:Desertification and its Control in the Thar, Sahara and Sahel Regions (Sen, A.K. and Kar, A. Eds.). pp. 249-267. Jodhpur, India: Scientific Publishers.

| CATAGORIZATION OF SYSTEMS Based on their structure and function | | | | |
|---|--|--|--|----------------------------------|
| STRUCTURE Nature and arrangement of components especially woody ones | | | FUNCTION Role and/or output of components especially woody once | |
| Arrangement of components | | Nature of components | Production function | Productive function |
| In time (temporal) | In space (Spatial) | Agrisilviculture (crops and trees incl. shrubs/trees and trees) | Food | Windbreak |
| Coincident | Boundary (trees on edges of plots) | Silvipastoral (Pasture/animals and trees) | Fodder | Soil conservation |
| Concomitant | Strip (Width of strip to be more than one tree) | Agrosilvopastoral (Crops, pasture/animals, and trees) | Fuel wood | Shelterbelt |
| Overlapping | Mixed sparce (e.g. Most system of trees in pastures) | Others (multipurpose tree lots, apiculture with trees, aquaculture with trees, etc.) | Other Woods | Soil improvement |
| Sequential (separate) | Mixed dense (e.g. Home garden) | | Other products | Shade (for crop, animal and man) |
| Interpolated | | | | |





Sutapa Sudipti Pradhan et al.

| | | |
|---|-------------------------------------|-----------------------|
| GROUPING OF SYSTEMS According to their spread and management | | |
| AGRO-ECOLOGICAL/ENVIRONMENTAL | SOCIO-ECONOMIC AND MANAGEMENT LEVEL | |
| Systems in/for | Based on level of technology input | Based on cost/benefit |
| Lowland humid tropics | Low input (Marginal) | Commercial |
| Highland humid tropics (above 1,200m a.s.l; e.g.: Andes, India, Malaysia) | Medium input | Intermediate |
| Lowland subhumid tropics e.g.: savanna zone of Africa, Cerrado of South America) | High input | Subsistence |
| Highland subhumid tropics (Tropical highlands) (e.g.: in Kenya, Ethiopia) | | |

Categories of agroforestry systems (Nair, 1987)

| Agroforestry System | Trees | Agricultural Crops | Crop Season | |
|---------------------------------------|---------------------------------|----------------------------------|-------------------------------|--------|
| Agri-horticultural system (AH) | <i>Mangifera indica</i> | <i>Oryza sativa</i> | Kharif | |
| | | <i>Dolichus lablab</i> | Rabi | |
| | | <i>Cicer arietinum</i> | Rabi | |
| Homegarden (HG) | <i>Tectona grandis</i> | <i>Cymbopogon species</i> | Kharif | |
| | <i>Manilkara zapota</i> | <i>Ocimum species</i> | Kharif | |
| | <i>Citrus species</i> | <i>Allium sativum</i> | Kharif | |
| | <i>Anona reticulata</i> | <i>Coriandrum sativum</i> | Kharif /Rabi | |
| | <i>Moringa olifera</i> | <i>Colocasia esculenta</i> | Kharif | |
| | <i>Artocarpus heterophyllus</i> | <i>Musa species</i> | Kharif | |
| | <i>Cordia dichotoma</i> | <i>Crica papaya</i> | Rabi | |
| | <i>Mangifera indica</i> | <i>Capsicum annum</i> | Rabi | |
| | <i>Tamarindus indica</i> | <i>Curcuma longa</i> | Kharif | |
| Agri-horti-silvicultural system (ASH) | <i>Cocous nucifera</i> | <i>Trigonella foenum-graecum</i> | Rabi | |
| | | <i>Tamarindus indica</i> | <i>Abelmoschus esculentus</i> | Kharif |
| | | <i>Mangifera indica</i> | <i>Solanum melongena</i> | Kharif |
| Horti-pastoral system (HP) | <i>Manilkara zapota</i> | <i>Sorghum species</i> | Kharif | |





Prediction of Stock Index using Hybrid Model of PCA, SVR and PSO: A Case Study of Hindustan Bio Science Ltd.

Sumanjit Das¹, Sasmita Kumari Nayak² and Mohammed Siddique^{3*}

¹SES, Indian Institute of Technology, Bhubaneswar, Odisha, India

²Department of CSE, Centurion University of Technology and Management, Odisha, India

³Department of Mathematics, Centurion University of Technology and Management, Odisha, India

Received: 05 Mar 2022

Revised: 06 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Mohammed Siddique

Department of Mathematics,

Centurion University of Technology and Management,

Odisha, India

Email: siddique1807@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In the present-day scenario prediction has become one of the vital objectives in the field of financial market. The stock market is an inter-connected important economic international business. The hybrid model of Principal component analysis (PCA), Support vector regression (SVR) with particle swarm optimization (PSO) is proposed in this research work. Parameter determination for an SVR model is appropriate for achieving high forecasting accuracy. PCA is able to remove the unnecessary and unrelated factors, and reduces the dimension of input variables and time complexity. After normalization of training dataset, the optimized parameter values of SVR parameters 'C' and ' γ ' are searched through PSO and this process of searching continues till the termination criteria are reached. Finally, SVR is built using the optimized values attained in the search process and applied on the testing dataset. The model was applied to forecast the daily open prices of stock index of Hindustan Bio Science Ltd. Empirical results show that the proposed model enhances the performance of the prediction model and can be used for taking better decision and more accurate predictions for financial investors.

Keywords: Hindustan Bio Science Ltd, Financial time series forecasting; Principal component analysis; Support vector regression; Particle swarm optimization.

INTRODUCTION

In this research aiming to anticipate the upcoming stock price using machine learning based optimization techniques. The evolution of computing power, database technology, and machine learning algorithms helps to predicts stock market index more accurately. However, high volatility in stock prices makes it difficult to predict the stock market movements. Though many specialized techniques of machine learning such as neural networks, support vector machine, genetic algorithms are already established, there are still scope for developing innovative

42956



**Sumanjit Das et al.**

models or systems which can cater the rising needs of investors. The dimension reduction technique PCA is implemented to SVR-PSO to predict the stock price of Tata Motors. Here PCA extracted the relevant features from the data sets which improve the prediction accuracy [1].

A supervised machine learning task undergoes two main steps, i.e., training and testing phase. During training phase, the model is constructed and same is tested during the testing phase. Then the selected data of Hindustan Bio Sciences are being divided into training (2654) and testing (889) dataset. Now, before entering into the training phase, the dataset undergoes a data pre-processing phase of feature extraction. Then the learning algorithm is selected and its parameters are initialized. In order to end the training process, termination criteria are set. Finally, the training starts and enters an iterative process of parameter optimization and a post processing phase. During this post processing phase, in order to evaluate the model, the testing dataset is applied. On application of new unseen and unlabeled data, prediction result is generated. In the proposed model, we used SVM for regression, PCA is used for reducing the dimension and PSO is used to optimize the values of its free parameters (C and γ) for better forecasting. In this paper, we proposed a hybrid regression model consisting of principal component analysis, support vector regression and particle swarm optimization. This hybrid model, referred as PCA-SVR-PSO, is considered for the prediction of stock price of Hindustan Bio Science Ltd. In several domains, such as pattern recognition, text categorization, and regression estimation, SVM has outstanding generalization performance. Some scholars have recently focused on the use of SVM in time series forecasting. They are concerned about using support vector regression to create exact value predictions. However, since stock time series are random walk and non-stationary, this is challenging. Obviously, we can earn if we can predict the direction of stock price movement. In this study, we use support vector classification to try to do this. Support Vector Machines (SVMs) are compared to a multi-layer perceptron trained using the Back Propagation (BP) approach in financial forecasting. Based on the criteria of Normalized Mean Square Error (NMSE), Mean Absolute Error (MAE), Directional Symmetry (DS), Correct Up (CP) trend, and Correct Down (CD) trend, SVMs predicted better than BP. The generalization error with regard to the free parameters of SVMs is explored in this experiment since there is no organized approach to pick the free parameters of SVMs. They have minimal effect on the solution, as shown in the experiment. The analysis of the experimental findings shows that using SVMs to predict financial time series is beneficial [2-4].

Literature Survey

From the literature survey we analyzed that the impact of hybrid concepts has improved the prediction accuracy of financial market. Not a particular combination of methods gives good result always. The literature survey speaks about both approaches of machine learning i.e traditional approaches and hybridization approach in the field of financial stock market prediction. In the traditional approaches mostly one technique was used to address the forecasting the stock market for example only ANN and only BP were used by many authors. But with the hybridization of machine learning techniques leads the scope in improvement in accuracy. Traditional regression methods give optimal result to some extent but a new hybridization method may give more accurate towards optimal solution but it does not mean that always that 1st method has drawback. As second method gives more accurate towards result, so that method should be adopted in a particular category of problems. In the forthcoming chapters, hybridizations of different methods were adopted to solve optimal forecasting problems of stock market. Since we are adopting different nontraditional methods meant for handling large data set, the method consists of two parts. In first part, the re-organization of huge data set is required where as in second part; a suitable optimization technique is used [5].

Das and Padhy (2015) projected the experimental results using the dataset of every day's last prices of the COMDEX commodity futures index and it observed that their planned model was very good as well good as camper to SVM and hybrid model of SVM and particle swarm optimization (PSO) [6]. Wei-Chiang Hong (2011) presented a forecasting model which combines the seasonal recurrent SVR with chaotic ABC algorithm and investigated electric load forecasting of Northeast China. The study employed here for SVR model to solve the non-linear forecasting problem and the messy behavior of honey bees, to determine suitable values of the three free parameters of SVR, i.e.,



**Sumanjit Das et al.**

C , ϵ , and γ . The performance results of the investigation indicated that the proposed model (namely SRSVRCABC) gives better prediction results than ARIMA and TF- ϵ -SVR-SA models [7]. Hong *et al.* (2011) proposed a hybrid model of support vector regression and CGA to forecast the tourism demands. In the proposed model named as SVR-CGA, CGA was employed in overcoming premature local optimum in determining three free parameters of SVR (i.e., σ , ϵ , and C). The empirical results which were evaluated using on MAPE, MAE, and RMSE, demonstrated that the proposed SVRCGA model outperformed other competing approaches on the data of tourist arrivals in Barbados. Jiang *et al.* (2011) studied the application of KPCA and SVR for reconstruction of cardiac transmembrane potentials. In the hybrid model, SVR addressed the prediction mechanism, PCA and KPCA were used for feature extraction, and GA and simplex optimization method was used to determine the parameters of the SVR. It was found from the analysis that the SVR with feature extraction performed good as compare to that of without feature extraction [9].

Kazem *et al.* (2013) proposed a forecasting model using SVR with chaos-based firefly algorithm for prediction of stock index. The model had three steps in which a delay coordinate embedding method was employed, followed by, a chaotic firefly algorithm was applied for getting optimal free parameters of SVR, then lastly, the optimal SVR was invoked to predict stock market price. The performance of the proposed model, named as SVR-CFA, was also compared with its competing models such as GA-based SVR, CGA-based SVR, firefly-based SVR, ANNs, and ANFIS based on MSE and MAPE. The results demonstrated over its competing models with MSE and MAPE. When utilizing SVM, one of the most important considerations is the kernel function to choose. Typically, linear kernels, polynomial kernels, RBF, and sigmoid kernels are used. We utilize a generic RBF kernel function with two parameters: C and $[10]$ in this study. The accuracy of SVM is determined on the parameters used during the training stage. For this approach, cross validation is preferred [11]. We split the training set into v equal-sized subgroups in v -fold cross-validation. Using the classifier trained on the remaining $v-1$ subsets, one subset is tested sequentially.

As a result, each occurrence of the whole training set is predicted just once, and the cross-validation accuracy is the proportion of properly categorized data. This may also help to prevent the issue of over-fitting. Grid-search, an automated grid and pattern search strategy that iterates across parameter ranges to discover the best parameter values [5], is also used to estimate the cross-validation rate. This method does a comprehensive parameter search, despite the fact that it is time expensive. Because there are just two parameters, the computing time is not significantly longer than other sophisticated approaches. Furthermore, since each (C_i) is independent, the grid-search may be simply parallelized [12].

Hung *et al.* [16], proposed an used an improved ant colony optimization algorithm in an SVR model, called SVRCACO, for selecting suitable parameters, with encouraging local search in areas where forecasting accuracy improvement continues to be made. Wei *et al.* [17] implemented period estimation method (PEM) to forecast the periodic term and used chaotic cloud particle swarm optimization (CCPSO) algorithm to optimize the parameters of the Least squares support vector regression (LSSVR) model. Wei *et al.* [18] developed a chaotic cloud quantum bats algorithm (CCQBA), a hybrid approach to improve evolution mechanism, local search mechanism, mutation mechanism and global convergence by using quantum computing mechanism (QCM) to update the searching position in the bat algorithm (BA). Fan *et al.* [19] proposed a hybrid model of support vector regression with empirical mode decomposition (EMD) and auto regression (AR) for forecasting of electric load data of the New South Wales market. Fan *et al.* [20] proposed a novel SVR-based load forecasting model, EMD-PSO-GA-SVR, by hybridizing the empirical mode decomposition (EMD) with two evolutionary algorithms particle swarm optimization (PSO) and the genetic algorithm (GA).

METHODOLOGY

Principal Component Analysis (PCA)

PCA is a feature extraction method based on linear statistical approach. The objective of the method is to reduce the dimension of original feature data set. It applies an orthogonal transformation to transform n dimensional data to m





Sumanjit Das et al.

dimension ($m < n$), possibly correlated features into uncorrelated features. These uncorrelated i.e distinct features called as Principal Components. The transform technique is designed in so that the 1st Principal Component has possibly highest variance as compare to rest. The 2nd Principal Component is possibly 2nd highest variance among them and so on. Again, another most important characteristic is that 1st Principal components are orthogonal to the 2nd one and so on. For example, we consider the distribution of data in two dimensional spaces. Here one can mark that the greater deviation occur in x-direction and a very small deviation occurred in y direction. PCA is a method for lowering the dimensionality of such datasets, boosting interpretability while minimizing information loss. It does this by generating new uncorrelated variables that optimize variance in a sequential manner. PCA is an adaptive data analysis methodology because it simplifies finding new variables, the principal components, to solving an eigenvalue/eigenvector problem, and the new variables are specified by the dataset at hand, not a priori. It's adaptable in another way, too, because different variants of the technique have been developed for different data types and structures. This article will begin by outlining the fundamental concepts of PCA, as well as what it can and cannot do. It will then go over a few different types of PCA and how they can be used [18].

It is very much clear that the x-direction has much dominance over y direction. If we sacrifice i.e. omits the y-components of data and retaining the x- components only, we can reconstruct the data set within the limit of permissible error. Of course, it may not happen always but it can be possible in high dimensional data set, where we can neglect the less important attributes of the sample. By this process a high dimensional statistical sample possible be reduced effectively onto lower dimension without loss of essential required information. This reduction helps to large economy in computation, transmission and also storage costs. Our next issue is to identify the principal components which are sufficiently accurate for reformation of data [19].

The eigenvectors of correlation matrix obtained from input data are the principal directions. The eigenvector corresponding to largest eigen value give rise to principal component of the data set. The eigenvector corresponding to next largest eigen value represents next principal component of the dataset. Similarly, we can find m ($m < n$) number of eigenvectors representing dominant directions from n dimensional given data set. This is known as projection of n -dimensional data onto m -dimensional subspace that is spanned by these m number of principal components. By this way the m prime information is retained and $n-m$ numbers of least important information are neglected. Let us consider N number of samples $X_1, X_2, X_3, \dots, X_N$ such that every sample has 'n' number of attributes or features. So, each sample has a representation in the form of a vector having n components. Each vector $X_j, j = 1, 2, 3, \dots, N$ has featured whose mean value is zero, it means, the mean value of original feature has been subtracted from feature value of each. Then the Covariance matrix of above vectors is computed as follow $C = \frac{1}{N} \sum_{k=1}^N X_k X_k^T$

Then a_{ij} th member of the matrix C can be expressed as $C_{ij} = \frac{1}{N} \sum_{k=1}^N X_k(i) X_k^T(j)$ Here $X_k(i)$ represents i th component of the k th sample. Next, we compute the n eigen values of C and denoted by $\lambda_1, \lambda_2, \lambda_3, \dots, \lambda_n$ and we arrange them as $\lambda_1 \geq \lambda_2 \geq \lambda_3, \dots, \geq \lambda_n$. Then we compute eigen vector for each eigen value and denoted as $\alpha_1, \alpha_2, \alpha_3, \dots, \alpha_n$ respectively. Now we choose m number of eigen values among largest to larger and next to larger as per our requirement to retain the number of features of given data. Alternatively, we can select the smallest value of m , so that $\lambda_{m-1} - \lambda_m$ is larger i.e $\sum_{i=1}^m \lambda_i \geq t \sum_{i=1}^N \lambda_i$, Where $t = 0.90$ as we want to maintain 90 % variance among the transformed sample, here $\sum_{i=1}^N \lambda_i$ is the total variance. Now the collection of eigen vectors form a matrix is known as transformation matrix and is denoted as $A = [\alpha_1 \alpha_2 \alpha_3 \dots \alpha_n]$. Now each data X_i with n features is transformed to matrix Y_i in the m -dimensional system by using $Y_i = A^T X_i, i = 1, 2, \dots, N$. Then the j th component $Y_i(j)$ is the projection of X_i on α_j i.e $Y_i(j) = \alpha_j^T X_i$.

Support Vector Regression (SVR)

SVR is a supervised machine learning method developed by Vapnik and Cortes (1995). SVR makes a decision boundary by which the greater part of the data points of the relevant kind falls on the same side of the boundary. Let us consider the data points of an n -dimensional feature vector space $X = (x_1, x_2, \dots, \dots, x_n)$, from which we construct a hyper plane





Sumanjit Das et al.

$$\alpha_0 = \sum_{j=1}^n \alpha_j x_j = 0$$

where the boundary of the optimal hyperplane can be obtained by the maximizing the distance from any point to the plane. The maximum margin hyperplane (MMH) separates the similar types of data points. The necessary feature is that only neighboring points to the boundary of the hyperplane are participated in selection keeping all other points as it is. These points are well-known as the support vectors, and support vectors are separated in respective class by a hyperplane, which is called the Support Vector Classifier (SVC). The inner products of support vector classifier are weighted by their labels, and it helps to maximize the distance from support vectors to the hyperplane [20]. For given

a sample data-set $S = (x_1; y_1); (x_2; y_2); \dots; (x_l; y_l)$ representing l input-output pairs, where each $x_i \in X \subset R^n$,

where X represents the n dimensional input sample space and matching target values $y_i \in Y \subset R^n$ for $i = 1, 2, \dots, l$, where l is the size of the training data. The purpose of this regression problem is to construct a function

$f: R^n \rightarrow R$, to approximate the value of y for unseen data x , which was not participated in training sample. By

taking a nonlinear function φ , the input data is mapped from R^n to a high dimensional space R^m , $m > n$, and consequently the estimation function f is defined as $f(x) = (w^T \varphi(x)) + b$

Particle Swarm Optimization (PSO)

PSO is a novel nontraditional population-based search method and an alternative method to find solution for complicated optimization problem of highly non-linear in nature. The PSO algorithm was first developed and implemented in 1995 by Dr Kennedy and Dr. Eberhart. They developed the PSO algorithm after inspired by social behaviour of some of living beings such as bird flocking, fish schooling and many others. Then they simulated the social behaviour of living beings in mathematical model. In the development of the model they followed how a group of birds or insects uses their optimal path to search their food or place of comfort stay zone. It is observed that birds are moving in large groups, every member has contribution in the activity of searching and communicating among themselves about better position. The birds do not have any idea about the best position. But by virtue of social behaviour, if any one finds the better path towards comfort zone, then all of others follow to him.

The PSO algorithms are nature inspired population-based algorithm and basically learned from birds' activity to solve the optimization problem. In PSO, each member of the population is termed as particle and the population is termed as swarm. The algorithm is initiated with any random values and moving in arbitrarily chosen direction. Each particle moves through searching space, keeping in mind the best past positions of itself and its nearest places. The swarm particles communicate with each other about good positions. Then they adjust dynamically their own position and velocity resulted from the best position among all particles at any instant of time. After reaching all the swarm particles at the new best position of that instant, again they start repeating the same procedure for getting better and better position. This procedure continues up to the swarm reaches approximately an optimum of the object function which is known as fitness function $f: R^n \rightarrow R$. The procedure of SVR-PSO is briefly demonstrated as following steps. Interested readers could refer to [17] for more detail.

RESULT AND DISCUSSION

Projected PCA-SVR-PSO model is designed with PCA for feature extraction, SVR as core prediction mechanism and its hyper parameters are optimized by PSO. Through the training data we built the hybrid model and after completion of training phase, we applied the testing data sets to the proposed model to measure the prediction efficiency of both phases. The hybrid model is used to predict the opening share price of Hindustan Bio Science Ltd. Errors evaluated with MAE, RMSE, and MAPE in training phase are 0.39, 1.2, and 3.69 (approx) respectively and the





Sumanjit Das et al.

errors in testing phase are 0.06, 0.07 and 3.21 (approx.) respectively which is better perform than the existing SVR-PSO model [10].

CONCLUSION

Our PCA-SVR-PSO hybrid model which is comprising of three leading techniques, is applied to the forecasting problem of next day stock price and the results indicate that the model is acceptable not only for research but also from application view point. The testing results obtained from the empirical study demonstrated 0.06 mean absolute error (MAE). The PCA-SVR-PSO hybrid model also outperformed SVR-PSO in all the three evaluation measures, i.e., MAE, RMSE, and MAPE. Such remarkable performance is achieved due to the application of principal component analysis (PCA) on the lagged time-series dataset and use of particle swarm optimization (PSO) to optimize the hyper parameters of support vector regression (SVR). Based on the outcome of this piece of research work, we propose to use our proposed PCA-SVR-PSO hybrid model for the future applications of regression-based forecasting tasks.

REFERENCES

1. Das, S. P. and Padhy, S. (2015). Support vector machines for prediction of futures prices in Indian stock market, *International Journal of Computer Applications*, Vol. 41 (3): 22-26.
2. Hong, W. C. (2011). Electric load forecasting by seasonal recurrent SVR (support vector regression) with chaotic artificial bee colony algorithm. *Energy*, Vol. 36(9): 5568–5578.
3. Hong, W. C., Dong, Y., Chen, L.Y and Wei, S.Y (2011). SVR with hybrid chaotic genetic algorithms for tourism demand forecasting, *Applied Soft Computing*, Vol. 11(2): 1881–1890.
4. Jiang, M., Zhu, L., Wang, Y., Xia, L., Shou, G., Liu, F. and Crozier, S. (2011). Application of kernel principal component analysis and support vector regression for reconstruction of cardiac transmembrane potentials, *Physics in Medicine & Biology*, Vol. 56 (6): 1727, 2011.
5. Kazem, A., Sharifi, E., Hussain, F. K., Saberi, M. and Hussain, O. K. (2013). Support vector regression with chaos-based firefly algorithm for stock market price forecasting," *Applied soft computing*, Vol. 13 (2): 947–958.
6. Nelson, D. M. Q., Pereira, A. C. M. and De Oliveira, R.A. (2017). Stock market's price movement prediction with LSTM neural networks. *Proceedings of the International Joint Conference on Neural Networks*, 1419–26.
7. Pesaran, M.H. and Timmermann, A. (1995) "The Robustness and Economic Significance of Predictability of Stock Returns". *Journal of Finance*, 50, 1201-1228.
8. Savsani, M. & Rathod, U. (2018). Comparative Risk Return Analysis of Bombay Stock Market with Selected Banking Stocks in India. *International Journal of Scientific Research in Science and Technology*, 4 (5), 908-916.
9. Siddique, M. and Panda, D. (2019). Prediction of Stock Index of Tata Steel using Hybrid Machine Learning Based Optimization Techniques, *International Journal of Recent Technology and Engineering*, Vol. 8 (2), 3186-3193.
10. Siddique, M. and Panda, (2019) D. A hybrid forecasting model for prediction of stock index of Tata Motors using principal component analysis, support vector regression and particle swarm optimization, *International Journal of Engineering and Advanced Technology*, Vol. 1 (9), 3032-3037.
11. Singh, J. & Yadav, P. (2016). A Study on the Factors Influencing Investors Decision in Investing in Equity Shares in Jaipur and Moradabad with Special Reference to Gender. *Amity Journal of Finance*, 1(1), 117-130.
12. Amiripalli, S. S., Kollu, V. V. R., Jaidhan, B. J., Srinivasa Chakravarthi, L., & Raju, V. A. (2020). Performance improvement model for airlines connectivity system using network science. *International Journal of Advanced Trends in Computer Science and Engineering*, 9(1), 789-792.
13. Potharaju, S. P., Sreedevi, M., & Amiripalli, S. S. (2019). An Ensemble Feature Selection Framework of Sonar Targets Using Symmetrical Uncertainty and Multi-Layer Perceptron (SU-MLP). In *Cognitive Informatics and Soft Computing* (pp. 247-256). Springer, Singapore.
14. Thota, J. R., Kothuru, M., & Shanmuk Srinivas (2020). A. Monitoring Diabetes Occurrence Probability Using Classification Technique with A UI.

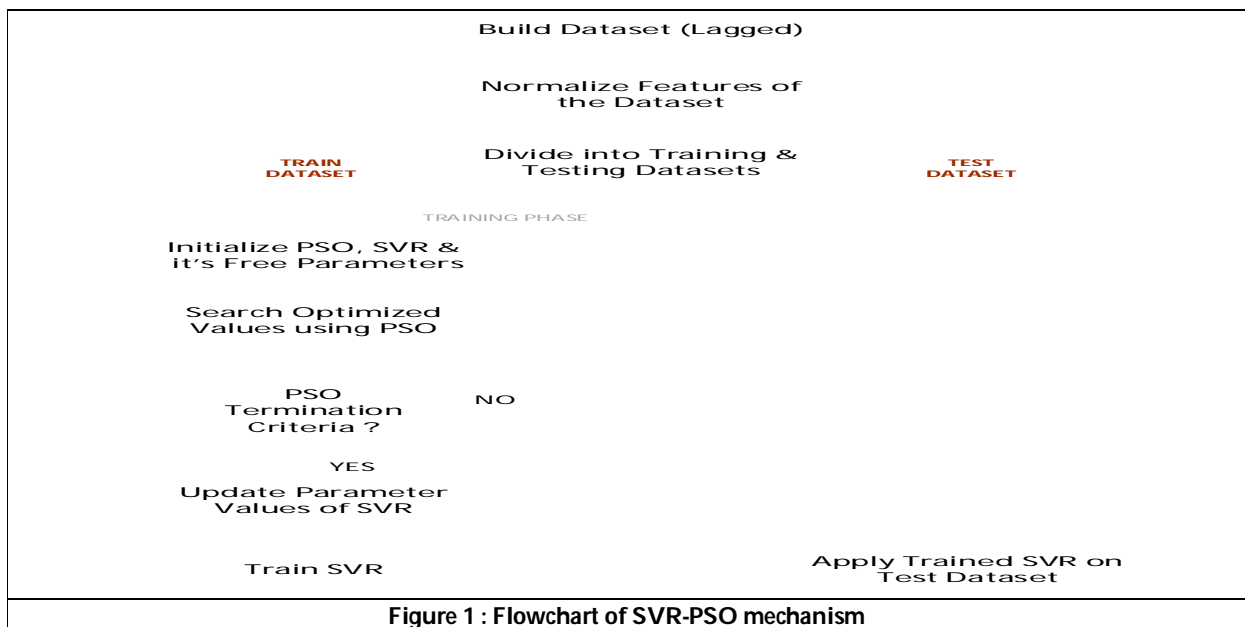




Sumanjit Das et al.

15. Jaidhan, B. J., Madhuri, B. D., Pushpa, K., & Devi, B. L. (2019). Application of Big Data Analytics and Pattern Recognition Aggregated with Random Forest for Detecting Fraudulent Credit Card Transactions (CCFD-BPRRF).
16. W.M.Hung, Wei-Chiang Hong, (2009) Application of SVR with improved ant colony optimization algorithms in exchange rate forecasting. Control and Cybernetics, 38(3), 863-891.
17. Ming-Wei, Li-JingGeng,Wei-Chiang Hong, Li-Dong Zhang, (2019) Periodogram estimation based on LSSVR-CCPSO compensation for forecasting ship motion. Nonlinear Dynamics, 97(4), 2579-2594.
18. Ming-Wei Li,Yu-Tain Wang, Jing Geng, Wei-Chiang Hong, (2021) Chaos cloud quantum bat hybrid optimization algorithm. Nonlinear Dynamics, 103(1), 1167-1193.
19. Guo-Feng Fan, Shan Qing, Hua Wang, Wei-Chiang Hong and Hong-Juan Li, (2019) Support Vector Regression Model Based on Empirical Mode Decomposition and Auto Regression for Electric Load Forecasting, Energies, 6(4), 1887-1901.
20. Guo-Feng Fan, Li-Ling Peng, XiangjunZha and Wei-Chiang Hong, (2017) Applications of Hybrid EMD with PSO and GA for an SVR-Based Load Forecasting Model, Energies, 10(11), 1713-1734.

| Table 1: Comparison of Training and Testing data | | | |
|---|------|---------|-------------|
| | | SVR-PSO | PCA-SVR-PSO |
| Training | MAE | 2.76 | 0.39 |
| | RMSE | 5.74 | 1.2 |
| | MAPE | 6.8 | 3.69 |
| Testing | MAE | 2.92 | 0.06 |
| | RMSE | 6.49 | 0.07 |
| | MAPE | 7.08 | 3.21 |





Sumanjit Das et al.

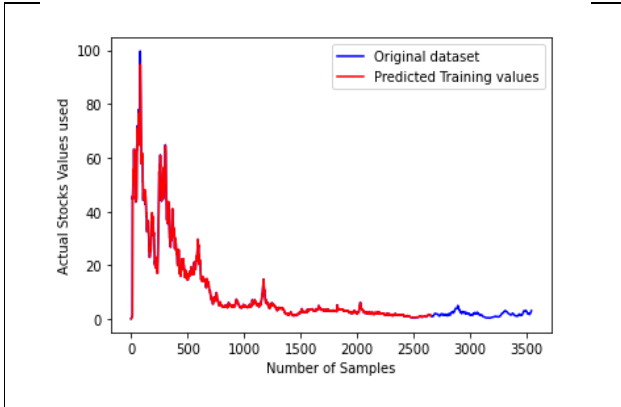


Figure 2: Actual vs predicted stock value of Hindustan Bio Science Ltd. In training phase

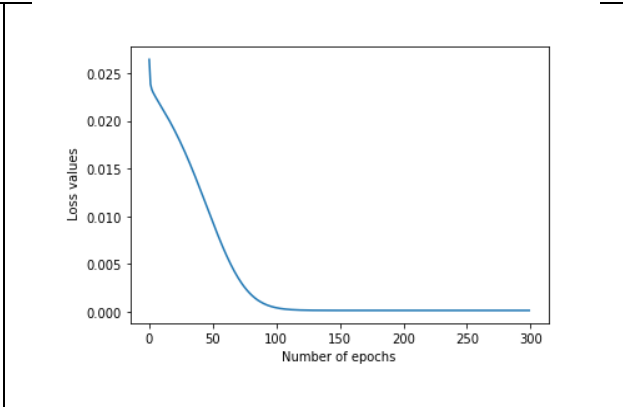


Figure 3: Error graph in of Hindustan Bio Science Ltd. in whole data set

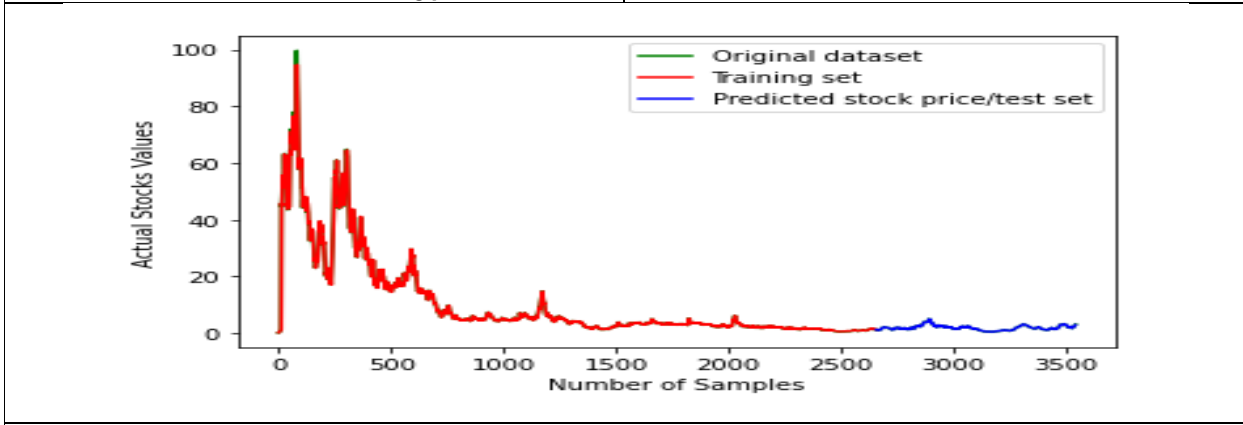


Figure 4: Actual vs predicted stock value of Hindustan Bio Science Ltd. In training phase





Land Surface Temperature Mapping of Titlagarh Municipality, Odisha- A Geospatial Approach

Prafulla Ku.Panda^{1*}, Sovan Sankalap¹, Sridhar Panda¹, Sai Soumya Shubhankara¹ and Smruti Rekha Sahoo²

¹Department of Civil Engineering, Centurion University of Technology and Management, Odisha, India.

²Department of Geology, Fakir Mohan University, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Prafulla Ku.Panda

Department of Civil Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: prafullapanda@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Land surface temperature (LST) is a crucial component in several areas, including environmental issues, urban growth with respect to land use and land cover balance analyses, and also a significant input for climate models. LANDSAT data has opened up a wide range of opportunities for studying land processes through remotely sensed data. Land surface temperature calculation is possible with the aid of remotely sensed images and digital image processing. In the present study, LST for Titlagarh Municipality, Odisha, was obtained using the SW algorithm and Landsat 8 Optical Land Imager (OLI) data with a resolution of 30 m and Thermal Infrared Sensor (TIR) data with a resolution of 100 m. The LST has been computed using the Normalized Difference Vegetation Index (NDVI) values from the Red and Near Infrared bands. The Land Surface Emissivity (LSE) is primarily obtained from the Thermal Infrared bands. The research work focused on ArcGIS Raster processes and Raster analysis using LANDSAT 8 December (2019) and May (2020) (thermal Bands (10 & 11). TIR bands 10 and 11 were used to calculate the spectral radiance. Emissivity was calculated using the NDVI threshold technique and OLI bands 2, 3, 4, and 5 were used for said proposes. The findings indicate that LST was high in the barren regions but low in the hilly regions due to vegetative cover. The results show that it is possible to determine NDVI, LSE, and LST with adequate precision.

Keywords: Land surface temperature, Land use land cover, Landsat, NDVI, LSE etc.





Prafulla Ku.Panda et al.,

INTRODUCTION

LST (Land Surface Temperature) is the temperature of the earth's surface that is directly in contact with the measuring instrument (usually measured in Kelvin). LST is the temperature at the earth's crust's surface where heat and radiation from the sun are absorbed, reflected, and refracted. It was greatly influenced by the rising levels of greenhouse gases in the atmosphere. It melts the glaciers and ice sheets in the Polar Regions as it rises. As a result, flooding and sea level rise occur. Increased LST also has an impact on the climatic conditions of monsoon countries, resulting in unpredictable rainfall.

Land Surface Temperature (LST) can be defined as the temperature felt when the land surface is touched with the hands or it is the skin temperature of the ground [1, 2, 3]. LST is the temperature emitted by the surface and measured in kelvin. It was greatly affected by the increasing greenhouse gases in the atmosphere. As it rises, it melts the glaciers and ice sheets in the polar region. Thus, it leads to flood and sea level rise. Increase in LST also affects the climatic condition of the monsoon countries leading to unpredictable rainfall. This will have an impact on the vegetation on the entire Earth's surface. An area's land use/land cover (LU/LC) can be used to estimate the amount of LST. Natural and anthropogenic activities alter an area's LU/LC. This has an effect on the LST in that area. The local climate of the area changes as its value changes. It is a significant phenomenon that should be investigated. As a result, many researchers computed LST using various algorithms and techniques. Ground surveys would permit a highly accurate Land Use Land Cover (LULC) classification, but they are time-consuming, burdensome and expensive, which highlights remote sensing an evident and preferred alternative. Identification and characterization of Urban Heat Island (UHI) is typically based on LST that varies spatially, due to the non-homogeneity of land surface cover and other atmospheric factors. LST is the key factor for calculating highest and lowest temperature of a particular location. Medium spatial resolution data, such as that from the LANDSAT and SPOT are suitable for land cover or vegetation mapping at regional local scale. LANDSAT 8 carries two sensors, i.e., the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). OLI collects data at a 30m spatial resolution with eight bands located in the visible and near-infrared and the shortwave infrared regions of the electromagnetic spectrum, and an additional panchromatic band of 15m spatial resolution. TIRS senses the TIR radiance at a spatial resolution of 100m using two bands located in the atmospheric window between 10 and 12 μ m. Before the invention of Earth Observation Satellites (EOS), it was hard to estimate the LST of an area. Generally, it was calculated for a particular set of sample points and interpolated into isotherms to generalize the point data into area data. Now with the advent of satellites and high-resolution sensors it is possible to estimate LST spatially. It can be calculated for a region at a stretch with the use of thermal infrared bands methodology is more feasible to estimate NDVI and surface emissivity.

Study Area

Titilagarh municipality situated in Bolangir district Odisha India and it occupies an area of 15,359 square kilometers (5,930 sq mi). Titilagarh lies between 20°17'3.52"N and 83°08'47.79"E (Fig.No-1). As per the physiography of the area is concerned It has an average elevation of 215 meters. The Maximum temperature reaches up to 50.1°C and minimum temperatures reach up to 24 °C during the summer and winter respectively. The average rainfall is 1384.1 mm. Titilagarh had a population of 27,756 (2001 Census). Males constitute 52% of the population and females 48%. Titilagarh has an average literacy rate of 67%, higher than the national average of 59.5%: male literacy is 75%, and female literacy is 57%. In Titilagarh, 12% of the population is under 6 years of age. The study area has Red & Yellow, Red & Black, Black, Laterite, Black cotton soil and brown forest soil.

Objectives

The goal of this present study is to estimate land surface temperature by the following objectives in order to persuade the goal are,





Prafulla Ku.Panda et al.,

To calculate Normalized Difference Vegetation Index (NDVI).

To convert TIRS band data to TOA spectral radiance .

To calculate Atmosphere Brightness Temperature

To estimate Land Surface Temperature .

To calculate the area for different temperature ranges.

MATERIALS AND METHODS

The data of Landsat 8 is available in USGS (United States Geological Survey) Earth Explorer website at free of cost. Landsat 8 satellite images the entire earth once in 16 days. In the present research, the TIR bands 10 and 11 were used to estimate brightness temperature and bands 4 and 5 were used to generate NDVI of the study area. Satellite data over Titalagarh region of December and June of 2019 and 2020 have been used in this study. Landsat 8 provides metadata of the bands such as thermal constant, rescaling factor value etc., which can be used for calculation like LST bands, wavelength and resolution of Landsat8 are as given in Table –1.

Following Meta data values are used for calculation

- Radiance Add Band 10 =0.10000
- Radiance Add Band 11 =0.10000
- Radiance Mult Band_10 =0.0003342
- Radiance Mult Band_11 =0.0003342
- K1 Constant band 10 =774.8853
- K2 Constant Band 10 =1321.0789
- K1 Constant Band 11 =480.8883
- K2 Constant Band 11 =1201.1442

Process

I. Top of Atmosphere (TOA) Radiance

Using the radiance rescaling factor, Thermal Infra-Red Digital Numbers can be converted to TOA spectral radiance. The value of Top of Atmospheric (TOA) spectral radiance (L_λ) was determined by multiplying multiplicative rescaling factor (0.000342) of TIR bands with its corresponding TIR band and adding additive rescaling factor (0.1) with it

$$L_\lambda = ML * Q_{cal} + AL$$

Where:

L_λ = TOA spectral radiance (Watts/ (m² * sr * μ m))

ML = Radiance multiplicative Band (No.)

AL = Radiance Add Band (No.)

Qcal = Quantized and calibrated standard product pixel values (DN)

Top of Atmosphere (TOA) Brightness Temperature

Spectral radiance data can be converted to top of atmosphere brightness temperature using the thermal constant Values in Meta data file. Brightness temperature (TB) is the microwave radiation radiance traveling upward from the top of Earth's atmosphere. The calibration process has been done for converting thermal DN values of thermal bands of TIR to TB. For finding TB of an area the Top of Atmospheric (TOA) spectral radiance of (L_λ) was needed. TB for both the TIRs bands was calculated by adopting the following formula

$$BT = K2 / \ln (K1 / L_\lambda + 1) - 272.15$$

Where:

BT = Top of atmosphere brightness temperature (°C)

L_λ = TOA spectral radiance (Watts/(m² * sr * μ m))





Prafulla Ku.Panda et al.,

K1 = K1 Constant Band (No.)

K2 = K2 Constant Band (No.)

Normalized Differential Vegetation Index (NDVI)

The Normalized Differential Vegetation Index (NDVI) is a standardized vegetation index which Calculated using Near Infra-red (Band 5) and Red (Band 4) bands. OLI bands 2, 3, 4 and 5 were layer stacked and NDVI was calculated using ERDAS Imagine software. The output value of NDVI ranged between -1 and 0.59. To get NDVIs the NDVI image was reclassified into soil and vegetation; the classified data were used to find out FVC. After generating LSE for both the bands of TIR, the mean and difference LSE was found as

$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

Where:

RED= DN values from the RED band

NIR= DN value from Near-Infrared band

Calculation of proportional vegetation (PV)

$$\text{PV} = [(\text{NDVI} - \text{NDVI min}) / (\text{NDVI max} - \text{NDVI min})]^2$$

Where:

PV = Proportion of Vegetation

NDVI = DN values from NDVI Image

NDVI min = Minimum DN values from NDVI Image

NDVI max = Maximum DN values from NDVI Image

Land Surface Emissivity (LSE)

Land surface emissivity (LSE) is the average emissivity of an element of the surface of the Earth calculated from NDVI values. To find LST it is necessary to calculate the LSE of the region. LSE was estimated using NDVI threshold method.

$$E = 0.004 * \text{PV} + 0.986$$

Where:

E=Land Surface Emissivity

PV = Proportion of Vegetation

Land Surface Temperature (LST)

The Land Surface Temperature (LST) is the radioactive temperature which calculated using Top of atmosphere brightness temperature, Wavelength of emitted radiance, Land Surface Emissivity.

$$\text{LST} = \text{BT} / (1 + W * (\text{BT} / \text{C2}) * \ln(E))$$

Where:

BT = Top of atmosphere brightness temperature (°C)

W = Wavelength of emitted radiance(For band 10 -10.8μm and Band 11- 12 μm)

C2=h.c/s=1.38*10⁻²³mK=14388 μm

s=Boltzmann Constant = 1.3806488 x 10⁻²³ Joules per degree Kelvin (J/K)

c=Velocity of light= 3.0 x 10⁸ m/s.

E = Land Surface Emissivity





Prafulla Ku.Panda et al.,

RESULT AND DISCUSSION

The NDVI map for December 2019 shows that the NDVI value ranged from -0.329 to 0.589. The resulting map shows moderate NDVI whereas area under water body has significant low value (Fig-3). The NDVI map for the month of May shows that the NDVI value ranged in between 0.729 to 0.982. The resulting map shows high NDVI (Fig-4). Using NDVI values LSE was created for the month of May (Fig-6). The LSE of AOI ranged between 0.947 and 0.992. Highly elevated regions in the district had a more vegetative cover; hence LSE was moderate in these regions. LSE was created for the month of December (Fig-5). The LSE of AOI ranged between 0.937 and 0.993. LSE was high in these regions. Land surface map (Fig-7) has been derived using brightness temperature and LSE. LST temperature ranges and areas for the month of December are shown in table-2. And Land surface map (Fig-8) has been DERIVED using brightness temperature and LSE. LST temperature ranges and areas for the month of May are shown in table-3.

CONCLUSION

NDVI, brightness temperature, LSE, and LST of an area were determined using Arc GIS. NDVI Maps shows that vegetation is high in the month of December 2019 when compared with the month of May 2020. Estimated LST values reveal that in the month of May 62.32% of the total area, surface temperature lies in the range of 38-44°C and in the month of December 68.99% of the total area, surface temperature lies in the range 29-33°C. Thus, LST can be estimated using Land sat 8 with multi band OLI and TIR images

REFERENCES

1. Prafulla Ku. Panda and G.Tanuja Land use and land cover change detection study using space input and GIS -a case study for Gajapati district, Odisha international Journal of Recent Scientific Research Vol. 8, Issue , 9, pp.2489-2491, September , 2017, 19815-19819, DOI: 10.24327/ijrsr.2017.0809.0765
2. D Anandababu, B M Purushothaman, Babu S. Suresh; Estimation of Land Surface Temperature using LANDSAT 8 Data International Journal of Advance Research, Ideas and Innovations in Technology, Volume 4, Issue 2
3. Candy, R. W. et al., Bulgın "The Impact of Satellite-Derived Land Surface Temperatures on Numerical Weather Prediction Analyses and Forecasts" Vol 122, issue 18, pg 9783 – 9802, 27 Sept 2017.
4. Dr. S. Narayana Reddy, et al., "Land Surface Temperature Retrieval from LANDSAT data using Emissivity Estimation" Vol 12, no 20, pp9670-9687.
5. S. Boussetta, A. et al., "Comparison of model land skin temperature with remotely sensed estimates and assessment of surface- atmosphere coupling" Vol 120, issue 23, pg 96-111, 16 Dec 2015.
6. Xubin Zeng, et al., "Comparison of land skin temperature from a land model, remote sensing, and in situ measurement" Vol 119, issue 6, pg 3093-3106, 27 Mar 2014.
7. Mani N D, et al., "Estimation of LST of Dindigul district using LANDSAT 8 data" Volume: 03 Issue: 05, pg 122-126, May- 2014.
8. Md Shahid Latif et al., "LST Retrieval of Landsat-8 Data Using Split Window Algorithm- A Case Study of Ranchi District", Volume 2, Issue 4, pp 3840-3849, 2014.
9. Katyar S.K, et al., "Impact analysis of open cast coal mines on land use/ land cover using remote sensing and GIS technique: A case study, International journal of engineering science and technology", Vol. 2 (12), pp.7171-7176, 2010.
10. Prakasam.C, et al., Land use and land cover change detection through remote sensing approach: A case study of Kodaikanal taluk, Tamil Nadu, and International Journal of Geomatics and Geosciences volume 1, no 2, pp. 150-158, 2010.
11. Kuma J.S, et al., Open pit mining and land use changes: an example from Bogosu Prestea area, south-west Ghana, Electronic Journal of Information Systems in Developing Countries (EJISDC) 36, 3, pp. 1-10, 2009.
12. Ololade O, et al., "Abstract of land-use/cover mapping & change detection in the Rustenburg mining region using Landsat images", IGARSS 2008.





Prafulla Ku.Panda et al.,

13. Saxena A, et al., "Change detection of land use and land cover patterns: A case study of Mandideep and Obedullaganj area in Madhya Pradesh", ITPI journal 5 : 4 pp. 65 – 72, 2008
14. V S. Singh, et al., "Heavy metal contamination in groundwater due to mining activities in Sukinda valley, Orissa" Vol. 1(4), pp. 058- 067, June 2008
15. Naço P, et al., Automated change detection from remote sensing data: A case study at the Pali Cape - Erzeni river mouth coastal sector, BALWOIS,2008.

Table-1 .Wavelength and resolution of Landsat 8

| Bands | Wavelength (micrometers) | Resolution(meters) | Path/ Row | Date of Acquisition | Sensor |
|---------------------------------------|--------------------------|--------------------|------------------------|------------------------------|--------|
| Band 1 - Ultra Blue (coastal/aerosol) | 0.435 - 0.451 | 30 | Path - 141 Row - 46 | 2019-12-05 And 2020-05-13 | OLI |
| Band 2 - Blue | 0.452 - 0.512 | 30 | | | |
| Band 3 - Green | 0.533 - 0.590 | 30 | | | |
| Band 4 - Red | 0.636 - 0.673 | 30 | | | |
| Band 5 - Near Infrared (NIR) | 0.851 - 0.879 | 30 | | | |
| Band 6 - Shortwave Infrared (SWIR) 1 | 1.566 - 1.651 | 30 | | | |
| Band 7 - Shortwave Infrared (SWIR) 2 | 2.107 - 2.294 | 30 | | | |
| Band 8 - Panchromatic | 0.503 - 0.676 | 15 | | | |
| Band 9 - Cirrus | 1.363 - 1.384 | 30 | | | |
| Band 10 - Thermal Infrared (TIRS) 1 | 10.60 - 11.19 | 100 | | | TIR |
| Band 11 - Thermal Infrared (TIRS) 2 | 11.50 - 12.51 | 100 | | | TIR |

Table-2 LST temperature ranges and areas

| S. No | Temperature (°C) | Area (Sq.km) | Percentage (%) |
|-------|------------------|--------------|----------------|
| 1 | 20-24 | 18 | 7.11 |
| 2 | 25 - 28 | 211.72 | 22.89 |
| 3 | 29- 33 | 651.12 | 68.99 |
| 4 | >33 | 3.66 | 1.01 |

Table-3 Temperature Ranges Month of May

| S.No | Temperature (°C) | Area (Sq.km) | Percentage (%) |
|------|------------------|--------------|----------------|
| 1 | 25-32 | 16 | 2.08 |
| 2 | 32- 38 | 211.72 | 26.9 |
| 3 | 38-44 | 602.12 | 62.33 |
| 4 | >44 | 58 | 8.69 |





Prafulla Ku.Panda et al.,

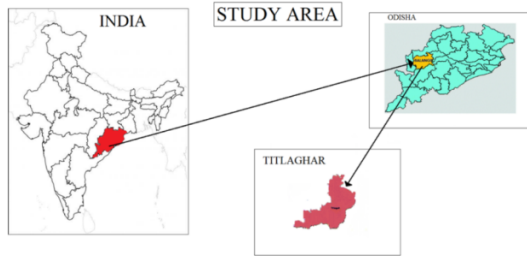


Fig no 1- Study Area Map

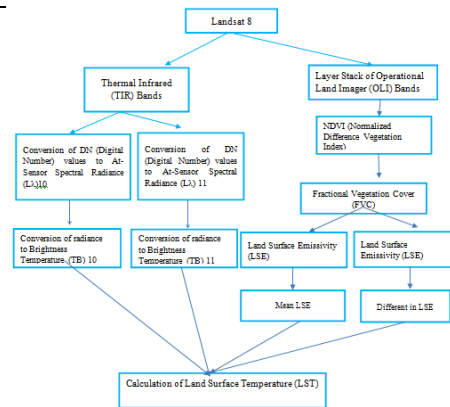


Fig No -2 Methodology of flow chart

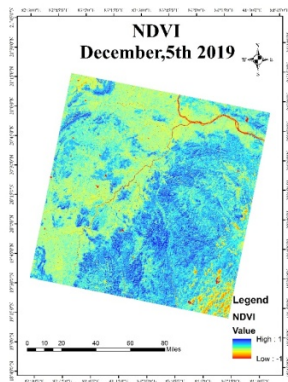


Fig .No.3

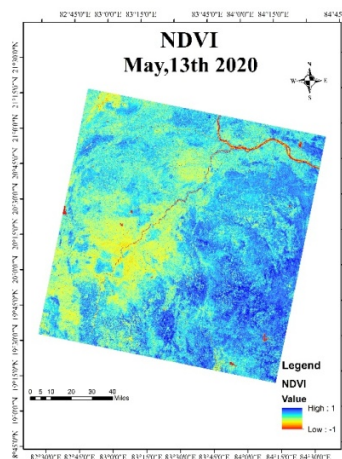


Fig .No.4

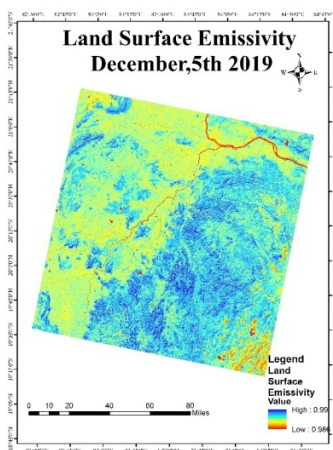


Fig.No.5

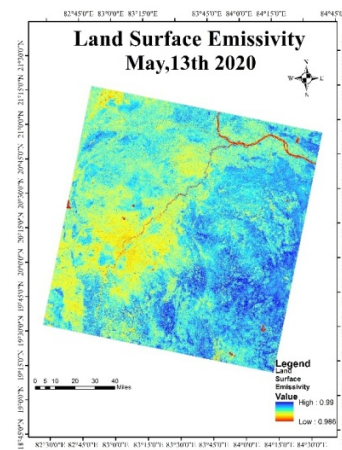


Fig.No.6





Prafulla Ku.Panda et al.,

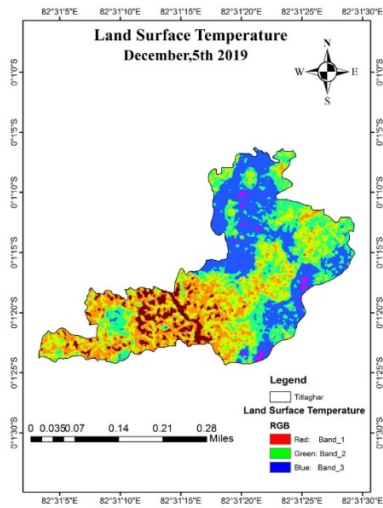


Fig .No.7

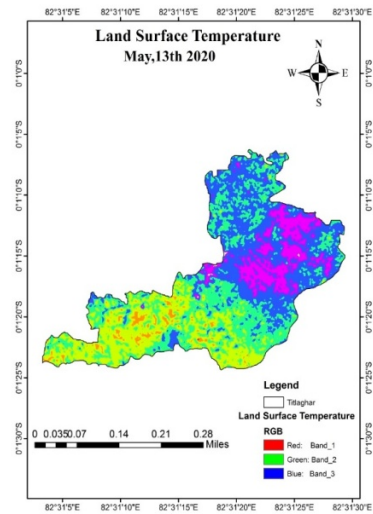


Fig .No.8

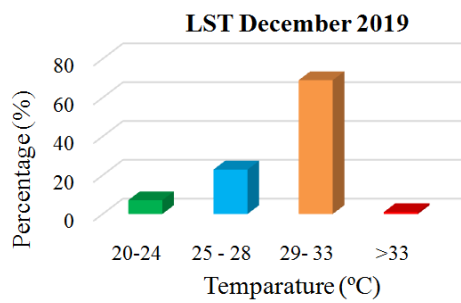


Fig .No.9 LST December 2019

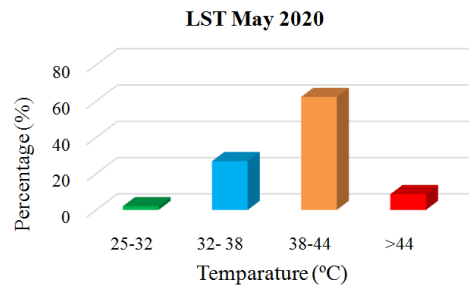


Fig .No.10. LST May 2020





Use of PEPCK Gene for Improved Yield and Tolerance against Salinity

Suchismita Prusty and Ranjan Kumar Sahoo*

Department of Biotechnology, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ranjan Kumar Sahoo

Department of Biotechnology,
Centurion University of Technology and Management,
Odisha, India.

Email: ranjan.sahoo@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In era of global warming and increased population growth, securing and elevating agricultural productivity is critical, and efforts to boost crop plant salt tolerance should be included, in addition to improving saline soils. The plant increases its endurance capacity by promoting several genes such as PEPCK, PEPC, and others at the transcriptional level in order to respond to these types of environmental challenges. PEPCK is a decarboxylase cytosolic enzyme, involved in metabolic processes such as gluconeogenesis, Krebs cycle and malic acid metabolism. These processes help to increase sugar content, reduce photorespiration and transpiration which aids in stomatal conductance and enhances photosynthetic ability as well as the vitality of the plant. In this review we have focused on different aspects of PEPCK gene to increase the productivity and improve tolerance factor.

Keywords: PEPCK, Productivity, Abiotic stress tolerance, Transgenic plants.

INTRODUCTION

Population explosion poses as a major challenge in elevating crop productivity, that too within limited land resources. Inspection of the demand in future provisions and growth of production under various situations are necessary for the achievement of global food security of various crops. Environmental stress factors such as salinity, drought, heat, cold, and heavy metals create hindrance for increasing crop productivity. These stressors cause photosynthetic depletion, germination percentage reduction, and biomass curtailment, as well as an increase in reactive oxygen species (ROS). This is raising concerns among scientists and inspiring them to develop novel transgenic varieties to overcome this situation. Previous studies shown that, among abiotic stresses, salinity preoccupies the second rank after drought (Ghosh *et al.*, 2016). It has been affecting around 20% of cultivated land globally, which is around 900 million hectares. India accounts for about 8.4 million hectares of affected areas (Ghosh *et al.*, 2012). Inhibition of bio-physiological processes leads to an imbalance in metabolism and cell signaling, as well as elevated ROS generation, which interferes with cell redox and energy balance. The link between physiological tolerance processes



**Suchismita Prusty and Ranjan Kumar Sahoo**

from molecular processes and agronomical tools for growth stabilization and yield may help to improve the crops. This will eradicate the future demand and will provide improvements for cultivating crops under salinity stress. Salinity stress results in the accumulation of glucose, sucrose, citrate, glutamate, and malate in certain plants. Many efforts have been given so far as to understand the complexity of salinity stress on various crop plants. One way to withstand the catastrophic effect of salinity stress is that the plant can raise the osmotic pressure by accumulating soluble sugar, which as a result could limit cell death rate thereby offering better development of it (Nemati *et al.* , 2011). Salinity stress can also be alleviated by increasing photosynthetic and antioxidant capacity, according to research (Tuteja *et al.* , 2013). The plant increases its endurance capacity by promoting several genes such as PEPCK, PEPC, and others at the transcriptional level in order to respond to these types of environmental challenges. According to some theories, a protein-encoding gene named Phospho Enol Pyruvate Carboxy Kinase (PEPCK) may have exhibited a positive response against salinity stress in certain plants (Huang *et al.* , 2015). The importance of the PEPCK gene in C₄ and CAM photosynthetic plants, as well as additional roles in biosynthetic and energy metabolism in non-photosynthetic tissues of C₄ plants, is well known (Aubry *et al.* , 2011). Two subfamilies of the poaceae family, Chloridoideae and Panicoideae, have revealed evolution of the PEPCK cycle pathway. It functions as a core decarboxylase agent that is activated by dephosphorylation. It is involved in metabolic processes such as gluconeogenesis, Krebs cycle and malic acid metabolism. As per some theories his enzyme helps to increase sugar content, reduce photorespiration and transpiration, aids in stomatal conductance and enhances photosynthetic ability as well as the vitality of the plants. Through this we can increase productivity and yield, thereby meeting population demand and raising the economic welfare. This article is based on the various roles and applications of the PEPCK gene, as well as its putative biochemical, morphological, and physiological effects on crop plants, such as providing salt resistance and increasing the productivity. This would lead to the adaptation of novel ways to eradicate the gap between the supply and demand rates that would provide the necessitous people an obtainable and inexpensive means.

Necessity Of Improving Yield

Crop improvement is critical in order to satisfy the demands of a rapidly changing planet (eg, population explosion, reducing the disparity between producers and consumers, climatic changes, abiotic and biotic stresses and decreasing land areas). The guesstimated value of yield diminution due to negative outcomes of abiotic stresses on various glycophytic crops is calculated to be approximately 70% (Acquaah, 2007). During plant development, abiotic stress conditions such as salt or drought have an inverse relationship with yield-related features. If salinity stress inhibits growth in the early stages of plant development, the yield will be severely reduced, and the quality and quantity of plant products will be impaired. When the growth requirements are properly managed, crop plants are able to produce high yields and achieve good quality grain, fiber, as well as high sugar, oil, or protein content. With the emergence of the latest modern technology evolves the proffer of prodigious possibilities to solve and develop a new system of agricultural practices. This will help the current situation along with uplifting of economy. Very crucial major steps have been taken to deal with possible solutions for accelerating the production of various crops and utilizing new post-harvest technologies for loss depletion. Some adaptation methods include revamping in soluble sugar level (trehalose, sucrose, and fructan), sterols and accumulation of several substances like amino acids and/or its derivatives (tryptophan and proline), alcohol, ammonium compounds (glycinebetaine, polyamines) etc in the plant. (Wewer *et al.* , 2011). The plant also promotes innumerable genes such as PEPCK, PEPC etc. at the transcriptional level and escalates its endurance capacity. Understanding the role of these genes in the post-genomic age is very challenging. The expansion of large-scale technologies like as genomics, transcriptomics, and proteomics, as well as plant genome sequences, has redefined our knowledge of cellular signaling. With this, we can now get a holistic "snapshot" of a cell, allowing for a better insight of physiologically complicated processes and cellular mechanisms. Specific stress pathways require further investigation and analysis using more integrative methods such as treatment mutagenesis screening, genome-wide transcriptome analysis, robust bioinformatics tools, and sensitive mass spectrometry (Atkinson and Urwin, 2012). Using this we can, with the developed protocols to create variability, through which we can develop new crop varieties to deal with several issues like salinity stress. With the help of tissue culture technology, improvements in plant varieties using genetic transformation, etc. , is now possible which can increase the efficiency of crop varieties; along with reproducible plant regenerating protocols that are





Suchismita Prusty and Ranjan Kumar Sahoo

available for the target genotypes where the resultant clones being true to the type of genotype could be easily selected for easy evaluation that had been selected (Rachmawati and Anzai, 2006).

Tolerance against salinity stress

Salinity stress occurs when the concentration of Na⁺, Cl⁻, and other allied salt ions in soil surpasses standard limits, disrupting osmotic processes. This as a result alters many metabolic activities necessary for plant growth and development. When the pH of the soil is between 7 and 8.5, the electrical conductivity ("EC" or =) is 4ds/m, the osmosis pressure is around 0.2 Mpa, and the amount of NaCl is around 40 Mm, the soil is considered to be saline. High salinity impacts almost one billion hectares of cultivable land worldwide, making it a cause for worry (Sahoo *et al.*, 2014). (Figure 1). The mitochondria and chloroplast are the organelles most impacted by salinity stress, which alter the concentration of chlorophyll and so reduce the plant's photosynthetic efficacy (Robles *et al.*, 2019). It also has a negative effect on enzymes that control the Calvin cycle (Li *et al.*, 2011). Salinity stress also causes lipid and protein instability in the plasma membrane, altering membrane permeability as well as ion disproportion, hyperosmotic and/or hyper ionic stressors, and toxicity, culminating in plant's death (Nessim and Kasim, 2019) (Figure 2).

There has been a remarkable decrease in the quantity of tillers, panicles, and spikelets, which could lead to plant sterility and loss of grain output (Joseph *et al.*, 2013). Plants adapt to stress by changing their soluble sugar levels (trehalose, sucrose, and fructan), sterols, and the accumulation of a variety of substances in the plant, such as amino acids and/or their derivatives (tryptophan and proline), alcohol, ammonium compounds (glycinebetaine, polyamines), and so on (Wewer *et al.*, 2011). An increase in carbohydrate-glucose metabolism also enables the plant to resume photosynthesis and deal with stress (Bhattacharya and Kundu, 2020). In response to salt stress, the plant up-regulates several genes to protect itself, either directly or indirectly (Tuteja *et al.*, 2007). The induction of specific foreign or novel genes in plants may give a biotic and abiotic stress tolerance component (Jia *et al.*, 2013). Tolerance of salinity stress is attributed to a large number of genes involved in diverse metabolic processes like as sodium ion compartmentalization, signal transduction, oxidative stress protection, carbon metabolism, and exclusion transport, among others.

PEPCK gene

Phosphoenolpyruvatecarboxykinase (PEPCK) is a pervasive, ATP-dependent cytosolic enzyme found in almost all flowering plants' bundle sheath cells. It is a proteinaceous enzyme that operates as a primary cytosolic decarboxylase primarily regulating CO₂ concentration via RuBisCO (Brown *et al.*, 2016). PEPCK has been involved in gluconeogenesis, the TCA cycle, malate, nitrogen sugar, organic acid, and amino acid metabolism, as well as maintaining pH stability. (Liu *et al.*, 2021). PEPCK1 is a critical protein-coding gene involved in gluconeogenesis, malate metabolism, and the TCA cycle (by catalysing the conversion of OAA to PEP), all of which are required for stomata closure in absolute darkness (Figure 3).

(a) Formation of OAA from PEP is facilitated by PEPC which either leads to formation of aspartate facilitated by AspAT or is reduced to malate formation inside chloroplast both occurs in mesophyll cell.

(b) In the chloroplast of bundle sheath cell decarboxylation of malate leads to formation of pyruvate.

(c) During this process an intermediate compound CO₂ is formed which is utilized by Calvin cycle for formation of PGA.

(d) In the mitochondria of bundle sheath cell aspartate with the help of AspAT forms OAA whose decarboxylation leads to formation of PEP in cytosol facilitated by PEPCK.

PEPCK2 is a mitochondrial enzyme that catalyses the conversion of OAA to PEP and is involved in adipocytokine signaling and glucose metabolism (Stockebrand, 2016). Although PEPCK gene's role in C₄ type and CAM type photosynthetic plants is well recognized, reports suggested about the varieties of other roles it plays in and biosynthetic and energy metabolism in both non-photosynthetic and photosynthetic tissues of C₄ plants (Aubry *et al.*, 2011). Salinity stress levels rises when the concentration of Na⁺, Cl⁻, and other allied salt ions in soil surpasses



**Suchismita Prusty and Ranjan Kumar Sahoo**

standard limits, disrupting osmotic processes and, as a result, altering many metabolic activities necessary for plant growth and development.

Role of PEPCK gene in salinity tolerance and yield improvement

PEPCK has been implicated in a variety of stress tolerance actions in addition to metabolism. Various studies have demonstrated the up-regulation of the Phosphoenolpyruvatecarboxykinase (PEPCK) gene and its functional significance in abiotic and biotic stress tolerance. (Song *et al.* , 2021). PEPCK is actively engaged in various metabolically processes like sugar, organic acid, and amino acid metabolism (Choi *et al.* , 2015). The presence of PEPCK has been reported in various somatic and reproductive cells of plants like Arabidopsis (Malone *et al.* , 2007). During the vegetative and reproduction phases of Arabidopsis, the action and expressions of PEPCK are active across several tissues (Malone *et al.* , 2007). In Arabidopsis, induction of PEPCK gene expression or enhanced enzyme activity in response to abiotic stressors, particularly in roots, has been reported. In Arabidopsis and pepper, PEPCK1 is implicated in innate and adaptive immunity against bacterial and oomycete infections. It was revealed that its activity was modest in healthy leaves but drastically elevated in avirulently infected leaves (amplified expression of CaPEPCK1 gene from capsicum when infected with an avirulent stage of Xcv in the presence of salicylic acid environment stress, preventing the occurrence of obligate biotrophicoomycete as well as hemibiotrophic bacteria)(Choi *et al.* , 2015). Low temperatures along with flooding stress increased the content of PEPCK, which aided the metabolism of energy and the photosynthesis (Wang *et al.* , 2021). PEPCK has been detected in the phloem of grape seeds at all stages of development with the help of immuno-blotting technique, confirming that PEPCK is active in the nitrogen assimilation metabolism (Delgado-Alvarado *et al.* , 2007). PEPCK is crucial for the gluconeogenic sugar formation from the reserve oil of germinating oilseeds during early seedling development in Arabidopsis (Rylott *et al.* , 2003). During the light-dark transient period, the mutant PEPCK1 plants show higher stomatal conduciveness and mild responses to darkness by stomata in compared to the wild type, meaning that stomata are being compressed in the open position (Penfield *et al.* , 2011) (Figure 4). By implementing this to create a transgenic plant, we can control and reduce transpiration rates, resulting in increased water content and reduced photorespiration, ensuring more carbon-dioxide absorption as well as elevating the photosynthetic rate, and increasing the vitality of plants that are susceptible to a variety of environmental stresses (especially salt stress), improving plant productivity and prompting high yielding.

CONCLUSION

Abiotic stress tolerance is a complex process involving numerous biochemical and physiological factors. Plants have the complex mechanism to cope these stresses. Many genes can be involved to create transgenic plants that have a high-stress tolerance characteristic. Through this review we have outcast the possible outcomes of introducing PEPCK gene to produce transgenic plants. These stress-tolerant plants would result in increased productivity as well as raised commercial value, both of which are critical for future agricultural and economic improvements.

REFERENCES

1. Aubry S, Brown NJ, Hibberd JM (2011) The role of proteins in C3 plants prior to their recruitment into the C4 pathway. *J Exp. Bot.* 62:3049-3059 <https://doi.org/10.1093/jxb/err012>
2. Bhattacharya S, Kundu A. (2020) Sugars and sugar polyols in overcoming environmental stresses. *Protective Chemical Agents in the Amelioration of Plant Abiotic Stress: Biochemical and Molecular Perspectives.* <https://doi.org/10.1002/9781119552154.ch4>
3. Brown DM, Williams H, Ryan KJ, Wilson TL, Daniel ZC, Mareko MH, Emes RD, Harris DW, Jones S, Wattis JA, Dryden IL (2016) Mitochondrial phosphoenolpyruvatecarboxykinase (PEPCK-M) and serine biosynthetic pathway genes are co-ordinately increased during anabolic agent-induced skeletal muscle growth. *Scientific reports* 6:1-4 <https://doi.org/10.1038/srep28693>




Suchismita Prusty and Ranjan Kumar Sahoo

4. Choi DS, Kim NH, Hwang BK (2015) The pepper phosphoenolpyruvatecarboxykinase CaPEPCK1 is involved in plant immunity against bacterial and oomycete pathogens. *Plant Mol. Biol.* 89: 99-111 <https://doi.org/10.1007/s11103-015-0354-6>
5. Delgado-alvarado AD, Walker RP, Leegood RC (2007) Phosphoenolpyruvatecarboxykinase in developing pea seeds is associated with tissues involved in solute transport and is nitrogen responsive *Plant Cell Environ.* 30:225-35 <https://doi.org/10.1111/j.1365-3040.2006.01622.x>
6. Ghosh N, Das SP, Mandal C, Gupta S, Das K, Dey N, Adak MK(2012) Variations of antioxidative responses in two rice cultivars with polyamine treatment under salinity stress *Physiol. Mol. Biol. Plants*18:301-13 <https://doi.org/10.1007/s12298-012-0124-8>
7. Ghosh, B. , & Ali Md, N. (2016). Response of Rice under Salinity Stress: A Review Update. *Rice Res. Open Access* 4:1-8 doi: 10.4172/2375-4338.1000167
8. Huang YX, Yin YG, Sanuki A, Fukuda N, Ezura H, Matsukura C (2015) Phosphoenolpyruvatecarboxykinase (PEPCK) deficiency affects the germination, growth and fruit sugar content in tomato (*Solanumlycopersicum* L.). *Plant Physiol. Biochem.* 96:417-25<https://doi.org/10.1016/j.plaphy.2015.08.021>
9. Jia J, Zhao S, Kong X, Li Y, Zhao G, He W (2013) Appels R, Pfeifer M, Tao Y, Zhang X, Jing R. *Aegilopstauschii* draft genome sequence reveals a gene repertoire for wheat adaptation. *Nature.* 496:91-5 <https://doi.org/10.1038/nature12028>
10. Joseph EA and MohananKV(2013) A study on the effect of salinity stress on the growth and yield of some native rice cultivars of Kerala state of India *Agric. For Fish* 2:141-150 DOI: 10.11648/j.aff.20130203.14
11. Li HW, Zang BS, Deng XW and Wang XP(2011b) Overexpression of the trehalose-6-phosphate synthase gene OsTPS1 enhances abiotic stress tolerance in rice. *Planta* 234:1007–1018 <https://doi.org/10.1007/s00425-011-1458-0>
12. Liu XC, Lin XH, Liu SC, Zhu CQ, Grierson D, Li SJ, Chen KS (2021) The effect of NH₄⁺ on phosphoenolpyruvatecarboxykinase gene expression, metabolic flux and citrate content of citrus juice sacs. *Plant Physiol. and Biochem.* 167:123-131 <https://doi.org/10.1016/j.plaphy.2021.07.041>
13. Malone S, Chen ZH, Bahrami AR, Walker RP, Gray JE, Leegood RC (2007) Phosphoenol pyruvate carboxykinase in *Arabidopsis*: changes in gene expression, protein and activity during vegetative and reproductive development *Plant cell physiol.* 48:441-450 <https://doi.org/10.1093/pcp/pcm014>
14. Nemati I, Moradi F, Gholizadeh S, Esmaeili M A, and Bihamta M R (2011) The effect of salinity stress on ions and soluble sugars distribution in leaves, leaf sheaths and roots of rice (*Oryza sativa* L.) seedlings. *Plant Soil Environ* 57:26–33<https://doi.org/10.17221/71/2010-PSE>
15. Nessim A, Kasim W (2019) Physiological impact of seed priming with CaCl₂ or Carrot root extract on *Lupinus termis* plants fully grown under salinity stress. *Egypt. J. Bot.* 10.21608/ejbo.2019.8026.1289
16. Penfield S, Clements S, Bailey KJ, Gilday AD, Leegood RC, Gray JE and Graham IA (2011) Expression and manipulation of phosphoenolpyruvate carboxykinase1 identifies a role for malate metabolism in stomatal closure. *Plant J.* 69:679–688 <https://doi.org/10.1111/j.1365-313X.2011.04822.x>
17. Rachmawati D, AnzaiH(2006) Studies on callus induction, plant regeneration and transformation of Javanica rice cultivars. *Plant Biotechnol.* 23:521-4 <https://doi.org/10.5511/plantbiotechnology.23.521>
18. Robles P, Quesada V (2019) Transcriptional and post-transcriptional regulation of organellar gene expression (OGE) and its roles in plant salt tolerance. *Int J Mol. Sci.* 20:1056 <https://doi.org/10.3390/ijms20051056>
19. Ryloft EL, Gilday AD, Graham IA (2003) The gluconeogenic enzyme phosphoenol pyruvate carboxykinase in *Arabidopsis* is essential for seedling establishment. *Plant Physiol.* 131:1834-42 <https://doi.org/10.1104/pp.102.019174>
20. Sahoo RK, Ansari MW, Tuteja R, Tuteja N (2014) OsSUV3 transgenic rice maintains higher endogenous levels of plant hormones that mitigates adverse effects of salinity and sustains crop productivity. *Rice* 07:1-3<https://doi.org/10.1186/s12284-014-0017-2>
21. Song Q, Joshi M, Wang S, Johnson CD, Joshi V(2021) Comparative Analysis of Root Transcriptome Profiles of Sesame (*Sesamum indicum* L.) in Response to Osmotic Stress *J. Plant Growth Regul.* 40:1787-1801 <https://doi.org/10.1007/s00344-020-10230-0>





Suchismita Prusty and Ranjan Kumar Sahoo

22. Stockebrand M, Nejad AS, Neu A, Kharbanda KK, Sauter K, Schillemeit S, Isbrandt D, Choe CU (2016) Transcriptomic and metabolic analyses reveal salvage pathways in creatine-deficient AGAT^{-/-} mice *Amino Acids* 48:2025-39 <https://doi.org/10.1007/s00726-016-2202-7>
23. Tuteja N (2007) Mechanisms of high salinity tolerance in plants. *Osmosensing and Osmosignaling*. Plant Molecular Biology. Elsevier Inc. 428:419–438 DOI: 10.1016/S0076-6879(07)28024-3
24. Tuteja N, Sahoo RK, Garg B, Tuteja R(2013) Os SUV 3 dual helicase functions in salinity stress tolerance by maintaining photosynthesis and antioxidant machinery in rice (*Oryza sativa* L. cv. IR 64). *Plant J.* 76:115-27 <https://doi.org/10.1111/tpj.12277>
25. Wang W, Du J, Chen L, Zeng Y, Tan X, Shi Q, Pan X, Wu Z, Zeng Y(2021) Transcriptomic, proteomic, and physiological comparative analyses of flooding mitigation of the damage induced by low-temperature stress in direct seeded early indica rice at the seedling stage. *BMC genomics* 22:1-15 <https://doi.org/10.1186/s12864-021-07458-9>
26. Wewer V, Dombrink I, vomDorp K, Dörmann P (2011) Quantification of sterol lipids in plants by quadrupole time-of-flight mass spectrometry *J. Lipid Res.* 52:1039-54 <https://doi.org/10.1194/jlr.D013987>
27. Atkinson, N. J. , Urwin, P. E. , 2012. The interaction of plant biotic and abiotic stresses: from genes to the field. *J. Exp. Bot.* 63, 35233543. Available from: <https://doi.org/10.1093/jxb/ers100>.

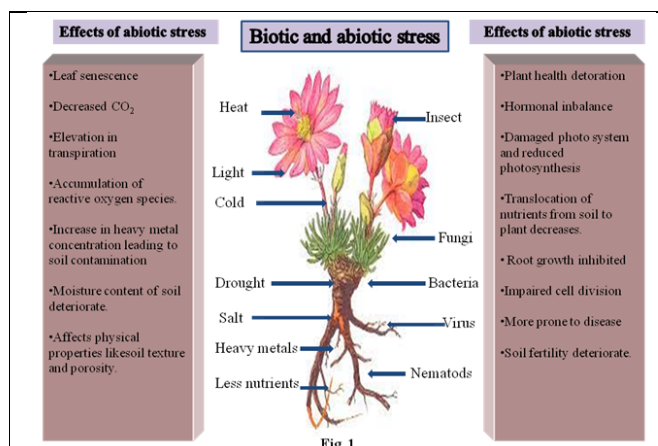


Figure 1 Effects and results of different biotic and abiotic stress on the physiological, morphological and biochemical of plant.

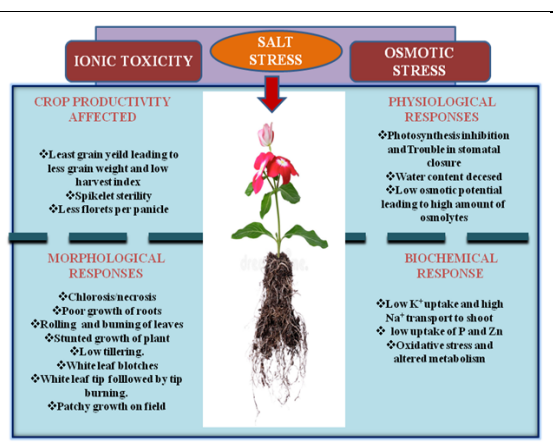


Figure 2 Effect of salt stress on plant showing its morphological, biochemical and physiological responses and how the crop productivity is affected.

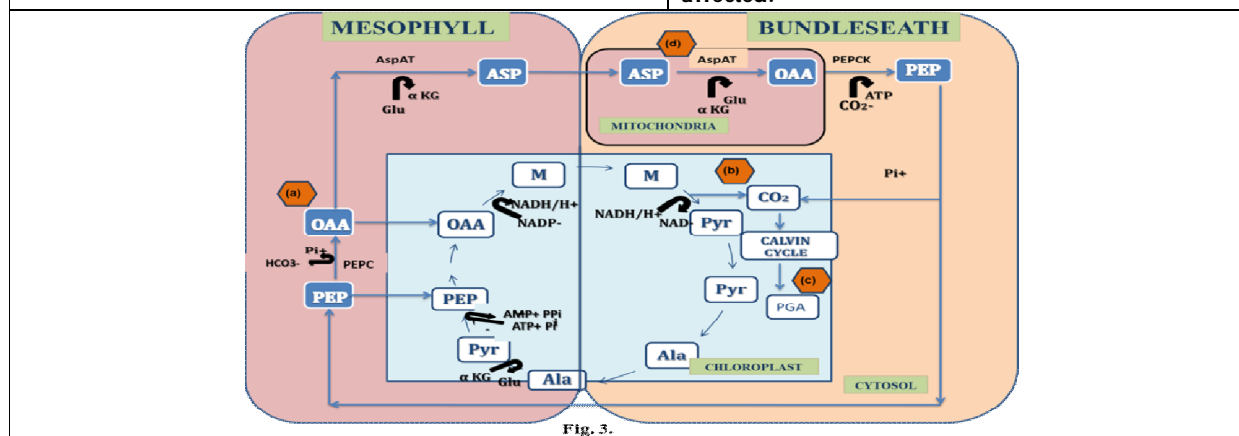


Figure 3Photosynthetic metabolism showing role of PEPCK.





Suchismita Prusty and Ranjan Kumar Sahoo

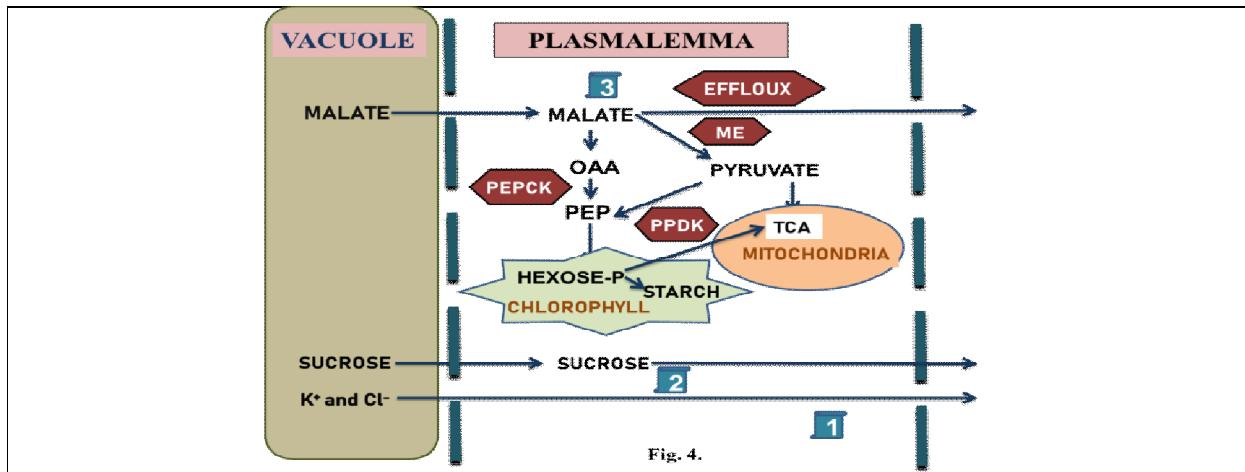


Fig. 4.

Figure 4 Probable occurrences happening in guard cell during stomatal closure. Loss of sucrose, malate, K⁺ and Cl⁻ affects the turgor pressure resulting in stomatal closure. (b) Sucrose might get converted to starch. (c) Malate is either metabolized through decarboxylation by Krebs cycle /malic enzyme or its conversion may result in formation of sucrose with the help of PEPCK via. Glucogenesis or is adrift across plasmalemma due to efflux.





Biochemical Analysis of Indigenous Liquid Organic Manures and Its Effect on Germination of Chilli Seeds

Balakumar K¹ and Ganesh P^{2*}

¹Assistant Professor in Microbiology, Department of Microbiology, Madras Christian College, Tambaram, Chennai, Tamil Nadu, India.

^{2*}Assistant Professor in Microbiology, Department of Microbiology, Faculty of Science, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Received: 11 Apr 2022

Revised: 05 May 2022

Accepted: 25 May 2022

*Address for Correspondence

Ganesh P

Assistant Professor in Microbiology,
Department of Microbiology, Faculty of Science,
Annamalai University, Annamalai Nagar,
Tamil Nadu, India
Email: drpg1974@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Biochemical analysis of three indigenous liquid organic manures (LOMs) like pancha gavya (PG), jeeva mirtham (JM) and amirtha karaisal (AK) was done using UV-VIS spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy and Nuclear Magnetic Resonance (NMR) spectroscopy and its influence on germination of chilli seeds was studied by conducting a pot culture study. In this study, the efficacy of these LOMs on seed germination was tested in sandy clay loam soil. Ten different treatments were designed to find the influence of the LOMs on seed germination at recommended concentration and its combination with vermin wash (VW) alone and with Liquid biofertilizer (LBF). The biochemical analysis of the three preparations by UV-VIS spectroscopy revealed phenolic compounds in all the three LOMs and flavonoids in PG and JM. FTIR analysis of the LOMs indicated the presence of compounds with functional groups like aliphatic amines, alkanes, H-bonded alcohols and phenols, and NMR spectroscopy revealed the presence of aliphatic aromatic compounds. The results of the pot culture study revealed the chilli seeds treated with PG 3% resulted in 100 % germination. Combination of PG 3% with VW 5%, VW 5% and LBF 1%, Combination JM 5% with VW 5% and LBF 1% and combination of AK 10% with VW 5% and LBF 1% also resulted in 100 percent germination. The result shows that PG alone is sufficient to get 100 % germination.

Keywords: Liquid Organic Manure (LOM), Amirthakaraisal (AK), Liquid Biofertiliser (LBF), Vermiwash (VM)

INTRODUCTION

Chilli plant belonging to *Solanaceae* family is one of the major crops grown in India. It is widely used in preparing dishes as a condiment to improve the taste and flavor. To improve the yield by the application of inorganic fertilizer



**Balakumar and Ganesh**

to Soil for the growth of plants has deteriorated the quality of Soil and reduced the plant growth and yield. Hence, there is urgent need to use organic manure and reduce the use of chemical fertilizers. The use of liquid organic supplements such as panchagavya and others improves soil and plant health and protects against plant diseases[1]. Vermi wash is a liquid extracted from earthworm beds containing many plant growth regulating substances[2]. It is a mixture containing mucous secretions and excretions of earthworms with micronutrients obtained from soil organic molecules. It also includes enzymes and microbes that fix nitrogen, solubilizes phosphate, and stimulate crop growth and yield[3]. The application of biofertilizer is essential for the plants since they play a significant role in fixing nitrogen, solubilizing phosphates, and producing growth-promoting substances[4]. Liquid organic manures (LOM) play an important role in organic crop production. LOM can be applied to crops in various stages, and seed treatment is among them. Seed germination is usually the most critical stage in seedling establishment, determining successful crop production [5,6]. The germination of the seed is a complex process depending on the genetic and environmental factors, such as temperature, light, and salinity [7,8]. Seed treatment with LOM may have a positive influence on seed germination and seedling vigour Hence this study was undertaken with the following objectives. To analyses the biochemicals of LOM sand to study the influence of LOMs on seed germination.

MATERIALS AND METHODS**Seeds and other raw materials**

Mature seeds of Chilli were procured from the local market. The ghee, milk, curd, coconut water, Jaggery, sugarcane juice, ripened banana, pigeon pea flour, vermiwash and the liquid biofertilizer were purchased from an organic store in Chennai. Cow dung and cow urine were obtained from a cattle farm in Chennai.

Preparation of liquid organic manure (LOM)**Preparation of Panchagavya:**

2 litres of Panchagavya were prepared by adding 500 g of fresh cow dung and 100ml of ghee (Clarified butter) into a plastic tub, mixed well and incubated for three days. The contents were mixed once every 24 hours. On the fourth day, 300ml of fresh cow urine, 200ml of milk (boiled and cooled), 200ml of curd, 300ml of tender coconut water, 100g of Jaggery (unrefined sugar) 300ml of sugarcane juice and 100g of ripened banana with skin (poovan)-mashed well and was added and mixed thoroughly and incubated for fermentation for 12 days. The mixture was stirred thoroughly two times a day in the morning and evening for 20 minutes. The plastic tub was covered with a cotton cloth and was kept in the shade. After 12 days of fermentation, the liquid mixture was filtered through a cotton cloth and stored in a PET bottle with a lid loosely closed. The time required for the preparation of Panchagavya by this method is 15 days.

Preparation of Jeevamirtham

2 liters of Jeevamirtham was prepared in a plastic tub by mixing 100g of fresh cow dung, 100ml of fresh cow urine, 5g of Jaggery (unrefined sugar), 10 gram of pigeon pea flour and 5g of garden soil, these ingredients were added into a plastic tub and mixed thoroughly and the volume can be made up to 2 liters by adding water. The mixture was stirred well three times a day, and the plastic tub was kept in the shade, covered with cotton cloth for 24 hours for fermentation.

Preparation of Amirthakaraisal

2 litres of Amirthakaraisal were prepared in a plastic tub by mixing 200g of cow dung and 200ml of fresh cow urine. To this mixture, 5g of Jaggery (unrefined sugar) was added, and the volume was made to 2 liters by adding water and stirred well until the Jaggery was fully dissolved. The mixture was allowed to ferment for 24 hours and stored in the shade by covering it with a cotton cloth.



**Balakumar and Ganesh****Soil sample collection**

Soil collected from the area near the department of Botany, Madras Christian College, Tambaram, Chennai-59, was used for the study. The soil samples were collected randomly from five places upto a depth of 20 cm in the field and mixed up thoroughly to make a composite sample, and the nutritional status was analyzed.

Determination of nutrient contents of Soil

The composite soil sample was analyzed for Physico-chemical characteristics of the Soil, such as Nitrogen [9], Phosphorous [10], Potassium [11], pH [12] and organic carbon [13] before commencing of the experiment.

Pot Preparation

The plastic pots of equal size (15 cm diameter × 17 cm height) were filled with homogenous Soil at 2 kg per pot and after the seed germinations, transferred into the pots of Soil.

Germination on chilli seeds

The Effect of LOMs on germination and seedling growth of Chilli was carried out in the Department of Botany, Madras Christian College, Tambaram, Chennai-59. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with ten treatments and three replications. The chilli seeds were obtained from a private vendor in Chennai during the entire period of study. The seeds are soaked in 3 different concentrations (3%, 6%, and 10%) of panchagavya, Jeevamirtham (3%, 6%, and 10%), and Amirthakaraisal (3%, 6%, and 10%) along with control (water soaking) which is soaked in different time duration like 12 and 24 hours. After the required soaking, the seeds are taken out and transferred to planting into Soil. The Soil used in this study was Soil, sand and organic matter with a ratio of 1:1:1. Data on the percentage of germination were recorded in all treatments. The onset and seed germination rates were calculated at 12 hours and 24 hours, respectively. Germination parameters were determined by the methods given by Srivastava *et al.*, (14). The percentage germination was calculated by using the following formula:

$$\text{Germination percentage} = \frac{NG}{NT} \times 100$$

NT = Number of seeds treated

NG = Number of seeds germinated

Methanol Extraction of liquid organic manures

The methanol extraction of LOMs was done by a slightly modified method of Athavale *et al.*, [15]. The LOMs were diluted with methanol 1:10 (v/v) and kept in a shaker at 150 rpm, 37 °C overnight. The upper aqueous phase of the extracts was filtered and utilized for biochemical analysis.

UV-VIS Spectrophotometric Analysis

The collected LOMs were dried entirely and suspended in deionized water. The absorbance range examination at the wavelength ranges from 200–800 nm using a UV-vis spectrophotometer (spectrophotometer Cary E 500). The size of compound nanoparticles is an essential feature for biological applications. Therefore, the dynamic light scattering assessment was adopted to observe the distribution of composite LOMs. A computer-based particles size and distribution analyzer was used to calculate the distribution of the ultrasonicated LOMs.

Fourier Transform Infrared (FTIR) Analysis

The IR spectra of crude extracts were recorded in FTIR spectrometer (Thermo Nicolet, AVATAR. 330 FFT-IR system, Madison WI 53711- 4495) in the 4000-400 cm⁻¹ spectral region using potassium bromide (KBr) solid cells. The FT-IR analysis was done in the Department of Chemistry, Annamalai University, Tamil Nadu, India. The concentration samples of crude extract were grounded with a purified potassium bromide salt (Sigma- Aldrich) to remove scattering effects from large crystals. This powdered mixture was then pressed in a mechanical press to form a translucent pellet through which the beam of the spectrometer could be passed. The spectra were recorded for the different shots and analyzed using the standard methods described by the previous authors (16-18).



**Balakumar and Ganesh****NMR Spectroscopy Analysis**

Three ml of the LOM samples were dried in a hot air oven at 55°C for 3 days. The dried preparation was suspended in 0.5 ml CDCl₃ to characterize lipophilic extracts of the sample. The dried LOM samples suspended in CDCl₃ were subjected to NMR analysis using Bruker NMR spectrometer (Bruker Biospin) with ¹H frequency of 500 MHz coupled with a 5 mm probe at constant temperature of 298K (25 °C) applying Carr–Purcell–Meiboom–Gill (CPMG) spin-echo pulse sequence [19]. Top Spin NMR software (version 3.5, Bruker Biospin Ltd.) was used for the visualization and processing of the NMR spectra.

RESULTS**Physico-chemical characters of Soil**

The Physico-chemical characteristics of the collected soil samples were determined before treating LOMs. Physico-chemical parameters such as soil texture, pH, Electrical conductivity, macronutrients such as Organic Carbon, Nitrogen, Phosphorus and Potassium, heavy metals viz., Iron, manganese, zinc, and copper were examined by appropriate standard analytical methods. The obtained analytical results are summarized in Table 1.

Effect of LOMs on Seed germination

The statistical analysis of data revealed that the effect of different concentration of ROMs on the germination of *Capsicum annuum* L. (Chili) was significant (Table 2). Among the various treatments of chilli seedling, 10% panchagavya with 24 hours soaking was found to be the best with 96.2±0.64% of germination, followed by Amirthakaraisaland Jeevamirtham with 24 hours soaking (68.4±0.26 and 70.1±0.54%). Control with 24 hours of soaking (68.4±0.26%) was found to have the least germination percentage. The total seed germination test was panchagavya is a high percentage compared to Amirthakaraisaland Jeevamirtham.

UV–vis spectroscopy analysis

The UV-VIS spectrum of the methanol extracts of the three LOM is represented in Fig.1a, b, c, respectively. Two significant peaks were observed at 273nm and 413nm in the methanol extracts of PG and JM, suggesting the presence of phenolic compounds and flavonoids, respectively. In the case of methanol extract of AK, a significant peak nearer to 273nm indicates the presence of phenolic compounds. The absence of the increased peak height at 413 nm suggests there is no detectable level of flavonoids or absence of flavonoids in the preparation.

FTIR analysis

The FTIR spectra of the methanol extracts of the three LOM are represented in Fig.2a, b, c, respectively. It showed peaks with wave numbers 500-4000 cm⁻¹ with different frequency levels. The FTIR spectra of methanol extracts of PG revealed the most prominent peaks at different frequencies of 1018.21, 1113.99, 2833.12, 2944.83 and 3322.10. The corresponding functional groups were identified as aliphatic amines, alkanes, H-bonded alcohols and phenols, respectively, based on the band frequencies. The FTIR spectra of methanol extracts of JM and AK also revealed the similar prominent peaks present in the FTIR spectra of PG, suggesting similar biochemical composition of the liquid organic manures.

NMR analysis

The NMR spectra of the three LOM in CDCl₃ are represented in Fig.3a, b, and c. The figure represents the NMR signals in the 7.28 and 8.12 ppm of the ¹H NMR spectra, which correspond to aromatic and amine groups in the liquid organic manures. The signals observed in the 0.8 and 2.8 correspond to aliphatic groups. As the LOM samples' spectra were recorded in CDCl₃ (apolar), it reveals mainly the presence of hydrophobic metabolites like aromatic, amine and aliphatic compounds in LOM, which could promote seed germination and plant growth.



**Balakumar and Ganesh****DISCUSSION**

We investigated the effects of PG, JM, and AK on chilli seed germination in pot culture experiments in this work. *C. annum*, the combination of vermicompost and Panchagavya, amirthakaraisal resulted in the highest germination rate. Some micronutrients in the vermicompost encourage plant development. The increased nitrogen concentration in Soil could be because vermicompost treated pots have fixed a considerable amount of atmospheric nitrogen[20]. The nutrient-hungry plants in the control pots may have eaten up all of the nutrients in the Soil, resulting in lower amounts of accessible N, P, K, and organic carbon. These findings are consistent with what other researchers have discovered[21]. Thus, when used as components in various strategies, organic manures like vermicompost and amirthakaraisal and Jeevamirtham show promising results in *C. annum*. It has also been found that vermicompost treatment gives enhanced growth in combination with amirthakaraisal and AbdAgold [22, 23]. The experiments clearly showed that seed germination was much improved by Panchagavya enriched seeds, which could be attributed to the action of microorganisms found in Panchagavya (24). Saritha *et al.*, (25) and Pathak and Ram (26) also reported that Panchagavya possesses almost all the major nutrients, micronutrients, and growth hormones that enhance plants' metabolic activity and support better seed germination. According to Naik and Sreenivasa (27), Panchagavya contains bacteria that produce plant growth-promoting chemicals and microorganisms that have physical deterrent properties. Microbes in Panchagavya, such as *Rhizobium*, *Azotobacter*, *Azospirillum* Phosphorous solubilizing bacteria, *Trichoderma*, and *Pseudomonas*, act as liquid bio-fertilizers and bio-pesticides(28). With increasing concentration levels and duration with organic fortification, seed germination and seedling quality features were sometimes lowered, which could be attributed to a supra optimum dose of the organic product, which is generally unique to crops(29). Amirthakaraisal and Jeevamirtham have well-developed roots that allow them to penetrate deeper into the Soil may explain the longest origins in Amirthakaraisal, and Jeevamirtham treated cuttings as compared to control cuttings. On the other hand, Anjali *et al.* (30) stated that shoot and root lengths of the chilli plants were higher in plants treated with 7% Amirthakaraisal solution. The results suggested that PG contains a complex mixture of different compounds. Earlier, it was reported (31) that PG showed two prominent peaks at 410 and 668 nm and revealed the presence of phenolics, steroids, triterpenoids, and flavonoids.

CONCLUSION

The biochemical analysis results obtained during the investigation revealed the presence of phenolic compounds, flavonoids, aliphatic compounds, and other aromatic compounds in the indigenous liquid organic manures like panchagavya and jeevamirtham and amirthakaraisal, which could play a vital role in seed germination of chilli seeds. It is concluded that even though the treatments T₁ – (Panchagavya 3%), T₂ – (Panchagavya 3% + Vermiwash 5%), T₃ – (Panchagavya 3% + Vermiwash 5% + Liquid Biofertiliser), T₆ – (Jeevamirtham 5% + Vermiwash 5% + Liquid Biofertiliser) and T₉ – (Amirthakaraisal 10% + Vermiwash 5% + Liquid Biofertiliser) resulted in 100 percent germination, 3% Panchagavya (T₁) alone is sufficient to get 100 % germination and could be used for used to get 100 percent germination of chilli seeds.

ACKNOWLEDGEMENT

The authors are grateful to the Department of Microbiology, Faculty of Science, Annamalai University, Annamalai Nagar, Tamil Nadu and Department of Microbiology, Madras Christian College, Tambaram, Chennai, Tamil Nadu, India, for providing the lab facilities for the research.

REFERENCES

1. Sarkar S, Kundu SS, Ghorai D. Validation of ancient liquid organics Panchagavya and Kunapajala as plant growth promoters. Indian Journal of Traditional Knowledge, 2014; 13(2): 398-403
2. Nielson R. Presence of plant growth substances in Earthworms demonstrated by Paper Chromatography and the Went Pea Test. Nature, 1965; 208, 1113-1114. doi:10.1038/2081113a0





Balakumar and Ganesh

3. Zambare VP, Padul MV, Yadav AA, Shete TB. Vermiwash: biochemical and microbiological approach as ecofriendly soil conditioner. ARPN Journal of Agricultural and Biological Science. 2008;3(4):1-5.
4. Upadhyay RG, Sharma S, Drawal NS. Effect of *rhizobium* inoculation and graded level of P on the growth and yield of green gram. Legume Research. 1999; 22:277-79.
5. Almansouri M, Kinet JM, Lutts S. Effect of salt and osmotic stresses on germination in durum wheat (*Triticum durum* Desf.). Plant and Soil. 2001 Apr;231(2):243-54.
6. Bhattacharjee S. Triadimefon pretreatment protects newly assembled membrane system and causes up-regulation of stress proteins in salinity stressed *Amaranthus lividus* L. during early germination. J. Environ. Biol. 2008 Sep 1;29(5):805-10.
7. Barbour MG. Germination Requirements of the Desert Shrub *Larrea Divaricata*. Ecology. 1968 Sep;49(5):915-23.
8. Mahmoud A. Germination of *Cassia italica* from Saudi Arabia. Arab Gulf journal of scientific research. 1985.
9. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956; 25:259–260.
10. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. US Department of Agriculture; 1954.
11. Stanford G, English L. Use of the flame photometer in rapid soil tests for K and Ca.
12. Jackson ML. Soil chemical analysis. Prentice Hall of India Private Ltd., New Delhi, 1973, 56-70.
13. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science. 1934 Jan 1;37(1):29-38.
14. Srivastava K, Raghava N, Raghava RP. Brassinosteroids stimulate seed germination parameters and chlorophyll content in moongbean. Indian Journal of Scientific Research. 2011;2(3):89-92.
15. Athavale A, Jirankalgikar N, Nariya P, Des S. Evaluation of in-vitro antioxidant activity of panchagavya: a traditional ayurvedic preparation. Int J Pharm Sci Res. 2012 Aug 1;3:2543-9.
16. Surfactants IB, Glycolipids A, Surfactants VY, Surfactants VF. Structure and Properties of Biosurf actants. Biosurfactants Biotechnol. 1987 Mar 27;25:21.
17. Lin M, Al-Holy M, Al-Qadiri H, Kang DH, Cavinato AG, Huang Y, Rasco BA. Discrimination of intact and injured *Listeria monocytogenes* by Fourier transform infrared spectroscopy and principal component analysis. Journal of agricultural and food chemistry. 2004 Sep 22;52(19):5769-72.
18. Yin C, Rosendahl LA, Kær SK. Grate-firing of biomass for heat and power production. Progress in Energy and combustion Science. 2008 Dec 1;34(6):725-54.
19. Carr HY, Purcell EM. Effects of diffusion on free precession in nuclear magnetic resonance experiments. Physical review. 1954 May 1;94(3):630.
20. Arancon NQ, Edwards CA, Lee S, Byrne R. Effects of humic acids from vermicomposts on plant growth. European journal of soil biology. 2006 Nov 1;42:S65-9.
21. Canellas LP, Olivares FL, Okorokova-Façanha AL, Façanha AR. Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence, and plasma membrane H⁺-ATPase activity in maize roots. Plant physiology. 2002 Dec;130(4):1951-7.
22. Vermitech, 2004. "For specific information on research into their products details." Available: http://www.vermitech.com/rd_fr.htm
23. Bansal S, Kapoor KK. Vermicomposting of crop residues and cattle dung with *Eisenia foetida*. Bioresource technology. 2000 Jun 1;73(2):95-8.
24. Ratnoo RS, Bhatnagar MS. Neem cake in disease control. Indian J. Mycol. Plant Pathol. 1993;23:186-8.
25. Saritha M, Vijayakumari B, Hiranmai YR, Kandari LS. Influence of selected organic manures on the seed germination and seedling growth of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub). Science, Technology and Arts Research Journal. 2013; Dec 17;2(2):16-21.
26. Pathak RK, Ram RA. Approaches for organic production of vegetable in India. Report of Central Institute of Sub-Tropical Horticulture, Lucknow, India. 2002;73.
27. Naik N, Sreenivasa MN. Influence of bacteria isolated from panchagavya on seed germination and seed vigour in wheat. Karnataka Journal of Agricultural Sciences. 2010 May 25;22(1).





Balakumar and Ganesh

28. Ali MN. Sustainable Agriculture with Low-Cost Technologies (SALoCT). School of Agriculture and Rural Development, Ramakrishna Mission Vivekananda University, Belur Math, West Bengal. 2011; p. 47.
29. Henig-Sever N, Eshel A, Ne'eman G. Regulation of the germination of Aleppo pine (*Pinushalepensis*) by nitrate, ammonium, and gibberellin, and its role in post-fire forest regeneration. *Physiologia Plantarum*. 2000 Apr;108(4):390-7.
30. Anjali, Tanveer Hassan, Muralitharan R, Murugalatha N, Rinkey Arya. Efficacy of organic fertilizer Amirthakaraisal on the growth of Chilli plant. *Journal of Plant Science Research*, 2017; 2(1):27-31.
31. Nariya P, Jirankalgikar N, Warma R, De S. Analytical Study & HPTLC Profile of Panchagavyaa Traditional Ayurvedic Preparation. *Asian J Biochem Pharm Res*. 2012;2(2):198-208.

Table 1: Physico-chemical study of Soil

| S. No | Soil Parameters and Nutrient Contents | |
|-------|---------------------------------------|------------|
| 1 | Soil texture | Sand |
| 2 | pH | 7.33±0.20 |
| 3 | EC (µS/cm) | 1708±0.31 |
| 4 | OC (%) | 6.4±0.48 |
| 5 | Moisture (%) | 23.2±5.22 |
| 6 | Calcium (%) | 0.24±0.006 |
| 7 | Phosphorus (%) | 0.17±0.005 |
| 8 | Potassium (%) | 0.26±0.012 |
| 9 | Iron (mg/L) | 3.37±0.41 |
| 10 | Manganese (mg/L) | 3.24±0.32 |

Table 2: Germination of chili seeds on LOM

| LOM | Concentration | Sacking time and Germination Percentage | |
|-----------------|---------------|---|-----------|
| | | 12 hrs | 24 hrs |
| Panchagavya | 3% | 74.3±0.15 | 81.3±0.16 |
| | 6% | 78.2±0.24 | 87.2±0.34 |
| | 10% | 84.2±0.22 | 96.2±0.64 |
| Jeevamirtham | 3% | 52.4±0.28 | 62.2±0.72 |
| | 6% | 58.4±0.34 | 68.4±0.76 |
| | 10% | 62.1±0.26 | 70.1±0.54 |
| Amirthakaraisal | 3% | 54.3±0.41 | 64.2±0.62 |
| | 6% | 57.4±0.32 | 69.2±0.38 |
| | 10% | 63.2±0.37 | 73.4±0.41 |
| Control | Water | 57.2±0.24 | 68.4±0.26 |

The values are expressed in the mean ± standard deviation of three replicates.





Balakumar and Ganesh

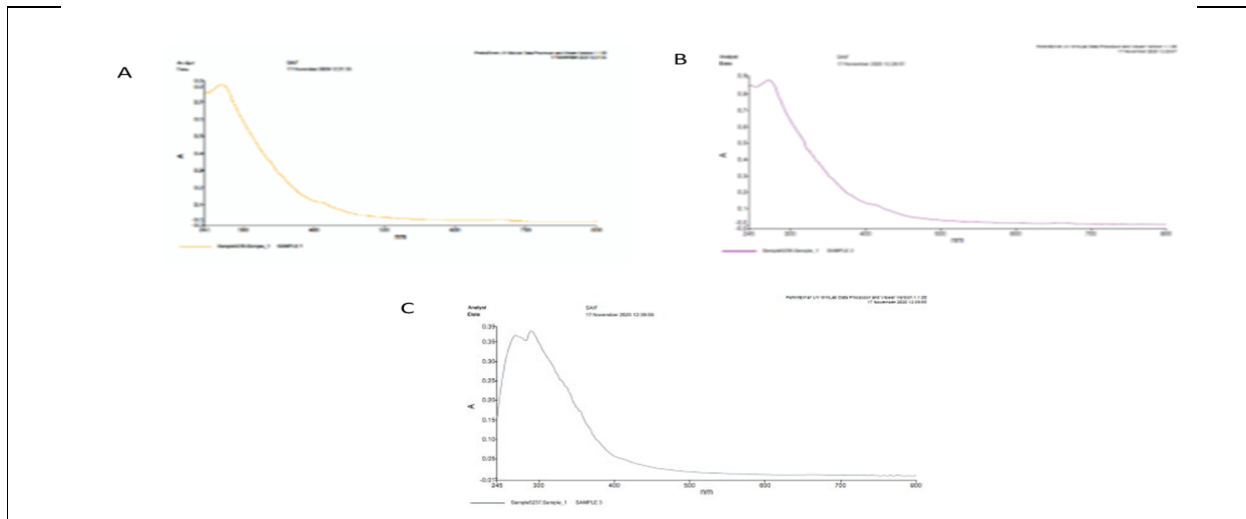


Figure. 1. UV-VIS spectrum analysis of LOMs. (a)Panchagavya, (b) Jeevamirtham, (c) Amirthakaraisal

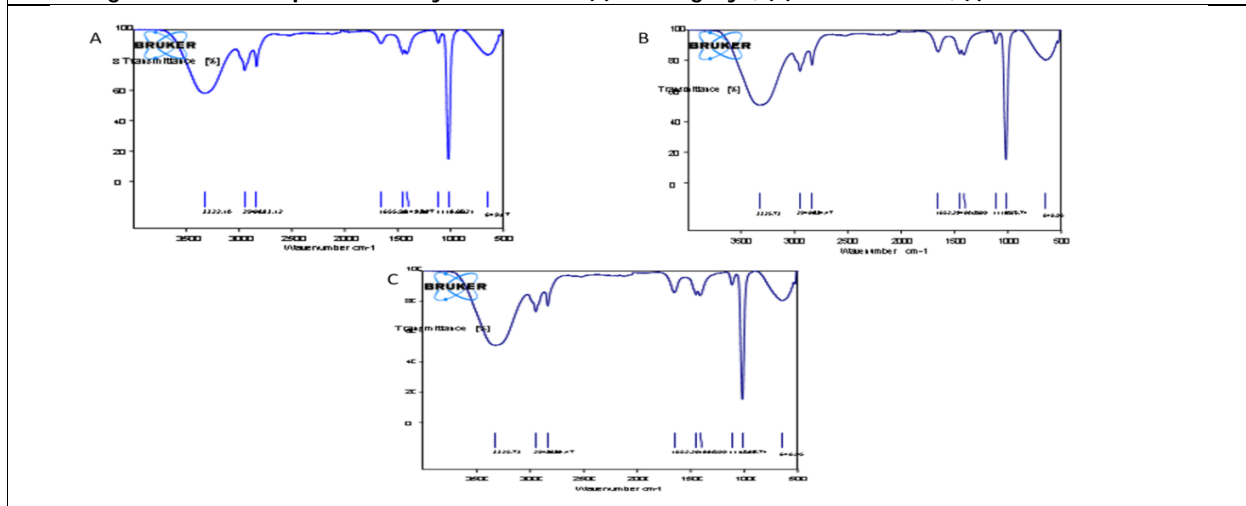


Figure. 2.FTIR analysis of LOMs.(a) Panchagavya, (b) Jeevamirtham, (c) Amirthakaraisal





Balakumar and Ganesh

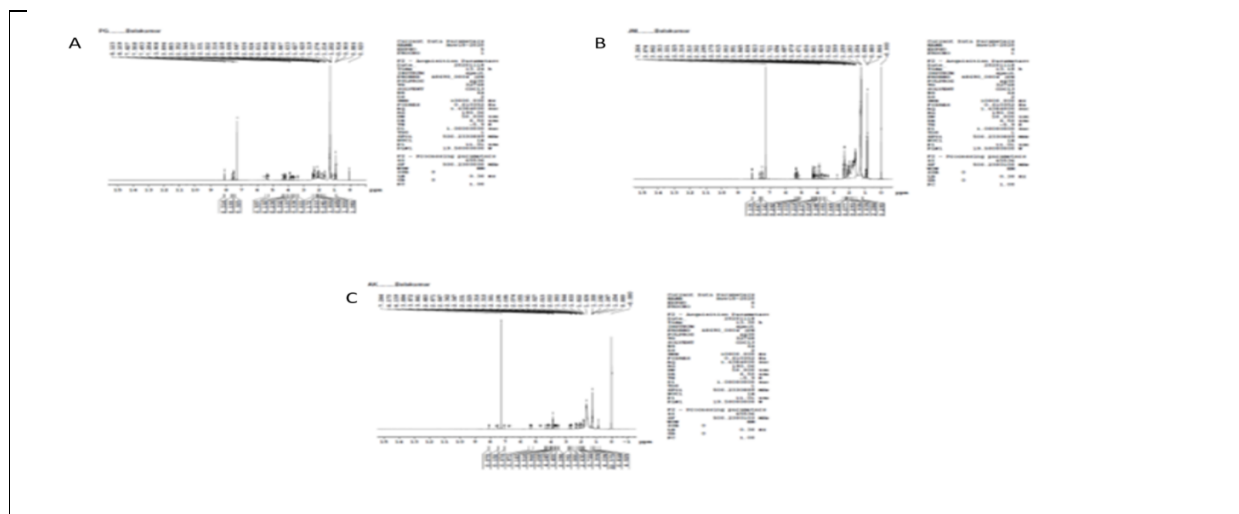


Figure. 3. NMR analysis of LOMs. (a) Panchagavya, (b) Jeevamirtham, (c) Amirthakaraisal





Role of Helicase Providing Stress Tolerance in Plants

Monalisha Dasmohapatra and Ranjan Kumar Sahoo*

Department of Biotechnology, Centurion University of Technology & Management, Odisha, India.

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ranjan Kumar Sahoo

Department of Biotechnology,
Centurion University of Technology & Management,
Odisha, India.

Email: ranjan.sahoo@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Food is the essential component of life sustainability and crucial for living beings. But annually Food and Agriculture Organization (FAO) reported that globally malnutrition and hunger killing more than 5 million children. The extreme climate variation induces a complex set of stresses, such as abiotic and biotic. Among all stresses drought and salinity are always shopping list of Indian farmers. In this current scenario all type of stresses are harshly damaging the agricultural plants as well as cultivated lands and strongly targeting towards the future food conservation. In Previous year, it had been technically difficult to produce improved cultivars through conventional breeding because of the involvement of complex nature of traits. Therefore, to overcome this challenging situation, researchers were positively working on modern transgenic approaches to develop the agricultural plant growth and yielding under multiple stress environment. Previously reported that plant helicases are responsible for abiotic stress and involve in plants molecular process like DNA replication, RNA replication, recombination, repair, translation transcription. DNA or RNA helicase are the class of enzyme and molecular motor protein, that unwind the duplex DNA and rearrange the RNA secondary structure by the help of ATP hydrolysis. In both eukaryotes and prokaryotes, these enzymes are largest and highly conserved. Here we attempt to review the role of helicase and their used as a key enzyme to increase plant productivity.

Keywords: Environmental stress, abiotic stress, DNA Helicase, RNA Helicase, agricultural plants effect

INTRODUCTION

Agricultural production development largely depends upon the various type of ecological factors such as light, water, soil, temperature. But the certain climate crisis is harshly damaging the plants growth and their yielding capacity largely (Canter 2018; Zorb *et al.* 2019; Nkurunziza 2020; Sahoo *et al.* 2021). Therefore, researchers are continuously working on plant physiology, molecular biology and genetics to develop the transgenic plants and secure our food energy through maximize the agricultural production. Previously the human society hugely

42988



**Monalisha Dasmohapatra and Ranjan Kumar Sahoo**

suffering in hunger and malnutrition because of food limitation (FAO: Food and Agriculture: Rome, United Kingdom 2017). The abiotic stresses affected about 90% of farming land and more than 60% of yield losses worldwide (Kumar 2020). Extreme temperature, drought, heavy metal, flood, salinity are the major abiotic stresses and highly responsible for the biochemical, physiological, morphological and biomass changes of agricultural plants and reduce the yielding capacity (Wania *et al.* 2016) (Fig. 1).

The continues growing population and their activity increasing global warming. So that the stress like heavy metals quantity gradually increasing in soil which leads to poor plant growth and less productivity. In Asia rice is a staple food, around 90% of the world's rice is consumed by human population. But the stresses like dispersive sodic soil and saline soil creates major problem in agriculture. Universally, drought is responsible for damaging around 45% of cultivated land whereas salinity affected 19.5%. The higher concentration of sodium increases the saline soil that reduces the water content in soil and responsible for crops poor development, inhibit root growth, and increase root diseases of plants. The excess sodic soil affected the land over 581 million ha and salinity stresses damage 351 million ha for yielding (Das *et al.* 2021). Universally only 60% of food energy consume from the horticulture Therefore, more than 5 million children loss their life by food deficiency (FAO 2017). Rice, wheat, and maize are highly consumed crops by whole human population but in current scenario the global warming impacts have caused a multiple stress which are immensely decreases the horticulture production. In 2018, reported that all over world high salinity of soil adversely affected the 77 million hectares/1.5 billion hectares of total farming land (Waqas *et al.* 2017). But the recent finding shows that about 10% of global lands and 50% of irrigated lands are mostly distressed by the salinity to produce the agricultural products (Ma *et al.* 2020). Globally water deficit is also largely damaging the agricultural land and limiting the crop production (Sok *et al.* 2021). Crops like *Hordeum vulgare*, *Oryza sativa*, *Triticum aestivum* are highly exposing towards the drought stress and significantly reducing their growth and yielding. With the relation of plants, drought stress is divided into two classes such as meteorological drought (Ogbaga *et al.* 2020). The lower water availability reduces the stem diameter, osmotic potential and water potential in plants and this is direct targeted the plants height and development (Conceição Sabino *et al.* 2021). In heavy metals Cd (cadmium) is require about 100 mg/kg in soil for farming, but the excess Cd in soil reduces photosynthesis, water uptake and translocation of nutrient uptake in plants. It causes plant morphology and physiology inhibition, oxidative damage and interrupt in plant metabolism, and inhibition of (Haider *et al.* 2021). Plants physiological and biochemical functions are gradually slowdown by the low or high temperature (Takahashi and Shinozaki 2019). Thus, the plant genomes are affected and limiting the food sources. Therefore, to overcome this challenging situation researchers are developing the stress tolerance plants through DNA repair and recombination process with the help of DNA/RNA helicase. Helicases are macromolecules and comes under essential enzymes, its storage energy as ATP to separate the duplex DNA and RNA molecule (Djanaguiraman *et al.* 2018). Helicases are the smallest biomolecules and conserved with signature motifs for the unwinding pathway (Lu and Davis 2021). There are different types of helicases play different role in cellular process such as replication, transcription and translation (Brosh *et al.* 2020) (Table 1).

Abdel-Monem *et al.* first introduced the prokaryotic helicase from *E. coli* in 1976 and in 1978 the first eukaryotic one (plant helicase) identified from the lily plant (Brosh *et al.* 2020). Unlike DNA helicase, RNA helicases are also a member of DEAD-box protein and perform in RNA metabolism and gene regulation (Whitford *et al.* 2021). In all cellular pathway RNA helicase involve in post-translational modification of proteins and the regulation of signalling pathways (Sergeeva and Zetsepina 2021). These helicases also remodelling the RNA structures and involve in RNA splicing, replication, translation initiation, editing, ribosome assembly, rRNA processing, nuclear mRNA transport and other cellular processes (Bohnsack *et al.* 2021). The plant DNA helicases participate in various cellular processes of nucleic acid metabolism (Zhang and Li 2021) and involve in genome stability and meiotic recombination (Dorn and Puchta 2019). Environmental stresses are classified into two classes, such as abiotic and biotic. The present study shows that Arabidopsis, rice, maize, and soybean have total 217, 199, 215, and 248 helicases (Xu *et al.* 2013). World's agricultural land is highly suffering from flash flooding and the abiotic stress is responsible for the induction of various stress-responsive biomolecules, extensive cellular damage and inhibit the physiological process of all crop plants.



**Monalisha Dasmohapatra and Ranjan Kumar Sahoo****Molecular Structure, Function of DNA and RNA Helicase**

Helicase are enzymes and provide energy to nucleoside triphosphate (NTPase) in nucleic acid metabolism (Spengelink 2021). Based on the polarity of their translocation helicases unwind the DNA from 5' to 3' direction or vice versa respectively (Colizzi *et al.* 2019). Basically, there are two types of helicases in biological cells such as DNA helicase and RNA helicase. Helicase can be either ring-shaped or non-ring shape. In eukaryotes the helicases are present in hexagonal ring-shaped structure (O'Donnell and Li 2018). In helicase, motifs are assembled together and form a domain by the help of two RecA. This domain differentiates the nucleic acid-binding site and developed ATP-binding pocket inside the cell. The non conserved regions of helicase contains some specific domain such are cellular localization domains, protein-protein interaction domains and DNA-recognition domains. Yokota (2021) studied helicase family consist of more than 200 proteins and seven conserved amino acid motifs.

DNA helicase located in certain degree and similar to the amino acid sequence. Recently researchers find there are 14 types of conserved motifs present in helicase core of *Escherichia coli*, bacteriophages contain 6, viruses contain 12, yeast contain 15 and 11 from calf thymus, and the humans have 31 helicase gene (Soo and Hoon 2018). These motifs are unchanged and the power house in DNA metabolic activity. These are also highly essential for cellular process such as ATP binding, hydrolysis and translocation as well as genetic reaction (Fernandez and Berger 2021). Helicase motifs are developed from many different organisms and the amino acid sequences. ssDNA helicase are Rep, PcrA, Dda, UvrD and HSV-UL5 while eIF4A, RecG, and PriA are dsDNA helicase. RecBCD, UvrD, Rep, and RecQ helicase develop replication fork to unwind the DNA in cellular process. Previously two proteins are identified for the NTPase catalysis such proteins are gp4 and rho. gp4 found in bacteriophage T7 and rho found in *Escherichia coli* (Gao *et al.* 2019). Based on the sequence motif helicase are classified into 6 super families such as SF1 to SF6 (Fig.2).

Among all the SF, SF2 reported as the largest superfamily and present DEAD-box helicases. Inside the DEAD-box helicases, helicase core domain present within 200 to 700 amino acids region. The helicase core domain contains two RecA-like domains core and 12 sequence motifs such as Q, I, Ia, Ib, Ic, II, III, IV, IVa, V, Va, and VI (Yadav *et al.* 2021). SF 1 and SF 2 are monomer where other families (SF3-SF6) are hexamer. In superfamily 1 and 2, helicases are not found in a ring structure but SF 3 & SF 5 have ring shape helicase. (O'Donnell and Li 2018). Helicase are again classified in to two categories by their translocation polarity such are Type A, B and α or β . ' α helicases' involve with single-strand DNA molecules while ' β helicases' involve with double-strand DNA molecule. Type A helicase is translocated at 3'-5' and Type B helicase at 5'-3' (Gao and Yang 2020).

Classification of Helicase Super family

Based on the sequence motifs helicases are classified in 6 groups. These groups are called as Super family (SF1-SF6). Among all the SF, some are forming ring structure. Based on the function of DNA strands, helicase again classified as α or β . Some helicase translocated towards 3'-5' that is Type A and some polarity towards 5'-3', that is known as Type B.

Helicase SUPERFAMILY 1 (SF1)

This helicase super family has two subfamilies such as SF1A and SF2B. SF1A Moves towards 3'-5' and SF2B moves towards 5'-3' of DNA molecule respectively. SF1A have 2 family such as UvrD from gram negative bacteria and PcrA from gram positive bacteria. RecD and Dda helicases are comes under SF2B. SF1 have 13 motifs these are Q, I, Ia, Ib, Ic, II, III, IIIa, IV, IVa, V, Va, Vb, and VI. "Motif Q" is highly mutated form of DEAD Box helicases and present in N-terminal region (Yokota 2021).

Helicase SUPERFAMILY 2 (SF2)

Among all SF, Helicase SF2 is the largest in helicase and classified in to 10 subfamilies and 7 signature motifs. RecG, RecQ, Rad3/XPD, Ski2, T1R, Swi/Snf, RIG-I, DEAD-box, DEAH/RHA, and NS3/NPH-I are the 10 subfamily and each have separate role in cellular process. Again, this helicase SF categorised by two small group such as type III





Monalisha Dasmohapatra and Ranjan Kumar Sahoo

restriction enzymes and Suv3(Yokota 2021). Here few helicases depend on NTP to switch and alter the nucleic acid and nucleoprotein (Brosh& Matson 2020).

Helicase SUPERFAMILY 3 (SF3)

This super family is a hexamer or double hexamer in structure with 3'-5' polarity and consists of AAA+ helicase. This is first identified from viruses with small genomes and some large nucleocytoplasmic DNA viruses. Papilloma virus E1 helicase is the most known helicase of SF3 (Chojnacki & Melendy 2018). SF3 members have five signature motifs and that highly conserved. Such motifs named as A (I) , B (II) , B0, C, and R (VI) . In SF3 Motifs B0 and C are unique members (Brosh 2021).

Helicase SUPERFAMILY 4 (SF4)

SF4 is known as a replicative helicase and this is first found in Bacterial cells and bacteriophages. The polarity of SF4 is type B and it has six signature motifs. Some unique motifs are identified in SF4 such as H1a, H3, and H4. The most used SF4 helicase is gp4 from bacteriophage T7(Brosh and Matson 2020).

Helicase SUPERFAMILY 5 (SF5)

Members of SF5 is also hexamer in structure and type B polarity. These helicases terminate the transcription process in Bacteria by unwinding of duplex DNA or DNA-RNA hybrid (Moreno del Álamo *et al.* 2021). SF5 helicases have four conserved signature motifs, these are I (A), Ia, II (B), and VI (R).

Helicase SUPERFAMILY 6 (SF6)

Helicase SUPERFAMILY 6 is called as AAA1 super family. Here ATPases involved with multiple cellular activities whereas some of the members are silent towards the helicase activity. This SF has been categorised into five signature motifs. Example of SF6 is mini chromosome maintenance (MCM), RuvB, RuvA, and RuvC. Plants are extremely revealing towards the various environmental factors, this is the primary cause of poor plant growth and yielding. DNA helicases are molecular machines and act as a motor in DNA replication to unwind the duplex DNA and regenerate duplicate copies of each DNA strand. (Verma *et al.* 2021). In DNA replication the starting position of DNA unwinding by helicase is known as origin. Then the helicase creates a replication fork and breaks the hydrogen bond between two nucleotides. In this process, helicase is present in the form of ATP and provides energy as a motor to unwind the duplex DNA. In plant cells, DNA helicases also participate in the process of transcription, DNA repair and recombination.

Based on their structure, sequence, and function DNA helicase and RNA helicase are closely similar and play vital roles in diverse biological processes. RNA helicase regulates translation initiation of mRNAs with a complex structure of 5'UTR. The RNA helicase unwinds the RNA and also mostly involves in RNA metabolism processes (Zhang and Li 2021). This helicase also controls the gene expression of cells by inducing gene silencing. In prokaryotes and viruses, the helicase found in has a ring structure. These are rearranging the RNA secondary structure or ribonucleoprotein (RNP) complexes. From all RNA populations more than 50% are RNA-mediated viruses and encoded by the viral RNA helicase. These viruses are highly present in SF2 super family (Zhao *et al.* 2020) and categorized into three groups such as Flaviviridae, Poxviridae and the plant Potyviridae. To unwind the dsRNA substrate DEAH/RHA helicases translocate along RNA strands with a 3'-5' directionality respectively (Bohnsack *et al.* 2021). RNA helicase expression and function is investigated by a unique model system with help of photosynthetic cyanobacteria. Unlike DNA helicase, RNA helicase has 6 super families (SF1 to SF6) and regulate endogenous RNAs. Its core consists of 12 conserved amino acid motifs (Fig.3) and showing two different mechanisms such as canonical double strand separation and local strand separation. Canonical double strand separation is the process where dsDNA separates step-by-step in one direction but in local strand separation, the helicase gene attaches at any part of DNA strands to continue the unwinding process. Here ATP provides energy to helicase for strand separation (Awate and Brosh 2017). After many researches on helicase still the function of helicase is not clear, but researchers found that the function of RNA helicase is not only for alteration of RNA structure but it involves in RNA clamping.



**Monalisha Dasmohapatra and Ranjan Kumar Sahoo**

The RNA clamping is the process of nucleation of protein-protein interactions and maintenance of the RNP complex for stable configuration. Several types of DNA and RNA helicases are reported to tolerance of stresses.

Helicase Dependent Stress Tolerance Plants

Molecular metabolism activated by direct and indirect involvement of helicases and this mechanism reduce the negative impacts of abiotic stress on plants. Various type of crops and fruits are damage or killed by multiple environmental factors, low temperature (0-12) is one of the harsh stresses for crops development and yielding. The new research found that, helicases play important role for healthy plant growth and their cell proliferation (Fig.4). Arabidopsis has total 94 helicases and that involved in stress regulated pathway(Zhang et al 2021). These helicases have own genomes and placed in three organelles of plant cells, such are nucleus, mitochondrion and chloroplast (Anand and Pandi 2021). Earlier this is reported that DNA helicases are involving in plants DNA recombination and "PDH45" gene is the first plant nuclear DNA helicase that encoded by cDNA PDH45 of pea (Krupinska *et al.* 2020). It was over-expressed on pea and the bacterial system purified the gene. Example of other plant DNA helicases are KU, SUV3, XPB, XPD, nucleolin, and mini-chromosome maintenance proteins. The previous study shows that helicase enhance the biological process like transcription and translation. It also stabilizes the protein synthesis and associated with DNA-protein complexes for the alteration of gene expression. Examples of some stress tolerance helicase genes(DNA/RNA) are FL25A4,HVD1, Pea DNA Helicase 45(PDH45), Pea DNA Helicase 47 (PDH47), STRS1 and STRS2, AvDH1,CrhR,CrhC,CsdA,RhIEtc(Table:2). MCM6 (Mini-chromosome maintenance 6) is RNA helicase that tolerant salinity stress in pea. In tomato plant, SIDEAD30 and SIDEAD31 genes are tolerance against the salt stress, ABA stress, drought and cold stress. Helicases are molecular motor and largely found in hexameric structure, some of them monomeric or dimeric. The hexameric DNA helicase is a ring-shaped and having six different subunits. The molecular weight of a DNA helicase is 300kDa. The vital role of helicase is unwinding the ds DNA and created multiple duplicate copies of ssDNA template(Fig.5)

CONCLUSION

In this adverse stress environment, food conservation is creating a huge difficulty for human sustainability. Therefore, researchers are continuing their research over the physiology, morphology and molecular mechanisms to develop the stress tolerance plants. In this paper we have attempted to present the helicase role on stress tolerance plant. Abiotic stress like drought, salinity, and temperature, salt, cold induces calcium influx and highly affected the agricultural yielding and reduces the Plants optimal biochemical and physiological function. Thus, the environmental stress is becoming a major limiting factor to our food energy. As compared with other enzyme classes, in plants the functions of DNA helicase have very little knowledge gained. In this paper we are sharing some knowledge on helicase and stresses and hope it will be helpful for future study and development of healthy plants and their yielding on variable stress condition.

ACKNOWLEDGEMENTS

The author thanks to Centurion University of Technology and Management, Bhubaneswar, India for providing necessary support for completion of this manuscript.

Conflict of Interest

Authors declare that there is no conflict of interest

REFERENCES

1. Anand A., Pandi G. 2021.Noncoding RNA: An Insight into Chloroplast and Mitochondrial Gene Expressions. Life11:49. <https://doi.org/10.3390/life11010049>



**Monalisha Dasmohapatra and Ranjan Kumar Sahoo**

2. Awate S., Brosh R.M. 2017. Interactive Roles of DNA Helicases and Translocases with the Single-Stranded DNA Binding Protein RPA in Nucleic Acid Metabolism. *Molecular sciences* 18:1233. <https://doi.org/10.3390/ijms18061233>
3. Bohnsack K.E., Ficner R., Bohnsack M.T., Stefanie J. 2021. Regulation of DEAH-box RNA helicases by G-patch proteins. *Biological Chemistry* 402:561-579. <https://doi.org/10.1515/hsz-2020-0338>
4. Bohnsack K.E., Ficner R.B., Markus T., Jonas S. 2021. Regulation of DEAH-box RNA helicases by G-patch proteins. *Biological Chemistry* 402:561-579. <https://doi.org/10.1515/hsz-2020-0338>
5. Brosh R.M. 2021. DNA Helicases: Mechanisms, Biological Pathways, and Disease Relevance. *Genes*, 12(3):356. <https://doi.org/10.3390/genes12030356>
6. Brosh R.M., Matson S.W. 2020. History of DNA Helicases. *Genes* 11:255. <https://doi.org/10.3390/genes11030255>
7. Canter L.W. 2018. Environmental Impact of Agricultural Production Activities. *Environment & Agriculture*. <https://doi.org/10.1201/9781351071796>
8. Chojnacki M., Melendy T. 2018. The human papillomavirus DNA helicase E1 binds, stimulates, and confers processivity to cellular DNA polymerase epsilon. *Nucleic Acids Research* 46:229–241. <https://doi.org/10.1093/nar/gkx1103>
9. Colizzi F., Perez-Gonzalez C., Fritzen R., Levy Y., White M.F., Penedo J.C., Bussi G. 2019. Asymmetric base-pair opening drives helicase unwinding dynamics. *Proceedings of the National Academy of Sciences of the United States of America* 116:22471–22477. <https://doi.org/10.1073/pnas.1901086116>
10. Das S., Chapman S., Christopher J., Choudhury M.R., Menzies N.W., Apan A., Dang Y.P. 2021. UAV-thermal imaging: A technological breakthrough for monitoring and quantifying crop abiotic stress to help sustain productivity on sodic soils – A case review on wheat, *Remote Sensing Applications. Society and Environment* 23. <https://doi.org/10.1016/j.rsase.2021.100583>
11. Djanaguiraman M., Perumal R., Jagadish S.V.K., Ciampitti I.A., Welti R., Prasad P.V.V. 2018. Sensitivity of sorghum pollen and pistil to high-temperature stress. *Plant Cell Environ.* 41:1065-1082. <http://doi.org/10.1111/pce.13089>
12. Dorn A., Puchta H. 2019. DNA Helicases as Safekeepers of Genome Stability in Plants. *Genes* 10(12):1028. <https://doi.org/10.3390/genes10121028>
13. FAO: Food and Agriculture Organization of the United Nations Rome 2017. <http://www.fao.org/3/i6583e/i6583e.pdf>
14. Fernandez A.J., Berger J.M. 2021. Mechanisms of hexameric helicases. *Biochem Mol Biol.* 17:1-19. <https://doi.org/10.1080/10409238.2021.1954597>
15. Gao Y., Cui Y., Fox T., Lin S., Wang H., de Val N., Zhou Z.H., Yang W. 2019. Structures and operating principles of the replisome. *Science* 363:6429. <https://doi.org/10.1126/science.aav7003>
16. Gao Y., Yang W. 2020. Different mechanisms for translocation by monomeric and hexameric helicases. *Structural Biology* 61(25-32). <https://doi.org/10.1016/j.sbi.2019.10.003>
17. Haider F.U., Liqun C., Coulter J.A., Cheema S.A., Wu J., Zhang R., Wenjun M., Farooq M. 2021. Cadmium toxicity in plants: Impacts and remediation strategies. *Ecotoxicology and Env. Safety* (211). <https://doi.org/10.1016/j.ecoenv.2020.111887>
18. Krupinska K., Blanco N.E., Oetke S., Zottini M. 2020. Genome communication in plants mediated by organelle-nucleus-located proteins. *Biological sciences* 375:20190397. <https://doi.org/10.1098/rstb.2019.0397>
19. Kumar S. 2020. Abiotic Stresses and Their Effects on Plant Growth, Yield and Nutritional Quality of Agricultural Produce. *Food Science and Agriculture* 4(4):367-378. <https://doi.org/10.26855/ijfsa.2020.12.002>
20. Lu H., Davis A.J. 2021. Human RecQ Helicases in DNA Double-Strand Break Repair. *Front. Cell Dev. Biol.* 9:279. <https://www.frontiersin.org/article/10.3389/fcell.2021.640755>
21. Ma Y., Dias M.C., Freitas H. 2020. Drought and Salinity Stress Responses and Microbe-Induced Tolerance in Plants. *Front. Plant Sci.* 11:591911. <https://doi.org/10.3389/fpls.2020.591911>
22. Moreno-del Alamo M., Carrasco B., Torres R., Alonso J.C. 2021. *Bacillus subtilis* PcrA Helicase Removes Trafficking Barriers. *Cells* 10:935. <https://doi.org/10.3390/cells10040935>





Monalisha Dasmohapatra and Ranjan Kumar Sahoo

23. Nkurunziza L., Watson C.A., Öborn I. *et al.* 2020. Socio-ecological factors determine crop performance in agricultural systems. <https://doi.org/10.1038/s41598-020-60927-1>
24. O'Donnell M.E., & Li H. 2018. The ring-shaped hexameric helicases that function at DNA replication forks. *Nature structural & molecular biology* 25:122–130. <https://doi.org/10.1038/s41594-018-0024-x>
25. Ogbaga C.C., Athar H.R., Amir M., Bano H., Chater C.C., Jellason N.P. 2020. Clarity on frequently asked questions about drought measurements in plant physiology. *Scientific African* 8. <https://doi.org/10.1016/j.sciaf.2020.e00405>
26. Sabino F.C., Bastos de Souza L.S., Gonçalves de Souza M.A., Alves de Barros JP, Rodrigues de Lucena LR, Alexandre Ferraz Jardim MR, Rocha AKP, Freire da Silva TG (2021) Morphological characteristics, biomass accumulation and gas exchange of an important species native for restoration in Semi-arid Brazilian areas affected by salt and water stress. *Plant Stress* 2:100021. <https://doi.org/10.1016/j.stress.2021.100021>
27. Sahoo R.K., Rani V., Tuteja N. 2021. *Azotobacter vinelandii* helps to combat chromium stress in rice by maintaining antioxidant machinery. *3 Biotech*. 11(6):275. <https://doi.org/10.1007/s13205-021-02835-3>
28. Sergeeva O., Zatepin T. 2021. RNA Helicases as Shadow Modulators of Cell Cycle Progression. *International Journal of Molecular Sciences* 22:2984. <https://doi.org/10.3390/ijms22062984>
29. Sok S., Chhinh N., Hor S., Ngunphan P. 2021. Climate Change Impacts on Rice Cultivation: A Comparative Study of the Tonle Sap and Mekong River. *Sustainability* 13:8979. <https://doi.org/10.3390/su13168979>
30. Soo S.Y., Hoon K.Y. 2018. The Human Replicative Helicase, the CMG Complex, as a Target for Anti-cancer Therapy. *Mol. Biosci.* 5:26. <https://doi.org/10.3389/fmolb.2018.00026>
31. Takahashi F., Shinozaki K. 2019. Long-distance signalling in plant stress response. *Plant Biol.* 47:106-111. <https://doi.org/10.1016/j.pbi.2018.10.006>
32. Verma P., Tandon R., Yadav G., Gaur V. 2020. Structural Aspects of DNA Repair and Recombination in Crop Improvement. *Front Genet.* 11:574549. <https://doi.org/10.3389/fgene.2020.574549>
33. Wania S.H., Kumar V., Shriram V., Sah S.K. 2016. Phytohormones and their metabolic engineering for abiotic stress tolerance in crop plants. *Crop* 4:162–176. <http://doi.org/10.1016/j.cj.2016.01.010>
34. Waqas M.A., Khan I., Akhter M.J., Noor M.A., Ashraf U. 2017. Exogenous application of plant growth regulators (PGRs) induces chilling tolerance in short-duration hybrid maize. *Environ Sci Pollution* 24(12):11459-11471. <http://doi.org/10.1007/s11356-017-8768-0>
35. Whitford D.S., Whitman B.T., Owtrim G.W. 2021. Genus specific distribution of DEAD-box RNA helicases in cyanobacteria. *Microbial genomics* 7. <https://doi.org/10.1099/mgen.0.000517>
36. Yadav M., Singh R.S., Hogan D., Dmitriev O.Y., Cygler M., Wu Y. 2021. The KH domain facilitates the substrate specificity and unwinding processivity of DDX43 helicase. *Biological Chemistry* 296:100085. <https://doi.org/10.1074/jbc.RA120.015824>
37. Yokota H. 2021. Roles of the C-Terminal Amino Acids of Non-Hexameric Helicases: Insights from *Escherichia coli* UvrD. *Molecular sciences* 22:1018. <https://doi.org/10.3390/ijms22031018>
38. Zhang H., Liu X., Wang X. *et al.* 2020. Genome-Wide Identification of GRAS Gene Family and Their Responses to Abiotic Stress in *Medicago sativa*. *Int J Mol Sci.* 22(14):7729. <https://doi.org/10.3390/ijms22147729>
39. Zhang L., Li X. 2021. DEAD-Box RNA Helicases in Cell Cycle Control and Clinical Therapy. *Cells* 10:1540. <https://doi.org/10.3390/cells10061540>
40. Zhao M.M., Wang R.S., Zhou Y.L., Yang Z.G. 2020. Emerging relationship between RNA helicases and autophagy. *SCIENCE* 21:767-778. <http://doi.org/10.1631/jzus.B2000245>
41. Zorb C., Geilfus C.M., Dietz K.J. 2019. Salinity and crop yield. *Plant Biol.* 21:31–38. <https://onlinelibrary.wiley.com/doi/10.1111/plb.12884>

Table 1: Types Of Helicases And Their Cellular Function

| Sl. No. | Cellular function of helicase | Types of helicases |
|---------|-------------------------------|--|
| 1 | Replicative helicases | PcrA1, RepA, UvrD, Dda, HSV UL5, HSV UL9, DnaB, PriA, T7gp4A and 4B, T4gp41, SV40, TAG, Polyoma TAG, BPV E1, MCM 4/6/7, Dna2, FFA-1, RecD, TraI, NS3, RecQL4 |





Monalisha Dasmohapatra and Ranjan Kumar Sahoo

| | | |
|---|-----------------------------|---|
| 2 | Repair helicases | UvrD, UvrAB, PcrA, Rad3, helicase E, XPD, XPB, Dna2, RecD2, BACH1, HDH II, RecQ, WRN, Rtel1, BLM, RuvB, Mph 1, CHD4 |
| 3 | Recombination helicases | RecBCD, RecG, RecQ, RuvAB, PriA, UvrD, T4 UvsW, HDH II, HDH IV, WRN, Tra I, Rho, PDH65, BLM, Srs2, Sgs1, Rtel1 |
| 4 | Transcription | SWI2, TFIIH, Rho, SNF2, Factor 2, TRCF, RecQL5, ERCC6/RAD26 |
| 5 | Chromatin remodelling | Rad54, ATRX, BLM, CHD4 |
| 6 | Translation | HSV UL5, eIF4A, RHA, Ded1p, vasa |
| 7 | Maintenance of telomeres | Pif1, Dna2, Rtel 1, WRN, BLM, FANC |
| 8 | Okazaki fragment maturation | Dna2, Pif1, WRN |

Table 2 Abiotic stress responses helicase and their source

| Sl. No | Helicase gene | Source | Types of stress | Functions |
|--------|-----------------|-----------------|---|--|
| 1 | FL25A4 | A. thaliana | Low temperature 4 °C | Suggested a new role for helicases in stress signalling |
| 2 | HVD1 | Hordeum vulgare | Salt and cold | Regulates transcripts concerned with salt tolerance, or important metabolism such as photosynthesis, in chloroplast |
| 3 | PDH45 | Pisum sativum | Salt | Possible role in translation or regulating DNA/RNA metabolism under stress conditions |
| 4 | PDH47 | P. sativum | Salt and cold | Efficient translation under stress condition or regulating the DNA/RNA metabolism |
| 5 | STRS1 and STRS2 | A. thaliana | Salt, osmotic, and heat | Mutations in either gene cause increased tolerance to salt, osmotic, and heat stresses, suggesting that the helicases suppress responses to abiotic stress |
| 6 | MH1 | M. sativa | Mannitol, NaCl, methylviologen, abscisic acid | The ectopic expression of MH1 in Arabidopsis improved seed germination and plant growth under drought, salt, and oxidative stress |
| 7 | CrhR, | Anabaena | Cold | Polar-biased localization |
| 8 | CrhC | Synechocystis | Light | Redox-regulated expression |
| 9 | CsdA, | E.coli | Cold | Cold-adapted degradosome |
| 10 | RhIE | P.syringae | Cold | Cold-adapted degradosome |





Monalisha Dasmohapatra and Ranjan Kumar Sahoo

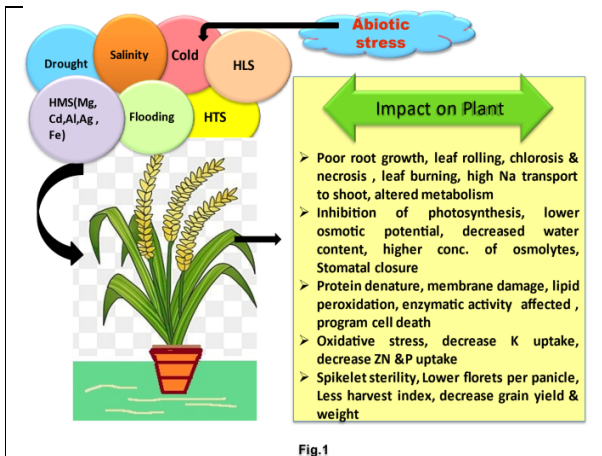


Fig.1

Fig.1 Effect of different abiotic stresses (high temperature, cold, heavy metal, highlight, drought, salinity, flood) on plants.)

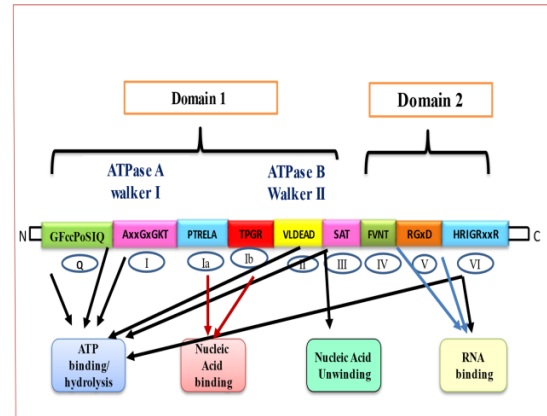


Fig.2 Helicase motif II contains RNA helicases and divided into two domains. Domain 1 are motifs I, Ia, Ib, II, and III and domain 2 are motifs IV, V, and VI.

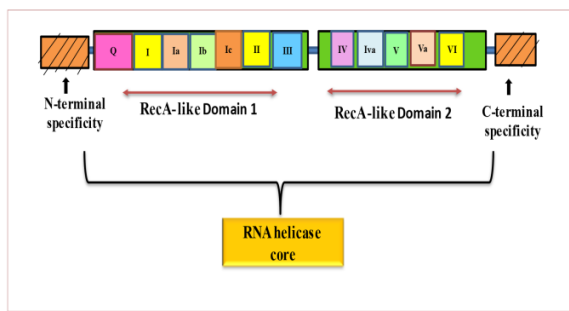


Fig.3 RNA helicase consists of total 12 conserved motif and two DEAD-box helicase core domain such as RecA-domain 1 and recB-domain 2. Domain I contain 7 motifs and domain II contains 5 sequence motifs. Such motifs are Q, I, II, and VI function as ATP binding and hydrolysis, and the motifs of Ia, Ib, Ic, IV, IVa, and V function as RNA binding. The function of motifs III and Vais to coordinate between RNA and ATP binding. Domain II includes the DEAD motif (asp-Glu-alaasp). The DEAD-box RNA helicases usually contain N and C terminal extensions and that determine their interaction with specific RNA and/or protein

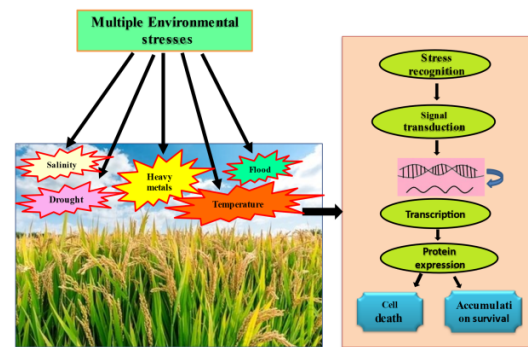


Fig.4 Plants membrane receptors is first receiving the extracellular stress signal and generate the secondary signal molecules. The signal developed multiple stress responsive genes, which mediate stress tolerance and resistance directly or indirectly, and restore the cellular and tissue homeostasis. The action of many gene coordinates through the stress responses, which may provide signal with each other.





Monalisha Dasmohapatra and Ranjan Kumar Sahoo

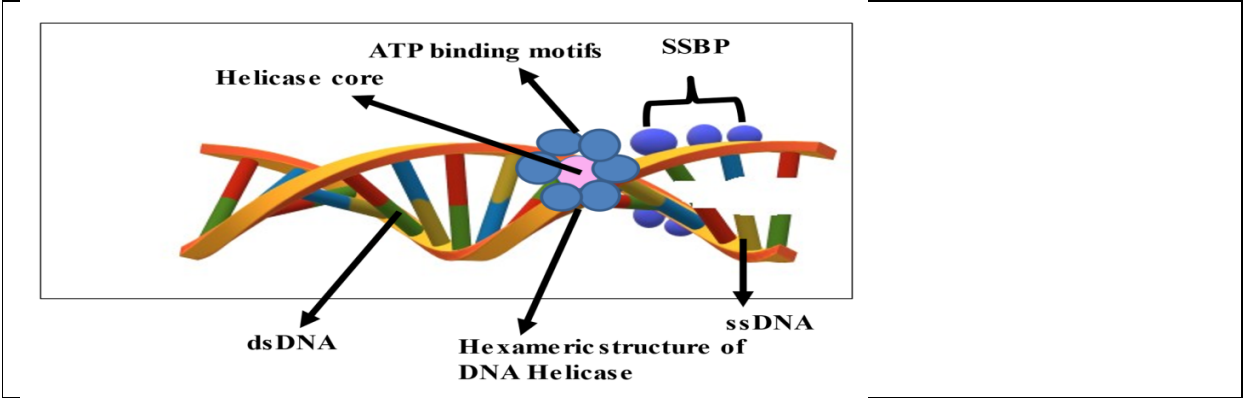


Fig.5 DNA enters into the holo part of hexameric helicase and then ATP provides energy to breakdown the hydrogen bonds and move forward. During this process, the helicase binds to one of the two dsDNA strands and passes it through its hollow core. Here SSBP (single strand binding protein) holds the unwinding ssDNA template.





Urban Sprawl Analysis using Geospatial Approach-A Case Study of Paralakhemundi Municipality, Odisha, India

P K Panda*, S Sankalap and A.Dandapat

Department of Civil Engineering, Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

P K Panda

Department of Civil Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: prafullapanda@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Urbanization is a dynamic set of process, responding to changing values and perceptions of intrinsic characteristics of rural versus urban areas. It is not a single process, although all are interrelated. The fundamental difference between urban and rural is that urban populations live in larger, denser and more heterogeneous cities as oppose to small, more sparse and less differentiated rural places. However, it is important to acknowledge that the criteria for defining what is urban may vary from place to place and country to country. Urbanization is an index of transformation from traditional rural economies to modern industrial one. It causes some changes in labor division and human behaviors. Urbanization is defined as an increase in the number of towns & urban population. It is the process that leads to the growth of towns due to industrialization & economic development Paralakhemundi is a small town which is undeveloped facing so many problems like communication with other cities, drainage system, water supply, improper town planning, current, roads etc.

Keywords : (Urbanization, Remote Sensing, Geospatial Technology)

INTRODUCTION

A modern nation, as a modern business, must have adequate information on many complex interrelated aspects of its activities in order to make decisions. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels. First, the processes of urbanization are considered, defined, and analysed. Second, the nature of rural

42998





Panda et al.,

land use is considered, and presented as a multifaceted phenomenon. Then, the impacts of urbanization are laid out, with the impacts presented as the result of a series of responses to a set of supply and demand situations created by urbanization processes. Particular attention is paid to emphasizing the highly differentiated nature of the impacts, ranging from positive complexes of change for rural land use to situations of rapid degeneration of rural land use.

The variety of land use and land cover data needs is exceedingly broad. Current land use and land cover data are needed for equalization of tax assessments in many States. Land use and land cover data also are needed by Federal, State, and local agencies for water- resource inventory, flood control, water-supply planning, and waste-water treatment. Many Federal agencies need current comprehensive inventories of existing activities on public lands combined with the existing and changing uses of adjacent private lands to improve the management of public lands. Federal agencies also need land use data to assess the environmental impact resulting from the development of energy resources, to manage wildlife resources and minimize man-wildlife ecosystem conflicts, to make national summaries of land use patterns and changes for national policy formulation, and to prepare environmental impact statements and assess future impacts on environmental quality. For many years, agencies at the various governmental levels have been collecting data about land, but for the most part they have worked independently and without coordination. Too often this has meant duplication of effort, or it has been found that data collected for a specific purpose were of little or no value for a similar purpose only a short time later.

There are many different sources of information on existing land use and land cover and on changes that are occurring. Local planning agencies make use of detailed information generated during ground surveys involving enumeration and observation. Interpretation of large-scale aerial photographs also has been used widely. In some cases, supplementary information is inferred on the basis of utility hook-ups, building permits, and similar information. Major problems are present in the application and interpretation of the existing data. These include changes in definitions of categories and data collection methods by source agencies, incomplete data coverage, varying data age, and employment of incompatible classification systems. In addition, it is nearly impossible to aggregate the available data because of the differing classification systems used.

Study area

The area selected for storm surge drainage lies within the larger part of the paralakhemundi town shown in Fig 1. There is already an existing storm drain, which is a surfaced drainage system, partially open and is rectangular in shape. The existing storm sewer drains water only from one side of the road. The existing drain however, is filled with sediment and debris at various places along its length and at some places it is also being used as a solid waste dumping site. One of the alternatives is to repair the existing drain however there is no guarantee that it will not lead to same disuse in future as it is now.

Parlakhemundi Block of Ganapati district has total population of 77,645 as per the Census 2011. Out of which 38,876 are males while 38,769 are females. In 2011 there were total 18,095 families residing in Parlakhemundi Block. The Average Sex Ratio of Parlakhemundi Block is 997. As per Census 2011 out of total population, 59.6% people lives in Urban areas while 40.4% lives in the Rural areas. The average literacy rate in urban areas is 81.6% while that in the rural areas is 51%. Also, the Sex Ratio.

Objectives

- To identify and study the land use and land cover of Parlakhemundi.
- To develop & identify a proper plan using multi temporal data sets.
- To develop clear objectives and activities for sustainable development of land use and land cover in Parlakhemundi town.



**Panda et al.,****Urbanisation as process**

Urbanization is a dynamic set of processes, responding to changing values and perceptions of the intrinsic characteristics of rural versus urban areas. It is not a single Process, although all are interrelated. At the macro scale, urbanization can be defined as the increasing concentration of population in urban areas both relatively and absolutely. Driven by values and the perceptions of the realities of quality of life differentials (e.g., jobs, living conditions) between urban and rural areas, the results and consequences have been vastly different in the older industrialized countries and developing countries. At the same time, urbanization has also been regarded as synonymous with urban expansion, particularly the type of urban growth known as urban sprawl, a set of processes that operate at regional (or micro) and local levels. Macro scale processes of urban growth are easy to link to urban expansion and sprawl. However, expansion of the urban area can take place in the absence of major increases in population and activity concentration in urban regions simply as the result of people's search for alternative Lifestyles and of the different and evolving needs of human activities, particularly in the older industrialized countries. These evolving needs over the course of the twentieth Century has included:

- Greater land requirements for horizontally laid out industrial production processes
- The changing nature of retail spaces in the development of large shopping centres with their associated parking infrastructure

Remote sensing techniques, including the use of conventional aerial photography, can be used effectively to complement surveys based on ground observation and enumeration, so the potential of a timely and accurate inventory of the current use of the Nation's land resources now exists. At the same time, data processing techniques permit the storage of large quantities of detailed data that can be organized in a variety of ways to meet specific needs.

Data used and methodology

- I. Topo sheet-74B_1 (Survey of India)
- II. Municipality Data (Land use land cover)
- III. Satellite data: Landsat (TM)

Problem regarding road network

In Paralakhemundi area the road network is not fully integrated into the national economy. In some street and connecting roots of the village is not being roadway up to yet. Lack of adequate planning and management due to poor coordination between multiple funding streams and agencies. Many road projects may not actually connect the settlement, but the inhabitants of the settlements may require less time to reach the road network and therefore its destination. Often the quality standard of the road link and road network, all year sedan vehicle accessible road networks. It is possible to formulate higher standards by incorporating a speed component. The drainage system and condition of roadway is not good. The traffic system is in underdeveloped condition. Divider, solders, road lamps, traffic signs (regulatory sign, warning sign, and informatory sign) are not provided. Deposited water in pot holes on roads are the main problem during rainy season. The most prominent problems on the existing roads are:

- Delay of travel time and is causes Noise pollution
- Noise pollution
- Traffic problems
- Vehicle emissions
- Road user cost and energy use

Types of Problem

Delay of travel time and its causes Travel time delays may also be caused by certain road conditions, factors are:- Improper Horizontal curvature, Road width, Pavement roughness, Sight distance





Panda et al.,

Noise pollution

The Noise level very much influenced by the traffic flow. The main reason of noise pollution is, more vehicles run over a specific road. The norms are often related to the environment, through which the road runs. Roads in urban areas have to meet high standards towards noise pollution. The norms in nature reserves are usually firmer than the norms for agricultural areas. In Urban areas, it is possible to quantify the noise pollution through counting the number of households that are negatively affected or are staying in noise levels that are exceeding the acceptable noise levels

Traffic problems

The traffic system is in underdeveloped condition. Divider, solders, road lamps, traffic signs (regulatory sign, warning sign, and inforatory sign) are not provided. Deposited water in pot holes on roads are the main problem during rainy season. Most countries have adopted speed limits for urban and rural areas. There may also be special speed limits for specific roads. In India we adopted the speed limit for urban areas; 60 km/hr., For Rural roads: 50 km/hr., for Motorways: 100 km/hr.

Road user cost and energy use road user costs like fuel consumption, tire consumption, maintenance and repair costs, engine oil and depreciation of the vehicles are also negative impacts for the environment. These items are grouped in one category Vehicle Operation Costs. Fuel consumption may account for 20 to 40% of the vehicle operation costs. Traffic congestion, road alignment and conditions may have negative impacts on the fuel consumption of the vehicles. Fuel consumption is not only a cost for the road user but is also considered an environmental hazard. Fuel consumption is often related to vehicles speed.

Creation of Land Use Land Cover Maps

Residential land uses range from high density, represented by the multiple-unit structures of urban cores, to low density, where houses are on lots of more than an acre, on the periphery of urban expansion. The land uses included in the Transportation Communications, and Utilities category occur to some degree within all of the other Urban or Buildup categories and actually can be found within many other categories.

RESULTS

The major land use and land cover types shown by the maps of 1990,2004, 2009 and 2016 include agricultural land, dense forest, dense scrub, land without scrub, open forest, open scrub, plantation, sand, scrub forest, rural settlement, urban settlement, water body etc.. As indicated in Figures below that the greatest share of land use and land cover from all classes is agricultural land, which covers an area of 148,209.5 ha contributes 18% of the total area. Dense forest covers an area of 219,307.37 hector, which is 15 % of the total area, settlements cover an area of 87,828.56 ha from the total area of Paralakhemundi.

CONCLUSION

This study shows the land use and land cover changes that have occurred in Paralakhemundi in the last 31 years are in 1975 built up area was 35%, in 1990 built up area was 40%, in 2004 built up area was 48%, in 2009 built up area as 55% and in 2016 built up area was 60% while the water bodies of different years was 18%, 16%, 15%, 12% and 11% then we calculated the agricultural area of different years that was find out to be 47%, 44%, 37%, 33% and 29% and considers as well as relates different components responsible for the change with the implications on increase in biodiversity loss, soil erosion, and inappropriate land management. The methods developed as an outcome of this study have been employed for their capability to assess the changes in land use and land cover, Remote Sensing integrated into a GIS environment provides an ability to characterize large assessment areas and establish reference conditions. Generally, the situations of land use and land cover dynamics have a depressing effect on the local scale as well as beyond that because its consequences do not have clear boundaries. There is, therefore, a need for local





Panda et al.,

land use planning and design with conservation practices of the study area. Settlement area is increasing gradually while the area of water bodies and agricultural land is decreasing.

REFERENCES

1. Mohit Sahu,Prafulla Kumar Panda, BarshaBehera,2020 Change detection study using geospatial technology and remotely sensed data- a case study for Gajapati District,Indian Journal of Natural Sciences, volume 10,issue 60.
2. Prafullaku.Panda and Tanuja G.2017, Land Use and Land Cover Change Detection Study at Gajapati District Using Space Input and Gis -A Case Study for Gajapati District, Odisha. Int J Recent Sci Res. 8(9), pp. 19815-19819. DOI: <http://dx.doi.org/10.24327/ijrsr.2017.0809.0765>
3. Canadian Journal of Remote Sensing<http://pubs.nrc-cnrc.gc.ca/cjrs/cjrs.html>
4. Prafullaku.Panda and Tanuja G .2017, Land Use and Land Cover Change Detection Study at Gajapati District Using Space Input and Gis -A Case Study for Gajapati District, Odisha. Int J Recent Sci Res. 8(9), pp. 19815-19819. DOI: <http://dx.doi.org/10.24327/ijrsr.2017.0809.0765>
5. Mohit Sahu, Prafulla Kumar Panda, Barsha Behera, Smrutirekha Sahoo and Debi Prasan Behera Change Detection Study Using Geospatial Technology and Remotely Sensed Data- A Case Study for Gajapati District, Indian Journal of Natural Sciences, Vol.10 / Issue 60 / June / 2020,PP22792-22800
6. International Journal of Remote Sensing<http://www.tandf.co.uk/journals/tf/01431161.html>
7. Remote Sensing and Image Interpretation by Lillesand Kiefer & Chipman
8. Adams, B.J. and C.K. Huyck, (2006), The Emerging Role of Remote Sensing Technology in Emergency Management, Infrastructure Risk Management Processes – Natural, Accidental, and Deliberate Hazards, Monograph 1, ASCE, Reston, Virginia.
9. Aoki, H., Matsuoka, M. and Yamazaki, F., (1998), Characteristics of Satellite SAR Images in the Damaged Areas Due to the Hyogoken-Nanbu Earthquake, Proceedings of the 1998 Asian Conference on Remote Sensing,
10. <http://www.gisdevelopment.net/aars/acrs/1998/ts3/ts3007.shtml>
11. DOT/NASA, (2003), Remote Sensing and Spatial Information Technologies Application to Multimodal Transportation. Developing and Implementing Advances to Transportation Practice.
12. <http://www.ncgia.ucsb.edu/ncrst/synthesis/http://landast.usgs.gov>

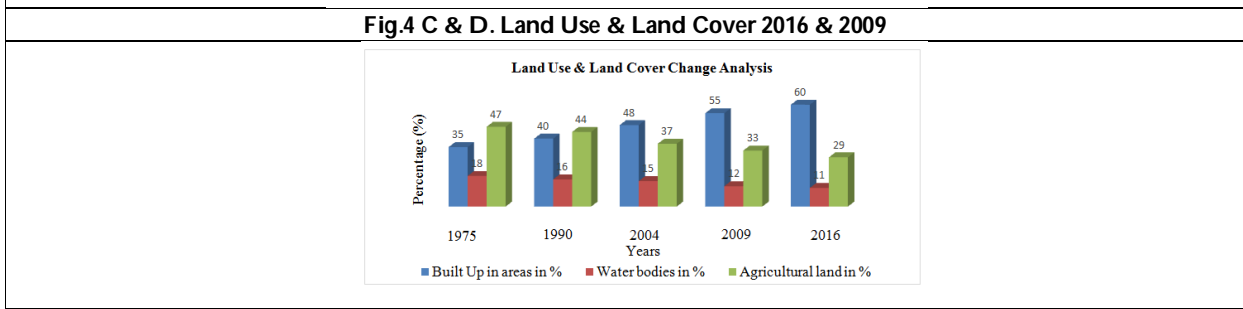
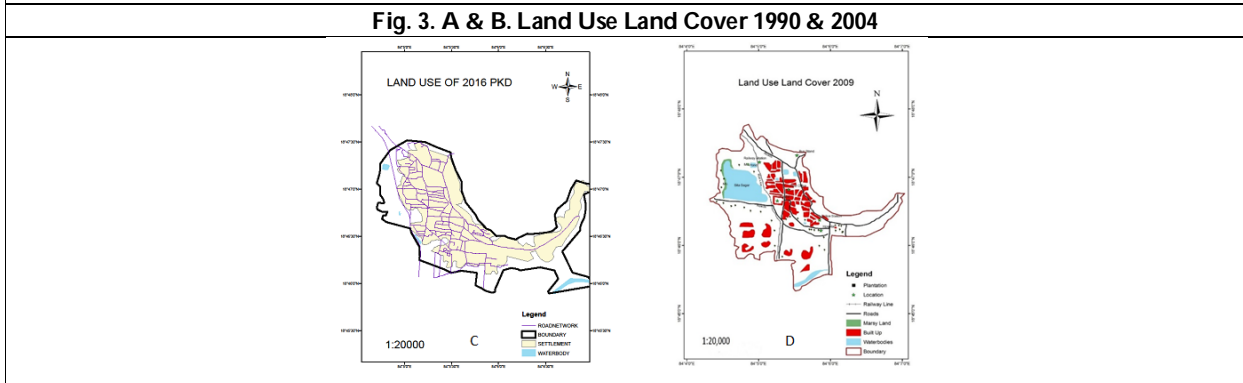
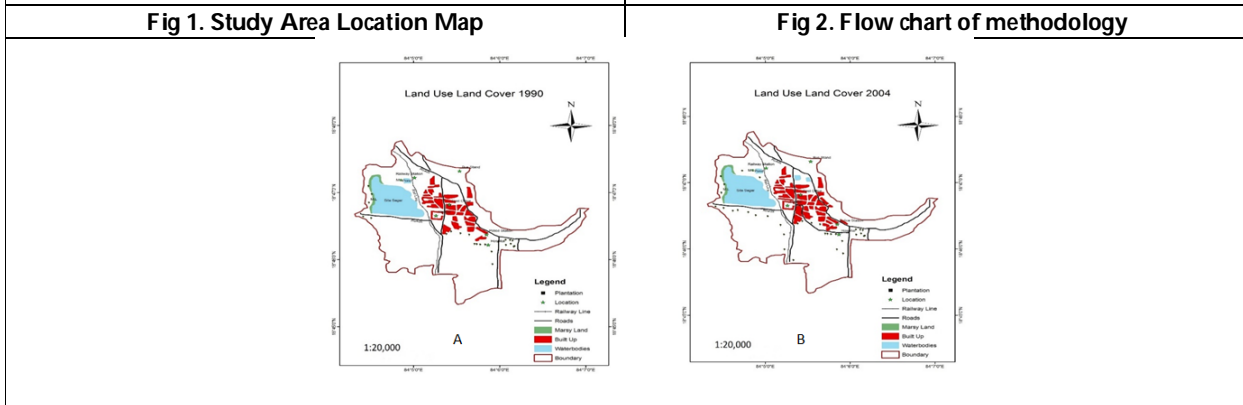
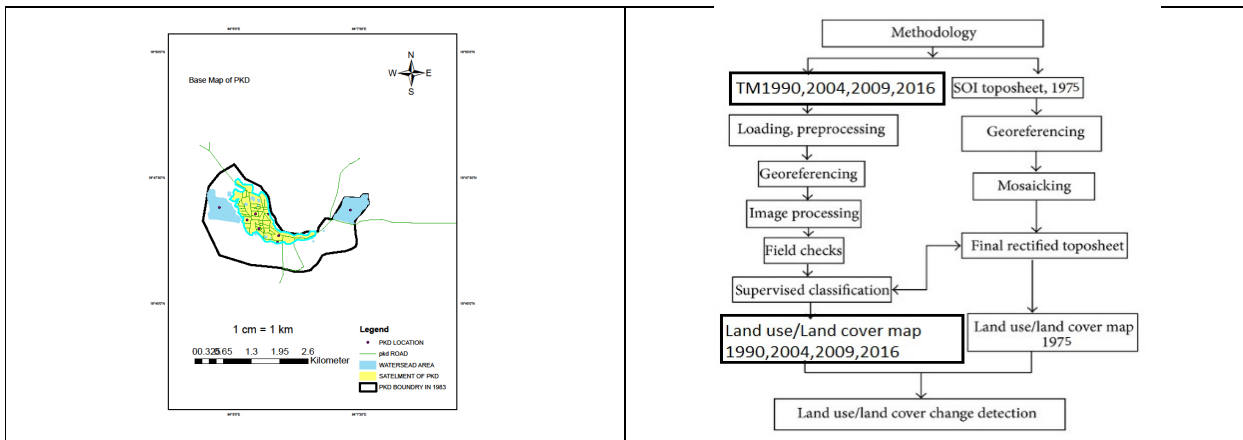
Table 1. Land Use & Land Cover % Changes at Paralakhemundi from 1975 – 2016

| Year | Built Up in areas in % | Water bodies in % | Agricultural land in % |
|------|------------------------|-------------------|------------------------|
| 1975 | 35 | 18 | 47 |
| 1990 | 40 | 16 | 44 |
| 2004 | 48 | 15 | 37 |
| 2009 | 55 | 12 | 33 |
| 2016 | 60 | 11 | 29 |





Panda et al.,



Chat No 1. Land Use & Land Cover Change Analysis





Biofilm Preparation from Corn Starch using Beetroot as Colouring Agent

Jayanti Rani Gouda, Ashish Kumar Sahoo*

Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ashish Kumar Sahoo

Centurion University of Technology and Management,
Odisha, India.

Email: ashish.sahoo@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The growing need for sustainability has led us to develop alternative pathways to save the non-renewable resources from depleting and thus protecting our ecosystem. One such step is to find an alternative of plastic that is used as packaging material. These plastics are usually petroleum -based products, and petroleum as we know is a fossil fuel. Even the after-use problem of plastic is an important point of discussion. The other packaging materials that are used also has disadvantages such as in case of metal, there is a chance of corrosion or reactivity which would affect the quality of the product especially in case of food items. The aim of this study is to focus on an alternative pathway that would help avoid such problems. A smart step would be choosing starch-based packaging material as an alternative for fossil fuel-based products. The motivation behind this alternative lies in the principles of green chemistry. Corn starch can be efficiently selected for preparation of biofilm that can be used as packaging material. The raw materials used were corn starch, distilled water, vinegar, glycerine. The prepared film is biodegradable and plant based. Thus, it is non-toxic and cost effective too. The preparation time took much less time as compared to preparation of other packaging materials. The elemental analysis was also done using XRF spectrometer. By the help of XRF data we were able to find that the elements present in this biofilm are non-hazardous and thus, can be used to wrap food items also. Thus the present work falls in the category of Sustainable Development Goals numbers SDG-9 (Industry , Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).

Keywords: Biodegradable films, Corn starch, packaging material, Beet root coloring agent

INTRODUCTION

Packaging is as important as product development for any type of product. Designing of the package starts with the recognition of all the requirements which involves structural, mechanical, and operational design; assurance of quality; environmental effects; shelf-life; cost; etc. The material that is used for packaging purpose is verified by

43004



**Jayanti Rani Gouda and Ashish Kumar Sahoo**

scientists, toxicologists, and engineers before incorporating the material into product packaging development. The quality of the material is being tested before processing it. Verification and validation of the packaging material is an essential step to be considered. The designing and manufacturing of pharmaceutical product package is either totally or partially machined or computer-aided. After development of the package, different tests such as drop test, vibration test, shock test, revolving drum test, etc. are also conducted to test the package quality. Packaging of product can provide protection of the product from environment, insects, microbial attack and transportation stress, market conveniency, avoids counterfeiting, etc. A package must be product relevant, that is, it shouldn't react with the stored contents and should have good mechanical strength along with being non-toxic in nature. The package should have good stability, that is, it should not react or affect the quality of the products inside the package. The shape of the package/container should be such that the contents can be easily drawn out of it. The material used for package should be economically viable. The package should not be so expensive that it would be problematic to sell or buy the particular product. If package would be expensive then, the overall price of the product would also increase. The packaging material should be easy and convenient to handle[1]. Moreover, the design should be acceptable in all manner. Nowadays, child-resistant and eco-friendly packaging are also available in the market.[2]

It is evident that the first type of packages that were used are natural materials, such as ceramics, reeds, wood, bronze, mulberry bark, leaves, etc[3]. With the advancement of modern technology and growth of industrialisation different types of materials such as plastics, nanomaterials, glass, rubber, paper, metals such as aluminium, iron, etc. are being used and available in the market and increasing at a greater pace. Paper is made up of cellulose. The reason behind using it for packaging is that it provides protection, provides improved display of substances and they are also flexible in nature. Paper is light in weight and thus can be handled easily. Paper can be used in the form of cartons for secondary packaging also. Cellophane or a polypropylene film is then used to wrap the carton, to give protection against moisture, though not completely but partially. Cardboard are being widely used nowadays which is based on corrugated paper. Generally, such type of packages is made by sandwiching thin sheets of paperboard between two flat sheets of paperboard. The advantage of using this is that, it is light in weight, cheap and it also has appreciable strength. The disadvantages of using paper for packaging are that it has low resistance to water. For production of paper in large quantities lot of deforestation needs to be done. Glass is a material made up of sand (SiO_2), sodium carbonate (Na_2CO_3), limestone (CaCO_3). It is fragile in nature. Hence, should be handled carefully. Glasses are of different types that include flat glass, toughened glass, patterned glass, laminated glass, mirrored glass, coated glass, tinted glass, sandblasted glass, soda lime glass, borosilicate glass, crystal glass, lead glass, etc. All these types have various uses too. Glass is generally used in packaging because it has certain qualities such as, it is economical, impermeable and has good strength and rigidity. Moreover, it is available in various shapes and sizes. It gives protection against light and also does not decompose. But it should be handled carefully due to its fragile nature and heavy weight.

Plastic is a polymer which may be synthetic or semi-synthetic in nature. Since, its invention, plastic is now being used over a wide range. They are petroleum-based materials. Their adaptability and flexibility make it more suitable for use in different applications. Unlike glasses they can resist breakage and thus are safe to use in the sense that careful handling is not so essential. They are also resistant to water. Different types of plastic such as polypropylene, polyethylene, polystyrene, polyvinyl chloride (PVC), polymethyl methacrylate (PMMA), PET, polyamides, etc. are widely used.[4] These containers are used along with certain additives. These additives include stabilizers, antistatic agents, lubricants, anti-oxidants, plasticizers, impact modifiers, etc. They have certain advantages such as durability, odourless, inert, light in weight, flexible, unbreakable, moisture resistant, etc. Among all the various types of plastics mentioned above, high-density polyethylene (HDPE) is most used for packaging purpose in pharmaceutical industries. Polypropylene is also used in pharmaceuticals industries. It has certain benefits such as stress-crack resistance. It has good vapor and gas barrier too. Polystyrene is used by pharmacists for making solid containers which is less expensive. It is not suitable for liquid products. It is also resistant to acids. Polycarbonate can be converted to clear, transparent, and rigid container. Hence, it can be a replacement to glass. It is resistant to dilute acids, salts, oils and greases. However, it is used less due to its expensiveness. However, it has certain disadvantages



**Jayanti Rani Gouda and Ashish Kumar Sahoo**

as non-biodegradability, pollution of food and water resources by microplastics, production of plastic releases harmful chemicals which are hazardous.

Among seventy metals in the periodic table a few of them are used for packaging. Metals such as tin, aluminum, silver are generally used. The advantages of metals include light-weight, break-resistance, compatibility, not permeable to light and moisture, etc. Tin is used due to its ductility and also offers improved appearance. Oxidation of the product is also prevented by its use. Even, alloys of tin are also used. It is inert in nature. Aluminum is light in weight and can thus save the shipping costs. Lead can be used with internal linings, but cannot be used alone as it can lead to lead poisoning. Metals can also be used in form of tubes to package the products for barrier protection. The disadvantage of using metal is that some of them are corrosive and can affect the quality of food. Product is not visible when packed in metal containers. Metal package manufacturing takes a long time and is not cost effective.

Modernization of packaging technologies is done for upgradation of packaging technologies and also to meet the demands of the market and make the package user-friendly. The availability of different types of packaging materials can help in storing various kinds of products be it solid or liquid. More researches are also still being carried out to increase the availability of more new varieties of packaging material which would be user friendly as well as eco-friendly. This would lead to a step forward towards sustainability. As the increasing need of keeping the environment safe is becoming an important topic nowadays due to the rapid pace of environmental pollution, it is essential to work towards making the environment greener and safer place to live in. [5]

One such step is the production of biofilm made from corn starch. which is completely biodegradable, easy to make and few time is needed to complete the process of production, thus time saving. Also, the raw materials are easily available and it is cost effective to prepare the film [6]. The reason behind choosing corn starch as a packaging material is that the fat content in it is low and it contains sodium and cholesterol. All these nutrients are health beneficial. Thus, when consumed it will have no negative impacts. Other packaging materials when disposed, sometimes they come in contact with animals who eat those disposed packages such as paper and polyethene wrappers. These polyethene wrappers may choke them and lead to sudden death of the animals. By developing biofilms, we can prevent these animals from losing their life. It is not a problem if the biofilms are eaten by them. Another important point to consider is that we use beetroot as a colouring agent in this biofilm just to make it look attractive in appearance. This beetroot also has certain essential nutrients such as nitrates, fiber, folates, magnesium, potassium, vitamin c and B9, iron. Thus, no harmful substances are present which might have been present if we used artificial food colours. Thus, the present work meets the necessary needs in the category of Sustainable Development Goals viz. SDG-9 (Industry , Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).

MATERIALS AND METHODS

Materials

Corn starch and vinegar was bought from grocery store. Glycerine was purchased from local supermarket. Beet root was purchased from local market. Distilled water was brought from chemistry laboratory of Centurion University of Technology and Management. Malvern PANalytical- Benchtop X-Ray Fluorescence(XRF) Spectrometer- Epsilon 3 was used in Centurion University of Technology and Management.

Biofilm Preparation

The preparation of biofilm involves the addition of 50 ml of distilled water to 10gm corn starch in a beaker. The mixture was stirred well. Then 5 ml glycerine was added to the above mixture with continuous stirring. Glycerine acts as plasticizer and makes the biofilm flexible. After that 5ml vinegar was added to it as a preserving agent and also to break the polymer chains of polylactic acid. Beet root was crushed with the help of mortar and pestle and few drops of the juice was added as colouring agent. It imparts a pink colour to the mixture solution. The mixture was continuously stirred and then the beaker was placed on Bunsen burner. Continuous stirring should be done to avoid

43006



**Jayanti Rani Gouda and Ashish Kumar Sahoo**

non-uniform coagulation of the mixture at a particular point. After about 10 minutes we observed a thick uniform mass was formed. This was transferred and spread on the aluminium foil and watch glass for drying. The drying was done for 3 days at room temperature. The film before and after drying are shown in the figure below.

RESULTS AND DISCUSSION**Characterization of the biofilm**

The compositional and elemental analysis of the prepared sample was done by X-Ray Spectrophotometer (XRF) Spectrometer. From the data obtained we found that the elements in the sample were non toxic and the few elements that are harmful although present, are within the allowed limits as per known literature found in internet. This is shown in the table1 and figure 3 below. Thus, the biofilm is benign and can be used for the purpose of packaging of different products. The advantage is that it is eco-friendly, sustainable and in accordance with the laws of green chemistry. Hence, these are efficient biodegradable packaging materials[7].

CONCLUSION

Biofilm has many positive points to be considered. There are few disadvantages too but the advantages are more when compared with. The biofilm was successfully prepared and we found positive results regarding its formation, non-toxicity, strength, etc. These can be used for large scale production in industrial sectors. These is an innovative idea to work on. However, the production and applicability depend on the acceptance and preferences of people. Also, awareness is another key factor. The use of such packaging material depend on the extent to which people are aware of it. The future scope for such type of packaging material is also considerable. These materials can be used in various applications such as storage bags, wrappers, carry bags, food packets, etc. With the adaptation of sustainability, the production of such materials is hoped to increase in the coming future. The banning of single use plastic has also created a hope that the biofilm would be accepted and used by the society in near future. Thus the present work falls in the category of Sustainable Development Goals numbers SDG-9 (Industry , Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).

REFERENCES

1. Jenke DJ Pharm Sci Technol, 2002; 56: 332-71.
2. Automating Management Information Systems: Barcode Engineering and Implementation - Harry E. Burke, Thomson Learning, ISBN 0-442-20712-3
3. Paula, Hook. "A History of Packaging". Ohio State University. Retrieved (December 29, 2020).
4. Wang Q, Cai J, Zhang L, Xu M, Cheng H, Han CC, Kuga S, Xiao J, Xiao R. A bioplastic with high strength constructed from a cellulose hydrogel by changing the aggregated structure. Journal of Materials Chemistry A. 2013;1(22): 6678-6686.
5. Ramakrishnan N, Sharma S, Gupta A, Alashwal BY. Keratin based bioplastic film from chicken feathers and its characterization. International Journal of Biological Macromolecules. 2018;111: 352-358.
6. Saberi B, Chockchaisawasdee S, Golding JB, Scarlett CJ, Stathopoulos CE. Characterization of pea starch-guar gum biocomposite edible films enriched by natural antimicrobial agents for active food packaging. Food and Bioproducts Processing. 2017;105: 51-63.
7. Alvarez-Chavez CR, Edwards S, Moure-Eraso RL, Geiser K. Sustainability of bio-based plastics: General Comparative Analysis and Recommendations for Improvement. Journal of Cleaner Production. 2011; 23(1): 46-7.





Jayanti Rani Gouda and Ashish Kumar Sahoo

Table 1- Elemental composition of biofilm

| Sample ident | | | | | | | | | | | | |
|---------------------------------------|--------|-------|-------|-------|-------|----------------------------|------|-----|-------|------|------|-------|
| Sample 04 | | | | | | | | | | | | |
| Application <Omnia> | | | | | | Normalisation factor 6.199 | | | | | | |
| Sequence 1 of 1 | | | | | | | | | | | | |
| Position Large sample | | | | | | | | | | | | |
| Measurement time 11-Apr-2022 08:16:53 | | | | | | | | | | | | |
| Compound | SiO2 | P2O5 | SO3 | Cl | K2O | CaO | TiO2 | MnO | Fe2O3 | ZnO | Br | Eu2O3 |
| Conc | 1.216 | 0.678 | 0.496 | 0.240 | 879.9 | 0.201 | 91.2 | 0.0 | 644.9 | 14.2 | 10.2 | 47.7 |
| Unit | % | % | % | % | ppm | % | ppm | ppm | ppm | ppm | ppm | ppm |
| Compound | H2O | Re | | | | | | | | | | |
| Conc | 97.000 | 1.8 | | | | | | | | | | |
| Unit | % | ppm | | | | | | | | | | |

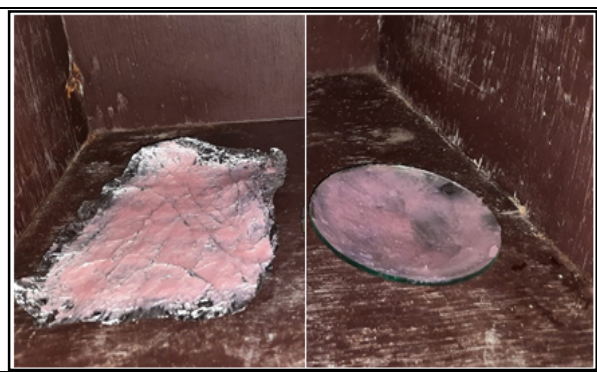


Figure 1: Biofilm before drying



Figure 2: Biofilm after drying

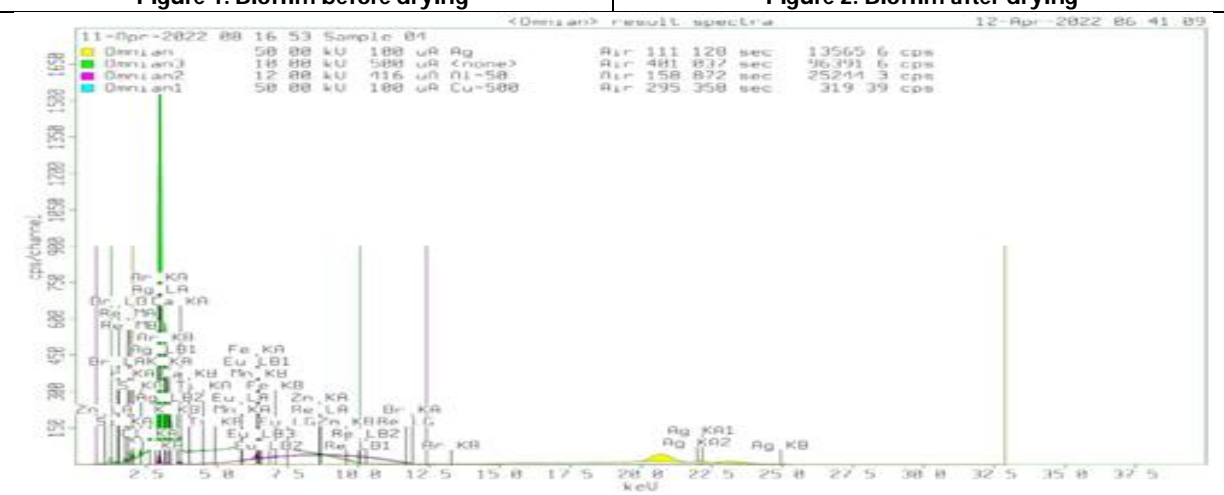


Figure 3- Graph obtained from XRF analysis of biofilm





Hair loss and Treatments-Updates and Perspectives

Swagatika Das^{1*}, Amulyaratna Behera¹, Ladi Alik Kumar¹, Dibyalochan Mohanty² and Prashanth PA³

¹Centurion University of Technology and Management, Odisha, India

²Department of Pharmaceutics, Anurag University, Hyderabad, Karnataka, India

³P.E.S College of Engineering, Mandya, Karnataka-571401, India

Received: 06 Mar 2022

Revised: 10 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Swagatika Das

Centurion University of Technology and Management,
Odisha, India.

Email: swagatikadas.med@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

However, hair loss does not a serious or life-threatening state, becoming bald can be stressful and uncomfortable from medications to vitamins to special tonics and shampoos for teating hair loss. Both drug therapy for those who do so early or repeatedly. Millions of dollars are spent annually on products ranging and hair transplantation are common hair retreating methods. The only two medications approved by the FDA for hair growth in males are minoxidil and finasteride. Minoxidil is the only therapeutic choice for women with androgenetic alopecia. These drugs have been demonstrated to be useful in the treatment of baldness in the vertex region of the scalp.

Keywords: Hair follicle, minoxidil, finasteride, hair growth, alopecia.

INTRODUCTION

On average, a healthy man or women's scalp has 80000 to 120000 essential terminal hairs. Keratin is a protein that is formed in the hair follicles and is used to make hair. Hair follicles go through a series of development and rest cycles. The growth rate of hair is roughly 0.3 mm per day during growth phase, which lasts 2-6 years [1]. The maximum length of hair that can be achieved is determined by the length of anagen phase. After a brief intermediary phase, the hair enters a rest phase that lasts 2 to 4 months before falling out [2]. The approximately 100000 hairs on a person's head develop autonomously in normal circumstances. Hair growth is cyclic, comprising anagen (enlargement), catagen (involution), and rest periods (telogen). Complex communications between the epithelium and the dermis regulate active growth and rest cycle, which are still poorly implicit [3,4]. In a healthy scalp, the majority of follicles are developing(92% to 96%), a small amount of involution(less than 1%),in addition to the rest is resting(5.5 to 10.5%). Hair is liberated and shed after telogen, and the next cycle begins. Day to day, till 100 telogen hairs fall out of the head, while nearly the equal number of follicles go through anagen [5]. The length of hair is determined by the length of anagen, while the diameter is firm by the volume of the hair bulb. We are born with 10000 terminal hair



**Swagatika Das et al.,**

follicles on our scalp that are programmed to produce healthy, thick and long hair. Vellus hair, which is small, fine and light coloured and covers a large portion of our bodies produced by other follicles. Systemic and local variables that affect the length of anagen and the size of the hair matrix can cause an early transition from anagen to telogen in hair follicles, culminating in visible hair loss 2-4 months later [6,7]. Hormones, growth factors, medications and the seasons are just a few of the elements that play a role. Hair loss can relate to one of 2 things: an increase in the rate of hair falling out daily or alopecia. Nearly 100 hairs usually fall out every day.^[8] Inquiring about the medications that patients are taking is crucial. While almost all package inserts identify "hair loss" as a possible adverse effect, only some medications are genuinely pertinent. Women should be questioned regarding gynaecological issues such as the start or stop of hormonal contraception [9]. Loss of hair is often associated with hair follicles transitioning from anagen to telogen. Transient postpartum effluvium is common: the stress of birth, as well as subsequent hormonal shifts, cause hair loss 2 to 4 months afterward. Chemotherapeutic medications, for example can cause hair loss 2 to 4 months afterward. Chemotherapeutic medications, for example, can cause harsh follicular damage, resulting in hairs falling out of their follicles in 1 to 3 weeks. Patients can be advised that this technique synchronizes the development phases of the follicles, resulting in hair that is frequently thicker than before once it has grown back, but it could have happened that straight regrows as curly and curly hairs regrow as straight hair [10,11].

Causes of hair loss

Hair goes through 3 stages of growth anagen, catagen and telogen. Anagen is the longest phase, which varies by species and body place [12]. That scalp anagen hair can live up to 3 years, whereas finger anagen hair only lasts 3 months. Thyroid-stimulating hormones, as well as pregnancy hormones such as androgens, affect human hair growth. Pregnancy hormones keep hair follicles in anagen, then return them to catagen and telogen after delivery, resulting in hair shedding. Androgen, which affects hair development, is influenced by genetics, and male pattern baldness and robust beard growth are related in families [13,14]. Even though several disorders that cause hair loss have been widely presented and discussed concerning pattern alopecia, as well as hypotheses on skull expansion relating to alopecia and clinical evaluation, AGA is the major focus of this article in terms of clinical significance. Androgen controls the transformation of vellus hair into thicker, terminal hairs, longer and darker in color. On the scalp, however, this hormone has a different effect, causing hair follicles to shrink, changing terminal hairs into vellus hairs. The severity of androgenetic alopecia, often known as male pattern baldness, is closely related to age [15,16].

Classification of hair loss in men

To construct the initial MPH classification, Hamilton studied over 700 people of diverse sexes, races and ages. As a result, all types of the scalp were investigated and an appropriate classification from untouched to severely impacted could be determined. The Hamilton categorization divides the scalp into two categories: "not bald" and "bald". Types I-III are classified as "not bald", but types IV-VIII are classified as "bald" [17,18].

Type I

There are bilateral recessions at the hairline's margin in the frontoparietal region.

Type II

The triangular zones of the recession on the frontoparietal area are included in this Hamilton classification, but only up to 3-4 cm anterior to line drawn in a coronal plane connecting the external auditory meatus (middle of the coronal line). The hair on the mid-frontal border of the scalp may be affected, but not as much as on the frontoparietal region.

Type III

Because of scars, asymmetry, odd types of sparseness and thinning of the hair and other variables, this type reflects borderline situations and hair loss which was difficult to diagnose.



**Swagatika Das et al.,****Type IV**

The least quantity of hair loss measured enough to demonstrate baldness. Deep triangular front temporal recessions extend posteriorly beyond the 3 cm anterior to the mid coronal line point. Furthermore, most patients, similar to type II, will experience hair loss in the mid-frontal area of the scalp. Type IVA hair loss is defined as broad band of hair loss that runs along the entire front edge of the hair line. Additional hair loss on the head can also occur in older people. Kind IV old is the name given to this type.

Type V

When compared to type IV, this kind has more frontoparietal recessions and hair loss on the crown area.

Type VI

When compared to type IV, this kind has more frontoparietal area of type VI appears as a horseshoe shape with a small island of hair on the mid- frontal area. The crown does not suffer from frontoparietal recession, but frontal hair loss is similar to type V. The hair on the mid-frontal island of variation type VIA is thin or nonexistent.

Type VII and VIII

Both of these types of hair loss, according to Hamilton, are the most severe. These varieties have a horseshoe-shaped downturn on the frontoparietal region, but the hair loss on the crown area is not separated. The presence of a hair bunch of at least a hundred coarse terminal hairs in the horseshoe-shaped scalp area distinguishes type VII from type VIII. In comparison to the previous varieties, there is also a wider bare region on the scalp [19,20,21].

Classification of hair loss in female**Grade 1**

From the mid-scalp region to the whorl, the surface reflected light band is visible very clearly. In a U shape, it runs parallel with the parting and does not deviate from it.

Grade 2

From the parietal area to the spiral, the surface reflected light band is visible very clearly, running parallel to the parting and curved in a U shape; nevertheless, it deviates by one or more but two widths.

Grade 3

From the mid-scalp area to the spiral, the surface reflected light band is visible, however, it is displaced to one side or to the centre with a deviation of two more widths of the surface reflected light band.

Grade 4

As the surface reflected light band moves from the parietal area to whorl, it attenuates and breaks more than one width of the light.

Grade 5

Surface reflected light is hazy all around the parietal area and whorl. Light now appears as a striped column.^[22,23,24]

Treatment in men

Androgenetic alopecia affects men in a variety of ways, from bitemporal hair loss to losing ground of the frontal and vertex area of the scalp to full baldness except the occipital and temporal fringes [25]. Several factors confirm the diagnosis, including hair loss with a pattern, the occurrence of tiny hairs, and a young age of onset. The purpose of treatment is to enhance scalp coverage and prevent additional hair loss.^[26] The only medications licensed for encouraging hair growth in males with androgenetic alopecia in the united states are orally administered 1 gm of finasteride every day and solutions of 2% and 5% minoxidil for topical application [27,28]. Both medicines can boost scalp coverage by expanding existing hairs and can also prevent future thinning in the vertex and frontal areas. If the thinning is minor, the major effect may be a delay in additional thinning. In general, 6 to 12 months, and density of hair will return to where it was before treatment [29,30].



**Swagatika Das et al.,****Finasteride**

It inhibits the conversion of testosterone to dihydrotestosterone by acting as a competitive inhibitor of type 2 5 α -reductase. Serum prostate –specific antigen levels reduced by 0.2 ng per millilitre in men 18 to 41 years old who took 1mg of finasteride daily, which was not a clinically significant reduction. Finasteride, at doses of 1mg or 5mg daily, reduces blood prostate-specific antigen levels by around 50% in older men with benign prostatic hyperplasia. To account for the drug's effect, the findings of a prostate-specific antigen test should be twice in older men using finasteride [31,32].

Minoxidil

When hair is impacted by numerous disorders, such as androgenetic alopecia, minoxidil increases hair growth. Despite the underlying reason, it lengthens anagen and enlarges undersized and sub optimal follicles. Minoxidil, for example, improves hair development in people with congenital hypotrichosis, alopecia areata and loose anagen syndrome, in addition to its efficiency in patients with androgenetic alopecia. Minoxidil was created to treat hypertension, and this is the most well- understood part of the drug's activity. It is a vasodilator and potassium channel opener. Its mechanism of action is stimulating hair growth is unknown, however, it does not appear to be dependent on vasodilation [33,34].

Treatment in women

Hair styling can hide androgenetic alopecia, which affects both men and women. Women's hair thinning is frequent, although it's most evident in the frontal and parietal areas of the scalp . The progression is milder in women as comparison to males due to differences in the quantities of 5 α -reductase and p-450 aromatase, as well as the number of androgen receptors in the hair follicles of the scalp. Even when the scalp is exposed, women usually leave an edge of hair along the frontal hair line [35,36].

Minoxidil

The only medicine that can help women with androgenetic alopecia to grow their hair is topical minoxidil solution. The FDA approved the 2% minoxidil solution for this use in 1991 after two week double-blind, placebo-controlled studies of 550 women aged 18 to 45 years old found it to be effective [37,38].

How to use it

Make sure your hair and scalp are completely dry. Apply the over-the –counter solution twice daily to every region where your hair is thinning, using the dropper or spray pump that comes with it. Massage it gently into your scalp with your fingers to allow it to reach the hair follicles. Then air dry your hair, don't shampoo for at least 4hours afterwards [39].

Anti-androgens

Androgens, which include testosterone and other male hormones, can hasten female hair loss. Some women who do not respond to minoxidil may benefit from adding the anti-androgen medicine spironolactone to their treatment for androgenetic alopecia. This is especially true for women with polycystic ovarian syndrome, which produces increased androgen production [40,41].

Physical therapy**Micro-needling**

It is a technique that involves puncturing the stratum corneum with very thin needles. When combined with other drugs like minoxidil and PRP, it has been shown to increase growth of hair. The needles micro-injuries promote skin permeability, which improves the release of hair growth chemicals to specific locations.^[42] In a 12-week randomized, evaluator-blinded study including one hundred male patients with AGA, micro-needling combined with topical minoxidil 5% for 2 times daily was compared to straight topical minoxidil therapy. The micro-needling group had a greater hair count(per cm² contains 91.4 hair) than the control group(per cm² contains 22.2 hairs) [43,44].



**Swagatika Das et al.,****Growth factors**

How to use it: Make sure your hair and scalp are completely dry . Apply the over-the –counter solution twice daily to every region where your hair is thinning, using the dropper or spray pump that comes with it [45]. Massage it gently into your scalp with your fingers to allow it to reach the hair follicles. Then, instead of shampooing, let your hair air dry [46]. Certain cells release growth factors, which drive cell multiplication. Platelet Rich Plasma is a related concentrate of human platelets with in a tiny amount of plasma prepared by centrifugation of the patient’s venous blood and injected into the areas of hair loss. Platelets secrete platelet-derived growth factors, TGF-1 and VEGF, basic fibroblastic growth factors, endothelial growth factors and insulin related growth factors, all of which are found in PRP. These cytokines are concerned with cell proliferation [47,48].

Treatment by laser therapy

Low-level laser treatment (LLLT) produces monochromatic, collimated light that is monochromatic and coherent. Tis coherence concentrates the energy and narrows the beam, allowing it to enter into the scalp and the hair follicles. Although the specific mechanism of action is uncertain, evidence shows that LLLT operates on mitochondria, increasing reactive oxygen species, adenosine triphosphate generation, and transcription factor induction leads to gene activation and the constructions of cell-required proteins [49,50]. The FDA authorized LLLT mediated by a laser comb as a safe treatment for AGA in 2007. LEDs emit light in a variety of wavelengths , by an incoherent and uncollimated beam. They have a far lower power out put than other lasers. As a result of these circumstances, it does not penetrate as far into the scalp. A meta-analysis of the effects of photobiomodulation on AGA indicated that it is an effective therapeutic modality. LLLT was found to be substantially more successful than a laser/LED treatment combination [51,52,53].

CONCLUSION

Over 14% of ladies over the age of 50 experience significant hair loss. Knowledge of probable underlying causes, physical comorbidities, differential diagnosis, and numerous therapy modalities available is required for effective care of this illness. It also necessitates an understanding of the psychological effects of hair loss on those who are affected as well as empathy during patient consultations. Without therapy, the illness will worsen. The current pharmaceutical therapy can stop the disease from progressing further and even encourage partial growth. The response is sluggish, regardless of whether the drug is used and both the patient and therapist must be patient and persistent. Cosmetic implications of this ailment should not be overlooked, thus in addition to medication, cosmetic aids and surgical alternatives should be considered with these patients .

REFERENCES

1. Abell E. Embryology and anatomy of the hair follicle. In: Olsen EA, ed. Disorders of hair growth: diagnosis and treatment. New York: McGraw-Hill. 1994:1-19.
2. Hamilton JB. Male hormone stimulation is prerequisite and an incitant in common baldness. Am J Anat. 1942;71:451-80.
3. Frieden IJ, Price VH. Androgenetic alopecia. In: Thiers BH, Dobson RL, eds. Pathogenesis of skin disease. New York: Churchill Livingstone. 1986:41-55.
4. Hamilton JB. Patterned loss of hair in man: types and incidence. Ann N Y Acad Sci. 1951;53:708-28.
5. Randall VA, Thornton MJ, Hamada K, et al. Androgens and the hair follicle: cultured human dermal papilla cells as a model system. Ann N Y Acad Sci. 1991;642:355-75.
6. Kaufman K. Androgen metabolism as it affects hair growth in androgenetic alopecia. Dermatol Clin. 1996;14:697-711.
7. Whiting DA. Diagnostic and predictive value of horizontal sections of scalp biopsy specimens in male pattern androgenetic alopecia. J Am Acad Dermatol. 1993;28:755-63.



**Swagatika Das et al.,**

8. Gormley GJ, Stoner E, Bruskewitz RC, et al. The effect of finasteride in men with benign prostatic hyperplasia. *N Engl J Med.* 1992;327:1185-91.
9. Rushton DH, Norris MJ, Dover R, Busuttill N. Causes of hair loss and the developments in hair rejuvenation. *Int J Cosmet Sci.* 2002;24(1):17-23.
10. Alessandrini A, Bruni F, Piraccini BM, Starace M. Common causes of hair loss - clinical manifestations, trichoscopy and therapy. *J Eur Acad Dermatol Venereol.* 2021;35(3):629-640.
11. Phillips TG, Slomiany WP, Allison R. Hair Loss: Common Causes and Treatment. *Am Fam Physician.* 2017;96(6):371-378.
12. Malkud S. A Hospital-based Study to Determine Causes of Diffuse Hair Loss in Women. *J Clin Diagn Res.* 2015;9(8):01-04.
13. Price VH. Treatment of hair loss. *N Engl J Med.* 1999;341(13):964-73.
14. Cotsarelis G, Millar SE. Towards a molecular understanding of hair loss and its treatment. *Trends Mol Med.* 2001;7(7):293-301.
15. Shapiro J. Clinical practice. Hair loss in women. *N Engl J Med.* 2007;357(16):1620-30.
16. Mounsey AL, Reed SW. Diagnosing and treating hair loss. *Am Fam Physician.* 2009;80(4):356-62.
17. Ross EK, Shapiro J. Management of hair loss. *Dermatol Clin.* 2005;23(2):227-43.
18. Phillips TG, Slomiany WP, Allison R. Hair Loss: Common Causes and Treatment. *Am Fam Physician.* 2017;96(6):371-378.
19. Gentile P, Cole JP, Cole MA, Garcovich S, Bielli A, Scioli MG, Orlandi A, Insalaco C, Cervelli V. Evaluation of Not-Activated and Activated PRP in Hair Loss Treatment: Role of Growth Factor and Cytokine Concentrations Obtained by Different Collection Systems. *Int J Mol Sci.* 2017;18(2):408.
20. Santos AC, Pereira-Silva M, Guerra C, Costa D, Peixoto D, Pereira I, Pita I, Ribeiro AJ, Veiga F. Topical Minoxidil-Loaded Nanotechnology Strategies for Alopecia. *Cosmetics.* 2020; 7(2):21.
21. York K, Meah N, Bhojru B, Sinclair R. A review of the treatment of male pattern hair loss. *Expert Opin Pharmacother.* 2020;21(5):603-612.
22. Fabbrocini G, Cantelli M, Masarà A, Annunziata MC, Marasca C, Cacciapuoti S. Female pattern hair loss: A clinical, pathophysiological, and therapeutic review. *Int J Womens Dermatol.* 2018;4(4):203-211.
23. Ayatollahi A, Hosseini H, Gholami J, Mirminachi B, Firooz F, Firooz A. Platelet rich plasma for treatment of non-scarring hair loss: systematic review of literature. *J Dermatolog Treat.* 2017;28(7):574-581.
24. Randolph M, Tosti A. Oral minoxidil treatment for hair loss: A review of efficacy and safety. *J Am Acad Dermatol.* 2021;84(3):737-746.
25. Ramos PM, Miot HA. Female Pattern Hair Loss: a clinical and pathophysiological review. *An Bras Dermatol.* 2015;90(4):529-543.
26. Van Zuuren EJ, Fedorowicz Z, Carter B. Evidence-based treatments for female pattern hair loss: a summary of a Cochrane systematic review. *Br J Dermatol.* 2012;167(5):995-1010.
27. Gupta M, Mysore V. Classifications of Patterned Hair Loss: A Review. *J Cutan Aesthet Surg.* 2016;9(1):3-12.
28. Iorizzo M, Vincenzi C, Voudouris S, Piraccini BM, Tosti A. Finasteride treatment of female pattern hair loss. *Arch Dermatol.* 2006;142(3):298-302.
29. Kaufman KD, Olsen EA, Whiting D, Savin R, DeVillez R, Bergfeld W, Price VH, Van Neste D, Roberts JL, Hordinsky M, Shapiro J, Binkowitz B, Gormley GJ. Finasteride in the treatment of men with androgenetic alopecia. Finasteride Male Pattern Hair Loss Study Group. *J Am Acad Dermatol.* 1998;39:578-89.
30. Stout SM, Stumpf JL. Finasteride treatment of hair loss in women. *Ann Pharmacother.* 2010;44(6):1090-7.
31. Sinclair R, Wewerinke M, Jolley D. Treatment of female pattern hair loss with oral antiandrogens. *Br J Dermatol.* 2005;152(3):466-73.
32. Avci, P., Gupta, G. K., Clark, J., Wikonkal, N., & Hamblin, M. R. Low-level laser (light) therapy (LLLT) for treatment of hair loss. *Lasers in surgery and medicine,* 2014;46(2),144–151.
33. Fabbrocini G, Cantelli M, Masarà A, Annunziata MC, Marasca C, Cacciapuoti S. Female pattern hair loss: A clinical, pathophysiological, and therapeutic review. *Int J Womens Dermatol.* 2018;4(4):203-211.



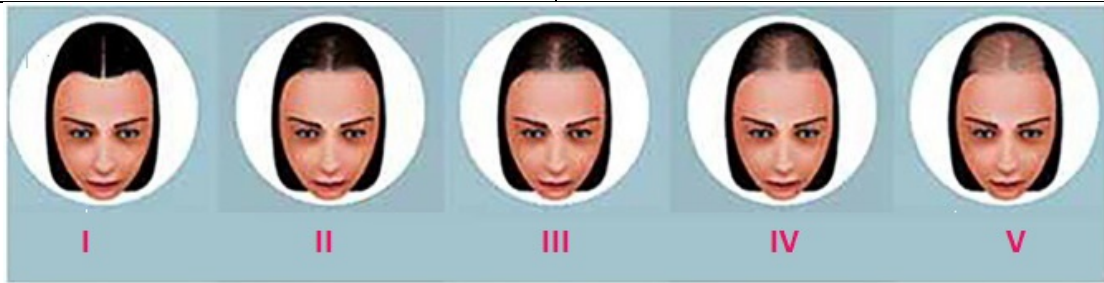
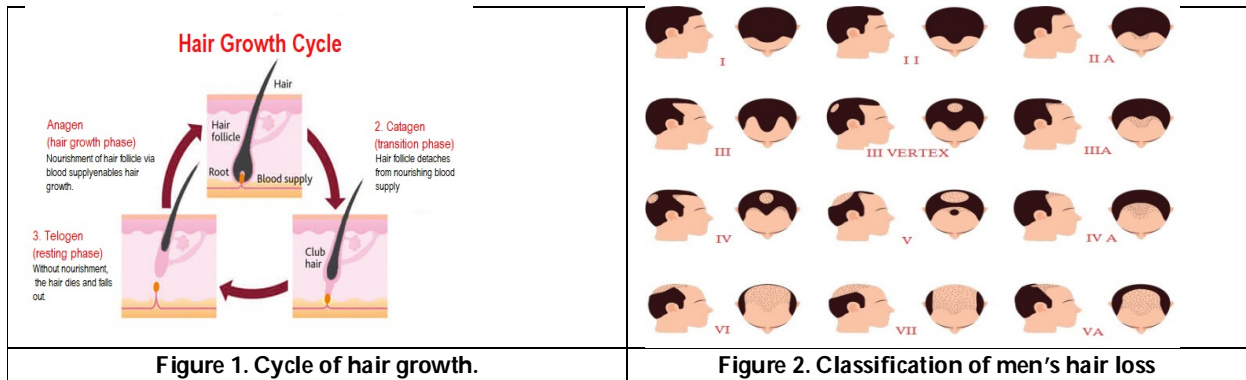
**Swagatika Das et al.,**

34. Fertig RM, Gamret AC, Cervantes J, Tosti A. Microneedling for the treatment of hair loss? *J Eur Acad Dermatol Venereol.* 2018;32(4):564-569.
35. Bertoli MJ, Sadoughifar R, Schwartz RA, Lotti TM, Janniger CK. Female pattern hair loss: A comprehensive review. *Dermatol Ther.* 2020;33(6):14055-66.
36. Suchonwanit, P., Thammarucha, S., & Leerunyakul, K. Minoxidil and its use in hair disorders: a review. *Drug design, development and therapy,* 2019;13, 2777–2786.
37. Messenger AG, Rundegren J. Minoxidil: mechanisms of action on hair growth. *Br J Dermatol.* 2004;150(2):186-94.
38. Zhuang XS, Zheng YY, Xu JJ, Fan WX. Quality of life in women with female pattern hair loss and the impact of topical minoxidil treatment on quality of life in these patients. *Exp Ther Med.* 2013;6(2):542-546.
39. Springer K, Brown M, Stulberg DL. Common hair loss disorders. *Am Fam Physician.* 2003;68(1):93-102.
40. Batchelor D. Hair and cancer chemotherapy: consequences and nursing care--a literature study. *Eur J Cancer Care (Engl).* 2001;10(3):147-63.
41. Cash TF. The psychosocial consequences of androgenetic alopecia: a review of the research literature. *Br J Dermatol.* 1999;141(3):398-405.
42. Paus R, Cotsarelis G. The biology of hair follicles. *N Engl J Med.* 1999;341(7):491-7.
43. Ross EK, Vincenzi C, Tosti A. Videodermoscopy in the evaluation of hair and scalp disorders. *J Am Acad Dermatol.* 2006;55(5):799-806.
44. Blume-Peytavi U, Blumeyer A, Tosti A, Finner A, Marmol V, Trakatelli M, Reygagne P, Messenger A; European Consensus Group. S1 guideline for diagnostic evaluation in androgenetic alopecia in men, women and adolescents. *Br J Dermatol.* 2011;164(1):5-15.
45. Blumeyer A, Tosti A, Messenger A, Reygagne P, Del Marmol V, Spuls PI, Trakatelli M, Finner A, Kiesewetter F, Trüeb R, Rzany B, Blume-Peytavi U; European Dermatology Forum (EDF). Evidence-based (S3) guideline for the treatment of androgenetic alopecia in women and in men. *J Dtsch Dermatol Ges.* 2011;6:S1-57.
46. Rhodes T, Girman CJ, Savin RC, Kaufman KD, Guo S, Lilly FR, Siervogel RM, Chumlea WC. Prevalence of male pattern hair loss in 18-49 year old men. *Dermatol Surg.* 1998;24(12):1330-2.
47. Severi G, Sinclair R, Hopper J, et al. Androgenetic alopecia in men aged 40–69 years: prevalence and risk factors. *Br J Dermatol.* 2003;149:1207–1213.
48. Lee WS, Lee HJ. Characteristics of androgenetic alopecia in asian. *Ann Dermatol.* 2012 Aug;24(3):243-52.
49. Kaufman KD, Olsen EA, Whiting D, Savin R, DeVillez R, Bergfeld W, Price VH, Van Neste D, Roberts JL, Hordinsky M, Shapiro J, Binkowitz B, Gormley GJ. Finasteride in the treatment of men with androgenetic alopecia. Finasteride Male Pattern Hair Loss Study Group. *J Am Acad Dermatol.* 1998;39:578-89.
50. Leyden J, Dunlap F, Miller B, Winters P, Lebwohl M, Hecker D, Kraus S, Baldwin H, Shalita A, Draelos Z, Markou M. Finasteride in the treatment of men with frontal male pattern hair loss. *Journal of the American Academy of Dermatology.* 1999;40(6):930-7.
51. Olsen EA, Messenger AG, Shapiro J, Bergfeld WF, Hordinsky MK, Roberts JL, Stough D, Washenik K, Whiting DA. Evaluation and treatment of male and female pattern hair loss. *Journal of the American Academy of Dermatology.* 2001;52(2):301-11.
52. Dinh QQ, Sinclair R. Female pattern hair loss: current treatment concepts. *Clinical interventions in aging.* 2007;2(2):189-192.
53. Fabbrocini G, Cantelli M, Masarà A, Annunziata MC, Marasca C, Cacciapuoti S. Female pattern hair loss: A clinical, pathophysiologic, and therapeutic review. *Int J Womens Dermatol.* 2018;4(4):203-211.





Swatika Das et al.,





Comparative Assessment of Elemental Contents Present in Biodegradable Biofilm Fabricated with Natural and Synthetic Dye as Food Colour

Ankit Kumar Barik, Swarup Kumar Sahu and Ashish Kumar Sahoo*

Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ashish Kumar Sahoo

Centurion University of Technology and Management,
Odisha, India.

Email: ashish.sahoo@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

In last few years there is a urgent need for sustainability has led us to fabricate the alternative pathways for non- renewable resources from depleting and thus protecting our ecosystem. One such step is to find an alternative of plastic that is used as packaging material. In this regard available packaging materials that are used also has disadvantages such as in case of metal, there is a chance of corrosion or reactivity which would affect the quality of the product especially in case of food items. The aim of the present study is to focus on an alternative pathway that would help avoid such problems. A smart step would be choosing starch-based packaging material as an alternative for fossil fuel-based products. The motivation behind this alternative lies in the principles of green chemistry. Corn starch can be efficiently selected for preparation of biofilm that can be used as packaging material. The raw materials used were corn starch, distilled water, vinegar, glycerine. The prepared film is biodegradable and plant based. Thus, it is non-toxic and cost effective too. The preparation time took much less time as compared to preparation of other packaging materials. The elemental analysis was also done using XRF spectrometer. By the help of XRF data we were able to find that the elements present in this biofilm are non-hazardous and thus, can be used to wrap food items also. Thus the present work falls in the category of Sustainable Development Goals numbers SDG-9 (Industry, Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).

Keywords: Biofilm, Corn starch, packaging material, synthetic dye coloring agent

INTRODUCTION

Biodegradable polymers are getting immense attention for its inherent potential to combat environmental issues which results from building up of artificial non-degradable containers [1]. Due to this lots of attempt has been made



**Ankit Kumar Bariket *al.*,**

to substitute the plastic films with biodegradable plastic films, so as to clear up the plastic film residue pollution. Biodegradable films are plastic based films having components which are commonly enzymes that allows to interrupt the plastic down [2]. This process may be carried out by living organisms like microorganisms, fungi or with or without oxygen with no environmental impact. These films may be organized the use of proteins, polysaccharides, or lipid substances [3].

Among those revolutionary techniques is the incorporation of antimicrobial or antioxidants agents in films, which may be used as packaging. These compounds are included into or coated onto food packaging substances to enhance food protection and shelf life. When the biodegradable film breaks down, it will become smaller portions of plastic. That is why it calls for unique situations to interrupt down, along with sunlight or certain temperatures to absolutely biodegrade [4-6]. Polyethylene will evidently fragment and is biodegradable. But it required many years for this, and may impose environmental problems. For remedy of such problems, the applied strategies are to adjust the carbon chain of polyethylene to enhance its degradability and hence biodegradability. However starch is primarily based on biodegradable films and can be crafted from corn, potatoes or wheat. The shape of the biodegradable films is made as per American Standard for Testing Materials (ASTM) and European norm EN13432. It degrades at least up to 90% inside a hundred and eighty days [7-9]. Examples of polymers with which starch is normally used are Polycaprolactone (PCL), Polyvinyl alcohol (PVA), Polylactic acid (PLA). The heat, moisture and aeration in an industrial composting offer the desired situations for this kind of film to biodegrade.

Advantages of starch-primarily based totally film are residual material is biodegradable and compostable, decreased fossil gas content (relying on loading of filler), quicker degradation of litter, no net growth of carbon dioxide within the global ecosystem. Some drawbacks of corn-based films are supply of starch may be problematic (opposition towards food use, rainforests being cleared to develop plants for bioplastics), poorer mechanical strength than additive based – filling a starch bag with wet leaves and putting it curbside can bring about the lowest falling out while a haulier choice it up, degradation in a sealed landfill takes at the least six months. They have a confined Shelf life. Some starch-primarily based totally film needs to be composted in industrial facilities due to the fact the temperature of the compost needs to be at 58°C. If combined with different plastics for recycling, the value of recycling is reduced [10]. To reduce those drawbacks, we brought plasticizers. Plasticizers are components that re brought to the material to alternate its properties. This might assist the material to growth its brittleness and hydrophilicity. The plasticizers used right here is glycerol. Glycerol is benign and isn't hazardous. The starch used right here is corn starch which includes 26%-30% of amylose and 70%-74% of amylopectin. The White vinegar used right here includes 5% acetic acid and 95% water. This becomes used to interrupt the amylopectin polymer chain. This is achieved to shape an awesome plastic with none hindrance.

The corn plastic is a substitute of plastic is made up of fermented plant starch [11], which is alternative to the most used plastic materials and its derivative is petroleum. This is made usually from polylactide acid [12-14]. The corn starch polymer is renewable source and biodegradable source. There has been demand for green products and many industries are growing because of it. The traditional plastics are banned in many areas of world and therefore polylactide acid is used as a good replacement. The corn polymers are useful for production of bioplastics which are highly biodegradable and at the same time are ecofriendly. This has become a popular alternative to traditional plastic because of its environmental friendly nature [15]. Synthetic food colour is manufactured by chemical reaction and is commonly used in food and pharmaceutical industries. Some of the common food colours are tartrazine, sunset yellow, amaranth, allura red, quinoline yellow, brilliant blue and indigo carmine. Natural food colour is any dye, pigment or any other substance obtained from vegetable, animal, mineral that is capable of colouring foods or drugs. Grass, beet root, and turmeric are some of the natural sources from which colours are extracted [16]. Here food colour was used to make the film attractive in appearance. Thus, the present work falls in the category of Sustainable Development Goals numbers SDG-9 (Industry, Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).



**Ankit Kumar Bariket *al.*,**

MATERIALS

The materials used for the preparation of bio-degradable films are corn starch, vinegar, glycerol and food colour were purchased from local market. Distilled water was provided by chemistry lab.

Preparation of film

50 mL distilled water was mixed with 10g corn starch to make the corn starch-based film solution. As a plasticizer, 5ml glycerol was added next. 5 mL white vinegar was then added to the solution. White vinegar is made up of 5 percent acetic acid and 95% water. It was utilised to split the polymer branches of amylopectin. The existence of heavy polymer branches obstructs the creation of excellent plastic; hence branch breaking is critical. The film was then given a component colour by adding a few drops (approximately 3-4) of food colour. Two sample were made i.e using natural colour, and synthetic food colour. The film solution was heated to 75°C and constantly stirred with a magnetic stirrer to achieve starch gelatinization. A viscous solution was generated as a result of constant stirring. This solution was then spread to an aluminum foil and allowed to dry for 3-4 days. A consistent film was obtained.

Tensile Test

The strength test was measured by tensile tester mechnie in which the prepared sample was maintained as per the dimension specified. A width of and length 30 and 110 mm was made as standard, with thickness of about 0.36 mm. Specimens were cut in dumbbell shape from the film and the stretching and tensile strengths were recorded in mega pascals [11].

Test for Moisture Content

The moisture content was measured in terms of weight loss of the films. For this the sample was cut into square pieces of size 2 cm². The weight was taken accurately. Then it was allowed to dry over oven at 110 °C until a dry weight was achieved [18].

The moisture content was determined using the following equation

$$\text{Moisture Content in (\%)} = [(W_i - W_f)/W_i] \times 100$$

where W_i is the weight at the beginning and W_f is the final weight.

Biodegradability Test

Specimen of the sample was cut into size of 4.0 cm². About 500 g of slightly moist soil with rich in nitrogenous bacteria was collected and kept in a container. The sample was buried in side 3 cm of the soil dept another 4 cm. The weight of the sample was measured after 15 days. Thus the biodegradability was measured using the equation

$$\text{Weight Loss (\%)} = [(W_o - W)/W_o] \times 100$$

where W_o and W are the weights of samples before and after the test

RESULT AND DISCUSSION

Tensile Properties

The tensile strength, Yong's modulus and elongation at break are shown in Table 1. From this it can easily be inferred that the mechanical resistance against rupture was improved by introduction of starch [19]. The improved mechanical properties are because of crosslinking [20].

Bioplastic Thickness

The thickness of the samples were measured at 10 places with thickness gauge, from which the average was determined. The average thickness was found to be about 0.3 mm. The results indicate that the thickness is maintained as per the government standards [21, 22]





Ankit Kumar Bariket *et al.*

Moisture Content

The moisture content for the various samples are calculated, and the results are shown in Table 2. It is shown that sample using natural colour shows the water absorption is the least. The least water absorption; however, sample using synthetic food colour shows greater content of moisture. The film solubility was enhanced because of the presence of hydrophilic compounds. On the other hand hydrophobic compound would decrease solubility [23]. Thus the solubility of the prepared films shows the similar tendency as per our expectation. They hydrophilic property decreases upon the presence of corn starch. Therefore, the moisture content of the sample prepared using natural colouring agent has the lowest value, thus enhancing the shelf life.

Biodegradability

This test was done from the most pronounced result of the tensile strength, water retention and thickness. Sample prepared using the naturel colour is tensted for biodegradability. The weight loss indicates it. Both the buried samples show same biodecomposibility.

Wo = 0.474 grams and W = 0.243 grams

whereWo and W are the weight of samples before and after the test.

Elemental analysis

2-Apr-2022 06:39:04 Page

Sample results

| | | | | | | | | | | | | |
|---------------------------------------|--|--|--|--|--|-------------------------------|--|--|--|--|--|--|
| Sample 02 | | | | | | | | | | | | |
| Sample ident | | | | | | | | | | | | |
| Application <Omnian> | | | | | | Normalisation factor 26.083 | | | | | | |
| Sequence 1 of 1 | | | | | | | | | | | | |
| Position Large sample | | | | | | | | | | | | |
| Measurement time 11-Apr-2022 07:23:52 | | | | | | | | | | | | |

| Compound | SiO2 | P2O5 | SO3 | Cl | K2O | CaO | TiO2 | Cr2O3 | MnO | Fe2O3 | ZnO | Br |
|----------|-------|-------|-------|--------|-------|-------|-------|-------|-----|-------|-------|-------|
| Conc | 8.982 | 4.315 | 4.531 | 71.564 | 2.079 | 6.665 | 0.232 | 0.129 | 0.0 | 1.154 | 306.5 | 154.7 |
| Unit | % | % | % | % | % | % | % | % | ppm | % | ppm | ppm |

| Compound | Eu2O3 | CO2 | Re |
|----------|-------|-----|------|
| Conc | 0.299 | 0.0 | 37.2 |
| Unit | % | ppm | ppm |

As per elemental analysis by X-rf method we found those compound in fig. which are non toxic for human body and those are consuming and also 100% biodegradable. Environmental friendly.corn starch products waterproof and oil resistance, corn starch is permanent waterproof and oil proof, corn starch is suitable for long-term storage, such as put some frozen chicken . Mainly the cornstarch film is used for packaging fresh fruits and processing food.

CONCLUSION

The results showed that the sample prepared from the corn-starch using natural food colour have better biodegradability than the sample prepared from the corn-starch using synthetic food colour and then the existing plastic materials.The average thickness of the bioplastics is 0.25 mm (250 microns). The average moisture content is 13.2%.The biodegradability of the sample is 48.7%, and it is achieved in 15 days. The maximum tensile strength of the bioplastics is found to be 12.5 MPa.From the above test results, it can be concluded that film prepared using natural food colour is better than that of using synthetic food colour and can be used for wrapping or packaging purposes.It can be a better substitute to the petroleum based or poly wrappers that we use in our day-to-day life that creates a burden on the environment. However more studies regarding its mechanical properties and toxicity level if any needs to be done to make the experiment successful. Furthermore, the success of the innovation would be a key step towards sustainability. It would provide more areas of research too. Thus the present work falls in the category of Sustainable Development Goals numbers SDG-9 (Industry, Innovation and Infrastructure), SDG-11 (Sustainable Cities and Communities) and SDG-12 (Responsible Consumption and Production).



**Ankit Kumar Bariket al.,****REFERENCES**

1. Ave´rous, L., Fringant, C., Moro, L., 2001. Plasticized starch–cellulose interactions in polysaccharides composites. *Polymer* 42, 6565–6572.
2. Krochta, J.M., Miller, K.S., 1997. Oxygen and aroma barrier properties of edible films: a review. *Trends in Food Science and Technology* 8, 228–237
3. Larotonda, F.D.S., Matsui, K.N., Sobral, P.J.A., Laurindo, J.B., 2005. Hygroscopicity and water vapor permeability of Kraft paper impregnated with starch acetate. *Journal of Food Engineering* 71, 394–402.
4. Mali, S., Sakanaka, L.S., Yamashita, F., Grossmann, M.V.E., 2005. Water sorption and mechanical properties of cassava starch films and their relation to plasticizing effect. *Carbohydrate Polymers* 60, 283–289.
5. Baldwin, E.A., Nisperos-Carriedo, M.O., Baker, R.A., 1995. Use of edible coatings to preserve quality of lightly (and slightly) processed products. *Critical Reviews in Food Science and Nutrition* 35, 509–524.
6. Tapia-Bla´cido, D., Sobral, P.J.A., Menegalli, F.C., 2005. Development and characterization of edible films based on amaranth flour (*Amaranthuscaudatus*). *Journal of Food Engineering* 67, 215–223
7. Rayas, L.M., Herna´ndez, R.J., 1997. Development and characterization of biodegradable/edible wheat protein films. *Journal of Food Science* 62 (1), 160–164
8. Chan, M.Y.; Koay, S.C. Biodegradation and thermal properties of crosslinked chitosan/corn cob biocomposite films by electron beam irradiation. *Polym. Eng. Sci.* 2019, 59, E59–E68.
9. Lammi, S.; Gastaldi, E.; Gaubiac, F. How olive pomace can be valorized as fillers to tune the biodegradation of PHBV based composites. *Polym. Degrad. Stab.* 2019, 166, 325–333.
10. Šerá, J.; Serbruyns, L.; De Wilde, B.; Koutný, M. Accelerated biodegradation testing of slowly degradable polyesters in soil. *Polym. Degrad. Stab.* 2020, 171, 109031.
11. GreenCompostables.com. (2020, 26 november). Biodegradable Films: Types, Applications and Benefits. Geraadpleegd op 24 april 2022, van <https://www.greencompostables.com/blog/biodegradable-films>
12. Waterschoot, J.; Gomand, S.V.; Fierens, E.; Delcour, J.A. Production, structure, physicochemical and functional properties of maize, cassava, wheat, potato and rice starches. *Starch/Staerke* 2015, 67, 14–29.
13. Sanyang, M.L.; Sapuan, S.M.; Jawaid, M.; Ishak, M.R.; Sahari, J. Effect of plasticizer type and concentration on physical properties of biodegradable films based on sugar palm (*Arengapinnata*) starch for food packaging. *J. Food Sci. Technol.* 2016, 53, 326–336. [CrossRef]
14. Zentou, H.; ZainalAbidin, Z.; Yunus, R.; Awang Biak, D.R.; Abdullah Issa, M.; YahayaPudza, M. A new model of alcoholic fermentation under a byproduct inhibitory effect. *ACS Omega* 2021, 6, 4137–4146.
15. Cowley, L. (2021, 7 juli). What is Corn Starch Plastic? Compostable plastic. *Eco World*. Geraadpleegd op 24 april 2022, van <https://ecoworldonline.com/what-is-corn-starch-plastic/>
16. *Food Colours*. (z.d.). Nestlé. Geraadpleegd op 24 april 2022, van <https://www.nestle.in/nhw/nutrition-basics/foods/food-colours>
17. Salarbashi, D.; Tajik, S.; Ghasemlou, M.; Shojaee-Aliabadi, S.; Noghabi, M.S.; Khaksar, R. Characterization of soluble soybean polysaccharide film incorporated essential oil intended for food packaging. *Carbohydr. Polym.* 2013, 98, 1127–1136
18. Kim, H.-Y.; Jane, J.-L.; Lamsal, B. Hydroxypropylation improves film properties of high amylose corn starch. *Ind. Crops Prod.* 2017, 95, 175–183.
19. Larotonda, F.D.; Matsui, K.N.; Soldi, V.; Laurindo, J.B. Biodegradable films made from raw and acetylated cassava starch. *Braz. Arch. Biol. Technol.* 2004, 47, 477–484.
20. Woggum, T.; Sirivongpaisal, P.; Wittaya, T. Properties and characteristics of dual-modified rice starch based biodegradable films. *Int. J. Biol. Macromol.* 2014, 67, 490–502.
21. Ghasemlou, M.; Aliheidari, N.; Fahmi, R.; Shojaee-Aliabadi, S.; Keshavarz, B.; Cran, M.J.; Khaksar, R. Physical, mechanical and barrier properties of corn starch films incorporated with plant essential oils. *Carbohydr. Polym.* 2013, 98, 1117–1126.





Ankit Kumar Bariket *et al.*,

22. Fakhouri, F.M.; Fontes, L.C.B.; Gonçalves, P.V.d.M.; Milanez, C.R.; Steel, C.J.; Collares-Queiroz, F.P. Films and edible coatings based on native starches and gelatin in the conservation and sensory acceptance of Crimson gra. *Food Sci. Technol.* 2007, 27, 369–375.
23. Kavooosi, G.; Dadfar, S.M.M.; Purfard, A.M. Mechanical, physical, antioxidant, and antimicrobial properties of gelatin films incorporated with thymol for potential use as nano wound dressing. *J. Food Sci.* 2013, 78, E244–E250.

Table 1. Tensile properties of different samples.

| Samples | Tensile Strength (MPa) | Young's Modulus (GPa) | Elongation (in %) |
|------------------------------------|------------------------|-----------------------|-------------------|
| Sample using synthetic food colour | 11.35 | 0.17 | 6.19 |
| Sample using natural food colour | 12.5 | 0.183 | 6.8 |

Table 2. Moisture content of thermoplastic starch (TPS).

| Sample | Initial Weight W_i (in gram) | Final Weight W_f (in gram) | Moisture Content in Percentage (%) |
|------------------------------------|--------------------------------|------------------------------|------------------------------------|
| Sample using synthetic food colour | 0.280 | 0.251 | 14.0 |
| Sample using natural food colour | 0.27 | 0.25 | 12.1 |

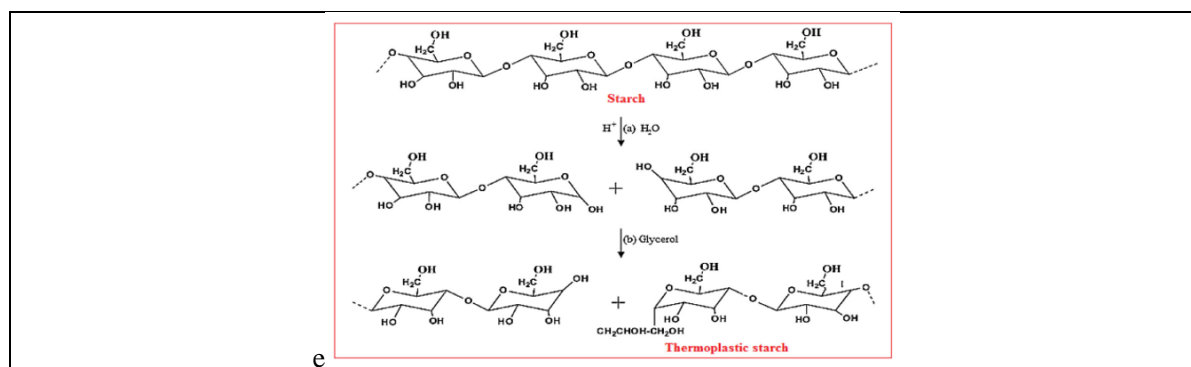


Figure 1. Reaction mechanism for the formation of thermoplastic starch.

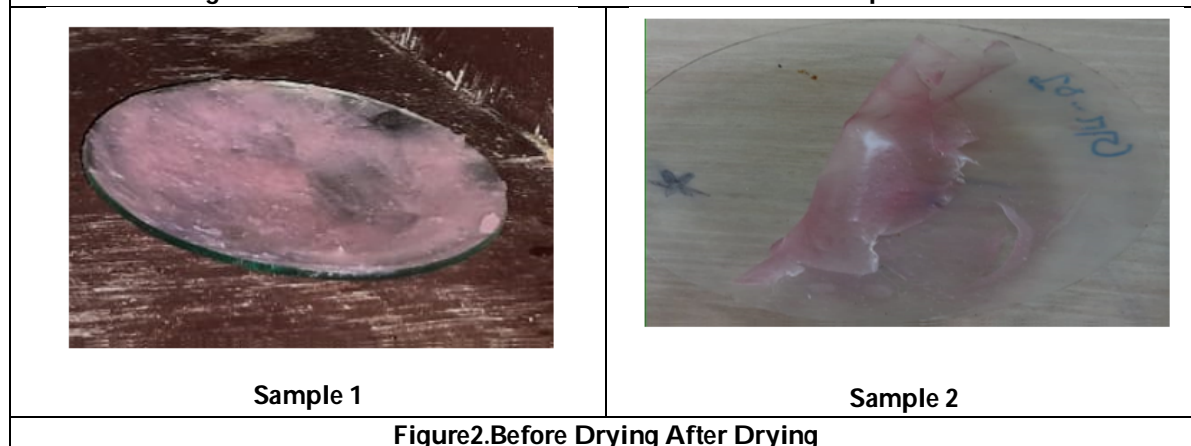


Figure 2. Before Drying After Drying





Ankit Kumar Bariket *et al.*,

| 1. CORN STARCH FILM | Samples before Degradation | 4 days | 8 days | 12 days |
|---------------------------|----------------------------|--------|--------|---------|
| (a) Under Vegetable Waste | | | | |
| (b) Under Soil | | | | |

Figure3. Degradability Test

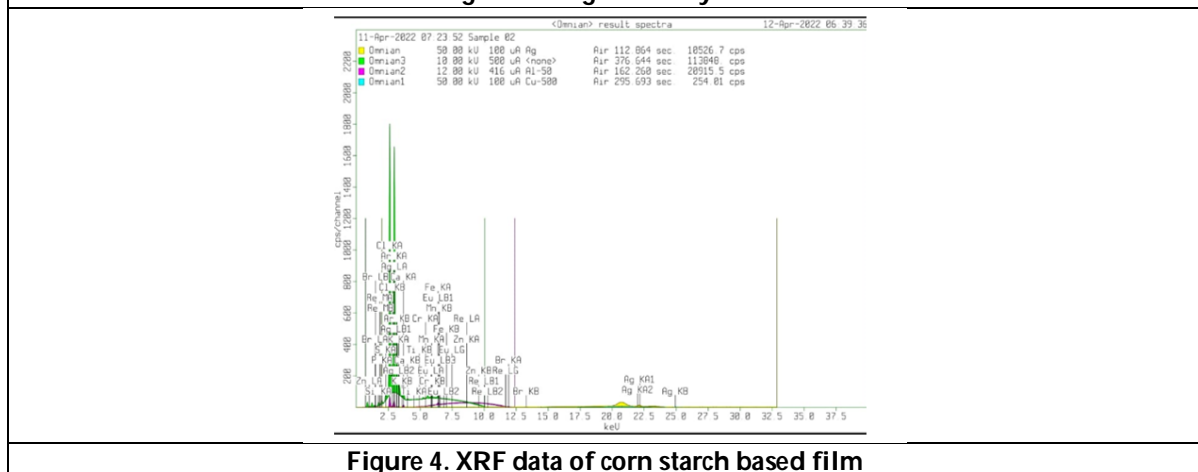


Figure 4. XRF data of corn starch based film





Edible Film for Food Packaging: a Review

Soumya Ranjan Pradhan, Ankita Subhrasmita Gadtya, Srikanta Moharana and Susanta Kumar Biswal*

School of Applied Sciences, Centurion University of Technology and Management, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Susanta Kumar Biswal

School of Applied Sciences,
Centurion University of Technology and Management,
Odisha, India
Email: dr.skbiswal@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

This paper described some of the creation of edible coating materials based on biodegradable ingredients that are utilized in food packaging. Because the use of fissile foils was minimized, the dangerous effect of polysaccharides-based materials was also reduced. The methodology and application of polymer packing materials based on carbohydrates such as plant cellulose and hemi-cellulose, as well as some active packing, were covered in this review.

Keywords: Food packaging, biodegradable material, Cellulose, Edible coating.

INTRODUCTION

Edible coating materials have recently attracted the interest of academic and industry researchers due to a number of benefits, including increased shelf life and reduced microbial contamination. Over artificial film. These coating materials are functionalized with antimicrobials and anti-oxidants and are employed in the field of various food products at the interface of several food layers. [1,8] The edible films combine multilayer packaging materials with non-edible film that comes into contact with the food's internal layer. These film materials, however, have inferior physical qualities than synthetic films. Approximately 30% of all food produced goes to waste each year due to oxidation, moisture changes, and microbial degradation during transportation and storage [6]. Food rotting can result in nutritional and sensory quality factors being lost. Food packaging must be safe for food safety, as well as safe transportation across vast distances at a specific time. Due to their significant advantages over synthetic film, packaging technology also operates quality of food with valuable issues, intensifies the eco-friendly environment such as strict regulation on pollutant and the disposal of municipal solid waste materials, and has received considerable enthusiasm. [22] The rising interest in edible coatings is driven by consumer demand for safety and convenience, as well as knowledge of the harmful environmental effects of non-biodegradable packaging. The package must satisfy many sorts of requirements both economically and efficiently; as a result, a new food package must be optimized and effectively incorporated into the food supply chain. Although edible coatings and films have a similar definition, there is a significant distinction. Edible films are often made separately and then applied to the

43024



**Soumya Ranjan Pradhan et al.**

food surface, whereas hand coatings are generated directly on the food surfaces [5]. In this typical review we have especially emphasized on edible film for food packaging

Classification

During the creation of the films, all edible film materials have the ability to produce films that are dispersed as well as dissolve in water, alcohol, or a mixture of other solvents. In this process, additives such as plasticizers, antibacterial agents, colours, and flavours are utilised as additives to boost the film's strength. The film solutions are then casted, dried at a specified temperature, and humidity is maintained. [22] Different methods for preservation are used in food processing applications, such as dipping, spraying, brushing, and panning, with drying allowed. There are three types of hydrocolloids, lipids, and composites used in the production of edible films. [5,27]

Polysaccharides

Polysaccharides are naturally renewable, edible, and biodegradable. There are two portions to these polysaccharides. 1. Monosaccharides 2. disaccharides are created when these polysaccharides polymerize and form glycoside bonds as well as polysaccharides materials. Hydrogen is launched as active agents due to the existence of hydroxyl groups. The polysaccharides coating is a great oxygen barrier, aroma barrier, and physical barrier. With the addition of lipophilic substances like wax and oil, the hydrophobicity of these substances will decrease. When antimicrobial and antioxidant chemicals are added to packing materials, they can minimise ripening and extend the shelf life of food. Plant-based, animal-based, marine-based, and microbial-based polysaccharides are split into several categories based on their source of origin.

1. Plant-based polysaccharides are cellulose, starch, pectin, and gum.

2. Alginate, agar, and carrageenan are marine-based natural polysaccharides.

Chitin and chitosan are natural polysaccharides derived from animals. Chitin is used to remove the exoskeleton of fungi. Chitosan is formed when chitin is deacetylated. Chitosan is a cationic polysaccharide derived from natural sources with excellent film-forming characteristics. Chitosan has antibacterial and antifungal characteristics and is utilised as an antimicrobial agent in polysaccharide coating formation. [5,27] Pullulan, gellan, and xanthan are microbial-based polysaccharides that are produced by highly selective bacteria and are used in packaging films and coatings to extend the shelf life of food products. [28] Starch-based derivatives, pectin, cellulose derivatives, seaweed extract, microbial fermentation gums, and chitosan are used in the preparation of edible film for polysaccharides. However, the polysaccharide coating does not create a good water barrier since the films are extremely hydrophilic, resulting in poor water and gas characteristics and moisture loss in food products. [17,16]

Protein

Peptide bonds are established between amino acid chains during polymerization, confirming the formation of the protein molecule. Acid-based compounds such as carboxylic acid, amino acid, and alkyl group are found in amino acids. Proteins have two different types of structures. 1. protein fibrous 2. protein globulation Fibrous proteins are related to corn and soy proteins and are peptide bond-parallel proteins. Collagen protein is found in foiled spheres that belong to the globular protein family and have good film characteristics, such as zain corn and soy. Because of their weak to moderate water barrier properties at high humidity, protein-based films are hydrophilic. They degrade the film's integrity. Fibrous protein is an excellent hydrophobic barrier in nature due to the presence of oil and fragrance. Antimicrobial and antioxidant properties are present in them. The coating film is made of milk protein, which is flexible and translucent by nature, and has antibacterial and antioxidant qualities that improve the milk quality. [27] Mammalian collagen protein can be found in muscle and tissue. Gelatin is made from the breakdown of collagen with the addition of water, and it is tasteless and transparent. As the film materials formed, it disintegrated in hot water. These films are made using the casting procedure and then dried in the oven. [5, 9]. Because lipids are hydrophobic and not polymers, they offer superior water barrier qualities when compared to polysaccharides and proteins. Wax, one of the lipid characteristics, has excellent moisture barrier capabilities in packing. Terpene resin and wood resin, both resin-based lipids, have glossy characteristics that coat tomatoes and green chillies to extend shelf life and prevent ripening. Lipid is a non-polar hydrophilic lipid that is added into the composite film to strengthen the moisture barrier. Different physical features of lipids include gloss, greasy surface, odour, and so



**Soumya Ranjan Pradhan et al.**

forth. [5,27] When wax is combined with a starch-based polymer, it improves the water barrier's inclination and produces a brown semi-solid. Water resistance and elongation are properties of triglycerides derived from fats and oils. Sun flower, for example, is used in pock meat because it possesses oxygen and water barrier characteristics. Some dried fruits, such as cloves, lemon peel, and thyme extract oil, have antibacterial characteristics, which are enhanced when combined with biopolymer. [9] Plasticizers like glycerol and polysorbate boost the biopolymer's flexibility in the packing film. Plasticizers boost the water and oxygen barrier qualities of biopolymers by lowering the intermolecular force in the polymer, making it more flexible. Phospholipids are emulsifier extracts from plants and animals that help to prevent phase separation. [5]

Preparation of Various Composite films

Composite materials are made up of many edible films that have been combined to increase mechanical, physical, or chemical qualities. Generally, polysaccharide and protein-based composite films have good gas barrier properties but not water vapour barrier properties. Lipids have good water barrier qualities because they contain lipids, polysaccharides, and proteins, which strengthen the water vapour and oxygen barrier of the film.

Solvent casting

In the casting procedure, edible film is dissolved in a solvent such as water or ethanol, and chemicals such as plasticizer are added to improve the coating film's flexibility. Hydrocolloids, which are hydrophilic and long chain polymers, are made up of polysaccharides and proteins. They produced a gel-like structure if they were combined with water or a solvent. Lipids are opaque, whereas these films are transparent. With the addition of various flavouring or colouring ingredients, polysaccharide-based coating films typically have strong intermolecular hydrogen bonding. Because they are hydrophilic in nature, and lipids are hydrophilic in nature, these hydrocolloid films are good oxygen binders but poor water vapour barriers. [22] It is the most important approach for film formation since it involves spraying a water or water and ethanol solution on a suitable surface, air drying for several hours in a ventilated place such as an infrared drying chamber, and evaporating the solvent without damaging the film peeling. Finally, the film's structure is determined by the casting solution's composition, wet thickness for casting solution temperature, and humidity in the drying environment. Rapid drying is avoided in this method because the film will be damaged if the solvent concentration is reduced too quickly, limiting the mobility of the polymer chain and bonding intermolecular interaction or covalent connection, which improves the film's strength. [22]

Extrusion

This method is based on the thermoplastic capabilities of ordinary polymers with the addition of plasticizer. As a result, as the temperature rises under low water conditions, the glass transition temperature drops. Due to the lack of solvent addition and evaporation, extrusion is a favoured commercial use. These techniques are utilised to make multilayer films, however the physical and chemical properties of each film material, as well as mechanical, optical, and barrier defect on exitance, differ.

Dipping

The coating procedure is crucial for food preservation in general. The dipping or spraying procedure creates a thin layer on the food that works as a semipermeable membrane that regulates moisture content and gas transmission. [22]

Spraying

Spraying is a technique for creating a semipermeable layer on a food product that results in the development of nozzle-shaped droplets on the targeted area during the coating process. Because of the high spray pressure (about 60-8 psi), this approach achieves superior coverage or requires less coating solvent. [22]



**Soumya Ranjan Pradhan et al.****Vacuum impregnation**

In the food sector, this technology is used to enrich products with micronutrients such as vitamins and minerals. Vacuum impregnation can generate an effective and thick layer with the inclusion of solutes into air conditioning porous food products such as vegetables and fruits, according to recent studies. Instead of dipping tanks, the food materials are dipped into two airtight vacuum chambers that are connected to the vacuum pump. [22] 4.0 Active edible coatings and films. The edible covering is biodegradable and long-lasting. They are non-toxic once used and do not contaminate the environment when placed on land. Food packaging improves barrier characteristics, prevents quality loss, protects against microorganisms, provides nutrients to food, and ultimately extends the shelf life of the product. [14,25].

Antibacterial and antioxidant properties

According to the researcher, microbial contamination causes 25% of food to decay, which is a significant economic problem in the food chain. Food spoilage is defined as the loss of colour, texture, nutritional content, and quality of a food product. [4,11] When bacteria and yeast come into touch with food, factors such as temperature, pH, oxygen availability, and moisture availability have a significant impact. Microbial contamination is treated with antimicrobial packaging or synthetic chemicals. This antibacterial property extends the shelf life of the food. [1,27] Food products with active antioxidant compounds have a longer shelf life. Antioxidants are stable molecules that signify the electron to the unstable molecule known as free radicals in chemistry. Chitosan and starch-based film derived from thyme, an antioxidant with active compounds such as vonoid glycoside and terpenoid. Polyphenols and flavonoids, for example, are two types of antioxidants found in guava fruit film [1,8,26].

Physical properties**Thickness**

The thickness of the edible coating has an impact on the biological nature and shelf life of the coating. The typical coating has a thickness of 0.25nm. These interactions revealed that starch concentrations vary, resulting in variable coating thicknesses. The thickness of the edible film coating varies between 0.06-0.125nm. Different parameters influence the thickness of the edible film coating, such as density, surface tension, and viscosity.

Moisture Barrier

Naturally edible films act as a barrier between food and the environment. Different gases, water droplets, and water vapour exist in the environment, all of which contribute to food rotting. Environmental and food product barriers are created via edible coating films. [20]. Polysaccharides and proteins produce a hydrophilic coating due to their high

wWater vapour permeability.

A lipid and wax-based coating with strong humidity resistance and hydrophobic characteristics also acts as an oxygen barrier for food products. Protein absorption will increase as the humidity in polysaccharides rises, lowering the water barrier.

Tensile strength:

According to some researchers, the tensile strength of coating materials made from polysaccharides such as maize, rice, potato, and wheat ranges from 10-100 MPa. Tensile strength increases with increasing starch concentration, according to the findings. As the starch concentration rises, so does the amylose content, resulting in great tensile strength. [16]

Solubility

The ability of an edible coating to dissolve and hold water is determined by its solubility. Because of the dissolved solid, which increases the number of bonds in molecules, the starch solution in edible coating dissolved readily and did not have the ability to retain in water as the solubility decreased.



**Soumya Ranjan Pradhan et al.****Elongation**

Increased concentration reduces flexibility, making starch-based elongation films more easily broken. Tensile strength is directly related to elongation. The elongation of polysaccharide films ranges from 1 to 80 percent, with the higher elongation edible films being more elastic. According to research, there is no substantial influence of starch on elongation because starch is the major element and plasticizer is an addition.

Application to food

Edible coatings are environmentally friendly, sustainable, and biodegradable in nature, as every customer is aware, and the demand for ecofriendly packaging is growing by the day. Edible films are commonly utilised in food products such as cheese, pork, fish, poultry, and fruits and vegetables for various coating purposes. These edible packaging creates a barrier between the food product and the environment, extending its shelf life.[6,7,22]

Poultry, meat, and seafood

Edible film protects meat, seafood, and poultry products. These foods have greater water content and are perishable in nature. Edible coatings inhibit physical qualities such as shrinkage loss, microbial growth control, and meat discoloration. Sodium alginate is a natural biopolymer polysaccharide produced from brown algae that is hydrophilic in nature and has high film forming capabilities. Some essential oils, such as oregano, thyme, cinnamon, and rosemary, are antimicrobial agents that suppress the antimicrobial growth of bacteria like *E. coli*, Enterobacteriaceae, and *Salmonella typhimurium* while also extending the shelf life of food. [2,3]

Vegetables and fruits

Fruit and vegetables are a healthier food for the environment. Consumers nowadays have higher expectations for food goods to be environmentally friendly, nutritious, and have a longer shelf life. Food goods deteriorate due to factors such as moisture loss, microbial development, respiration, and ethylene generation. Aloe vera gel is a natural gel biopolymer that works as a semi-permeable water and oxygen barrier in food goods, helping to keep them fresh. Aloe vera contains antimicrobial and antioxidant qualities that extend the shelf life of food goods and protect them from microorganisms when used as a coating. When humans consume the coating, the ripening and ageing processes are postponed or the shelf life is extended. [23]

The importance of food packaging in food preservation

When food products are made, packaging becomes the most important factor for food preservation and transit from the factory to the point of sale or distribution. As a functional component of the food product, these components add organoleptic and physicochemical properties. The food packaging does not come into contact with the food and protects it from external sources of chemical, physical, and biological property harm. Moisture absorption, exposure to gas, and light contamination are examples of chemical damage; physical qualities include shock or vibration; and biological damage is caused by pathogens, insects, and animals. To preserve food, various food packaging materials such as glass, metal, plastics, and paper are used. [10,31]

Materials used in traditional food packaging

Because of the inexpensive cost of petrochemical-based plastic packaging materials, they are widely employed. However, they are carefully regulated in the environment, yet are commonly used in packaging because they are totally recyclable or biodegradable. Glass was once employed as a packaging material because it is chemically inert and odorless. Currently, glasses are thin and resistant to sterilizing at a specific temperature and pressure. [18] Environmental impact of replacing traditional packaging materials with synthetic plastic edible films Increased public demand for sustainable and environmentally acceptable sustainable bio-plastic packaging materials [29]. These edible films are manufactured in a variety of ways, including coating on solution by dipping and spraying, and extrusion. There are numerous types of physical coatings on food goods, such as solid edible laminated film that wraps around the food. The edible film is made from a solution that can be used to make a coated film that can be used in food. Polysaccharides, proteins, and lipids are examples of materials that can be used to create coatings. [19]



**Soumya Ranjan Pradhan et al.****Storage life**

The edible coating covers the surface of the food product and extends its shelf life without sacrificing nutritional value or sensory perception. Foodborne microorganisms require nutrients such as glucose, protein, sugar, and water to proliferate, resulting in food deterioration. Food deterioration is damaging to the environment and human health, hence edible films are used to prevent the growth of certain microorganisms. Antimicrobial compounds are used to cure bacteria and extend the shelf life of food products. Active agents are used to change the inside climate of packaging. [27]. For instance, according to a recent study, uncoated strawberries have a shelf life of 14 days. However, coating with a starch solution extends the shelf life by around 21 days. The starchy solution acts as a barrier between the strawberries and the bacteria that cause contamination. Another example is the application of gum Arabic film to an apple, which functions as an antibacterial coating and extends the shelf life of the meal.

Closing Thoughts

Edible packaging is a viable alternative to petroleum-based packaging materials, which are commonly utilised as additives in food-grade materials. Some of the active compounds contain specific biopolymers that are naturally found in foods, extending their shelf life. When primary food packaging is coated with food, it usually does not replace conventional packing. Edible film and coating are put to the surface of the food and vegetable to improve the shelf life of the product while also maintaining the microbiological and nutritional integrity.

Future Trends

Food packaging is eliminated from the waste cycle in the sustainable sector, although recycling is not mandated. The majority of edible film packaging is compostable and biodegradable. When employed, these coatings and films can block the movement of moisture, oxygen, carbon dioxide, smells, and lipids, among other things. These films have the ability to improve the mechanical characteristics of food when coated with culinary ingredients. In some applications, these edible films have the potential to replace some existing polymeric packaging materials. [14-15]

Acknowledgement

The authors gratefully acknowledge the support provided by Centurion University of Technology and Management, Odisha, India for carrying out the present research work.

REFERENCES

1. Abral, H., Pratama, A. B., Handayani, D., Mahardika, M., Aminah, I., Sandrawati, N., & Ilyas, R. A. (2021). Antimicrobial edible film prepared from bacterial cellulose nanofibers/starch/chitosan for a food packaging alternative. *International Journal of Polymer Science*, 2021.
2. Bharti, S. K., Pathak, V., Alam, T., Arya, A., Basak, G., & Awasthi, M. G. (2020). Materiality of edible film packaging in muscle foods: A worthwhile conception. *Journal of Packaging Technology and Research*, 4(1), 117-132
3. Bharti, S. K., Pathak, V., Alam, T., Arya, A., Basak, G., & Awasthi, M. G. (2020). Materiality of edible film packaging in muscle foods: A worthwhile conception. *Journal of Packaging Technology and Research*, 4(1), 117-132.
4. Bonilla, J., & Sobral, P. J. (2016). Investigation of the physicochemical, antimicrobial and antioxidant properties of gelatin-chitosan edible film mixed with plant ethanolic extracts. *Food Bioscience*, 16, 17-25.
5. Bourtoom, T. (2008). Edible films and coatings: characteristics and properties. *International food research journal*, 15(3), 237-248.
6. Bourtoom, T. (2008). Factors affecting the properties of edible film prepared from mung bean proteins. *International Food Research Journal*, 15(2), 167-180
7. Chen, H. (1995). Functional properties and applications of edible films made of milk proteins. *Journal of dairy science*, 78(11), 2563-2583
8. Chawla, R., Sivakumar, S., & Kaur, H. (2021). Antimicrobial edible films in food packaging: Current scenario and recent nanotechnological advancements-a review. *Carbohydrate Polymer Technologies and Applications*, 2, 100024





Soumya Ranjan Pradhan et al.

9. Cortés-Rodríguez, M., Villegas-Yépez, C., González, J. H. G., Rodríguez, P. E., & Ortega-Toro, R. (2020). Development and evaluation of edible films based on cassava starch, whey protein, and bees wax. *Heliyon*, 6(9), e04884.
10. Díaz-Montes, E., & Castro-Muñoz, R. (2021). Edible films and coatings as food-quality preservers: An overview. *Foods*, 10(2), 249.
11. Dinika, I., Verma, D. K., Balia, R., Utama, G. L., & Patel, A. R. (2020). Potential of cheese whey bioactive proteins and peptides in the development of antimicrobial edible film composite: A review of recent trends. *Trends in Food Science & Technology*, 103, 57-67
12. Debeaufort, F., & Voilley, A. (2009). Lipid-based edible films and coatings. In *Edible films and coatings for food applications* (pp. 135-168). Springer, New York, NY.
13. Fajardo, P., Martins, J. T., Fuciños, C., Pastrana, L., Teixeira, J. A., & Vicente, A. A. (2010). Evaluation of a chitosan-based edible film as carrier of natamycin to improve the storability of Saloio cheese. *Journal of Food Engineering*, 101(4), 349-356.
14. Falguera, V., Quintero, J. P., Jiménez, A., Muñoz, J. A., & Ibarz, A. (2011). Edible films and coatings: Structures, active functions and trends in their use. *Trends in Food Science & Technology*, 22(6), 292-303.
15. Han, J. H. (2014). Edible films and coatings: a review. *Innovations in food packaging*, 213-255.
16. Hatmi, R. U., Apriyati, E., & Cahyaningrum, N. (2020). Edible coating quality with three types of starch and sorbitol plasticizer. In *E3S Web of Conferences* (Vol. 142, p. 02003). EDP Sciences.
17. Indrianti, N., & Ratnawati, L. (2019, November). Application of edible film from heat-moisture treated sweet potato starch on the quality of pineapple dodol. In *AIP Conference Proceedings* (Vol. 2175, No. 1, p. 020007). AIP Publishing LLC.
18. Janjarasskul, T., & Krochta, J. M. (2010). Edible packaging materials. *Annual review of food science and technology*, 1, 415-448.
19. Jeevahan, J. J., Chandrasekaran, M., Venkatesan, S. P., Sriram, V., Joseph, G. B., Mageshwaran, G., & Durairaj, R. B. (2020). Scaling up difficulties and commercial aspects of edible films for food packaging: A review. *Trends in Food Science & Technology*, 100, 210-222.
20. Kamper, S. L., & Fennema, O. (1985). Use of an edible film to maintain water vapor gradients in foods. *Journal of Food Science*, 50(2), 382-384.
21. Khazaei, N., Esmaili, M., Djomeh, Z. E., Ghasemlou, M., & Jouki, M. (2014). Characterization of new biodegradable edible film made from basil seed (*Ocimum basilicum* L.) Gum. *Carbohydrate polymers*, 102, 199-206.
22. Kumari, N., Bangar, S. P., Petru, M., Ilyas, R. A., Singh, A., & Kumar, P. (2021). Development and characterization of fenugreek protein-based edible film. *Foods*, 10(9), 1976.
23. Mostafavi, F. S., & Zaeim, D. (2020). Agar-based edible films for food packaging applications-A review. *International journal of biological macromolecules*, 159, 1165-1176.
24. Pooja Saklani, Siddhnath, Sambit Kishor Das and Shiv Mohan Singh. 2019. A Review of Edible Packaging for Foods. *Int.J.Curr.Microbiol.App.Sci.* 8(07): 2885-2895
25. Randazzo, W., Jiménez-Belenguer, A., Settanni, L., Perdones, A., Moschetti, M., Palazzolo, E., ... & Moschetti, G. (2016). Antilisterial effect of citrus essential oils and their performance in edible film formulations. *Food Control*, 59, 750-758.
26. Saucedo-Pompa, S., Rojas-Molina, R., Aguilera-Carbó, A. F., Saenz-Galindo, A., de La Garza, H., Jasso-Cantú, D., & Aguilar, C. N. (2009). Edible film based on candelilla wax to improve the shelf life and quality of avocado. *Food Research International*, 42(4), 511-515.
27. Senturk Parreidt, T., Müller, K., & Schmid, M. (2018). Alginate-based edible films and coatings for food packaging applications. *Foods*, 7(10), 170.
28. Shit, S. C., & Shah, P. M. (2014). Edible polymers: challenges and opportunities. *Journal of Polymers*, 2014.
29. Umaraw, P., & Verma, A. K. (2017). Comprehensive review on application of edible film on meat and meat products: An eco-friendly approach. *Critical reviews in food science and nutrition*, 57(6), 1270-1279.
30. Vicentini, N. M., Dupuy, N., Leitzelman, M., Cereda, M. P., & Sobral, P. J. A. (2005). Prediction of cassava starch edible film properties by chemometric analysis of infrared spectra. *Spectroscopy Letters*, 38(6), 749-767





Study of Ground State Properties of Atomic Nuclei using Hartree Fock Bogoliubov Approach

Sumaya Gul* and Honey Sharma

Department of Physics, Sant Baba Bagh Singh University, Jalandhar, Punjab-144030, India.

Received: 14 Apr 2022

Revised: 02 May 2022

Accepted: 22 May 2022

*Address for Correspondence

Sumaya Gul

Department of Physics,
Sant Baba Bagh Singh University,
Jalandhar, Punjab-144030, India.
Email: sumayagulphy2019@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The potential energy surfaces of even-even nuclei in the sd-shell region have been obtained using USD Hamiltonian in the Hartree-Fock Bogoliubov method. The stable deformed ground state shapes for most of the studied nuclei have been observed in agreement with the experimental and other theoretical studies. There is significant shape dynamics in this mass region and in few cases shape co-existence is also witnessed. The evolution of deformation with particle number beyond shell closure can be observed.

Keywords: Potential energy surfaces, Deformation, Binding Energy, Prolate and Oblate shapes.

INTRODUCTION

Atomic nuclei are the interesting quantum many body systems, which have played a pivotal role in exploring the nature of phenomena existing at various scales in the universe. The exotic nuclei produced and analyzed as a result of remarkable experimental progress, has ushered in a renaissance of nuclear structure models [1, 2]. Self-consistent mean field model is one of the successful theoretical approaches, used to describe and predict the properties of quantum many-body systems. The reason behind the success of mean-field approach is the simplified wave function used to describe both the fermion and boson systems and at the same time allows the application of field theory techniques like Wick's theorem, used to solve the two-body Matrix easily. Quantum mechanical variational principle is used in the mean-field, to generate the single particle orbitals and when applied to Slater determinant in case of fermion systems results in familiar Hartree-Fock (HF) method, which is inadequate to describe the systems where correlations are induced due to short range attractive interactions resulting in superconductivity or super fluidity hence leading to BCS theory [3]. The HF theory together with the concept of quasi-particles introduced by the BCS theory leads to the mean-field HFB theory [4]. The ground state properties of the atomic nuclei are successfully described by the HF and HFB approaches of the mean-field theory [5–8]. The basic properties of the atomic nuclei like the binding energy, radii, deformation etc. are accurately described by Energy Density Functional approach, which uses the density dependent phenomenological effective interactions like the Skyrme interaction [9–13], Gogny





Sumaya Gul and Honey Sharma

interaction [14, 15], and the relativistic models [11, 16, 17]. However, on considering the properties like spin, isotope and particle stability the mean-field approach breaks down and one has to go a far from the mean-field approach [18]. This is due to the symmetry break down of Hamiltonian used in the mean-field theory which otherwise is preserved by the original many-body Hamiltonian. In the present study, the total energy of a system as a function of deformations in the even-even sd-shell nuclei has been carried out. The isotopic chains of Ne , Mg , Si , S , and Ar with N = 10 to 20 have been studied in the generalized self-consistent mean field approach using shell model USD effective interaction . The model space for this study is comprising of three sd levels, 0d5/2, 0d3/2, 1s1/2. The USD interaction has been successfully used in the recent past and has provided realistic sd-shell wave functions for use in nuclear structure models, nuclear spectroscopy, and nuclear reactions. The USD interaction consists three single-particle energies (SPE) for the three levels and 63 Two body matrix elements (TBME). The values for SPE and TBME are obtained from the normalized G-matrix. This technique has been used to reproduce the experimental binding energies and excitation energies for nuclei in the mass region A = 16-40. The essence of this study lies in the fact that a smaller model space has been used that needs minimal computational timings to study various nuclei in this region. Similar other studies have been done, but with larger model spaces.

BASIC FORMULAE

The nuclear many-body Hamiltonian in second quantization is expressed in particle operators ($c_1^\dagger, c_2^\dagger, \dots, c_A^\dagger$)

$$H = \sum_{ij} \epsilon_{ij} c_i^\dagger c_j + \frac{1}{4} \sum_{ijkl} \langle i, j | \bar{v} | k, l \rangle c_i^\dagger c_j^\dagger c_l c_k \dots\dots\dots(1)$$

The indices ijkl designate a single-particle state. The first term represents the spherical part and second term gives residual interaction between the active nucleons. The effective nucleon-nucleon interaction \bar{v} is anti-symmetrized, so that

$$\bar{v}_{ijkl} = v_{ijkl} - v_{ijlk} \dots\dots\dots(2)$$

For the description of the pairing correlations of the Hamiltonian (1) the most basic approach is the mean-field HFB method, in which the wave function representing the ground-state is a product state of quasi-particle operator as $(\alpha, \alpha^\dagger) = (\alpha_1, \dots, \alpha_m; \alpha + 1, \dots, \alpha_m^\dagger)$ these quasi-particle operator are connected to the original particle operators by a linear transformation which is independently defined for neutrons and protons as

$$\alpha_m = \sum_i (U_{im}^* c_i + V_{im}^* c_i^\dagger) \dots\dots\dots(3)$$

$$\alpha_m^\dagger = \sum_i (V_{im} c_i + U_{im} c_i^\dagger) \dots\dots\dots(4)$$

The vacuum operator is annihilated by these operators and are $|\Phi\rangle$, defined by

$$\alpha_k |\Phi\rangle = 0 \dots\dots\dots(5)$$

for each value of k. $|\Phi\rangle$ representing an approximation to the ground state of the system turns out to be a generalized Slater determinant (1) in the mean-field theory. Mixing of creation and annihilation operators due to quasi-particle transformation, $|\Phi\rangle$ does not lead to the wave function with good particle number. Giving rise to two types of densities, the pairing tensor (κ) and the normal density (ρ), defined as

$$\rho_{ij} = \langle \Phi | c_j^\dagger c_i | \Phi \rangle \dots\dots\dots(6)$$

$$\kappa_{ij} = \langle \Phi | c_j c_i | \Phi \rangle \dots\dots\dots(7)$$

The above can be expressed in terms of HFB coefficient as

$$\rho = V^* V^T \dots\dots\dots(8)$$

$$\kappa = V^* U^T \dots\dots\dots(9)$$

The HFB energy is given by





$$E_{HFB} = \frac{\langle \Phi | \widehat{H} | \Phi \rangle}{\langle \Phi | \Phi \rangle} \dots\dots\dots(10)$$

$$= \sum_{ij} [(\epsilon_{ij} + \frac{1}{2} \Gamma_{ij}) \rho_{ji} - \frac{1}{2} (\Delta_{ij} \kappa_{ji}^*)] \dots\dots\dots(11)$$

where the mean field Γ and pairing field Δ are defined as

$$\Gamma_{ij} = \sum_{jl} \bar{v}_{ijkl} \rho_{jl} \dots\dots\dots(12)$$

$$\Delta_{ij} = \frac{1}{2} \sum_{kl} \bar{v}_{ijkl} \kappa_{kl}^* \dots\dots\dots(13)$$

In order to derive an equation through which the HFB coefficients U and V are obtained and in turn the quasi-particles and the HFB wave function $|\Phi\rangle$, variation of HFB energy with respect to both the densities ρ and κ is done.

The variational principle

$$\delta \frac{\langle \Phi | \widehat{H} | \Phi \rangle}{\langle \Phi | \Phi \rangle} = 0 \dots\dots\dots(14)$$

results into a set of non-linear equations

$$\begin{pmatrix} h & \Delta \\ -\Delta^* & -h^* \end{pmatrix} \begin{pmatrix} U_m \\ V_m \end{pmatrix} = E_m \begin{pmatrix} U_m \\ V_m \end{pmatrix} \dots\dots\dots(15)$$

where $h = \epsilon + \Gamma$

These are the standard HFB equations and can be solved by iterative diagonalization of HFB matrix.

RESULTS AND DISCUSSION

The calculations performed in this paper include the study of sd-shell nuclei using HFB method involving USD effective interaction [19, 20], and assuming reflection and axial symmetries, as most of sd-shell nuclei are known to obey these symmetries. An accurate description of experimental data is provided by spherical shell model analysis performed with USD effective interaction. The total energies (E) calculated in HFB approach as a function of intrinsic quadrupole moment (Q_0) are presented in figures (1 – 5) for the studied sd-shell region. We have employed here the effective charges instead of the bare charges to calculate the intrinsic total quadrupole moment. The effective charges for neutrons and protons used in our work are $e_n = 0.5e, e_p = 1.5e$ respectively and have been adopted from the interacting shell model studies[21–23]. In figure (1) the potential energy surfaces(PES) of neutron-rich Ne isotopes shows that $Ne^{20,22,24}$ have prolate minimum energy lower than the oblate minimum by about 24.598MeV and, therefore, the ground-state shape of Ne^{20-24} is predicted to be prolate. The prolate shape for these isotopes has been verified by other theoretical approaches and also by the experimental data. $Ne^{26,28}$ show shape coexistence with prolate and oblate shapes at almost the same lowest energy. Calculations are also performed for $Mg^{22,24,28,30}$ isotopes and are presented in the top right of figure (2). It is evident from figure that almost all of these isotopes have prolate ground state shapes. The minima are at larger deformations of $Q_0 = +57.8085efm^2$, $+61.2106efm^2$ and $+54.2119efm^2$, $47.7806efm^2$. Mg^{26} depicts shape coexistence with prolate and oblate shapes at the same lowest energy. We have also performed the mean-field study for Si isotopes as shown in middle of figure (3) there is shape change in Si isotopes, from prolate in Si^{24} to oblate in $Si^{28,30}$. Further, in $Si^{26,28,32}$, the ground state shape





Sumaya Gul and Honey Sharma

has been depicted as prolate by our study, figure (4) S^{30} has a prominent oblate ground state shape. Also from figure (5), it is obvious that Ar isotopes also show shape dynamics, $Ar^{28,30}$ have prolate ground state shapes and for $Ar^{32,36}$, our calculations show prolate and oblate minima $Q_0 = +21.4149efm^2$, $23.6557efm^2$ and $Q_0 = -52.1286$, $46.9369efm^2$ with a very small energy difference between the two. For the isotopes that lie near N and/or Z = 20 closed shell, it is evident to include $1f_{7/2}$

level and the corresponding effective interaction to get the exact ground state shape of such nuclei. With the current study the ground state shapes of all the sd-shell nuclei except N=20 cases have been established well with much less computational efforts and gives the notion that the density Dependent interaction can be replaced by an effective interaction defined over a limited configuration space. This feature of the HFB theory could be exploited to investigate heavy mass regions and high spin states of the nuclei.

CONCLUSION

The main aim of the present work is to include correlations (BCS) in the standard HF mean-field approximation and study the ground state properties of nuclei in sd-shell region using USD effective interaction. Preliminary calculations in the sd-shell region have been performed in Ne, Mg, Si, S, and Ar isotopes to calculate total energies (E) as a function of intrinsic quadrupole moment (Q_0). The results are fairly in good agreement with other approaches and experimental results. Shape co-existence has been observed in many isotopes especially in $Ne^{26,28}$ and Mg^{26} with prolate and oblate shapes at the same lowest energy. Further, Ar isotopes also show shape dynamics. $Ar^{28,30}$ Have prolate ground state shapes and for $Ar^{32,36}$, our calculations show prolate and oblate minima with a very small energy difference between the two. The present analysis has been limited to lighter nuclei with smaller configuration spaces. Although, performing a mean-field study with a larger configuration space is certainly feasible, our study shows that the results of the density-dependent effective interactions in a larger configuration space can be reproduced with an empirical interaction employing a limited configuration space. In future, we would like to investigate heavier nuclei as mean field becomes more accurate for heavier systems. The effective interactions for heavier nuclei need to be obtained using the G-matrix renormalization procedure. Also we are in the process of implementing particle number and angular momentum projection techniques in the mean field. This can be used to perform a mean-field study with a simultaneous particle-number and angular-momentum projection. The other possibility is to employ the recently developed mapping procedure [24]. We are presently working along this direction and the results obtained will be discussed in our future study.

REFERENCES

1. G. Duplančić and J. Trampetić, Physical Review D 69, 117501 (2004).
2. G. Moruzzi, F. Strumia, P. Carnesecchi, R. Lees, I. Mukhopadhyay, and J. Johns, Infrared Physics 29, 583 (1989).
3. M. Casas, J. Getino, M. De Llano, A. Puente, R. Quick, H. Rubio, and D. Van der Walt, Solid state communications 94, 419 (1995).
4. P. Ring and P. Schuck, The nuclear many-body problem (Springer Science & Business Media, 2004).
5. M. Bender, P.-H. Heenen, and P.-G. Reinhard, Reviews of Modern Physics 75, 121 (2003).
6. J. Dobaczewski, W. Nazarewicz, T. Werner, J. Berger, C. Chinn, and J. Dechargee, Physical Review C 53, 2809 (1996).
7. T. R. Rodríguez and J. L. Egido, Physical review letters 99, 062501 (2007).
8. S. Goriely, M. Samyn, P.-H. Heenen, J. Pearson, and F. Tondeur, Physical Review C 66, 024326 (2002). 9. D. Vautherin and D. t. Brink, Physical Review C 5, 626 (1972).





Sumaya Gul and Honey Sharma

9. D. Vautherin, Physical Review C 7, 296 (1973).
10. P.-G. Reinhard and W. Nazarewicz (2021), 2101.00320.
11. M. Samyn, S. Goriely, M. Bender, and J. Pearson, Physical Review C 70, 044309 (2004).
12. M. Girod, J. Delaroche, D. Gogny, and J. Berger, Physical review letters 62, 2452 (1989).
13. J. Egido and L. Robledo, Physical review letters 70, 2876 (1993).
14. M. Anguiano, J. Egido, and L. Robledo, Nuclear Physics A 696, 467 (2001).
15. W. Pannert, P. Ring, and J. Boguta, Physical review letters 59, 2420 (1987).
16. P. Ring, Progress in Particle and Nuclear Physics 37, 193 (1996).
17. T. Werner, J. Sheikh, M. Misu, W. Nazarewicz, J. Rikowska, K. Heeger, A. Umar, and M. Strayer, Nuclear Physics A 597, 327 (1996).
18. M. Baranger and K. Kumar, Nuclear Physics 62, 113 (1965).
19. J. Egido and P. Ring, Nuclear Physics A 383, 189 (1982).
20. B. A. Brown and B. Wildenthal, Annual Review of Nuclear and Particle Science 38, 29 (1988).
21. B. A. Brown and W. Richter, Physical Review C 74, 034315 (2006).
22. M. Honma, T. Otsuka, B. A. Brown, and T. Mizusaki, Physical Review C 69, 034335 (2004).
23. R. Rodriguez-Guzman, Y. Alhassid, and G. F. Bertsch, Physical Review C 77, 064308 (2008).
24. Y. Alhassid, G. Bertsch, L. Fang, and B. Sabbey, Physical Review C 74, 034301 (2006)

Table I: Quadrupole moments (in the units of efm^2) for the lowest obtained prolate and oblate shapes of $^{20-28}\text{Ne}$, $^{22-30}\text{Mg}$, $^{24-32}\text{Si}$, $^{26-34}\text{S}$, $^{28-36}\text{Ar}$ isotopes are compared.

| Isotopes | HFB Prolateoblate | Raman | Expt |
|------------------|----------------------|---------|--------------|
| ^{20}Ne | +49.4288 –19.2724 | 58.426 | +80.7 ± 10. |
| ^{22}Ne | +52.7579 –25.6289 | 48.10 | +66.4 ± 14.0 |
| ^{24}Ne | +49.7314 –32.2863 | 41.7 | - |
| ^{26}Ne | +49.5801 –26.9899 | 47.743 | - |
| ^{28}Ne | +37.9238 –27.8979 | 50.14 | - |
| ^{22}Mg | +57.8058 –29.9622 | 60.11 | - |
| ^{24}Mg | +61.2106 –41.6898 | 65.98 | +63.2 ± 7.0 |
| ^{26}Mg | +61.9672 –49.6343 | 55.412 | +45.6 ± 10.5 |
| ^{28}Mg | +54.2119 –42.2573 | 59.242 | - |
| ^{30}Mg | +47.7806 –33.1778 | 54.424 | - |
| ^{24}Si | +41.2421 –45.0126 | - | - |
| ^{26}Si | +62.8701 –54.1538 | 59.8929 | -56.0 ± 10.5 |
| ^{28}Si | +82.0782 –65.9168 | 57.211 | 45.6 ± 10.5 |
| ^{30}Si | +43.7024 –55.1627 | 46.511 | - |
| ^{32}Si | +20.7011 –44.2673 | 33.5 | - |
| ^{26}S | +39.7982 –45.3216 | - | - |
| ^{28}S | +52.8878 –42.4464 | - | - |
| ^{30}S | +45.6999 –54.174 | - | - |
| ^{32}S | +52.6986 –52.4713 | 54.912 | - |
| ^{34}S | +11.0843 –44.1488 | 46.113 | - |
| ^{28}Ar | +27.1866 –22.9773 | 54.912 | - |
| ^{30}Ar | +34.0858 –42.3329 | 46.113 | - |
| ^{32}Ar | +21.4149 –52.1286 | - | - |
| ^{34}Ar | +32.2459 –45.9887 | 48.941 | - |
| ^{36}Ar | +23.6557 –46.9369 | 54.827 | - |





Sumaya Gul and Honey Sharma

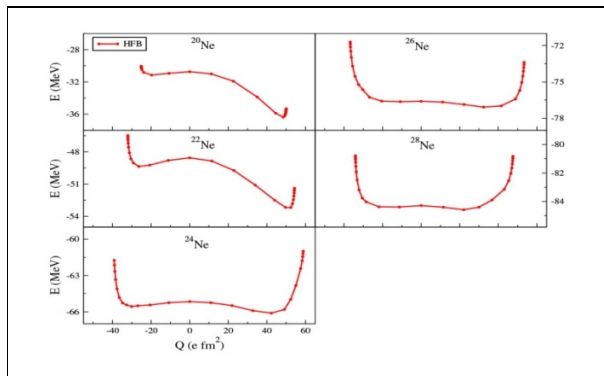


FIG. 1: Hartree-Fock-Bogoliubov (HFB) results of energy surfaces of $^{20-28}\text{Ne}$ isotopes using the USD effective interaction.

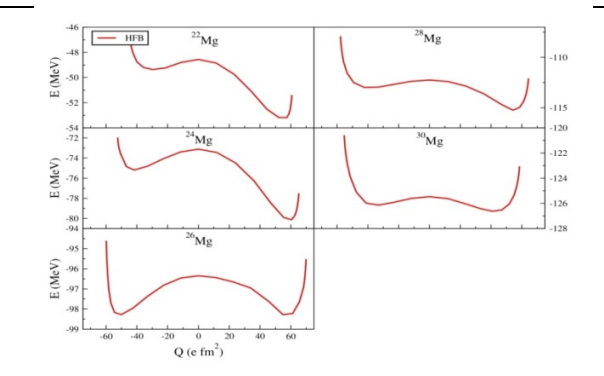


FIG. 2: Hartree-Fock-Bogoliubov (HFB) results of energy surfaces of $^{22-30}\text{Mg}$ isotopes, using the USD effective interaction.

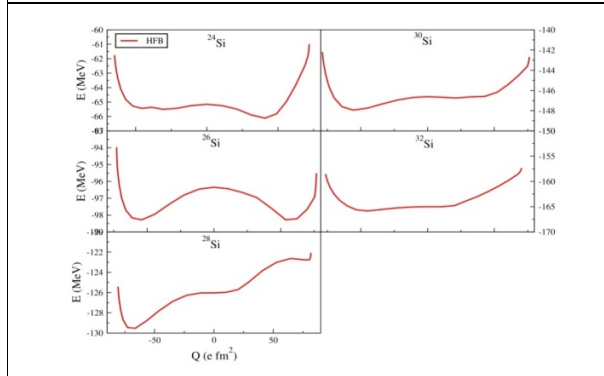


FIG. 3: Hartree-Fock-Bogoliubov (HFB) results of energy surfaces of $^{24-32}\text{Si}$ isotopes, using the USD effective interaction.

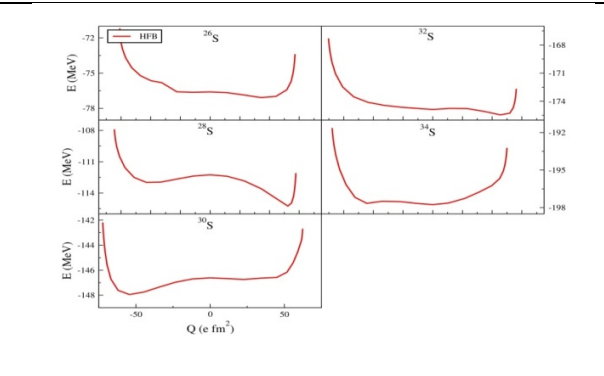


FIG. 4: Hartree-Fock-Bogoliubov (HFB) results of energy surfaces of $^{26-34}\text{S}$ isotopes, using the USD effective interaction.

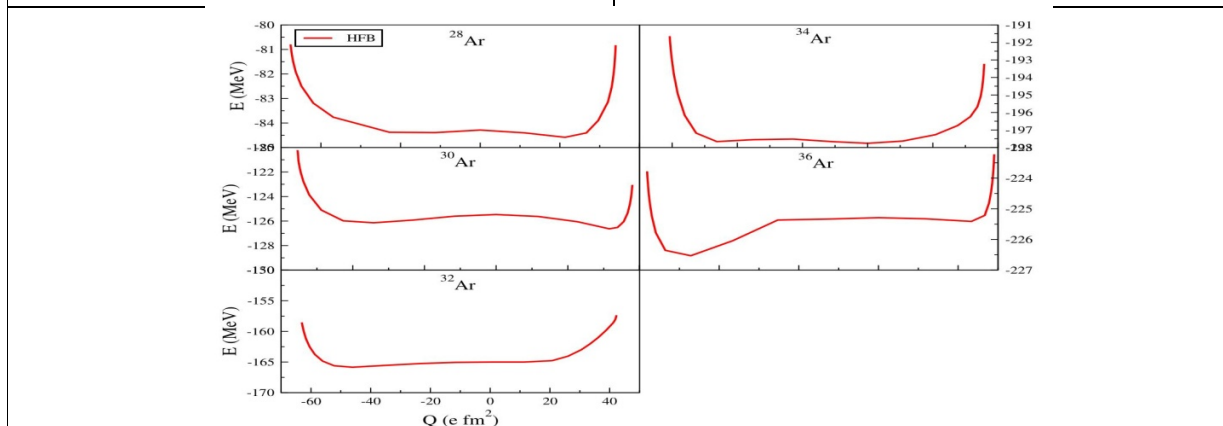


FIG. 5: Hartree-Fock-Bogoliubov (HFB) results of energy surfaces of $^{28-36}\text{Ar}$ isotopes, using the USD effective interaction.





Investigation of Lithium-Ion Bombardment on Dichloromethane Using SRIM

Narayan Gouda*, I. Siva Ramakoti and Satyanarayan Dhal

Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Narayan Gouda

Centurion University of Technology and Management,
Odisha, India.

Email: narayangouda@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The Monte-Carlo simulation of Lithium (Li^+) ions with an energy of 50 keV irradiating Dichloromethane is performed in order to acquire ion distribution, recoil distribution, energy to recoils, and ionisation data, which will support the experimental data obtained after irradiation. The impact on the structure of Dichloromethane when bombarded with Li ions with a potential of 50 keV is calculated using the SRIM (Stopping and Range of Ions in Matter) software.

Keywords: Monte-Carlo simulation, Dichloromethane, SRIM, irradiation of lithium ions

INTRODUCTION

Dichloromethane was prepared by mixing chloromethane and chlorine in the presence of sun light. It is a very efficient and versatile solvent for almost all organic compounds. Halomethanes cause several problems in the environment including acute toxicity on the living organisms, genetic mutation, and carcinogenicity [1]. Dichloromethane is likely to release chlorine gas to the stratosphere because of its small absorption cross-section area for solar radiation, and the half-life period of DCM in the troposphere is calculated to be more than months. Municipal disinfection is the key source of dichloromethane and supplementary halomethanes in drinking water sources [2]. A heterogeneous catalyst that promotes the breakdown of CH_2Cl_2 and other halomethanes by solar radiation might be highly useful, and the current research was started to learn more about how such a catalyst would work. Dichloromethane also has some therapeutic potential. DCM: methanolic leaf and root bark extracts of *Carissa edulis*, as described by Maina *et al.*, has antipyretic and antinociceptive properties [3]. Similarly, Wang *et al.* reported the Anti-inflammatory and Anticancer Properties of the mixture of Dichloromethane and Butanol obtained from the Bark of *Broussonetia papyrifera* [4]. In this study the simulation of the irradiation of low energy lithium ion on dichloromethane is done in order to know the effect of collision of the ions on its properties.



**Narayan Gouda et al.**

METHODOLOGY

This study uses a Monte-Carlo based simulation called SRIM in order to determine the behaviour of dichloromethane (DCM) when irradiated with lithium ions. Simulations are performed here to interpret the effect of low-energy lithium ions on DCM as a target molecule. The experiment will be done after getting enough data from the SRIM simulation.

RESULTS AND DISCUSSION

The stopping and range of ions can be computed using TRIM, which is part of the SRIM program [5]. The TRIM setup window and trim calculation are shown in Figure 1. The calculated damage is based on a thorough calculation using the complete damage cascade. The distribution of recoil ions is expected in the XY plane. The angle of incidence is kept at 0 degrees. The TRIM setup window is applied to answer data about the types of ions, targets, and TRIM calculations. Here, DCM is used as the target and lithium ion is used as the ion data. The energy used in the collision was a very low energy of 50 keV. In this figure, lithium ions collide perpendicularly with target atoms such as carbon, hydrogen, and chlorine with an energy of 50 keV in the XY plane.

Ion Trajectory

Figure 2 depicts the trajectories at the $E = 50$ keV incidence energy level. The red dots in the graph represent the distribution of lithium ions as they pass through the target DCM atoms, causing lattice displacement. The other colours of dot clusters, on the other hand, signifies the displacement of the target atoms, which creates a vacancy when the other atoms recoil. The green coloured dots indicate the vacancies formed by recoiling dichloromethane molecular atoms. The groups of green dots formed because of continuous damage produced by ions that is recoiling DCM atoms. When lithium ions collide strongly with a DCM molecule atom, some energy is lost from the system. Each collision between the hard ion and DCM results in a green cascade, with the possibility of the ions changing direction. A single recoil atom may be the main reason for creating 1000 vacancies as denoted by green dots, but ions produce only one vacancy (red dots). Red dots indicate collisions between lithium ions and DCM atoms, with target atoms colliding from their lattice sites. The bouncing DCM atom is the main reason for the collision cascade that amplifies the damage process. The dots indicate that the transferred energy is not small enough to move the hit atom out of its lattice site.

Ion And Atom Distribution

Figure 3 (a) shows the two-dimensional (2D) distribution of lithium-ion enhancement in the DCM target. Here, the target depth is set to 3000 Å, so you can easily predict more ions in the plot. In Figure 3 (a), the X-axis represents the depth of the target and the Y-axis represents the number of atoms per unit volume (concentration) or per unit area. For an energy of 50 keV, the ion range is 1764 Å, the spread or straggle is 752 Å, the skewness is 0.4313, and the kurtosis is 2.1850. Figure 3 (b) shows a 2D plot of the ion / recoil distribution of the DCM. This graph shows the number of atoms that recoiled back at the depth of the target. In the graph, the recoil distribution of hydrogen atoms is represented by red, the recoil distribution of carbon atoms is shown by cyan colour, and the pink curve is the recoil distribution of chlorine atoms. From this figure, it can be interpreted that by applying energy of 50 keV and penetrating these atoms, all DCM atoms are removed from the lattice site to form vacancies. From this figure, it can be predicted that the maximum number of hydrogen atoms (that is, 10×10^5 atoms / cm^3 or more) rebounded, and the average number of 8×10^5 atoms / cm^3 carbon atoms recoiled at target depth near to 3000 Å. Similarly, the maximum of 6×10^5 atoms/ cm^3 of chlorine atoms are recoiled back at around 3000 Å target depth.

Energy to Recoil Distribution

Figure 4 shows a 2D graph of the recoil distribution to energy for 50 keV energy. This figure gives information about target damage from ion irradiation. This figure shows the energy absorbed by a lithium atom when it collides with a





Narayan Gouda et al.

DCM. Here, the orange graph shows the energy absorbed by hydrogen, the blue graph shows the energy absorbed by carbon, and the pink graph shows the energy absorbed by chlorine atoms. From this figure, it is clear that the energy absorbed by the chlorine atom is the maximum (that is, 0.8 eV / ion) and the energy absorbed by the hydrogen atom is the minimum (that is, 0.3 eV / ion). The energy absorbed by the carbon atom is 0.4 eV / ion.

Collision Events

The two-dimensional plot for collision events is shown in Figure 5. In the plot, Replacement collisions, target vacancies and target displacements are shown in green/blue and red colour respectively and indicating that the vacancy is less than the target displacement. The target displacements and vacancies are almost same at the higher target depth where as the replacement collisions are very less throughout the target depth.

CONCLUSIONS

In this study, we have stated the Monte- Carlo simulation for the irradiation of low energy (50keV)Lithium ions on the dichloromethane in order to study the change in properties of DCM after irradiation. The simulation study is highly important before doing the experiment of irradiation of ions on any materials. Here, we have calculated the ion range, ion and atom distribution, energy to recoil distribution, and collision events. This work will be tremendously helpful in the experimental procedure of bombardment of lithium ions on the dichloromethane molecules. We have considered 50 keV energy lithium ions on dichloromethane compound.

REFERENCES

1. U.S. Environmental Protection Agency. Ambient water quality criteria for halomethanes; EPA 440 5-80-051; 1980.
2. N., Yang, "Dichloromethane," *Encyclopedia of Toxicology*, 99–101,2014.
3. G.S., Maina, J.K., Kelvin, M.B.,Maina, N. J., Muriithi, M. J., Kiambi, A., Umar, M.K., John, N. W., Ann, M.N., David, and N.M., Piero, "Antinociceptive properties of dichloromethane: methanolic leaf and root bark extracts of *Carissa edulis* in rats," *The Journal of Phytopharmacology*, 4(2): 106-112, 2015.
4. L., Wang, H., Jeong Son, M.L., Xu, J.-H., Hu, and M.H., Wang, "Anti-inflammatory and anticancer properties of dichloromethane and butanol fractions from the stem bark of *Broussonetiapapyrifera*," *J. Korean Soc. Appl. Biol. Chem.*,53(3): 297–303, 2010.
5. N., Gouda, S., Dhal, P.K., Rath and Y., Muguli, "Simulation of 50 keV Argon ion on SrO₂ Nanoparticles using SRIM," *Indian Journal of Natural Sciences*, 10(60): 20938-20940, 2020.

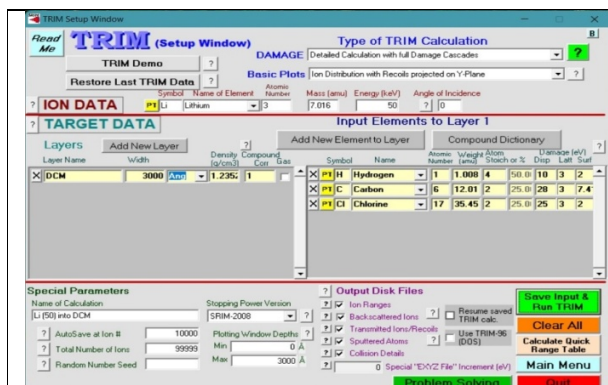


Fig.1 TRIM setup window for 50keV energy

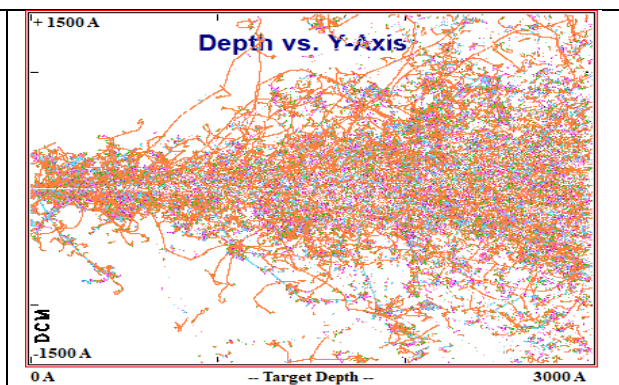


Fig.2 Ion trajectory of 50 keV Lithium atoms on DCM target





Narayan Gouda et al.

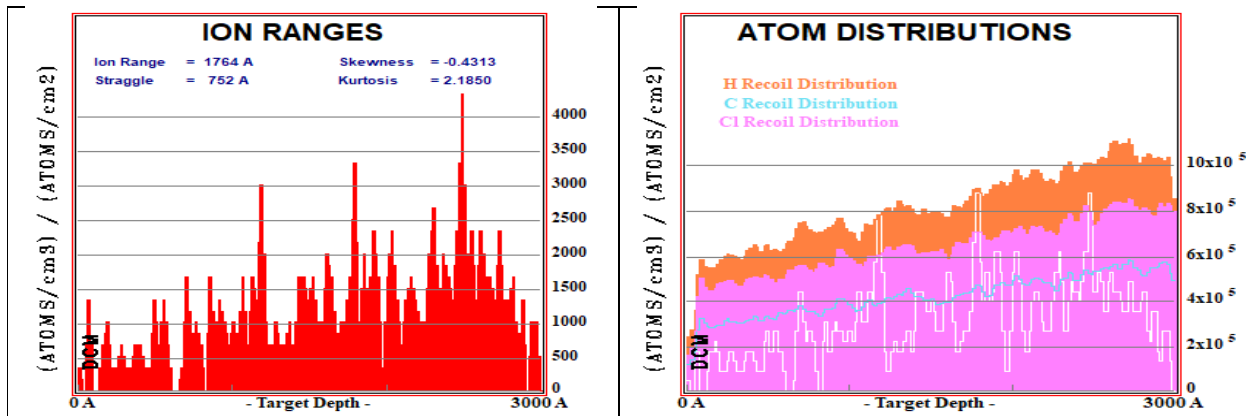


Fig.3 (a) Distribution of lithium ions (50 keV) building up in the DCM target

Fig. 3 (b) Atomic distributions of DCM after lithium ions (50 keV) exposure

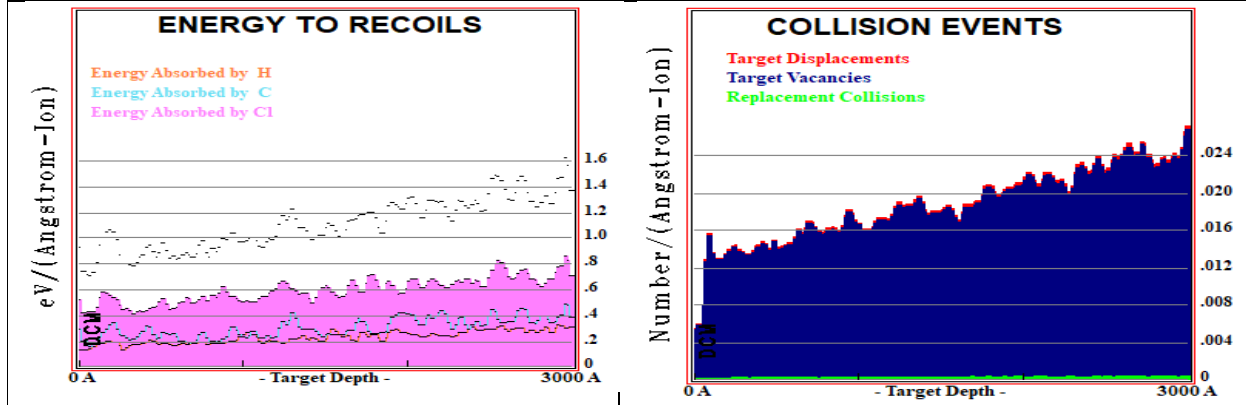


Fig.4 Two-dimensional Energy to Recoil distribution plot

Fig.5 2D plots of Collision Events for 50 keV energy





A Novel Approach for Determining Heavy Metal Concentration using UV-Vis Spectrophotometer

Kirti Pandya^{1*}, Sanjukta Rajhans², Himanshu Pandya³ and Archana Mankad⁴

¹M.Sc. Student, Department of Botany, Gujarat University, Ahmedabad, Gujarat, India.

²Research Scholar, Department of Botany, Gujarat University, Ahmedabad, Gujarat, India.

³Professor, Department of Botany, Gujarat University, Ahmedabad, Gujarat, India.

⁴Professor and Head, Department of Botany, Gujarat University, Ahmedabad, Gujarat, India.

Received: 06 Apr 2022

Revised: 03 May 2022

Accepted: 24 May 2022

*Address for Correspondence

Kirti Pandya

Department of Botany,

Bioinformatics and Climate Change Impacts Management,

Gujarat university, Ahmedabad, 380009

Email: kirtipandya99@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Ornamentals have always been used for phytoremediation as they can accumulate heavy metals and add a picturesque view to a place. But, for the evaluation of heavy metal content AAS (Atomic Absorption Spectroscopy) methods have been used predominantly by the researchers across the world. In the present study an alternative to AAS (Atomic Absorption Spectroscopy) method has been used i.e., UV-Vis spectrophotometry for evaluating the metal content in the solutions. The plant chosen for the experiment was *Tagetes erecta* L. which was provided with nutrient medium and kept in soilless media. The hydroponics technique has also been focused in the paper as an alternative to soil media for growing plants. Hence, the combination of hydroponics technique and UV-Vis spectrophotometry for evaluating the metal stress on *Tagetes erecta* L. plant makes the research work unique and novel.

Keywords: Hydroponics, Phytoremediation, UV-Vis spectrophotometry, Arsenic, Boron.

INTRODUCTION

The pollution in the environment is increasing day by day. The contamination of fresh water bodies is expanding at a fast rate. The major pollutants include heavy metals due to various types of industrial sources. Additionally, the pollution caused due to heavy metals also has major ill effects in the terrestrial ecosystem. Generally, the elements present in the fourth period in the periodic table are referred to as heavy metals. The characteristics of heavy metals are high atomic weight and greater density than water. They pile up to formidable amount in the environment as well as in the food chain via soil. So, the excellent method to get rid of such dilemma is "Phytoremediation". It is a



**Kirti Pandya et al.**

natural and advancing technique that uses plants to compensate polluted soil, water and sediments [1]. The factors influencing phytoremediation are selecting a proper plant, periodic distinction of seasons, composition of left-over produced, kind of contaminant and variation of plant utilized [2]. For the purpose of phytoremediation ornamental plants are very suitable as they can intensify the scenic effect of an area [3]. The main advantage of using ornamental plants is that risk of entering the heavy metals is reduced. [2]. There are two different methods for cultivating ornamental plants for phytoremediation which includes soil and soilless culture. In the present study hydroponics i.e., soilless culture was used for experiment. In comparison to soil-based culture, soilless culture is one of the improved methods used by researchers in recent times. In hydroponics system, a nutrient solution is provided to the plants which contains various soluble salts of the elements which are essential for plants [4]. The productivity and quality of crops is increased. Hydroponics makes the use of water efficiently. Hydroponics culture also provides the controlled condition for the growth of plants. The system provides various conditions to control nutrients, light, temperature and pH to the medium. Hydroponics can be helpful to researchers to study the deficiency symptoms in different plant species. Thus, hydroponics can be the best technique for phytoremediation [4]. The present study involves the use of *Tagetes erecta* L. plant for phytoremediation. The culture was carried out using the hydroponics. The treatment of heavy metals i.e., Arsenic and Boron was provided to plants of marigold. Subsequently, growth parameters were analyzed after 5 days interval.

MATERIALS AND METHODS

The plants brought from nearby nursery were washed to get rid of soil particles. The plants of the control set was seeded with distilled water, whereas the other 4 sets were provided with nutrient solution i.e., - Hoagland No.2 Basalt salt mixture (HIMEDIA) along with heavy metal treatment of Arsenic (50 and 100 ppm) and Boron (50 and 100 ppm). The plants were allowed to adapt in the laboratory conditions. After a week the plants were introduced in the glass jars containing freshly prepared nutrient solution. The saplings of *Tagetes erecta* L. were obtained from the nearby nursery. The marigold plants which were healthy and free from any kind of disease symptom had been selected for the experimental study. Marigold plants acquired from the nursery were thoroughly washed with distilled water to remove any traces of dirt and soil. The plants were then utilized for treatment of heavy metal solution of Arsenic and Boron. Various concentrations of Arsenic (50 and 100 ppm) and Boron (50 and 100 ppm) were prepared. One set which was used as control, comprised entirely of nutrient solution. The plants of *Tagetes erecta* L. were placed in the glass jars with roots submerged in the nutrient solution. The nutrient solution used for the present study was freshly prepared Hoagland No. 2 basal salt mixture (Modification no.1) (HIMEDIA). For each treatment 8 glass jars were used. The experiment was performed in triplicates. In the course of 20 days of research work, the heavy metal and nutrient solution were discarded after every 5 days and the sets were replenished with freshly prepared Hoagland and heavy metal solution. The evaporation losses were taken care by covering the opening of glass jars with aluminum foil. After every 5 days interval the growth parameters such as root length, shoot length, fresh weight, dry weight, number of flowers and buds were measured. The alteration in shoot and root length was measured using metric scale and thread. The biomass accumulation such as fresh and dry weight was measured using analytical balance. For dry weight, the harvested plants were dried in the hot air oven at 80°C for 20 minutes. The accumulation of heavy metals i.e., Arsenic and Boron was analyzed using UV-Vis spectrophotometer.

RESULTS**Plant Growth Analysis**

The plants used for the study were observed for changes in various growth parameters after the interval of 5 days. Measurements of root length, shoot length, fresh weight, dry weight, number of flowers and buds were taken. The results of shoot length are as follows- Boron (100ppm) > Arsenic (50 ppm) > Arsenic (100 ppm) > Control > Boron (50 ppm). The Figure 1 represents the shoot length of various treatment. The next parameter observed was root length. The comparative analysis of root length showed the following results- Boron (50 ppm) > Boron (100 ppm) > Control > Arsenic (50 ppm) > Arsenic (100 ppm). The graph below in Figure 2 represents the comparative data of root length.



**Kirti Pandya et al.**

The graph presented in **Figure 3** shows the fresh weight of all the treatments used in the present study. Fresh weight was observed highest in Arsenic (50 ppm) treated set and least fresh weight was observed in the Boron (100 ppm). Also, the result showed that the fresh weight was observed similar in Arsenic (50 ppm) and Boron (50 ppm) set. Among the morphological features the next parameter observed was dry weight. The set treated with Arsenic (50 ppm) showed excessive increase in the dry weight, followed by Boron (50 ppm) set. The set treated with Arsenic (100 ppm) and control showed similar trends. The next parameter observed was number of buds. The highest number of buds was observed in the Boron (50 ppm) treated set followed by Arsenic (50 ppm) treated set. The set treated with Arsenic (100 ppm) and Boron (100 ppm) set both showed single bud after 20 days interval. And the bud was completely absent in control treated set after the interval of 20 days. The last parameter in the growth analysis includes the number of flowers. After the interval of 20 days Arsenic (50 ppm) and Boron (100 ppm) showed highest number of flowers i.e., 4. The control set showed 2 flowers. The least number of flowers was observed in the Arsenic (100 ppm) and Boron (50 ppm) treated set. The graph in the **Figure 6** shows the comparative data of number of flowers.

UV-Vis Spectrophotometer

In the present study UV-Vis spectrophotometer was used for quantification of heavy metals of Arsenic and Boron. This method is a substitute for AAS (atomic absorption spectrometry) [8]. The spectrophotometric methods require certain type colour or dye compound which helps in detecting the elements during UV-Vis spectrophotometer. As in our experiment for Arsenic Toluidine blue and for Boron Azomethine reagent was used as colour agent. The Arsenic stock solution was prepared using Sodium Arsenite. The aliquots of sample were used and transferred to respective test tubes. 0.05 gm of Toluidine blue, 86 ml of conc. HCl, 2 gm of Potassium Iodate, 13.61gm of Sodium Acetate each one of them were added to 100ml distilled water. The prepared solutions were incubated for 2 minutes and analysed in UV-Vis spectrophotometer. For Boron, Boric acid was used as the stock solution. Further, 2 gm of Ascorbic acid, 5 ml Azomethine reagent, 40 gm of Ammonium Acetate, 125 ml of Glacial Acetic Acid, 6.7 gm of EDTA, 60 ml of Thioglycolic acid altogether to form a solution of buffer. The incubation time was about 2 minutes and observed in UV-Vis spectrophotometer. The above-mentioned methodology was followed according to [9] with some modifications. The results obtained after the UV-Vis spectrophotometer are described in the form of graphs for each heavy metal. The calibration curve representing the standard for Arsenic solution is represented below in Figure 7. The concentration of solution was measured at 628 nm. The curve for Arsenic was obtained by the equation $y = -0.037x + 0.8918$ and $R^2 = 0.6897$. The heavy metal Arsenic contained other two concentration solution that is 50 and 100 ppm. The Figure 8 and Figure 9 represents the Arsenic (50 and 100 ppm) respectively. The results obtained for Boron are represented in the graph with standard concentration, 50 ppm treated set and 100 ppm treated set. The Figures 10-12 represents the standard calibration curve for Boron, 50 ppm treated set and 100 ppm treated set respectively. The standard equation for Boron calibration curve is $y = 0.0061x + 1.1167$ and $R^2 = 0.9477$.

DISCUSSION

Plant Growth Parameters

Ornamental plants are elegant constituent in phytoremediation. There are a variety of terrestrial and aquatic ornamental plants which are well acclimatized to wide environmental conditions. Employing ornamental plants can help in remediating water and beautifying the area. The plant used in the present study was *Tagetes erecta* L. This plant has many advantages along with economic benefits. In this study the root length decreased as the concentration increased from 50 to 100 ppm respectively for both the treatments. The shoot length of marigold after the treatment of Arsenic increased from 50 ppm to 100 ppm, while for the boron treated set the length of shoot was almost similar. The biomass accumulated (Fresh and dry weight) for each treatment decreased with increase in the concentration of heavy metal solution. The number of flowers and buds decreased from Arsenic (50 ppm) to Arsenic (100 ppm) set. The boron treated set showed different results for the parameters such as number of flowers and buds. The number of flowers increased with increase in the concentration while, the number buds decreased with increase in the concentration. The control set consists of 2 flowers and absence of buds after 20 days. One of the experiments



**Kirti Pandya et al.**

by [5] assessed Arsenic accumulated in various ornamental plants including *Tagetes erecta* L. The concentration of Arsenic ranged from 0.0mgL^{-1} to 5.25mgL^{-1} . The results showed that no discrete change was observed in the dry weight of the treatment. The observed changes supported the results obtained in our experiment. Our study comprised of another heavy metal Boron with 50 and 100 ppm treatment. The set treated with Boron 50 ppm ranked second in the dry weight among all the treated sets. And the lowest dry weight was observed in the Boron (100 ppm) set. In another research work performed by [6] on marigold (*Tagetes erecta* L.) by means of hydroponics culture, the heavy metal treatment given was Lead and Nickel. The growth analysis was carried out including root length, shoot length, fresh weight and dry weight. The results were recorded after 21 days. The fresh weight and shoot length were found to decrease with rise in the concentration of heavy metal. One of researches conducted by [7] on *Tagetes erecta* L. stated that when the plant was treated with Batik wastewater buds of flowers were only found in the set treated with 50% treatment and control set. In present study it was observed that buds were present in each of the treatments except the one for control. According to [7] it was observed that as the concentration of the waste increased the texture and appearance of the leaves changed, the leaves turned darker colour to blackish and converted to rough in texture. The results obtained from our experiment showed similar outcomes at the end of experiment.

UV-Vis Spectrophotometer

The results obtained for Arsenic 50 and 100 ppm showed highest content of Arsenic at 15 ml concentration in *Tagetes erecta* L. For Boron the highest concentration was observed at $100\mu\text{l}$ concentration. The standard values according to [10] for Arsenic and Boron are 0.3 mg/l and 5 mg/l respectively. One of the research works performed by [9] showed increase in the concentration of heavy metals leads to decrease in the absorbance of the medium. The Boron treated set showed just opposite results, increase in the concentration lead to lowering down of absorbance. The results of Boron (100 ppm) treated set by [9] showed similar results for Boron standard in our set. The result of standard Arsenic treated set showed same results in accordance with the [9]. The result obtained for Arsenic (50 and 100 ppm) set showed results in accordance to [9].

CONCLUSION

The present study suggests that *Tagetes erecta* L. is an important plant that can be utilized for the phytoremediation purpose. It has been further observed that the survival of plants can be possible only up to a certain limit when metal stress is provided to them. This is the reason that each metal has its own permissible limit. Here, 50 ppm and 100 ppm concentration of Arsenic and Boron were applied which was more than their permissible limit i.e., 0.3 mg/L for Arsenic and 5mg/L for Boron. Further from this study it was observed that hydroponics technique works successfully as a soilless media when nutrients are balanced. It was the hydroponics method which provided the platform for performing UV-Vis spectrophotometry as an alternative to AAS (Atomic Absorption Spectroscopy). In future research works anatomical configurations and techniques like SEM (Scanning Electron Microscope) and TEM (Transmission Electron Microscope) can be utilized for in depth studies. The combination of hydroponics and UV-vis spectrophotometry will surely be helpful in the agricultural research works. Moreover, due to the variations in the climatic conditions the use hydroponics can provide great advantage in future for growing crops.

REFERENCES

1. Dey, P., Rehman, R. M., and Choudhury, R. M. (2017). Potential of phytoremediation approaches in regeneration of Hazaribagh brownfield area. *Proceedings of the 3rd International Conference on Civil Engineering for Sustainable Development (ICCESD)*. (53-61). Bangladesh: Khulna University of Engineering and Technology (KUET).
2. Khan, A.H.A., Butt, T. A., Mirza, C. R., Yousaf, S., Nawaz, I. and Iqbal, M. (2019). Combined application of selected heavy metals and EDTA reduced the growth of *Petunia hybrida* L. *Scientific Reports*. 9(4138): 1-12.





Kirti Pandya et al.

3. Pandya, K., Rajhans, S., Pandya, H., and Mankad, A. (2022). Phytoremediation: An innovative perspective for reclaiming contaminated environment using ornamental plants. *World Journal of Advanced Research and Reviews*. 13(2): 1-14.
4. Asao, T. (2012). *Hydroponics- A standard methology for Plant Biological Researches*. London: Intech Open.
5. Reed, S., Silva, T. A., Dunn, C. B., Gordon, G. G., Meerow, A. (2013). Nutrient uptake of ornamental plants exposed to Arsenic in hydroponic solution. *Journal of Agricultural Science*. 5(12): 1-13.
6. Bardiya, K. B., Sharma, S., Mishra, Y., Patankar, C. (2017). *Tagetes erecta* (Marigold), a phytoremediant for Ni- and Pb- contaminated area: a hydroponic analysis and factors involved. *Rendiconti. Lincei. Scienze. Fisiche e Naturali*. 28(4): 673-678.
7. Murti, V. M., and Maryani. (2019). Anatomical responses of marigold (*Tagetes erecta* L.) roots and stems to Batik wastewater. *The 6th International Conference on Biological Science (ICBS)*, 2260(1), 030018-1-030018-11. <https://doi.org/10.1063/5.0015766>.
8. Kulkarni, S., Dhokpande, S., Kaware, J. (2015). A review on spectrophotometric determination of heavy metals with emphasis on Cadmium and Nickel determination by UV vis- spectrophotometry. *Journal of hazardous materials*. 170(1): 530-551.
9. Udeagbara, S. G., Ogiriki, S. O., Afolabi, F., Fakorede, O. (2019). Quantitative analysis of heavy metals in produced water from NDX011 in Niger- Delta oil field. *International journal of Petroleum and Gas Engineering Research*. 3(1): 19-33.
10. Fakhru'l, R. A., and Pendashteh, A. (2009). Review of technologies for oil and gas produced water treatment. *Journal of Hazardous materials*. 170(2-3): 530-551.

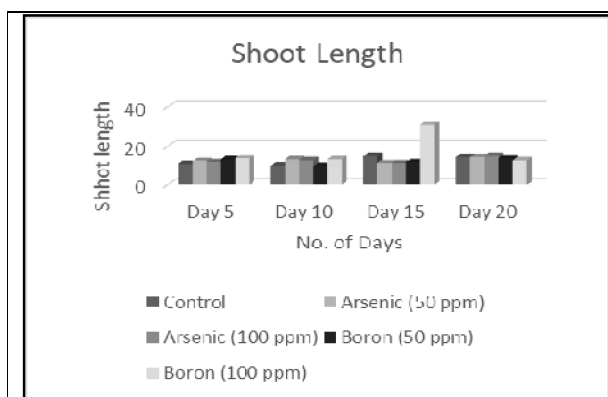


Figure 1 Represents the length of shoot of various treatments.

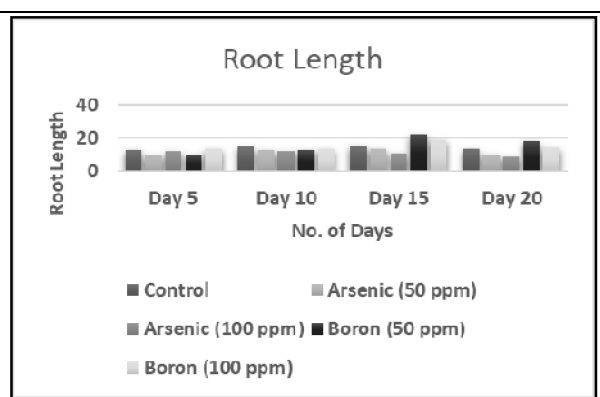


Figure 2 Represents the root length from Day 5 to Day 20.

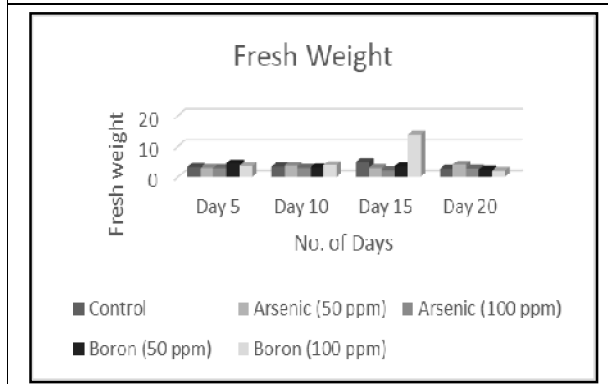


Figure 3 Represents the fresh weight of various treatment.

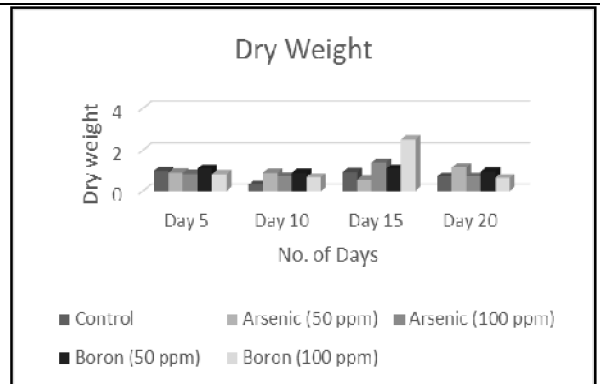


Figure 4 The graph represents the dry weight of the treatments.





Kirti Pandya et al.

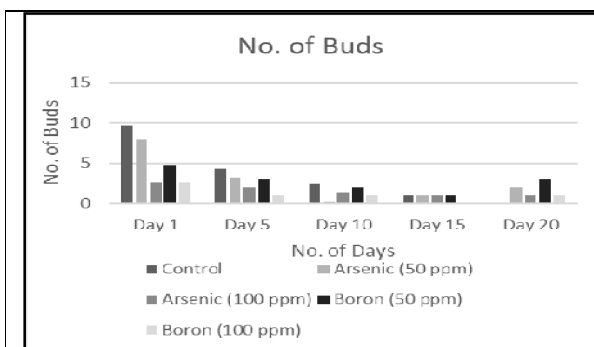


Figure 5 The graph represents the number of buds.

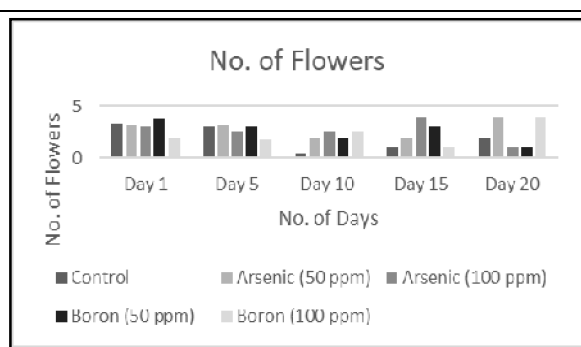


Figure 6 Comparative data of number of flowers.

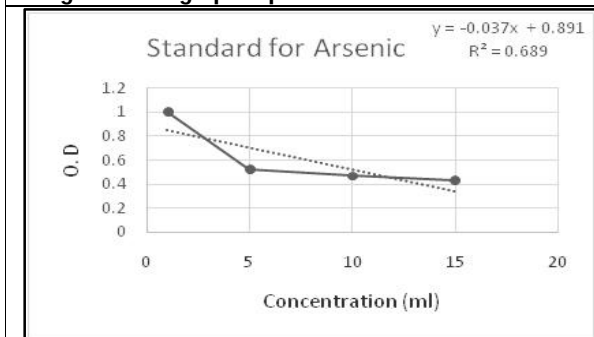


Figure 7 Calibration curve for Arsenic standard solution.

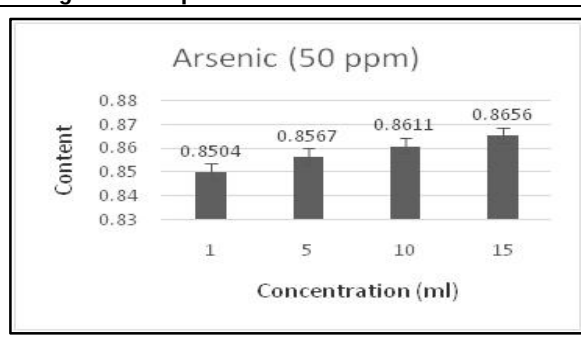


Figure 8 Graph showing the Arsenic (50ppm) set.

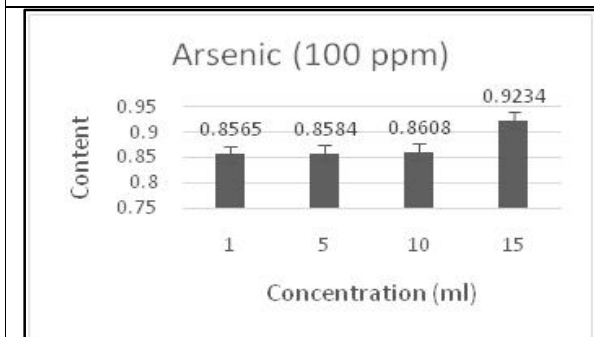


Figure 9 Graph showing the Arsenic (100 ppm) set.

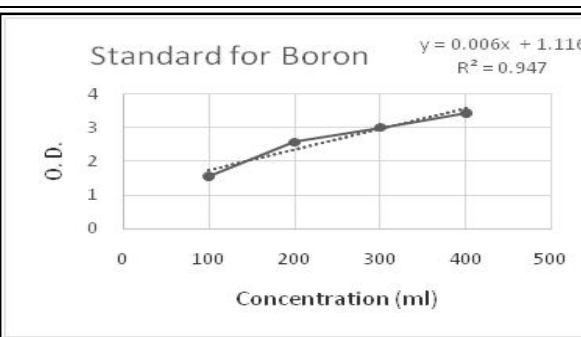


Figure 10 Shows standard calibration curve of Boron.

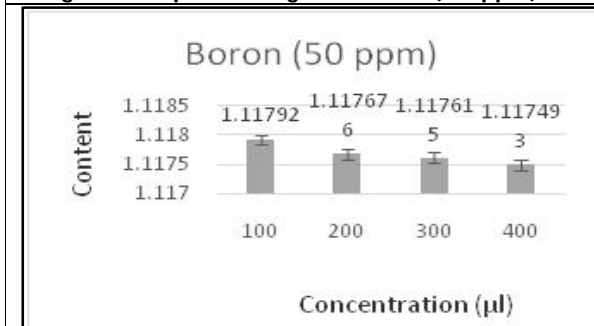


Figure 11 Represents the Boron (50 ppm) treated set.

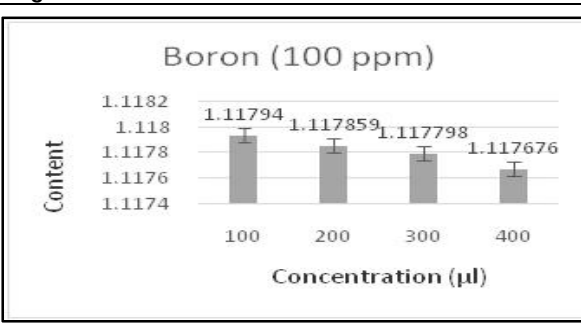


Figure 12 Represents the Boron (100 ppm) treated set.





A Study of NPAS and It's Impact on Productivity

Sheetal Arun Khandre*

Assistant Professor, Department of Social Science and Humanities, Mahatma Gandhi Mission University, Aurangabad, Maharashtra, India

Received: 20 Jan 2022

Revised: 22 Apr 2022

Accepted: 25 May 2022

*Address for Correspondence

Sheetal Arun Khandre*

Assistant Professor,
Department of Social Science and Humanities,
Mahatma Gandhi Mission University,
Aurangabad, Maharashtra, India.
Email: sakhandre7@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The service sector is the most significant economic sector in India. The share of the service sector is estimated at 96.54 Lack Crore (2020-2021) in Indian rupees. In this developing process, the banking sector played a significant role. At present, the asset quality in banks, especially the public sector banks (PSBs), is constantly failing and thus causing insupportable stress to the banking sector, regulators, and the Indian economy. The goal of this study is to recognize the level of Non-Performing Assets (NPAs) in public sector banks (PSBs) and private sector banks (PVBs) and the impact of NPAs on these banks. The study calculated the Gross and Net NPA of PSBs & PVBs from 2015 to March 31 2021. The study identified that both the PSBs and PVBs Gross and Net NPAs are regularly increased in this period. The study found a significant relationship between Gross NPA and Net NPA of PSBs and PVBs. The study calculated the cost-to-income ratio of PSBs and PVBs to see the productivity of the banking sector, and their value is high, which is low means productivity.

Keywords: Non-Performing Assets (NPAs), GDP, Productivity, Public Sector Banks (PSBs), Private Sector Banks (PVBs)

INTRODUCTION

Managing an account segment is the foundation of any monetary framework, and it is vital to ensure that the keeping money framework runs smoothly for a country's economy to function properly. Banks create credits by accepting store and loaning advances, and the funds received from borrowers in the form of interest on advances and repayment of essentials are repurposed to raise funds. Non-Performing Assets (NPAs) typically disrupt the cycle of our monetary framework since they hamper credit growth by affecting banks' profits. NPAs serve as a



**Sheetal Arun Khandre**

measurement for judging banks' performance and failures, and they can inhibit the economy's ability to function and the economy's ability to perform. The number of NPAs reflects the number of credit defaulters of the bank, which dissolves the assets' esteem by influencing the productivity and net worth of the bank. The rise of NPAs has become one of the only calamitous issues for commercial banks worldwide. India the nationalization of the bank in 1969, there has been an impressive rise within the physical nearness of banks. However, at the same time, the benefit and financial soundness of different banks have been adversely affected due to the expanded taken toll of upkeep and the loaning of cash, two masses at a sensible fetch to satisfy the social objective of banks.

The concept of NPAs was first introduced in 1991 by the Narasimhan Committee (Committee on Financial System Reforms). In simple words, an NPAs is a credit or development for the principal sum that has not been paid for more than 90 days. Amounts that have not been paid within 30 days of the due date are considered 'past due.' NPAs are loans that have not been paid back by the borrower, and they become a source of income for the bank because the borrower has not paid the interest. In this case, the advance is considered as past-due debt.

LITERATURE REVIEW

According to Namita Rajput, Anu Priya Arora, and Baljeet Kaur (2011), these considerations are primarily centred NPAs in Indian Open segment banks. It watches that efficient and providing principles and other activities taken by the administrative bodies have pressurized banks to move forward their execution, and subsequently come about into trim down of NPAs and development within the money related wellbeing of the Indian keeping money framework. According to Samir and Deepa Kamra's (2013) research, NPAs are more prevalent in open division banks in India than in private and foreign banks. In essence, the problem of NPAs is more commonplace in the no-need segment than in the need and open sectors. In addition, the SSI department has the most significant percentage of the total NPAs of necessity division. The budgetary health of banks has been severely harmed due to this. They believe that banks in India should adhere to the fundamental norms of financial management to address concerns such as rising NPAs and improving recovery management, corporate management, and reforming innovation, among others.

Banerjee, R., Verma, D., and Jaiswal (2018), have inspected the status of Gross NPAs and Net NPAs in private segment banks and public sector banks to ponder their impact on the resource quality of the banks. Think advance defaulting, destitute credit administration approaches, endorsing of advances without examining the risk-bearing capacity of borrowers are the most reasons for heaping up of NPAs. The banks have to push away a better procedure definition and its legitimate execution. Rigid arrangements by the government may offer assistance in diminishing the level of NPAs. According to Dr Ritu Jain (2018), in her considers, NPAs have a genuinely negative effect on the productivity and liquidity of the keeping money segment. Concurring to her that the issue of NPAs is overseen proficiently can fortified numerous microeconomic problems such as destitution, unemployment, lopsided characteristics of adjusting of instalments, the money advertises.

Singh, Ombir (2018) clarified that due to NPAs, credit creation and reusing get unfavourably. The investigation outlined the Narasimham Committee Report, 1991, which gave numerous suggestions to be actualized within the budgetary division. According to B. Senthil Arasu, P. Sridevi, P. Nageswari, and R. Ramya (2019), the average Gross and Net NPAs of SBI, PNB, and BOI are higher than the usual average of the test banks. From 2014 to 2018, Gross and Net NPAs in public and private sector banks grew steadily. As a result, controllers and individual bank authorities are urged to take the necessary actions to reduce NPAs and advance the recovery process. In addition, it was discovered that there is a significant positive association between Gross NPAs and Net NPAs of public and private sector banks and a critical negative relationship between Gross and Net NPAs with ROA of public and private sector banks.





Sheetal Arun Khandre

Agarwala & Agarwala (2019) analyzed that the private bank is doing over the top with NPAs within the monetary emergency in differentiate to the public sector banks, and there is a straight bearing on the bank's presentation due to the danger of NPAs and NPAs have an unfriendly result and boost on the act of both public and private sector banks. They clinched that all through 2018-19, there has been a preeminent positive degree within the resource qualification of recorded merchantable banks as the Net NPAs proportion has weakened from 11.5% to 9.3% as of Walk 2019. In the Indian Banking sector, the primary point behind the growing NPAs of the open division banks is the inflexible interfering within the effectiveness of public sector banks.

Problem Statement

The NPAs is the circumstance of the Indian keeping money framework as spoken to by 23 banks — 9 public sector banks and 14 private sector banks that have pronounced comes about so distant shows a progressive enhancement within the NPAs proportion in September 2021, concurring to an evaluation by Credit Analysis & Research Ltd (CARE) Ratings. The Gross NPAs (GNPA), the proportion of the previously mentioned banks, have made strides to 6.97% as of September end 2021 against 7.32% as at June-end 2021 and 7.36% as of September-end 2020, the credit rating organization said. The Gross NPA (GNPA) proportion of public sector banks has moved forward to 11.52% as of September-end 2021 against 11.94% as of June-end 2021 and 12.32% as of September-end 2020, concurring to the agency. The Net NPA (NNPA) proportion of private sector banks has made strides to 3.94% as of September-end 2021 against 4.16% as of June-end 2021 and 3.82% as of September-end 2020.

HYPOTHESES OF STUDY

For this study, the following hypothesis has been formulated

- There is a significant relationship between GNPs of the public and the private sector bank.
- There is a significant impact of NPAs on productivity.

OBJECTIVE

- 1) To analyze the NPAs of the public and private sector banks.
- 2) To evaluate the impact of NPAs on productivity.

METHODOLOGY OF THE STUDY

Sample and Sources of data

The study is based on data from **2015 to March 2021** (6 years).

The data is collected through RBI <https://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications#14>.

TOOLS USED FOR ANALYSIS

“Standard Deviation”

Standard Deviation is a calculation that determines how far may be extended. Its depiction is as follows: (the Greek letter sigma). The square root of the Variance is the way.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

Where

x_i is an individual value

μ is the mean/expected value

N is the total number of values

t-Test





Sheetal Arun Khandre

The t-test is a statistical test for comparing the means of two groups. It is frequently used in hypothesis testing to see if a method or treatment affects the population of interest or whether two groups are different.

Only when comparing the means of two groups, can a t-test be employed. Use an ANOVA or a post-doc test to reach more than two groups or make many pair-wise comparisons.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Linear Regression Model

Regression studies show how the representative value of the dependent variable varies when one of the independent variables is changed while the others are kept constant. It may be inferred that an essential link between the independent and dependent variables utilized regression analysis.

$$Y = \beta_1 + \beta_2 x$$

Cost Income Ratio

The cost-to-income ratio is one of the productivity ratios used to instrument an administration's efficiency. It is used to compare a bank's operating expenses to its operating earnings. The lowest value of the cost-to-income ratio is better the company's performance. The cost-to-income ratio is mainly used in determining the productivity of banks. It represents the productivity at which the bank is being run. The lower ratio, the better, and it indicates more productivity of banks. There is an indirect relationship between the cost-to-income ratio and the bank's productivity.

$$CIR = \frac{\text{Operating Expenses}}{\text{Operating Income}} \times 100$$

Limitations of the Present Study

The study covers only six years of the Gross and Net NPA of public sector banks and private sector banks from 2015 to March 2021. Therefore, a comprehensive examination covering a general time has not been completed, which could provide a little unusual outcome.

ANALYSIS AND INTERPRETATION

Table - 1 shows the Gross and NET NPA of public sector banks. This table shows the highest value of gross and net NPA. Table – 2 shows the Gross NPA and Net NPA of private Sector banks. In 2020 and 2021, the private banks will increase the Gross and Net NPA. The highest Net NPA in 2019 is more than 67 thousand Cr. This data shows that the Gross NPA and Net NPA increase in private Sector banks.

LINEAR REGRESSION

$$Y = \beta_1 + \beta_2 x$$

Regression Line Equation

$$\hat{Y} = - 5934.6663 + 0.2138X$$

Y and X relationship

(R²) equals **0.3333**. It means that the value of the Gross NPA of public sector banks and private sector banks is 33.3% of the variability of private sector banks is explained by public sector banks. Correlation (R) is to equal 0.5773. It means that present is a direct relationship between public and private sector GNPA.



**Sheetal Arun Khandre****Goodness of fit**

Overall regression: right-tailed, $F(1, 5) = 2.4992$, $p\text{-value} = 0.1747$. Since $p\text{-value} \geq \alpha (0.05)$, we accept the H_1 .

The linear regression model, $Y = \beta_1 + \beta_2 x$, does not provide a better fit than the model without the independent variable resulting in $Y = b_0 + \varepsilon$.

The Slope (a): two-tailed, $T(5) = 1.5809$, $p\text{-value} = 0.1747$. It is the same as the $p\text{-value}$ for the overall model for one predictor.

The Y-intercept (b): two-tailed, $T(5) = -0.06674$, $p\text{-value} = 1.0506$. Hence b is not significantly different from zero. It is still most likely recommended not to force b to be zero.

Residual normality

The linear regression model assumes normality for residual errors. Shapiro wills $p\text{-value}$ equals **0.1116**. It is believed that the data is usually distributed.

Outliers

The data does not contain any outliers.

Table 4 shows the value of the cost-to-income ratio is more that means low productivity of the banking sector. The productivity is decreasing while the profit level is also going down. Public sector banks' cost-to-income ratio value is more than private sector banks. The public sector banks' deal of the cost-income ratio is highest in 2016 at 82.53%. Chart 3 shows the total net profit of public and private sector banks. In the last five years, the net profit of public sector banks has continuously decreased (2016 to 2020). The highest net profit value is (-85370.52) of public sector banks in 2018.

CONCLUSION

India is a developing country, and the service industry is an essential part of that development. Banks are the keystone of these services in the service sector, so they play a vital role in the economy. The bank industries need to preserve asset quality. The asset quality of public and private sector banks, particularly public sector banks, is continually failing, causing severe stress in the financial industry. The study determines the Gross and Net NPAs of public and private sector banks based on data collected from the RBI from 2015 to March 2021. Public and private sector GNPA Correlation (R) is to equal 0.5773. It means the direct relationship between public and private sector GNPA. There is a significant relationship between GNPA of the public and the private sector bank the first hypothesis is accepted. The value of the cost-to-income ratio is more than productivity. That means there is a significant impact of NPAs on productivity. Both hypotheses of this study are fulfilling, which means the public and private sector bank NPAs are increasing, and their productivity is going downward.

REFERENCES

1. Agarwala, V., & Agarwala, N. (2019). A Critical Review Of Non-Performing Assets in the Indian banking industry. *Rajagiri Management Journal*, 13(2), 12-23. <https://doi.org/10.1108/ramj-08-2019-0010>
2. B. S., L. (2020). Study of Non-Performing Assets in Selected Indian Banks. *ANVESHAK-International Journal Of Management*, 9(1), 50. <https://doi.org/10.15410/aijm/2020/v9i1/149823>
3. Banerjee, R., Verma, D., & Jaiswal, B. (2018). "Non-Performing Assets: A Comparative Study of the Indian Commercial Banks". *International Journal Of Social Relevance & Concern*, 6(2), 01. <https://doi.org/10.26821/ijsrc.6.2.2018.6202>
4. *Banks' gross NPAs may rise to 9.5% in September 2022: RBI report. (2021, December 29). The Economic Times.* <https://economictimes.indiatimes.com/industry/banking/finance/banking/banks-gross-npas-may-rise-to-9-5-in-sept-2022-rbi-report/articleshow/88572587.cms>





Sheetal Arun Khandre

5. Dodia, B. (2020). A Study Of Non-Performing Assets With Selected Scheduled Commercial Banks. Towards Excellence, 127-136. <https://doi.org/10.37867/te120312>
6. Ibrahim, M. (2019). Trend of Non-performing Assets (NPAs) of Indian Commercial Banks-An Analysis. International Journal Of Advances In Management And Economics, 8(5), 01-07. <https://doi.org/10.31270/ijame/v08/i05/2019/1>
7. Jha, P. (2019). Analysis of non-performing assets (NPAs) among SBI bank and ICICI bank for operating 2011–2018. Asian Journal of Research in Banking and Finance, 9(1), 1. <https://doi.org/10.5958/2249-7323.2019.00001.4>
8. Kanoujiya, J., Bhimavarapu, V., & Rastogi, S. (2021). Banks in India: A Balancing Act Between Profitability, Regulation, and NPA. Vision: The Journal Of Business Perspective, 097226292110344. <https://doi.org/10.1177/09722629211034417>
9. Kavitha, N., & Muthukrishna, V. (2019). Impact of Non-Performing Assets on the Profitability in Indian Scheduled Commercial Banks. African Journal Of Business Management, 13(4), 128-137. <https://doi.org/10.5897/ajbm2018.8683>
10. Lele, A. (2021, December 30). *Bank NPAs may go beyond 8% by September 2022, says RBI report*. Business News, Finance News, India News, BSE/NSE News, Stock Markets News, Sensex NIFTY, Latest Breaking News Headlines. https://www.business-standard.com/article/finance/bank-npas-may-go-beyond-8-by-september-2022-says-rbi-report-121123000062_1.html
11. Mishra, B., & Rath, S. (2021). A Comparative Study of Non-performing Assets Using Non-parametric Test: Indian Scheduled Commercial Banks. Arthritis: Journal Of Economic Theory And Practice, 097674792110278. <https://doi.org/10.1177/09767479211027874>
12. Sharma, D. P. (2017). A study of Non Performing Assets Management With Reference To Select Indian Public Sector Banks And Private Sector Banks. *SSRN Electronic Journal*, 4(1), 8. <https://doi.org/10.2139/ssrn.3036419>
13. Sikdar, P., & Makkad, M. (2019). Non-Performing Assets and Capital Adequacy Position: A Study on Selected Public, Private and Foreign Commercial Banks in India. *BULMIM Journal Of Management And Research*, 4(2), 51. <https://doi.org/10.5958/2455-3298.2019.00007.2>
14. Sindhu, D. (2020). An Analysis Of Non-Performing Assets Of Scheduled Commercial Banks In India. *International Journal Of Social Science And Economic Research*, 05(02), 404-416. <https://doi.org/10.46609/ijsser.2020.v05i02.010>
15. Wadhwa, R., & Ramaswamy, K. (2020). Impact of NPA on Profitability of Banks. *International Journal Of Engineering Technology And Management Sciences*, 4(3), 1-8. <https://doi.org/10.46647/ijetms.2020.v04i03.001>

Table 1: Public Sector Banks

Amount in Crore

| Year | Gross NPA | Net NPA |
|---------------------------------|------------------------|------------------------|
| 2015 | 278467.92 | 159951.08 |
| 2016 | 539956.35 | 320375.14 |
| 2017 | 684732.28 | 383088.76 |
| 2018 | 895601.26 | 454472.66 |
| 2019 | 739541.00 | 285122.17 |
| 2020 | 678316.98 | 230917.59 |
| 2021* | 616615.55 | 196450.81 |
| Mean | 633318.76285714 | 290054.03 |
| Standard Deviation (σ) | 177143.25090682 | 96966.930121921 |

* The value March 31 2021

Sources – RBI





Sheetal Arun Khandre

Table 2: Private Sector Bank

Amount in Crore

| Year | Gross NPA | Net NPA |
|---------------------------------|------------------------|------------------------|
| 2015 | 34106.23 | 14128.32 |
| 2016 | 56185.69 | 26677.41 |
| 2017 | 93209.22 | 47780.22 |
| 2018 | 129335.24 | 64380.47 |
| 2019 | 183603.66 | 67380.89 |
| 2020 | 209568.15 | 55683.41 |
| 2021* | 200140.98 | 55808.98 |
| Mean | 129449.88142857 | 47405.671428571 |
| Standard Deviation (σ) | 65596.441983797 | 18374.955474794 |

* The value March 31 2021

Sources – RBI

Table 3 – Gross Non-Performing Assets for Public and Private Sector Banks

Amount in Crore

| | Public Sector Bank | Private Sector Bank |
|-------|--------------------|---------------------|
| Year | Gross NPA | Gross NPA |
| 2015 | 278467.92 | 34106.23 |
| 2016 | 539956.35 | 56185.69 |
| 2017 | 684732.28 | 93209.22 |
| 2018 | 895601.26 | 129335.24 |
| 2019 | 739541.00 | 183603.66 |
| 2020 | 678316.98 | 209568.15 |
| 2021* | 616615.55 | 200140.98 |

Table 4 t-Test

| | t-Test | Mean | N | Std. Deviation | Std. Error Mean |
|-----------|--------|-------------|---|----------------|-----------------|
| PSB G NPA | 6.5338 | 633318.7629 | 7 | 191336.5793 | 72318.4293 |
| PVB G NPA | | 129449.8814 | 7 | 70852.2552 | 26779.6353 |

Table 5 Regression ANOVA

| Source | DF | Sum of Square | Mean Square | F Statistic (df ₁ ,df ₂) | P-value |
|---|----|---------------|-------------|---|---------|
| Regression (between \hat{y}_i and \bar{y}) | 1 | 10037851090 | 10037851090 | 2.4992 (1,5) | 0.1747 |
| Residual (between y_i and \hat{y}_i) | 5 | 20082401310 | 4016480263 | | |
| Total (between y_i and \bar{y}) | 6 | 30120252410 | 5020042068 | | |



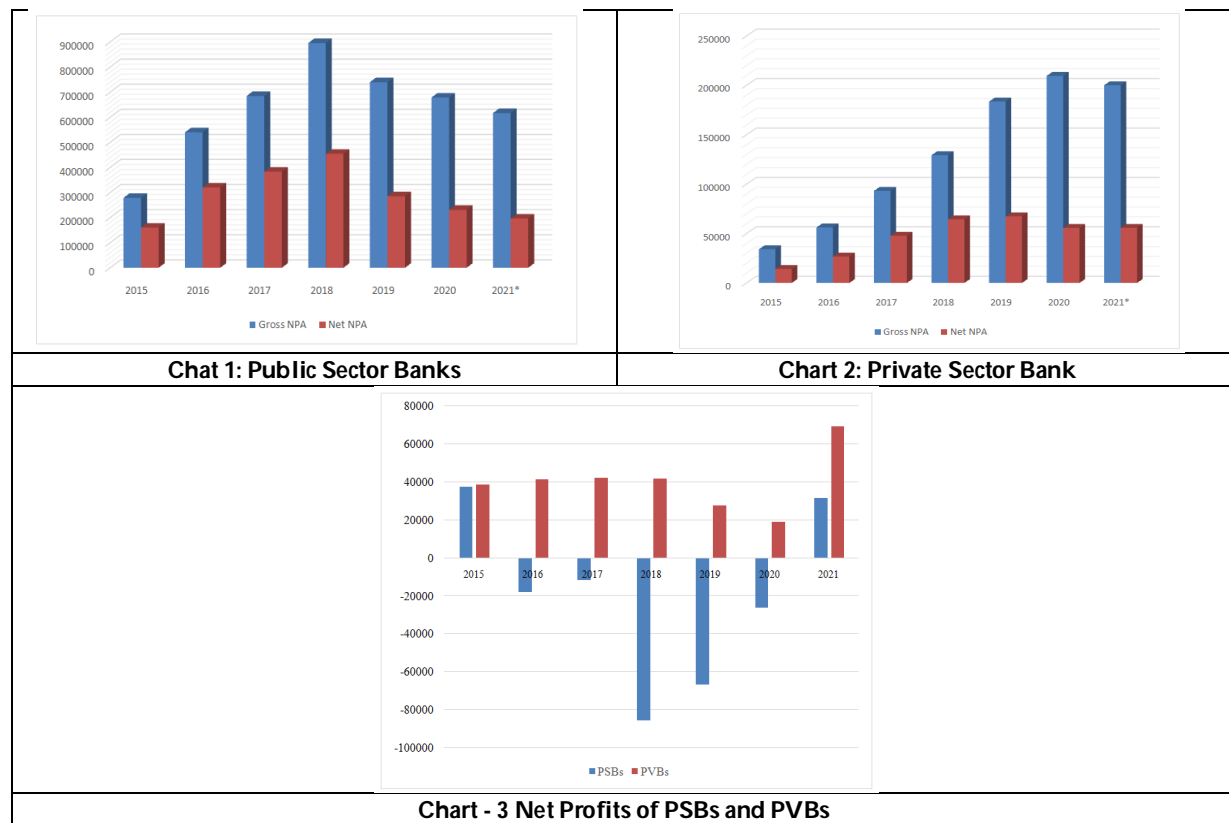


Sheetal Arun Khandre

Table 6 Cost to Income Ratio for PSBs and PVBs

| years | PSB | PVB |
|-------|-----------|-------------|
| 2015 | 81.584987 | 72.81673565 |
| 2016 | 82.533382 | 71.74802028 |
| 2017 | 79.973691 | 70.28309679 |
| 2018 | 79.914029 | 70.06977675 |
| 2019 | 80.704647 | 72.91008656 |
| 2020 | 79.193309 | 70.41322348 |
| 2021 | 76.273589 | 66.50169205 |

CIP > Productivity





Using Poetry for Brainstorming to Enhance Paragraph Writing Skills for ESL Learners

Pramod Kumar Das¹ and Ajit Kumar Pradhan^{2*}

¹Assistant Professor (English), School of Languages, Kalinga Institute of Industrial Technology, (Deemed to be University), Bhubaneswar, India

²Associate Professor (English), Centurion University of Technology & Management, Odisha, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Ajit Kumar Pradhan

Associate Professor (English),
Centurion University of Technology & Management,
Odisha, India



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

“Reading makes a full man, conference a ready man and writing an exact man”. (“Of Studies” Francis Bacon). What we understand from this is writing is about exactness, precision and clarity so that it will be understood effectively. In other words, if one cannot think clearly, he or she cannot write clearly. It focuses on how thinking and writing are linked to a great extent. We have taken two poems from Anand Mahanand’s *Whispering Groves* to examine and see how we can develop paragraph writing after reading and analyzing these poems. As teachers of English language, when we teach poetry in class, we try to make it activity-oriented. In this study, the poems have been used to brainstorm ideas for writing. Based on exploratory model of research paradigm this study used students’ written scripts and semi-structured interviews to ascertain the effectiveness of using poetry for brainstorming to enhance paragraph writing skills. It was noticed that students’ paragraph writing skill, especially coherence, was enhanced in the process. Thus, using poetry has been suggested for brainstorming while teaching writing skills.

Keywords: Paragraph writing, Brainstorming, and Process Writing

INTRODUCTION

The present study intends to find out effectiveness of using poetry as brainstorming to enhance paragraph writing skills of graduate students. Writing is considered to be the most challenging skills among the four basic language skills including listening, speaking, reading and writing. Students, especially those who study English as their second language need to be trained in their writing skills for their academic and professional needs. Paragraph writing skill is the basic to any piece of writing. There are basically two approached to paragraph writing: Product



**Pramod Kumar Das and Ajit Kumar Pradhan**

Approach and Process Approach. In a product approach, the focus is in the result where as in the process approach of writing the focus is given more the process of writing than the end result.

The Process Writing Approach

The process writing approach treats writing as a process rather than an end product. In other words, the focus of the writer primarily remains improving the skills of writing. Thus, the role of teacher in the process of teaching 'process writing' rests in providing constructive feedback in each steps of writing i.e. brain-storming, drafting, editing and redrafting. Unlike product-based approach, which does not help in enhancing learners' writing skills (Murray, 1972), process approach enhances learners' skills of writing. In other words, the process approach focuses on writing skills, whereas the product approach focuses on 'memory'.

Flower and Hayes (1981) have highlighted four approaches of process approach. The first is the process of thinking to jot down key points representing distinctive thought processes. The second is to give a shape to the thought processes. The third is to compose in a goal-directed approach keeping the thinking process in mind and the fourth involves producing many sub-goals. These four points are integrated to produce a coherent piece of writing. Thus, all these stages can be represented as separate five stages: *pre-writing, drafting, editing, revising* and *publishing*. (Bayat, 2014). Thus, brainstorming as a part of pre-writing stage is very significant stage in the process of learning and teaching writing skill.

The Need for Brainstorming

Brainstorming is a process of individual and group thinking aloud process where it leads to an environment of ideation. As an individual and groups many suggestions emerge out of brainstorming. These suggestions can be effectively used to collate, combine, expand, refine and prioritize the information discussed. (Mullen, Johnson & Salas, 1991). Further, brainstorming helps the participants to share their ideas without having inhibitions. In fact, it has been observed that even those who feel shy to participate tend to share their ideas. (Rickards, 1999)

The Present Study

As the students are expected to achieve at least B1 level of proficiency in English as per CEFR (Common European Framework of Reference) for language, the following evaluation criteria was used to evaluate students' written responses.

1. Content: This criterion focuses on the candidate's skills in completing the given task.
2. Communicative Achievement: This focuses whether candidate uses appropriate register to complete the task.
3. Organization: This focuses on the logical order of the written text.
4. Language: This deals with accuracy in grammar and vocabulary.

The following questions were generated based on the above criteria to evaluate the written texts of the students. (Weigle, 2002)

1. Is all the information related to the task?
2. Is the target reader completely informed?
3. Does the writer ensure the use of the conventions of the task in appropriate ways?
4. Does the writer communicate the ideas in a straight forward manner?
5. Is the text connected and coherent?
6. Does the student use basic linking words and number of cohesive devices?
7. Does the student use everyday vocabulary appropriately?
8. Does the student use simple grammatical forms with a good degree of control?



**Pramod Kumar Das and Ajit Kumar Pradhan**

A group of 30 students were part of the experiment. A pre-test was conducted by asking the students write a paragraph (about 100 words) on a familiar topic to them. Further, students were exposed to the two poems from Anand Mahanand's Whispering Groves. (Refer Appendix). Students were asked to brainstorm on the poems and later asked to write a paragraph on one of the poems about 100 words. Students were later asked to provide their opinions through semi-structure interviews. They opined that brainstorming helped them to write the paragraph better. The following three vignettes from students confirm to the concept that using poetry as a brainstorming technique enhances students' motivation.

Vignette-1

"Brainstorming helped me to decide what to write and where to write. It actually helped me to picturize the beginning, body and conclusion of the paragraph before I started to write"

Vignette-2

"Poetry is very close to my hearts and I enjoy doing things with poetry. In the process of writing the poems by Mahananda helped immensely as it created an image in my mind"

Vignette-3

"Planning (Brainstroming) before writing was helpful in my writing and in the process of revising my write-up, I could find my own mistakes and rework on them" The above opinions from the students testify that brainstorming helps immensely in enhancing critical thinking and that supports in better writing.

CONCLUSION

The findings of the study reveal that using poetry as brainstorming helps in enhancing students' paragraph writing skills. As the students get change to think properly before embarking on writing, their writing becomes more coherent with appropriate language. This technique can be recommended to the language teachers to use in their classes.

REFERENCES

1. Bayat (2014). The Effect of Process Writing Approach on Writing Success and Anxiety. *Education Sciences: Theory and Practice*, 1133-1141.
2. Flower, L., & Hayes, J. R. (1981). A cognitive process theory of writing. *College Composition and Communication*, 32(4), 365-387.
3. Mullen, B., Johnson, C. & Salas, E. (1991). Productivity loss in brainstorming groups: a meta-analytic integration. *Basic and Applied Social Psychology*, 12, 3-23.
4. Murray, D. M. (1972). Teaching Writing as a process not product. *The Leaflet*, November, 11-14.
5. Rickards, T., (1999). Brainstorming, in Runco M. & Pritzker, S. Eds, *Encyclopedia of creativity*, 1, 219-228, San Diego: Academic Press.
6. Weigle, S. C. (2002). *Assessing writing*. Cambridge: Cambridge University Press.

Appendix**Fifty Eight****Forward and Backward**

You want us to go back to

Our tradition.

Why do you want us to move backward?





Pramod Kumar Das and Ajit Kumar Pradhan

Do you want us to go backward
While you can move ahead?

You call it identity affirmation
But what is the use of it
When it generates hate and aggression.

We want to march ahead
Breaking the tradition
Because our tradition is dark
We will move ahead with the sway of tide
We are nothing less than any one
We can walk alone
Page 79

Interrogative
Paragraph on Childhood Experience

Fifty Nine

Grandma's Last Story

The story grandma told last night was the last
We will not hear it anymore
With her she took away all the stories of her *muni*.

Even the language she spoke is gone.
We will not hear that tongue
Because the teller doesn't exist
The language that lived and flourished is gone
With all the wisdom.

We can't even recall them
They have really vanished
Into the void. (Page 80)

| | Evaluation Criteria | Before Brainstorming | After Brainstorming |
|---|--|-----------------------------|----------------------------|
| 1 | Is all the information related to the task? | Majority No (60%) | Majority Yes (70%) |
| 2 | Is the target reader completely informed? | Majority No (70%) | Majority No (60%) |
| 3 | Does the writer ensure the use of the conventions of the task in appropriate ways? | Majority No (60%) | Majority Yes (70%) |
| 4 | Does the writer communicate the ideas in a straight forward manner? | Majority No (80%) | Majority Yes (70%) |
| 5 | Is the text connected and coherent? | Majority No (80%) | Majority Yes (70%) |
| 6 | Does the student use basic linking words and number of cohesive devices? | Majority No (80%) | Majority Yes (80%) |
| 7 | Does the student use everyday vocabulary appropriately? | Majority No (70%) | Majority Yes (70%) |
| 8 | Does the student use simple grammatical forms with a good degree of control? | Majority No (80%) | Majority Yes (70%) |





A Study on Online Trading System in Indian Stock Exchanges

Subhramaya Nayak

Asst Professor, School of Management, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Subhramaya Nayak

Asst Professor,
School of Management,
Centurion University of Technology and Management,
Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Trading in stock market is one of the most popular and attracting investment alternative among the investors now a days, especially among the young investors. Due to its easy access, transparency and mobile friendly behavior the young investors are preferring this investment vehicle more than other traditional products. Now a days all the trading and settlement process are taking place through online mode like placing buying and selling orders, opening of Demat and trading account, clearing and settlement of shares, transfer of funds , etc. As we know that in India both the two leading stock exchanges BSE and NSE are providing online trading facilities to the investors. In this article we will discuss about the online trading facilities provided by stock exchanges, advantages, disadvantages and different soft wares and applications provided by the stock brokers.

Keywords: Online Trading, Stock Exchange, financial service, economic growth.

INTRODUCTION

In this era the information Technology has brought out revolutionary changes in the function of stock exchanges in India. Almost all financial service providers are depending more on technology. The new technology has replaced traditional method of trading without the use of technology which was time consuming and inefficient. The technological changes has attracted many new players in the markets which leads to the economic growth of the country due to more circulation of funds. Due to the new trading technologies the volume of trading has also increased. National stock exchange (NSE) first time in India introduced a nationwide on line fully automated Screen Based Trading System (SBTS) . Geojit securities is the first stock broker to go online. Now other stock exchanges have been forced to adopt SBTS and today India can boast that almost 100% trading take place through electronic order matching. Under SBTS, a member can place the order for the quantities and the price at which he likes to transact the transaction for a particular share. It is executed as soon as it finds a matching buy or sell order from a

43059



**Subhramaya Nayak**

counter party. Thus, we can say that technology is used to carry the trading platform from the trading exchanges to the premises of stock brokers. Both NSE and BSE are providing their online trading facilities through their online platform NSE NEAT and BSE BOLT respectively. The online trading facilities is also helping the brokers to settle the intraday and delivery-based trading in a more smoothen way. One can buy or sell shares online only after opening a Demat and trading account with registered depository participant and registered broker respectively. The different steps include to start online trading are:

- Find a broker: First of all, one need to find a registered broker with whom the investor wants to trade. While selecting a broker the investor should consider the account opening charges, brokerage charges, service quality, soft wares or mobile apps provided by the company for trading purpose, etc.
- Open Demat and trading account: After finding a broker the investor has to open a demat account with the registered depository participant and trading account. The documents required to open a trading account are Aadhaar card , PAN card, Bank account details and other KYC documents , valid email id , valid mobile number.
- Login to account and add money : Once the account is opened then the account holder has to add money to the account for trading purpose which is known as margin money.
- Select the company and start trading : After opening the accounts and adding initial margin money the client now can trade.

Objectives

The name of the study itself tells that the basic objective of the study is based on the detail mechanism of online trading .

The main objectives of my study are:

- To know the process of online trading.
- To differentiate between online and offline trading.
- To highlight the advantage and disadvantage of online trading.
- To explain terms related to online trading.

RESEARCH METHODOLOGY

For this study purpose all the data and information has been collected from secondary source like financial websites , books , etc. No statistical tools have been used for the study, it is based on theoretical explanation.

LITERATURE REVIEW

In their research report Walia N. and Kumar R. (2012) examined the investors' preference for traditional trading and online trading, investor's perception on Online trading & comparing current usage of online trading and offline trading. The result of the study said that out of every 100 investors only 28 trade online, which points out a question as why investors were not able to realize the importance of technology in stock trading. In the study they found that Indian investors are conservative, they don't change the brokers frequently. Jaiswal M., Vashist D. and Kumar A (2009) had studies on the growth of online trading from the year 2000 using statistics on volume of online trading, number of e- broking firms, brokerages and demographic patterns. In the result they found that online trading has dramatically changed the way stock business has been conducted over the years. Dr. A Abdul Rahim (2013) has discovered the pitfalls related to online trading in his study "Problems and Prospects of Online Share Trading Practices in India, International Journal of Marketing, Financial Services and Management Research". He suggests that investors should be protected from all hassles and problems so as to remain confident while trading online and also explained about trading and equity related mutual funds. Professor Aadil Bade (2017) on his study "Analysis-Demat account and online trading", which was published in the Scholarly Research Journal for Interdisciplinary studies, said that in India, Online trading is still at its infancy stage.



**Subhramaya Nayak****Online Trading Scenario in Indian Stock Market**

In India the demand for online trading is increasing by day to day due the advancement of technology, increase in awareness among investors regarding stock trading, attractive schemes provided by discount brokers, etc. the broking houses are using their own trading platform for trading purpose by developing some soft wares. Almost all the stock brokers are focusing and following the trading system of the two leading stock exchanges in India Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) . the online trading system for BSE and NSE are popularly known as BOLT (BSE's Online Trading System) and NEAT (National Exchange for Automated Trading).

BSE BOLT

- Bombay Stock Exchange's trading system which is popularly known as BOLT (BSE's Online Trading System). The BSE has deployed an Online Trading system (BOLT) on March 14, 1995
- BOLT has a two-tier architecture. The trader workstations are connected directly to the backend server, which acts as a communication server and a Central Trading Engine (CTE).
- Other services like information dissemination, index computation, and position monitoring are also provided by the system.
- Access to market related information through the trader workstations is essential for the market participants to act on real-time basis and take immediate decisions
- It makes the trade efficient, transparent and time saving.

NSE NEAT

- NSE provides its customers with a fully automated screen based trading system known as NEAT system, in which a member can punch into the computer quantities of securities and the prices at which he likes to transact and the transaction is executed as soon as it finds a matching sale or buy order from a counter party.
- It electronically matches orders on a price/time priority and hence cuts down on time, cost and risk of error, as well as on fraud, resulting in improved operational efficiency.
- It allows faster incorporation of price sensitive information into prevailing prices, thus increasing the informational efficiency of markets.
- The stocks are hold in a demutualised format helping in fast, transparent and efficient preservation and transactions.

The demand for digital trading or online trading by the investors is increasing day by day. As per the data of statista.com "The digital trading market's volume grew by about 49 percent in financial year 2021 across India. This was a steep increase from the previous year's growth rate of ten percent in the country". From the graph 1 we can find that the digital trading volume was just 5% in the year 2017 but in the year 2021 it is 49%. We can also say that by analysing the data that the demand for digital trading has increased rapidly in post covid era that is after 2020 there is a rapid growth has seen in the digital trading. By referring the data provided by statista.com we can also say that "the digital trading market in India grew by about 70 percent in financial year 2021. This was a steep increase from the previous year's growth rate in the country." The digital investments are expected to rise further in the coming years owing to factors like higher digital penetration and increasing household income. The number of Demat accounts also grew by about 35 percent in financial year 2021 across the country. It was an increase from the previous year's growth rate of 14 percent in the country.

Types of Trading Platforms in India

In India almost all brokers are providing their trading software for trading purpose. They are providing their own trading software for desk top , mobile applications for mobile trading and also providing the facility to trade on their website. We can also say that primarily three types of online trading platform are used by traders and investors in India. These are:

- Mobile-based
- Browser-based





Subhramaya Nayak

- Desktop-based

Mobile-based/Mobile App

Mobile trading platform is one that can be accessed by through smartphones by the investors. In mobile trading the broking companies provide a mobile application to the investors and they can trade through the mobile app. The demand for mobile trading is increasing day to day due to its ease in usage, portability and no physical barriers.

Browser-based/Web-based

A browser-based trading platform is one that can be accessed by the investors on a web browser. Almost all the web browsers like Internet Explorer, Mozilla Firefox, and Google Chrome supports this web trading. This platform helps a lot to the investors where access to smartphones and desktops is not accessible.

Desktop-based

in this platform the software can be downloaded and installed on a desktop and laptop. This is certainly the best trading platform in India one can use for trading purpose. In software based trading one can use some shortcut keys like f1/+ to buy , f2/- to sell , f5 for market watch, etc. Some of the popular trading software are ODIN , Zerodha Kite, Sharekhan Trade Tiger, Speed Pro, Trade Station, Trade Eye, Trade Racer, NSE Now , etc.

Benefits of Online Trading

The popularity for online trading is increasing day to day by the investors in this technological era due to a number of reasons. The main reasons include:

- Convenient: Online trading is convenient and accessible from any location with limited hassle and it also saves time.
- One can monitor the investments anytime: By using online trading one can buy and sell the shares as per their convenient time and also can watch their holdings and their market position any time.
- Eliminates the Middleman : It allows the investors to trade virtually with no direct broker communication.
- Investors has greater control: in case of online trading the investors has more control over the trading mechanism. In traditional methos the investors were depended on the brokers for their trading purpose. But in online trading investors can review all their trading related activities without depending on the stock broker in every aspect.
- Multiple options in one place: In online trading platform the investor can invest in other investments like IPO, Bonds, Mutual funds, Gold , etc apart from trading.
- Paperless Transaction: all the transactions are done through online including share certificate get deposited in demat account in electronic format.

Disadvantages of Online Trading

Online trading has a number of advantages for the investors. Like advantages there are also some disadvantages of online trading available in the market like :

- **Technical knowledge:**

The investors should have technical knowledge to operate the online trading platform. Without having the proper technical knowledge one can not utilize all the benefits of online trading.

- **Technological Error**

Sometimes the investor may face some technological error like website may run slow, the internet speed issue, the computer hardware or software problem, the server may go down, and the trading terminus may not be convenient to use.

- **Without proper investment advice could cause big loss.**

Without having proper investment knowledge, one may face some problem during investment. Another thing is that no product knowledge and no product advice from expert could cause a big monetary loss for the investor.



**Subhramaya Nayak**

CONCLUSION

As we know that during the covid19 pandemic the general people get more acquainted with the technology. Another thing is that most of the shares were available at a lower cost than their fare value, that means we can also say that most of the shares were traded undervalued. So, people started more investing in the most attractive investment alternative which leads in the growth of online trading. The demand for online trading increased during the pandemic but we can not say that online trading was not their before pandemic. Now a days almost all broking houses are doing their business through their own trading software. Basically the discounted brokers are providing more attractive schemes to the investors. The number of the investors is increasing day to day in the online stock trading platform due to its lucrative advantages. In the online trading the password play a critical role, so the investors should change their password in a regular interval. The investors should close the trading session before leaving the trading terminal. They should use the two step verification process to protect their account, etc. As it is said that every coin has two sides , in online trading platform there are also some limitations like the advantages. From the above study we can conclude that online trading platform is ease to access, transparent, flexible and other advantages, but while dealing with this online trading world the investors should not enter without having proper technical knowledge related to the access of trading software. Only after getting all the basic knowledge about online trading one should enter in the online trading world.

REFERENCES

1. Advanced Research In Applied Sciences, Volume 7 Issue 3, P.No-51-57, ISSN NO: 2279-543X,Mar/2018
2. Dr.C K Gomathy, Article: A Study on the Effect of Digital Literacy and information Management, IAETSD Journal For
3. Dr.C K Gomathy, Article: A Study on the recent Advancements in Online Surveying , International Journal of Emerging technologies and Innovative Research (JETIR) Volume 5 | Issue 11 | ISSN : 2349-5162, P.No:327-331, Nov-2018
4. Dr.C.K.Gomathy,C K Hemalatha, Article: A Study On Employee Safety And Health Management International Research Journal Of Engineering And Technology (Ijret)- Volume: 08 Issue: 04 | Apr 2021
5. Ichael A. Goldsteina, PavitraKumarb and Frank C. Gravesb “Computerized and high frequency trading” The Financial Review, May 2014, Vol. 49, No. 2
6. Michael A. Goldsteina, PavitraKumarb and Frank C. Gravesb “Computerized and high frequency trading” The Financial Review, May 2014, Vol. 49, No. 2

Websites

- www.5paisa.com
- www.bonanzaonline.com
- www.equityblues.com
- www.outlookmoney.com
- www.statista.com
- www.stockamj.com
- www.thebeststockbroker.com





Essential Oil and Cancer Cells: A Review

Mostofa Hassan Khandakar¹, Surjya Loying², Rajeev Sarmah³, Devabrata Saikia², Hijam Chandramani Singh⁴ and Manash Pratim Sarma^{3*}

¹Assistant Professor, Department of Biochemistry, Faculty of Paramedical Science, Assam Downtown University, Guwahati, Assam, India.

²Assistant Professor, Department of Biotechnology, Assam Downtown University, Guwahati, Assam, India.

³Associate Professor, Department of Biotechnology, Assam Downtown University, Guwahati, Assam, India.

⁴Assistant Professor, Department of MLT, Assam Downtown University, Guwahati, Assam, India.

Received: 22 Mar 2022

Revised: 25 Apr 2022

Accepted: 19 May 2022

*Address for Correspondence

Manash Pratim Sarma

Associate Professor,
Department of Biotechnology,
Assam Downtown University,
Guwahati, Assam, India.
Email: manash3268@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The Essential oils are the volatile components or the secondary metabolites which are produced by a wide range of aromatic plants leaves and flowers. It is complex mixture containing mainly aromatic terpenes classified as monoterpenes and sesquiterpenes. The essential oils can be extracted via steam distillation by the Clevenger apparatus and its composition can be analyzed by GCMS. By doing cytotoxic assay on 96-plated wells and MTT assay, it was found that the essential oil has been shown a promising anticancer activity against a broad range of cancer cell lines like A549, affecting their growth and metastasis in a concentration and time dependent manner. L-scopoletin, nordamnacanthal, camphor, 9-H-pyrido and beta-thujene found on the essential oil can work as a strong anticancer agent against these cancer cells. The essential oil can inhibit the proliferation of these cancer cell lines by inducing apoptosis via intrinsic as well as extrinsic pathways. It will depolarize the mitochondrial membrane integrity and releases cytochrome C that causes apoptosis or cell death. Various cancer causing genes like caspase 3, BAX and BCL2 can be regulated by the action of essential oil on the cancer cells and also it can control the cell cycle via G1 and S-phase arrest by regulating various Cyclins and CDKs. By observing the cancer cells under phase contrast microscope it was also found that there is a formation of structural rearrangements, nuclear damage, chromatin condensation and cytoplasmic shrinkage on these cancer cells. Moreover, the essential oil can delay the adverse side effects of the conventional chemotherapy and increases the efficacy of anticancer drugs along with the combination of the essential oil.





Mostofa Hassan Khandakar et al.,

Keywords: Essential oil, cancer cell line treatment, antimicrobial activity, anticancer activity, GCMS, Cell cycle, CDKs, Cyclins

INTRODUCTION

In the height of developments made in scientific fields, an increase in interest has been raised towards the essential oil in various industries and medicinal fields because of their impeccable biological activities such as anti-microbial, anti-fungicidal, anti-cancerogenic, antioxidant, antiviral, insecticidal and much more. The role of natural antimicrobial agents for food preservation induced by essential oils has been emerged in food industries to increase the shelf life and quality of the products which are beneficial to mankind. Citrus EOs are broadly used as natural food additives in several food and beverage products because they have been classified as generally recognized as safe (GRAS) [1].

Furthermore, Essential oils are used as natural preservatives due to their broad spectrum of biological activities including antimicrobial and antioxidant effects. The presence of terpenes, flavonoids, carotenes, and coumarins is thought to be responsible for the strong anti-oxidative and antimicrobial activities [1, 2]. Essential oils are aromatic volatile compounds found in most of the plant parts such as the leaves, seeds, flowers, bark, fruits and peels. It is complex mixture containing mainly aromatic terpenes classified as monoterpenes and sesquiterpenes according to the number of isoprene units but also phenylpropanoid compounds. These compounds are secondary metabolites formed by isoprenoid pathways in specialized secretory tissues of aromatic plants and diffused at the surface of their flowers or leaves. The biological effects of essential oils have been extensively researched, as they can easily pass through cellular membranes and influence a variety of molecular targets from ion channels to intracellular enzymes [5]. An important characteristic of essential oils and their components is hydrophobicity, which enables them to partition with the lipids present in the cell membrane of bacteria and mitochondria, rendering them more permeable by disturbing the cell structures. This eventually results in the death of bacterial cell due to leakage of critical molecules and ions from the bacterial cell to a great extent. Some compounds modulate drug resistance by targeting efflux mechanisms in several species of Gram-negative bacteria [4, 3].

The presence of terpenes, flavonoids, carotenes, and coumarins is thought to be responsible for the strong anti-oxidative and antimicrobial activities. The monoterpenes act by disrupting the microbial cytoplasmic membrane, which thus loses its high impermeability for protons and bigger ions. Two or more composition of essential oils shows Synergistic activity i.e. the combination of eugenol with linalool or menthol exhibited the highest synergy, suggesting that combination of a monoterpenoid phenol with a monoterpenoid alcohol is effective against a wide range of pathogenic microbes [3].

Experiments on the effect of Essential oil against cancer cells

Gourav et al studied on "Invitro scavenging activity of the essential oil has been found against human colon cancer cell lines by the generation of reactive oxygen species or free radicals that decreases the nitric oxide production in LPS-stimulated J774A.1 cells. It was found that the essential oil can induce the growth of human peripheral blood mononuclear cells (PBMCs) and increases the release of IL-2, IFN-gamma, and TNF-alpha. The EO breaks the mitochondrial membrane integrity while killing the cancer cells. The EO has an immune suppressor activity by killing the colon cancer cells via oil induced human lymphocytes. The antioxidant activity of the EO can be done by using DPPH radical scavenging activity and ABTS radical scavenging activity. The anti-inflammatory activity of the EO which can be analyzed by RBC membrane stabilization and BSA denaturation method in which the EO can stops the denaturation of Albumin. Damascenone found in the essential oil can stop the LPS-induced nitric oxide synthase activity in Raw 2647 macrophages. The EO increases the production of intracellular granulysin protein formation in the cytotoxic granules of CTL and NK-cells which can be act as an immunomarkers for the anti-tumor immune responses [6]."



**Mostofa Hassan Khandakar et al.,**

Fahimeh Salehi et al studied on "Polyphenols like flavonoids found in the essential oil can be act as anticancer agent in a wide range of cancer cells like human breast cancer cell by the generation of reactive oxygen species and reduction of cellular GSH (Glutathione) that will ultimately disturb the mitochondrial membrane integrity and release of cytochrome PARP cleavage which will induce the apoptosis. The essential oil can also activates the p21 that causes G1/S-phase cell cycle arrest via suppressing the mTOR (Mechanistic target rapamycin) and p^{PK1} (protein pyruvate dehydrogenase kinase 1) that will ultimately lead to cell death in the necrotic cells. The essential oil can stops the cellular proliferation of cancer cells by decrease in Cyt C, increase in GST, UGT, and EH in the previous study [7]."

Nidal Jaradat et al studied on "Essential oil can stop the growth of cervical cancer cells due to its anti-proliferative and anti-migratory effect against these cells. By MTT assay it was found that the EO is non-cytotoxic and it will significantly stops the migration of HeLa cells in different doses and time dependent manner [8] in the authors study."

Yousefian Red E et al studied on "Essential oil posse's anti-angiogenic effect on human lung cancer cell lines such as A549 which can be done by chicken chorioallantoic membrane (CAM) assay. Monoterpenes and limonene present in citrus lemon essential oil can be acts as a highly potent antioxidant and anticancer agent. Essential oil can also up regulate the apoptotic genes like Cas-3 that will lead to cell death. Studies on the chick embryo found that on treatment with essential oil there is a decrease in length and number of chick embryo chorioallantoic membrane blood vessel that will indicate that EO has a strong anti-angiogenesis property. This angiogenesis property is basically due to the presence of bioactive compounds such as oxygenated monoterpenes, limonene, alpha-pinene, alpha-terpineol, etc [9]."

Jardak M et al studied on "Increase in percentage of essential oil on human breast adeno-carcinoma cancer cells lines like MC7-7 and HaLa cells will drastically decreases their viability which was basically due to the cytotoxic compounds present in the EO and their interaction with the cancer cells. 1,8-cineole, camphore, alpha-pinene and beta-caryophyllene can act as an effective agent for cancer cell lines and also slow down the migration and growth of cancer cells[10]."

Taheri E et al studied on "The essential oil will kill the cancer cells in a concentration and time dependent manner. More the oil concentration less will be the number of the cancer cells. Some important morphological changes observed after the application of the EO in the cancer cells are cell shrinkage, fragmented nuclei, damaged nuclear membrane and decreased in their size. Moreover by the study of mRNA expression on the cancer cell lines it was found that the EO will upregulate and downregulate the expression of the BAX gene and BCL-2 gene respectively which are responsible for the cell death[11]."

Azadi M et al studied on "The essential oil proposed to inhibit the growth of mouse mammary tumor cells and cervical cancer cells in a dose and time dependent manner. The EO works apoptosis of the cancer cells by inhibiting the growth of both the mono layer and spheroid cancer cells which can be detected by the fluorescent and flow cytometric analysis. The EO will also trigger the activity of caspase -3 protein that will lead to cell death via caspase-3 dependent pathway [12]."

Athamneh et al studied on "The essential oil has an anticancer activity against on the human HT-29 colorectal cancer cell lines that will slow down their growth in a time and concentration dependent manner. Higher dose will significantly decreases the viability and stops the colony forming capabilities of these cancer cells. The extrinsic as well as the intrinsic pathway of apoptosis is generated by the essential oil via cleaved PARP, Caspase-3 and by upregulating the TNF-alpha. There is a decrease in the levels of phosphorylation of mTORC1 at Ser2448 after the treatment of essential oil which will stops the mTOR signaling pathway that will ultimately lead to autophagy in the cancer cells. There is also an increase in phosphorylation of p38 that will start the p38 MAPK pathway that will lead to the apoptosis in the cancer cells [13]."



**Mostofa Hassan Khandakar et al.,**

Abdella AN et al studied on the “Cytotoxic activity was found in the essential oil on the ovarian(A2780) and colorectal(HT.29) cells by decrease in their growth and proliferation which is mainly due to the presence of 1,8-cineole, a oxygenated monoterpene that halt the S-phase of the cell cycle leading to apoptosis [14].”

Pavithra PS et al Studies on “The action of EO in A431 and HaCaT cells found that it will stops the growth and colony formation of these cancer cells via inducing the nuclear condensation, breaking membrane integrity, fragmenting DNA, increase in the content of Sub G1-DNA and generation of ROS levels. Certain compounds such as beta-caryophyllene, 11-eudesmadiene, aromadendrene oxide and phytols which may be responsible for their anticancer activity. Some morphological changes was observed in A431 and HaCaT cells like nuclear beads formation, condensation of chromatin and membrane doubling after the treatment of Eos on these cancer cells that will lead to cell death or apoptosis [15].”

Composition of Essential Oil

The Various anticancer compounds have been found in the EO like L-scopoletin, nordamcanthal, beta-morindone, alpha-copaene, 9-H-pyrido, beta-thujene and terpinolene which are acts as a prominent molecule while destroying the cancer lines in human A549 lung cancer cells. Increase in apoptosis in this cancer cells were observed by the phase contrast microscope due to their loss in their reproducing ability, formation of structural rearrangement, nuclear damage, condensed chromatin fragments and cytoplasmic shrinkage. The EO will also block the cell cycle and stops the DNA polymerase function via generation of ROS in the cancer cell lines. There will be depolarization of the mitochondrial membrane that will trigger the intrinsic apoptotic pathway [16].

Science behind the Role of Essential oil on The Cancer Cell lines:

The essential oil along with conventional chemotherapy will halt the growth of cancer cells as well as delay the adverse side effects of the chemotherapy. The combination of 5-FU along with essential oil can increase the anti metastatic effect that will inhibit the colon cancer cells in invitro conditions. There is also decrease in CXCL8 secretion after the treatment of EO in tumor growth and metastasis that will ultimately slow down the proliferation of these cancer cells. The CXC concentration can be used as a biomarker in cancer patients [17].

The G1-phase of the cell cycle was arrested after the application of EO on the cancer cells which can be analyzed by flow cytometry. There are certain apoptotic proteins such as caspase-3, Bcl-2 and Bax are also regulated by the EO and it was analyzed by western blotting technique that will induce the intrinsic pathway of cell death in A549 lung cancer cells. Citral found on the essential oil can act as a prominent cytotoxic agent against human leukemia cell lines that cause apoptosis in these cells via activating the procaspase-3 [18]. Certain genotoxic and cytotoxic compounds has been identified in essential oil, these are nerolidol, thymol, geraniol, methylisoeugenol, eugenol, linalool, and Agolin blend which can causes methylation DNA damage to HT-29 cancer cells [19].

On the exposure of essential oil a time-dependent increase in the sub-G1 cell death will occur in a culture of A549 and NCI-H358 cells which will generate the exposure of phosphatidylserine (PS) in A549 and NCI-H358 cells. Essential oil will decrease the amount of procaspase-3, -8, and -9 in the cancer cell that will result in activating both the extrinsic as well as intrinsic pathway that will lead to apoptosis in those cancer cells. Moreover the essential oil will rise up the mitochondrial membrane potential which will slow down the action of anti-apoptotic Bcl-2 and Bcl-XL protein levels and elevate the expression of pro-apoptotic Bad that will triggers the caspase activation in A549 and NCI-H358 cells. β -caryophyllene found in the essential oil can act as a potent anti cancer agent since it will minimizes the expression of CDK 2, CDK4, CDK6, cyclin D1, and cyclin E, retinoblastoma phosphorylation and upregulate p21CIP1/WAF1 and p27KIP1 which will cause the G1cell cycle arrest [20].

Role of Essential oil on apoptotic genes and cell cycle check points

Essential oil can has a potent anticancer effect on a variety of cancer cell lines while inducing apoptosis through intrinsic and extrinsic pathway that will depolarize the mitochondrial membrane and releases the cytochrome C [13]. A wide range of apoptotic genes and cell cycle regulatory genes can be controlled by the activity of the essential oil





Mostofa Hassan Khandakar et al.,

or by its bioactive compounds present in the oil. Genes and their protein products such as caspase-3, BCL2, BAX, CDK1, CDKN1B, CDK2, CDK4, CDK6, Cyclin-D, Cyclin-E can be down regulated or upregulated the activity of the essential oil [11].

Essential oil can up regulate the activity of caspase 3 in certain cancer cell lines (A549) which is basically a cysteine-a spartate directed protease that is involved in the activation cascade of caspases responsible for apoptosis execution. It will cause cleavage of many cellular proteins that may result in the chromatin condensation, DNA fragmentation and Blebbing [18]. Normally Caspase-3 exists in the cytosol of cells as an inactive precursor which is proteolytically activated when cells are signed to undergo apoptosis. The apoptosis or programmed cell death can occur in two stages: At first, cleavage of cytosolic caspase-3 and thus activated in a reaction which will release the cytochrome C from the mitochondria; and secondly, the activated caspase-3 communicates with the other cytosolic proteins to generate fragmented DNA when it is added to isolated nuclei. Thus caspase-3 is an essential component for the anti-proliferation or apoptosis of a damaged or cancerous cell. Expression of caspase-3 can be used as a potent marker for various cancer cell lines [21].

The essential oil may down regulate the activity of BCL2 gene in the cancer cells that will trigger the apoptosis. BCL2 is a proto-oncogene and the main function of BCL2 protein is to maintain the integrity of the mitochondrial membrane that will prevent cytochrome c release and its subsequent binding to APAF1 (apoptosis activating factor-1). The BCL2 transcript protein contains all the four BCL2 homology or BH domains (BH1 to BH4). The hydrophobic cleft is constituted by BH1, BH2 and BH3 through which the protein interacts and forms homo- and heterodimers with the pro-apoptotic members of the BCL2 family of proteins [22]. In almost 50% of all human cancers, BCL2 is upregulated, consistent with its role as an apoptotic regulator [23, 24].

Essential oil can also upregulate the activity of the BAX gene which is characterized by five protein coding transcript (alpha/psi, beta, delta, epsilon and sigma) that plays an important role in the mitochondrial apoptotic process. Under stress conditions, it can undergo a conformation change that induces the translocation to the mitochondrion membrane, leading to the liberation of cytochrome c that then triggers apoptosis. BAX also promotes activation of caspase-3, and thereby induce apoptosis [25]. BAX interacts with the BCL2L11, promotes BAX oligomerization and association with mitochondrial membranes, with subsequent release of cytochrome c that will triggers the apoptosis [26]. It forms a homologous protein like BCL2 that triggers the cell death while competing with BCL2. Both BCL2 and BAX are the transcriptional target for p53 that induces cell cycle arrest or apoptosis in response to DNA damage or cancer [31].

Essential oil can arrest the cancer cell division by regulating various cyclins and cyclin dependent kinases. The cyclin D and E, CDK-2, CDK-4 and CDK-6 are down regulated by the essential oil whereas CDK1/CDKN1A/p21CIP1/WAF1 and CDKN1B/p27kip1 are upregulated by the activity of the essential oil in the cancer cell lines [20]. The cyclin D/CDK complex formation will results in phosphorylation and activation of the CDKs. During cell-cycle progression, CDK4 and CDK6 phosphorylate the tumor suppressor pRb thus permits the transition from G1 to the S phase. At the late G1, there is an increased expression of cyclin E, and cyclin E/CDK2 complexes activation is required for the transition from G1 to the S phase. DNA synthesis proceeds when cyclin A binds to CDK2. In end of S phase, cyclin A binds with CDK1. At G2 check point if there is a presence of DNA damage or incomplete DNA synthesis, progression into mitosis is delayed allowing DNA repair or the cycle is aborted [27].

CDK1 or P21CIP1 can be involved in p53/TP53 mediated inhibition of cellular growth in response to DNA damage. It will bind and inhibits cyclin-dependent kinase activity, stops the phosphorylation of critical cyclin-dependent kinase substrates and halt cell cycle progression.[28] CDKN1B:/p27kip1 stops the kinase activity of CDK2 bound to cyclin A, but has low inhibitory activity on CDK2 bound to SPDYA(Speedy protein A) [29]. It is involved in G1 arrest, potential inhibitor of cyclin E- and cyclin A-CDK2 complexes. It also makes a complex with cyclin type D-CDK4 complexes and is involved in the assembly, stability, and modulation of CCND1-CDK4 complex activation [30].





Mostofa Hassan Khandakar *et al.*,

Future challenges

- The compounds present in the essential oil acts as species biomarker and could be useful to monitoring quality and consumer safety.
- The global market size of the essential oils was valued at USD 18.6 billion in 2020 and it is expected to increase at a compound annual growth rate (CAGR) of 7.4% in terms of revenue from 2021 to 2028. This is because of the increasing demand from major end-use industries, such as food and beverage, personal care and cosmetics, and aromatherapy.
- Essential oil can be used as a food coating for increasing the shelf life of the foods as well as protect it from the microbial degradation.
- Essential oil can be used as a next generation medicine due to its high yield antimicrobial activities by killing the antibiotic drug resistant pathogenic microbes.
- Essential oil can overcome the side effects of chemotherapy and chemo-drugs.

Conclusion and summary

By the development of modern science and techniques, the role of essential oil and its application has been increased in a number of sectors like food, medicine, beverage and cosmetic industries due to its antimicrobial, antifungal, anticancer, antioxidant, antiviral activities and more. The essential oils are the secondary metabolites which are produced by a wide range of aromatic plants and flowers. The essential oil can be extracted via steam distillation by Clevenger apparatus and its composition can be analyzed by doing GCMS. The cell toxicity can be analyzed by 96-plate well and by MTT assay and it was found that the essential can stops the cancer cell growth by the concentration and time-dependent manner. Studies on the essential oil also found that the essential oil doesn't affect the proliferation of normal or healthy cells.

Due to its hydrophobic nature, essential oil can easily penetrate in the cell membrane of a pathogenic microbes and cancer cells that disrupt the membrane integrity and polarity. Various compounds found in the essential oil such as limonene, alpha-terpineol, 1, 8-cineole, camphore, L-Scopoletin, geraniol, eugenol, etc can work as a effective agents against a wide range of cancer cell lines like human colon cancer cell lines, HeLa cells, A549 cells and human breast cancer cells that triggers the apoptosis via intrinsic as well as extrinsic pathways apoptosis while releasing the cytochrome C by depolarizing the mitochondrial membrane. The essential oil can regulate variety of cancer causing genes, apoptotic factors, cyclins and CDKs. The essential oil can upregulate the caspase-3 and BAX genes that increases the rate of apoptosis in cancer cells. Similarly, it can down regulate the activity of the activity of BCL2, various cyclins like cycline A, B, C and D and also various CDKs that ultimately causes G1 and S-phase cell cycle arrest.

REFERENCES

1. Dosoky NS, Setzer WN. (1966) Biological Activities and Safety of *Citrus* spp. Essential Oils. Int J Mol Sci. 2018 Jul 5; 19(7).
2. Tsai ML, Lin CD, Khoo KA, Wang MY, Kuan TK, Lin WC, Zhang YN, Wang YY (2017) Composition and Bioactivity of Essential Oil from *Citrus grandis* (L.) Osbeck 'Mato Peiyu' Leaf. *Molecules*.;22(12):2154.
3. Chouhan S, Sharma K, Guleria S. (2017) Antimicrobial Activity of Some Essential Oils-Present Status and Future Perspectives. *Medicines (Basel)*; 4(3):58.
4. Han P, Han T, Peng W, Wang XR. (2013) Antidepressant-like effects of essential oil and asarone, a major essential oil component from the rhizome of *Acorus tatarinowii*. *Pharm Biol*;51(5):589-94.
5. González-Mas MC, Rambla JL, López-Gresa MP, Blázquez MA, Granel A (2019) Volatile Compounds in *Citrus* Essential Oils: A Comprehensive Review. *Front Plant Sci*.5;10:12.
6. Chandan G, Kumar C, Verma MK, Satti NK, Saini AK, Saini RV (2020) *Datura stramonium* essential oil composition and its immunostimulatory potential against colon cancer cells. *3 Biotech*;10(10):451



**Mostofa Hassan Khandakar et al.,**

7. Salehi F, Behboudi H, Kavooosi G, Ardestani SK.(2020) Incorporation of Zataria multiflora essential oil into chitosan biopolymer nanoparticles: A nanoemulsion based delivery system to improve the in-vitro efficacy, stability and anticancer activity of ZEO against breast cancer cells. Int J Biol Macromol;143:382-392
8. Nidal Jaradat, Nawaf Al-Maharik, Samer Abdallah, Ramzi Shawahna, Ahmad Mousa, Abeer Qtishat (2020) Nepeta curviflora essential oil-Phytochemical composition, antioxidant, anti-proliferative and anti-migratory efficacy against cervical cancer cells, and α -glucosidase, α -amylase and porcine pancreatic lipase inhibitory activities, Industrial Crops and Products, Volume 158, 112946, ISSN 0926-6690
9. Yousefian Rad E, Homayouni Tabrizi M, Ardalan P, Seyedi SMR, Yadamani S, Zamani-Esmati P et al (2020) Citrus lemon essential oil nanoemulsion (CLEO-NE), a safe cell-dependent apoptosis inducer in human A549 lung cancer cells with anti-angiogenic activity. J Microencapsule; 37(5):394-402
10. Jardak M, Elloumi-Mseddi J, Aifa S, Mnif S (2017) Chemical composition, anti-biofilm activity and potential cytotoxic effect on cancer cells of Rosmarinus officinalis L. essential oil from Tunisia. Lipids Health Dis.;16(1):190
11. Taheri E, Ghorbani S, Safi M, Seyyed Sani N, Firouzi A moodizaj F, Heidari M et al (2020) Inhibition of Colorectal Cancer Cell Line CaCo-2 by Essential Oil of Eucalyptus camaldulensis Through Induction of Apoptosis. Acta Med Iran.;58(6):260-265.
12. Azadi M, Jamali T, Kianmehr Z, Kavooosi G, Ardestani SK (2020 Jul 15) In-vitro (2D and 3D cultures) and in-vivo cytotoxic properties of Zataria multiflora essential oil (ZEO) emulsion in breast and cervical cancer cells along with the investigation of immunomodulatory potential. J Ethnopharmacol;257:112865.
13. Athamneh K, Alneyadi A, Alsamri H, Alrashedi A, Palakott A, El-Tarabily KA (2020) Origanum majorana Essential Oil Triggers p38 MAPK-Mediated Protective Autophagy, Apoptosis, and Caspase-Dependent Cleavage of P70S6K in Colorectal Cancer Cells. Biomolecules;10(3):412
14. Abdalla AN, Shaheen U, Abdallah QMA, Flamini G, Bkhaitan MM, Abdelhady MIS, Ascrizzi R, Bader A (2020) Proapoptotic Activity of Achillea membranacea Essential Oil and Its Major Constituent 1,8-Cineole against A2780 Ovarian Cancer Cells. Molecules. 30;25(7):1582
15. Pavithra PS, Mehta A, Verma RS (2018) Induction of apoptosis by essential oil from P. missionis in skin epidermoid cancer cells. Phytomedicine. 15;50:184-195
16. Oriana Awwad, Reem Alabbassi, Ismail F. Abaza, Francesca Coperchini, Mario Rotondi, Luca Chiovato & Fatma U. Afifi (2020) Effect of Pistacia palaestina Boiss. Essential Oil on Colorectal Cancer Cells: Inhibition of Proliferation and Migration, Journal of Essential Oil Bearing Plants, 23:1, 26-37
17. Trang DT, Hoang TKV, Nguyen TTM, Van Cuong P, Dang NH, Dang HD et al (2020) Essential Oils of Lemongrass (Cymbopogon citratus Stapf) Induces Apoptosis and Cell Cycle Arrest in A549 Lung Cancer Cells. Biomed Res Int. 11;:5924856.
18. Jamali T, Kavooosi G, Ardestani SK (2020) In-vitro and in-vivo anti-breast cancer activity of OEO (Oliveria decumbens vent essential oil) through promoting the apoptosis and immunomodulatory effects. J Ethnopharmacol ;248:112313
19. Thapa D, Richardson AJ, Zweifel B, Wallace RJ, Gratz SW (2019) Genoprotective Effects of Essential Oil Compounds Against Oxidative and Methylated DNA Damage in Human Colon Cancer Cells. J Food Sci; 84(7):1979-1985.
20. Chung KS, Hong JY, Lee JH, Lee HJ, Park JY, Choi JH et al (2019) β -Caryophyllene in the Essential Oil from Chrysanthemum Boreale Induces G₁ Phase Cell Cycle Arrest in Human Lung Cancer Cells. Molecules.;24(20):3754
21. Ahn C, Lee JH, Park MJ, Kim JW, Yang J, Yoo YM, Jeung EB (2020) Cytostatic effects of plant essential oils on human skin and lung cells. Exp Ther Med.;19(3):2008-2018.
22. Thomadaki, Hellinida & Scorilas, Andreas (2006) BCL2 Family of Apoptosis-Related Genes: Functions and Clinical Implications in Cancer. Critical reviews in clinical laboratory sciences. 43. 1-67.
23. Yip, K., Reed, J. (2008) Bcl-2 family proteins and cancer. Oncogene 27, 6398–6406
24. Cory S, Huang DC, Adams JM. (2003)The Bcl-2 family: roles in cell survival and oncogenesis. Oncogene.;22(53):8590-607.
25. Oltvai ZN, Milliman CL, Korsmeyer SJ(1993) Bcl-2 heterodimerizes in vivo with a conserved homolog, Bax, that accelerates programmed cell death. Cell.;74(4):609-19.





Mostofa Hassan Khandakar et al.,

26. Wei B, Cui Y, Huang Y, Liu H, Li L, Li M, et al (2015) Tom70 mediates Sendai virus-induced apoptosis on mitochondria. *J Virol.* 89(7):3804-18.
27. Ahn C, Lee JH, Park MJ, Kim JW, Yang J, Yoo YM, Jeung EB (2020) Cytostatic effects of plant essential oils on human skin and lung cells. *Exp Ther Med.*; 19(3):2008-2018.
28. Ducoux M, Urbach S, Baldacci G, Hübscher U, Koundrioukoff S, Christensen J, Hughes P. (2001) Mediation of proliferating cell nuclear antigen (PCNA)-dependent DNA replication through a conserved p21(Cip1)-like PCNA-binding motif present in the third subunit of human DNA polymerase delta. *J Biol Chem.*; 276(52):49258-66.
29. McGrath DA, Fifield BA, Marceau AH, Tripathi S, Porter LA, Rubin SM (2017) Structural basis of divergent cyclin-dependent kinase activation by Spy1/RINGO proteins. *EMBO J.*; 36(15):2251-2262.
30. shida N, Kitagawa M, Hatakeyama S, Nakayama K. (2000) Phosphorylation at serine 10, a major phosphorylation site of p27(Kip1), increases its protein stability. *J Biol Chem.*; 275(33):25146-54.
31. Sakuragi N, Salah-eldin AE, Watari H, Itoh T, Inoue S, Moriuchi T, Fujimoto S (2002) Bax, Bcl-2, and p53 expression in endometrial cancer. *Gynecol Oncol.*; 86(3):288-96.

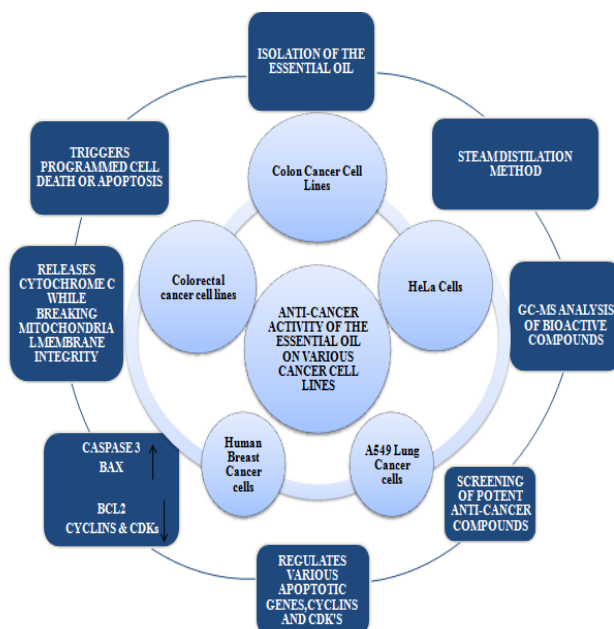


Fig.1. Schematic representation depicts the procedure for essential oil evaluation and its possible relation with the cancer cells.





***Wrightia tinctoria* : A Comprehensive Review On Pharmacognosy And Pharmacological Studies**

Adhithya KV¹, Farsana TM^{1*} and Flowerlet Mathew²

¹VIIIth Semester, B Pharm Student, Nirmala College of Pharmacy, Muvattupuzha, Kerala, India.

²Associate Professor, Nirmala College of Pharmacy, Muvattupuzha, Kerala, India.

Received: 18 Feb 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

***Address for Correspondence**

Farsana TM

VIIIth Semester, B Pharm Student,

Nirmala College of Pharmacy,

Muvattupuzha, Kerala, India.

Email : farsanamoideen999@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Wrightia tinctoria is a deciduous tree of family Apocynaceae mainly found in Asia, Africa, and Australia, and is endemic to Australia, India, Myanmar, Nepal, and Vietnam. According to several literature reviews collected, it is found that *Wrightia tinctoria* most often used in ayurveda, siddha medicine to treat wounds, jaundice, leukaemia, gynecological disorders, seizures, toothache, headache, dandruff and skin disorders like psoriasis, eczema, diarrhoea, scabies etc. They exhibit wide spectrum of pharmacological activities on anti-microbial, antipsoriatic, anti-oxidant, anti-cancer, anti-inflammatory, analgesic, anti-diabetic, diuretic, anti-diarrhoeal, anti-helminthic, hepatoprotective and anti-ulcer properties. The entire plant or parts of plants were used from ancient time onwards. Several investigation on this medicinal plant species have been conducted over the last three decades to provide data in support of its traditional usage. The plant grows in arid, semi-arid and damp climates, as well as a variety of soil types. The aim of this review is to provide extensive information on the geographical- botanical description, pharmacognostical, past pharmacological studies and about patents and certain marketed formulations of *Wrightia tinctoria* which serve as a common platform for further scientific research.

Keywords: *Wrightia tinctoria*, Pharmacognosy, Pharmacological action, Patent, Marketed formulations

INTRODUCTION

Plants are being used to treat various diseases for many years. *Wrightia tinctoria* is a deciduous tree of family Apocynaceae[1]. They are generally known by various names such as Ivory tree, Easter tree, Sweet indrajao and Pala indigo plant. In India, it is locally called by its different vernacular names, the most often used ones are Indrajava, Svetkutaja, Krsnkutaja, Kalakuada and Mitha indrajau [2]. The entire plant or its specific parts such as bark, leaf,



**Adhithya et al.**

seed and root have medicinal properties and have a long history of use by ancient communities in India. Conventionally, *Wrightia tinctoria* used to treat wounds, jaundice, leukaemia, gynecological disorders, seizures, toothache, headache, dandruff and skin disorders like psoriasis, eczema, diarrhoea, scabies. They exhibit wide spectrum of pharmacological activities on anti-microbial, antipsoriatic, anti-oxidant, anti-cancer, anti-inflammatory, analgesic, anti-diabetic, diuretic, anti-diarrhoeal, anti-helminthic, hepatoprotective and anti-ulcer properties [1].

Geographical Distribution and Ecology

W. tinctoria is a plant that may be found in Asia, Africa, and Australia, and is endemic to Australia, India, Myanmar, Nepal, and Vietnam. Western, Central, and Peninsular India are the most common locations for this species. The plant thrives in arid, semi-arid, and damp climates, as well as a variety of soil types. This plant can be found as undergrowth in deciduous forests and is especially widespread along hillsides and valleys. White wood is excellent for turnery, carving, toy making, matchboxes, miniature boxes, and furniture because of its outstanding quality and value[3].

Botanical Description

Table 1 summarize the botanical description of *Wrightia tinctoria*.

Pharmacognostical Studies**Leaves**

The leaf has amphistomatic and dorsiventral arrangement and the stomata are paracytic. Mesophyll differentiate into single layered palisade and spongy tissue of loosely arranged cells. The trichomes are uniseriate and 3-7 celled, thick walled. Adaxial epidermis is having striations. Midrib found to have an arc shaped vascular bundle. The stomatal index found to be 21.0. Vein islet number and vein-let termination number are 21.0 and 21.8 respectively obtained from quantitative microscopy. Transverse section of the fresh leaves are used for histochemical color reactions [2].

Bark

Bark is smooth and yellowish-brown in color. Transverse section of bark comprises tangentially elongated thick walled, suberised 6-8 layers of cork cells, arranged in radial alignment or rows followed by phellogen composed of tangentially elongated parenchyma cells. Phelloderm is parenchymatous and inter spaced with phloem fibers and stone cells. Stone cells are present in the ground tissue of old bark. Parenchyma cells consists of starch grains and prisms of calcium oxalate crystals. Phloem fibers and medullary rays are often uniseriate and few are biseriate [6,7].

Seed

Seeds are brown and flat with a bunch of white hairs at the chalazal end. A comparative pharmacognostical study was carried out on seeds of *Holarrhena antidysenterica* and *W.tinctoria* the species. The seeds of those two taxa have different patterns of folding of cotyledons and spermodermal ornamentation. In the outer epidermal cells of the seed coat, *H.antidysenterica* has a lot of tanniferous deposition, whereas *W. tinctoria* has very little [8].

Root

Root epidermis made of compactly arranged smaller cells with periderm formation has been observed. Multi layered cork is made up of radially aligned rectangular cells. Multi layered cortex and phloem lies beneath it. Phloem cell consist of starch and oxalate crystals. Xylem occupies a significant part and the medullary rays are build up of 1-2 rows of cells. Vessel elements in the roots varies in length and diameter with simple perforations. The tail is short or long with mostly pointed end.Pits are simple, alternate and thickly arranged [2].

Pharmacological Action**Wound healing activity**

The ethanol extract of *W. tinctoria* bark has high wound healing potential, as per a studies [9]. Increased collagen production, cross-linking, and better alignment and maturation all contribute to the pro-healing effect. The presence of triterpenoids in the plant may be to blame for this. *Wrightia tinctoria* ethanolic extract has strong wound healing efficacy [10].Ayurvedic literature mentioned that decoction and poultices which has been prepared from the bark were used for cleaning wounds[9].



**Adhithya et al.****Anti inflammatory activity**

Wrightia tinctoria has been utilized to treat anti-arthritic and anti-inflammatory disorders, according to various studies. Tharkar et al. first reported anti-inflammatory action in *W. tinctoria* bark in 2010, claiming that the aqueous, chloroform, and methanol extracts inhibited kinin and prostaglandin-like mediators, as well as suppressing the proliferative stages of inflammation at a dose of 200 mg/kg. The result found to be statistically significant and the level of inhibition was less than compared to the standard drug, diclofenac. The methanol petroleum ether extracts of the *W. tinctoria* woody stem at the doses of 100, 200 and 400 mg/kg caused inhibition on inflammation in the carrageenan- and histamine- induced rat paw oedema which can be attributed to the presence and synergistic action of flavonoids, steroids and triterpenoids [11]. Anti-inflammatory activity was discovered in the ethyl acetate and aqueous fractions of *W. tinctoria* leaves [12]. Petroleum ether, alcohol, and aqueous alcohol were used to extract the bark of *W. tinctoria*. The rat paw oedema test and macrophage clearance phagocytic index demonstrated that the petroleum ether and alcohol extracts had immunomodulatory action, but the aqueous alcohol extract had none [13].

Anti diabetic activity

Diabetes is one of the common diseases of carbohydrate metabolism, resulted into hypoglycemic condition. Hyperglycemic condition leads to various complications such as retinopathy, nephropathy [2]. Studies prove that anti-diabetic activity of *Wrightia tinctoria* extracts in alloxan induced diabetic rats which could be due to presence of steroids, flavanoids and tannins in methanolic and ethyl acetate extract [9]. *Wrightia tinctoria* bark shown to have alpha glycosidase inhibitory activity at 1500 g/ml, suggesting that it could be used to help diabetic patients control their blood glucose levels [14].

Antiviral activity

The methanolic extract of *Wrightia tinctoria* has the presence of alkaloids and flavanoids. The presence of indole derivatives such as isatin and indirubin, which have potential antiviral action, was discovered in a methanolic extract of *Wrightia tinctoria* utilising several analytical techniques such as UV, TPLC, and HPLC [9].

Anti-nociceptive/anti-analgesic activity

Pain and inflammation are the bodies defense reaction to eliminate or limit the spread of injurious agents from living mammalian tissues. Acetic acid-induced writhing test was used to evaluate *Wrightia tinctoria* bark, in which methanol extract showed to have anti-nociceptive activity comparable to acetyl salicylic acid [15]. The ethanol extract of *Wrightia tinctoria* bark had an antinociceptive and moderate analgesic effect against thermal and chemical stimuli, but not mechanical stimuli, which could be attributed to the presence of steroids [16]. The study also come to the conclusion that *W. tinctoria* didn't have any sedative effects. The ethyl acetate fraction of *W. tinctoria* leaves has analgesic properties and is effective in inhibiting both cerebral and peripheral pain pathways [12].

Antimicrobial activity

The current study by P.vedhanarayanan et al. was designed to test the antibacterial activity of dried *Wrightia tinctoria* leaf. The antimicrobial activity of chloroform, ethanol and methanol extract of *W. tinctoria* was tested using disc diffusion method against chosen experimental pathogen such as *E. coli* and *Bacillus subtilis*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. It is because of their ability to bind extracellular and soluble protein, as well as bacterial cell wall [17]. Nagalakshmi et al. reported that the seed extract of *Wrightia tinctoria* had antibacterial action. The antibacterial activity was also explained using the agar cell diffusion method. The seed extracts, both aqueous and methanolic, were evaluated against gram positive and gram negative bacterial pathogens. Methanolic extract of seed extract was shown to be more efficient against gram positive bacteria than gram negative bacteria, while seed extract from brown and beige kinds inhibited *Staphylococcus citreus* the most. *E. coli*, *P. mirabilis*, and *S. marcescens* were all shown to be susceptible to the brown methanolic seed extract [18].

Uses

Table 2 summarise the uses of *Wrightia tinctoria* [1]



**Adhithya et al.**

LITERATURE REVIEWS

Leaf

Mahadevan N *et al.* 1998, in his work explained that *Wrightia tinctora* is a tree that is frequently used as a traditional medicine in Tamilnadu for pain and inflammation. The latex from the plant, particularly the leaves, is put directly to the irritation. Because *Wrightia tinctoria* is closely related to other *Wrightia* species, pharmacognostical and preliminary phytochemical investigations of its leaves were performed. He discovered the dorsiventral structure in the transverse section of the leaf. The leaf's vascular tissue, which is encircled by a pericyclic fibre, is an important feature. The preparation of the surface reveals paracytic stomata. Leaf constants, ash values, and extractive values are all calculated and kept track of. The transverse section of the leaf, as well as the other criteria described above, are useful for identifying and authenticating the plant in the future [19]. Rajalakshmi G R *et al.* 2012, used HRBC method to test the anti-inflammatory activity of ethyl alcohol and an aqueous extract of *Wrightia tinctoria*. Anti-inflammatory activity was measured by preventing hypotonicity-induced HRBC membrane lysis, and these extracts have biphasic effects. Their effects are compared to those of the common medication diclofenac sodium [20]. Sathianarayanan S *et al.* 2012, in this study explained humoral antibody response for a specific immunological response was used to assess the influence of a methanolic extract of the leaves of the plant *Wrightia tinctoria* on primary and secondary antibody responses. The neutrophil adhesion test for a nonspecific immunological response was used to assess the effect of *Wrightia tinctoria* on neutrophil activation. One-way ANOVA was used to examine the data, followed by Duncan's multiple range test/unit. *Wrightia tinctoria* also exhibits a strong delayed hypersensitive response in increasing doses, with increased activity at 200 mg/kg/bw. By increasing doses, the serum immunoglobulin test elicited a considerable increase in the ethanolic extract of the leaves of the plant *Wrightia tinctoria*, with a maximum at 200 mg/kg/bw [21].

Bark

Khyade Mahendra S *et al.* 2011, in the work compared the bark of *Wrightia tinctoria* and *Wrightia arborea* for phytochemical and antibacterial activity. Both species' bark extracts revealed the presence of alkaloids, phenolics, saponins, and tannins. The antibacterial properties of bark from *W. tinctoria* and *W. arborea* were investigated against gram +ve and gram -ve organisms in various solvents. When compared to *W. tinctoria*, the chloroform extracts of *W. arborea* demonstrated a wider range of antibacterial activity [22]. Y.S.R. Reddy *et al.* 1999, aims to provide a comprehensive list of pharmacognostical characteristics in order to provide a clear standard for drug identification. The bark of *Wrightia tinctoria* is employed as an adulterant in *Holarrhena antidysenterica*, a well-known medicine [7]. Papiya Bigoniya *et al.* 2008, look into the pharmacological profile of *Wrightia tinctoria* hydro-alcoholic extract in mice and rats utilizing diverse models. The extract & effects were detected at three different dose levels 300, 500, and 1000 mg/kg, with no evidence of toxicity up to 3000 mg/kg. Antinociceptive activity was studied using thermal, pharmacological, and mechanical noxious stimuli, as well as pentobarbitone to induce hypnosis. Carrageenan-induced paw edoema model and a cotton pellet-induced granuloma paradigm anti-inflammatory activity was tested. Urine volume and renal excretion of Na⁺, Cl⁻, and K⁺ ions were used to determine diuretic activity. At 1000 mg/kg, the study found a moderate analgesic efficacy against thermal and chemical painful stimuli, as well as anti-inflammatory activity [23].

Fibre

Mothilal B *et al.* 2019, in the project intends to investigate the fibre content, longitudinal view, cross-sectional view, fibre diameter, moisture content, SEM analysis, surface resistivity, swelling, and other characteristics of *Wrightia tinctoria* fibre includes fibre mechanical qualities such fibre strength, elongation, and linearity density, and so on using the pilot. Carding machine made from *Wrightia tinctoria* fibre and cotton blends, Bamboo and polyester in 25:75 and 50:50 blend ratios for GSM were required. Dressing mass and thickness, wound dressing absorbency, dressing dehydration rate, wettability, vertical wicking, air permeability, hydrogen potential, water vapour permeability, and antibacterial properties were all tested on the nonwovens generated. The study's test results were examined in depth, and it was discovered that the production of a product from *Wrightia tinctoria* fibre had enormous potential for curing numerous skin ailments [24].



**Adhithya et al.**

Subramanian K *et al.* 2005, focused on a previously unstudied ligno-cellulosic seed fibre from the plant *Wrightia tinctoria* in order to learn more about its physical features and potential applications in textiles. X-ray diffraction, optical microscopy, and FTIR spectra were used to examine raw and partially delignified fibres for morphological and structural features, thermal properties by thermogravimetry and differential scanning calorimetry, and fibre fineness parameters. Due to the lower fibre rigidity conferred by lignin, the non-spinnable brittle virgin fibre becomes spinnable following partial delignification. Knitted fabrics were successfully manufactured with and without cotton blending [25].

Fruit

Khandekar US *et al.* 2013, in the current research is focused on the phytochemical examination of *Wrightia tinctoria* fruit. Secondary metabolites such as carbohydrates, alkaloids, phytosterols, phenolic compounds, tannins, flavonoids, coumarin, amino acids, terpenoids, and saponins were found in both ethanolic and aqueous fruit extracts during phytochemical screening. The current study also assesses the overall chlorophyll content of fruits with peel and cellulose, revealing a high chlorophyll content in the peel [26]. Sakthivadivel M *et al.* 2019, performed experiment to determine the larvicidal activity of crude aqueous and petroleum ether of *Wrightia tinctoria* fruits and leaves against the filarial vector, *Culex quinquefasciatus*. So the larvicidal activity was evaluated at concentrations of 0.06%, 0.12%, 0.25%, 0.50% and 1.00%. For 24 and 48 hours, larval mortality was detected. He discovered that aqueous fruit extract had the highest larvicidal activity among the plant parts examined, followed by aqueous leaf extract, with LC50 values of 0.17 percent and 0.09 percent; 0.21 percent and 0.11 percent after 24 and 48 hours, respectively [27].

Patent

Table 3 summarise the patent of *Wrightia tinctoria*

The patents clustered together enlist original patent and its division or continuation which may either be accepted or abandoned at present

Marketed Formulations

Some of the marketed formulations are outlined in table 4

CONCLUSION

Wrightia tinctoria is a plant having a wide range of applications in medicine. Our natural environment has supplied an abundant supply of pharmaceuticals, with plants accounting for the majority of these potential medicinal molecules. Wound healing, Anti-inflammatory, Antipsoriatic, Antidiabetic, Antinoceptive, Anticancer, Antidandruff, Antioxidant, Clot producing, Diuretic, Antiviral, Cytotoxicity, and Antiulcer activity are just some of the pharmacological properties of *Wrightia tinctoria*. Based on the findings, we expect that this review will help people become more interested in *Wrightia tinctoria* in the near future, and that it will also be useful in the development of novel formulations of this plant with greater medicinal potential and commercial value.

REFERENCES

1. Rao B, Rajeswari D, Devarakonda R, Battu H. Phytochemical and Pharmacological Studies on *Wrightia tinctoria*. World J. Pharm. Pharm. Sci. 2019. doi:10.20959/wjpps20184-11336
2. Khyade MS, Vaikos NP. *Wrightia tinctoria* R. Br.-a review on its ethnobotany, pharmacognosy and pharmacological profile. Journal of Coastal Life Medicine. 2014;2(10):826-40. doi: 10.12980/JCLM.2.2014C1221
3. Raju AS, Zafar R, Rao SP. Floral device for obligate selfing by remote insect activity and anemochory in *Wrightia tinctoria* (Roxb.) R. Br.(Apocynaceae). Current Science. 2005 May 10;88(9):1378-80.
4. Rao PS, Rao GM, Venkaiah K, Satyanarayana VV. Rooting of stem cuttings of *Wrightia tinctoria* (Roxb.) R. Br.: An important medicinal plant. Indian forester. 1999 Apr 1;125(4):427-8.



**Adhithya et al.**

5. Reddi CS, Reddi EUB and Reddi MS. A novel mechanism of pollination in *Wrightia tinctoria* R.Br. *Curr Sci* .1979 . 48(16): 746-747.
6. Atal CK, Sethi PD. *Wrightia Tinctoria* Bark, an Adulterant of Kurchi. *Journal of Pharmacy and Pharmacology*. 1962 Sep;14(1):41-5.
7. Reddy YS, Venkatesh S, Ravichandran T, Subburaju T, Suresh B. Pharmacognostical studies on *Wrightia tinctoria* bark. *Pharmaceutical biology*. 1999 Jan 1;37(4):291-5. doi.org/10.1076/phbi.37.4.291.5798
8. Jolly CI, Mechery NR. Comparative Pharmacognostical, Physicochemical And Antibacterial Studies On Seeds Of *Holarrhena Antidysenterica* Wall And *Wrightia Tinctoria* R. Br. *Indian journal of pharmaceutical sciences*. 1996;58(2):51.
9. Chandrashekar R, Adake P, Rao SN, Santanusaha S. *Wrightia tinctoria*: An overview. *Journal of Drug Delivery and Therapeutics*. 2013 Mar 15;3(2).
10. Veerapur VP, Palkar MB, Srinivasa H, Kumar MS, Patra S, Rao PG, Srinivasan KK. The effect of ethanol extract of *Wrightia tinctoria* bark on wound healing in rats. *Journal of Natural Remedies*. 2004 Jun 1;4(2):155-9.
11. Sathianarayanan S, Jose A, Rajasekaran A, George RM, Chittethu AB. Diuretic activity of aqueous and alcoholic extracts of *Wrightia tinctoria*. *Phytomedicine*. 2011;2:7-8.
12. Krishnamoorthy JR, Ranganathan S, Shankar SG, Ranjith MS. Dano: A herbal solution for dandruff. *African Journal of Biotechnology*. 2006;5(10).
13. Tharkar PR, Tatiya AU, Surana SJ, Bhajipale NS. Anti-inflammatory study of *Wrightia tinctoria* R. Br stem bark in experimental animal models. *International Journal of PharmTech Research*. 2010;2(4):2434-7.
14. Jain R And Jain SK . Total Phenolic Contents and Antioxidant Activities of Some Selected Anti-cancer Medicinal Plants from Chhattisgarh State, India. *Apoptosis*. 2011;12(13), p.14.
15. ReddyYSR, VenkateshS, Ravichandran T, MuruganV And SureshB. Antinociceptive activity of *Wrightia tinctoria* bark. *Fitoterapia*, 2002;73(5), pp.421-423.
16. BigoniyaP and Rana AC. Absence of central activity in *Wrightia tinctoria* bark ethanolic extract. *Journal of Pharmaceutical Negative Results*, 2010;1(2), pp.51-54.
17. Vedhanarayanan P, Unnikannan P, Sundaramoorthy P. Antimicrobial activity and phytochemical screening of *Wrightia tinctoria* (Roxb.) R. Br. *Journal of Pharmacognosy and Phytochemistry*. 2013 Nov 1;2(4).
18. Nagalakshmi¹ HS, Das A, Bhattacharya S. In vitro Antimicrobial Properties and Phytochemical Evaluation of Mature Seed Extracts of *Wrightia tinctoria* R. Br. *JOURNAL OF PURE AND APPLIED MICROBIOLOGY*. 2012 Sep 1;6(3):1273-9.
19. Mahadevan N, Moorthy K, Perumal P, Raju SV. Pharmacognosy of leaves of *wrightia tinctoria* R. Br. *Ancient science of life*. 1998 Jul;18(1):78.
20. Rajalakshmi GR, Harindran J. Anti-inflammatory activity of *Wrightia tinctoria* leaves by membrane stabilization. *Int J Pharm Sci Res*. 2012;3(10).
21. Sathianarayanan S, Rajasekaran A. Immunomodulatory activity of ethanolic extract of *Wrightia tinctoria* leaves. *immunity*. 2012 Aug 1;5:8.
22. Khyade MS, Vaikos NP. Comparative phytochemical and antibacterial studies on the bark of *Wrightia tinctoria* and *Wrightia arborea*. *Int J Pharm Bio Sci*. 2011;2(1):176-81.
23. Bigoniya P, Shukla A, Agrawal GP, Rana AC. Pharmacological screening of *Wrightia tinctoria* bark hydro-alcoholic extract. *Asian J Exp Sci*. 2008;22(3):235-44.
24. Mothilal B, Prakash C, Ramakrishnan G. Design and development of non-woven medical product from *Wrightia tinctoria* fiber. *Journal of Natural Fibers*. 2019 May 19;16(4):576-88
25. Subramanian K, Kumar PS, Jeyapal P, Venkatesh N. Characterization of ligno-cellulosic seed fibre from *Wrightia Tinctoria* plant for textile applications—an exploratory investigation. *European Polymer Journal*. 2005 Apr 1;41(4):853-61.
26. Khandekar US, Ghongade RA, Mankar MS. Phytochemical Investigation on *Wrightia tinctoria* Fruit. *INTERNATIONAL JOURNAL OF PHARMACOGNOSY AND PHYTOCHEMICAL RESEARCH*. 2013 May 25;5(01):41-4.





Adhithya et al.

27. Sakthivadivel M, Samuel T, Arivoli S, Selvakumar S, Jeyabharathi S, Marin G. Smoke repellency effect of *Wrightia tinctoria* (Roxb.) R. Br.(Apocynaceae) on mosquitoes. International Journal of Mosquito Research. 2019;6(6):124-9.
28. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR.2010; US Patent , US 7,666.450 B2
29. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR. 2013; US Patent , US 8,597.698 B2
30. Rangari VD , BorkarVS , Daud AS,PatniSA and ManeMP. 2011; International Pub No. WO 2011/077455 A2 (Unijules Life Sciences Ltd.).
31. KanaujiaP ,BalakrishnanR, RajanJ andKatageri S.2009; International Pub No. WO 2009/084032 A2 (Vedic Elements Pvt. Ltd.).
32. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR . 2009 ;US Patent, US 2009/0142422 A1.
33. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR.2009; US Patent, US 2009/0123574 A1.
34. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR..2007;US Patent, US 2007/0231415,.
35. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR . 2008;US Patent, US 2008/0160113 A1
36. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR 2007;US Patent, US 2007/0237842 A1
37. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR.2009;US Patent, US 2009/0181113 A1 (Apptec, Inc.)
38. ReddyNBB ,ReddyNRKV, TorgalkarA and MuruganNR. 2008;US Patent, US 2008/0069908 A1
39. ReddyNBB ,ReddyNRKV, TorgalkarAand MuruganNR..2007;US Patent, US 2007/0122498 A1 (Apptec Inc.)
40. Jacob G . 1999; Herbal medication for the treatment of psoriasis,US Patent, US 585837

Table 1: Botanical description of *Wrightia tinctoria*

| | |
|---------------|--|
| Leaves | Opposite, petiolate, glands axillary and glabrous |
| Bark | Smooth with yellowish brown colour and about 10 mm thick producing milky white latex |
| Inflorescence | Terminal and flowers are white, bisexual, actinomorphic and hypogynous, flowers appear in corymb-like cymes, at the end of branches. Flowers are with oblong petals which are rounded at the tip, and are similar to the flowers of frangipani [3] |
| Seeds | With hairs at the chalazal end and they are dispersed by wind [4] |
| Fruits | Mericaarpous in origin, dark green in color and have paired pendulous follicles which is joined at the tips. |
| Reproduction | Autogamous |
| Pollination | Entemophilous without any direct contact of the biotic factor with pollen or stigma [5] |

Table 2 : Uses of *Wrightia tinctoria*

| | |
|-------------------|---|
| Bark | Antidote for snakebite (root bark), Kidney stones (powder), Psoriasis, Cure flatulence, Bilious infections, Urinary problems(with cow's urine), Piles (mixed with sunthi). |
| Wood | Used for all classes of turnery |
| Seed | Non-specific dermatitis, Psoriasis, Cure flatulence, Bilous infections |
| Leaves | Mumps and Herpes(poultice), Food for the cattle,goat and sheep, Relieve toothache(with salt), Treatment of fever (with water). |
| Milk of the plant | Treat tooth gum problems, Stop bleeding |
| Flowers | Used as vegetable |
| Roots | Improving fertility in women |
| Other uses | Anti-dandruff properties-Hair oil preparations, Anti-inflammatory properties, Diarrhoea, Blood pressure, Rheumatoid arthritis, Osteoarthritis, Constipation, Stomach ache, Green manuring rice fields |





Adhithya et al.

Table 3: Patents of *Wrightia tinctoria*

| Patent publication No | Topic | Use |
|-----------------------|--|---|
| US 8,597.698 B2 [28] | Formulations for treatment of skin disorders | Diminishing or regressing dermal tortuosity, reducing spongiform pustules, reversing and regressing stratum granulosum in keratinization disorders. |
| US 7,666.450,B2 [29] | Herbal compositions for the regression of chronic inflammatory skin disorders. | Psoriasis, Eczema and seborrheic dermatitis. |
| WO2011/077455A2[30] | Development of an effective herbal drug formulation for the treatment of sickle cell disease and the process thereof | Sickle cell anemia |
| WO2009/084032A2[31] | Stable hydrophobic topical herbal formulation | Inflammation, dermatitis, Psoriasis, eczema |
| US2009/0142422A1[32] | Herbal compositions for the regression of chronic inflammatory skin disorder | Psoriasis,eczema, seborrheicdermatitis |
| US2009/0123574A1[33] | Composition for the regression of spongiform pustules | psoriasis |
| US2007/0231415A1[34] | | |
| US2009/018113A1[35] | Composition for the reversal of stratum granulosum in keratinisation disorders | Chronic inflammation disorder, Dermal vessel tortuosity, psoriasis. |
| US2008/0160113A1[36] | Composition for the regression of dermal vessel tortuosity | |
| US2008/0069908A1[37] | Compositions for safe and effective regression of dermal vessel tortuosity in psoriatic lesions | |
| US2007/0237842A1[38] | Composition for safe and effective reversal of stratum granulosam in keratinisation disorders | |
| US2007/0122498A1[39] | Composition for safe and effective the regression of dermal vessel tortuosity | |
| US5,858,372[40] | Herbal medication for the treatment of psoriasis | Psoriasis |





Adhithya et al.

Table 4: Marketed formulations of *Wrightia tinctoria*

| Product | Use | Manufacturer |
|----------------------|--|----------------------|
| Winsoria Oil | Psoriasis | Kerala Ayurveda Ltd |
| 777 Oil | Psoriasis | Caredura Products |
| Vetpalai Thailam | Acne, Psoriasis, Dark Spots, Eczema, Skin Redness, fungal infection, insect bite, skin allergy | GBRC |
| Psorease Oil | Psoriasis, Redness | Dr. Stanley's |
| Vettupala Thailam | Psoriasis, dermatitis, dandruff | Vedagiri Herbals |
| Atrisor Shampoo | Psoriasis, Dry, Itchy, Flaky Scalp | ATRIMED |
| Vetpalai Thailam | Psoriasis | SKM Siddha |
| Danthapala Thailam | psoriasis | Vaidyaratnam Bruhath |
| Vetpalai thailam | Psoriasis | Lakshmi Seva Sangam |
| Vetpalai Thailam | Psoriasis | Zigma |
| Psoralin oil | Psoriasis | Dr JRK |
| Nagarjuna Psoria oil | Psoriasis | Nagarjuna |





Effect of Fertilizers Along With Boron on Yield and Quality of Cauliflower (*Brassica oleracea* var. *botrytis* L.) Grown at Central Uttar Pradesh

R. C. Meena¹, M. L. Meena², Razauddin¹, Mayaram¹, V. K. Meena³, A. R. Meena⁴ and S. Maji^{5*}

¹Research Scholar, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, UP, India.

²Associate Professor, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, UP, India.

³Research Scholar, MPUAT, Udaipur, Rajasthan, India

⁴Research Scholar, SKRU, Bikaner, Rajasthan, India

⁵Assistant Professor, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, UP, India.

Received: 15 Mar 2022

Revised: 18 Apr 2022

Accepted: 18 May 2022

*Address for Correspondence

S. Maji

Assistant Professor,
Department of Horticulture,
Babasaheb Bhimrao Ambedkar University,
Lucknow, UP, India.
Email: majisutanu@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Cauliflower is a heavy feeder cole crop, but, indiscriminate use of chemical fertilizers has a detrimental effect on human, soil, plant and environment. Thus, judicious nutrient management is the key to produce cauliflower in a sustainable manner. The field experiment was conducted during *rabi* season of 2018-19 to evaluate fertility levels of inorganic and organic fertilizers and levels of boron on cauliflower. The experiment comprised of 16 treatment combinations with four levels of fertilizers (F0-zero, F1-100% RDF through inorganic fertilizers, F2-75% RDF through inorganic fertilizers +25% through VC and F3-50% RDF through inorganic fertilizers + 50% through VC) and boron levels (F0- 0, F1-1.5, F2-2.0 and F3-2.5 kg/ha) in Factorial Randomized Block Design with three replications. The application of 75% RDF through inorganic fertilizers + 25% through VC resulted the maximum values of yield and quality parameters viz., weight of curd (352.40g), diameter of curd (22.47 mm), volume of curd (154.65 cc), curd yield per plot (5.65 kg), Total curd yield per hectare (261.69 q), Vitamin C (64.25mg/100 g), TSS (7.75° Brix), Total sugars (2.87%), Reducing sugar (1.92%), Non-reducing sugar (1.02%), Total chlorophyll content at harvest (1.27mg/g), as compared to control. Similarly, the application of 2.5 kg Boron/ha resulted the better performance in respect of yield and curd quality parameters. However, in combined

43081



**Meena et al.**

effect it was seen that F2xB2 had maximum yield whereas, F3xB3 showed better quality of curd. Thus, it may be concluded that F2xB2 could be suggested for more production to get more profit whereas, F3xB3 might be recommended for getting better quality cauliflower curds.

Keywords: Boron, Cauliflower, Fertility level, Quality, Yield.

INTRODUCTION

Among the cole crops cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most popular vegetable grown round the year and used extensively in many culinary purposes. India is the largest producer of cauliflower after China having 9083 MT production from 465 ha area [1]. It is grown widely in West Bengal, Bihar, Orissa, Uttar Pradesh, Assam, Haryana, Maharashtra and Rajasthan during *rabi* season. Its flower head is used for cooking for its high nutritive values along with some nutraceuticals. However, cauliflower needs high amount of fertilizers for its good production and known as a heavy feeder cole crop. But, indiscriminate use of chemical fertilizers has a detrimental effect on human, soil, plant and environment. Thus, judicious nutrient management is the key to produce cauliflower in a sustainable manner. Optimum treatment of nitrogen helps in the transformation of carbohydrates into protein beneficial for vegetative growth. It is evident from many researches that along with primary and secondary minerals, micronutrients also play important role for higher yield and better quality. Among the micronutrients, boron is one to deficient growth due to abnormal cell division and show hollow stem disorder in cauliflower. Boron also helps in absorption of nitrogen and has better combination for efficient crop growth resulting good yield and quality [2]. Boron also stimulates auxin activity, reduces the growth retarding endogenous inhibitors and stimulates curd peduncle growth [3]. Use of organics also has a great importance for sustainable plant nutrient management due to its less hazardous nature to environment. It can improve soil texture as well as soil flora and fauna ultimately improve soil health. Use of organic manures like FYM, vermicompost etc can increase the water holding capacity of soil and make soil porous better for good soil aeration. Keeping these views, the present investigation was planned to see the effect of NPK, FYM, vermicompost along with different levels of boron on yield and quality of cauliflower grown in Lucknow.

MATERIALS AND METHODS

The present investigation was conducted at Horticultural Research Farm-I of the Department of Horticulture, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya Vihar, Raebareli Road, Lucknow, UP, India during *rabi* season of 2018—19. The seed of cauliflower variety Pusa Snowball K-1 were sown on nursery beds of Horticulture Research Farm, BBAU, Lucknow, through broadcasting methods on two raised nursery beds of 3 × 1 × 0.15 m size were prepared by mixing well rotten farm yard manure in soil at the rate of 15 kg per square meter. Seeds were treated with 0.02% thiram to check the infection of damping off. Seeds were sown on 12th October, 2018 in shallow furrows 5-6 cm apart by dropping the seeds at 1-2 cm depth. A thin layer of powdered leaf mould was applied to cover the seed. Regular watering, hoeing, weeding, plant protection measures, were done time to time. The seedlings were ready for transplanting within five-six weeks. The experiment comprised of 16 treatment combinations with four levels of each fertility levels (Control, 100% RDF through inorganic fertilizers, 75% RDF through inorganic fertilizers +25% through VC and 50% RDF through inorganic fertilizers + 50% through VC) and boron levels (Control, 1.5 kg/ha, 2 kg/ha and 2.5 kg/ha) in Randomized Block Design with three replications. The application of 75% RDF through inorganic fertilizers + 25% % through VC. the application of 2.5 kg zinc /ha resulted in the maximum and significantly more values of yield and quality parameters viz., weight of curd (g), Diameter of curd (mm), Volume of curd (cc), Curd yield per plot (kg), Total curd yield per hectare (q), Vitamin-C (mg/100 g), Total soluble solid (TSS) (0 Brix), Total sugars (%),Reducing sugar(%), Non reducing sugar(%),Total chlorophyll content at harvest (mg/g). Least significant difference at 5% level was used for finding the significant differences among the treatment means. The data obtained from selected plants were subjected to analysis of variance [4].



Meena *et al.*

RESULTS AND DISCUSSION

Application of 75% RDF through inorganic fertilizers + 25% through VC (F2) observed maximum weight of curd (352.40 g). Application of boron B₃ (2.5 kg/ha) recorded the maximum weight of curd (318.58g). While, combined application of F3 x B1 however showed maximum weight of curd (333.93 g) which influenced the curd yield also. The application of 75 % RDF and 25 % vermicompost (F2) significantly increased the curd yield showing maximum yield of 5.65 kg/plot and 261.6 q/ha. Among the boron application, B₂ (2kg B/ha) had the highest curd yield (5.10 kg/plot and 235.88q/ha). However, in the interaction effect, it was seen that combined application of F2 x B₂ showed the maximum yield of 6.08 kg/plot and 281.48q/ha.

The present findings were also in line with Kumhar *et al.* [5] in cauliflower, Singh *et al.* [6] in broccoli, Mahala [7] in spouting broccoli, Choudhary *et al.* [8] in broccoli and Rai *et al.* [9] in cabbage. The significant improvement in yield and yield attributes with vermicompost might be due to fact that it contains b group vitamins and other characters helpful for soil microflora and fauna resulting better nutrient use efficiency [10]. Further, increased vegetative growth might have provided more sites of translocation of photosynthates, which ultimately resulted an increased in yield. The application of 75% RDF through inorganic fertilizers + 25% through VC (F2) significantly increased the maximum volume of curd (154.65cc) and the application of boron B₃ (2.5 kg/ha), also noted maximum volume of curd (144.70cc). While, it was observed that combined application of F2 x B₂ (2kg B/ha) showed maximum volume of curd (157.3cc). 75 per cent RDF through inorganic fertilizers + 25 per cent through vermi compost (F₂) application showed the maximum diameter of curd (22.63 mm) at harvest. Application of boron (B₃ - 2.5 kg per ha) recorded maximum diameter of curd (20.95 mm) and the interaction effect suggested that combined application of F₂xB₂ showed maximum diameter of curd (23.04 mm).

The application of 75% RDF through inorganic fertilizers + 25% through VC (F2) also noted the maximum TSS was (7.75 ° Brix) and B₃ (2.5 kg/ha) recorded maximum TSS of (7.52 ° Brix). In the interaction effect, it was seen that combined application of F2 x B₂ recorded the maximum TSS (8.01° Brix).in cauliflower curd. The application of 50% RDF + 50% through VC (F3) significantly recorded the maximum Vitamin C content (64.25mg/100gm). and minimum was recorded in the control (45.84mg/100gm). the application of boron B₃ (2.5 kg/ha). noted maximum Vitamin C (56.10mg/100gm) and minimum was recorded in the control (53.58mg/100gm). Combined application of F3 x B₃ however showed maximum Vitamin C (66.55mg/100gm). Maximum total sugar (2.87%) was estimated in the treatment with application of 50% RDF through inorganic fertilizers + 50% through VC (F3). Application of boron B₃ (2.5 kg/ha) determine maximum total sugars (2.80%) in the interaction effect of combined application of (F₂xB₂) showed maximum total sugars (3.08%). Application of boron B₃ (2.5 kg/ha) noted maximum reducing sugar (1.81%) and application of 75% RDF through inorganic fertilizers + 25% through VC (F2) recorded maximum reducing sugar (1.92%). In the interaction effect (F₂xB₂) observed maximum reducing sugars (2.15%). Significantly, F₂ showed the maximum non reducing sugars (1.02%). while the application of boron B₃ (2.5 kg/ha) recorded maximum non reducing sugar (1.09%). (1.18%) was seen in the interaction effect of (F₀XB₁). The application of 75% RDF through inorganic fertilizers + 25% through VC (F2) also observed maximum total chlorophyll content in leave at harvest (1.27mg/g). Application of boron B₃ (2.5 kg/ha) seen maximum total chlorophyll content (1.26mg/g).while interaction effect (F₂xB₂) it was noted maximum chlorophyll content (1.34mg/g).

The results of present investigation revealed that TSS (7.75 °Brix), Total sugars (2.87 %), reducing sugars (1.92 %) and non-reducing sugars (1.02 %) content of cauliflower increased significantly with the application of 75% RDF through inorganic fertilizers and 25% through vermicompost. However, vitamin C (64.25 mg/100 g) was higher with application of 50% RDF through inorganic fertilize and 50% through vermicompost. The increased TSS, total sugar, reducing sugar and non-reducing sugar content might be due to better growth of plant and favourable nutritional environment for supply of nutrients in balanced form and in adequate amount improved efficiency of the plant in terms of physiological aspect and utility might have been achieved through a higher NPK and micronutrient uptake capacity by plant. The results are in close conformity with the findings of Kumhar *et al.* [5] in cauliflower and Choudhary *et al.* [8] in sprouting broccoli. It is established fact that nutrient uptake by the crop depends primarily on





Meena et al.

boron accumulation and secondary nutrient concentration at cellular levels. The results obtained in the present investigation are in close conformity with the findings of Saha *et al.* [11] in broccoli.

CONCLUSION

Results revealed that application of 75 per cent RDF through inorganic fertilizers and 25 per cent through vermicompost along with 2.5 kg/ha boron was found to be the best for yield and quality.

REFERENCES

1. Anonymous (2019). Indian Horticulture Database. Ministry of Agriculture, Government of India, Gurgaon (Haryana).
2. Shirvona, I.P., Skvortsov, V.G., Smirnov, P.S., Iyalin, G.S. (1988). Effect of boron compound on growth process and auxin activity in cauliflower plants. In: mineral nutrient nutrition of plants. Rostov Razvitiya Rosteniil, Kursk, USSR. 21-27.
3. Singh, K. (1991). Manurial requirement of vegetable crop. Indian Council of Agricultural Research: 4-12.
4. Panse, V. G., Sukhatme, P. V. (1961). In: Statistical methods for agricultural workers. 2nd Edn.I.C.A.R., New Delhi.
5. Kumhar, R.D. (2004). Effect of NPK and vermicompost on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Katki. M.Sc. (Ag.) Thesis, Submitted to Rajasthan Agricultural University, Bikaner, Campus-Jobner.
6. Singh, A., Maji, S., Kumar, S. (2014). Effect of biofertilizers on yield and biomolecules of anti-cancerous vegetable broccoli. International Journal of Bio-resource and Stress Management 5(2): 262-268.
7. Mahala, S.C. (2011). Integrated Nutrient Management in sprouting broccoli (*Brassica oleracea* var. *italica* L). Cv. Fiesta. M.Sc. (Ag). Thesis, submitted to Rajasthan Agriculture University, Bikaner, Campus-Jobner.
8. Choudhary, S., Soni, A.K., Jat, N.K. (2012). Effect of organic and inorganic source of nutrient on growth, yield and quality of sprouting broccoli (*Brassica oleracea* var. *italica* L.) cv. CBH. Indian Journal of Horticulture, 69 (4): 550-554.
9. Rai, R., Thapa, U., Mandal, A.R., Roy, B. (2013). Growth, yield and quality of cabbage (*Brassica oleracea* var. *capitata* L.) as influenced by vermicompost. Environment and Ecology, 31 (1A): 314-317.
10. Maji, S., Das, B.C., Sarkar, S.K. (2015). Efficacy of some chemicals on crop regulation of Sardar guava. Scientia Horticulturae, 188: 66-70.
11. Saha, P., Chatterjee, R., Das, N.R. (2010). Effect of foliar application of boron and molybdenum in sprouting broccoli (*Brassica oleracea* var. *italica* P.) under terai region of West Bengal. Research Journal of Agricultural Sciences, 1(4): 335-337.

Table 1: Interactive effect of fertility levels and boron on yield and yield attributes of cauliflower.

| Treatment | Curd yield per plot (kg) | | | | Mean | Total curd yield per hectare (q) | | | | Mean | Volume of curd (cc) | | | | Mean |
|----------------|--------------------------|----------------|----------------|----------------|------|----------------------------------|----------------|----------------|----------------|--------|---------------------|----------------|----------------|----------------|--------|
| | B ₀ | B ₁ | B ₂ | B ₃ | | B ₀ | B ₁ | B ₂ | B ₃ | | B ₀ | B ₁ | B ₂ | B ₃ | |
| F ₀ | 3.61 | 4.27 | 4.09 | 4.2 | 4.04 | 167.00 | 197.68 | 189.35 | 194 | 187.01 | 108.36 | 102.04 | 121.44 | 133.62 | 116.37 |
| F ₁ | 4.76 | 4.92 | 4.89 | 4.83 | 4.85 | 227.77 | 220.37 | 226.38 | 223.61 | 224.53 | 138.16 | 125.91 | 144.51 | 137.84 | 136.61 |
| F ₂ | 5.02 | 5.63 | 6.08 | 5.88 | 5.65 | 260.64 | 232.40 | 281.48 | 272.22 | 261.69 | 153.88 | 162.04 | 147.05 | 155.63 | 154.65 |
| F ₃ | 5.1 | 5.34 | 5.04 | 5.48 | 5.24 | 247.22 | 236.11 | 233.33 | 253.70 | 242.59 | 139.03 | 152.89 | 157.93 | 151.69 | 150.39 |
| Mean | 4.62 | 5.04 | 5.03 | 5.10 | | 225.66 | 221.64 | 232.64 | 235.88 | | 134.86 | 135.72 | 142.73 | 144.70 | |
| SEm± | | F | 0.06 | | | 2.78 | | | | | 2.32 | | | | |
| | | B | 0.06 | | | 2.78 | | | | | 2.32 | | | | |
| | | FxB | 0.12 | | | 5.56 | | | | | 2.64 | | | | |
| CD (P≤0.05) | | F | 0.18 | | | 8.07 | | | | | 6.73 | | | | |
| | | B | 0.18 | | | 8.07 | | | | | 6.73 | | | | |
| | | FxB | 0.12 | | | 16.14 | | | | | 13.45 | | | | |





Meena et al.

Table 2: Influence of fertilizers and boron on curd weight and diameter of cauliflower.

| Treatments | weight of curd (g) | | | | | Diameter of curd (mm) | | | | |
|----------------|--------------------|----------------|----------------|----------------|--------|-----------------------|----------------|----------------|----------------|-------|
| | B ₀ | B ₁ | B ₂ | B ₃ | Mean | B ₀ | B ₁ | B ₂ | B ₃ | Mean |
| F ₀ | 266.87 | 225.62 | 255.62 | 262.05 | 252.54 | 16.81 | 19.04 | 17.64 | 18.19 | 17.92 |
| F ₁ | 297.31 | 307.05 | 307.68 | 303.75 | 303.95 | 20.88 | 16.05 | 20.34 | 19.97 | 19.31 |
| F ₂ | 313.56 | 349.81 | 380 | 366.22 | 352.40 | 22.26 | 21.67 | 23.04 | 22.89 | 22.47 |
| F ₃ | 299.12 | 333.93 | 315.18 | 342.31 | 322.64 | 21.78 | 21.07 | 20.98 | 22.1 | 21.48 |
| Mean | 294.22 | 304.10 | 314.62 | 318.58 | | 20.43 | 19.46 | 20.50 | 20.79 | |
| SEm± | F | 2.55 | | | | 0.20 | | | | |
| | B | 2.55 | | | | 0.20 | | | | |
| | FxB | 5.11 | | | | 0.41 | | | | |
| CD (P≤0.05) | F | 7.41 | | | | 0.60 | | | | |
| | B | 7.41 | | | | 0.60 | | | | |
| | FxB | 14.83 | | | | 1.20 | | | | |

Table 3: Effects of fertility levels and boron on ascorbic acid, TSS and total sugars of cauliflower.

| Treatments | Ascorbic acid (mg/100g) | | | | | TSS (%) | | | | | Total sugars (%) | | | | |
|----------------|-------------------------|----------------|----------------|----------------|-------|----------------|----------------|----------------|----------------|------|------------------|----------------|----------------|----------------|------|
| | B ₀ | B ₁ | B ₂ | B ₃ | Mean | B ₀ | B ₁ | B ₂ | B ₃ | Mean | B ₀ | B ₁ | B ₂ | B ₃ | Mean |
| F ₀ | 45.84 | 47.01 | 48.12 | 46.1 | 46.77 | 6.97 | 7.18 | 7.24 | 7.02 | 7.10 | 2.11 | 2.51 | 2.76 | 2.5 | 2.47 |
| F ₁ | 49.89 | 51.14 | 50.59 | 54.71 | 51.58 | 7.53 | 6.99 | 7.14 | 7.84 | 7.38 | 2.55 | 2.88 | 2.13 | 2.69 | 2.56 |
| F ₂ | 52.38 | 58.61 | 63.97 | 57.02 | 58.00 | 7.69 | 7.98 | 8.01 | 7.31 | 7.75 | 2.58 | 2.84 | 3.08 | 2.97 | 2.87 |
| F ₃ | 66.19 | 63.17 | 61.08 | 66.55 | 64.25 | 7.11 | 7.30 | 7.01 | 7.89 | 7.33 | 2.98 | 2.92 | 2.54 | 3.02 | 2.87 |
| Mean | 53.58 | 54.98 | 55.94 | 56.10 | | 7.33 | 7.36 | 7.35 | 7.52 | | 2.56 | 2.79 | 2.63 | 2.80 | |
| SEm± | F | 0.57 | | | | 0.04 | | | | | 0.05 | | | | |
| | B | 0.57 | | | | 0.04 | | | | | 0.05 | | | | |
| | FxB | 1.14 | | | | 0.08 | | | | | 0.11 | | | | |
| CD (P≤0.05) | F | 1.65 | | | | 0.13 | | | | | 0.16 | | | | |
| | B | 1.65 | | | | 0.13 | | | | | 0.16 | | | | |
| | FxB | 3.30 | | | | 0.25 | | | | | 0.32 | | | | |

Table 4: Effect of fertility levels and boron on sugars in curd and chlorophyll content in leaves of cauliflower.

| Treatments | Reducing sugar (%) | | | | | Non-reducing sugar (%) | | | | | Total chlorophyll content at harvest (mg/g) | | | | |
|----------------|--------------------|----------------|----------------|----------------|------|------------------------|----------------|----------------|----------------|------|---|----------------|----------------|----------------|------|
| | B ₀ | B ₁ | B ₂ | B ₃ | Mean | B ₀ | B ₁ | B ₂ | B ₃ | Mean | B ₀ | B ₁ | B ₂ | B ₃ | Mean |
| F ₀ | 1.34 | 1.51 | 1.58 | 1.47 | 1.48 | 0.76 | 1.18 | 1.04 | 0.99 | 0.99 | 1.08 | 1.18 | 1.14 | 1.23 | 1.16 |
| F ₁ | 1.54 | 1.57 | 1.64 | 1.98 | 1.68 | 1.01 | 0.79 | 0.9 | 1.12 | 0.96 | 1.19 | 1.29 | 1.13 | 1.28 | 1.22 |
| F ₂ | 1.74 | 1.82 | 2.15 | 1.97 | 1.92 | 0.99 | 0.89 | 1.08 | 1.1 | 1.02 | 1.16 | 1.24 | 1.34 | 1.32 | 1.27 |
| F ₃ | 1.99 | 1.92 | 1.65 | 1.82 | 1.85 | 0.84 | 0.93 | 0.87 | 1.15 | 0.95 | 1.17 | 1.15 | 1.26 | 1.22 | 1.20 |
| Mean | 1.65 | 1.71 | 1.76 | 1.81 | | 0.90 | 0.95 | 0.97 | 1.09 | | 1.15 | 1.22 | 1.22 | 1.26 | |
| SEm± | F | | 0.01 | | | 0.01 | | | | | 0.02 | | | | |
| | B | | 0.01 | | | 0.01 | | | | | 0.02 | | | | |
| | FxB | | 0.03 | | | 0.03 | | | | | 0.05 | | | | |
| CD (P≤0.05) | F | | 0.04 | | | 0.05 | | | | | 0.07 | | | | |
| | B | | 0.04 | | | 0.05 | | | | | 0.07 | | | | |
| | FxB | | 0.09 | | | 0.10 | | | | | N/S | | | | |





Current Approaches and Challenges of Polymeric Nanoparticles in the Treatment of Brain Tumor

Ladi Alik Kumar^{1*}, Gurudutta Pattnaik¹, Bhabani Sankar Satapathy², Chandra Sekhar Patro¹ and Swagatika Das¹

¹Centurion University of Technology and Management, Odisha, India

²School of Pharmaceutical Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Received: 06 Mar 2022

Revised: 07 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Ladi Alik Kumar

Asst Professor,

School of Pharmacy,

CUTM, Rayagada

Email: alikkumar3@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License (CC BY-NC-ND 3.0)** which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Gliomas were among the worst types of brain cancer, despite breakthroughs in treatment. The average survival time is only 15 months despite advances in treatment. Due to poor BBB penetration, especially by hydrophilic medications, traditional chemotherapy does not deliver the appropriate dose of drugs to tumours. Low molecular weight drugs also have a short circulation half-life and are unable to acquire selective accumulation in malignant cells. When compared to administering a free drug, nanoparticles could be developed to penetrate the BBB and distribute their drugs within the brain, increasing their therapy efficacy. Polymeric nanoparticles, in particular, have showed tremendous promise due to their unique features, such as great tunability, simplicity of manufacturing, and control over drug release profiles. The implications of particle size, shape, and surface changes on BBB penetration are explored in this study of polymeric nanoparticle systems for drug delivery to the central nervous system. Moreover, the paper will discuss the potential of polymeric nanoparticles in the treatment of malignant gliomas, as well as how coatings and functionalizations can affect their ability to cross the blood-brain barrier.

Keywords: Blood Brain Barrier, High Grade gliomas, Brain tumor, Good health

INTRODUCTION

Cancer is widely regarded as the leading cause of death worldwide. Despite decades of research and billions of dollars invested in improving our understanding of the underlying mechanisms of carcinogenesis, cancer-related mortality remains high today[1]. Glioblastoma (GBM) is the majority prevalent type of primary brain tumours in



**Ladi Alik Kumar et al.**

adults and is considered the most fatal and severe form of brain cancer. It affects over 600,000 people in the United States[2]. In the United States, over 25000 new instances of brain cancer are reported each year, with nearly 15000 deaths[3]. Primary brain tumours are among the most complex malignant tumours to treat, as they are seldom cured and have a 5-year overall survival rate of only 35%. In adults, gliomas are most prevalent type of malignant primary brain tumour[4]. Glioma cells were divided as low grade (WHO- I and II) and high grade (WHO- III and IV) based on their potential to infiltrate and metastasis to surrounding brain regions. Gliomas comprise the propensity to invade nearby tissue, making it difficult to detect their margins[5]. As a result, traditional therapeutic procedures are ineffective in producing a curative outcome. Furthermore, the physical and chemical barriers that prevent medications from accessing tumour locations contribute to the difficulties in developing viable therapeutic approaches. There are two main barriers preventing medications from entering the brain unless they meet certain criteria: the blood brain barrier (BBB) and the blood brain tumour barrier (BBTB) which represented in image 1 and 2. Because most of the procedures are obtrusive and have significant side effects, therapeutic strategies should focus not only on extending lives but also on changing patients' life by eliminating side effects[6]. The utilize of polymeric nanoparticles for drug delivery and targeting is one of the most advanced therapeutic methods. In vitro and in vivo investigations for drug-loaded nanoparticles targeting gliomas have exposed encouraging results, as will be complete further in this review[7]. As a result, greater effort should be put into developing these nanomedicines in provisions of loading efficiency, coating, and capacity to aim gliomas[8].

High Grade Gliomas

Tumors of glial cells, which are available in the brain and spinal cord, are known as high-grade gliomas. High-grade tumors are increasing and spread very fastly through brain tissue, making them treat difficult[9]. The most common malignant brain tumor in adults is a glioma, and 75% of these are high grade gliomas (HGG) affecting the central nervous-system (CNS). Each year, the incidence rate is 3-5 % per 100,000, with the majority of victims being men. Especially in the fifth and sixth decades of life, HGG is more likely to strike than at any other age[10]. High-grade gliomas are classified according to where they are located and how they show under a microscope[11]. Tumor classification helps decide how the disease develop, and which treatment is most effective. In 2016, the WHO recognized and reported genetic and molecular factors associated with gliomas. Among these factors are the mutation status of isocitrate dehydrogenase (IDH), the co-deletion status of 1p/19q, and the mutation status of the X-linked protein/gene (ATRX) associated with alpha thalassemia/mental retardation syndrome[12]. The World Health Organization classifies grade III tumours, including anaplastic astrocytomas, anaplastic oligodendrogliomas, and mixed anaplastic oligoastrocytomas, as well as grade IV glioblastomas, in 2016 as HGGs. HGGs, which constitutes up to 60–70% of all cases of GBM, have the highest incidence rate[13]. Approximately 10 to 15 percent of cases are anaplastic astrocytomas. On the other hand, anaplastic oligodendrogliomas and anaplastic oligoastrocytomas have a 10% incidence rate. Ionizing radiation has only been recognised as a prospective risk factor for HGGs, but the major cause is still unknown[14].

Treatment

Resection Surgical

The location, grade, and form of the tumour will find out whether or not surgical excision is possible[15]. Patients having high-grade tumours entail near-complete excision to minimise the tumor's burden and pressure inside the skull, results enhances the patient's chances of survival. Because GBM is invasive, surgical resection cannot completely cure it, and 80% of patients result in decline in a size of 2-3 cm of the initial tumour border[16].

Radiation Therapy

Radiation therapy (RT) is the usual treatment strategy for HGGs and can be given internally or externally[17]. The usual external RT treatment consists of 25 to 35 treatments per day for 6 to 8 weeks. Total radiation dose is determined by a number of criteria, including the tumour location, grade, histology, and the degree of resection. In the 1970s, a randomised trial found that after surgical resection, total brain irradiation with 60 Gy improved survival for patients with HGG. As a result, RT has become a routine therapy for HGG tumour elimination[18]. On the other hand, research comparing fractional and complete brain irradiation for HGG treatment found that total brain



**Ladi Alik Kumar et al.**

irradiation did not present any additional advantage when compare to part irradiation of the brain. Though, using tomography and magnetic resonance to maintain a partial irradiation of the brain for HGG instances, there was an expansion in delineation accuracy[19]. The advancements in imaging and RT have allowed for larger doses of irradiation of tumour locations while lowering the volume of normal brain tissue bare to irradiation. As a result, involved field RT was approved as the gold standard of care for HGGs. However, with efforts to target invading tumour cells, the issue of RT delivery for smaller surface areas remnants contentious[19]. Fixed field intensity modulated RT (IMRT), dynamic arc IMRT, volumetric-modulated arc treatment (VMAT), and stereotactic radiosurgery are some of the approaches that have been acknowledged for providing better focused irradiation to tumour tissues (SRS) [20]. These strategies have been shown to provide a more targeted approach to afflicted tissues while lowering toxicity to healthy tissues . SRS is a treatment for recurrent GBM that is used as a supplement to external beam RT. The utility of SRS for the treatment of newly diagnosed malignant gliomas, on the other hand, is still under investigation[21]. Interstitial RT, also known as brachytherapy, is a type of RT in which radioactive material is surgically placed inside the tumour. Proton treatment, rather than photon irradiation, may be utilised to help target damaged areas [22]. RT has some drawbacks, with necrosis of normal brain tissue, neuronal injury, and tumour cell radiation resistance [23].

Chemotherapy

In patients with HGG, the chemotherapeutic medication temozolomide (TMZ) is used in grouping through RT to increase patient survival rates[24].. In Clinical Trial Phase III, this procedure, called as Stupp protocol, revealed a medium endurance rate of 15.8 months comparing to 12.2 months (when RT alone was delivered) [25]. After completing RT treatment, TMZ is given every day dose of 75 mg/m² for 6 weeks, followed by a 30 days rest period. In the first month, TMZ treatment resumes with a everyday dose of 150 mg/m² for 6 days. If the patient can tolerate this amount, a higher daily dose of 200 mg/m² is given for 5 successive days each month awaiting the treatment stage is finished[26]. Following RT, the stupp regimen administers TMZ therapy for 6 months. Over a 5yr medication period, the synergistic impact of combination therapy with RT and adjuvant chemotherapy with TMZ persisted. Additionally, individuals with a methylated gene promoter encoding O-6-methylguanine-DNA methyltransferase benefited more from the addition of TMZ. (MGMT) [27]. As a result, MGMT was identified as the first biomarker in brain tumours to assist predict the responsiveness to TMZ treatment and consequently choose patients . Except in senior GBM patients, MGMT is unreliable in patients who not have a methylated promoter of MGMT[28]. Some other chemotherapeutic drugs have shown effectiveness against recurrent malignant gliomas These medications include methylating compounds like irinotecan and bevacizumab, which target the vascular endothelial growth factor[29].. Gefitinib, erlotinib, and imatinib are chemotherapeutic medicines that target the epidermal and platelet-derived growth factor receptors. Optune®, a device approved by the United States Food and Drug Administration (FDA) in October 2015, is one of the most recent treatment techniques. This gadget can deliver electric fields that can be used to treat tumours by interfering with cell division and inducing cell death. It is the standard of care for adults who have been newly diagnosed with supratentorial GBM and are receiving adjuvant therapy with TMZ subsequent surgical resection[30].. When compared to treatment with TMZ alone, the Optune® treatment regimen with TMZ extended survival from 4 to 7 months[31].. In 2011, the FDA approved Optune® as a single treatment for recurrent GBM for the first time. After surgery and RT has been proved to be ineffective, Optune® is utilised as an alternate treatment for primary GBM. In a randomised clinical trial, the Optune® treatment group had a similar percentage of survival and fewer side effects, as well as a significant reduction in infectious, gastrointestinal, and hematologic problems when compared to the standard chemotherapy group[32]. The National Comprehensive Cancer Network (NCCN) recommended Optune® as a treatment for recurrent GBM because of its low side effects and ease of administration.

Postoperative Treatment

Treatment Following Surgery Seizures, cerebral edoema, gastrointestinal turbulences, osteoporosis, venous thromboembolism, cognitive impairment, and mood deterioration all require follow-up to check postoperative complications and manage disease symptoms, which involve seizures, cerebral edoema, gastrointestinal turbulences, osteoporosis, venous thromboembolism, cognitive impairment, and mood deterioration[33].. Magnetic Resonance



**Ladi Alik Kumar et al.**

Imaging (MRI) scans were utilised to check the tumor's size and are performed three days after surgery to evaluate how much of the tumour was removed. Patients suffering from vasogenic edoema are given steroids[34]. Steroids were administer to patients with vasogenic edoema. Steroid treatments, on the other hand, have been related to harmful side effects like myopathy[35]. It affects 10% of people with HGGs and has a higher incidence rate in older patients who have been on corticosteroids for a long time[36]. Mental impairment, diabetes, and gastrointestinal problems are also more common in patients, as are opportunistic bacterial infections like *Pneumocystis jiroveci*[37]. Dexamethasone was a superior corticosteroid since it has a lower activity level and can be used to reverse myopathy. Patients having GBM and CNS lymphoma are more possible to develop venous thromboembolism, specially after craniotomy[38]. Vena cava filters are less efficient than low-molecular-weight warfarin or heparin for controlling anticoagulation and reducing complications[39].

Prognosis

Despite advancements in surgical tumour excision, the prediction for patients residue less, with a normal survival time of 15 months. The survival rate of patients among anaplastic astrocytoma is 2 - 3 years only[40]. Patients having anaplastic oligodendroglioma had the best prognosis, with an average rate of survival is 12 to 15 years. The size of the tumour removed, the patient's age, and the Karnofsky Performance Status Z are all considerations to consider[41]. Younger age and greater performance status may indicate a higher chance of survival. Tumors greater than 5 to 6 cm have been linked to negative effects[43]. Tumors of the cerebrum or cerebellum that may be surgically removed have a improved prognosis than those of the brainstem[42,44].

Challenges;

The past few decades have seen a lot of changes in clinical oncology. However, it's a known fact that none of these advanced strategies have had any substantial effect on either the mortality rate or quality of life of brain cancer patients[45]. While nanocarrier-based delivery systems may contain provided a spark of hope, there are still lots of problems to be resolved. One of such essential issues is the toxicity alarm of nanodrug formulations. Tissue accumulation is possible because of the very tiny size of the carriers[46]. NPs containing metals such as iron, cobalt, zinc, gold, or other such heavy metals can accrue in vital organs such as the liver, lungs, or brain, leading to chronic toxic things Metallic NPs can make free oxygen species, which can show the way to toxicity. In addition, since such NPs are nonbiodegradable, they can remain in the environment for an extended period of time, resulting in constant human exposure and unknown environmental effects[47,48]. According to reports, CNTs can produce reactive oxygen species, resulting in lipid peroxidation, mitochondrial dysfunction, or cellular damage. The dose ranges for anticancer drugs loaded on nanocarriers must be properly determined[49]. An in vivo investigation of the pharmacokinetics of nanomaterials in blood and brain is necessary to understand their ADME behavior. It is however hard to illustrate any strong conclusions concerning the effectiveness of nanodrug carriers for the handling of brain tumors due to the lack of adequate preclinical data regarding nanodrug carriers' delivery of active substances to the brain, as well as the in vitro-in vivo correlation, for which it is actually very complicated to draw any conclusion[50]. The number of studies and reports on nanodrug formulations may have been large, but there are only a few of these nanosystems (transport, diffusion, and biocompatibility are few more crucial aspects to be thoroughly examined with appropriate animal models).

Many medical experts also question the rationality or practicality of experiments on laboratory animals because of the dramatic differences between human anatomy and the anatomy of laboratory animals[51]. A information is that animals (rodents) do not suffer from brain tumors or other cancers as frequently as humans. Humans and animals react and metabolize substances differently, i.e. a substance that is nontoxic to animals may be toxic to humans[52,53]. In addition, in experimental models they are difficult to establish due to the lack of sufficient knowledge on the exact mechanism of development and progression of brain tumors, or the types of biochemical factors or specific antigens/proteins involved[54,55]. Thus, scientists today debate whether using genetically modified animals can serve the purpose of testing in vivo the efficacy of nanodrug carriers, or whether the results obtained using animal models can be trusted[56,57]. There are several critical issues that remain unresolved in the practical field of nanodrug carrier production on a large scale. The pharmaceutical industry is hesitant to invest more



**Ladi Alik Kumar et al.**

in nanocarrier-based drug delivery platforms, despite all of the benefits. Thus, the greatest amount of research is conducted only in academic or small-scale research labs that never reach the bedside[58,59]. Manufacturing costs are one of several important factors. Approximately all nanocarrier-based formulations proposed for human applications have a much advanced manufacturing cost than conventional formulations[60]. As well as these issues, there are practical issues at the production stage such as batch-to-batch variation, low amounts of drug loading, and stability issues, for which most pharmaceutical industries are unwilling to take the risk.

Conclusions and Future Prospects

Nanotechnology-based strategy have enhanced the treatment of metastatic brain tumors as a result of advances in molecular neuroscience. Nanocarrier-based drug delivery platform should reach greater heights in the coming years, changing the landscape of oncology research significantly. Nanocarriers must be successfully translated into clinical trials in order to get better survival rate of brain cancer patients. For nanodrug delivery systems to be effective in vivo, they need to be well-characterized, biocompatible, biodegradable, and intelligent. For maximum therapeutic impact, it must also be specific, i.e., concentrated in brain tissue beyond the BBB and avoided in offtarget tissues. Future research should concentrate on the development of multifunctional targeted nanocarriers using accessible drugs with standardized formulation parameters for smooth technology transfer. Nanodrug carriers are only relevant when translated into an industrial scale.

REFERENCES

1. Mendes M, Sousa J, Pais A, Vitorino C. Targeted theranostic nanoparticles for brain tumor treatment. *Pharmaceutics*. 2018 Oct 9;10(4):181.
2. Cerna T, Stiborova M, Adam V, Kizek R, Eckschlager T. Nanocarrier drugs in the treatment of brain tumors. *J. Cancer Metastasis Treat*. 2016;2:407-16.
3. Wilson TA, Karajannis MA, Harter DH. Glioblastoma multiforme: State of the art and future therapeutics. *Surgical neurology international*. 2014;5.
4. Young RM, Jamshidi A, Davis G, Sherman JH. Current trends in the surgical management and treatment of adult glioblastoma. *Annals of translational medicine*. 2015 Jun;3(9).
5. Wu J, Yu P, Susha AS, Sablon KA, Chen H, Zhou Z, Li H, Ji H, Niu X, Govorov AO, Rogach AL. Broadband efficiency enhancement in quantum dot solar cells coupled with multispiked plasmonic nanostars. *Nano Energy*. 2015 Apr 1;13:827-35.
6. Armulik A, Genové G, Mäe M, Nisancioglu MH, Wallgard E, Niaudet C, He L, Norlin J, Lindblom P, Strittmatter K, Johansson BR. Pericytes regulate the blood–brain barrier. *Nature*. 2010 Nov;468(7323):557.
7. Daneman R. The blood–brain barrier in health and disease. *Annals of neurology*. 2012 Nov;72(5):648-72.
8. Haseloff RF, Dithmer S, Winkler L, Wolburg H, Blasig IE. Transmembrane proteins of the tight junctions at the blood–brain barrier: structural and functional aspects. In *Seminars in cell & developmental biology* 2015 Feb 1 (Vol. 38, pp. 16-25). Academic Press.
9. Daneman R, Prat A. The blood–brain barrier. *Cold Spring Harbor perspectives in biology*. 2015 Jan 1;7(1):a020412.
10. Serlin Y, Shelef I, Knyazer B, Friedman A. Anatomy and physiology of the blood–brain barrier. In *Seminars in cell & developmental biology* 2015 Feb 1 (Vol. 38, pp. 2-6). Academic Press.
11. Blanco E, Shen H, Ferrari M. Principles of nanoparticle design for overcoming biological barriers to drug delivery. *Nature biotechnology*. 2015 Sep;33(9):941.
12. Bertrand N, Wu J, Xu X, Kamaly N, Farokhzad OC. Cancer nanotechnology: the impact of passive and active targeting in the era of modern cancer biology. *Advanced drug delivery reviews*. 2014 Feb 1;66:2-5.
13. Wohlfart S, Gelperina S, Kreuter J. Transport of drugs across the blood–brain barrier by nanoparticles. *Journal of controlled release*. 2012 Jul 20;161(2):264-73.
14. Rosenblum D, Joshi N, Tao W, Karp JM, Peer D. Progress and challenges towards targeted delivery of cancer therapeutics. *Nature communications*. 2018 Apr 12;9(1):1410.



**Ladi Alik Kumar et al.**

15. Yuan F, Dellian M, Fukumura D, Leunig M, Berk DA, Torchilin VP, Jain RK. Vascular permeability in a human tumor xenograft: molecular size dependence and cutoff size. *Cancer research*. 1995 Sep 1;55(17):3752-6.
16. Bertrand N, Wu J, Xu X, Kamaly N, Farokhzad OC. Cancer nanotechnology: the impact of passive and active targeting in the era of modern cancer biology. *Advanced drug delivery reviews*. 2014 Feb 1;66:2-5.
17. Rosenblum D, Joshi N, Tao W, Karp JM, Peer D. Progress and challenges towards targeted delivery of cancer therapeutics. *Nature communications*. 2018 Apr 12;9(1):1410.
18. Chai Z, Hu X, Wei X, Zhan C, Lu L, Jiang K, Su B, Ruan H, Ran D, Fang RH, Zhang L. A facile approach to functionalizing cell membrane-coated nanoparticles with neurotoxin-derived peptide for brain-targeted drug delivery. *Journal of Controlled Release*. 2017 Oct 28;264:102-11.
19. Dawidczyk CM, Russell LM, Searson PC. Nanomedicines for cancer therapy: state-of-the-art and limitations to pre-clinical studies that hinder future developments. *Frontiers in chemistry*. 2014 Aug 25;2:69.
20. Ediriwickrema A, Saltzman WM. Nanotherapy for cancer: targeting and multifunctionality in the future of cancer therapies. *ACS biomaterials science & engineering*. 2015 Feb 1;1(2):64-78.
21. Peer D, Karp JM, Hong S, Farokhzad OC, Margalit R, Langer R. Nanocarriers as an emerging platform for cancer therapy. *Nature nanotechnology*. 2007 Dec;2(12):751.
22. Yang Z, Tang W, Luo X, Zhang X, Zhang C, Li H, Gao D, Luo H, Jiang Q, Liu J. Dual-ligand modified polymer-lipid hybrid nanoparticles for docetaxel targeting delivery to Her2/neu overexpressed human breast cancer cells. *Journal of biomedical nanotechnology*. 2015 Aug 1;11(8):1401-17.
23. Kateb B, Chiu K, Black KL, Yamamoto V, Khalsa B, Ljubimova JY, Ding H, Patil R, Portilla-Arias JA, Modo M, Moore DF. Nanoplatforams for constructing new approaches to cancer treatment, imaging, and drug delivery: what should be the policy?. *Neuroimage*. 2011 Jan 1;54:S106-24.
24. Agrahari V, Agrahari V, Mitra AK. Next generation drug delivery: circulatory cells-mediated nanotherapeutic approaches.
25. Zuckerman JE, Davis ME. Clinical experiences with systemically administered siRNA-based therapeutics in cancer. *Nature reviews Drug discovery*. 2015 Dec;14(12):843.
26. Bertrand N, Wu J, Xu X, Kamaly N, Farokhzad OC. Cancer nanotechnology: the impact of passive and active targeting in the era of modern cancer biology. *Advanced drug delivery reviews*. 2014 Feb 1;66:2-5.
27. Kumar A, Lee JY, Kim HS. Selective fluorescence sensing of 3, 5-dinitrosalicylic acid based on pyrenesulfonamide-functionalized inorganic/organic hybrid nanoparticles. *Journal of Industrial and Engineering Chemistry*. 2016 Dec 25;44:82-9.
28. Di Martino A, Guselnikova OA, Trusova ME, Postnikov PS, Sedlarik V. Organic-inorganic hybrid nanoparticles controlled delivery system for anticancer drugs. *International journal of pharmaceutics*. 2017 Jun 30;526(1-2):380-90.
29. Nagavarma BV, Yadav HK, Ayaz AV, Vasudha LS, Shivakumar HG. Different techniques for preparation of polymeric nanoparticles-a review. *Asian J. Pharm. Clin. Res*. 2012 Jun;5(3):16-23.
30. Shokri N, Javar HA, Fouladdel SH, Khalaj A, Khoshayand MR, Dinarvand R, Atyabi F, Nomani A, Azizi E. Preparation and evaluation of poly (caprolactone fumarate) nanoparticles containing doxorubicin HCl. *Daru: journal of Faculty of Pharmacy, Tehran University of Medical Sciences*. 2011;19(1):12.
31. Geckeler KE, Nishide H, editors. *Advanced nanomaterials*. Weinheim, Germany: Wiley-VCH; 2010.
32. Luppi B, Bigucci F, Corace G, Delucca A, Cerchiara T, Sorrenti M, Catenacci L, Di Pietra AM, Zecchi V. Albumin nanoparticles carrying cyclodextrins for nasal delivery of the anti-Alzheimer drug tacrine. *European Journal of Pharmaceutical Sciences*. 2011 Nov 20;44(4):559-65.
33. Kateb B, Chiu K, Black KL, Yamamoto V, Khalsa B, Ljubimova JY, Ding H, Patil R, Portilla-Arias JA, Modo M, Moore DF. Nanoplatforams for constructing new approaches to cancer treatment, imaging, and drug delivery: what should be the policy?. *Neuroimage*. 2011 Jan 1;54:S106-24.
34. Morshed N, Jahan N, Penheiro DE. Polymeric nanoparticles for targeted delivery in cancer treatment: n overview. *International Journal of Pharmaceutical Sciences Review and Research*. 2018;19:101-11.
35. Oerlemans C, Bult W, Bos M, Storm G, Nijsen JF, Hennink WE. Polymeric micelles in anticancer therapy: targeting, imaging and triggered release. *Pharmaceutical research*. 2010 Dec 1;27(12):2569-89.



**Ladi Alik Kumar et al.**

36. Wang H, Agarwal P, Zhao S, Xu RX, Yu J, Lu X, He X. Hyaluronic acid-decorated dual responsive nanoparticles of Pluronic F127, PLGA, and chitosan for targeted co-delivery of doxorubicin and irinotecan to eliminate cancer stem-like cells. *Biomaterials*. 2015 Dec 1;72:74-89.
37. Kumar SS. Formulation and Characterization of Noscapine-loaded Polycaprolactone Nanoparticles. *Asian Journal of Pharmaceutics (AJP): Free full text articles from Asian J Pharm*. 2019 Mar 9;13(01).
38. Agarwal S, Mohamed MS, Mizuki T, Maekawa T, Kumar DS. Chlorotoxin modified morusin-PLGA nanoparticles for targeted glioblastoma therapy. *Journal of Materials Chemistry B*. 2019.
39. Ramos-Cabrer P, Campos F. Liposomes and nanotechnology in drug development: focus on neurological targets. *International journal of nanomedicine*. 2013;8:951.
40. Akbarzadeh A, Rezaei-Sadabady R, Davaran S, Joo SW, Zarghami N, Hanifehpour Y, Samiei M, Kouhi M, Nejati-Koshki K. Liposome: classification, preparation, and applications. *Nanoscale research letters*. 2013 Dec 1;8(1):102.
41. Gosk S, Vermehren C, Storm G, Moos T. Targeting Anti-Transferrin Receptor Antibody (OX26) and OX26-Conjugated Liposomes to Brain Capillary Endothelial Cells Using In Situ Perfusion. *Journal of Cerebral Blood Flow & Metabolism*. 2004 Nov;24(11):1193-204.
42. Wen CJ, Zhang LW, Al-Suwayeh SA, Yen TC, Fang JY. Theranostic liposomes loaded with quantum dots and apomorphine for brain targeting and bioimaging. *International journal of nanomedicine*. 2012;7:1599.
43. Dawidczyk CM, Russell LM, Searson PC. Nanomedicines for cancer therapy: state-of-the-art and limitations to pre-clinical studies that hinder future developments. *Frontiers in chemistry*. 2014 Aug 25;2:69.
44. Hong HY, Lee HY, Kwak W, Yoo J, Na MH, So IS, Kwon TH, Park HS, Huh S, Oh GT, Kwon IC. Phage display selection of peptides that home to atherosclerotic plaques: IL-4 receptor as a candidate target in atherosclerosis. *Journal of cellular and molecular medicine*. 2008 Oct;12(5b):2003-14.
45. Belhadj Z, Zhan C, Ying M, Wei X, Xie C, Yan Z, Lu W. Multifunctional targeted liposomal drug delivery for efficient glioblastoma treatment. *Oncotarget*. 2017 Sep 15;8(40):66889.
46. Sun Y, Wang H, Wang P, Zhang K, Geng X, Liu Q, Wang X. Tumor targeting DVDMS-nanoliposomes for an enhanced sonodynamic therapy of gliomas. *Biomaterials science*. 2019;7(3):985-94.
47. Sun Y, Wang H, Wang P, Zhang K, Geng X, Liu Q, Wang X. Tumor targeting DVDMS-nanoliposomes for an enhanced sonodynamic therapy of gliomas. *Biomaterials science*. 2019;7(3):985-94.
48. Morikawa A. Comparison of Properties among Dendritic and Hyperbranched Poly (ether ether ketone) s and Linear Poly (ether ketone) s. *Molecules*. 2016;21(2):219.
49. Krůpa P, Řehák S, Diaz-Garcia D, Filip S. Nanotechnology—new trends in the treatment of brain tumours. *Acta Med (Hradec Kralove)*. 2014;57:142-50.
50. Blanco E, Hsiao A, Mann AP, Landry MG, Meric-Bernstam F, Ferrari M. Nanomedicine in cancer therapy: innovative trends and prospects. *Cancer science*. 2011 Jul;102(7):1247-52.
51. Wolinsky JB, Grinstaff MW. Therapeutic and diagnostic applications of dendrimers for cancer treatment. *Advanced drug delivery reviews*. 2008 Jun 10;60(9):1037-55.
52. Satsangi A, Roy SS, Satsangi RK, Tolcher AW, Vadlamudi RK, Goins B, Ong JL. Synthesis of a novel, sequentially active-targeted drug delivery nanoplatfrom for breast cancer therapy. *Biomaterials*. 2015 Aug 1;59:88-101.
53. Valdés Lizama O, Vilos C, Durán-Lara E. Techniques of structural characterization of dendrimers. *Current Organic Chemistry*. 2016 Oct 1;20(24):2591-605.
54. Mukherjee J, Wong PT, Tang S, Gam K, Coulter A, Baker Jr JR, Choi SK. Mechanism of Cooperativity and Nonlinear Release Kinetics in Multivalent Dendrimer-Atropine Complexes. *Molecular pharmaceutics*. 2015 Oct 27;12(12):4498-508.
55. Kesharwani P, Jain K, Jain NK. Dendrimer as nanocarrier for drug delivery. *Progress in Polymer Science*. 2014 Feb 1;39(2):268-307.
56. Kesharwani P, Tekade RK, Jain NK. Generation dependent cancer targeting potential of poly (propyleneimine) dendrimer. *Biomaterials*. 2014 Jul 1;35(21):5539-48.





Ladi Alik Kumar et al.

57. Sk UH, Dixit D, Sen E. Comparative study of microtubule inhibitors–estramustine and natural podophyllotoxin conjugated PAMAM dendrimer on glioma cell proliferation. *European journal of medicinal chemistry*. 2013 Oct 1;68:47-57.

58. Teow HM, Zhou Z, Najlah M, Yusof SR, Abbott NJ, D'Emanuele A. Delivery of paclitaxel across cellular barriers using a dendrimer-based nanocarrier. *International journal of pharmaceutics*. 2013 Jan 30;441(1-2):701-11.

59. Zhao J, Zhang B, Shen S, Chen J, Zhang Q, Jiang X, Pang Z. CREKA peptide-conjugated dendrimer nanoparticles for glioblastoma multiforme delivery. *Journal of colloid and interface science*. 2015 Jul 15;450:396-403.

60. Zhao J, Zhang B, Shen S, Chen J, Zhang Q, Jiang X, Pang Z. CREKA peptide-conjugated dendrimer nanoparticles for glioblastoma multiforme delivery. *Journal of colloid and interface science*. 2015 Jul 15;450:396-403.

61. Zhang Y, Ren K, Zhang X, Chao Z, Yang Y, Ye D, Dai Z, Liu Y, Ju H. Photo-tearable tape close-wrapped upconversionnanocapsules for near-infrared modulated efficient siRNA delivery and therapy. *Biomaterials*. 2018 May 1;163:55-66

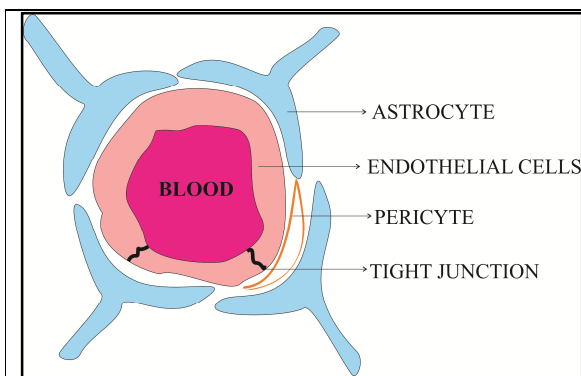


Image 1. Blood Brain Barrier-A

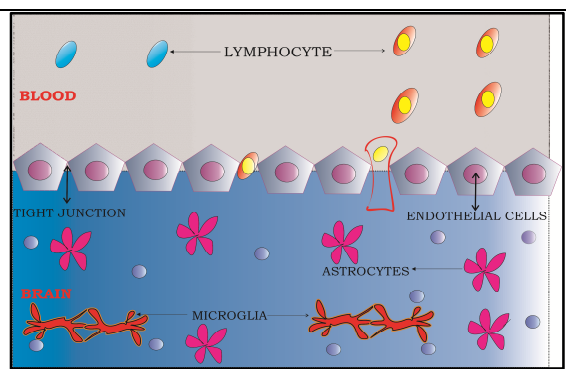


Image 2. Blood Brain Barrier-B

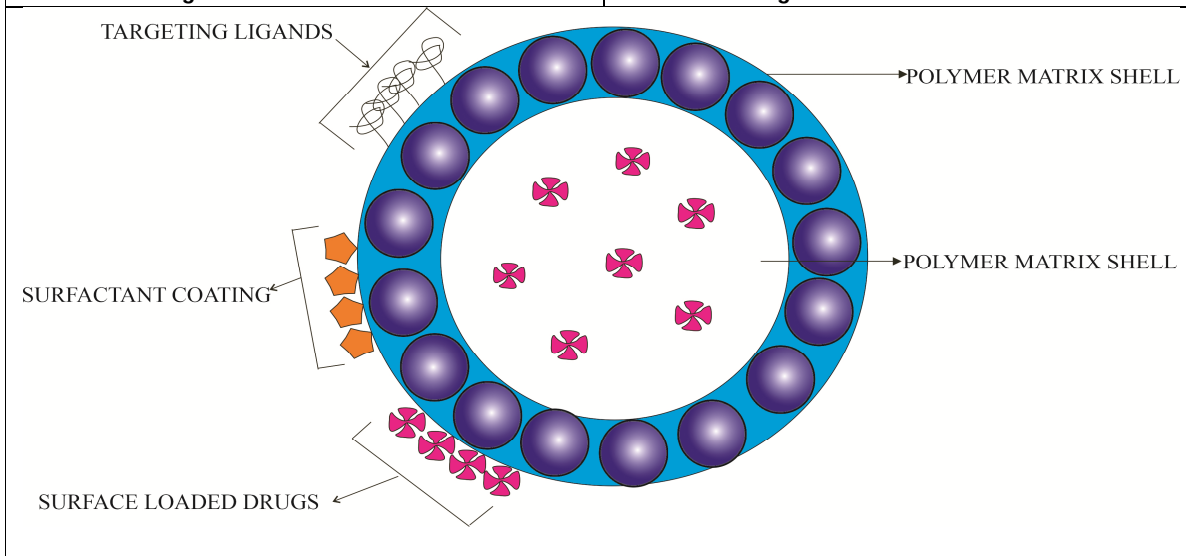


Image 3. Polymeric Nnaoparticle-PNP





The Estimation of Haemoglobin status among the Gunagi community of Uttar Kannada District, Karnataka, India.

Pramod S Giniwalad^{1*} and Aruna Hallikeri²

¹Research Scholar, Dept., of Studies in Anthropology, Karnatak University, Dharwad. Karnataka, India.

²Associate Professor, Dept., of Athropology, Karnataka Arts College, Dharwad. Karnataka, India.

Received: 02 Apr 2022

Revised: 28 Apr 2022

Accepted: 25 May 2022

*Address for Correspondence

Pramod S Giniwalad

Research Scholar, Dept, of Studies in Anthropology,
Karnatak University, Dharwad. Karnataka, India.

Email:pammu.sg@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Anemia is a disorder in which the quantity of red blood cells in the body is reduced, and it has major consequences for the health, cognitive development, and productivity of adults and children around the world. India remains one among the countries with a high prevalence rate of anemia. According to the National Family Health Survey (NFHS-3), 55.3 percent of people have anaemia. The aim of this study is to learn more about the nutritional and health status of the Gunagi community in Karnataka who are scattered over the Coastal region of Uttara Kannada district. The overall prevalence of anemia among Gunagi community of Karnataka was found to be 40.36%. It is seen that anemia affects the overall nutritional status of Gunagi community of Karnataka.

Keywords: Anemia, health, Gunagi community, Karnataka, Coastal

INTRODUCTION

Anemia is a disorder in which the quantity of red blood cells in the body is reduced, and it has major consequences for the health, cognitive development, and productivity of adults and children around the world. As of 2010, the global prevalence of anaemia was around 32.9 percent, with women and children in low- and middle-income countries in Africa and South Asia bearing the brunt of the burden [1]. Despite recent economic progress and preventative measures, anaemia is still a major problem in India, and it is the leading cause of disability [2]. India remains one among the countries with a high prevalence rate of anemia. According to the National Family Health Survey (NFHS-3), 55.3 percent of people have anaemia. [3] According to the NFHS-3, the prevalence of any type of anaemia in Karnataka is estimated to be 51.5 percent, placing half of the population at risk. In the Indian setting, previous research has found numerous probable reasons of anaemia, including inadequate iron intake [4], reduced vitamin C intake [5, 6], and lower gastric acidity compared to European populations [7].



**Pramod Giniwalad and Aruna Hallikeri**

The Estimation of Hemoglobin status In order to assess prevalence estimates of mild, moderate, and severe anaemia in males and females, we conducted a cross-sectional study among the Gunagi community in Uttar Kannada District of Karnataka, South India. Anemia and other demographic, social variables were also investigated. Overall, this research adds to the body of knowledge the Estimation of Hemoglobin status among the Gunagi community of Uttar Kannada District which can be used to inform policy, public health initiatives, and future research.

METHODS AND MATERIAL

The aim of this study is to learn more about the nutritional and health status of the Gunagi community in Karnataka who are scattered over the Coastal region of Uttara Kannada district. They are settled in the four taluks of Uttara Kannada district namely Karwar, Kumta, Yellapur and Ankola. They are thickly populated in Karwar followed by Kumta. In this neighbourhood, there are approximately 1000 families, the majority of which belong to the Gunagi community, with a small number of other communities renting dwellings. 140 families from the Gunagi community were chosen by using cluster sampling technique followed by simple random sampling.. There are 550 people in these 140 families (267 males and 283 females). Children aged 4 and above are included in the study. Anthropometric measurements were taken on the full sample of 550 people ranging in age from 4 years old to 87 years old. The primary data collection tool was an interview schedule. The schedule had five sections with questions pertaining to the following domains of demographic details and haemoglobin estimation. In this study, Hb Meter, lancet, test strips, and the code chip, were used for estimating the haemoglobin. The data was collected and entered in MSEXCEL and analysed by using SPSS software version 22. The data was represented in the form of frequency and percentage.

RESULTS

A total of 550 participants included in the study. There are 267 males (48.5%) and 283 females (51.5%) out of 550 participants, thus the proportion of females in sample is higher than the male about 3%. The highest percentage of participants is seen in the age 31-40 years, i.e., 16.2%. Out off 550 study participants 148 (55.43%) males and 148 (52.30%) females were married. Education plays an important role in any community which influences economic, social and cultural spheres of life. In present study, a literacy rate of 82.8 % was found among the Gunagi community with higher percentage among males (91.0%) compared to females (74.9%). The illiteracy rate is more in females (26.1%) than the males (9.1%). The main occupation of the Gunagi community of the present sample is wage labour (Coolie). Only about 7.5 % to 3.3 % each are employed in private and government organizations. Majority of the women, i.e., 30.0 % are reported to be house wife's. About one-fourth of the study participants are studying at various levels. A cross-sectional study was conducted to estimate the Hemoglobin status among the Gunagi community of Uttar Kannada District. A total of 550 participants involved in the study. The age of the participants was ranging between 4 to 87 years. Anaemic condition prevailed in 40.36% of the study participants. Among them, 2% were severely, 17.45% moderately, and 19.09% mildly anaemic. Table 1 indicated that anaemia is the most prevalent in the age group of 21 to 40 years. The table indicated the high prevalence of anaemia was 22.36% among the females and 16.18% of males were anaemic.

DISCUSSION

This study confirms that anaemia is widely prevalent in the age group (21 to 40 years) among the Gunagi Community. The overall prevalence of anemia was found to be 40.36% but was lower than other regional populations in TamilNadu and elsewhere in India [8, 9]. The present study reveals that the high prevalence of anaemia was found among the females as compared to males. Women did not consume significantly more iron than men despite having increased requirements, and a greater proportion of women than men failed to meet sex-specific recommended dietary allowances for iron [10]. According to the WHO, a population is deemed severely anaemic if the prevalence





Pramod Giniwalad and Aruna Hallikeri

of anaemia is detected to be 40% or above. [11] The prevalence of anaemia among the study population is 40.36 percent, slightly higher than the WHO definition for severe anaemia, putting the Gunagi community of Karnataka in the category of severely anaemic.

CONCLUSION

The overall prevalence of anemia among Gunagi community of Karnataka was found to be 40.36%. It is seen that anemia affects the overall nutritional status of Gunagi community of Karnataka. This study indicates that anaemia is the most prevalent in the age group of 21 to 40 years and the high prevalence of anaemia was found among the females as compared to males.

REFERENCES

1. N. J. Kassebaum, R. Jasrasaria, M. Naghavi et al., "A systematic analysis of global anemia burden from 1990 to 2010," *Blood*, vol. 123, no. 5, pp. 615–624, 2014.
2. C. Michalos, *Encyclopedia of Quality of Life and Well-Being Research*, Springer Netherlands, Dordrecht, 2014.
3. International Institute for Population Sciences (IIPS), NFHS 3 report- Chapter Nutrition and Anemia; 2006.
4. Rammohan, N. Awofeso, and M.-C. Robitaille, "Addressing female iron-deficiency anaemia in india: is vegetarianism the major obstacle?" *ISRN Public Health*, vol. 2012, 8 pages, 2012.
5. S. Seshadri, A. Shah, and S. Bhade, "Haematologic response of anaemic preschool children to ascorbic acid supplementation," *Human Nutrition: Applied Nutrition*, vol. 39, no. 2, pp. 151–154, 1985.
6. S. A. Chiplonkar, V. V. Agte, S. S. Mengale, and K. V. Tarwadi, "Are lifestyle factors good predictors of retinol and vitamin deficiency in apparently healthy adults?" *European Journal of Clinical Nutrition*, vol. 56, no. 2, pp. 96–104, 2002.
7. K. Madhavan Nair and V. Vasupradalyengar, "Iron content, bioavailability & factors affecting iron status of indians," *Indian Journal of Medical Research*, vol. 130, no. 5, pp. 634–645, 2009.
8. V. Sampathkumar and A. Rajaratnam, "Prevalence of anaemia and hookworm infestation among adolescent girls in one rural block of TamilNadu.," *Indian journal of maternal and childhealth : official publication of Indian Maternal and Child Health Association*, vol. 8, no. 3-4, pp. 73–75, 1997.
9. G. Alvarez-Uria, P. K. Naik, M. Midde, P. S. Yalla, and R. Pakam, "Prevalence and severity of anaemia stratified by age and gender in rural India," *Anemia*, vol. 2014, Article ID 176182, 5 pages, 2014.
10. G. Nahler, *Dictionary of Pharmaceutical Medicine*, Springer Vienna, Vienna, 2009.
11. WHO. Hemoglobin concentrations for the diagnosis of anemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011.

Table 1: Demographic details of the participants

| Age (in years) | Male | % | Female | % | Total | % |
|----------------|------|-------|--------|-------|-------|-------|
| 4-6 | 13 | 4.87 | 15 | 5.30 | 28 | 5.09 |
| 7-9 | 14 | 5.24 | 11 | 3.89 | 25 | 4.55 |
| 9-12 | 6 | 2.25 | 17 | 6.01 | 23 | 4.18 |
| 13-15 | 14 | 5.24 | 13 | 4.59 | 27 | 4.91 |
| 16-18 | 8 | 3.00 | 13 | 4.59 | 21 | 3.82 |
| 19-24 | 24 | 8.99 | 15 | 5.30 | 39 | 7.09 |
| 25-30 | 25 | 9.36 | 33 | 11.66 | 58 | 10.55 |
| 31-40 | 43 | 16.10 | 46 | 16.25 | 89 | 16.18 |
| 41-50 | 40 | 14.98 | 38 | 13.43 | 78 | 14.18 |
| 51-60 | 37 | 13.86 | 48 | 16.96 | 85 | 15.45 |
| Above 60 | 43 | 16.10 | 34 | 12.01 | 77 | 14.00 |





Pramod Giniwalad and Aruna Hallikeri

| Marital Status | | | | | | |
|------------------|-----|--------|-----|--------|-----|--------|
| Married | 148 | 55.43 | 148 | 52.30 | 296 | 53.82 |
| Unmarried | 115 | 43.07 | 100 | 35.34 | 215 | 39.09 |
| Widow | 4 | 1.50 | 35 | 12.37 | 39 | 7.09 |
| Education | | | | | | |
| Uneducated | 24 | 8.99 | 74 | 26.15 | 98 | 17.82 |
| Up VthStd | 57 | 21.35 | 60 | 21.20 | 117 | 21.27 |
| VI to X | 112 | 41.95 | 89 | 31.45 | 201 | 36.55 |
| PUC | 21 | 7.87 | 21 | 7.42 | 42 | 7.64 |
| Graduate | 50 | 18.73 | 36 | 12.72 | 86 | 15.64 |
| Post Graduate | 3 | 1.12 | 3 | 1.06 | 6 | 1.09 |
| Occupation | | | | | | |
| Unemployed | 1 | 0.37 | 5 | 1.77 | 6 | 1.09 |
| House wife | 6 | 2.25 | 159 | 56.18 | 165 | 30.00 |
| Student | 70 | 26.22 | 77 | 27.21 | 147 | 26.73 |
| Private employee | 37 | 13.86 | 4 | 1.41 | 41 | 7.45 |
| Govt. Employee | 11 | 4.12 | 7 | 2.47 | 18 | 3.27 |
| Pensioner | 16 | 5.99 | 3 | 1.06 | 19 | 3.45 |
| Dependent | 2 | 0.75 | 1 | 0.35 | 3 | 0.55 |
| Coolie | 100 | 37.45 | 25 | 8.83 | 125 | 22.73 |
| Business | 8 | 3.00 | 2 | 0.71 | 10 | 1.82 |
| Former | 16 | 5.99 | 0 | 0.00 | 16 | 2.91 |
| Total | 267 | 100.00 | 283 | 100.00 | 550 | 100.00 |

Table 2: Status of anaemia according age group.

| Age (in years) | HB | | | | | | | | Total | % |
|----------------|--------|-------|------|-------|----------|-------|--------|-------|-------|--------|
| | Normal | % | Mild | % | Moderate | % | Severe | % | | |
| 4 to 6 | 14 | 4.14 | 7 | 6.67 | 7 | 7.29 | 0 | 0.00 | 28 | 5.09 |
| 7 to 9 | 13 | 3.85 | 7 | 6.67 | 5 | 5.21 | 0 | 0.00 | 25 | 4.55 |
| 10 to 12 | 14 | 4.14 | 5 | 4.76 | 4 | 4.17 | 0 | 0.00 | 23 | 4.18 |
| 13 to 15 | 17 | 5.03 | 4 | 3.81 | 5 | 5.21 | 1 | 9.09 | 27 | 4.91 |
| 16 to 18 | 11 | 3.25 | 4 | 3.81 | 6 | 6.25 | 0 | 0.00 | 21 | 3.82 |
| 19 to 24 | 29 | 8.58 | 4 | 3.81 | 5 | 5.21 | 1 | 9.09 | 39 | 7.09 |
| 25 to30 | 38 | 11.24 | 10 | 9.52 | 10 | 10.42 | 0 | 0.00 | 58 | 10.55 |
| 31 to 40 | 54 | 15.98 | 20 | 19.05 | 13 | 13.54 | 2 | 18.18 | 89 | 16.18 |
| 41 to 50 | 47 | 13.91 | 15 | 14.29 | 15 | 15.63 | 1 | 9.09 | 78 | 14.18 |
| 51 to 60 | 53 | 15.68 | 17 | 16.19 | 13 | 13.54 | 2 | 18.18 | 85 | 15.45 |
| 60 + | 48 | 14.20 | 12 | 11.43 | 13 | 13.54 | 4 | 36.36 | 77 | 14.00 |
| Total | 338 | 61.45 | 105 | 19.09 | 96 | 17.45 | 11 | 2.00 | 550 | 100.00 |

Table 3: Status of anaemia according to gender.

| Sex | HB | | | | | | | | Total | % |
|--------|--------|-------|------|-------|----------|-------|--------|-------|-------|--------|
| | Normal | % | Mild | % | Moderate | % | Severe | % | | |
| Male | 178 | 52.66 | 41 | 39.05 | 43 | 44.79 | 5 | 45.45 | 267 | 48.55 |
| Female | 160 | 47.34 | 64 | 60.95 | 53 | 55.21 | 6 | 54.55 | 283 | 51.45 |
| Total | 338 | 61.45 | 105 | 19.09 | 96 | 17.45 | 11 | 2.00 | 550 | 100.00 |





Deep Learning and Semantic Framework for Webpage Recommendation

Sugendran G^{1*} and S.Sujatha²

¹Research Scholar, Department of Computer Science, G.R.Damodaran College of Science, Coimbatore, Tamil Nadu, India

²Head of the Department, Department of Computer Science, G.R.Damodaran College of Science, Coimbatore, Tamil Nadu, India

Received: 04 Mar 2022

Revised: 13 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Sugendran

Research Scholar,
Department of Computer Science,
G.R.Damodaran College of Science,
Coimbatore, Tamil Nadu, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The process of extracting the hidden information from the huge web log data is known as web mining. In the wide range of applications in web data mining, the recommendation is moving to a great extent in the research area. The web log data is one of the applications where the frequent pattern discovery is commonly used. In web usage mining, the hidden information present in the web log data has been extracted and processed using hidden markov model on the semantic web. The web server logs record the user, tasks and sessions in a periodical manner, the algorithms get implemented to obtain the actual usage pattern. In this paper, we proposed a new framework named as Deep Semantic Web framework which employs the deep learning and semantic web architecture for accurate web page recommendation on automatically extracting the semantic information of the web log data. The comparison between semantic web and deep semantic web helps in analyzing the deviation present in the navigation and the suggestions provide to the user to obtain better page recommendation. This helps in improve the usability by reducing the issues present in the web log usage. The optimization method as genetic algorithm is implemented in this work to improve the usability of the navigation. The experiment is performed with the bench mark dataset named as wikidata in order to provide more number of page recommendation to the users for better usability.

Keywords: Deep Learning, Semantic framework, Web Content Mining , Web Structure Mining, Web Usage Mining





INTRODUCTION

Now a day, web mining is one of the hot research areas towards data mining to find the material outline as the web information. Web mining is used to find the information patterns in the web log data. The size of web resource and the number of web documents increases in day by day Web mining helps to improve the efficiency of the search engine on discovering the web pages and classifying the web documents. Based on the data to be mined, web mining is split into three forms. In general, search engines keep online resources in the form of Meta data that has been categorised depending on the context of content. Web mining enhances the efficacy of web search engines by categorising web resources and recognising web pages. It is used for Web Searching, such as Google and Yahoo, as well as Vertical Searching, such as FatLens and Become. Web mining is a technique for predicting user behaviour. Web mining is extremely beneficial to a certain Website and e-service, such as landing page optimization.

Web Content Mining

The technique of extracting useful information from web documents is known as web content mining. The technique of uncovering structural information from the Web is known as structure mining. Because of the variability and lack of structure in online data, automated identification of new knowledge patterns can be difficult. Web content mining scans and mines text, pictures, and groups of web sites based on the content of the input (query), presenting the results in search engines.

Web Structure Mining

The Web's structure may be considered of as a network, with web pages serving as nodes and hyperlinks linking the two related pages acting as edges between any two nodes. It is used to indicate if the web pages are linked by information or a direct link connection. The goal of structure mining is to generate a structural overview of a website and related web pages.

Web Usage Mining

The technique of obtaining user access patterns from server records is known as web use mining. Web usage mining is used to mine web log records that include access information for web pages stored on a web server and aids in the discovery of user access patterns for web sites. Every web page is assigned a web log entry by the web server in a meaningful manner. Similarities in web log records can be evaluated to identify potential clients for page recommendation. The application of identifying or uncovering interesting usage patterns from big data sets is known as web usage mining. And these patterns allow you to understand usage patterns or anything along those lines. Users access data on the web and gather data in the form of logs in web use mining. As a result, Web use mining is also known as log mining.

Web log files provide information about the websites that the user visited depending on their interests, which is then analysed using a data mining algorithm to get the forecast result. These web log data give information about the user's interaction type with websites as well as the pattern of navigation between information in the defined time period for customised page suggestion. The significance of online usage mining is to obtain crucial information from web log files through content or structure mining. Web Data is a collection of web usage patterns gathered from many sources. Fig 1.1 represents the web mining process.

Web log mining techniques

Web use mining extracts data from web server logs to evaluate the number of users for a particular website, the time spent on each job, and the session navigation for obtaining useful information. The time spent on each website offers a measure of its information content's worth, and the data is tied to the user's search. The web server logs aid in the discovery of usage patterns. The traffic for a certain website aids in the analysis of the detail of data included in it. Figure 1.3 shows the process of online usage mining as pre-processing, pattern finding, and pattern analysis.



**Sugendran and Sujatha****Pre-processing**

Pre-processing is a type of information abstraction in which patterns may be discovered by extracting information from data usage, content, and structure [4]. Because it includes inadequate information, the pre-processing conducted by use is a time-consuming procedure. Only the client's IP address and click stream may be used to access the client's data. The act of turning the text, context, and pictures contained in to a format useful for web mining is known as content pre-processing. The text may be separated and keywords extracted, which is useful for web log mining. The structure establishes the relationship between the hypertext.

Pattern analysis tool

The pattern analysis helps in figuring the identification of the frequent patterns in the website usage. This helps in discovering the usage of a particular site and the analysis include in the different views as,

1. the frequency of visits per document,
2. most recent visit per document,
3. who is visiting which documents,
4. frequency of use of each hyperlink, and
5. Most recent use of each hyperlink.

The pattern discovery tools can be implemented on the data traffic collected on the information theory. This can be used in the various domains as statistics, pattern recognition and machine learning mechanisms. Different mechanisms are present to support the discovery pattern in effective manner [4]. Personalization of web content is considered as web usage mining technique which can be applied to personalize websites depending on user profile and behaviour. Personalization is important in creating a deeper relationship on the content of the user and web page which further used to build acceptable page suggestion on various strategies and to automate the products suggestion for similar user. Finally web usage mining aims to obtain information that supports website design to allow easier and faster access on the part of user. The web log data undergoes the various processes to provide the effective trace list for the effective representation of the data using data Pre-processing for identifying the missing value, pattern analysis for the navigation information and pattern extraction form the similar index. Decisions making rules and constraints have been employed in the large extent for extracting the useful pattern including the session and task identification for a different variant of user.

METHODOLOGY**Collection of Weblog and Stored in the Database**

In the website, the web log file can be obtained with the URL and the click streams information which includes the user page navigation and frequently visited pages by a user in a continuous manner. Distinctive methods are important to realise as it use and recognize data the visitors on the website and data changing with time for frequent site updating. The web log record is collaborated based on the spatial and temporal information of the user. The information in the web log document is sorted and examined under varied condition of the decision making rules utilizing unique tokenizer and delimiter.

Data Pre-Processing

The web data collected in terms of web usage is considered as the source which is deviated from the web server logs. In addition referral logs have been also processed in parallel to eliminate the transaction failure information. The complete data of the user behavior and usage of the web page has to be formed by integrating the trace of the information network server and application server for data mining. In order to obtain the better grouping of web log data on various concepts will be filtered using the filtering models. The filtering process helps to remove the raw data and also eliminate the outliers. This process used to remove the irrelevant data from the web log data group to avoid the redundant traces, the semantic groups can be formed by accessing the individual pages.





Sugendran and Sujatha

The irrelevant data should be reduced using singular value decomposition model which reduce the processing of the web traffic. The files which are irrelevant can be identified by checking the suffix. The URL name reveal the file format with the help of that the image files get removed. The resultant data after removal of redundant files helps in better prediction of the user navigation on the web pages. The documents which are not critical for the examination get evacuated. The client ID gets gathered from mix of IP, client operator, and referrer fields to get verification. The user page visit to the web site gets stored as an activity record in the session or cache which get loaded in the trace file of the particular network. The elapse by time and threshold focuses is built up to get powerful session records. The missed references in reserve are getting acquired from the learning of site topology and referrer data, alongside transient data from server logs.

Deep Semantic Web

The actual user behaviour is extracted from the web server logs and by utilizing the cognitive user models the anticipated user behaviour gets captured, then between these two a comparison is performed. This deviation examination would help us recognize some route related convenience issues [7].

Deep Semantic Web (DSW) Algorithm for Prediction of Potential Pages

For D = 1 to N do

Generate the instance a training data

For i = 1 to M do

Where m is the kernel of the data

Calculate class C = {V1, V2, V3...}

Where v1, v2 are input vectors

End for

Error = Similarity difference between d1 and d2 > threshold

If (errors == 1)

Optimize the parameter using behavioural clustering

Else

Finalize the class formation

Medoid Clustering

Web server logs contain the spatial and local information of the network used for the website visit. Each trace of the log contains the IP location of the starting host on the running server, the timestamp of the domain hosted, the requested Web page from the user. In addition the referrer, the user agent and other data of the network provider also stored. Normally, the raw data need to be pre-processed and changed into user sessions and cache based on the unsupervised learning model along the web transactions to extract usage patterns on the traffic pattern of the particular server.

Initial Medoid Clustering Algorithm:

1. Start with K data points designated as medoids.
2. Create cluster around a medoid by moving data points close to the medoid O_j belongs to O_i
if $(d(O_j, O_i) = \min_{O_e} d(O_j, O_e))$



**Sugendran and Sujatha**

3. Iteratively replace O_i with O_h if quality of clustering improves.
4. Swapping cost, C_{ijh} , associated for replacing a selected object O_i with a non-selected object O_h

Optimization using Genetic Algorithm

In genetic algorithm, the attacker can be computed using the three important factors which are named as selection, crossover and mutation. The attacker which is visit page frequently in the specific time is considered as selection. This process helps in evaluating better solution from the attacker and normal user chosen on the web usage pattern on the page visit. The higher quality of the attacker can be extracted from the selection process. The crossover process helps in combining the attacker converting to the normal user. The new generation of attackers gets evolved from the normal user generated by the crossover process in the fitness computation.

The iterative process of the optimized model helps in effective prediction of the details regarding the usage pattern of the attacker on the various network region with high granularity of data types. The delay and frustration in finding the pattern get reduced and solve the usability problem of the network path planning and short path prediction from the source. The success rate depends on the accuracy and efficiency using the time for the prediction task and attack determining causes.

Experimental Design

The page prediction pattern is identified using the deep semantic web framework on extracting the similarity and deviation of the data on the analysis. On employment of that technique, the time variation is reduced. The genetic process is implemented to obtain the optimized result with effective suggestion to the users.

Methodology of the Process (Fig.3)**Data Set Used**

The dataset employed in this work is named as wiki data. It consists of semantic structure of the website domains in large volume of attributes which contain different information.

Description of the Data Set

The dataset contains twelve attributes. These attributes provide the complete information about the access of particular site by the user. The values present in the each attribute are numeric or data. Some important attribute only took in to the process of user pattern detection.

The attributes present are,

- i. User id
- ii. Host
- iii. Time stamp
- iv. Offset
- v. Method
- vi. Path
- vii. Protocol
- viii. Status
- ix. Size
- x. url
- xi. Type
- xii. Page

The implementation of the proposed framework is carried out using the Dotnet technology. The implementation of framework is carried out using visual studio for processing of the data through machine learning algorithm and SQL server for storing of the dataset.





RESULT ANALYSIS AND DISCUSSION

Performance Analysis of the Web Page Prediction

In the experimental results, the deep learning model's proposal employing the semantic architecture and evolutionary algorithm provides the use pattern of a normal and aggressive user. It is compared using several cross validation metrics, and the outcome is depicted in the performance graph. The initial step is to upload the weblog database, which will be followed by the rest of the procedure. Figure 1 shows a comparison between the cognitive model's and the genetic algorithm's suggestions. Because of the iterative process, the genetic algorithm presents the user with a greater number of correct ideas in an efficient manner

Performance Metric descriptions

The proposed model is evaluated against the following measures such as (PC), Precision (P); Recall(R), F1-scores (F) and computation time.

Precision

The proportion of relevant examples among the recovered instances is referred to as the positive predictive value. Precision is defined as the number of accurate features divided by the total number of returned feature space.

$$\text{Precision} = \frac{\text{True positive}}{\text{True positive} + \text{False Positive}}$$

True positive is a number of real positive cases in the data and false negative is number of real negative cases in the data.

Recall

It is the proportion of relevant examples that have been retrieved in comparison to the entire number of relevant instances. The recall is the portion of the relevant documents that have been correctly sorted into the correct classes.

$$\text{Recall} = \frac{\text{True positive}}{\text{True positive} + \text{False negative}}$$

F Measure

It is a measure of a test's accuracy and is defined as the weighted harmonic mean of the precision and recall of the test.

Execution Time

The execution time refers to time taken for execution of the model to determine the road cluster as prediction output for particular user preferences. The table 1 provide the performance value of proposed model and existing value for different medoid values. Precision is measured in terms of set of the instance mapped with high similarity index. Recall is measured as actual instance identified. F measure is mean of precision and Recall.

CONCLUSION

The weblog data collected from network traces and crawled by search engines is used to improve the usability of various users' web browsing patterns and to propose web pages based on user similarities. The probabilistic measure is used to identify differences in the time between the patterns. The usefulness of data consumption and online visits is increased by reducing the variance. By studying the existing and projected pattern, the new framework was used to tackle the web-related navigation problem in the network and application server. When a user visits a web page via a web request, an unsupervised technique is used to detect the user's link to other user activity, drive ongoing





Sugendran and Sujatha

improvements, and make suggestions. The suggested approach has been designed to assess web data traffic to the server in relation to use extraction. It outperforms in terms of scaling rate and accuracy when compared to data categorization.

REFERENCES

1. VikasVerma, A. K. Verma , S. S. Bhatia, "Comprehensive Analysis of Web Log Files for Mining" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 6, No 3, November 2011 ISSN (Online): 1694-0814.
2. MagdaliniEirinaki, and MichalisVazirgiannis, "Web Mining for Web Personalization", PKDD, 2005.
3. R.Rooba, Dr.V.Vallimayil, "Review the Steps of Server Log Data Processing for Web Usage Mining" ,International Journal of Innovative Research in Computer and Communication Engineering, Vol. 3, Issue 11, November 2015.
4. Jaideep Srivastava y, Robert Cooleyz ,MukundDeshpande, Pang-Ning Tan, "Web Usage Mining: Discovery and Applications of Usage Patterns from Web Data" SIGKDD Explorations. ACM SIGKDD, Jan 2000.
5. Sankar K. Pal, VarunTalwar, and PabitraMitra, "Web Mining in Soft Computing Framework: Relevance, State of the Art and Future Directions", IEEE TRANSACTIONS ON NEURAL NETWORKS, VOL. 13, NO. 5, SEPTEMBER 2002.
6. Dr.S. Vijayarani¹ and Ms. E. Suganya, "RESEARCH ISSUES IN WEB MINING" International Journal of Computer-Aided Technologies July 2015.
7. RuiliGeng, and Jeff Tian, "Improving Web Navigation Usability by Comparing
8. Actual and Anticipated Usage" IEEE transactions on human-machine systems, vol. 45, no. 1, february 2015
9. RafatRana S.H. Rizvi¹, Ranjit R. Keole, "A Review on Analyzing Actual and Anticipated Usage to Promote Web Navigation Usability" International Journal of Advance Research in Computer Science and Management Studies Research Volume 3, Issue 10, October 2015
10. YogeshRajaramBhalerao , Prof. P. P. Rokade, "User Navigation Pattern Prediction using Statistical Classifier and Modern Techniques" International Journal of Emerging Technology and Advanced Engineering Volume 5, Issue 5, May 2015.
11. Fang Liu, "Usability evaluation on websites" Computer-Aided Industrial
12. Design and Conceptual Design, 2008.
13. Chang Jinling ,ZhengZhou, Guan Huan. "Measuring Website Usability of Chinese Enterprise with a Heuristic Procedure" e-Business Engineering, 2007. ICEBE 2007. IEEE International Conference on Oct. 2007
14. F. Massegli, M. Teisseire, P. Poncelet "Real time Web usage mining: a heuristic based distributed miner" Web Information Systems Engineering, 2001. Proceedings of the Second International Conference on Dec. 2001
15. A. Agarwal, M. Prabaker and J. Jacko, "Building on the usability study: Two explorations on how to better understand an interface,"Human-Computer Interaction. New Trends, pp. 385-394, 2009, Springer.
16. T. Arce, P. E. Romn, J. D. Velquez and V. Parada, "Identifying web sessions with simulated annealing,"Expert Syst. Appl., vol. 41, no. 4, pp. 1593-1600, 2014
17. M. F. Arlitt and C. L. Williamson, "Internet Web servers: Workload characterization and performance implications", IEEE/ACM Trans. Netw., vol. 5, no. 5, pp. 631-645, 1997.
18. M. C. Burton and J. B. Walther, "The value of Web log data in use-based design and testing,"J. Comput.-Mediated Commun., vol. 6, no. 3, pp. 0, 2001
19. Ammar Al-Dallal, Rasha Shaker, "Genetic Algorithm in Web Search using inverted index representation" GCC Conference & Exhibition, 2009
20. Zahra Hossaini, Amir MasoudRahmani, Saied Setayeshi"Web Pages Classification and Clustering by Means of Genetic Algorithms: A Variable Size Page Representing Approach" Computational Intelligence for Modeling Control & Automation, 2008
21. Junli Wang Zhijun Ding ; Changjun Jiang, "GAOM: Genetic Algorithm Based Ontology Matching" IEEE Asia-Pacific Conference on Services Computing, 2006.





Sugendran and Sujatha

22. Chungsheng Zhang and LiyanZhuang , "New Path Filling Method on Data Preprocessing in Web Mining" , Computer and Information ScienceJournal , August 2008.
23. Catlegde L. and Pitkow J., "Characterising browsing behaviours in the world wide Web" , Computer Networks and ISDN systems, 1995.
24. SpilipoulouM.and Mobasher B, Berendt B, "A framework for the Evaluation of Session Reconstruction Heuristics in Web Usage Analysis," INFORMS Journal on Computing Spring ,2003.
25. ThanakornPamutha, SiripornChimphlee, Chom Kimpan1, and ParinyaSanguansat,"Data Preprocessing on Web Server Log Files for MiningUsers Access Patterns",International Journal of Research and Reviews in Wireless Communications (IJRRWC) Vol. 2, No. 2, June 2012
26. PriyankaPatil and UjwalaPatil , "Preprocessing of web server log file for web mining" , World Journal of Science and Technology, 2012.
27. T. Revathi , M. MohanaRao, Ch. S. Sasanka and K. Jayanth Kumar, B. UdayKiran, " An Enhanced Pre-Processing Research Framework forWeb Log Data" , International Journal of Advanced Research in Computer Science and Software Engineering , Volume 2, Issue 3, March 2012ISSN: 2277 128X.
28. Naga Lakshmi, Raja SekharaRao ,SaiSatyanarayana Reddy, "An Overview of Preprocessing on Web Log Data for Web UsageAnalysis",International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-4, March 2013 .

Table 1. Performance Analysis of the Architectures Employed for the Web Log usage Mining

| Technique | Precision | Recall | F measure | Execution Time ms |
|--|-----------|--------|-----------|-------------------|
| Semantic based web usage mining – Existing | 89 | 87 | 89 | 50.29 |
| Deep Semantic web framework – Proposed | 96 | 86 | 96 | 29.85 |

Fig 1. Process of Web Usage Mining

Fig 2. Web Mining Process

Fig 3. Methodology of the Process

Fig 4. Comparison between the suggestions





Sugendran and Sujatha

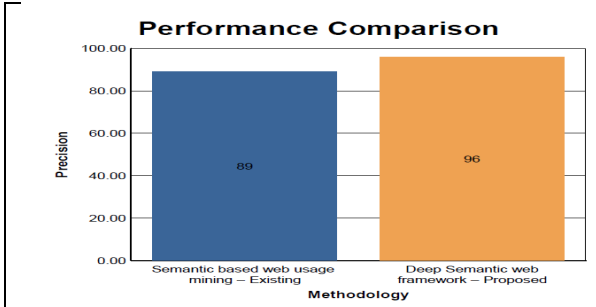


Fig 5. Performance analysis on precision

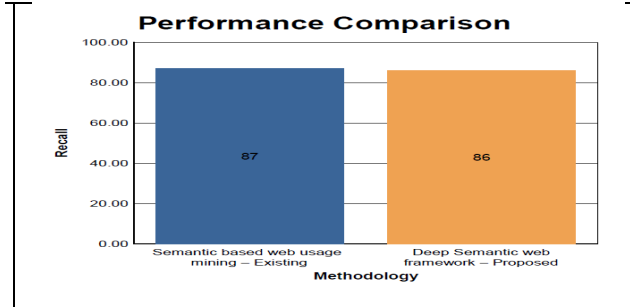


Fig 6. Performance analysis on Recall

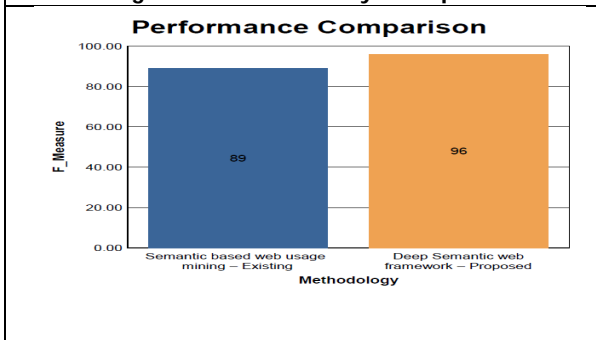


Fig 7. Performance analysis on F-measure

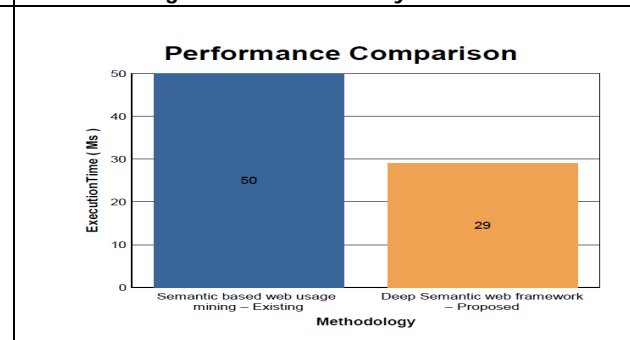


Figure 8. Performance analysis on the execution time





A Review on Effect of Terrazyme on the Geotechnical Behaviour of Fly Ash-Stabilized Soil

RK Majhi*, DK Das, K. Kumar, B. Singh, BP Reddy

Department of Civil Engineering, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Received: 06 Mar 2022

Revised: 10 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

RK Majhi

Department of Civil Engineering,
Centurion University of Technology and Management,
Paralakhemundi, Odisha, India
Email: rajib.majhi@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Nearly about 74-million-hectare fields in India are covered with black cotton soil. From these soils cover an area of 0.96 million hectares of land in Odisha which is around 6% of the total geographical area of the State. These soils are highly argillaceous (particles smaller than 0.06mm in diameter) with clay content more than 50 percent. For that the soil comes under the property of expansiveness, so it creates a harmful impact on structure when doing construction because of its low bearing capacity, low permeability and high level of volumetric changes. After a period of time, due to its high compressibility nature cracks and settlement is a biggest problem for structure. To reduce the expansiveness and plasticity of the soil uses of waste material such as fly ash, makes a change on such types of soils. In some extent we all need stabilized soil within less time. For this mixture of enzyme solution gives a better effect on these types of soil. This work presents the review of literature related to clayey soil mixed with fly ash and terrazyme.

Keywords: Clayey Soil, Fly Ash, Terrazyme, Soil Stabilization, Strength Parameter, Shear Parameter.

INTRODUCTION

Whenever the term “clayey soil” comes to our mind, it reflects of having more plasticity property. Clays are a finely grained natural soil material, mixed with one or more clay minerals like MgO, SiO₂, Al₂O₃, and other organic matter. Some expansive soils are found in Maharashtra, Madhya Pradesh, Gujarat, Odisha, Tamilnadu, Andhra Pradesh, and Karnataka states of India. These soils are called as black cotton soil due to their black colour which is a result of high iron, hummus and magnesium minerals derived from trap and basalt [1]. These soils swell and shrink, respectively, with the increase and decrease in the water content. After the absorption of water, soils become compressible and it leads to a decrease in strength of the soil [2].



**Majhi et al.**

From an engineering point of view, the classification of soils is done depending on the suitability for construction purpose, foundation, highways, etc. Soils are arranged according to their grain sizes such as gravel, sand, and clay. These terms are used only to identify the particle size. There are four systems used to classify the grain size (a) U.S Bureau of soil and the public road administration system of the United States.(b) international soil classification (c) The M.I.T classification (d) Indian standard classification [3].The atomic structure of common clay has been determined by many investigators. From those, two structural units are considered. One is of two sheets of closely packed oxygens or hydroxyls in which aluminium, iron, or magnesium atoms are connected in octahedral coordination. The second unit is of silica tetrahedrons. In each tetrahedron, a silicon atom is equidistant from four oxygen or hydroxyls arranged in a form of a tetrahedron with a silicon atom at the center[4].

The swelling and contraction of the black cotton soil mainly occur due to the presence of montmorillonite minerals in the soil [5]. Montmorillonite has a central octahedral sheet sandwiched among twofold tetrahedral sheets and it forms a three-layer element. A reason for swelling is the weak bond between the elements, which can be broken due to the absorption of water. The researchers have found that the diffusion of water can be the main cause of swelling [6]. The swelling of soil comprises of two stages, the first stage is intercrystalline swelling and the second stage refers to double layer repulsion.

Soil Stabilization

Soil stabilization is a method of creating an improved soil material, acquiring the desired engineering properties. Soil stabilization is the alteration of soils to enhance their physical properties. It has been done by chemical and by mechanical method.

Soil stabilization is divided into two parts:

- (a) In the first part, a physicochemical process by an addition of chemicals such as lime, cement, calcium chloride, fly ash, and other additives improve the load carrying capacity of the soil.
- (b) In other parts a waterproofing or water retention process by the addition of asphalts and other bituminous materials,

Fly Ash

Fly ashes are closely related to the volcanic ashes. In early age, volcanic ashes were used as hydraulic cement, which was made near the small Italian town Pozzuoli. Hence the term "pozzolan" was coined. That was one of the best pozzolans used in the world [8].Nowadays, fly ashes are generated from coal-fired electricity generating plants. With rapid industrialization, there has been an increase in the production of fly ash. It is generally a wastage material generated from thermal plants. Now about 110 million tons of fly ash is generated from Thermal Power Plants in India, from his 30 million tons generate from Odisha. The major problem of production of fly ash is that, safe disposal and management. The waste generated from industries are complex characteristics and composition, hence it is necessary to safely dispose of the wastes otherwise it will harm the environment and social life, which will ultimately disturb the ecological system [9, 10]. Generated fly ashes are classified into 2 types as per chemical composition such as Class C fly ash and Class F fly ash[11].

Terrazyme (Bio-enzyme)

Terrazyme is a proprietary blend of active whole food enzymes and supporting mineral cofactors that are often deficient in cooked, processed and preservative-laden foods. The powerful combination of digestive enzymes found in terrazyme supports the body's constant production of enzymes critical for healthy biochemical functions throughout the body, including healthy digestion of food nutrients and cellular metabolism of nutrients to energy.The use of enzymes was initially developed in horticultural applications to improve the pH, increase the organic matter and nutrients in the soils and thus improving the crop production [12]. Later, the use of enzymes found its application in engineering and has been extensively used to improve the performance of soils for



**Majhi et al.**

construction of roads, dams and airport runways, as it increases cohesion and stability, reduces permeability and helps in erosion control of the treated soil [13-19].

Methods Of Stabilization

Stabilization can be achieved by the use of thermal, electrical, mechanical or chemical methods. The first two methods are rarely used. However, mechanical and chemical stabilization have gained popularity because, these are easy to handle as well as to manage in any construction environment.

Mechanical Stabilization

Densification of soil by compaction through the application of mechanical energy is known as mechanical stabilization. This method is effective for cohesionless soils where mechanical compaction causes interlocking of soil particles by rearrangement. But, this method is not effective under significant moisture fluctuations in field conditions. Also with the increase in fine content, the efficacy of the method may decrease. Mechanical stabilization can also be achieved by nailing or sand columns or by reinforcement in the soil. Mechanical stabilization results in an increase of the strength as well as a reduction in settlement of soil [20].

Chemical Stabilization

The addition of chemical additives (organic or inorganic) to the soils improves the geotechnical properties of soils. These organic or inorganic chemical additives perform cementations and bonding action. Bituminous materials are used as an organic stabilizer, whereas cement, lime, slag, fly ash, sodium silicate, etc are used as an inorganic stabilizer. Addition of chemical agents such as cement, cement kiln dust, fly ash, lime, etc, result in the formation of cementitious bonds between soil particles and stabilizers [21].

Enzymatic or Bio-enzyme Stabilization

The stabilization of soil with bio-enzyme is a revolutionary technique which became popular worldwide. Recently there are many bio-enzymes available for soil stabilization such as Fujibeton, renolith, Terra-Zyme, Perma-Zyme etc. These enzymes have been proven to be very effective and economical. Another advantage of the bio-enzyme is that these are environment-friendly. When these bio-enzymes are mixed with soil they improve its engineering properties. Their efficiency depends upon the amount of dose, type of soil available and field conditions. The use of bio-enzyme in soil stabilization is not very popular due to the lack of awareness between engineers and the non availability of standardized data [22]. Enzyme proteins were absorbed by the clay particles, thus modifying the clay particle. Enzymes predominantly attach with the clay substrate, alter the clay molecule, and later reattach itself from the modified clay by returning to its original form after the reaction is concluded. Economic advantages of using enzymatic stabilization technique on local soil, is reducing construction time, avoiding transportation cost and reducing construction materials.

Stabilization Using Fly ash

Pandian et al.(2001) [23] studied the stabilization of expansive soil by using Class F Fly ash. He Found that fly ash can use for an effective additive when he saw that with 20% fly ash content, the CBR value of Black cotton soil improved (about 175%) then decreased at 60% fly ash content and again increased at 80% fly ash content. Turker *et al.* (2004) [24] employed sand along with Class C & Class F fly ash for stabilization of expansive soil. Without any contradiction of belief, Class C fly ash was more effective in stabilization, and a decrease in free swell with curing period was observed. The percentage content of the soil, Class C fly ash and sand that gave the best result was 75%, 15% and 10% respectively. Satyanarayana *et al.* (2004) [25] aimed to study the mutual effect of the addition of lime and fly ash on the engineering properties of the expansive soil. He found out that 70%, 26% and 4% were the optimum percent mixture of the ingredients for the construction of roads and embankments. Bhuvanewari *et al.* (2005) [26] studied the properties of expansive soil with fly ash in varying percentage both in the laboratory test and field test. They found locally available borrow soil had high plasticity (LL > 50), it was difficult to use it directly for construction. the workability was maximum with 25% fly ash. Also, they observed the dry density was maximum for 25% of fly ash.



**Majhi et al.**

Sharma et al.(2007) [27]contemplated the impact on swelling of highly plastic expansive clay, and the compressibility of another non-expansive but highly plastic clay when fly ash was employed. At a given dry unit weight of the mixture, the swelling pressure and swell potential showed a decrease of nearly 50%. A decrease of 40% at 20% fly ash content in the coefficient of secondary consolidation and compression index of both the samples was observed. Kalyanshetti *et al.* (2013) [28] studied the effect of fly ash in 5%, 10%, 20%, 25%, 30% and 40% proportion on black cotton soil. They found that the soil plasticity and liquid limit decreases with an increase in fly ash content to it. It is observed that, with the addition of 10-15% fly ash, the plasticity index reduces by 30-40%.With increased percentage of fly ash, free swelling index and swelling pressure decreases. OMC decreased and MDD increased. Adding of fly ash at 25% to 30% un-soaked CBR increased by 40 % to 45%, and with an increase in fly ash content Shrinkage limit goes on increasing constantly.

Saravanan *et al.* (2013) [29]studied the effect of clayey soil by added fly ash in 10%,20%,30%,40%, they found that the unconfined compression strength of the given soil sample had increased 21% in addition of the fly ash content. The dry density of the clayey soil sample was increased by 15 % of the natural soil sample. Somaiya *et al.* (2013) [30] studied the effect of black cotton soil by mixed fly ash in 15%,20%,30% they found the unconfined compressive stress of natural soil without fly ash which was 114kN/m², increased to 123 kN/m² at 20% fly ash in natural soil showing 7.89 % improvement. Also found liquid limit was decreased with increases in the percentage of fly ash up 30% in natural soil which was 74.4%, decreased to 72.5% and Plastic limit was decreased with increases in the percentage of fly ash up 30% in natural soil which was 38.4%, decreased to 32.93%. Choudari *et al.* (2015) [31] studied the effect of fly ash in different percentage (4%, 8%, 12%, 16%, 20%, 22%, 24% and 26%) on expansive soil found maximum dry density decreases and optimum moisture content increases with an increase in the percentage of fly ash. Strength gives a maximum value with an addition of 26% fly ash.

Mohanty *et al.* (2015) [32]studied the properties of expansive soil by adding different percentage of fly ash (10%, 20%, 30%, 40%, 50%). They found the Maximum Dry Density (MDD) value of the black cotton soil initially decreased with the addition of fly ash. Then, it showed increment with increasing fly ash content in the soil, they found the maximum MDD value at 30% fly ash then decreases. Maximum bearing capacity at 20% fly ash then consistently decrease. Zumrawi *et al.* (2016) [33]For observing the engineering properties they used fly ash in 10%, 20%, 25% and 30% on expansive soil, they found that, with an increase in fly ash content the liquid limit decreases. Addition of 30% Fly ash to the expansive soil causes around the reduction in the liquid limit up to 20%. For the plastic limit, like fly ash increases from 0 to 30%, there was a little increase in the plastic limit values. Also, the plasticity index reduces by 55% with the addition of 30% fly ash.

Stabilization by Using Terrazyme

Kaur *et al.* (2014) [34]by using of bio-enzyme on un surfaced roads they found a reduction of dust up to 75%. They observed, when bio-enzymes were added to soil pavement, compressive strength and hardness of the soil increases. It provides flexibility and durability to the subgrade and reduces the formation of crack. Bio-enzymes reduce the swelling properties of the soil. The aggregate free pavement is possible in locally available soil with the use of bio-enzyme. Vaishnava *et al.* (2015) [35]they mixed terrazyme 3m³ per 200ml, 2.5 m³ per 200ml, 2.0m³ per 200ml and 1.5m³ per 200ml on local soil. They found that the value of CBR more on the 1stweak of curing then 2nd weak.

Ganta *et al.* (2016) [36] they study the effect of Terrazyme added with the soil here the amount of clay content plays a major role in the variation of consistency limits. They found that the liquid limit decreases from 61.40% to 56.49% while the plastic limit reduces from 34.00% to 31.70% at the particular dosage. They observed that the treated soaked CBR values are increased as the curing period's increase which is because soil treated with enzyme. The UCS value increases from 3.53 kN/m² to 8.86 kN/m² when compared to the original soil after 4weeks of curing period and CBR value was 5.80% which shows an increase of 387% from the original soil. Gowshik *et al.* (2016) [37]in this paper "experimental study of expansive soil stabilized with terrazyme" they study the effect of enzyme on expansive soil they added terrazyme in various dosage 200ml/3.0m³, 200ml/2.5m³, 200ml/2.0m³, found that the value of liquid limit decreases from 60.2% to 56.53% and the plastic limit also decreases from 32% to 30.09%, The UCS value increases



**Majhi et al.**

from 3.57% to 8.72% when compared to actual soil with 4 weeks of curing. They also found that the CBR value increases from 1.20% to 5.67%. Maximum dry density increases from 1.5 g/cm³ to 1.612 g/cm³. Also found Optimum moisture content decreases from 22.80% to 21.80%.

Gowshik *et al.* (2016) [38] studied the effect of the enzyme on expansive soil, they added terrazyme in 200ml/3.0m³, 200ml/2.5m³ and 200ml/2.0m³ dosages found that the liquid limit decreases from 60.2% to 56.53% and the plastic limit decreases from 32% to 30.09%. After 4 weeks of curing, the UCS value increases from 3.57% to 8.72%. They also found that the CBR value increases from 1.20% to 5.67 % and maximum dry density increases from 1.5 g/cm³ to 1.612 g/cm³. Jagadeesh *et al.* (2017) [39] studied by using bio-enzyme, aggregate-free pavement is possible and also promotes the use of locally available material. They found by the use of bio-enzymes results in high compressive strength and also increases the hardness of stabilized soil. They also found, Bio-enzymes provide flexibility and durability to the pavement and also reduce the formation of crack.

Guptaa *et al.* (2017) [40] described by the use of Terrazyme the strength of the soil increases which was evident by the increase in UCS and CBR values. Also, Terrazyme decrease the voids between the soil particles and thus increases the compaction and density of the soil. Aimi *et al.* (2017) [41] studied at a Micro Level Investigation the optimum fly ash content was found at 20% considering the unconfined compressive strength of treated soil. As the increased strength of soil with the addition of fly ash was not adequate enough to be used as good foundation material, addition of lime in conjunction with fly ash was adopted for stabilization. They observed a minimum lime content of 8.5 % was recommended for stabilizing the soil has resulted from the pH value test. The UCS value increased to 105.2 kPa and the CBR value increased to 5.7 % by addition of 20 % fly ash and 8.5 % lime. The addition of fly ash also improved the geotechnical properties of the soil.

Maharana *et al.* (2018) [42] studies the effects of terrazyme on atterberg limits, compaction characteristics, ucs and triaxial compression test. They found that the liquid limit decreases from 48% for original untreated soil to 37% for treated soil, while plastic limit reduces from 26% to 17% with a decrease in plasticity index from 22% to 19%. UCS value increase from 102.32 kPa to 637.58 kPa when compared to the original soil after 28 days of curing periods.

CONCLUSION

From the above literature review, it is observed that a lot of researches have been carried out by using fly ash on expansive soils and also by using terrazyme on such soils. Most of the researchers from their research found that at 30 to 40% fly ash on soil improves strength to a large extent as well as reduce expansiveness of the soil. Similarly, terrazyme treated soil improves the CBR, UCS and shearing strength of the soil. Using terrazyme gives the best cost-saving results for a long time period and improves the soil structures. But in this research combined effect of fly ash and terrazyme on soil's bearing strength and shearing strength behavior are studied for geotechnical purposes. Behaviors are studied by doing laboratory tests just after preparing samples and after 24-hour curing.

REFERENCES

1. R.P. Shukla, N. Parihar, R.P. Tiwari, B.K. Agrawal, Black cotton soil modification using sea salt. *Electron. J. Geotech. Eng.* 19, 8807–8816 (2014).
2. K.S. Subba Rao, G.G. Satyadas, in 6th International Conference on Expansive Soils. Swelling potential with cycles of swelling and partial shrinkage, Vol 1, pp. 137–142 (1987).
3. Dr. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain. "Soil Mechanics and Foundation" Book.
4. Rudolph Vincent Matalucci, "Laboratory Experiments In The Stabilization of Clay With Gypsum" Bachelor of Science University of New Hampshire Durham, New Hampshire (1960).
5. F.H. Chen, Foundations on Expansive Soils (Elsevier Scientific Publishing Co., Amsterdam, 1975).
6. R.C.K. Wong, Swelling and softening behavior of La Biche Shale. *Can. Geotech. J.* 35(2), 206–221 (1998).





Majhi et al.

7. Pratik Somaiya, Yashwant Zala, Rushikesh Dangar, "Stabilization of Expansive Soil Using Fly Ash" <https://www.researchgate.net/publication/28015305> .
8. Aarathi Prasad and Sujatha Bai, K. (1999), "Lime reactivity in some Indian coal ashes" , *Proc. Nat. Seminar on Fly Ash Characterization and its Geotechnical Applications*, Bangalore, India, pp:15-20.
9. Alam J., Akhtar M.N. (2011) "Fly ash utilization in different sectors in Indian scenario". Issue 1, ISSN 2249-6149.
10. Alok Ranjan, Guru Vittal, Satander Kumar and Murthy, A.V.S.R. (1998), "Some aspects of fly ash characterization and utilization", *Proc. Inter. Conf. on Fly ash Disposal and Utilization*, New Delhi, VIII-3, pp:14-19.
11. Virendra Kumar Yadav & M.H. Fuleka, "The Current Scenario Of Thermal Power Plants And Fly Ash: Production And Utilization With A Focus In India" *International Journal of Advance Engineering and Research Development Volume 5, Issue 04, April -2018*.
12. Fageria NK, Baligar VC (2005) Properties of termite mound soils and responses of rice and bean to nitrogen, phosphorus, and potassium fertilization on such soil. *Commun Soil Sci Plant Anal* 35:2097–2109.
13. Brazetti R (1998) Considerations about the influence of different additives in organic micromorphological, mineralogical, physical, mechanical and hydraulics characteristics of a lateritic soil. *Escola Politecnica de Sao Paulo, Sao Paulo*.
14. Brazetti R, Murphy SR (2001) Objective performance measurement of actual road sites treated with an organic soil stabilizer. In: *First road transportation technology transfer conference in Africa, Dar Es Salaam, Tanzania*.
15. Guthrie WS, Simmons DO, Eggett DL (2015) Enzyme stabilization of low-volume gravel roads. *Transp Res Rec J Transp Res Board* 2511:112–120.
16. Isaac KP, Biju PB, Veeraragavan A (2003) Soil stabilization using bio-enzyme for rural roads. In: *Integrated development of rural an arterial road networks for socio-economic development, Delhi*.
17. Li YJ, Li L, Dan HC (2011) Study on application of TerraZyme in road base course of road. *Appl Mech Mater* 97:1098–1108.
18. Marasteanu M, Hozalski R, Clyne TR, Velasquez R (2005) Preliminary laboratory investigation of enzyme solutions as a soil stabiliser, *Minnesota Department of Transportation Research*.
19. Renforth P, Manning DAC, Lopez-Capel E (2009) Carbonate precipitation in artificial soils as a sink for atmospheric carbon dioxide. *Appl Geochem* 24:1757–1764.
20. Little, D. N. and Nair, S. (2009). "Recommended Practice for Stabilization of Subgrade Soils and Base Materials." *Report for NCHRP Project 20-07. Texas Transportation Institute, Texas A&M University, Texas*.
21. Osinubi, K. J. (1997). "Soil stabilization using phosphatic waste." In *Proc. of 4th Regional Conference on Geotechnical Engineering, GEOTROPIKA 1997, Johor Bahru, Malaysia, 11 – 12 Nov.*, pp 225 -244.
22. Vijay Rajoria, Suneet Kaur "A Review On Stabilization of Soil Using Bio-Enzyme" *International Journal of Research in Engineering and Technology* eISSN: 2319-1163.
23. Pandian, N. S., Krishna. K. C, and Sridharan, A, "California Bearing Ratio Behavior Of Soil-Fly Ash Mixtures" *Journal of Testing and Evaluation. JTEVA, VoL 29, No.2, March "2001*, pp. 220-226.
24. Turker and cokca, " Stabilization Of Expansive Soils Using Class C And Class F Type Fly Ash" *Elsevier science directory* 2004.
25. Satyanarayana P.V.V., Rama Rao R., Krishna Rao C.V, "Utilization of Lime Fly Ash Stabilized Expensive Soil In Roads And Embankments" *Proceedings of Indian Geotechnical Conference, Warangal (India)*. 465-467.
26. S. Bhuvaneshwari, R. G. Robinson, S. R. Gandhi, "Stabilization of Expansive Soils Using Flyash" *Fly Ash Utilization Programme (FAUP), TIFAC, DST, New Delhi – 110016*.
27. Phanikumar, B.R., and Sharma, R. (2007), "Volume Change Behavior of Fly Ash-Stabilized Clays" *Journal of Materials in Civil Engineering*, Vol. 19, SPECIAL ISSUE: Geochemical Aspects of Stabilized Materials, pp. 67–74.
28. Mahesh G. Kalyanshetti, Satish Basavaraj Thalange, "Effect of Fly Ash on The Properties of Expansive Soil" *International Journal of Scientific & Engineering Research* Volume 4, Issue 5, May-2013 ISSN 2229-551.
29. R. Saravanan, Roopa Saira Thomas, Merlin Joseph, "A Study on Soil Stabilization of Clay Soil Using Fly Ash" *International Journal of Research in Civil Engineering, Architecture & Design* Volume 1, Issue 2, October-December, 2013, pp. 33-37, © IASTER.
30. Prof. Pratik Somaiya, Prof. Yashwant Zala, Prof. Rushikesh Dangar, "stabilization of expansive soil using fly ash".





Majhi et al.

31. Sudheer Choudari, Y. Bhargava Gopi Krishna, "Effect of Flyash on Compaction Characteristics Of Expansive Soils, Near Anandapuram, Visakhapatnam, Andhra Pradesh, India" International Journal of Engineering Research & Technology (IJERT) Issn: 2278-0181 Ijertv4is030380, www.ijert.org Vol. 4 Issue 03, March-2015.
32. Manmay Kumar Mohanty, Dr. N. Roy, "Stabilization of Expansive Soil Using Fly Ash" NIT Rourkela.
33. Magdi M. E. Zumrawi, Mohammed H. Mohammed "Effect of Fly Ash on the Characteristics of Expansive Soils in Sudan".
34. Vijay Rajoria, Suneet Kaur, "A Review on Stabilization of Soil Using Bio-Enzyme" International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
35. Venika Saini, and Priyanka Vaishnava, "soil stabilization by using terrazyme" international Journal of Advances in Engineering & Technology, Aug, 2015.
36. Srinivas ganta, Amith kadabasheshadri, "Black Cotton Soil Stabilization By Bio Enzymes" Anveshana's international journal of research in engineering and applied sciences, volume 1, issue 10 (2016, oct).
37. Gowshik, A. V. Karthick Rajeshwar, M. Mohanasundram, "Experimental Study of Expansive Soil Stabilized with Terrazyme" International Journal of Engineering Research & Technology (IJERT). <http://www.ijert.org>. ISSN: 2278-0181 IJERTV5IS010627 Vol. 5 Issue 01, January-2016.
38. Gowshik, A. V. Karthick Rajeshwar, M. Mohanasundram, "Experimental Study of Expansive Soil Stabilized with Terrazyme" International Journal of Engineering Research & Technology (IJERT).
39. Prof. R. Jagadeesh Kumar, Guru S, Krishna Puthiran V S, Manikandan G, "A Review on Stabilization of Soil using Various Admixtures" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181 IJERTV6IS020332 Vol. 6 Issue 02, February-2017.
40. Anjali Gupta, Vishal Saxena, Ayush Saxena, Mohd. Salman, ShamsulAarfin, Avinash Kumar, "Review Paper on Soil Stabilization by Terrazyme" *Int. Journal of Engineering Research and Application* www.ijera.com ISSN : 2248-9622, Vol. 7, Issue 4, (Part -6) April 2017, pp.54-57.
41. Siti Aimi Nadia Mohd Yusoff, Mastura Azmi, Harris Ramli, Ismail Bakar, D. C. Wijeyesekera, "Laboratory investigation of TerraZyme as a soil stabilizer" American Institute of Physics, <https://doi.org/10.1063/1.5005680>.
42. DR M Maharana, Manisha pardhi, "soil stabilization by using terrazyme" IGIT Sarang.

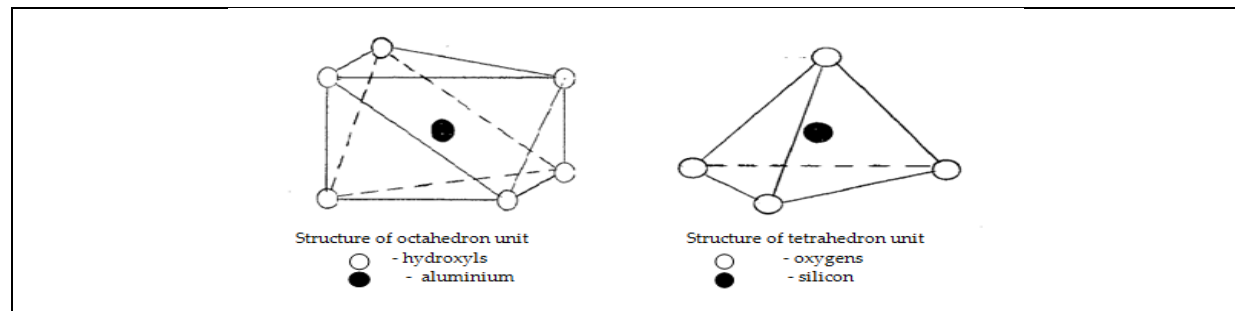


Figure 1 Structure of clay minerals

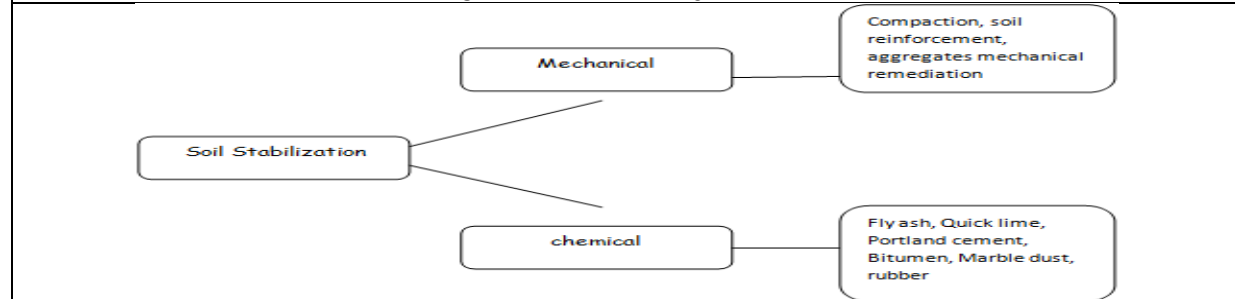


Figure 2. Different type of soil stabilization [7]





Shy Canines: Diagnosis and Treatment Options.

Prakash N¹, Suma S^{2*} and Raghunath N³

¹PG Student, Department of Orthodontics and Dentofacial Orthopedics, JSS DCH, JSSAHER, Mysuru, Karnataka, India.

²Reader, Department of Orthodontics and Dentofacial Orthopedics, JSS DCH, JSSAHER, Mysuru, Karnataka, India.

³Professor & Head, Department of Orthodontics and Dentofacial Orthopedics, JSS DCH, JSSAHER, Mysuru, Karnataka, India.

Received: 25 Feb 2022

Revised: 03 Apr 2022

Accepted: 16 May 2022

*Address for Correspondence

Suma S

Reader,

Department of Orthodontics and Dentofacial Orthopedics,

JSS DCH, JSSAHER, Mysuru,

Karnataka, India.

Email: dr.suma@jssuni.edu.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Why has disimpaction or dealing with of impacted canines turned out to be so crucial in last three decades? Due to the fact an absent canine causes aesthetic and functional issues, and the canine have a lengthy root and solid bone support, it is useful for lateral excursions and acts as an ideal anchorage for permanent and removable prostheses. Due to this, canine is generally considered as “cornerstone” of the maxillary arch. As an end result, effective treatment plans for impacted maxillary canines (IMC) need to be evolved to fulfill the affected person's wishes in phrases of aesthetics and function. The clinical diagnosis, radiographic examination, and appropriate interceptive treatment all make contributions to a proper treatment method. The purpose of this overview is to contain the research that encompass specific radiographic assessment of impacted dog in horizontal and vertical relationship to adjacent teeth structure, treatment prognosis, as well as system to forecast MCI.

Keywords: Canine impaction, Treatment, Diagnosis, treatment options

INTRODUCTION

Management of impacted maxillary canines is an average hassle that dental practitioners confront on an every day basis. In 1975, Archer described an impacted tooth as one which absolutely or partly un-erupted and located towards the adjoining tooth, bone, or soft tissue, making further eruption not likely. Tooth impaction is likewise described because the teeth infra-osseous position after the scheduled time of eruption. The mandibular third molar is the





Prakash et al.,

maximum common impacted teeth, followed by way of the maxillary 3rd molar, maxillary canine, mandibular premolar, mandibular canine and maxillary incisors. The most prevalent cause of maxillary canine is mandibular 3rd molar impaction. Ericson and Kuroi found that 1.7 percent of canine have ectopic canine eruptions. The most time-honored kind of canine impaction is maxillary canine impaction, accompanied by mandibular canine impaction. The superiority of the maxillary canine impaction is definitely pretty low, ranges of 0.92 percent to 2.2 percent of the residents with 2:1 predisposition to harm women over men. In perspective, the incidence of mandibular canine impaction (0.35 percent) is lower than the prevalence of impacted maxillary canine (2,3). Consistent with the statistics, 85 percent of canine impactions occur palatally, with the final 15 percent going on buccally (4). The palatal to buccal canine impaction ratio is 2:1 or 3:1. (5). However, Oliver 1989 established in his study that Asians are much more likely to have buccally affected canines (6).

Dachi and Howell additionally found, that 92 percent of maxillary canine impactions are unilateral, remaining 8 percent being bilateral (7). Canines with buccal and palatally impacted teeth have diverse etiologies. In step with Jacoby's studies, 85 percent of palatally displaced canines had enough arch length to erupt, but 83 percent of labially affected canines did not have enough arch length to erupt. As a result, overcrowding was identified as the predominant etiological cause of labial impactions (8). There have been numerous hypotheses offered to provide an explanation for the etiology of palatally impacted canine. In step with the steering concept proposed via Becker et al. in 1981 and Miller in 1963, Canine eruption is guided by the distal part of the lateral incisor. Palatally impacted canine have been located to be quite closely linked through spacing dentitions and lateral incisors which are peg-shaped, or congenitally missing in their take a look at. About half of the palatal impactions studied were related to peculiar lateral incisors (9, 10). According to the hereditary assumption by Peck et al. (11) in 1994, the dental anomaly of canine impaction is the consequence of a combination of hereditary and environmental factors. They established this hypothesis based on the actuality that palatally displaced canine associate with other dental abnormalities such as lateral-premolar hypodontia as well as peg laterals, which they occur bilaterally, moreover prevalence varies by gender, family, and population. Other factors documented in the multifactorial aetiology of impacted canines include supernumeraries, Odontomes, Pathological lesions, Delayed exfoliation of the deciduous canine, Early trauma to the maxilla; Cleft lip and palate; Ankylosis; Displacement of the crypt; Long path of eruption; and Syndromes.

Various radiographic assessment method for impacted maxillary canine Ericson and Kuroi Method -1988 (1, 12)

Sector classification (Figure: 1)

Sector 1: Impacted canine cusp is positioned in the middle of the mesial to first premolar and the distal part of the lateral incisor.

Sector 2: Impacted canine cusp tip is located in the middle of the distal to lateral incisor and its long axis.

Sector 3: Impacted canine cusp tip is placed in the middle of the lateral incisor's long axis and its mesial aspect.

Sector 4: Impacted canine cusp tip is positioned in the middle of the mesial portion of lateral incisor and central incisor's long axis.

Sector 5: Impacted canine cusp tip is located in the middle of central incisor's long axis and interincisor median line.

Risk of root resorption of the lateral incisor will increase through 50% if the canine's cusp belongs to region 1 or 2, and the duration of its time period is longer if the canine is located in region 1, and shorter if it's far discovered in region 3, compared to region 2.

Canine angulation to midline (α): (Figure 2)

The term angle (α) was used to denote the angle formed by the inter-incisor midline and the canine long axis. Mean range of α angle $22^\circ \pm 11^\circ$ (12). In terms of inclination angle of affected canines to the interincisal plane, as this inclination angle advances, the prognosis of canine realignment decreases. An inclination angle of 15° is regarded a





Prakash et al.,

favorable prognosis, an inclination angle of 16-30° is considered a fair prognosis, and an inclination angle of greater than 31° significantly reduces the likelihood of eruption (13).

Grade 1: 0–15°

Grade 2: 16–30°

Grade 3: More than 31°

Perpendicular Distance (d): (Figure 3)

The canine vertical height was measured as the perpendicular distance from the impacted canine cusp tip to the occlusal plane defined with a tangent line runs through incisal edge of the maxillary central incisors and the occlusal surface of the maxillary first molar. The mean average distance for good prognosis is 14.7 ± 3.2 mm⁽¹¹⁾. It's been suggested that time duration for disimpaction and alignment of impacted canine by orthodontically takes a mean of 24 months while the position of cusp tip of impacted tooth is lower than 14 mm above the occlusal plane, and this time is extended to 31 months for vertical height displacements greater than 14 mm. (14)

Modification of Ericson and Kuroi's by Steven J. Lindauer et al -1992 (15):(Figure 4)

Sector I: This region located distally, tangent to the lateral incisor distal crown and root.

Sector II: This region located between the distal surface's tangent and the long axis of lateral incisor tooth.

Sector III: This region located in the middle of the long axis and tangent to the lateral incisor distal crown and root.

Sector IV: All locations from the mesial to the third sector is included.

The overlap with respect to the nearest incisor by Susan M. Power In 1993: (Figure 5)

The amount by which the canine crown exceeds the root of an adjacent incisor, most notably the lateral incisor. If a lateral incisor was absent, the overlap of the central incisor was measured. (16).

Stage 0 = no overlap

Stage 1 = Less than half incisor root width

Stage 2 = More than half incisor root width

Stage 3 = Beyond the incisor root and with full overlap.

No horizontal overlap with the next incisor indicates a better prognosis, overlapping up to half the root size indicates an intermediate prognosis, and whole the root overlapping indicates a poor prognosis (17).

The vertical axial eruptive path (VAEP) by Harry S. Orton et al in 1995: (Figure 7)

Harry et al. proposed utilizing a lateral cephalogram to assess the vertical axial eruptive path. The angle of canine impaction is evaluated by tracing its long axis and intersection with the vertical line which is at right angle to FH plane. A labial tilting of 10 degree with respect to the FH plane is the optimal vertical axial eruptive path (VAEP) of an unerupted upper canine. When paired with midline displacement, small increments in forward tilting result in a rapid worsening of prognosis (18). A forward tilt of 15 degree to 25 degree necessitates therapy. 25 degree to 50 degree is additional challenging; 45 degree is often untreatable orthodontically. Labial tipping of an impacted maxillary canine of 15° or more, along with height and midline displacement, might cause resorption in incisor apices.

Sector Classification by Yoojun Kim in 2011 (19): (Figure 8)

There are two conventional lines for evaluating the mesiodistal location of impacted canines.

Sector I (a): It refers to the locations where impacted canine appears distal to the lateral incisor but does not overlap the lateral incisor root.

Sector II (b): The zone where the canine crown and the lateral incisor root appear to be overlapping.

Sector III (c): The zone where the canine crown appears to have gone through the lateral incisor.





Prakash et al.,

Angular measurement by John H. Warford et al in 2003 :(Figure 9)

To establish the horizontal baseline, Warford et al. used the superior most portion of the condyle as skeletal landmarks. Following that, the bicondylar line was established also utilized as a designed horizontal orientation line. The mesio angular dimension created by the established horizontal line and the unerupted canine's long axis. Non-impacted teeth had a higher angulation, with a mean of 75.12° compared to 63.20° for impacted teeth. (20, 17).

Ali Alqerban and Reinhilde Jacobs in 2014 (21): (Figure 10)

Sector classification

Sector -1= Located distal to the standard position (in the premolar region).

Sector 0= Located in Standard position (primary canine).

Sector 1= Located distal to the lateral incisor's long axis.

Sector 2= Located mesial to the lateral incisor's long axis.

Sector 3= Located distal to the central incisor's long axis.

Sector 4= Located mesial to the central incisor's long axis.

Vertical canine location: (Figure 11)

The canine crown's height in relation to the CEJ (cemento-enamel junction) of the lateral incisor

Grade 1: The canine cusp is situated beneath the CEJ of the adjoining lateral incisor.

Grade 2: The canine cusp is situated apical to the CEJ however less than half the length of the root.

Grade 3: The canine cusp extends from the apex to half of the lateral incisor root.

Grade 4: The canine cusp is apical apex of the lateral incisor

From the cemento-enamel junction to less than midway up the root of the lateral incisor, the prognosis is favorable; far beyond midway up the root but below the level of entire root length, the prognosis is fair; and above the entire root length, the prognosis is poor. (17)

Canine root apex in anteroposterior relationship (22): (Figure 12)

The anteroposterior position of canine root apex in relation to the 1st and 2nd pre-molar tooth also predicts the displacement and alignment of impacted canine.

Grade 1: Located above the ideal canine position.

Grade 2: Located above in area of the upper 1st premolar.

Grade 3: Located above in area of the upper 2nd premolar.

Displacement and alignment prognosis is good if the canine apex is placed above the usual canine position; fair if it's located next to the 1st premolar area; and unfavorable if it is located just above 2nd premolar region (18).

CONCLUSION

Orthodontists determine whether to expose or extract an affected upper permanent canine based on radiographic evidence. Panoramic radiography is a good indication for assessing the IMC in an inexpensive, quick, and readily distributed imaging technology that exposes the patient to low radiation. The multivariate prognostic system is thought to be a valuable diagnostic method for predicting IMC alignment based on its mesio-distal position as determined by sector categorization, angulation of the tooth long axis with respect to neighboring anatomical structure, vertical height of such impacted canine as from occlusal plane, and horizontal orientation of its root apex.

REFERENCES

1. Ericson S, Kurol J. Early treatment of palatally erupting maxillary canines by extraction of the primary canines. *Europ J Orthod* 1988; 10:283-295.
2. Bishara SE. Impacted maxillary canines: a review. *Am J Orthod Dentofacial Orthop.* 1992;101:159–171.





Prakash et al.,

3. Cooke J, Wang H-L. Canine impactions: incidence and management. *Int J Periodontics Restorative Dent*. 2006;26.
4. Hitchen AD. The impacted maxillary canine. *Br Dent J* 1956; 100: 1–14.
5. Fournier A, Turcotte JY, Bernard C. Orthodontic considerations in the treatment of maxillary impacted canines. *Am J Orthod*. 1982;81:236–239.
6. Rohrer A. Displaced and impacted canines. *Int J OrthodOralSurg*1929;15:1003.
7. Dachi SF, Howell FV. A survey of 3,874 routine full-mouth radiographs. II. A study of impacted teeth. *Oral Surg Oral Med Oral Pathol* 1961; 14(10): 1165–1169
8. Jacoby H. The etiology of maxillary canine impactions. *Am J Orthod* 1983; 84: 125–132.
9. Becker A, Smith P, Behr R. The incidence of anomalous maxillary lateral incisors in relation to palatally displaced cuspids. *Angle Orthod* 1981; 51: 24–29
10. Pritam Mohanty, Swati Saraswata Acharya, Subha Soumya Dany, Debapreeti Mohanty. Maxillary canine impaction and its management - a review. *International Journal of Contemporary Medical Research* 2015;2(4):949-955
11. Peck S, Peck L, Kataja M. The palatally displaced canine as a dental anomaly of genetic origin. *Angle Orthod* 1994; 64(4): 250–256
12. Arriola-Guillén LE, Ruíz-Mora GA, Rodríguez-Cárdenas YA, Aliaga-Del Castillo A, Boessio-Vizzotto M, Dias-Da Silveira HL. Influence of impacted maxillary canine orthodontic traction complexity on root resorption of incisors: A retrospective longitudinal study. *Am J Orthod Dentofacial Orthop*. 2019 Jan;155(1):28-39. doi: 10.1016/j.ajodo.2018.02.011. PMID: 30591160.
13. Ruba J Mohammad, Orthodontic Evaluation of Impacted Maxillary Canine by Panoramic Radiograph–A Literature Review, *J Res Med Dent Sci*, 2021, 9(8): 220-227
14. Alhammadi MS, Asiri HA, Almashraqi AA. Incidence, severity and orth-odontic treatment difβiculty index of impacted canines in Saudi population . *J Clin Exp Dent* 2018; 10:e327-34.
15. Lindauer SJ, Rubenstein LK, Hang WM, et al. Canine impaction identified early with panoramic radiographs. *J Am Dent Assoc* 1992; 123:91–97.
16. Power SM, Short MB. An investigation into the response of palatally displaced canines to the removal of deciduous canines and an assessment of factors contributing to favorable eruption. *Br J Orthod* 1993; 20:215–223.
17. Counihan K, Al-Awadhi EA, Butler J. Guidelines for the assessment of the impacted maxillary canine. *Dent Update*. 2013 Nov;40(9):770-2, 775-7. doi: 10.12968/denu.2013.40.9.770. PMID: 24386769.
18. Orton HS, Garvey MT, Pearson MH. Extrusion of the ectopic maxillary canine using a lower removable appliance. *Am J Orthod Dentofacial Orthop*. 1995 Apr;107(4):349-59. doi: 10.1016/s0889-5406(95)70087-0. PMID: 7709899.
19. Kim Y, Hyun H, Jang K. The position of maxillary canine impactions and the inβluenced factors to adjacent root resorption in the Korean population. *Europ J Orthod* 2012; 34:302–306.
20. Warford JH, Grandhi RK, Tira DE. Prediction of maxillary canine impaction using sectors and angular measurement. *Am J Orthod Dentofaci Orthop* 2003; 124:651–655.
21. Alqerban A, Jacobs R, van Keirsbilck P, et al. The effect of using CBCT in the diagnosis of canine impaction and its impact on the orthodontic treatment outcome. *J Orthodont Sci* 2014; 3:34-40.
22. Stivaros N, Mandall NA. Radiographic factors affecting the management of impacted upper permanent canines. *J Orthod* 2000; 27:169-173.





Prakash et al.,

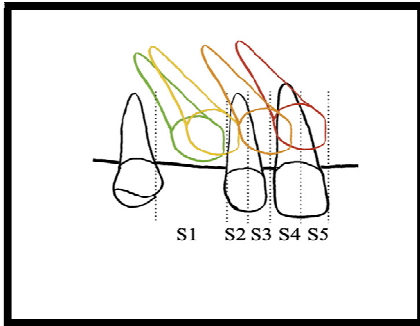


Figure 1: Sector classification by Ericson and Kuroi Method

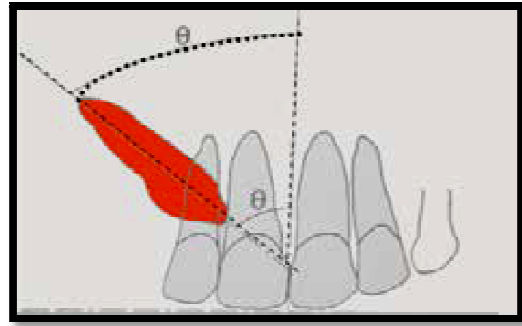


Figure 2: Canine angulation to midline

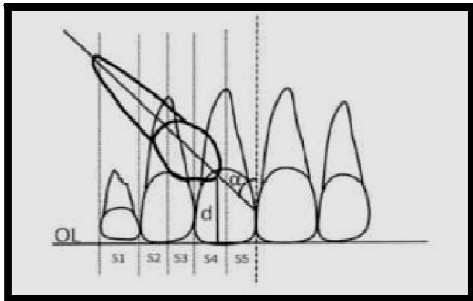


Figure 3: Alpha angle and Perpendicular distance by Ericson and Kuroi Method

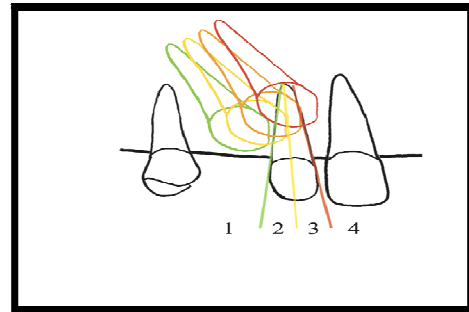


Figure 4: Sector Analysis by Steven J. Lindauer et al.,

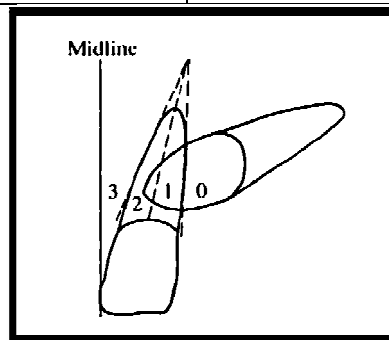


Figure 5: Horizontal overlap of the adjacent incisor

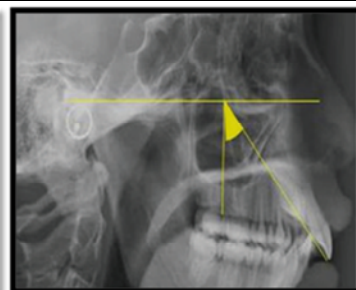
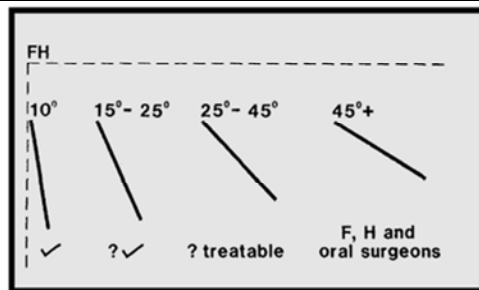


Figure 7: The vertical axial eruptive path (VAEP)





Prakash et al.,

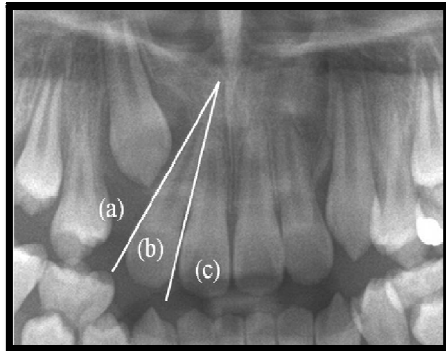


Figure 8: Sector Analysis by Yoojun Kim Jacobs

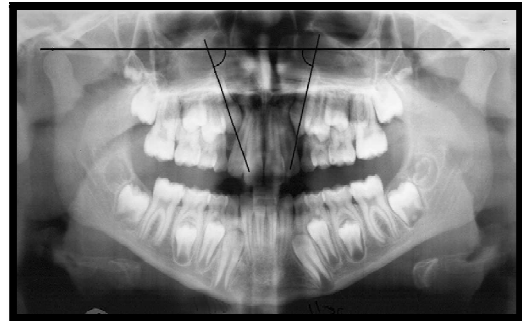


Figure 9: Angular measurement by John H. Warford et al.

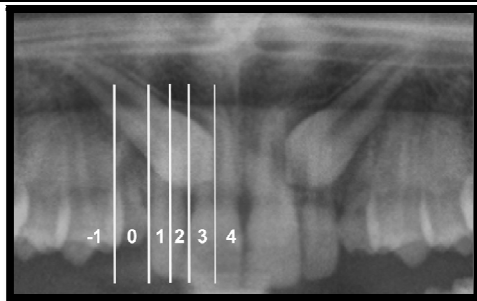


Figure 10: Sector Analysis by Ali Alqerban and Reinhilde Jacobs

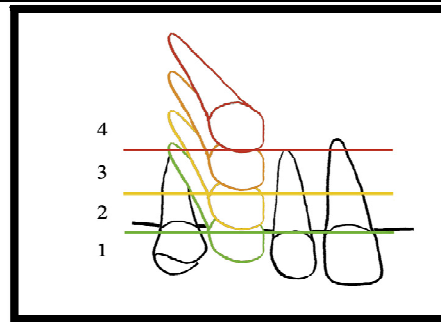


Figure 11: Vertical canine location by Ali Alqerban and Reinhilde Jacobs

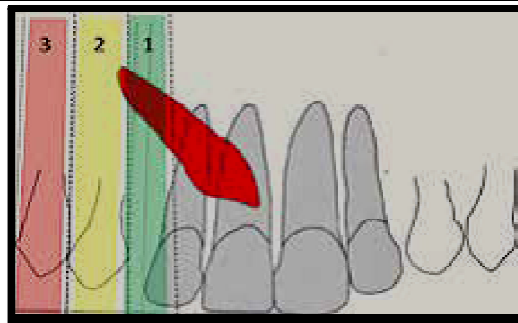


Figure 12: Canine Root Apex in Antero-posterior relation.





Alteration in Different Chemical Constituents Present in Banana Juice Due to Addition of Preservative (Vinegar)

Arpita Patel, Ekshita Pattjoshi, Suchismita Acharya* and Atia Arzoo

Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Suchismita Acharya

Centurion University of Technology and Management,
Odisha, India.

Email: suchismita.acharya@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Banana is a much-appreciated tropical fruit due to its unique aroma, flavor, and also for its nutritional components. In this work, we aim to identify the elemental concentrations of freshly prepared and vinegar added banana juice. Bananas were collected, peeled and washed it properly by using distilled water and grounded it to make juice. Two kinds of juices were prepared. One was normal juice and another one was prepared with preservatives, i.e 1:10 ratio of vinegar to juice. Both the juices were analysed through X-Ray fluorescence technique. In this study, it was found that, the elemental concentrations slightly increased in case of vinegar treated juice as compare to the fresh one.

Keywords: Food Security, Banana juice, Vinegar, X-Ray Fluorescence

INTRODUCTION

Banana is the most popular fruit among all due to its sweet taste and aroma. Also, it contains different nutrients such as antioxidants, protein, carbohydrate, vitamins and minerals. Besides that, it has a great composition of energy sources, which provide health-promoting benefits. Banana has a moderate acidity, a very good sugar content, and possess different kinds of enzymes and nutrients. The unique flavor of banana attracts the people towards it. But banana is a climactic fruit with less shelf life and fast deterioration. Thus, it is necessary to produce new healthy banana products. Fruit juice is a kind of nutritious beverage, which is favoured by both elders and teenagers due to its special benefits on health. Nowadays, fruit juices have gained much popularity recently and provided an alternative substitute to traditional beverages such as coffee, tea or carbonated soft drinks [1]. Fruit juices are good source of nutritional compounds, such as carotenoids, flavonoids, macro elements (e.g., Ca, K, Mg, Na), proteins and vitamins etc [2-4]. Consumption of food juice on daily basis increase the nutrient content in human body, so it contributes to the human diet in a daily basis.

The processing of tropical fruits into clarified and concentrated juice is an important route of development and valorisation of products nowadays. Several research has been conducted for the traditional fruit juice to produce

43121





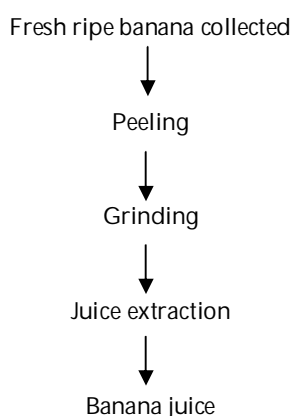
Arpita Patel et al.,

high-quality fruit juice obtained [5]. Among the traditional fruit juices, banana juice holds a special place, particularly in the tropical and subtropical regions where bananas are produced in plenty. It contains sufficient sugar and is a source of energy. There are various methods used for analysis of the elemental content present in the juice but XRF analysis is the more significant way. This method is used widely because of its low cost of sample preparation and stability. It is one of the best analytical techniques for analysis of all kind of samples such as solid, liquid or powders. Based on this idea, this work aims to characterize the concentrations of elements present in freshly prepared banana juice and after addition of vinegar in it.

EXPERIMENTAL

Fresh ripe bananas were collected from nearby local market and then it was grinded by using grinder. Then the juice was extracted. The juice was then divided into two equal parts. One part was mixed with vinegar and the other part was left as normal one. Both the normal juice and vinegar added juice were subjected for XRF analysis to know the elemental content present in it.

Processing of banana to make banana juice involves following steps



RESULTS AND DISCUSSION

The determination of the elemental composition of fruit juices is very important in terms of consumer safety and protection. The alteration of different chemical constituents present in banana juice were investigated by XRF analyser. Table-1 and Fig-1 depicted about elemental content present in banana juice without employing any type of preservative. In a very similar way, Table-2 and Fig-2 represent elemental content present in banana juice with addition of preservative as vinegar. From the present study we have found that, fresh banana juice contains elements like P, S, Cl, K, Ca, Mn, Fe, Sn, as well as H₂O content, whereas after addition of vinegar the preserved juice contain an extra element like Si. It was found that the concentration of elemental contents of the banana juice was increased except potassium (K) and sulphur (S) after addition of the preservative (vinegar) into it. But the percentage of water content is slightly decreased in vinegar preserved banana juice.

CONCLUSION

All elements present in banana juice like P, S, Cl, K, Ca, Mn, Fe, Sn, Si, H₂O etc are considered as micronutrients for all plants and animals. So, consumption of banana juice is also considered as healthy diet due to the presence of all essential nutrients. But it cannot be preserved for a longer period. As vinegar is not having any harmful constituents,





Arpita Patel et al.,

so addition of vinegar can be recommended to preserve it for longer time period. This research paper reflects the idea about improvement of nutritional value, which is coming under SDG-2.

ACKNOWLEDGMENT

The authors are thankful to the authorities of centurion university of technology and management, Odisha for their support and valuable advice.

REFERENCES

1. Maskan, M., Production of pomegranate (*Punica granatum* L.) juice concentrate by various heating methods: Color degradation and kinetics. *J. Food Eng.*, 72 (3), 218–224, (2006).
2. Szymczycha-Madeja, A., Welna, M., Jedryczko, D., Pohl, P., Developments and strategies in the spectrochemical elemental analysis of fruit juices, *Trends Anal. Chem.*, 55, 68-80, (2014).
3. Demir, F., Seyhun Kipcak, A., Dere Ozdemir, O., Moroydor Derun, E., Determination of essential and non-essential element concentrations and health risk assessment of some commercial fruit juices in Turkey, *J. Food Sci. Technol.*, 57, 4432-4442, (2020).
4. Pohl, P., A revisited FAAS method for very simple and fast determination of total concentrations of Cu, Fe, Mn and Zn in grape juices with sample preparation developed by modelling experimental design and optimization, *Microchem. J.*, 157, 104998, (2020).
5. Vaillant, F., Millan, A., Dornier, M., Decloux, M., Reynes, M., Strategy for economical optimisation of the clarification of pulpy fruit juices using crossflow microfiltration. *J. Food Eng.*, 48 (1), 83–90, (2001).

Table-1: Elemental contents present in normal banana juice

| Elements name | Concentration | Unit |
|------------------|---------------|------|
| P | 575.9 | ppm |
| S | 314.1 | ppm |
| Cl | 453.6 | ppm |
| K | 1370 | ppm |
| Ca | 218.4 | ppm |
| Fe | 14.0 | ppm |
| Sn | 45.8 | ppm |
| H ₂ O | 99.690 | % |

Table-2: Elemental contents present in vinegar added banana juice.

| Elements name | Concentration unit | Unit |
|------------------|--------------------|------|
| P | 623.5 | ppm |
| S | 260.6 | ppm |
| Cl | 513.8 | ppm |
| K | 1230 | ppm |
| Ca | 220.9 | ppm |
| Fe | 17.5 | ppm |
| Sn | 46.7 | ppm |
| H ₂ O | 99.65 | % |
| Si | 458.9 | ppm |





Arpita Patel et al.,

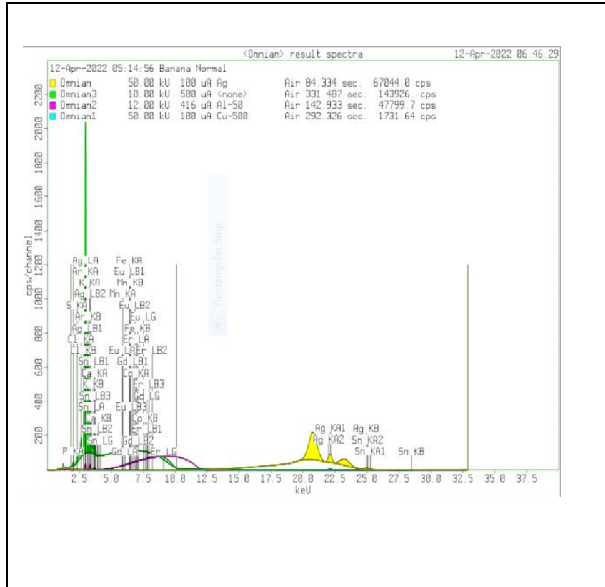


Figure 1: X-Ray Fluorescence of fresh banana juice

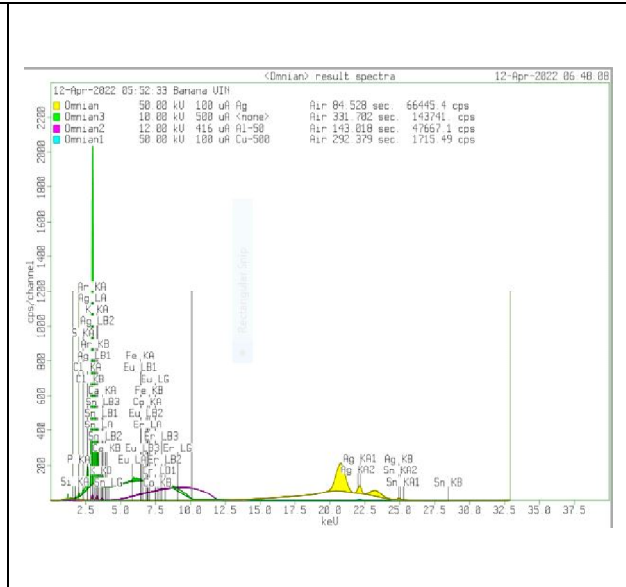


Figure 2: X-Ray Fluorescence of vinegar added banana juice

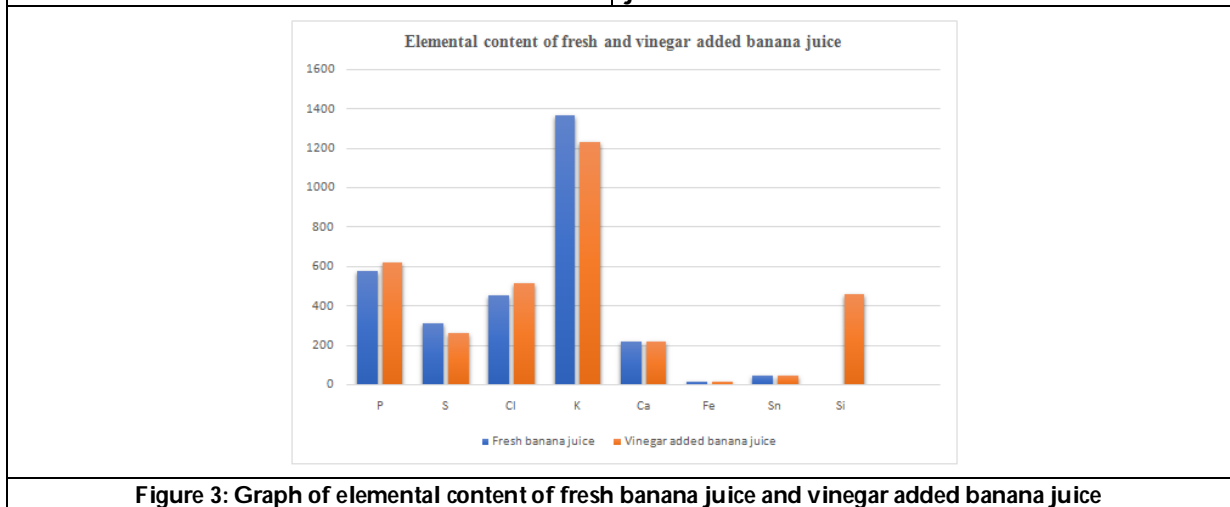


Figure 3: Graph of elemental content of fresh banana juice and vinegar added banana juice





Analysis and Design of RC-Trigging Circuit for Electric Vehicle Battery Charger

Trilochan Penthia*

Centurion University of Technology & Management, Paralakhemundi, Odisha, India

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Trilochan Penthia

Centurion University of Technology & Management,

Paralakhemundi, Odisha, India

Email: trilochan.penthia@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A battery charging system is one of the most frequently discussed topics today in electric vehicle applications. The whole global is chasing after electric vehicle technology due to the depletion of fossil fuels and global warming caused by carbon-dioxide emitting vehicles. Charging infrastructure, sustainable energy storage systems (batteries), and charging time are the major challenges in the electric vehicle ecosystem that need to be explored further. This paper presents a low-cost, compact, and simple silicon-controlled rectifier (SCR) for battery charging purposes. The SCR is a half-controlled semiconductor device that requires an external signal (i.e., triggering) for operation. Resistive-Capacitive (RC) triggering circuit is a popular gate triggering method of SCR. It operates in alternating current (AC) supply only. SCR with RC triggering has a high degree of freedom in battery charging applications. The operation and design of the proposed RC triggering method of SCR is analyzed in this paper. Simulation of the proposed SCR-based battery charger is performed and analyzed using MATLAB/Simulink 2021.

Keywords: SCR triggering circuits, Battery charging system, Electric vehicle technology

INTRODUCTION

The use of electric vehicles is increasing rapidly. Recently, Norway has initiated a process to replace all the internal combustion (IC) engines with electric vehicles [1]. Introducing the electric vehicle (EV) technology into the market has been a political agenda of governments around the world. Many efforts are being made by the governments (e.g., subsidies, exchange offers, etc.) to encourage people to use it. Apart from the design of the electric vehicle, battery management systems, charging systems, and integration with the grid are important parts of the EV ecosystem [2]. An SCR comes under the thyristor family. It is widely used in low to high-power applications. SCR is one of the suitable switching devices for battery charging when the supply is AC type. A triggering method is needed to turn on the SCR in order to operate and control the output. Various triggering methods are available such as gate triggering (AC, DC and pulse), forward-voltage triggering, temperature triggering, light triggering, and dv/dt





Trilochan Penthia

triggering. RC-triggering is an AC type gate triggering method where the input signal and also gate controlling signal is AC type. This method has a better degree of freedom to control the output voltage. The output is then used for battery charging purposes. The RC triggering has a triggering angle of 0° to 180° to regulate the SCR, and hence the output. The detail of the RC-triggering circuit of SCR is presented in this paper. The SCR converts an AC voltage to a rectified DC voltage. The average value of rectified DC voltage is utilized for battery charging. A block diagram of SCR with RC triggering for EV battery charging is shown in Figure 1. This paper consists of four sections. The paper starts with an introduction to the importance of electric vehicle technology and then battery charging systems in section-1. It highlights the role of SCR based battery charging circuit. Section-2 describes the designing parameters of RC-triggering circuit of SCR. It also summarizes the different parameters of a Li-ion battery. Results and discussions are presented in section-3. Finally, concluding remarks are made in section-4.

Design Of Circuit Topology

The proposed SCR-based EV battery charger is a simple power electronic converter and has a good performance. The circuit topology of the SCR-based battery charger is shown in Figure 2. An AC supply of 230V, 50 Hz is initially stepped-down to V_s of 28V, 50 Hz supply using a step-down transformer. This transformer with a manual switch also acts as a protection device that isolates the supply from the battery charger. SCR is the main switching component in the circuit having an RC-triggering circuit. The triggering circuit has a variable resistance (R), capacitance (C) and two diodes (D1 and D2). A Li-ion battery having an internal resistance of 0.5Ω is connected between the cathode terminal of SCR and the capacitor. The triggering or firing angle (α) of SCR varies from 0 to 180 degrees giving a chance to control the positive half cycle of the input AC signal. The designing value R and C for a time period of $T(=1/f)$ is given as:

$$RC \geq \frac{1.3T}{2} \quad (1)$$

The RC factor in the circuit decides the firing angle for SCR in order to regulate the battery charging. The resistance 'R' ensures a minimum gate current ($I_{g(min)}$) to flow in the SCR through diode D₁. The capacitor is responsible for maintaining a suitable gate to cathode voltage (V_g). A minimum gate to cathode voltage ($V_{g(min)}$) should be maintained to turn on the SCR. Considering a voltage across diode D₁ (V_{D1}), a minimum value of R can be given in Eq. (2) to provide a minimum gate current to SCR.

$$R = \frac{V_s - V_{g(min)} - V_{D1}}{I_{g(min)}} \quad (2)$$

A lithium-ion battery or Li-ion battery having a nominal voltage of 12V and current capacity of 55 Ah is considered for an electric vehicle application. The considered battery parameters are presented in Table-1. More details on the design and analysis of this battery can be found in the literature [3].

The average output voltage (V_0) w.r.t firing angle (α) and input peak voltage (V_m) is given as:

$$V_0 = \frac{1}{2\pi} \int_{\alpha}^{\pi} V_s dt = \frac{V_m}{2\pi} (1 + \cos\alpha) \quad (3)$$

RESULTS AND DISCUSSION

In this section, MATLAB simulation results are presented and discussed. A MATLAB model is prepared as per the circuit diagram which is shown in Figure 2. MATLAB simulation model is depicted in Figure 3. The corresponding simulation parameters are also illustrated in Table-2. The battery charging process is divided into two modes. In mode-1, the resistance value of RC-triggering circuit varies from 750Ω to 1400Ω (i.e., $750\Omega < R \leq 1400\Omega$) in order to achieve a firing angle of 90° to 180° . Similarly, in mode-2, the resistance value varies from 50Ω to 740Ω (i.e., $50\Omega < R < 750\Omega$) resulting in a firing angle range between 0° to 90° . Details of these two case studies are analyzed with simulation results here.

Mode-1: Battery charging when the firing angle (α) is between 90 to 180 degrees

Figure 4 shows the waveform of input voltage (V_s), output voltage (V_0) and output current (I_0) of the battery charging circuit. As the output voltage depends on the firing angle of the SCR as presented in Eq. (3). The output voltage is





Trilochan Penthia

connected to the battery for charging. The corresponding SCR voltage (V_T), SCR current (I_T) and capacitor voltage (V_C) are depicted in Figure 5. The capacitor voltage acts as a gate-to-cathode voltage which is responsible for SCR triggering. The resistance value of 1100Ω (i.e., $750\Omega < R \leq 1400\Omega$) is taken for the simulation, and a firing angle of approximately 120° is achieved.

Mode-2: Battery charging when the firing angle (α) is between 0 to 90 degrees

Figure 6 shows the waveform of input voltage (V_s), output voltage (V_o) and output current (I_o) of the battery charging circuit. As the output voltage depends on the firing angle of the SCR as presented in Eq. (3). The output voltage is connected to the battery for charging. The corresponding SCR voltage (V_T), SCR current (I_T) and capacitor voltage (V_C) are depicted in Figure 7. The resistance value of 550Ω (i.e., $50\Omega < R < 750\Omega$) is taken for the simulation, and a firing angle of approximately 70° is achieved. From Figure 4, and Eq. (3), it is clear that the average DC voltage (V_o) of the battery charger decreases from higher to lower value when the firing angle increases from 90° to 180° . It means the rectified DC voltage will be not sufficient for fast charging of the battery during this mode of firing angles. This mode of operation (firing angle: 90° to 180°) can be applied for the online mode of battery charging only where charging and discharging will happen parallelly. In Figure 5, it is observed that the gate-to-cathode voltage (V_C) is also comparably small. A sufficient amount of DC voltage is available during the firing angle range 0° to 90° , as can be observed in Figure 6 and Figure 7. A firing angle between 0° to 90° can be applied for both offline and online modes of battery charging. MATLAB/Simulink uses an inbuilt dynamic model of Li-ion battery. The model implements a modified Shepherd curve-fitting model for analysis. A discharge characteristic of the battery is shown in Figure 8. This characteristic graph confirms a better voltage polarization and battery current. It also represents the state-of-charge (SOC) effects on the battery. More details on the battery model, charging and discharging of battery are presented in [3], [4], [5]. Figure 9 represents the fully charged battery voltage (V_B), charging battery current (I_B), and state-of-charge (SOC in %) graph of the proposed battery charger. The battery fully charged around at 14V with a nominal voltage of 12V. The battery can provide a different current of 1.5A, 3A or 4.5A without affecting the battery performance.

CONCLUSION

A cheap and simple battery charger is designed and analyzed using MATLAB simulation. An RC-triggering is implemented to operate the low-cost SCR for battery charging. The proposed SCR-based battery charger can operate in online modes or offline modes of operation. The complete analysis is performed based on the simulation results. It is expected that this work could be a battery charging solution for the upcoming electric vehicle technology in the market.

REFERENCES

1. Henriksen, I.M., Throndsen, W., Ryghaug, M. *et al.*, Electric vehicle charging and end-user motivation for flexibility: a case study from Norway. *Energy, Sustainability and Society*, 11, 44 (2021). <https://doi.org/10.1186/s13705-021-00319-z>.
2. IRENA (2017), *Electric Vehicles: technology brief*, International Renewable Energy Agency, Abu Dhabi.
3. Sayed K., Kassem A., Saleeb H., Alghamdi A.S., Abo-Khalil A.G., Energy-Saving of Battery Electric Vehicle Powertrain and Efficiency Improvement during Different Standard Driving Cycles. *Sustainability* 2020, 12, 10466. <https://doi.org/10.3390/su122410466>
4. S. NjoyaMotapon, L. Dessaint, and K. Al-Haddad, "A comparative study of energy management schemes for a fuel-cell hybrid emergency power system of more-electric aircraft," *IEEE Transactions on Industrial Electronics*, vol. 61, no. 3, pp. 1320–1334, 2014.
5. Mohamed M. Albarghot, M. Tariq Iqbal, Kevin Pope, Luc Rolland, "Sizing and Dynamic Modeling of a Power System for the MUN Explorer Autonomous Underwater Vehicle Using a Fuel Cell and Batteries", *Journal of Energy*, vol. 2019, Article ID 4531497, 17 pages, 2019. <https://doi.org/10.1155/2019/4531497>.





Trilochan Penthia

Table-1: Battery parameters for simulation

| |
|--|
| Input parameters and value |
| Nominal voltage = 12V |
| Rated current capacity = 55 Ah |
| Maximum current capacity = 55 Ah |
| Nominal discharge current = 23.91 A |
| Fully charged voltage = 13.97 V |
| Total internal resistance = 0.5 Ω |
| Capacity at nominal voltage = 49.74 Ah |

Table-2: Simulation parameters of circuit for battery charger

| |
|---|
| Input voltage, $V_s = 28\text{ V (peak)} = V_m$ |
| Input frequency, $f = 50\text{ Hz}$ |
| Resistance, $R = 50\Omega\text{ to }1400\Omega$ |
| Capacitance, $C = 35\mu\text{F}$ |
| Equivalent internal resistance at load/battery = 0.5Ω |

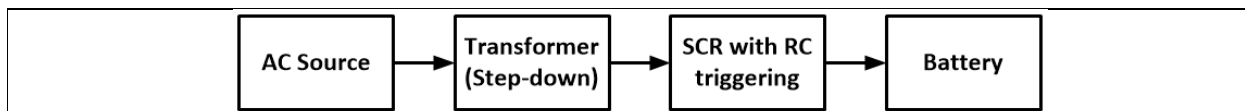


Figure 1: Block diagram of SCR with RC triggering EV battery charger

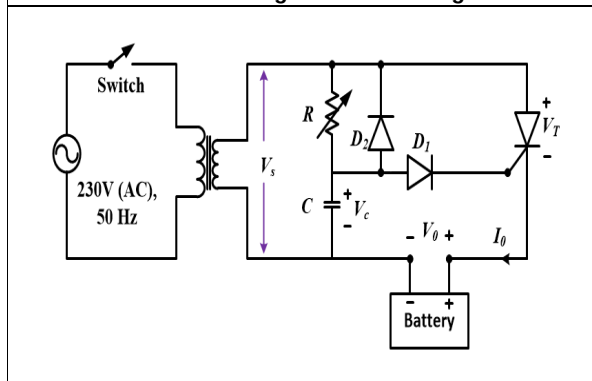


Figure 2: Circuit diagram of SCR-based circuit for battery charging.

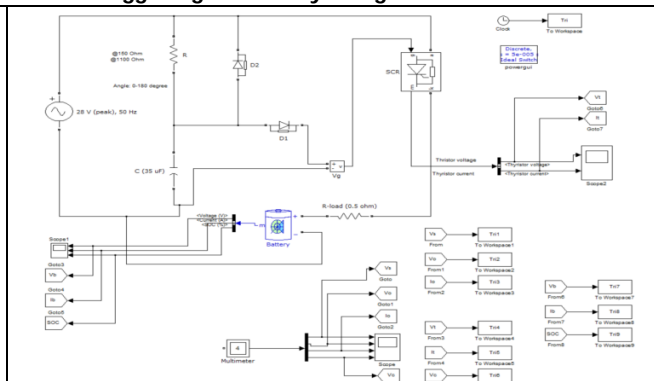


Figure 3: Simulation model using MATLAB/Simulink.

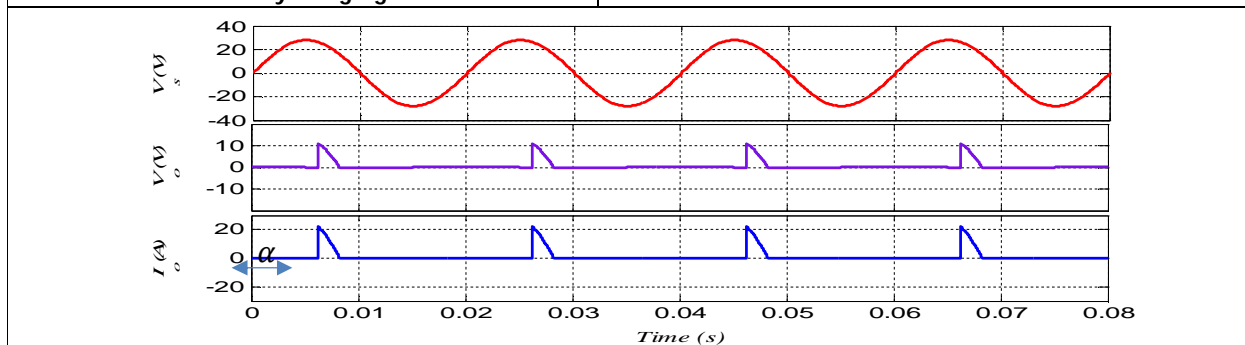


Figure 4: MATLAB simulation waveform of input voltage (V_s), output voltage (V_0) and output current (I_0) of the battery charging circuit





Trilochan Penthia

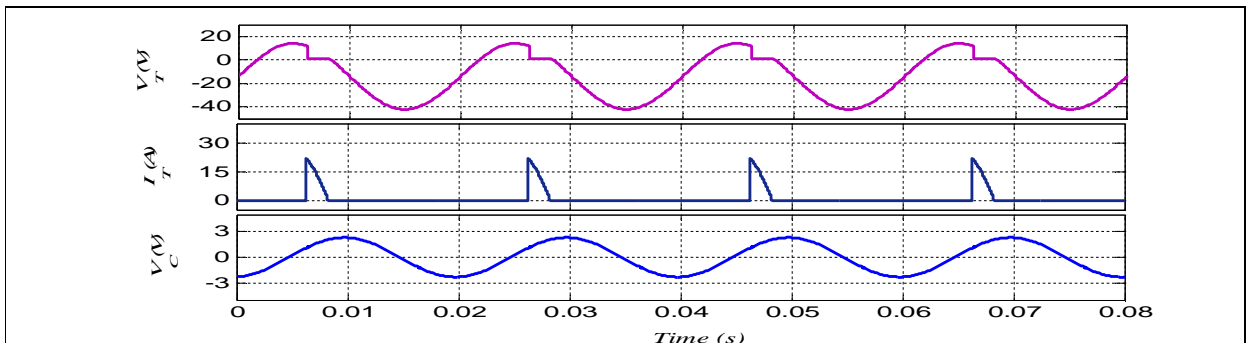


Figure 5:Simulation waveform of SCR voltage (V_T), SCR current (I_T) and capacitor voltage (V_C).

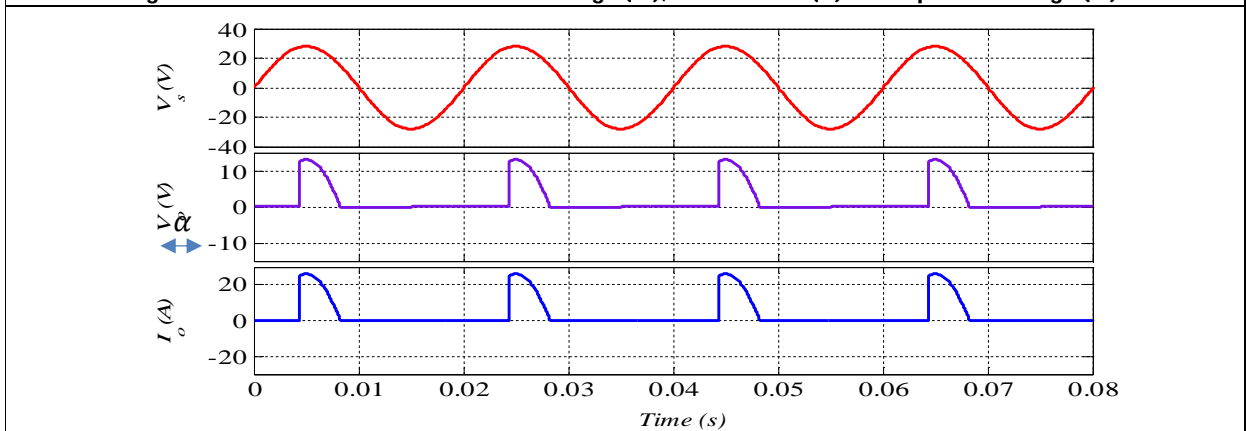


Figure 6:MATLAB simulation waveform of input voltage (V_s), output voltage (V_o) and output current (I_o) of the battery charger.

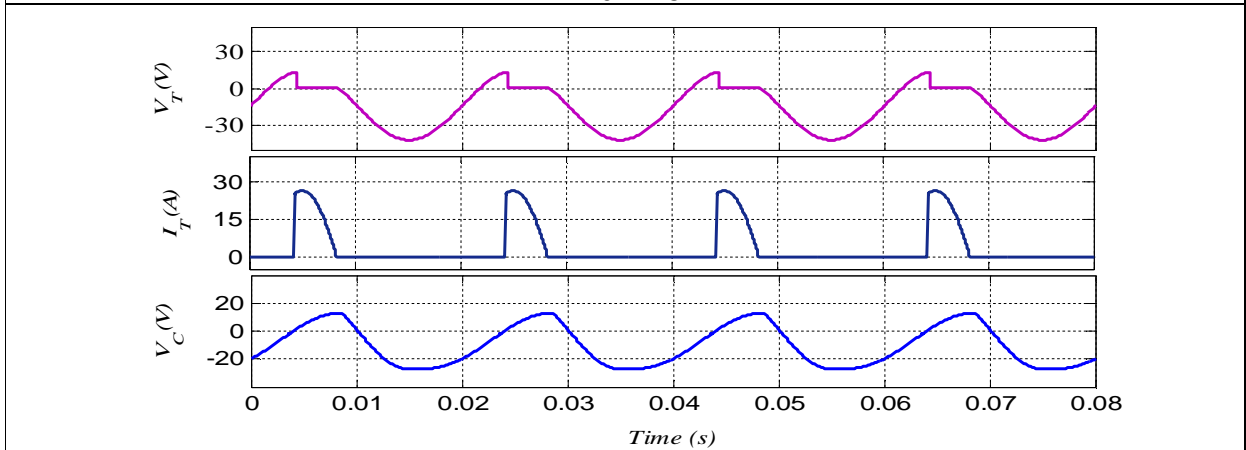


Figure 7:Simulation waveform of SCR voltage (V_T), SCR current (I_T) and capacitor voltage (V_C).





Trilochan Penthia

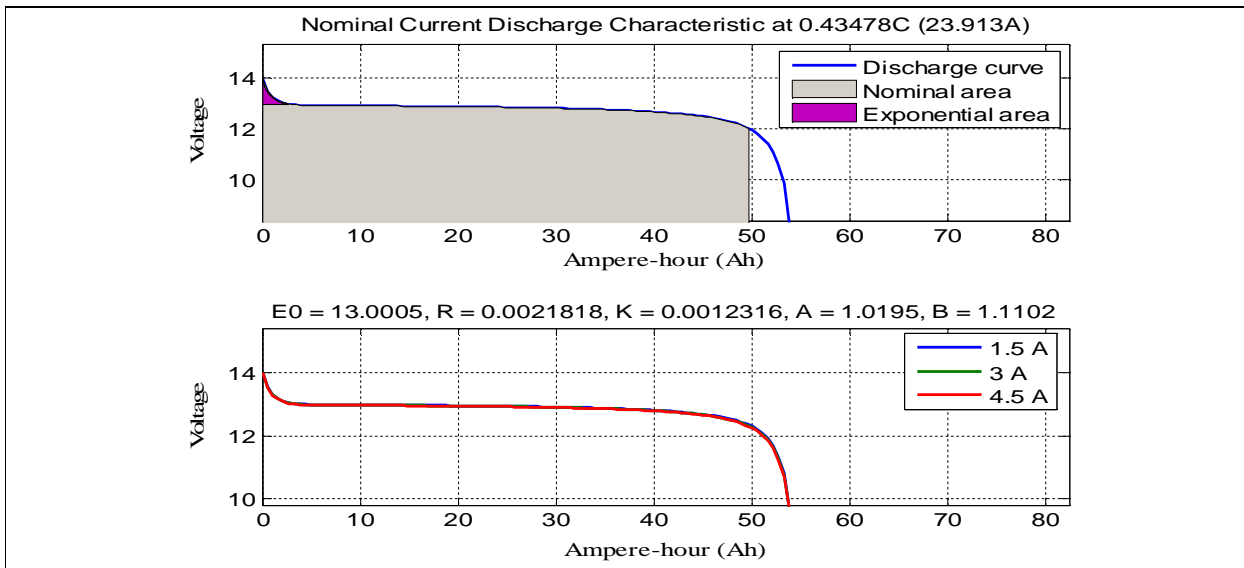


Figure 8: Discharge profile of the Li-ion battery.

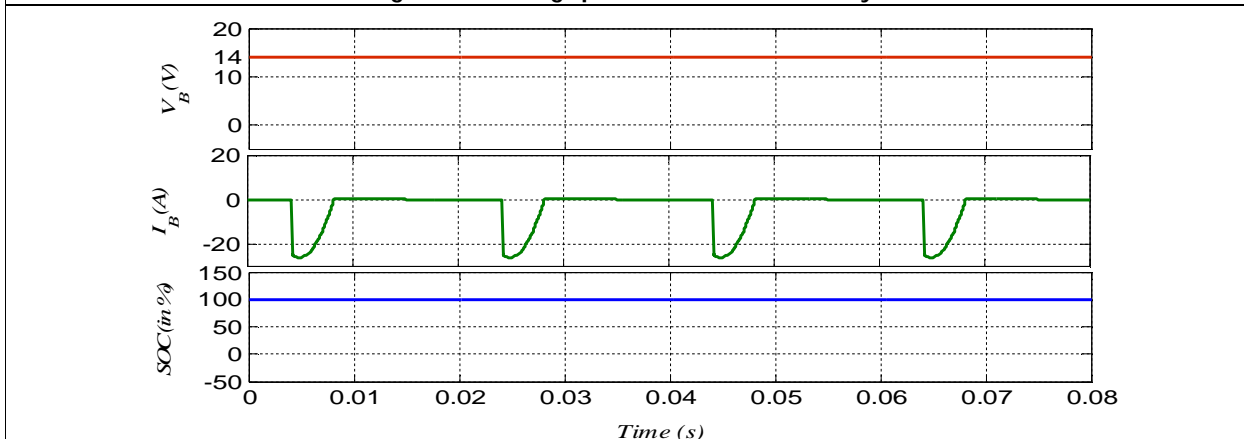


Figure 9: Represents fully charged battery voltage (V_B), charging battery current (I_B), and state-of-charge (SOC in %) graph.





Impact of COVID-19 on Construction Project Management in Odisha

RK Majhi*, SK Panda, SS Subhankar, P Chandrasekhar and AK Patra

Department of Civil Engineering, Centurion University of Technology and Management, Pralakhemundi, Odisha-761211

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

RK Majhi

Department of Civil Engineering,
Centurion University of Technology and Management,
Pralakhemundi, Odisha-761211
Email: rajib.majhi@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Corona virus (COVID-19) outbreaks have severely disrupted the economy, with devastating effects on global trade and it has simultaneously affected households, businesses, financial institution, industrial establishments and infrastructure companies. The economic crisis caused by the virus has hit many more organizations around the world. Similarly, construction and engineering projects around the world have been jeopardizing in various ways by the COVID-19 pandemic and many projects have closed. As a result, there has been a financial recession in the construction industry in almost all countries and has created unemployment. All in all, this situation has caused great concern, uncertainty and unrest in the construction industry. This paper observes in several countries and describes the global impact of the Corona virus on the construction industry. This paper also explains how it is possible to continue construction work in this situation. If construction work continues, the economic downturn will be reduced and unemployment will be reduced.

Keywords: COVID-19; Construction; Global impact; Economy; Supply chain.

INTRODUCTION (An Indian Scenario)

There is no place in today's globalized world that has not been damaged by the Corona virus (COVID-19) pandemic. Almost all commercial, economic and social activities are suffering from the COVID-19 pandemic. Similarly, the construction and engineering industries are no different, they are also suffering from this crisis. Corona virus is an infectious disease therefore to stop the spread of this disease, the construction work has been temporarily stopped keeping in mind the concerns of the workers in the construction industry. As a result, construction industries are gaining nothing but losses, which have an impact on world economy. It has also disrupted the transportation system which has disrupted the supply of materials. Many construction companies are going through a financial recession



**Majhi et al.**

so companies are laying off a lot of their workers. Overall, construction industry has taken a terrible turn. The construction sector in India is a development sector. It creates more investment opportunities to increase the national income of the country. This is an unorganized sector and huge labor-intensive. Principle companies, contractors, subcontractors, consultancy all have specific roles to play towards the smooth running of this sector. In 2011–12, the industry had contributed 670,778 crores (US\$ 131 billion estimated) to the national GDP with a share of 8.2%. 65% of the total investment in construction comes under the infrastructure of the county. Real estate sector under construction is very much recognized. It is expected that the real estate market will be grown up to Rs. 65,000 crores by 2040 from Rs. 12,000 crores (US\$ 1.72 billion) in 2019. It is also expected that the real estate sector will contribute 13% of the country's GDP by 2025. Research has revealed that the real estate sector in India will be increased by 19.5% CAGR by 2028.

India is not the only country to face the predicament in the construction sector for this Covid-19 pandemic. According to the World Bank report on global economic prospect India's gross domestic product (GDP) to be contracted by 3.2% in 2020–21. It is expected that there can be a moderate recovery to 3.1% growth in 2021–22. This says that the GDP of the year 2021–22 will be less than it was in the years 2019–20. In 2018–19 construction had a share of 8% in GVA (Gross Value Added) but as per PLFS (Periodic Labour Force Survey) its employment share was 12% in 2018–19. On the other hand financial services, real estate, and professional services, the GVA share was 22% in 2018–19. The employment share of the construction sector was only 3.4%. It gives the view that construction is a more labor-intensive sector than finance.

Due to this COVID-19 pandemic, the investment in construction-related projects has been reduced in the range of 13–30% that will have a significant impact on Gross Value Added (GVA) and employment in this sector. Construction-related GVA is expected to reduce between 15 and 34% and employment between 11 and 25%, respectively. On account of this pandemic, construction sector is expected to face a reduction in both supply and demand simultaneously. The sector is driven by infrastructure projects to a large scale, it is expected that there will be a severe hit by the current levels of uncertainty, loss of income, dismal business, and consumer sentiments as well as the preservation of government funds toward management of COVID-19. In addition, the remedial measures that need to be taken to continue the construction work are described in this paper. If these measures are taken, the construction industry will turn around again. An abstract of the impact of COVID-19 on the GDP, construction sector and unemployment of INDIA has been furnished in Table 1.

COVID-19 Crisis Puts Construction Sector in a Catch-22 Situation (Odisha Scenario)

Infrastructure developers in Odisha are struggling to resume operations, amid the COVID-19 crisis, even after additional manpower of 5.82 lakh workers have returned from different States, yet infrastructure developers are struggling to resume operations. The State Government has allowed movement of workers since last week of April so that ongoing projects are not stuck and laborers do not lose livelihood but shortage of workers at construction sites continue to be a major problem during unlock 1.0 leading to delay and cost escalations. The supply chain of construction materials though has normalized, insufficient construction workers, painters, plumbers and fabrication workers has severely impacted construction operations across the State. The construction sector forms an important sector for Odisha, contributing 6.7% (2020-21 AE) of the State's GVA and the second largest employer after agriculture. The construction sector contributed 6.7% of the State's total GVA and 18.4% of the industry sector GVA in 2020-21(AE). However, the share of the sector has been witnessing a declining trend, like the trend observed at all-India level. From 21.5% of industry GVA (9.4% in total GVA) in the year 2011-12, the share is estimated to decline to 18.4% in 2020-21 (AE) (6.7% in total GVA). Growth in the sector has been volatile with the annual average growth of around 2.1% between the years 2012-13 and 2019-20. However, the year 2017-18 witnessed the highest growth in the last eight years, growing at 8.26%.

Insufficient Workers

Odisha has severally been affected by this insufficient number of workers, including the plumbers and fabrication workers, who have a great role to play in construction purposes. The workers who are available and willing to work



**Majhi et al.**

for, lack expertise in the particular work. Even though the supply chain of construction materials has normalized, the above-stated reasons have been leading to zero construction work in the State. Nearly 70 per cent of construction workers who are employed in Odisha belong to either West Bengal, Bihar, Jharkhand, Uttar Pradesh or Andhra Pradesh, many of whom have left for their states, before the lockdown for the pandemic. The remaining went after their respective state governments facilitated the process as ordered by the Supreme Court. The capital city has got over 500 ongoing projects that have been impacted by the COVID-19 crisis. "Out of 1,000 workers engaged in my Z-1 site before lockdown, I'm now left with less than 100", says the Managing Director of Z Estates Tapan Kumar Mohanty. He further says that the rest of the workers who were brought in for completing the work are in quarantine for 14 days, following the rules of the Government.

Migrant Workers and Construction Sector

It was believed that the migrant worker returnees could play a big role in supporting the sector, as after the agriculture industry, the construction sector is considered as the second-largest employer. But, efforts to employ the returnees have not yet shown any desired result as most lack the expertise, while rest are uninterested owing to the fear of getting infected. Despite the inrush of migrants, following the mandate of the State government, firms like Z Estate are failing at getting local workers, for their construction purpose. Despite the influx of migrants, firms like Z Estate are unable to get local workers. "After discussions with the skill development officials, our staff visited several quarantine centers in Banki, Mahanga and Narasinghapur areas. But the outcome is not encouraging as those came forward for work lacked expertise," he added.

Projects Behind Schedule

Most of the projects are running at least six months behind schedule, says the President of Association for Odisha Real Estate Developers (AFORD) Nishit Ranjan Nanda. "When approached the local laborers, they showed their unwillingness to stay in quarantine both at the worksite and at villages after their return and the rest were unavailable, while the developers are on the other hand alarmed by the action for bringing back the workers as some apartment projects have already been sealed with the COVID-19 crisis. Thus, we have landed in a catch-22 situation at present," Nanda added. Chairman of CREDAI (Odisha chapter) DS Tripathi, when contacted, informs that the association has approached the Government intending to permit at least one-year extension of projects in place of six months as approved by the Real Estate Regulatory Authority across the country.

Impacts of COVID-19 on Construction Sector

The numbers of COVID-19 victims are increasing day by day, which is also having an impact on the construction industry. The supply chain is being disrupted due to government lockdowns, labor shortages are occurring, companies are facing economic recession and having trouble keeping various contracts.

Supply chain Management

The supply chain has been disrupted in various ways in different parts of the world. Various construction materials are required but for lockdown these are not reaching the construction site from outside which is hampering the construction work. The various materials that come from different factories in the country or abroad through different vehicles for construction work, those things cannot come. All vehicles are not able to come to lockdown due to which the required materials are not arriving so the work is off. It has not only shut down the construction industry, it has also damaged the livelihoods of those who bring these things in vehicles and the factories that make all these materials are also losing a lot of money because these are not being sold.

Transportation Problem

All transportations in the country have been disrupted due to lockdown in all parts of the country. That's why no materials are arriving in the construction sector and no workers are able to come to work from their home. That's why the work has stopped.





Majhi et al.

Labor Shortage

First, workers are unable to reach their workplaces because the transportation system is completely closed. Second, the disease is caused by a viral infection, So workers are more likely to spread the disease when they come in contact with each other. Therefore, many workers are not willing to come to work. Moreover, it is not possible to make the workers work without any protection.

Financial Problem

The companies are not making any kind of profit due to work stoppage in the companies and on the contrary more losses are being incurred and not only the company is losing money but also all the suppliers who are providing the required materials to different companies to be used in construction sector, all those suppliers are also incurring huge losses. Since the closure of the company, the supply chain has been shut down and the factories that produce goods have stopped production, resulting in many losses of them. Moreover, due to non-sale of factory-produced goods and closure of the construction sector, the government is unable to collect proper taxes from all these places which is having a direct impact on the country's GDP and when the country's GDP goes down, it affects the global economy.

Contractual Implication Problems

It is mainly based on a clause called 'Force majeure'. There are many rules mentioned in this clause, 'Large Scale Epidemic' is one of them. COVID-19 pandemic falls within this category. Different contractors put their different tools in different places for use in different machinery construction sector but as a result of this lockdown, all these equipments have been lying there for a long time. The companies have a contract with the contractors to work with all these equipments on the basis of some money and if the 'Force Majeure' Clause is mentioned in the contract then no compensation will be paid to the contractor by the agency due to delay. The result is a lot of financial loss when contractors stop working.

Unemployment

Companies are suffering huge economic losses due to this lockdown. That is why companies are not able to pay their employees properly and the company is laying off a lot of workers. Due to this, many people's jobs have been snatched away. Their families are also going through a lot of hardships as a result of losing their jobs. All in all, a worrying situation has arisen.

Remedial Measures

Uncertainty has been created all over the world for Corona virus. Work in all construction sectors has come to a standstill and in almost all countries the economy is going downhill. In this situation, some remedial measures have to be taken to revive the construction sector against this disease. Some remedial measures are discussed below.

Comply with the Guidelines of the WHO and the Government

No vaccine for this disease has come on the market yet. So to avoid this infection, workers must follow all the guidelines of World Health Organization (WHO) and in addition, the rules issued by the government of each country must be obeyed. Companies also need to follow these guidelines.

Maintaining Social Distance

This disease is transmitted from person to person that's why it is not possible to gather many workers in one place. Therefore, according to the rules and regulations of the government, it is necessary to work within a sufficient distance between two people. In the office, the gap between the two seats should be increased.

Wearing Safety Equipment

When working in the construction sector, you need safety equipments such as helmets, safety shoes etc. but here the safety equipment is the equipment that is needed to protect against the transmission of the disease. So workers must wear mask to protect themselves. Workers must also wear gloves on their hands, personal protective





Majhi et al.

equipment(PPE) on their bodies and worker must keep sanitizer. Sanitizer must be used from time to time to keep hands clean.

Workplace Sanitization

Every place in the workplace should be well cleaned every day and the companies have to keep a bottle of sanitizer in the office. All new products or materials coming from outside should be sanitized.

Arrange to Stay

After opening the company, Workers living far from the construction site will also come to work. Now they will not be able to travel from home every day because the vehicles are not running in that sense now. That's why companies should arrange accommodation for them when it comes to working with them. Those places have to be clean enough and have to be cleaned every day. Companies should also provide them with at least two meals a day. In addition, workers should maintain social distance in their place of residence.

Alternate Duties

Now it would not be right to work with all the workers together. That's why companies need to share responsibilities with each employee and the assembly is less if each employee is brought in a few days a week instead of every days such rules must be introduced by the organization. In other words, if an employee comes to the office today to work, then that employee will come to the office again after one or two days to work and in the middle one or two days another employee will come to work and that employee will have another two days off.

Allowing Goods Transportation System

When the construction work starts, there will be a need for goods, so companies have to transport the goods from outside to get the supply. That's why government should be allowed to transport goods subject to certain condition. All heavy vehicles transporting goods will have to get a transport permit issued to the government in this lockdown. Only those drivers will be able to drive for transportation goods. Besides, the driver has to aware and does all the work according to the social distance.

Medical Facilities

Every company has to make some medical arrangements in advance for each of their sites. When their workers enter the site to work, they will be allowed to enter only after daily thermal scanning test. In addition to this, the level of oxygen in the body will be seen with the help of pulse oximeter. If an employee is infected Corona virus while working, some of the medical expenses will need help from the company. Such rules should be made by the companies. Companies also need to organize occasional general checkup camp for employees.

Modular Construction

Companies can use modular construction in such situations. Modular construction will cost much less and it will complete the construction very quickly.

3D Printing

3D printing or additive manufacturing is the process by which each layer accumulates to form a physical object. Everything can now be created with 3D printing according to the prototype. In Covid-19 pandemic situation, we can use this technology to create different types of home models, building models, bridge models etc.

Software

Some coding software can be used in this situation in the construction sector. Construction work can be made much easier in this situation by using artificial intelligence (AI) and machine learning (ML). Using those software, employee will do all the digital work instead of notebook pens, so the work will be faster and in less assembly. Also AutoCAD, Staad Pro, Etabs, Revit etc. are used for designing and with these software, employees can design at home.



**Majhi et al.****Remote Working**

Many sector workers are working from home for the lockdown. It is quite difficult to work from home in the construction sector. However, the company should try to keep employees away from each other as much as possible, so it is safe to work from home. So workers should work from home as much as possible such as holding meetings, filling out Google forms to get some information from labor, signing contracts digitally, making conversation or sending mails etc. Designing, planning or estimation and costing can also be done with software at home.

Financial Package

The government should provide some financial assistance or some financial loan to the companies that are going through a severe financial crisis. The government's main goal should be for companies to resume work.

CONCLUSION

The COVID-19 pandemic has done a lot of damage to society. It has affected the society as well as the economy of every country. The disease is spreading so fast that the government has been forced to lockdown. As a result of this lockdown, all transportation systems have been shut down, supply chains have been disrupted and workers are not able to come to the construction site even from home. That's why work in the construction fields has stopped and the construction workers have also faced extreme uncertainty. So construction companies are facing a financial recession. Companies need to start working again to end this financial crisis. That's why everyone should return to work in according to the guidelines given by WHO and the government. Construction companies need to take necessary remedial measures for their workers. Companies should keep an eye on whether it's easy to work with new technology or software and try to do most of the work from home. The government should ask the construction company to continue working consciously. So work should continue in this way until the situation becomes normal or the vaccine is released. Not only the construction sector but other organizations should be aware of this and continue to work so that the economy will improve and unemployment will be reduced.

REFERENCES

1. Abhishek Waghmare. India GDP growth. 1st September 2020. Business Standard. https://www.business-standard.com/article/economy-policy/first-economic-contraction-in-4-decades-india-gdp-shrinks-23-9-in-q1fy21-120083101301_1.html
2. Construction placement. 3 April 2020. <https://www.constructionplacements.com/top-construction-companies-in-india-2020/>
3. WIKIPEDIA. Construction industry of India.
4. https://en.m.wikipedia.org/wiki/Construction_industry_of_India. Jonathan Ananda. THE NEW INDIAN EXPRESS. 27th March 2020. <https://www.newindianexpress.com/business/2020/mar/27/15-crore-unregistered-construction-workers-in-the-lurch-sans-relief-2122056.html>
5. MONEY CONTROL. 8 May 2020. <https://www.moneycontrol.com/news/real-estate-2/coronavirus-construction-sector-facing-daily-loss-of-rs-30000-crore-investments-in-projects-to-fall-13-30-kpmg-5243761.html>
6. THE HINDU. 5 May 2020. <https://www.thehindu.com/business/indias-unemployment-rate-rises-to-2711-amid-covid-19-crisis-cmie/article31511006.ece>
7. Dominic Rushe. The Guardian. 29 April 2020. <https://www.theguardian.com/business/2020/apr/29/us-economy-shrinks-coronavirus-ends-longest-expansion>
8. T. Wang. 17 Jul 2019. U.S. Construction Industry - Statistics & Facts. Statista. https://www.statista.com/topics/974/construction/#dossierSummary__chapter1
9. Chris Kolmar. THESE ARE THE 10 BIGGEST COMPANIES IN AMERICA. ZIPPIA <https://www.zippia.com/advice/biggest-construction-companies-in-america/>





Majhi et al.

10. Michael.C.Loulakis, Lauren P. McLaughlin. The Law: Construction Industry Impact in the COVID-19 World. ASCE News.
11. <https://news.asce.org/the-law-construction-industry-impacts-in-the-covid-19-world/>
12. Statista. Number of employees in the U.S. construction industry from 2000 to 2018. 12 March 2020.<https://www.statista.com/statistics/187412/number-of-employees-in-us-construction/>
13. Jack Kelly. Forbes. 8 May 2020. <https://www.forbes.com/sites/jackkelly/2020/05/08/us-unemployment-is-at-its-highest-rate-since-the-great-depression-at-147-with-205-million-more-jobs-lost-in-april/#4d24466b656d>
14. China GDP Annual Growth Rate. TRADING ECONOMICS. <https://tradingeconomics.com/china/gdp-growth-annual>
15. Building Construction Industry in China- Market Research Report. IBISWorld. 2020. <https://www.ibisworld.com/china/market-research-reports/building-construction-industry/>
16. The impact of COVID-19 on Construction Industry in China. ARCADIS.<https://www.arcadis.com/en/asia/our-perspectives/articles/the-impact-of-covid19-on-construction-industry-in-china/>
17. LEXOLOGY. The Impact of COVID-19 on the Construction Industry in China. 26August 2020.<https://www.lexology.com/library/detail.aspx?g=8c82eeea-7826-48f3-9cff-5aa023ff0819>
18. Mary Hui. 21 May 2020. "Suspiciously stable": How China's unemployment rate is calculated. QUARTZ.
19. <https://qz.com/1858923/coronavirus-how-china-calculates-its-unemployment-rate/>
20. Business Today. 30April 2020. <https://www.businesstoday.in/top-story/coronavirus-crisis-italy-gdp-shrinks-47-in-q1-steepest-drop-in-25-years/story/402492.html>
21. Italy GDP From Construction. TRADING ECONOMICS. <https://tradingeconomics.com/italy/gdp-from-construction>
22. WIKIPEDIA. Associazione Nazionale Costruttori Edili. https://en.wikipedia.org/wiki/Associazione_Nazionale_Costruttori_Edili

Table 1. The impact of COVID-19 on the GDP, construction sector and unemployment of INDIA

| GDP Shrink | % GDP came from Construction | Construction Company | Construction worker | Losses in Construction | Overall employment |
|--|--|--|--|---|--|
| GDP of India shrinks 23.9% in the year 2021. | Construction sector accounts for 8% of India's GDP | 200 firms in the construction industry in India. Also, 120000 class A contractors in government construction industries. | Around 5.1crore construction workers in the country. | A loss of Rs 30,000crore loss every day has been estimated. | 27.11% rise in unemployment by May 2021. |

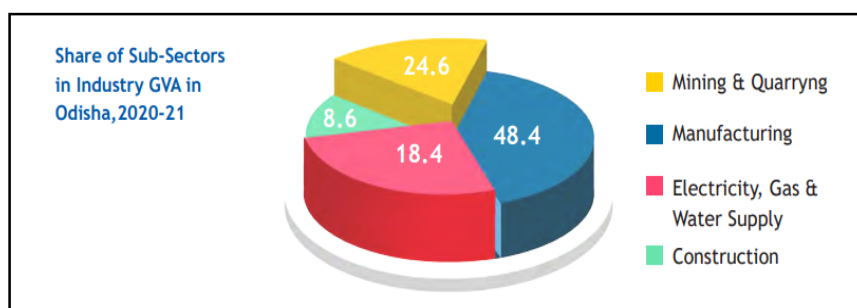


Fig. 1. Share of Sub-Sectors in Industry GVA (Gross Value Added) in Odisha, 2020-2021





To Assess the Effects of Kinesio-Tape on Surgical Incisions in Subjects with Lower Abdominal Surgery

Vaishali D. Suthar ^{1*} and V. P. Hathila²

¹Ph.D. Scholar at Parul University, Assistant Professor, Ahmedabad Institute of Medical Sciences (AIMS), Ahmedabad, Gujarat India.

²General Surgeon and Dean of Medical Faculty, Parul Institute of Medical Sciences (Affiliated to Parul University) Vadodara, Gujarat, India.

Received: 06 Feb 2022

Revised: 14 Apr 2022

Accepted: 25 May 2022

*Address for Correspondence

Vaishali D. Suthar

Ph.D. Scholar at Parul University,

Assistant Professor, Ahmedabad Institute of Medical Sciences (AIMS),

Ahmedabad, Gujarat India.

Email: Vaishu82in@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Several studies in physiotherapy using kinesio-tape are available to prevent and cure the musculoskeletal and neurological disorders in patients. However, few studies are available for using Kinesio-tape in abdominal surgery patients. Therefore, the main objective is to assess the effect of Kinesio-tape on surgical incisions in subjects with lower abdominal surgery. The secondary objectives are to assess the effectiveness of Kinesio-taping in improving patient outcomes in form of pain relief, ambulation and to determine the level of prescribing of Kinesio-taping immediately after abdominal surgery. Total 22 participants with age between 25years to 50 years old both males and females underwent lower abdominal surgery allocated randomly. The participants were divided into two groups: Control group received conventional treatment and experimental group received conventional treatment and Kinesio-taping. Following assessment tool was used as outcome measure in both the groups and was administered 4 hours of surgery. Documenting Surgical Incision Site Care (DSISC) and Visual Analogue Scale (VAS). Outcome measures were assessed post conventional treatment and Kinesio tape application in control and experimental group. Descriptive statistics and data was analysed on SPSS by adopting proper statistical tests. There was significant difference found between control and experimental group in pain, however, no significant difference found on surgical incision site. There was faster recovery with kinesio-tape application in pain with lower abdominal surgery subjects. There was no obvious changes seen on surgical incision site. It is recommended to apply kinesio-tape with physiotherapy in post abdominal surgery to relieve pain. Thus reducing the dose of analgesics.

Key words: Kinesio-tape, Surgical incisions, Abdominal surgery.





Vaishali D. Suthar and V. P. Hathila

INTRODUCTION

Abdominal surgery consists of disease processes of various etio-pathology and may responsible to cause postoperative complications. The complications which occurs after surgical operations is connected with malfunction or failure of the alimentary canal. This malfunction may be the cause of flatulence and oedema of the stomach cover, which leads to pain. The other possible reason for post surgical complication is post-operative immobilization which is caused by hypokinesia [1]. Physiotherapy in patients after surgeries should lead to the fastest possible mobilization of the patient and the time of recovery and return to normal physical activity depends on the extent of surgical operation and patient's condition.

The advanced technique known as kinesio-taping in post abdominal surgery suggest its usefulness for treatment of pain, accelerating post-operative wound healing processes. It is a therapeutic technique which was developed by Dr. Kenzo Kase in Japan more than 25 years before. Kinesio-taping applications individually suited to patients' needs, support, curing processes and provide new quality of physiotherapy. According to the manufacturers of Kinesio-taping, the tape causes micro-convolutions or folds in the skin which causes a lifting of the skin away from the tissue beneath. This facilitates a release in pressure on tender tissues underneath and provides space for lymphatic fluid movement, increases circulation of blood which helps to fasten wound healing. This can help relieve pain, prevent over contraction, facilitate lymphatic drainage and improve kinesthetic awareness [2].

Kinesio-taping can be applied in four basic therapeutic aims: Mechanical correction which gives stabilization, muscular and fascial tone normalization, improvement and correction of mobility range, pain and swelling reduction. Restoration of normal fluid perfusion helps in facilitation of lymph blood flow, swelling reduction and resulting reduction of incorrect sensibility and pain of skin and muscles. Provides support for muscular activity to relax muscles, fatigue reduction and restoration of mobility range and pain relief. Analgesic system activation helps in elimination of pain cause and activation of pain inhibitors [3]. Kinesio taping is a commonly used intervention in the treatment for several musculoskeletal and neurological disorders in patients. Also in sports injuries, Kinesio-tape is useful. But very few studies are available for using kinesio-tape in abdominal surgery patients. Therefore, need arise to assess the effects of kinesio-tape on surgical incisions in subjects with lower abdominal surgery

AIM AND OBJECTIVES

AIM: To assess the effects of Kinesio tape on surgical incisions in subjects with lower abdominal surgery.

OBJECTIVES

1. To study the effects of kinesio-tape on surgical incisions in post abdominal surgery.
2. To compare the effects of kinesio-tape between control and experimental group.
3. To determine the level of prescribing of kinesio-taping immediately after abdominal surgery.

Hypothesis

Null hypothesis(H0): No significant changes in outcome measures between the control and experimental group.

Alternate hypothesis(H1): Significant changes in outcome measures between the control and experimental group.

MATERIALS AND MATHODS

Materials: Kinesio-tape roll, Scissor, pen, paper, sanitizer

Source of data: From Surgical and maternity hospitals.





Vaishali D. Suthar and V. P. Hathila

Method of data collection: Convenient and allocation of group by randomization of participants.

Inclusion criteria

- Age between 25-50 years old both male and female, underwent lower abdominal surgery.

Exclusion criteria:

- Upper abdominal surgery
- Laparoscopy surgery
- Severe cardiac and lung conditions, known case of diabetes and post-operative complications (e.g. fever, wound infection) and neurological impairment

Study design: Randomized controlled clinical trial

Before application of Kinesio-taping, skin sensitivity test was done pre-operatively to check any allergic reaction due to Kinesio-taping. Skin sensitivity test for Kinesio-taping: A piece of kinesio-tape was applied over flexor aspect of forearm for 6-8 hours with stretch of inhibitory technique [4]. Skin reaction by means of itching, redness was noted in randomly selected participants. The participants were randomly divided into two groups.

Group 1- Control group (11 participants) only conventional treatment given

Group 2- Experimental group (11 participants) conventional treatment followed by Kinesio-tape

Sample size: 22

Assessment criteria: Basic demographic information was collected and baseline evaluations were performed at the time of post-operative. Both the groups were received standard methods of treatment by means of medical care and physiotherapy.

The participants consents were obtained to participate in the study. All the volunteered participants were randomly divided into two groups. The control group and the experimental group.

Following assessment tool was used as outcome measure in both the groups and was administered after 4 hours of surgery as the participant gets withdrawn from anaesthetic effect.

- Documenting Surgical Incision Site Care (DSISC) [5]
- VAS (Visual Analog Scale) to assess pain intensity [6]

The outcome measure were assessed post treatment on the basis of first 24hrs, 48hrs, 72hrs...till 5th day postoperatively.

In group 1 (Control group)

Participants received conventional treatment by means of medical care and physiotherapy. Physiotherapy care included education about post-operative complications, bed exercises (hip, knee and ankle movements), early transfer to chair (on day of surgery or POD1) and ambulation, diaphragmatic breathing and manual techniques as clinically indicated. Informed consent form was delivered to each participant prior to procedure. Documenting Surgical Incision Site Care (DSISC) and Visual Analogue Scale (VAS) were assessed immediately after conventional treatment till 5th day. Following components of DSISC were assessed and documented: the anatomic location of the incision, the length of the incision in cm and depth measurement in mm, the appearance of the incision and surrounding skin, assess pain by Visual Analogue Scale (VAS).



**Vaishali D. Suthar and V. P. Hathila****In group 2 (Experimental group)**

Participants received conventional treatment and Kinesio-tape applications. A clear explanation about the kinesio-tape procedure was given to each participant, that was applied post-operatively after the conventional treatment and was changed every 24 hours until 5th day post-operative in addition to the standard post-operative care. Removal of tape was done gently rubbing on skin and removing the tape simultaneously.

Following kinesio-taping techniques were used over abdominal area.**Muscle inhibition application**

Kinesio-taping was applied from distal to proximal attachment on external oblique (EO) muscle on the left side with 15% of stretch⁷. This technique is more preferable in very acute stage as mechanically it inhibits and relaxes the muscle and thus inhibits pain.

Muscle facilitation application

Kinesio-taping was applied from proximal to distal attachment on internal oblique (IO) muscle on right side with 25% of stretch⁷. For transversus abdominis (TA) muscle Kinesio-tape was applied proximal to distal attachment of bilaterally with 25% of stretch. During the application patient was instructed to inhale in his/her comfort zone to stimulate the stretch reflex. Kinesio-tape was applied for 24 hours. Informed consent form was delivered to each participant prior to procedure. Documenting Surgical Incision Site Care (DSISC) and Visual Analogue Scale (VAS) were assessed after conventional and Kinesio-tape application till 5th day.

Documenting Surgical Incision Site Care (DSISC)

Document the anatomic location of the incision, chart the length of the incision in cm and include depth measurement, note the appearance of the incision and surrounding skin, assess pain by Visual Analogue Scale (VAS).

Statistical methods for analysis

All the collected data were inserted in the SPSS to apply both descriptive and inferential statistical analysis. Mann Whitney test was used to compare the outcomes between groups and one way ANOVA was used to compare the outcomes within groups. The level of significance was at 0.05.

RESULT

Total 22 patients (20 females, 2 males) were participated in the current study with mean age (40.83±5.99). They underwent different lower abdominal surgeries, the experimental group (8 LSCS, 2 abdominal hysterectomy, 1 appendectomy) and the control group (9 LSCS, 1 abdominal hysterectomy, 1 appendectomy). Regarding the length of the incision both experimental (1.55±0.52) and control group (1.32±0.22) did not show significant difference between group in length of the incision, between Day1 and Day5 (p>0.05). Further, the width of the incision was compared in both experimental (1.97±0.83) and control group (1.73±0.61) and there was no significant difference between group from Days1 and Day5 (p>0.05). In addition, the appearance of incision both experimental and control group and there was no significant difference between group from Day1 and Day 5. Regarding VAS both experimental (4.55±_ 0.79) and control group (2.25±_0.41) showed between group a significant difference between Day1 and Day5 (U= 1.5) (p<0.05).

DISCUSSION

The current study showed significant (p<0.05) pain reduction in experimental group in VAS and the possible explanations to this reduction are, Kinesio tape's elasticity creates skin folds which can lift the skin to increase space between skin and muscle to improve circulation of blood and lymph. Since this space contains a variety of nerve

43141



**Vaishali D. Suthar and V. P. Hathila**

receptors that send specific information to the brain. Kinesio tape modulates the information that is sent by the receptors to the brain and makes less reactive responses in the body. This process allows the body to have an adaptive normal function by moving out of the barrier which naturally slow down the recovery process⁸. In this study there was significant pain reduction noted at or near the incisional site.

In addition taping activates neurological suppression in order to reduce pain and increase joint range of motion. Also, Kinesio tape lift the fascia and soft tissue above the areas of pain, align fascial tissues and provide positional stimulus through the skin [9]. Yoshida and Kahanov stated that Kinesio tape is to decrease pain by stimulating the neuromuscular system; assists in restoration of proper muscle function and realignment of joints as a result of injury or disease. Finally, Kinesio tape enhances comprehensive body function by improving the flow of blood and lymphatic fluid throughout the body [10]. Marcin Krajczyk et al concluded that kinesio taping is an effective method of physiotherapy support in patients after abdominal surgery, there was regular and significant reduction was obtained in abdominal circumference what caused pain relief and use of fewer analgesic agents [3]. Another possible theory to be taken into account for the analgesic effects of KT is the gate control theory of pain modulation. The tape has been suggested to stimulate neuromuscular pathways via afferent feedback. Increased afferent stimulus to large diameter nerve fibers might reduce pain perception level due to an input decrease from the small diameter nerve fibers conducting nociception [11,12]. One more study by Marcin Krajczyk et al. on Kinesio taping in patients after laparoscopic cholecystectomy found that Kinesio taping employed in physiotherapy of patients after laparoscopic cholecystectomy leads to a decrease in pain perception and significantly reduces pain relief medicines' intake, improvement in effort tolerance achieved and provides effective support for physiotherapy and through postoperative wound stabilization, reduces functional activity disorders resulting from cholecystectomy allowing for shortening of hospitalization time [14].

Ana Luiza Machado et al. studied Kinesio taping effects on healing area and revealed a significant reduction in the scar area in all tissues subjected to KT strains, a significant increase in the vascular density of scar tissue subjected to 80% strain, in addition to the predominance of type III collagen fibers and reduction of type I collagen fibers. Thus KT bandaging was able to cause changes in scar tissue and may influence the healing process of the skin, but further molecular studies are still required to find out how the mechanisms occur, however potential benefits of KT in modulating the architecture and function of cutaneous repair tissue was noted [19]. In the present study there was no significant changes found on incision healing by means of length, width and appearance of incision. However, subjects were less in number. In future, with large number of subjects the effects of KT on surgical incisions recommended.

Ethical clearance- Ethical clearance is received from Institutional Ethical Committee for Human Research (PU-IECHR).

Declaration- The prior consent of the participants was taken before application of Kinesio-taping and the work was carried out after getting clearance from the institutional ethics committee.

REFERENCES

1. Sayed Tantawy, Dalia Kamel, October 2015, Effect of kinesio-taping on pain post laparoscopic abdominal surgery: randomized controlled trial, International Journal of Therapies and Rehabilitation Research.
2. Akbas E, Atay O, Yuksel L. The effects of additional kinesiotaping over exercise in the treatment of patellofemoral pain syndrome. Acta Orthop Traumatol Turc 2011; 45:335-341.
3. Marcin Krajczyk et al, January 2007, "Kinesiotaping in physiotherapy after abdominal surgery", Fizjoterapia Polska, Vol. 7, 299-307.





Vaishali D. Suthar and V. P. Hathila

4. K Taping, An Illustrated guide, author: B. Kumbrink, Kinesio-taping. DOI 10.1007/978-3-642-12932-2, Springer-Verlag Berlin Heidelberg 2012.
5. Allison Squires, February 2003, Documenting Surgical Incision Site Care, Article in Nursing management, DOI: 10.1097/00152193-200301000-00051, Source PubMed.
6. Mudasir Maqbool et al, January 2019, Assessment of Pain management in Post-operative cases using different scales and questionnaires. IAJPS 2019, 06 (01), 983-987.
7. Mariya Gramatikova et al. (2014), "Nature, application and effect of Kinesio-taping" Activities in Physical Education and Sport, Vol.4, No.2, pp. 115-119.
8. Kase K, Wallis J, Kase T. Clinical Therapeutic Applications of the Kinesio Taping Method. Tokyo, Japan 2003; Ken Ikai Co Ltd.
9. Maruko K. Tokyo, Japan: Kinesio taping association 1999, 70-73.
10. Yoshida, A., & Kahanov, L. (2007). The effects of kinesio taping in lower trunk range of motions. Research in sports medicine, 15, 103-112.
11. Krajczy M et al. The influence of Kinesio taping on the effects of physiotherapy in patients after laparoscopic cholecystectomy. Sci world J 2012. Article ID 948282, 5 pages doi:10.1100/2012/948282.
12. Szczegielniak J, Krajczy M et al., Kinesio taping in physiotherapy after abdominal surgery, Medsportpress 2007; 3: 299-307.
13. Hanan K. Mohamed et al., 2020, Kinesio taping and strength recovery of postnatal abdominal muscles and cesarean section. Egyptian journal of Physical Therapy, 2020; 4:12-19.
14. Marcin Krajczy et al., 2011, The influence of Kinesio taping on the effects of physiotherapy in patients after laparoscopic cholecystectomy, The Scientific world journal, Volume 2012, Article ID 948282, 5 pages.
15. Zeljko Mimica et al, 2007, "Effect of surgical incision on pain and respiratory function after abdominal surgery: A randomized clinical trial", Hepato-Gastroenterology; 54:2216-2220.
16. Patnaik et al, 2001, Surgical Incisions- Their anatomical basis, J. Anat. Soc. India 50(2) 170-178 (2001).
17. Clair Johnson, Measuring pain. Visual Analog Scale versus Numeric Pain Scale: What is the difference? Journal of Chiropractic Medicine.
18. M B Ferraz et al., 1990, Reliability of pain scales in the assesment of literate and illiterate patients with rheumatoid arthritis. The journal of rheumatology 17 (8), 1022-1024, 1990.
19. Ana Luiza Machado Wunderlich et al., Kinesio taping decreases healing area and modulates the tissue architecture on the cutaneous wound. Research, Society and development, v. 10, n. 1, e41110111888, 2021.
20. "Kinesio-taping for skin wounds" - Kiyotaka Oka, Office Ikuno, Author: Brono Lowagia President.

Table 1. Gender distribution

| Gender | | | |
|--------------------|-------|-----------|---------|
| Group | | Frequency | Percent |
| Experimental Group | F | 10 | 90.91 |
| | M | 1 | 9.09 |
| | Total | 11 | 100.0 |
| Control Group | F | 10 | 90.91 |
| | M | 1 | 9.09 |
| | Total | 11 | 100.0 |





Vaishali D. Suthar and V. P. Hathila

Table 2. Difference in DSISC and VAS score in both groups

| DSISC | Experimental | | Control | | Man Whitney | P Value |
|---|--------------|------|---------|------|----------------|---------|
| | Mean | SD | Mean | SD | | |
| Difference length of incision day1 and day5 | 1.55 | 0.52 | 1.32 | 0.22 | 2.5 | 0.098 |
| Difference depth of incision day1 and day5 | 1.97 | 0.83 | 1.73 | 0.61 | 1.5 | 0.099 |
| Difference VAS Day1 and Day5 | 4.55 | 0.79 | 2.25 | 0.41 | 0 | <0.05 |





Gummy Smile: A Contemporary and Interdisciplinary Approach

Suma S^{1*}, Avinash B.S² and Chandrashekar BR³

¹Reader, Department of Orthodontics, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India.

²Reader, Department of Periodontics, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India.

³Professor and Head, Department of Public Health Dentistry, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, Karnataka, India.

Received: 14 Mar 2022

Revised: 23 Apr 2022

Accepted: 17 May 2022

*Address for Correspondence

Suma S

Reader, Department of Orthodontics,
JSS Dental College and Hospital,
JSS Academy of Higher Education and Research,
Mysuru, Karnataka, India.
Email: dr.suma@jssuni.edu.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The essential factor in this demand doubtless concerns a youthful and harmonious smile. Excessive gingival display in smiling may make the smile displeasing or even repulsive. Correcting “gummy smile” thus becomes a prime treatment objective in response to patient demand. A 16 years female patient, presented with a harmonious face externally, but fairly severe labial version of the maxillary incisors. Intraorally, she showed Angle class I malocclusion with Bimaxillary Proclination with gummy smile. After analysis of panoramic and lateral radiographs and study models, and it was decided extract all first premolar to correct Bimaxillary Proclination followed by lip lengthening procedure to correct gummy smile. This case report discusses the treatment of gummy smile with Orthodontic treatment in combination with lip lengthening procedure.

Keywords: Gummy Smile, Orthodontics, Periodontics, Smile Designing

INTRODUCTION

Orthodontists today have to meet their patients' increasing demand for Esthetic satisfaction. This quest for youth and beauty is a new development in orthodontics, leading practitioners to try to discern the elements that determine facial esthetics and to set out rules and principles. The essential factor in this demand doubtless concerns a youthful and harmonious smile. Excessive gingival display in smiling may make the smile displeasing or even repulsive. Correcting “gummy smile” thus becomes a prime treatment objective in response to patient demand [1]. Gummy smile may not present with any pathologic difficulties, but definitely affects the patient's psychosocial behavior. It is



**Suma et al.,**

the gingiva which dominates the visual feature in gummy smile when compared with teeth and lips giving an unaesthetic appearance [2]. It is essential to determine the etiology of a gummy smile in order to optimize treatment. There are three main etiologies, skeletal, the occlusion plane and the orientation of the palatine plane and dental-labial relations [3]. This case report discusses the treatment of gummy smile with Orthodontic treatment in combination with lip lengthening procedure.

Case presentation

A 16 years female patient, presented with a harmonious face externally, but fairly severe labial version of the maxillary incisors. Intraorally, she showed Angle class I malocclusion with Bimaxillary Proclination with gummy smile. After analysis of panoramic and lateral radiographs and study models, and it was decided extract all first premolar to correct Bimaxillary Proclination followed by lip lengthening procedure to correct gummy smile. At the end of the orthodontic treatment patient presented with normal inclination of maxillary and mandibular incisors but with excessive gingival visibility (Fig 1). The case was further followed by periodontist for lip lengthening surgery.

Surgical procedure

Adequate local anesthetic (lignocaine 2% with epinephrine 1:100,000) was administered in vestibular mucosa and lip from maxillary right first molar to maxillary left first molar. The surgical site was marked with an indelible pencil. A partial thickness flap was raised from mesial line angle of left maxillary first molar to the mesial line angle of right maxillary first molar at the mucogingival junction. A second incision 10–12 mm above the first incision was made in the labial mucosa. The two incisions were joined on either side and a strip of partial thickness flap was removed, exposing the underlying connective tissue [Figure 2]. The two incisions were then approximated using continuous interlocking sutures [Figure 3]. Patient was prescribed nonsteroidal anti-inflammatory drugs and oral antibiotics. Patient was instructed to apply ice pack post operatively and minimize lip movement for 1 week. Sutures were removed 2 weeks post operatively. Patient reported mild pain and tension while smiling during the first week after surgery. Sutures were removed 2 weeks postoperatively. Suture line healed in the form of a scar which was covered by labial mucosa and therefore not visible on smiling [Figure 4].

RESULT

Gingival display at baseline was 5-6 mm which changed drastically at 3 and 6 months postoperatively. At 3 month and at 6 months gingival display was 3 mm. There was no difference in gingival display between 3 and 6 months. However, the lip reverted back to its original position with almost complete relapse after 12 months.

DISCUSSION

This report aimed to document lip repositioning technique to decrease the amount of gingival display in patients with gummy smile. Studies have shown that minimal gingival display during smile is considered esthetically acceptable.[4,5,6] However, aesthetic perception varies depending on social environment, personal experience and culture.[7,8] Dental professionals are usually more critical than laypersons regarding gingival display.[9,10] The amount of gingival display that is considered attractive varies from 1-3 mm.[11,12]. The results showed that the employed surgical procedure successfully reduced the gingival display with low morbidity. The procedure is safe and has minimum side effects.[13] Reports in the literature have shown minimal post operative bruising, discomfort and swelling. Mucocele formation has been the most severe reported complication [14,15].

CONCLUSION

Lip repositioning procedure is an effective way of reducing the EGD. However, long-term stability of the results needs to be seen. None the less, this procedure appears to be a promising alternative treatment option for excessive gingival display.





Suma et al.,

REFERENCES

1. E. Izraelewicz-Djebali1, C. Chabre. Gummy smile: orthodontic or surgical treatment? J Dentofacial Anom Orthod 2015; 18:102:1-15.
2. Jacobs PJ, Jacobs BP. Lip repositioning with reversible trial for the management of excessive gingival display: A case series. Int J Periodontics Restorative Dent 2013; 33:169-75.
3. Peck S, Peck L, Kataja M. The gingival smile line. Angle Orthod 1992; 62(2):91-100; 101-102.
4. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part I. Am J Orthod Dentofacial Orthop. 1993;103:299-312.
5. Fowler P. Orthodontics and orthognatic surgery in the combined treatment of an excessive gummy smile. N Z Dent J. 1999;95:53-4.
6. Zachrisson BU. Esthetic factors involved in anterior tooth display and smile: Vertical dimension. J Clin Orthod. 1998;32:432-45.
7. Oumeish OY. The cultural and philosophical concepts of cosmetics in beauty and art through the medical history of mankind. Clin Dermatol. 2001;19:375-86.
8. Flores-Mir C, Silva E, Barriga MI, Lagravere MO, Major PW. Layperson's perception of smile aesthetics in dental and facial views. J Orthod. 2004;31:204-9.
9. Roden-Johnson D, Gallerano R, English J. The effects of buccal corridor spaces and arch form on smile esthetics. Am J Orthod Dentofac Orthop. 2005;127:343-50.
10. Pinho S, Ciriaco C, Faber J, Lenza MA. Impact of dental asymmetries on the perception of smile esthetics. Am J Orthod Dentofacial Orthop. 2007;132:748-3
11. Geron S, Atalia W. Influence of sex on the perception of oral and smile esthetics with different gingival display and incisal plane inclination. Angle Orthod. 2005;75:778-84
12. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: A symmetric and symmetric situations. Am J Orthod Dentofacial Orthop. 2006;130:141-51.
13. Kamer FM. "How do I do it"- Plastic surgery, practical suggestions on facial plastic surgery, smile surgery. Laryngoscope. 1979;89:1528-32.
14. Rosenblatt A, Simon Z. Lip repositioning for reduction of excessive gingival display: A clinical report. Int J Periodontics Restorative Dent. 2006;26:433-7.
15. Simon Z, Roseblatt A, Dorfmann W. Eliminating a gummy smile with surgical lip repositioning. J Cosmetic Dent. 2007; 23:100-8.

Fig 1: Intra oral photograph after completion of orthodontic therapy



Fig 2: During Surgical Procedure





Suma et al.,

Fig 3: After Suturing



Fig 4: Post retention Procedure





Erosion Wear Behaviour of Polymer Nanocomposites

Hrusikesh Nayak, Mandakini Behari and Dillip Kumar Mohanta*

Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 10 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Dillip Kumar Mohanta

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: dillip.mohanta@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Carbon nanotubes have emerged as a promising reinforcement for polymer-based nanocomposites because of their exceptional mechanical and good tribological properties. 0.1, 0.3, 0.5, 0.7, and 1.0 weight percent functionalized multi-walled carbon nanotubes (f-MWCNTs) in a thermoplastic polymer matrix Polymethyl-methacrylate was used to construct nanocomposites (PMMA). The procedure involved micro-compounding and extrusion using a small injection molding machine. Taguchi method was used to analyze the solid particle erosion behavior of f-MWCNT/PMMA nanocomposites. The erosion rate of these composites was measured experimentally in samples at 30°, 60°, and 90° degrees with pressures of 1, 2, and 3 bar, corresponding to erodent particle velocities of 48, 69, and 82 m/s. The SN ratio was observed for all three input parameters. The erosion rate rose with impingement angle and decreased with pressure or velocity. The produced nanocomposites' wear resistance was compared to virgin polymer. The semi-brittle behavior of nanocomposites was determined by observing the influence of reinforcing on the resistance to erosive wear. 1 bar pressure and 90° impingement nanocomposites had the greatest erosion resistance. The FE-SEM images of the samples showed surface erosion at various angles, indicating angle as a significant determinant in semi-brittle nanocomposite degradation.

Keywords: Taguchi Method, Functionalized multi-walled carbon nanotubes (f-MWCNTs), Polymethyl-methacrylate (PMMA), Signal to Noise ratio (SN ratio), erosion rate, FE-SEM

INTRODUCTION

Polymer nanocomposites are widely used in electronics, structural and aeronautical components. Carbon nanotubes, graphite, and graphene, as potential reinforcement, have carved out a position in metal matrix and polymer composites. The dispersion of nano-platelets of graphite in a polymer matrix improves thermal stability and





Hrusikesh Nayak et al.

electrical conductivity [1]. Because of their small diameter and length, carbon nanotubes dispersed in thermoplastics like polyacrylonitrile and polystyrene have high stiffness, higher mechanical qualities, and better tribological properties [2]. The issue for CNT polymer or CNT metal matrix nanocomposites is effective dispersion in a matrix without aggregation [3]. However, adding nano-fillers to polymers reduces the mechanical strength and tribological (wear) properties of a composite [4]. Many studies have been done on these composites' mechanical and thermal properties. Although the polymer nanocomposites outperform the original polymer's physical and chemical properties, their thermal stability is still an issue. The tribological properties of these composites will be examined when employed in wear-and-tear components. Tribological studies are important in coatings and claddings, coupled with mechanical and chemical interactions. There is a lot of literature on polymer nanocomposites wear in abrasion. In three-body abrasion, increasing the reinforcement in epoxy polymer composites reduced the specific wear rate [5]. There is little research on polymer nanocomposites erosion. Components exposed to high velocity and pressure fluid flow are erodible due to the bombardment of micron-sized solid particles. The erodent's mass erodent depends on the composite's ductility or brittleness. It depends on the fluid flow velocity, Erodent size, angle of impingement, sample properties, distance from the sample, and ambient parameters like temperature and humidity. CNTs and carbon fiber fillers in epoxy resin significantly impact composite hardness and erosion resistance [6].

Experimentation

Functionalization of MWCNTs

The functionalized MWCNTs improved interfacial adhesion between the matrix and reinforcement. This prevents debonding and improves mechanical characteristics. At room temperature, pristine Nanotubes were initially treated with a 3:1 mixture of strong sulfuric and nitric acid (H_2SO_4) [7]. To improve polymer matrix adherence, concentrated sulfuric acid (H_2SO_4) and hydrogen peroxide were used (H_2O_2). Cut the edges and add carboxyl groups to the surfaces. To obtain a powder, these f-MWCNTs were then dehydrated at 80°C for 24 hours before being cryomilled at 15Hz.

Fabrication of Nanocomposites

Multiwall carbon nanotubes with a diameter of 10-20 nm and a 10-30 nm length were obtained at Sisco Research Laboratory in Mumbai, India. The thermoplastic polymer Polymethyl Meth Acrylate (PMMA) with an average molecular weight of 15,000 is employed as the reinforcing matrix. Injection moulding is the best fabrication method for thermoplastic materials. The composites were made by combining 10 g of f-MWCNTs with the rest of PMMA in five batches. F-MWCNTs were added to the composite samples in weight percentages of 0.1, 0.3, 0.5, 0.7, and 1%. The DSM XPLORE Micro-compounder machine was used to mix the f-MWCNTs in PMMA at 220°C for 20 minutes per batch [8]. Taken in five batches. The DSM XPLORE 5 Micro compounder was used to compound this 10 gm mixture of f-MWCNTs and PMMA. For 20 minutes, the mixture is heated to 220°C using twin screws at 13-15 RPM. Then, ASTM standard samples were prepared using a DSM micro injection moulding machine at 8 bar pressure [9].

Erosion Wear Test

The solid particle erosive wear behavior of f-MWCNTs PMMA nanocomposites evaluated by ASTM G76 standard experiments. The solid particle erosion tests followed ASTM G76. The sand particles were combined with room temperature compressed air and impinged on the samples at various angles. A solid erodent particle of Silica sand size 300µm was used to erode nanocomposites with f-MWCNT weight percentages of 0.1 percent, 0.3 percent, 0.5 percent, 0.7 percent, and 1.0 percent at pressures of 1, 2 and 3 bar [10, 11]. Wear was assessed using a mass loss criterion. The precision electronic balance monitored the weight change of the samples before to mounting and after erosion. The mass loss per unit erodent mass (gm/gm) was determined. The erosion test used pressures, angles, and percentages as input parameters. The minimum number of experiments was calculated using MINTAB 14's L18 mixed 2-3 level design. The erosion wear rate of a material was calculated by the following equation:

$$E_w = \frac{\Delta W}{w_e} \quad (1)$$

Where ΔW = loss of weight of the material, determined by weighting the sample before to and after each experiment.



**Hrusikesh Nayak et al.**

W_e = The total weight of the erodent used.

The erodent was fed from an 8mm nozzle at 8 gm/min, keeping samples 10 mm away. Each specimen was tested for 2 minutes. the erodent impingement at various angles (0, 30°, 60°, 90° degrees, and impact pressures of 1, 2 and 3 bar corresponding to measured velocities of 48, 69, and 82 m/s. Table 1 shows the levels of the main controlling variables.

RESULTS AND DISCUSSION

The impact pressure has a considerable effect on the Erosion rate of f- MWCNTs Nanocomposites. Due to an increase in pressure the higher velocities lead to more wear of particles. The angle of impingement in combination with the pressure has also a prominent role in the wear of the samples. Figure 1 represents the scattered plot of Erosive wear versus angle in degrees, f-MWCNTs and pressure in bar. The rate of erosion is found to be maximum at 8th combination in Table-2 with 0.3 weight percentage, 60 degrees of impingement, and 3 bar of pressure, which indicates the intermediate behavior of the Nanocomposites which is neither completely brittle nor ductile but exhibiting more of behavior of semi-brittle nature.

The 4th and 15th combination of parameters indicates the minimum erosion rate which reflects that even at either lower or higher pressure (velocities) of impingement has little effect on the rate of Erosion compared to the angle of impingement. The Signal to Noise ratio (S/N ratio) for erosive wear of f-MWCNT-PMMA Nanocomposite was calculated using MINI-TAB software for all the three controlling factors. The smaller is better Signal to noise criterion is chosen for the analysis. The optimum value of the S/N ratio obtained was 72.575 corresponding to minimum erosion of the specimen.

The calculated S/N ratio for three factors on the Erosion rate in f-MWCNT-PMMA Nanocomposite for each level is shown in Table 2. From Figure 2 it is evident that the best optimum conditions for the Erosive wear resistance are (a) 0.7%, fiber percentage (b) 30°, impingement angle (c) 1 bar, pressure. The combination for maximum erosion are (a) 0.3%, fiber percentage (b) 60° impingement angle (c) 3 bar, pressure. So the material behaves as semi-brittle because the maximum erosion occurs at 90° for brittle material and 0 to 30° for ductile. The maximum value of the SN ratio is 72.575 and the minimum value is 59.498. The average SN ratio is 66.03 [12]. The FE- SEM image of the fractured surface by erosion is shown below in Figures 3 and 4 [13]. Figure 3(a) and 3(b) show the image of the eroded sample at 0.5 and 1.0 percentage f-MWCNT fractured by 2 bar pressure at a 90° angle. Both specimens show a similar pattern of wear of surfaces by fatigue. It clearly indicates that figure 4 shows images at 0.7 percentage f-MWCNT fractured by 3 bar pressure at 60° angle having maximum erosion of sample. This confirms that not only the sample is Semi-brittle but also the erosion rate is much influenced by impingement angle rather than the pressure or velocity of the solid erosion particles.

CONCLUSION

The present study has concluded the tribological behavior of f-MWCNT PMMA nanocomposites. The erosion rate evaluated at a particular combination of pressure and angle for various percentages of f-MWCNTs in the Nanocomposite shows that the inclusion of f-MWCNT Nanofibers has significantly increased the erosive resistance. The increased erosion of pure PMMA is due to surface fatigue and brittleness. The f-MWCNT adds strength and shields the matrix from erosion. The Nano-composites are semi-brittle, with maximal erosion at 3 bar at 60° angle with 0.3 percent f-MWCNT loading. In erosion, the angle of impingement is more important than the pressure. This is at 0.7 percent nanofiber loading, 1 bar pressure and 90° impingement. The highest surface fracture at 60° impingement angle to the nanocomposites confirms the specimen's semi-brittle nature. As a result of the specimen's fatigue, the interfacial adhesion between Nanotube and matrix may have weakened, allowing erosive wear to occur.





Hrusikesh Nayak et al.

REFERENCES

1. Prusty G, Swain S K. Dispersion of Expanded Graphite as Nanoplatelets in a Copolymer Matrix and its Effect on Thermal Stability, Electrical Conductivity and Permeability. *New Carbon Materials*, **27**: 271-277 (2012)
2. Wang Ce, Xue Tong, Dong Bing, Wang Zhe, Li Hu-Lin. Polystyrene-acrylonitrile-CNTs nanocomposites preparations and tribological behavior research. *Wear* **265**:1923-1926, (2008).
3. Agarwal Gaurav, Patnaik Amar, Sharma Rajesh Kumar. Mechanical and Tribological Properties of Self-lubricating Metal Matrix Nanocomposites Reinforced by Carbon Nanotubes (CNTs) and Graphene- A Review. *Composites Part B* **77**:402– 420, (2015)
4. Dasari Aravind, Yu Zhong-Zhen, Mai Yiu-Wing. Fundamental aspects and recent progress on wear/scratch damage in polymer nanocomposites. *Materials Science and Engineering, R* **63**:31– 80, (2009)
5. Agarwal Gaurav, Patnaik Amar, Sharma Rajesh Kumar. Parametric Optimization and Three-Body Abrasive Wear Behavior of Sic Filled Chopped Glass Fiber Reinforced Epoxy Composites. *International Journal of Composite Materials*, **3(2)**:32– 38, (2013)
6. Papadopoulos A, Gkikas G, Paipetis A.S, Barkoula N.M. Effect of CNTs Addition on The Erosive Wear Response of Epoxy Resin and Carbon Fibre Composites. *Composites Part A* **84**: 299– 307, (2016)
7. Pradhan A.K, Swain S. K. Electrical Conductivity and Oxygen Permeability of Polyacrylonitrile/Multiwalled Carbon Nanotubes Composites. *Polymer Composites*, **33**: 1114– 1119, (2012)
8. Villmow Tobias, Kretschmar Bernd, Potschke Petra. Influence of Screw Configuration, Residence time, and Specific mechanical energy in Twin-screw Extrusion of Polycaprolactone/multi-walled Carbon Nanotube Composites. *Composites Science and Technology*, **70**: 2045–2055, (2010)
9. Mallick A., Mishra P., Swain S.K. *The Effect of Functionalized MWCNT on Mechanical and Electrical Properties of PMMA Nanocomposites*. Nano-electronic Material and Devices. Lecture Notes in Electrical Engineering, 466: Springer Singapore, 2017: 1-9
10. Mishra S.C, Das Satyabati, Satapathy Alok, Ananthapadmanabhan P. V, Sreekumar K.P. Effect of CNTs Addition on The Erosive Wear Response of Epoxy Resin and Carbon Fibre Composites. *Tribology Transactions*, **52(3)**: 401– 404, (2009)
11. Gujjala Raghavendra, Acharya S. K, Deo C. R, Mishra P. Fabrication-Modelling and Analysis on Tribological Performance of Natural Composites Using Taguchi Approach. *ICMOC-2012, Procedia Engineering* **38**, 2012: 2635-2644.
12. Biswas Sandhyarani, Xess Prity Aniva. Erosion Wear Behavior of Bamboo/Glass Fiber Reinforced Epoxy Based Hybrid Composites. *International Journal of Mechanical and Industrial Engineering* **1(4)**: 79-83, (2012)
13. Chen Jinhu, Trevarthen James A, Deng Tong, Bradley Michael S.A, Rahatekar Sameer S, Koziol Krzysztof K.K. Aligned carbon nanotube reinforced high performance polymer composites with low erosive wear. *Composites Part A*, **67**: 86-95, (2014)

Table 1: Levels of controlling factors

| Controlling factors; Notation; Unit | Levels | | | | | |
|--------------------------------------|--------|-----|-----|-----|-----|-----|
| | I | II | III | IV | V | VI |
| f-MWCNT weight percentage; W; mg | 0 | 0.1 | 0.3 | 0.5 | 0.7 | 1.0 |
| Impingement angle; α ; Degree | 30 | 60 | 90 | - | - | - |
| Pressure; P; Bar | 1 | 2 | 3 | - | - | - |





Hrusikesh Nayak et al.

Table 2: Experimental Results

| W | α | P | Input Sample weight in mg | Output Sample weight in mg | weight loss in mg | Weight of erodent used in mg | Erosion rate | Signal/Noise Ratio |
|-----|----------|---|---------------------------|----------------------------|-------------------|------------------------------|--------------|--------------------|
| 0 | 30 | 1 | 1.840 | 1.681 | 0.159 | 17.003 | 0.009 | 70.629 |
| 0 | 60 | 2 | 1.820 | 1.657 | 0.164 | 16.998 | 0.010 | 63.778 |
| 0 | 90 | 3 | 1.867 | 1.696 | 0.171 | 16.986 | 0.010 | 61.678 |
| 0.1 | 30 | 1 | 1.802 | 1.648 | 0.155 | 17.017 | 0.009 | 72.575 |
| 0.1 | 60 | 2 | 1.756 | 1.599 | 0.156 | 17.009 | 0.009 | 65.527 |
| 0.1 | 90 | 3 | 1.724 | 1.566 | 0.158 | 16.990 | 0.009 | 62.323 |
| 0.3 | 30 | 2 | 1.768 | 1.615 | 0.153 | 17.003 | 0.009 | 70.629 |
| 0.3 | 60 | 3 | 1.852 | 1.678 | 0.174 | 16.993 | 0.010 | 59.498 |
| 0.3 | 90 | 1 | 1.860 | 1.698 | 0.162 | 16.993 | 0.010 | 69.041 |
| 0.5 | 30 | 3 | 1.820 | 1.656 | 0.165 | 16.993 | 0.010 | 63.020 |
| 0.5 | 60 | 1 | 1.782 | 1.627 | 0.155 | 16.993 | 0.009 | 69.041 |
| 0.5 | 90 | 2 | 1.813 | 1.648 | 0.165 | 16.990 | 0.010 | 62.323 |
| 0.7 | 30 | 2 | 1.786 | 1.631 | 0.154 | 17.003 | 0.009 | 70.629 |
| 0.7 | 60 | 3 | 1.866 | 1.695 | 0.171 | 17.005 | 0.010 | 61.625 |
| 0.7 | 90 | 1 | 1.824 | 1.668 | 0.156 | 17.017 | 0.009 | 72.575 |
| 1 | 30 | 3 | 1.890 | 1.722 | 0.169 | 17.003 | 0.010 | 64.609 |
| 1 | 60 | 1 | 1.832 | 1.674 | 0.158 | 16.996 | 0.009 | 70.454 |
| 1 | 90 | 2 | 1.800 | 1.637 | 0.163 | 16.993 | 0.010 | 63.020 |
| | | | | | | | | |

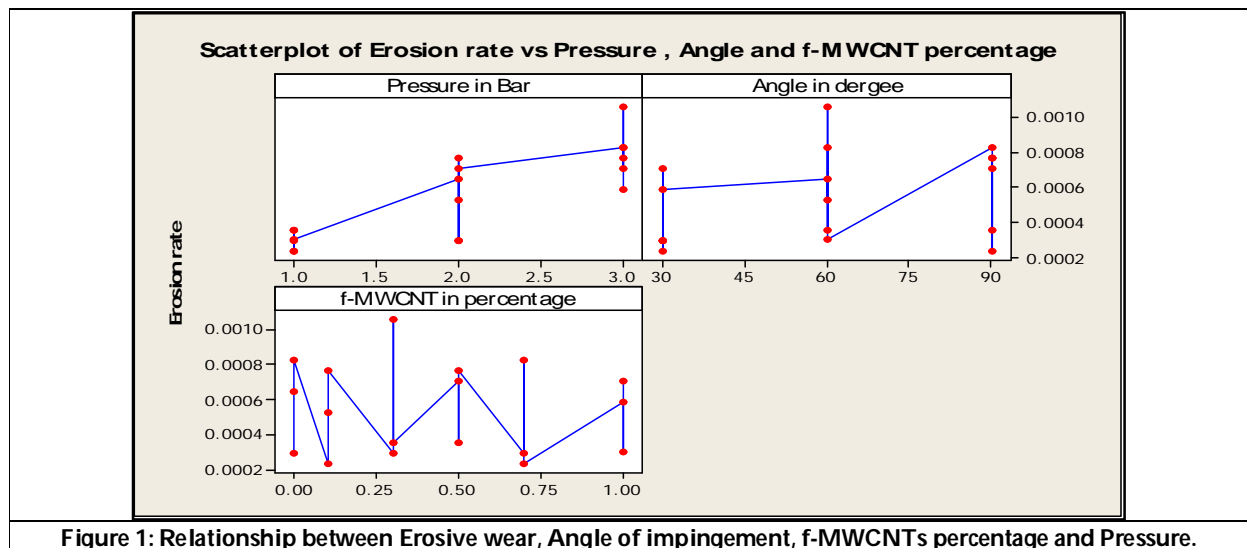


Figure 1: Relationship between Erosive wear, Angle of impingement, f-MWCNTs percentage and Pressure.





Hrusikesh Nayak et al.

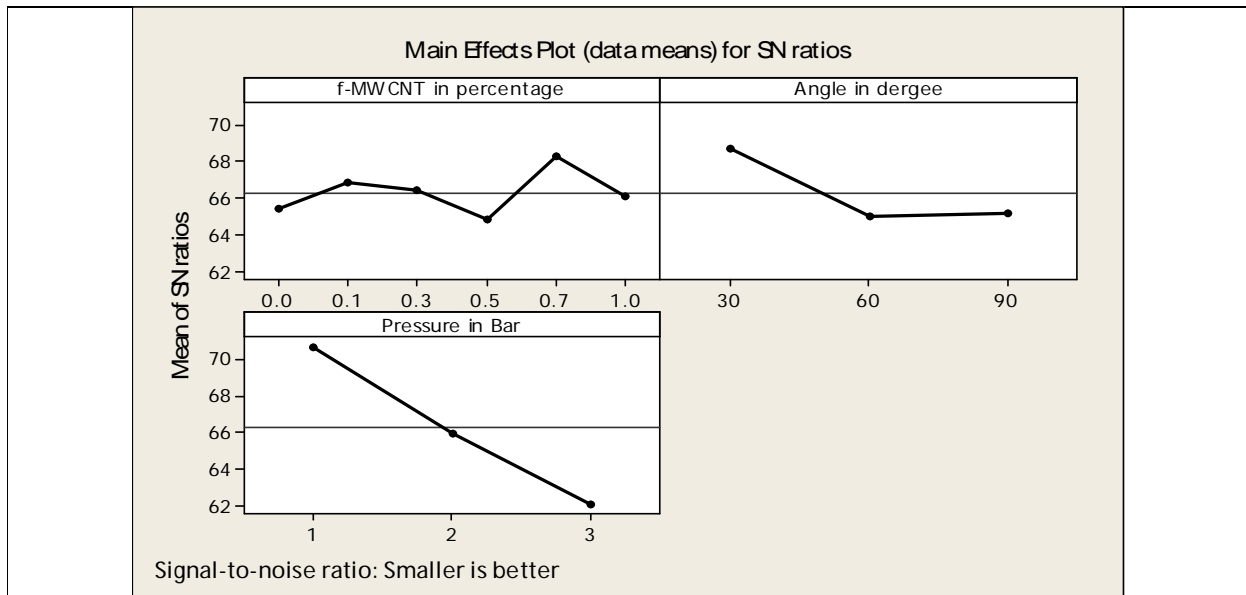


Figure2: Main effect plot for S/N ratio

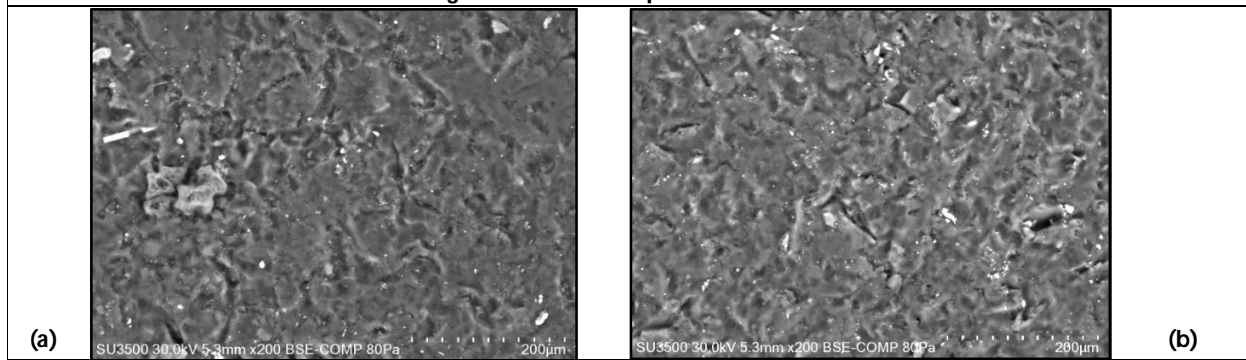


Figure3 (a): FE-SEM image of the eroded surface of the f-MWCNT/PMMA with 0.5 weight percentage of f-MWCNT and figure (b) 1.0 weight percentage of f-MWCNT

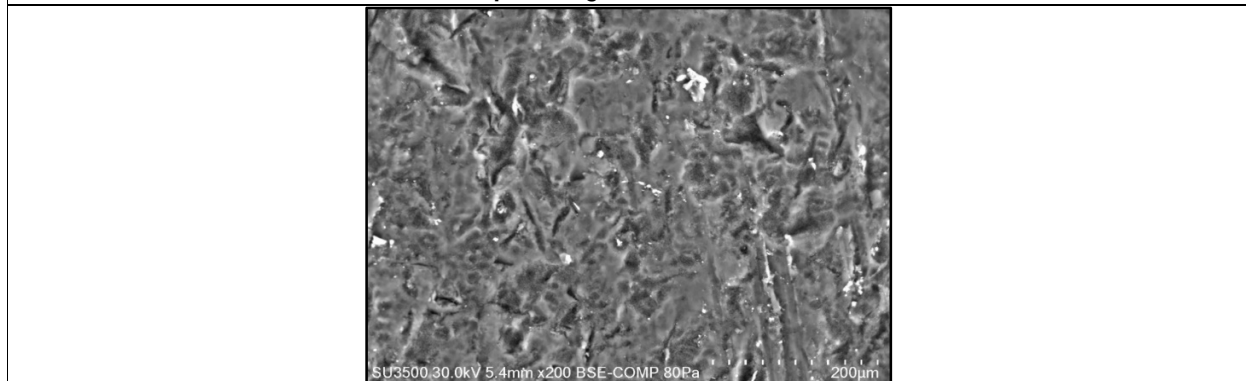


Figure4: FE-SEM image of the eroded surface of the f-MWCNT/PMMA with 0.7 weight percentage of f-MWCNT





Studies on Impact and Economics of Various Irrigation and Fertilizer Levels Treatments on Wheat in Western Region of India

P. P. Gaikwad¹, Rajesh. S. Kalasare², Sameer Mohapatro³ and Manish Kumar Yadav⁴

¹Assistant Professor, Department of Agronomy, COA, Selu, Parbhani, Maharashtra, India

²Associate Professor, Department of Agronomy and Agroforestry, MS Swaminathan School of Agriculture, Centurion University of Technology and Management Paralakhemundi, Gajapati, Odisha, India

³Ph. D Scholar, Department of Agronomy and Agroforestry, MS Swaminathan School of Agriculture, Centurion University of Technology and Management Paralakhemundi, Gajapati, Odisha, India

⁴Assistant Professor, Department of Entomology, Centurion University of Technology and Management, Odisha, India

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Rajesh. S. Kalasare

Associate Professor,
Department of Agronomy and Agroforestry,
MS Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Paralakhemundi, Gajapati, Odisha, India.
Email: rajesh.kalasare@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The given experiment was laid out in Split Plot Design with a total number of 12 treatment combinations with total three replications for each to find out the most suitable combination of irrigation and fertilizer in the term of yield and Economics of wheat in Western region of India. The study considered 03 levels of irrigation i.e. 0.8 IW/CPE , 1.0 IW/CPE ratio with context of 04 levels of fertilizers, namely, the Recommended fertilizer dose of 100:50:50 NPK kg ha⁻¹ , 75% Recommended dose of fertilizer (RDF) + 20 kg ZnSO₄, 100 % Recommended dose of fertilizer + 20 kg ZnSO₄, 125% Recommended dose of fertilizer + 20 kg ZnSO₄ with combination of total 12 treatments. The data of various traits namely, leaf area index, grain straw ration, total cultivation cost, gross mandatory return, net mandatory return and B:C ratio have been taken under all the replications of the selected treatments. The result revealed that the highest LAI was obtained with application of irrigation at 1.2 IW/CPE ratio rather than 1.0 and 0.8 IW/CPE ratios at different crop growth stages. The 1.2 value of IW/CPE ratio (I₃) also recorded significantly maximum gross monetary and net monetary returns over 1.0 IW/CPE ratio (I₂) and 0.8 IW/CPE (I₁) ratio. The irrigation level 1.2 IW/CPE ratio (I₃) produced the highest B:C ratio (2.19) in comparison with 1.0 IW/CPE ratio (I₂) (2.15) and 0.8 IW/CPE ratio (I₁) (2.10).



**Gaikwad et al.,****Keywords:** Leaf area index, economics, fertilizers, yield, cost, wheat

INTRODUCTION

Wheat (*Triticumaestivum* L.) crop holds a precious position among all cereals because of its huge area of cultivation. Wheat crop belongs to the family of poaceae and is considered as the staple food of the world. It's an annual plant and its straw is used as a cattle feed. Its rich in gluten protein and is cultivated in a larger area obtaining maximum production in India. The favourable growing conditions in India, has made it possible to be the second largest wheat production nation in the world, contributing to about 9% of the global wheat production (Sharma and Tandon, 1992). India witnessed a production of 107.86 million tonnes of wheat, contributing about 16% of global world production. In Uttar Pradesh, wheat was cultivated in an area of about 96 lakh hectares with an annual production of 26 million tonnes contributing about 37% of the total production of wheat in India. Wheat crop gets affected due to various environment related stresses like water stress, temperature stress (heat and chilling) and salinity which impacts its yield and quality (Hossain *et al.*, 2021).

North India's soil are very fertile and suits better for wheat production but the late sowing of the crop has been the main problem in these regions. The maturity period of the crop collides with high temperature witnessing months thereby hampering the yield and quality of the crop (Belcaret *et al.*, 2020). Environmental changes related to variable climatic aberrations and water demands have been the critical factor in decreasing the cereal production in many parts of the world. The elevations in mean temperature and frequency of temperature variations, pressurizes the growing ecosystem of wheat growing regions (Conrory *et al.*, 2015). Wheat is mostly grown in areas with limited amount of irrigation water, so it is more important to use the available irrigation water in such an efficient way to get maximum profit and the biofertilizers activity is confined to certain range of irrigation levels (Brummer *et al.* 2011). Out of the 17 SDGs recommended by UNDP, irrigation and fertilizer application on wheat has enough potential to fulfill SDG 2 and 3 (FAO, 2021).

MATERIALS AND METHODS

A research or experiment on field was conducted at the agronomy research farm at Vasandrao Naik Marathwada Agricultural University, Parbhani, Maharashtra. The research was carried out in Split Plot Design comprising 12 treatments and 3 replications with three irrigation levels viz. 0.8 IW/CPE (I1), 1.0 IW/CPE (I2) and 1.2 IW/CPE (I3) and four fertilizer levels *i.e.* Control, RDF 100:50:50 NPK kg ha⁻¹(F1), 75 percent RDF+20kg Znso₄(F2), 100 percent RDF+ 20kg Znso₄(F3), 125 percent RDF+20kg Znso₄ (F4). The research site was levelled with better drainage and soil being clayey in texture. The available nitrogen and phosphorus in soil is very less but higher in available potassium content and neutral in reaction. During the experimental period, about 19.90 mm of precipitation was recorded and distributed in two days of rain. The mean of maximum and minimum temperature were 28.10C to 37.20C and 6.60C to 17.30C, respectively.

While the relative humidity ranged from 55 to 81% during morning hours and 21 to 47 % during afternoon hours. The sowing of wheat was done by line sowing on 12th November, 2014 at 22.5 cm spacing. Gap filling was done on 12 days after sowing. Two hand weeding at 30 DAS and 45 DAS were undertaken. Irrigations were given as per treatments; fertilizers were also given as per recommended dose. The experiment has been conducted by using Split Plot Design with following treatments and tested with each other in total 12 combination of treatments. The treatment details consist in main plot (irrigation levels) were I1: 0.8 IW/CPE, I2: 1.0 IW/CPE and I3: 1.2 IW/CPE. The Sub plot (Fertilizer doses) with 100: 50: 50 NPK kg ha⁻¹.*i.e.* F1: Control, F2: 75 % RDF + 20 kg ZnSO₄, F3: 100 % RDF + 20 kg ZnSO₄ and F4: 125 % RDF + 20 kg ZnSO₄. The following data in the form of impact of above combinations have been taken by their suitable respective methods from all the replications of each treatment and ANOVA has been calculated: The data recorded during the experiment were Leaf Area index ,Grain straw ration Harvest Index, Gross mandatory returns, Net mandatory return and Benefit cost ratio



Gaikwad *et al.*,

RESULTS AND DISCUSSIONS

Leaf Area Index (LAI)

Data recorded from different treatments at various crop growth stages are given in Table 1. The mean LAI at 30, 50, 70 and 90 DAS was 1.73, 5.14, 3.30 and 2.27 respectively. LAI was increased up to 50 days and decreased thereafter slowly up to maturity similar type of result found Arshadullah *et al.*, (2017).

Irrigation levels: The highest LAI was recorded with the irrigation of 1.2 IW/CPE ratio over 1.0 and 0.8 IW/CPE ratios at different crop stages.

Fertilizer levels: In case of fertilizer levels (F) the application of 125 per cent RDF+20 kg ZnSO₄ fertilizer levels recorded the higher LAI at all stages than rest of fertilizer level. The LAI was highest at 51-70 days and at 70 DAS, a sudden decline in the value of LAI was found till maturity. These all characters were found to have highest value with irrigation level 1.2 IW/CPE ratio. These results are in proportion with the findings, Mirsky *et al.*, (2013), Richard *et al.*, (2011) and Xue *et al.*, (2003).

Grain to straw ratio

Data of grain: straw ratio is presented in Table 2 the mean grain: straw ratio was 0.87.

Irrigation levels: Maximum grain to straw ratio was observed under irrigation level 1.2 and 1.0 IW/CPE ratio (0.88) followed by 0.8 IW/CPE ratio (0.85).

Fertilizer levels (F): The highest grain to straw ratio (0.88) was recorded in the treatment (F4) i.e., 125 per cent RDF +20 kg ZnSO₄ and (F3) i.e., 100 per cent RDF +20 kg ZnSO₄ followed by F1 and F2. The grain, straw and biological yields were significantly influenced by irrigation levels. It can be attributed to the fact that water stress reduced the photosynthetic area which consequently reduced the yield attributing characters and finally the grain yield. Similar type of results was also reported by Dhillon *et al.* (2020).

Harvest index

The data presented in Table 2 revealed that the mean harvest index of wheat was 46.68 per cent.

Irrigation levels: The irrigation at 1.2 IW/CPE ratio recorded highest harvest index (47.03) whereas minimum harvest index was found in 0.8 IW/CPE ratio (46.01 per cent).

Fertilizer levels (F): The data in Table 2 represents that the harvest index of wheat was significantly influenced by different fertilizer doses. The dose of 125 per cent RDF + 20 kg ZnSO₄ (F4) recorded maximum harvest index (46.96 %) which was found to be better than rest of the fertilizer doses. Peleg *et al.*, (2008), Thompson and Scott, (2002)

Gross and net monetary returns

The data in Table 3 represents the mean cost of cultivation, gross returns and net monetary returns ha⁻¹ i.e. Rs. 15,592, Rs. 41,369 and Rs. 25,776 respectively.

Irrigation levels: In case of irrigation levels, 1.2 IW/CPE ratio (I3) produced highest gross monetary and net monetary returns over 1.0 IW/CPE (I2) and 0.8 IW/CPE (I1).

Fertilizer levels: The application of 125 per cent RDF +20 kg ZnSO₄ recorded significantly higher gross monetary and net monetary returns over rest of the fertilizer treatment.

Interactions: The data in table 21 showcases the effect of interaction of different irrigation and fertilizer doses to be not significant in case of the gross and net monetary returns.



**Gaikwad et al.,****B:C ratio**

The data on B: C ratio affected due to various irrigation levels and fertilizer levels are presented in Table 3.

Irrigation levels: The mean B:C ratio was (2.77). The irrigation level 1.2 IW/CPE ratio (I3) produced the highest B:C ratio (2.19) over 1.0 IW/CPE (I2) (2.15) and 0.8 IW/CPE (I1) (2.10).

Fertilizer levels: In case of Fertilizer levels 75per cent RDF +20 kg ZnSO₄ recorded highest B:C ratio (3.74) followed by 100 per cent RDF +20 kg ZnSO₄(3.18), 125 per cent RDF +20 kg ZnSO₄ (3.12) and control RDF (2.94) Fertilizer levels.

CONCLUSION

The research on various levels of fertilizers and irrigation points determined the effect on wheat crop growth and yield. The growth of crop was completely influenced with the different irrigation levels. This determines the timely application and quantity of water on wheat crop growth. The different levels of fertilizer also affected the different physiological and morphological growth of wheat crop. The growth of wheat crop gets influenced with the doses of fertilizer and the quantity of irrigation water. These treatments impact the different growth stages of wheat crop. This experiment focuses on the importance of research on wheat crop with different parameters into consideration. Such experiments in wheat crop improves the production and agronomic efficiencies of wheat crop. The result of cultivation of wheat crop in different regions in different soil types and topographical conditions can be better estimated. A perfect boost to the yield of wheat crop can be provided with such experiments in the future.

REFERENCES

1. Arshadullah, M., S. I. Hyder, I. A. Mahmood, T. Sultan, and Naveed, S. (2017). Mitigation of salt stress in wheat plant (*Triticum aestivum*) by plant growth promoting rhizobacteria for ACC deaminase. *International Journal of Advanced Research in Biological Sciences*, 4:41–6.
2. Belcar, J., Kaszuba, J., & Gorzelany, J. Effect of Wheat and Barley Malt Addition on the Quality of the Baking Blend and Wheat Bread. (2020) *Polish Journal of Food and Nutrition Sciences*, 72(2):129-139
3. Brummer, E Charles, Wesley T. Barber, Sarah M. Collier, Thomas S. Cox, Randy Johnson, Seth C. Murray, Richard T. Olsen, Richard C. Pratt, and Ann Marie Thro. (2011). Plantbreeding for harmony between agriculture and the environment. *Frontiers in Ecology and the Environment* 9(10):561–8. doi: 10.1890/100225.
4. Conrory, G., Y. Rouphael, P. Bonini, and M. Cardarelli. (2015). Coating seeds with endophytic fungi enhances growth, nutrient uptake, yield and grain quality of winter wheat. *International Journal of Plant Production* 9:171–90.
5. Dhillon, J., Eickhoff, E., Aula, L., Omara, P., Weymeyer, G., Nambi, E., ...& Raun, W. (2020). Nitrogen management impact on winter wheat grain yield and estimated plant nitrogen loss. *Agronomy Journal*, 112(1):564-577.
6. FAO 2021. Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 3rd May, 2022).
7. Hossain, A., Skalicky, M., Brestic, M., Maitra, S., Alam, M.A., Syed, M.A., Hossain, J., Sarkar, S., Saha, S., Bhadra, P., Shankar, T., Bhatt, R., Chaki, A.K., Sabagh, A.E.L. and Islam, T. (2021). Consequences and Mitigation Strategies of Abiotic Stresses in Wheat (*Triticum aestivum* L.) under the Changing Climate. *Agronomy* 2021, 11(2): 241; <https://doi.org/10.3390/agronomy11020241>
8. Lakshmi, P.V., Singh, S.K., Pramanick, B., Kumar, M., Laik, R., Kumari, A., Shukla, A.K., Abdel Latef, A.A.H., Ali, O.M., Hossain, A. 2021. Long term zinc fertilization in calcareous soils improves wheat (*Triticum aestivum* L.) productivity and soil zinc status in the rice-wheat cropping system. *Agronomy*, 11: 1306. <https://doi.org/10.3390/agronomy11071306>





Gaikwad et al.,

9. Mirsky, Steven, Ryan, Matthew, Teasdale, John, Curran, William, Reberg-Horton, Chris, Spargo, John, (2013). Overcoming Weed Management Challenges in Cover Crop-Based Organic Rotational No-Till Soybean Production in the Eastern United States. *Weed Technology*, 27:193-203. <https://doi.org/10.1614/WT-D-12-00078.1>
10. Peleg, Z. Saranga, Y. Fahima, T., Ozturk, L. and Cakmak, I., (2008). Grain zinc, iron and protein concentrations and zinc-efficiency in wild emmer wheat under contrasting irrigation regimes. *Plant & Soil*. 306(1-2):57-67.
11. Richard, G., Petit, Sandrine & Gaba, Sabrina. (2011). Functional traits relating arable weed communities to crop characteristics. *Journal of Vegetation Science*, 22:541-550. <https://doi.org/10.1111/j.1654-1103.2011.01273.x>
12. Sharma, P.K. and Tandon, H.L.S. (1992). In: Management of nutrient interaction in agriculture (Ed.HLS, Tandon), FDCO, pp. 1-20.
13. Thompson, M.W. and Scott J.N. (2002). Influence of Shade and Irrigation on the Response of Corn (*Zea mays*), Soybean (*Glycine max*), and Wheat (*Triticum aestivum*) to Carfentrazone-Ethyl. *Weed Technology*. 16(2):314-318.
14. Xue, Q. Zhu, Z., Musick, J.T., Stewart, B.A. and Dusek, D.A. (2003). Root growth and water uptake in winter wheat under deficit irrigation. *Plant & Soil*. 257(1):151-161.

Table 1: The effect on mean Leaf Area Index (LAI) recorded from different treatments at various crop growth stages

| Treatments | Days after sowing | | | |
|---|-------------------|-------|-------|---------------|
| | 30-50 | 51-70 | 71-90 | 91 to harvest |
| Irrigation levels (I) | | | | |
| I ₁ - 0.8 IW/CPE | 1.68 | 4.95 | 3.15 | 1.73 |
| I ₂ - 1.0 IW/CPE | 1.73 | 5.18 | 3.33 | 2.46 |
| I ₃ - 1.2 IW/CPE | 1.77 | 5.29 | 3.43 | 2.62 |
| Fertilizer levels (F) | | | | |
| F ₁ - Control | 1.68 | 5.12 | 3.28 | 2.25 |
| F ₂ - 75 %RDF + 20 kg ZnSO ₄ | 1.71 | 5.13 | 3.30 | 2.27 |
| F ₃ - 100 %RDF + 20 kg ZnSO ₄ | 1.72 | 5.15 | 3.31 | 2.28 |
| F ₄ - 125 %RDF + 20 kg ZnSO ₄ | 1.79 | 5.16 | 3.33 | 2.29 |
| Mean | 1.73 | 5.14 | 3.30 | 2.27 |

Table 2: Revealed that the mean harvest index of wheat was 46.68 per cent

| Treatments | Grain to straw ratio | Harvest index (%) |
|---|----------------------|-------------------|
| Irrigation levels (I) | | |
| I ₁ : 0.8 IW/CPE | 0.85 | 46.01 |
| I ₂ : 1.0 IW/CPE | 0.88 | 47.02 |
| I ₃ : 1.2 IW/CPE | 0.88 | 47.03 |
| S.E. ± | - | - |
| C.D. at 5% | - | - |
| Fertilizer levels (F) | | |
| F ₁ : Control | 0.87 | 46.61 |
| F ₂ : 75 %RDF + 20 kg ZnSO ₄ | 0.86 | 46.29 |
| F ₃ ; 100 %RDF + 20 kg ZnSO ₄ | 0.88 | 46.95 |
| F ₄ : 125 %RDF + 20 kg ZnSO ₄ | 0.88 | 46.96 |
| S.E. ± | - | - |
| C.D. (5 %) | - | - |
| Interaction (I x F) | | |
| S.E. ± | - | - |
| C.D. at (5 %) | - | - |
| G. mean | 0.87 | 46.68 |





Gaikwad et al.,

Table 3: Treatment wise cultivation costs, net and gross monetary returns (Rs ha⁻¹) and B: C ratio in wheat

| Treatments | Gross monetary returns (Rs ha ⁻¹) | Net monetary Returns(Rs ha ⁻¹) | B : C ratio |
|---|---|--|-------------|
| Irrigation levels | | | |
| I1 - 0.8 IW/CPE | 38262 | 20037 | 2.10 |
| I2 – 1.0 IW/CPE | 41731 | 22286 | 2.15 |
| I3 - 1.2 IW/CPE | 44115 | 24060 | 2.19 |
| S.E. + | 128.59 | 71.64 | - |
| C.D. at 5% | 384.93 | 214.47 | - |
| Fertilizer levels (F) | | | |
| F1 - Control RDF (100 : 50 : 50 NPK kg ha ⁻¹) | 38759 | 25579 | 2.94 |
| F2 - 75 %RDF + 20 kg ZnSO ₄ | 39923 | 29238 | 3.74 |
| F3 – 100 %RDF + 20 kg ZnSO ₄ | 42737 | 29302 | 3.18 |
| F4 - 125 %RDF + 20 kg ZnSO ₄ | 44059 | 29934 | 3.12 |
| S.E. + | 80.77 | 86.69 | - |
| C.D. at 5% | 241.80 | 259.51 | - |
| Interaction | | | |
| S.E. + | 161.55 | 173.39 | 0.16 |
| C.D. at 5% | N.S. | N.S. | N.S. |
| G. Mean | 41369 | 25776 | 2.77 |

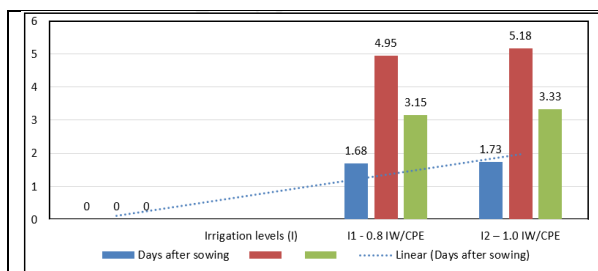


Figure 1: The mean leaf area index (LAI) as recorded from different treatments at various crop growth stages

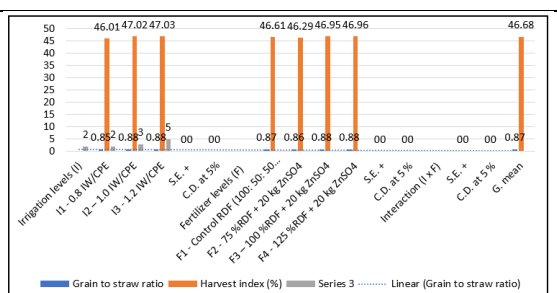


Plate 2: Ratio of grain: straw and harvest index as effected by different treatments

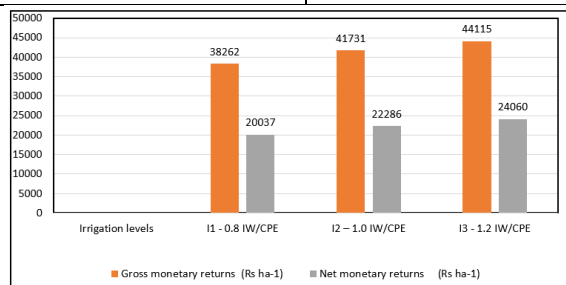


Plate 3: Treatment wise cultivation costs, net and gross monetary returns (Rs ha⁻¹) and B : C ratio in wheat





ESL Students' Listening Skill: A Study in Odisha Context

Pradeep Kumar Sahoo*

Assistant Professor, Department of English, Centurion University of Technology & Management, Odisha

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Pradeep Kumar Sahoo

Assistant Professor,
Department of English,
Centurion University of Technology & Management,
Odisha, India.



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

ESL learners, in an Indian context, hail from different linguistic backgrounds with a variable proficiency level in English language. However, in the midst of globalization, all college students must meet the global standard in English language proficiency. This research intends to find out if and how well the entry level ESL college students of Odisha possess the prerequisite skills in English language to meet the global challenge. The present study is aimed at determining the ESL students' proficiency level in listening skill. A standardized language proficiency test with reference to listening skill has been administered to assess ESL learners' proficiency level in English. It is found that the ESL students of Odisha at degree level do not possess adequate proficiency in listening skill. Moreover, the learners have been interviewed and they have been recommended for the enhancement of their listening skill.

Keywords: ESL students, proficiency, enhancement, listening skill

INTRODUCTION

Learners of English from non-western former British colonies are termed as second language (ESL) users irrespective of the fact that it is possible that the learner may not speak the first language usually associated with the mother tongue or ethnic identity. In spite of linguistic diversity in Odisha, English has been chosen as the medium of instruction for college students at degree level continuing their studies under all the Government as well as private universities except Sanskrit University present in the state. But, in real classroom practice, it has been observed that Hindi and Odia are being used in the classroom along with English. The teachers themselves, as Tickoo (2004) pointed out, are not well-equipped to teach neither correct English pronunciation nor speaking or reading skills to students. Except reading and writing skills, no other skills are being practised. It may be because the teachers might have been brought up in a similar educational system, with little expertise in ELT and phonetics as there is no provision in the state universities to teach phonetics or spoken English in the undergraduate courses. Moreover, there are scopes (like on-line courses) for the teachers engaged for undergraduate courses to master the language



**Pradeep Kumar Sahoo**

skills but there are various reasons why teachers do not subscribe to these courses including lack of motivation. The complete teaching-learning system, Tickoo (2004) pointed out, could be at fault due to lack of English proficiency in our students, as they have been taught by teachers those who are not highly proficient in its use. Gokak (1964) points out that "The foundational years for the teaching of English in schools are in the hands of teachers who neither know enough English nor are familiar with the latest and far-reaching developments in the pedagogy of English" (p.65). Observing the rapid change in the place of English in India Scrase (1989) remarked: "English is recognised as an important global or international language, essential for professional employment and significantly, a key component of the cultural capital of middle class Indians." Lax English language proficiency restricts the ESL students in Odisha for their academic and professional growth. It cannot be denied that better English language proficiency has been considered to be an important parameter in the selection process for getting well-paid jobs or better institutions for higher studies. It has been treated as the most significant language in India. So, in order to compete with the students of other states and countries, the students of Odisha at degree level have to be proficient in English language skills. In this regard, assessment of their language competence becomes essential. It will help them not only in acquiring English language but also all other subjects that they go through. In order to make them well equipped to face the academic and professional career in life the assessment of English language skills and finally, the recommendation for improvement is to be made.

Listening as a Skill

Listening has often played second fiddle to its counterpart, speaking. Speaking a language is not possible without listening to it. So, listening skill may be treated as a component of speaking skill. One's speaking ability is well connected to one's listening ability. If we analyze a day's activity we find people do more listening activity than speaking. Aural comprehensions outstrip oral production in terms of effort, number of words, time and attention. "Listening is a bridge to learn a language", as stated by Nation and Jonathen (2009). So, a good ability in listening is essential in language learning. Hammer (2007) agrees to this and opines that listening can be helpful for students in running successful communication. Bulley-Allen (1995) and Flowdew (2010) state that listening is a dominant activity in daily communication covering almost 40% of the total communication process. Listening for comprehending the aural information involves both linguistic and non-linguistic knowledge. Linguistic knowledge deals in the learner's abilities in understanding phonology, semantics and syntax of the language whereas; non-linguistic knowledge discusses the topic and overall context. Ghaderpanahi (2012) concerns about the barriers like native speaker's pronunciation, pace, intonation etc. create barriers in the effective language listening process. Moreover, background information also affects comprehension process during listening. Hsueh-Jui (2008) in his study states the significant relationship among students' listening strategy, style, and proficiency levels.

Proficiency Tests

As per Oxford Advanced Learners' Dictionary (2015) A skill is "an ability to do something better". The general ambience or in other words, the environmental stimuli stand responsible for the easy and quick acquisition of any language. Proficiency tests have been designed to assess learner's language proficiency. These tests are highly required for academic and other reasons like travel and short stay in native English-speaking countries. There are many standardized proficiency tests and among them tests like TOEFL, IELTS, SAT are very popular among test-takers. In these tests related to listening skill the test takers are being evaluated on their ability to synthesize and convey information for the integrated questions. The spontaneity, clarity and coherence in the speaking abilities of the test takers are tested.

METHODOLOGY

The mixed-method approach has been followed for the current study. Both qualitative data and quantitative data have been taken through participant observation, literature review, semi-structured interview, questionnaire and a standardized language proficiency test. Random sampling technique has been adopted to achieve accuracy in result.



**Pradeep Kumar Sahoo**

The samples for the present study have been carefully chosen among the ESL college students of Odisha using random sampling techniques. For this purpose, students from five different technical and non-technical degree colleges have been taken into account. In total 300 numbers of students, equally from each college, form the sample size for the current study.

Instruments Used

A semi-structured questionnaire, standardized language proficiency test with reference to listening skill and an interview protocol were the instruments used as to carry out the present research work. A statistical tool like SPSS 21.0 has been used for data interpretation. Before administering the questionnaire and the test for listening skill a pilot study was conducted in order to check the level of difficulty of the test questions designed for the study. It helped to adopt and standardize the test questions. The participants were well informed about the purpose of the test and ethical practices as prescribed by American Psychological Association (1982) was followed which deals with human samples.

RESULTS AND DISCUSSION

The diagram (Diagram No.-1) highlights learners' perceptions about their proficiency in listening skill. There are seven specific statements posed to the students to encapsulate this information. A three-point Likert scale (i.e. always, sometimes and never) is used to find learners' perception on this statement. The first statement is whether learners can comprehend while listening to lectures in English inside the classroom. As per the diagram (Diagram No.-1) it is evident that 240 students out of 300 responded that 'always' they are able to comprehend lectures in English inside the classroom. Only 60 students responded that they 'sometimes' comprehend English inside the classroom. However, there are no such responses for 'never'. During peer-group interaction 198 students, as diagram(Diagram No.-1) shows, are able to comprehend in English 'always' and there is a response from 96 students in favour of 'sometimes' and 6 students only responded 'never'. Likewise, data reveal 114 students are able to comprehend English news 'always';162 students, 'sometimes' and 24 students 'never'. Further, 168 students are 'always' able to comprehend while watching English movies; 114 students, 'sometimes' and 18 students 'never' comprehend English movies. Similarly, diagram (Diagram No.-1) shows that 120 students are 'always' able to comprehend English songs; 150 samples, 'sometimes' and 30 students 'never' understand English songs. In the same manner, 234 students out of 300 are 'always' able to understand instructions in English; 60 students only 'sometimes' and 6 students only 'never' understand instructions even in English. The last question in this section, as shown in the diagram (Diagram No.-1) gives a scope to the respondents to opine about their personal interest (if any). There is no response to this question.

CONCLUSION

After the reality check by administering the standardized language proficiency test focusing on listening skill and the interview protocol it has been observed that the average standard of the language proficiency level of ESL college students is far below than the global standard. Hence, it may be suggested that proper infrastructure may be provided in different institutions to enable a healthy environment to enhance language proficiency and to boost up academic growth of the students. Moreover, not only the language teachers but also the teachers of all other subjects and peer-group interaction must contribute towards the creation of the general ambience to enhance ESL students' language proficiency.

REFERENCES

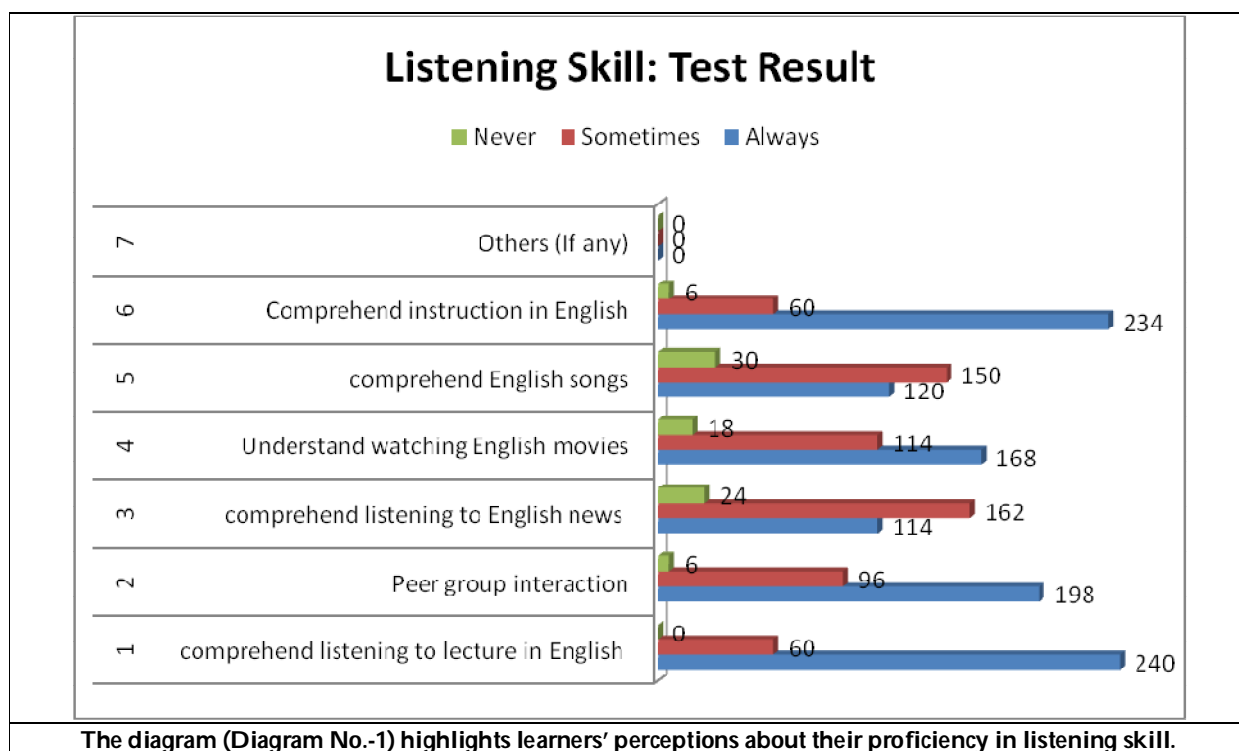
1. Allen, JF: Natural Language Understanding, pp. 654, ISBN 0-8053-0334-0, The Benjamin/Cummings Publishing Company, Inc. (1995).





Pradeep Kumar Sahoo

2. Ghaderpanahi, Leila. 2012. Using Authentic Aural Materials to Develop Listening Comprehension in the EFL Classroom. English Language Teaching, Vo.5, No. 6; June 2012, ISSN 1916-4742, E- ISSN 1916-4750.
3. Gokak, V.K. (1964) English in India—Its Present and Future. London, Asia Publishing House
4. Harmer, Jeremy. 2007. How to Teach English. Kuala Lumpur: Pearson Education Limited.
5. HJ Liu - Annual Review of Education, Communication & ..., 2008 - research.ncl.ac.uk
6. J Flowerdew, L Miller - ... and human communication in the 21st ..., 2010 - Wiley Online Library
7. L Ghaderpanahi (2012) - English language teaching, 2012 – ERIC
8. Lado, R. (1957) Linguistics across cultures. Applied linguistics for language teachers. University of Michigan Press.
9. Nation, I.S.P and Jonathan Newton. 2009. Teaching ESL/EFL Listening and Speaking. Routledge: New Yourk. Peterson, Pat Wilcox. 2001."
10. Scrase J. Timothy (1989) Place of English in India, The Hegemony of English, Asia Pacific
11. Tickoo , M.L. (2004). ELT in India. New Delhi: Orient Longman





Nutraceuticals in Pharmaceutical Field

Nihar Ranjan Kar*

Centurion University of Technology and Management, Odisha, India

Received: 09 Mar 2022

Revised: 12 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Nihar Ranjan Kar

Centurion University of Technology and Management,
Odisha, India

Email: nihar_795@rediffmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Nutraceuticals are natural chemical compounds used for prevention of disease and health fitness. In pharmaceutical field, the use of nutraceuticals has gained immense importance in the recent times. The High-tech treatment of disease with the help of modern methods are included in this type of chemical compounds. In the below discussion, some famous articles are reviewed to gain a conclusion regarding the use of nutraceuticals in pharma field. The use of nutraceuticals in food and health are included in this article review paper along with the new era transition. Medical backgrounds are experiencing immense transformation due to technical advancements. This article review would help on understanding all of them with detailed examples and explanation.

Keywords: Pharmaceutics, medicine, limonoids, dietary, supplements, nutraceuticals, technology, immunity.

INTRODUCTION

The name "nutraceutical" was invented in 1989 by Stephen DE Felice, MD, organiser and executive of the Foundation for Innovation in Medicine (FIM), Cranford, NJ, by joining the words "sustenance" and "medication." Nutraceutical is characterized as "a food (or part of a food) that gives clinical or health advantages, including the counteraction and treatment of illness, "according to DE Felice (Akhavan, *et al.*, 2018). 1 However, there is no official definition for the phrase nutraceutical as it is commonly used in advertising. I suggest that utilitarian food types and nutraceuticals be reclassified. Food is characterised as "utilitarian food" when it is cooked or organised with "logical understanding" regardless of how or why it is used. As a result, practical food provides the body with the essential amount of nutrients, fats, supportive of teens, carbs, and so on, for it to function properly. In application of Neutraceutocals tools in pharmaceutical field we have taken 5 major articles.

Article Review

Nutraceuticals in Food and Pharmacy



**Nihar Ranjan Kar**

Food containing organically dynamic accumulates, notably cancer prevention agents, which can support the human body in resisting oxidative strain, has grown in popularity as consumer awareness of food and health has increased. Many unexpected or novel sources of cancer prevention agents have been discovered, which is critical not only for food but also for the pharmaceutical industry (Assadpour and Mahdi, 2019). It has been demonstrated that unrefined components, as well as squander from foods grown from the ground, contain significant particles such as proteins, basic amino acids, cancer prevention agents, dietary filaments, regular shades, or sweet-smelling compounds, which can be extracted, decontaminated, and modernised in food or drugs with added value.



This is the foundation for the enormous potential of unprocessed plant and biotechnological components, as well as food waste, as a source of cancer-prevention agents. The majority of nutraceuticals are claimed phytochemicals derived from vegetables. Citrus organic products, which are important for their content of L-ascorbic acid, folates, and fibre, also appear to be a source of organically active combinations, known as limonoids. There is also mounting evidence that monoterpenes limonene has anti-cancer growth effects. Garlic, which has long been thought to be the most potent natural anti-infection, is also thought to be a source of anti-malignant growth experts. While logical research supports the organic movement of many dietary phytochemicals, health claims ascribed to recent nutraceutical goods supplied on the market sometimes have little or no logical basis.

Human clinical preliminaries are intriguing and confusing, hence in vitro testing are commonly used. Bioavailability, digestion, portion size, and poisonousness of these bioactive food ingredients or nutraceuticals themselves are only a few of the major grounds of debate. Several polyphenol groups are being used in the nutraceutical industry among phytochemicals (anthocyanins, proanthocyanins, flavanones, isoflavones, resveratrol and ellagic corrosive). In this way, logical data on the bioavailability and natural movement of these polyphenols was studied, as well as health claims attributed to fixes (which are not often supported by logical analysis).

A nutraceutical is a concentrated food or substance that is not part of a food construct and has a health-promoting or preventative effect, such as capsules, tablets, extricates, and other similar forms of prescriptions. These are goods that fall between pharmaceuticals and traditional foods, and are available in a variety of formats such as pills, containers, tablets, syrups, and other forms. Nutraceuticals are bio-substances or combinations of bio-substances derived from crude materials of animal, vegetable, and biotechnological origin that have been distributed (disconnected) through inventive innovations (Calado, *et al.*, 2018). Plant ex-parcels, including spices, natural goods, eggs, colostrum, beekeeping items, and so on, are among the most commonly used and most recognised unpolished ingredients for the formulation of nutraceuticals. Since the 1990s, the word narcotics has been used to describe dietary supplements or diverse food kinds in medication form that have health-promoting qualities (which brings medical advantages).

Nutraceuticals: New Era of Medicine and Health

The idea of nutraceuticals rose up out of a review led in the United Kingdom, Germany, and France, which reasoned that buyers esteem food more profoundly than training or inherited qualities in accomplishing extraordinary wellbeing (Simat, 2021). Nutraceutical is a word used to depict intensifies that are not frequently considered supplements yet significantly affect the human body. They don't handily fall into the legitimate classes of food and



**Nihar Ranjan Kar**

medication, and they regularly have a murky connection between the two. The gamble of harming or prescription hostile impacts provoked us to research safer nutraceutical and utilitarian food-based procedures for the leaders' prosperity. This brought about a tremendous change in the nutraceutical business. The nutraceutical revolution will introduce another period of medication and wellbeing, where the food business, similar to the medication business, will become research-driven. Customers might find that utilitarian food sources and nutraceuticals give a few advantages:

- May increase the nutritional value of our eating habits.
- May help us live longer lives.
- Could help us avoid certain illnesses.
- Working on something for oneself may provide a mental benefit.
- May be perceived as more "normal" than conventional drugs and less likely to cause terrible side effects.
- Can provide meals for populations with special needs (for example supplement thick food sources for the old)

Expanding awareness levels regarding wellness and wellbeing, prompted by media coverage, is motivating most people to live healthier lives, practise more, and eat better. The growing nutraceutical business demonstrates that consumers want minimally processed foods with additional dietary benefits and organoleptic value. As a result of this turn of events, the nutraceutical industry is expanding globally.

The arising nutraceuticals business is bound to assume a part in the new thousand years. Its enormous development has suggestions for the food, therapeutic, clinical, and cultivation businesses. Numerous analysts concur that synthetics tackle one of nutraceuticals' more captivating hindrances (Puglia and Lauro, 2019) . "Impetuses have been underutilized, yet they will end up being a hot area later on." Fermentation innovation that utilizes organisms to make novel food sources additionally has guarantee. It is impossible to change global patterns into solid things. Organizations who start to lead the pack by investing firmly in science, product development, marketing, and customer education will be rewarded. Nutraceuticals have been utilized to treat an assortment of infirmities, including joint inflammation, pain killers, cold and influenza, resting issues, ingestion and anticipation of specific diseases, osteoporosis, beat, cholesterol, despairing, and diabetes.

Nutraceuticals: A Review on Current Status

Nutraceuticals refers to dietary sources that have a therapeutic effect on people's strength. It includes dietary supplements, natural products, probiotics and prebiotics, as well as therapeutic food variety used to prevent and treat illnesses. Major nutraceuticals force multiple beneficial effects while avoiding negative effects, so attracting greater client attention. Expansion in the shift toward preventive treatments and expanding discretionary cashflow, as well as good valuing climate development in the pharma corporate store and expansion in medical services spending, are all fundamentally responsible for the growing market for nutraceuticals in India. However, lack of standardisation and mindfulness, high evaluating, promoting, and dispersion are a few challenges(Puglia and Lauro, 2019). The nutraceutical business is booming, especially in the United States, India, and European countries. Business association models, appealing administrative consistency, and identifying important patterns and purchaser reference may all help you get into this market faster. Nutraceutical foods or food components that aid in the treatment and prevention of illnesses are made from unprocessed homegrown/plant material. This is a rapidly growing industry (7-12 percent every year), with a large number of people throughout the world using these common things. By 2015, the global nutraceutical industry is expected to exceed \$ 450 billion. According to a recent Euro screen study. The Indian public's awareness of common nutraceutical ingredients is severely limited, and nutraceutical manufacturers must take up the cause and educate the Indian public about their products. In the previous ten years, the global nutraceutical industry has grown the most. Over the next five years in India, refreshments and utilitarian food are expected to grow at a far faster rate than dietary enhancement²(Jha, *et al.*, 2017). Japan is the largest buyer in the Asia Pacific nutraceutical item market, followed by China. In 2017, the Indian helpful food market is expected to grow at a modest pace, with utilitarian food sources and beverages accounting for over 71% of the dietary improvement market. Dietary supplements were the fastest growing business category in the nutraceutical industry in the Middle East and Africa, with annual growth of about 31% between 2007 and 2011. Non-





Nihar Ranjan Kar

herbals were the fastest growing segment in 2011, while proteins and peptides were the most profitable market segment. Extension in dietary improvements and practical food market sections is energising nutraceutical item market development in Eastern Europe. Russia is the world's largest consumer of nutraceuticals¹³. In 2017, Hungary and Russia are expected to possess just over 20% and just under 24.5 percent of the nutraceutical market, respectively (Hardy, *et al.*, 2020). Nutraceuticals first appeared in the form of a container, pill, or powder in a suggested portion, however today's nutraceuticals are available as food kinds, remembered for food variety, or as whole foods, such as probiotic drink and yoghurt. There is a lack of conjecture and focus on new work, as well as the discomfort of food provided to the undernourished by government schemes.

Nutraceuticals - A Regulatory Review

There are several rules that govern Nutraceuticals under various titles depending on the jurisdiction. Even the name differs per region. from nutraceuticals to dietary supplements improvements, and there are a few countries that have done so. Nutraceuticals should be included in the food category (Durazzo, *et al.*, 2020). A dietary supplement is, in general, a substance. This is administered orally and consists of a nutritional supplement that is designed to supplement one's diet. There are several meanings and terminologies used. They are similar to Nutraceuticals in general. In the United States, it's known as dietary supplementation; in Canada, it's known as the term "regular health product" is used in Australia. European Union, essential prescriptions Food Supplements clearly states this, and It is known as Foods for Special Dietary Use in India.

Dietary Supplement Health Education Act (DSHEA) 1994: This legislation was introduced in the Senate by Senator Orrin G. Hatch, and it defines the term "dietary enhancement" as well as the legal requirements for promoting dietary enhancement products in the United States. The following is how the law defines a dietary enhancement: includes at least one of the following dietary ingredients:

i) nutrient; ii) mineral; iii) spice or other herbal; iv) amino corrosive; v) dietary substance for supplementing the diet by increasing the aggregate dietary admission of that fixing; and vi) a concentration, metabolite, component, concentrate, or blend of any of the above.

Dietary supplements, according to DSHEA, should be the goods that are expected for oral administration.

Food handling standard and principles act (FSSA) 2006: This regulation was established in 2006 to make the FSSA, an administrative organization that supervises the assembling, creation, transportation, exchange, and import of food and food merchandise inside the nation (Hardy, *et al.*, 2018). The FSS act 2006, guidelines and rules 2011 incorporate nutraceuticals under the heading of food assortment. Fragment 22(1) of the FSSA describes "food arrangements for unprecedented dietary purposes or important food combinations or Nutraceutical or flourishing enhancements" as: a) food collections that are exceptionally dealt with or figured out to meet express dietary necessities that exist thinking about a specific physical or physiological condition or unequivocal afflictions and issues and are introduced in that breaking point, Whereas, accepting such standard food sources exist, the game-plan of these product should differentiate fundamentally from the piece of standard food wellsprings of relative nature, and may include somewhere near one of the going with decorations, unequivocally:

(i). Plants or botanicals, or their parts, in powder, pack, or move structure in water, ethyl alcohol, or hydro alcoholic concentrate, single or blended; (ii). Minerals, supplements, proteins, metals, or their blends or amino acids (in totals that don't outflank the Recommended Daily Recompense for Indians) or main impetuses (inside agreeable cut-off edges); b) (i) a thing that is separate as a "Food for unequivocal dietary purposes or sensible food sources or Nutraceuticals or flourishing enhancements or essentially indistinguishable such food sources" that isn't tended to for use as a standard food and which can be figured out as powders, granules, tablets, cases, fluids, or relative such food sources and which can be figured out as powders, granules, tablets, cases, fluids, or similar such food sources (ii) such thing restricts a medicine as depicted in approach (b), as well as Ayurvedic, Siddha, and Unani arrangements as depicted in conditions (a) and (h) of section 3 of the Drugs and Cosmetics Act, 1940 (23 of 1940) and its guidelines; (iii) genuinely amends or traditionalists no issues. with the exception of clear pollution, unsettling, or



**Nihar Ranjan Kar**

condition (iv) precludes a mitigating remedy or a psychotropic substance as portrayed in the Timetable of the Narcotic Drugs and Psychotropic Drugs Act, 1985 and precludes spread there under, as well as substances kept in Plans E and E(l) of the Drugs and Beauty Care Products Rules, 1945.

Nutraceuticals–An Opportunity of Healthcare

Nutraceuticals are considered bioactive compounds, and their ingredients are either naturally occurring or intentionally defined substances that are widely accepted to contribute considerably to the medication's beneficial activity. Nutraceuticals have sparked widespread attention due to their alleged health benefits and potential nutritional and therapeutic effects. Nutraceuticals, which provide medicinal benefits and are an alternative to current drugs, have recently gained popularity (Daliu, *et al.*, 2019). It may be possible to reduce or eliminate the need for standard prescriptions by using nutraceuticals, hence lowering the risk of any negative consequences. Weight, osteoporosis, sickness, diabetes, hypersensitivity, and dental concerns are all common ailments among people of advanced age. An item that is separated or filtered from food variations and sold in healing structures that are not frequently connected with food. A nutraceutical is displayed to offer a physiological advantage or give insurance against proceeding with ailment. In this review, they generally talked about the helpful job of nutraceuticals in many kinds of issues.

Nutraceuticals and Obesity: Angina pectoris, congestive cardiovascular breakdown, hypertension, hyperlipidaemia, respiratory hardships, renal vein blood vessel breakage, osteoarthritis, illness, impaired richness, and so on are all deeply rooted danger factors for weight, which is defined as an awful measure of muscle to fat ratio. Obesity is now a global general medical problem, with an estimated 315 million people classified as obese by the World Health Organization. In obese persons, a nutritional supplement including glucomannan, chitosan, fenugreek, Sylvester, and L-ascorbic acid effectively reduced body weight and promoted fat loss. Further research is likely to reveal a long-term viability and negative effect potential. The prevalence of obesity is exceedingly high all over the world, and as a result, nutrition and exercise play a crucial role in its prevention and treatment (Rajasekaran, *et al.*, 2020). Nutraceutical drugs are currently being studied for a wide range of purposes, including as predicted treatments for stoutness and weight management. Nutraceuticals with Antibes characteristics include formed linoleic corrosive (CLA), capsaicin, Momordica Charentais (MC), and Psyllium fibre.

Nutraceuticals and Allergy: Sensitivity is a condition in which the body reacts incorrectly to a drug or a meal. Quercetin belongs to a group of polyphenolic compounds known as flavonoids. Quercetin is a flavonoid that belongs to the flavanol family of flavonoids. It is widely distributed in the plant kingdom in the form of skins and barks. Onions, red wine, and green tea are particularly significant sources of Quercetin (Williamson, *et al.*, 2020). Quercetin is a common allergy treatment that works against the receptor's activity in the body. Hypersensitive and provocative responses are caused by receptors. It can help to relieve the discomfort caused by roughage fever, bursitis, gout, joint pain, and asthma. Quercetin inhibits a few potentially harmful proteins, such as lipid peroxidases, and reduces leukotriene formation. Quercetin possesses antiviral, immunomodulatory, anticancer, and gastro-defensive properties. Quercetin restrains an atom that causes the amassing of sorbitol, which has been connected to nerve, eye, and kidney harm in diabetics (pandey, *et al.*, 2019). Quercetin has solid cell-supporting capacities also. It safeguards LDL cholesterol from being harmed. Quercetin safeguards veins against harm brought about by certain types of cholesterol and different artificial materials created by the body. LDL cholesterol is a significant reason for coronary supply route disease. Quercetin additionally goes about as a cell defender by searching for hurtful particles in the body known as free revolutionaries. Individuals with diabetes are more likely to have their veins damaged by free radicals (Wildman, *et al.*, 2021). Nutraceuticals contain a diverse range of beneficial properties that are likely to protect the human body against a variety of neurotic conditions. Despite several pleiotropic actions of nutraceuticals on continuing problems such as diabetes mellitus, malignant growth, corpulence, osteoarthritis, and neurodegenerative difficulties, the most essential therapeutic applications of nutraceuticals are still in the line of thirst. As a result, more focused research on clear exploratory models, human preliminaries, and an understanding of the instrument of activity is critical.



**Nihar Ranjan Kar**

CONCLUSION

The nutraceutical industry is growing at a faster rate than the food and pharmaceutical industries. The most promising business sector is Successful nutraceutical companies are likely to be ones whose helpful products are just one part of a larger line of products that cater to both traditional and wellness needs. Buyer perceptions of the link between nutrition and sickness will determine nutraceutical interest in the future. Despite the fact that nutraceuticals have a critical role to play in the advancement of human wellbeing and illness avoidance, wellbeing experts, nutritionists, and authoritative toxicologists ought to cooperate to foster fitting rules that will give mankind with a definitive health and healing advantage. Long-term clinical trials are expected to confirm the efficacy of nutraceuticals in various diseases. Another area that should be considered is the interaction of nutraceuticals with meals and drugs. The influence of various handling procedures on nutraceuticals' natural accessibility and adequacy is currently a work in progress. Nutraceuticals, like pharmaceuticals, should be subject to stringent administrative oversight.

REFERENCES

1. Akhavan, S., Assadpour, E., Katouzian, I. and Jafari, S.M., 2018. Lipid nano scale cargos for the protection and delivery of food bioactive ingredients and nutraceuticals. *Trends in Food Science & Technology*, 74, pp.132-146. <https://www.sciencedirect.com/science/article/pii/S0924224417305502>
2. Assadpour, E. and Mahdi Jafari, S., 2019. A systematic review on nanoencapsulation of food bioactive ingredients and nutraceuticals by various nanocarriers. *Critical reviews in food science and nutrition*, 59(19), pp.3129-3151. <https://www.tandfonline.com/doi/abs/10.1080/10408398.2018.1484687>
3. Calado, R., Leal, M.C., Gaspar, H., Santos, S., Marques, A., Nunes, M.L. and Vieira, H., 2018. How to succeed in marketing marine natural products for nutraceutical, pharmaceutical and cosmeceutical markets. In *Grand challenges in marine biotechnology* (pp. 317-403). Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-319-69075-9_9
4. Daliu, P., Santini, A. and Novellino, E., 2019. From pharmaceuticals to nutraceuticals: Bridging disease prevention and management. *Expert Review of Clinical Pharmacology*, 12(1), pp.1-7. <https://www.tandfonline.com/doi/abs/10.1080/17512433.2019.1552135>
5. Durazzo, A., Lucarini, M. and Santini, A., 2020. Nutraceuticals in human health. *Foods*, 9(3), p.370. <https://www.mdpi.com/671412>
6. Hardy, G., Hardy, I. and Ball, P.A., 2018. Nutraceuticals-a pharmaceutical viewpoint: part II. *Current Opinion in Clinical Nutrition & Metabolic Care*, 6(6), pp.661-671. https://journals.lww.com/co-clinicalnutrition/Fulltext/2003/11000/Nutraceuticals_a_pharmaceutical_viewpoint_I.00010.aspx
7. Hardy, G., Hardy, I. and McElroy, B., 2020. Nutraceuticals: a pharmaceutical viewpoint: I. *Current Opinion in Clinical Nutrition & Metabolic Care*, 5(6), pp.671-677. https://journals.lww.com/co-clinicalnutrition/Fulltext/2002/11000/Nucleotides_as_immunomodulators_in_clinical.10.aspx
8. Jha, D., Jain, V., Sharma, B., Kant, A. and Garlapati, V.K., 2017. Microalgae-based pharmaceuticals and nutraceuticals: an emerging field with immense market potential. *ChemBioEng Reviews*, 4(4), pp.257-272. <https://onlinelibrary.wiley.com/doi/abs/10.1002/cben.201600023>
9. Liu, H., Singh, R.P., Zhang, Z., Han, X., Liu, Y. and Hu, L., 2021. Microfluidic assembly: an innovative tool for the encapsulation, protection, and controlled release of nutraceuticals. *Journal of Agricultural and Food Chemistry*, 69(10), pp.2936-2949. <https://pubs.acs.org/doi/abs/10.1021/acs.jafc.0c05395>
10. Puglia, C. and Lauro, M.R., 2019. Botanicals: innovative tools for pharmaceutical, cosmetic and nutraceutical. *Current Medicinal Chemistry*, 26(24), pp.4504-4505. <https://www.ingentaconnect.com/content/ben/cmc/2019/00000026/00000024/art00006>
11. Šimat, V., 2021. Nutraceuticals and Pharmaceuticals from Marine Fish and Invertebrates. *Marine Drugs*, 19(7), p.401. <https://www.mdpi.com/1660-3397/19/7/401/htm>



**Nihar Ranjan Kar**

12. Williamson, E.M., Liu, X. and Izzo, A.A., 2020. Trends in use, pharmacology, and clinical applications of emerging herbal nutraceuticals. *British Journal of Pharmacology*, 177(6), pp.1227-1240. <https://bpspubs.onlinelibrary.wiley.com/doi/abs/10.1111/bph.14943>
13. Rajasekaran, A., Sivagnanam, G. and Xavier, R., 2020. Nutraceuticals as therapeutic agents: A Review. *Research Journal of Pharmacy and Technology*, 1(4), pp.328-340. https://www.researchgate.net/profile/Rathinam-Xavier/publication/268427982_Nutraceuticals_as_therapeutic_agents_A_Review/links/561c813408ae6d17308b1a16/Nutraceuticals-as-therapeutic-agents-A-Review.pdf
14. Pandey, M., Verma, R.K. and Saraf, S.A., 2019. Nutraceuticals: new era of medicine and health. *Asian J Pharm Clin Res*, 3(1), pp.11-15. https://www.researchgate.net/profile/Rohit_Verma8/publication/259170781_Nutraceuticals_new_era_of_medicine_and_health/links/00b4952a1a21d7b7fe000000/Nutraceuticals-new-era-of-medicine-and-health.pdf
15. Wildman, R.E., Wildman, R. and Wallace, T.C., 2021. *Handbook of nutraceuticals and functional foods*. CRC press. <https://www.taylorfrancis.com/books/mono/10.1201/9781420006186/handbook-nutraceuticals-functional-foods-robert-wildman-robert-wildman-taylor-wallace>

Article Links

- https://www.researchgate.net/publication/240719276_Nutraceuticals_New_Era_of_Medicine_and_Health
- https://www.researchgate.net/publication/338536050_Nutraceuticals_in_food_and_pharmacy_A_Review
- https://www.researchgate.net/publication/260419957_Nutraceuticals_A_Review_on_current_statusNUTRACEUTICALS_-_A_REGULATORY_REVIEW.pdf
- https://www.researchgate.net/publication/311876288_NUTRACEUTICALS_AN_OPPORTUNITY_OF_HEALTH_CARE_A_REVIEW





Role of Sulphur Nutrition in Enhancing the Productivity of Pulses and Oilseeds

K. Karthika Vishnu Priya and Abha Manohar K*

Department of Agronomy, Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Abha Manohar K*

Department of Agronomy,
Centurion University of Technology and Management,
Odisha, India.

Email: abha.manohar@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

After nitrogen, phosphorous, and potassium, sulphur is the fourth most important nutrients for plant. Sulphur has numerous functions in plant development, ranging from being a structural constituent of macro biomolecules to influencing several physiological processes and abiotic stress tolerance. Despite the fact that sulphur nutrition has been long been recognized element but in the aspect of agriculture it paid little attention towards it. Recently serious problem with sulphur has been noticed, as the intensification of food, fibre and energy production to feed the ever-growing human population, livestock production is increasing. sulphur can help to meet the growing need for high quality pulses and oilseed crops. sulphur is a key element to improve the quality of oil extracted from oilseed crops. sulphur is responsible for the formation of proteins, vitamins and chlorophyll. Sulphur is a necessary ingredient for all living cells, as it is contained 21 amino acids that helps in formation of protein. Pulses are especially susceptible to sulphur deficiency, which results in lower quality and yields. Sulphur is exclusively taken up by plants in the form of sulphate (SO_4^{2-}), and it decomposes into sulphur. A mixture of amino acids and other substances. The usage of sulphur enhances the use of nitrogen. Sulphur deficit has a significant impact on the efficiency of N, P, and K. The application of 30 and 40 kg S/ha-1, together with the prescribed dose, was found to be effective in pulses.

Keywords: Sulphur, Oilseeds, Pulses, Transformation of Sulphur, Food security.

INTRODUCTION

One of richest sources of proteins is pulses. The major pulses grown in India are chickpea, red gram, green gram, black gram, red kidney bean, lentils, peas (Asif *et al.*, 2022). These crops are mainly grown for human consumption as dal to meet the requirements of body which is of low-cost protein and its end product is used as fodder for animals (Ghosh *et al.*, 1996; Nadathure *et al.*, 2017). Growing pulses can improve the nutrient status in the soil by fixing

43172



**Karthika Vishnu Priya and Abha Manohar**

atmospheric nitrogen to the soil as pulses are leguminous crops and maintain soil fertility and improves soil health (Abobatta *et al.*, 2022; Sahu *et al.*, 2020). Pulses are considered as poor man's meat as it provides energy and imbalances proteins, vitamins and minerals as deficiency of protein is major in India (Sahu *et al.*, 2021). The edible portion of green gram contains calcium-75mg, phosphorous-4.5grams, protein-24.5g and 348k cal energy. In present year 2021, about 45grams of pulses was available per capita daily it shows there is an increase compared to 2020 (Statista Research Department, 2022). Area of cultivating pulse crops was estimated around 29million hectares production of pulses in India was estimated that 25million metric tons in 2021 (Statistics Research Department, 2022).

The crops which are grown for oil derivatives and oil seeds and industrially used are called oilseed crops. Oilseed crops include groundnut, sesame, rapeseed, mustard, niger and safflower are cultivated since long which are used for human consumption. Soybean and sunflower are the recent introduction in India whereas other oilseeds which cannot be consumed are linseed and castor. Rapeseed and mustard oilseed crops contain lowest amount of saturated fats and contain the essential fatty acids good for health and also provide animal feed through oil-free meal rich in protein (Wanasundara *et al.*, 2016). The sunflower meal or cake a distinctive residual part derived from extracted sunflower processed seeds accounting for 36% mass composition protein varying from 45 to 50% (Adeleke and Babalola, 2020). To manufacture soaps, paints, hair oils, textiles, cosmetics oils and fats are used as important raw materials. Oilcake and meals can also use as fertilizers by providing nutrients to the soil and to improve nutrient status of soil by adding organic matter to the soil and improve the humus contain in soil (Singh *et al.*, 2020). Out of the 17 SDGs suggested by UNDP, rice-based cropping system with resource conservation technologies has potential to fulfill SDG 2, 3 and 15 (FAO, 2021).

Sachs knop is the scientist who describes essentiality of sulphur in 1857 (Moller, 2020). Sulphur is considered as most abundant secondary macro element on earth as it shows effect on growth and productivity on oilseeds and pulses (Zenda, 2021). The amount of sulphur to be present in the plant vary between 0.1% to 5% (Sutaret *et al.*, 2017). If the amount of sulphur is less than that range it leads to deficiency and if it exceeds it causes toxicity in plants. Sufficient amount of sulphur is required for plant growth and development (Samadder *et al.*, 1997; Jamal *et al.*, 2010). In past sulphur application is through fertilizers and which is fixed by the atmosphere is more sufficient to meet the industrial requirements in developed countries of western Europe and north America (Feinberg *et al.*, 2021). As the population increasing day by day it is difficult to meet their food requirements thereby to increase the food production varieties which are high yielding, crop with short duration, fertilizer responsive etc and resistance to pest and disease incidence are introduced (Reddy, 2009).

As there is growth in population the harvest levels was also increased which resulting in high demand for nutrients sulphur application. sulphur deficiency is major nutrient problem in agricultural production which results in decrease in crop productivity (Haneklaus *et al.*, 2008), it shows impact on quality of crop and crop become susceptible to pest and disease (Bloem., 2005). Sulphur contain essential aminoacids like, cysteine, methionine, several coenzymes (Biotin, coenzyme A, Thiamine Pyrophosphate an lipolic acid), thirodoxins and sulpho lipids. Cystein is required protein and glutathione (GSH) synthesis and redox reactions or act as a sulphur donor for methionine and secondary metabolite biosynthesis (Hesse, 2004). Glutathione helps to control the concentration of reactive oxygen species (ROS) and participates in the regulation of sulphate uptake and in the detoxification of heavy metals (Arianmehret *et al.*, 2022). Sulphur also helps in the formation of chlorophyll and chloroplast, promote root growth and helps in the formation of enzymes & vitamins.

The production of sulphur bond require sulphur which helps in maintaining stable structure of protein (Mukwevhoet *et al.*, 2014). Sulphur is required for the formation of glucosinolates in oilseed crops (Patel *et al.*, 2019). Pulses not only have high sulphur requirements, but they also have the ability to extract sulphur from the soil nutrient pool in comparison to fertiliser application, as evidenced by radio sulphur experiments (Meena *et al.*, 2013). Oilseeds have the highest sulphur demand (12 kg/tons of yield), followed by pulses (8 kg/tons of yield) (Aulakh, 2003). The addition of sulphur to groundnut improve the absorption of numerous macro and micro nutrients (Zenda *et al.*, 2021). India contributes very little to world seed production. There are various factors behind



**Karthika Vishnu Priya and Abha Manohar**

the low productivity oilseeds. sulphur deficiency is one of the most important causes for imbalanced fertilization in oilseeds especially sunflower. Due to strong nutritional potential of crops, its ability to protect against abiotic stresses and its translocation in the soil-plant system, sulphur is receiving most interesting nutrient in soil science, crop production and plant nutrition (Zenda *et al.*, 2021). If the sulphur is lacking in the soil crops cannot attain their full potential in terms of yield, oil content and protein content and plants cannot make efficient use of applied N, because it is required for enzyme and protein production. Sulphur deficiency can also cause primary metabolic impairment. Less amount of sulphur in plant affects the physiological and metabolic activities and carbohydrate (sugar and starch) metabolism in plant. starch was accumulated in the leaf portion and sugar content was decreased in sulphur deficiency crop. The amount of Sulphur present in plant tissues varies between 0.3 and 7.6 percent in oilseeds (Walker and Booth, 2003). sulphur containing amino acids cysteine (Cys) and methionine (Met), these are essential for the formation of structure of proteins and the action of enzymes (Millward, 2019). Sulphur is a constituent of chlorophyll, oligopeptides, vitamins, and co factors. It also plays role in nitrogen metabolism. Hence plants use N and sulphur in combined form to biosynthesize proteins (Aarabiet *et al.*, 2016).

Chemistry of sulphur**Sulphur in soil and rocks**

Sulphur is obtained in the form of sulphide in metamorphic and igneous rocks, organic matter, oceans industrial wastes, in gaseous form in atmosphere in gaseous form. Sulphur is present both in organic and inorganic forms and the amount of sulphur depends upon pH of soil, texture and soil characteristics (Dhamaket *et al.*, 2014). The inorganic forms which are available to plant are sulphides (S^{2-}), elemental sulphur (S_0), and sulphate (SO_4^{2-}) (Udayana, 2021) which promote growth and development of plant (Benavides-Mendoza, 2019). The amount of sulphur in the soil is reduced due to stricter emission regulations, decreased use of S containing fungicide, use of high analysis low S synthetic fertilizers, low S returns from farm animal derived manure, cultivation of sulphur demanding varieties and intensification of agriculture have all contributed to wide spread sulphur scarcity around the world in recent years. Scientific studies showed that sulphur can be improved by applying sulphur containing fertilizers like ammonium sulphate, potassium sulphate and magnesium sulphate etc to obtain optimal yield (Jamal *et al.*, 2010). Application of elemental sulphur to the soil reduces pH of the soil and used for the reclamation of sodic soils. Oilseed crops and pulses require more amount of sulphur owing that boosts oil synthesis and produce large quantity of protein in pulse crop (Jukantiet *et al.*, 2012).

The sulphur transformation takes place by the following steps mineralization, immobilization, oxidation, reduction (Gupt and Germida, 2021). Organic forms are available through different sources like plant residues, animal manures and decomposition of microbes and generally it is present upto 1.5-5% (Scherer, 2001). When organic matter adds to the soil it enhances the activity of microbes and boosts microbiological process which contain microbial sulphur (Murphy *et al.*, 2007) Meanwhile, S^{2-} can present in acid sulphate soils, and considerable SO_4^{2-} can be found in arid soils or soils with large gypsum inputs (Kheiret *et al.*, 2018). Plants, on the other hand, cannot absorb or use organic S or S^{2-} unless it is converted to SO_4^{2-} . Mineralisation is the conversion of organic sulphur to inorganic sulphur such as hydrogen sulphide (H_2S), elemental sulphur (Ma *et al.*, 2022). By this process sulphur present in organic sulphur is converted to sulphate (SO_4^{2-}) and become available to the plant (Mazid *et al.*, 2011). The enzymes which promotes this process are aryl sulfatase, sulpho hydrolase (AR), rhodanese (thiosulphate reductase) and transferases. It takes place when carbon:sulphur ratio is less than 200:1. Heterotrophic microorganisms help in conversion of organic sulphur to inorganic sulphur known as mineralisation.

The transformation of inorganic form to organic form called immobilization. It is reverse process of mineralization. This process takes place when C:S ratio is greater than 200:1. The factors such as soil, temperature, pH influences the mineralization and immobilization process (Ng., 2005.). Hence the sulphur present in the soil alters throughout the year. Large amount of sulphur present where there is more amount of available moisture is present and become available to the plant by microbial oxidation. Sulphide minerals, such as pyrite (FeS_2), can accumulate in large quantities in wetlands. The Sulphur can also be found as S_2 in wet soils, which is converted to plant-available SO_4^{2-}



**Karthika Vishnu Priya and Abha Manohar**

when the soil dries out. When the soil drains out as the elemental sulphur, H₂S, sulphite and thiosulphate changes to sulphate by the process of oxidation which results in decrease in pH of soil. This process takes place by chemautotrophs and photosynthetic bacteria such as *Thiobacillusthiooxidans*. The sulphate can be improved by the application of sulphur containing fertilizers. This form can be utilized by microbes and also other residues present below the surface soil than the residues present on the surface soil (Eriksen, 2009). sulphate can be reduced to hydrogen sulphide. This process known as reduction of sulphur. The autotrophic bacteria which are *Thiobacillusdenitrificans* and *Thiobacillusthioparus* which control oxidation-reduction process (Li, 2016).

Sulphur in the Plant System**Absorption and translocation of sulphur in plants**

Plants have different sulphate carriers which transfer sulphur from rhizosphere to different plant parts based on the availability of sulphur to the plant. Plants absorb sulphur from the atmosphere and used by the aerial parts but it does not meet the requirement of the plant hence it uptake SO₄²⁻ anions from soil through artificial sulphur containing fertilizers (Li *et al.*, 2020). When sulphur fertilizers added to the soil it is absorbed by the plants through roots and it is stored in xylem and it is transferred through phloem in between tissues through trans membrane by SO₄²⁻ carriers (Takahashi, 2019). The intake and absorption of SO₄²⁻ into organic compounds are regulated by numerous transporter genes (Chang, 2007). In autotrophic plants SULTRI 3 a high affinity transporter which is present in phloem and responsible for transport of sulphur over long distance through source (from roots) to sink (leaves and reproductive parts) (Mazid *et al.*, 2011).

Assessment of sulphur in soil and plant sample

Assessment of sulphur Soil analysis: Sulphur in the soil can be estimated by different methods but in India widely sulphur can be estimated with 0.15% CaCl₂ solution (Kour and Jalali, 2008). This method is mainly done for poor or deficient sulphur containing soil i.e the soils which contain less than 10ppm the method chosen should be valid and relevant to the crop (Jackson, 2011).

Assessment of sulphur in Plant analysis: To determine amount of sulphur present in the soil standard analytical methods. Sulphur in plant can be estimated by 2 methods such as a) Wet digestion and b) Dry digestion. To extract sulphur in dry digestion plant digest can be extracted by dry ashing and wet digestion can be done with HNO₃ and HClO₄ (Mahanta *et al.*, 2017).

Deficiency of sulphur in soils

The Sulphur nutrient is lacking in pulses and oilseed crops growing regions in India. Oilseed crops are primarily grown in coarse-textured soils with low sulphur content it means sulphur deficient soils. According to ICAR's micronutrient research, 40.7 percent of soils were found to be sulphur deficient (Shukla and Behra, 2019). Organic matter is the principal source of sulphur (Yu *et al.*, 2022) claim that soils with less than 10ppm sulphur are inadequate. The mean critical values of soil accessible sulphur for distinct oilseeds are 10.1 ppm (groundnut), 10.4 ppm (mustard), 18.8 ppm (sunflower), and 11.7 ppm (soybean).

Symptoms observed in case of sulphur deficiency

Yellowing of younger leaves even it is mobile element it cannot transport as nitrogen (Karthika *et al.*, 2018). Plants become stunted and shoots become slender, sulphur deficiency can be mostly observed in shoots than in root (Karthika *et al.*, 2018). In groundnut in case of sulphur deficiency formation of trifoliolate leaves can be observed as V shape due to leaves are erect from the petiole (Singh *et al.*, 1999). If the sulphur free amino acids (asparagine, glutamine) present in excess it leads to hamper of protein synthesis in pulses (Zanotti *et al.*, 2022). The lower surface of the leaves become red and cup shaped appearance is seen in rapeseed (Abit and Arnall, 2016). In case of sulphur deficiency in pulses results in poor nodule formation and shows decrease in nitrogen fixation (Zhao *et al.*, 1999). It reduces oil content in oil seed crops (Raza *et al.*, 2018). Pale colour appearance of leaves and inflorescence can be seen in sunflower as sulphur is responsible for chlorophyll formation (Singh, 1999).



**Karthika Vishnu Priya and Abha Manohar**

Role of sulphur in pulses

Role of sulphur in enhancing yield

Sulphur is important element for the pulse crop (Vidyalakshmi *et al.*, 2009). The amount of sulphur present in pulses is 0.24 – 0.32%. It is responsible for protein synthesis, chlorophyll formation, growth and metabolism (Parashar and Tripathi, 2020). Soils containing less amount of sulphur in pulse crops growing region show stunted growth and causes decline in photosystem 1 and photosystem 2 which results in decrease in chlorophyll which leads to less photosynthetic rates (Giordano *et al.*, 2000) which finally cause decrease in the chlorophyll a/b binding protein and Rubisco (Jamal, 2006). In sulphur deprived plants Rubisco content and the number of monosaccharides were significantly decreased and there will be increase in amount of starch substance. While there are no changes in the metabolite levels were observed in the calvin cycle or TCA (Lunde *et al.*, 2009). Sulphur content show positive effect on yield and its effect is clearly seen, when sulphur substance is near to the ground in soil (Eriksen, 2009). Due to the less amount of sulphur in soil, biological nitrogen fixation, nodulation and yield of peanut crops are decreased (Jamal *et al.*, 2010) form of sulphur there is increase in whole plant dry mass, nodule biomass, and root length, expressed on root length basis due to the application of sulphate form of S because to inadequate nodule development, as well as low nitrogenase and leghaemoglobin synthesis, nitrogen fixation was severely effected in sulphur scarce plants that the application of sulphur cause nodule formation.

Role of sulphur in oilseeds

Sulphur in enhancing growth and yield of oilseeds

Sulphur nutrition is an important component of oilseed crop quality (Walker and Booth, 2003). The amount of sulphur present in oilseeds crop is (1.1-1.7) less application of sulphur in oilseed crops, cause formation of poor quality seed (Haneklaus *et al.*, 2016). Sulphur is necessary to enhance the quantity of glucosides, glucosinolate, and protein in rapeseed and mustard (Chandele *et al.*, 2003). According to the results of the experiment sulphur application at a level of 60kg/ha had a substantial impact on the content of glucosinolate and oil percent increased by 44.6 %. At the stage of grain filling, oilseed crops were more responsive to specific nutrient and irrigation management to mitigate derivatives of oil components. Application of sulphur to ensure the flavour imparting components in oil is vital for oil quality (Nepali and Bhandari, 2019). The concentration of allyl isothiocyanate in mustard seeds increased when sulphur fertilizer levels increased from 0 to 60 kg S/ha (Chandele *et al.*, 2003).

Future aspects of sulphur in enhancing productivity of pulses and oilseeds

According to previous studies it is observed that sulphur play an significant role in protein synthesis, increasing growth and yield and improving oil content in both pulses and oilseed crops.

- In future it is necessary to understand the sulphur relationship between atmosphere-soil-plant system is necessary (Kopriva *et al.*, 2019).
- To establish the relationship between rhizobia and arbuscular mycorrhiza fungi more researches are needed in terms of sulphur mineralisation and N fixation.
- To know the symbiotic connections between plants and the microbes. The significance of S metabolites in facilitating mutualistic plant interactions and rhizospheric bacteria are still to be researched (Ohkama-Ohtsu and Wasaki, 2010).
- It is necessary to understand the influence of S with other nutrients for the exact application of sulphur for plant uptake and metabolism.
- Sulphur should be supplied in correct amount and in right time more application of sulphur leads to the toxicity or fixation with other nutrients and shows S residual effect on soil and plants it should be avoided (Hodges, 2010).
- The nutritional value of grasses should be improved with sulphur as non ruminant animals feed on the plants for their prey to supply energy and nutrients whereas plants and microbes can use inorganic S to manufacture S containing amino acids, various enzymes and vitamins (Potash Development Association, 2017)





Karthika Vishnu Priya and Abha Manohar

CONCLUSION

In Indian soils Sulphur deficiency is most commonly observed due to the lack of sulphur fertilizers, which resulting in lower oilseed output. When there is sulphur deficiency the applied NPK cannot be utilized efficiently by the crop. To reach agricultural production targets efficiently the sulphur nutrient should not be neglected and should be balanced by applying sulphur to crop in the form of gypsum, pyrites, phosphogypsum, elemental sulphur can be used as primary source of nutrition. It's critical to have a strong output and good quality of oilseeds if sufficient amount of sulphur is not supplied. Sulphur is important for plant growth and development. Amount of sulphur supplied to the pulses and oilseeds is from sulphur containing amino acids such as cysteine, methionine, glutathione and other sulpholipids which contain more percent of sulphur produces more yields.

REFERENCES

1. Ma, Q., Xu, M., Liu, M., Cao, X., Hill, P.W., Chadwick, D.R., Wu, L. and Jones, D.L. (2022). Organic and inorganic sulfur and nitrogen uptake by co-existing grassland plant species competing with soil microorganisms. *Soil Biology and Biochemistry*, 168,108627
2. Aarabi, F., Kusajima, M., Tohge, T., Konishi, T., Gigolashvili, T., Takamune, M., Sasazaki, Y., Watanabe, M., Nakashita, H., Fernie, A.R. and Saito, K. (2016). Sulfur deficiency-induced repressor proteins optimize glucosinolate biosynthesis in plants. *Science Advances*, 2(10), p.e1601087.
3. Abobatta, W.F., Hegab, R.H. and El-Hashash, E.F., (2022). Challenges and Opportunities for the Global Cultivation and Adaptation of Legumes B. Opportunities for Increasing Legumes Production and Availability. *Ann Agric Crop Sci*, 7(1),1107.
4. Adeleke, B.S. and Babalola, O.O., 2020. Oilseed crop sunflower (*Helianthus annuus*) as a source of food: Nutritional and health benefits. *Food Science & Nutrition*, 8(9),4666-4684.
5. Arianmehr, M., Karimi, N. and Souri, Z., 2022. Exogenous supplementation of Sulfur (S) and Reduced Glutathione (GSH) Alleviates Arsenic Toxicity in Shoots of *Isatis cappadocica* Desv and *Erysimum allionii* L. *Environmental Science and Pollution Research*, pp.1-10.
6. Asif, M., Rooney, L.W., Ali, R. and Riaz, M.N., 2013. Application and opportunities of pulses in food system: a review. *Critical reviews in food science and nutrition*, 53(11), 1168-1179.
7. Barłóg, P. and Łukowiak, R. (2021) Potassium and Elemental Sulfur as Factors Determining Nitrogen Management Indices of Soil and Faba Bean (*Vicia faba* L.). *Agronomy*, 11(6),1137.
8. Bloem, E., Haneklaus, S. and Schnug, E. (2005). Significance of sulfur compounds in the protection of plants against pests and diseases. *Journal of Plant nutrition*, 28(5),763-784.
9. Chandel, R.S., Sudhakar, P.C. and Singh, K., (2003). Response of sulphur nutrition in mustard—A review. *Agricultural Reviews*, 24(3),175-182.
10. Chang, P.T. (2007). Regulation of Sulfate Uptake, Expression of Sulfate Transporter Genes in Rapid-cycling Base Populations of the Brassica (*Brassica Oleracea*) as Affected by Temperature, SeO_4^{2-} and SO_4^{2-} Nutrition (Doctoral dissertation, University of Georgia).
11. Deshbhratar, P.B., Singh, P.K., Jambhulkar, A.P. and Ramteke, D.S., (2010). Effect of sulphur and phosphorus on yield, quality and nutrient status of pigeonpea (*Cajanus cajan*). *Journal of Environmental Biology*, 31(6),933.
12. Dhamak, A.L., Meshram, N.A. and Waikar, S.L. (2014) Comparative studies on dynamics soil properties and forms of sulphur in oilseed growing soils of Ambajogai Tahsil of Beed district. *Journal of Agriculture and Veterinary Scienc*, 7(12),98-102.
13. El Sabagh, A., Hossain, A., Barutcular, C., Gormus, O., Ahmad, Z., Hussain, S., Islam, M.S., Alharby, H., Bamagoos, A., Kumar, N. and Akdeniz, H., (2019). Effects of drought stress on the quality of major oilseed crops: Implications and possible mitigation strategies—A review. *Appl. Ecol. Environ. Res.*, 17(2),4019-4043.
14. Eriksen, J. (2009). Soil sulfur cycling in temperate agricultural systems. *Advances in Agronomy*, 102,55-89.
15. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 30th April, 2022).





Karthika Vishnu Priya and Abha Manohar

16. Feinberg, A., Stenke, A., Peter, T., Hinckley, E.L.S., Driscoll, C.T. and Winkel, L.H.(2021). Reductions in the deposition of sulfur and selenium to agricultural soils pose risk of future nutrient deficiencies. *Communications Earth & Environment*, 2(1),1-8.
17. Fuentes-Lara, L.O., Medrano-Macias, J., Pérez-Labrada, F., Rivas-Martínez, E.N., García-Enciso, E.L., González-Morales, S., Juárez-Maldonado, A., Rincón-Sánchez, F. and Benavides-Mendoza, A. (2019). From elemental sulfur to hydrogen sulfide in agricultural soils and plants. *Molecules*, 24(12),2282.
18. Ghosh, T.K., Maitra, S., Saren, B.K. Roy, D. K., and Singh S. S. (1996). Effect of different levels and methods of sulfur application on growth and yield of blackgram. *Environment and Ecology*, 14(2), 765-768
19. Giordano, M., Pezzoni, V. and Hell, R. (2000). Strategies for the allocation of resources under sulphur limitation in the green alga *Dunaliellasalina*. *Plant Physiol.*, 124,857-864.
20. Gupta, V.V.S.R. and Germida, J.J. (2021). Microbial transformations of sulfur in soil. In *Principles and Applications of Soil Microbiology* Elsevier, pp. 489-522.
21. Haneklaus, S., Bloem, E. and Schnug, E., (2008). History of sulfur deficiency in crops. *Sulfur: A Missing Link Between Soils, Crops, and Nutrition*, 50,45-58.
22. Haneklaus, S., Bloem, E., Schnug, E., de Kok, L.J. and Stulen, I. (2016). Sulfur. *Plant Nutrition*, 7,183.
23. Hesse, H., Nikiforova, V., Gakière, B. and Hoefgen, R. (2004). Molecular analysis and control of cysteine biosynthesis: integration of nitrogen and sulphur metabolism. *Journal of Experimental Botany*, 55(401),1283-1292.
24. Hodges, S.C., 2010. Soil fertility basics. *Soil Science Extension, North Carolina State University*.
25. Jackson, D., 2011. Soils, nutrients and water. *Temperate and Subtropical Fruit Production*, p.101.
26. Jamal, A., Moon, Y.S. and ZainulAbdin, M., 2010. Enzyme activity assessment of peanut (*Arachis hypogea* L.) under slow-release sulphur fertilization. *Australian Journal of Crop Science*, 4(3),169-174.
27. Jamal, A., Moon, Y.S. and ZainulAbdin, M., 2010. Sulphur-a general overview and interaction with nitrogen. *Australian Journal of Crop Science*, 4(7), pp.523-529.
28. Jukanti, A.K., Gaur, P.M., Gowda, C.L.L. and Chibbar, R.N., 2012. Nutritional quality and health benefits of chickpea (*Cicerarietinum* L.): a review. *British Journal of Nutrition*, 108(S1),S11-S26.
29. Karthika, K.S., Rashmi, I. and Parvathi, M.S., (2018). Biological functions, uptake and transport of essential nutrients in relation to plant growth. In *Plant nutrients and abiotic stress tolerance* Springer, Singapore, pp. 1-49.
30. Kheir, A., Shabana, M. and Seleiman, M., 2018. Effect of gypsum, sulfuric acid, nano-zeolite application on saline-sodic soil properties and wheat productivity under different tillage types. *Journal of Soil Sciences and Agricultural Engineering*, 9(12), 829-838.
31. Kopriva, S., Malagoli, M. and Takahashi, H. (2019) Sulfur nutrition: Impacts on plant development, metabolism, and stress responses. *J. Exp. Bot.* 70, 4069–4073.
32. Kour, S. and Jalali, V.K., 2008. Forms of sulphur and their relationships in soils of different agro-climatic zones of Jammu region. *Journal of the Indian Society of Soil Science*, 56(3),309-312.
33. Li, Q., Gao, Y. and Yang, A. (2020). Sulfur homeostasis in plants. *International Journal of Molecular Sciences*, 21(23),8926.
34. Li, R., Feng, C., Hu, W., Xi, B., Chen, N., Zhao, B., Liu, Y., Hao, C. and Pu, J. (2016). Woodchip-sulfur based heterotrophic and autotrophic denitrification (WSHAD) process for nitrate contaminated water remediation. *Water Research*, 89,171-179.
35. Mahanta, P.L., Singh, A.K., Radhamani, R. and Rao, D.P. (2017). Determination of Total Sulfur and Sulfate Sulfur D in Geological Materials of Rocks, Soils, and Sediments by ICP-OES After Sample Digestion Using Alkali Flux. *Atomic Spectroscopy*, 38, 99.
36. Mazid, M., Saima, Q., Khan, T.A. and Mohammad, F. (2011). Significance of sulphur nutrition against metal induced oxidative stress in plants. *Journal of Stress Physiology & Biochemistry*, 7(3),165-184.
37. Meena, K.K., Meena, R.S. and Kumawat, S.M. (2013). Effect of sulphur and iron fertilization on yield attributes, yield and nutrient uptake of mungbean (*Vignaradiata*). *Indian Journal of Agricultural Science*, 83(4),472-476.
38. Millward, D.J., Lanham-New, S.A., Hill, T.R., Gallagher, A.M. and Vorster, H.H. (2019). Nutrition and metabolism of proteins and amino acids. *Introduction to human nutrition. 3rd ed. Oxford: Wiley-Blackwell*, pp.131-60.
39. Moller, D. (2020). History, Change and Sustainability. In *History, Change and Sustainability*. De Gruyter.





Karthika Vishnu Priya and Abha Manohar

40. Mukwevho, E., Ferreira, Z. and Ayeleso, A. (2014). Potential role of sulfur-containing antioxidant systems in highly oxidative environments. *Molecules*, 19(12),19376-19389.
41. Murphy, D.V., Stockdale, E.A., Brookes, P.C. and Goulding, K.W. (2007). Impact of microorganisms on chemical transformations in soil. In *Soil biological fertility* Springer, Dordrecht, pp. 37-59.
42. Nadathur, S.R., Wanasundara, J.P.D. and Scanlin, L. (2017). Proteins in the diet: Challenges in feeding the global population. In *Sustainable protein sources* Academic Press, pp. 1-19.
43. Nepali, B. and Bhandari, D. (2019). Enhancing the Yield and Quality of Oilseed Crops in Nepal Through Application of Sulphur Fertilizers. *Big Data In Agriculture (BDA)*, 1(2), 10-11.
44. Ohkama-Ohtsu, N. and Wasaki, J. (2010). Recent Progress in Plant Nutrition, Research: Cross-Talk Between Nutrients, Plant Physiology and Soil Microorganisms. *Plant Cell Physiol.* 51,1255–1264.
45. Parashar, A. and Tripathi, L., 2020. Effect of phosphorus and sulphur on the growth and yield of black gram (*Vignamungo* L.). *Journal of Pharmacognosy and Phytochemistry*, 9(5), 2585-2588.
46. Parmar, N.N., Patel, A.P. and Choudhary, M., 2018. Effect of sources and levels of sulphur on growth, yield and quality of summer sesame under south Gujarat condition (*Sesamum indicum* L.). *International Journal of Current Microbiology and Applied Sciences*, 7(2),2600-05.
47. Patel, A.K., Nath, T., Prajapati, A., Singh, V.K. and Pandey, S.K., 2018. Effect of doses and sources of sulphur on growth and yield of black gram (*Vignamungo* L. Hepper) under rainfed condition of Vindhyan Soil. *J PharmacogPhytochem*, 1,91-94.
48. Patel, P.K., Kadivala, V.A.H. and Patel, V.N., 2019. Role of Sulphur in Oilseed Crops: A Review. *J. Plant Dev. Sci*, 11,109-114.
49. Potash Development Association. Sulphur as a Nutrient for Crops and Grass. (2017). Available online: <https://www.pda.org.uk/sulphur-nutrient-crops-grass/> (accessed on 25 August 2020).
50. Rao, K.T., Rao, A.U. and Sekhar, D. (2013). Effect of sources and levels of sulphur on groundnut. *Journal of Academia and Industrial Research*, 2(5), pp.268-270.
51. Reddy, A.A. (2009). Pulses production technology: Status and way forward. *Economic and Political Weekly*, pp.73-80.
52. Sahu, S., Shankar, T. Maitra, S., Mohapatro, S. and Swamy, GVVS.N. (2020). A Review on Effect of Phosphorus and Sulphur on Growth, Productivity and Nutrient Uptake of Green Gram (*Vignaradiata* L.), *Agro Economist*, 7, 91-93.
53. Sahu, S., Shankar, T., Maitra, S., Adhikary, R., Mondal, T. and Sarath Kumar D. 2021. Impact of phosphorus and sulphur on the growth and productivity of green gram (*Vignaradiata*). *Research on Crops*, 22 (4), 785-791 DOI: 10.31830/2348-7542.2021.131.
54. Saleem, M., Elahi, E., Gandahi, A.W., Bhatti, S.M., Ibrahim, H. and Ali, M., (2019). Effect of Sulphur Application on Growth, Oil Content and Yield of Sunflower. *Sarhad Journal of Agriculture*, 35(4),1-14.
55. Sammader, G., Sounda, G., Maitra, S., Roy, D. K. and Panda, P.K. (1997). Effect of irrigation and sulfur levels on productivity, oil yield and water use of Indian mustard. *Environment and Ecology*, 15 (3), 553-555.
56. Scherer, H.W., 2001. Sulphur in crop production. *European Journal of Agronomy*, 14(2), pp.81-111.
57. Shukla, A.K. and Behra, S.K. (2019). All India coordinated research project on micro-and secondary nutrients and pollutant elements in soils and plants: Research achievements and future thrusts. *Indian J Fert*, 15(5),522-543.
58. Singh, A.L. (1999). Sulphur Nutrition of Oilseed Crops. *Advances in Plant Physiology* (Ed. A. Hemantranjan), 2,201-226.
59. Singh, S.P., Kumar, Y. and Singh, S. (2017). Effect of sources and levels of sulphur on yield, quality and uptake of nutrients in green gram (*Vignaradiata*). *Annals of Plant and Soil Research*, 19(2), pp.143-147.
60. Singh, T.B., Ali, A., Prasad, M., Yadav, A., Shrivastav, P., Goyal, D. and Dantu, P.K. (2020). Role of organic fertilizers in improving soil fertility. In *Contaminants in agriculture* Springer, Cham, pp. 61-77.
61. Sutar, R.K., Pujar, A.M., Kumar, B.A. and Hebsur, N.S. (2017). Sulphur nutrition in maize-a critical review. *Int J Pure App Biosci*, 5(6),1582-1596.
62. Takahashi, H. (2019). Sulfate transport systems in plants: functional diversity and molecular mechanisms underlying regulatory coordination. *Journal of Experimental Botany*, 70(16), 4075-4087.





Karthika Vishnu Priya and Abha Manohar

63. Udayana, S.K., Singh, P., Jaison, M. and Roy, A. (2021). Sulphur: A boon in agriculture. Walker, K.C. and Booth, E.J., 2003. Sulphur nutrition and oilseed quality. In *Sulphur in plants* Springer, Dordrecht, pp. 323-339.
64. Wanasundara, J.P., McIntosh, T.C., Perera, S.P., Withana-Gamage, T.S. and Mitra, P., (2016). Canola/rapeseed protein-functionality and nutrition. *OCI*, 23(4),407.
65. Yu, J., Sun, M.X. and Yang, G.P. (2022). Occurrence and emissions of volatile sulfur compounds in the Changjiang estuary and the adjacent East China Sea. *Marine Chemistry*, 238, 104062.
66. Zenda, T., Liu, S., Dong, A. and Duan, H. (2021). Revisiting sulphur—The once neglected nutrient: It's roles in plant growth, metabolism, stress tolerance and crop production. *Agriculture*, 11(7), 626.

Table 1. Some case studies on pulses crop

| BLACK GRAM | | | | | | | | | | |
|------------|-------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|--------------------------|------------------------------|------------------------------|-------------------------|--------------------------------|
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | Plant Height (cm) (Harvest Stage) | No. of Trifoliolate Leaf per Plant | No. Of Branches Per Plant | No. Of Pod Per Plant | Pod Length Per Plant(cm) | Grains Count (No. Per Plant) | Grain Yield (Q Per Ha) | Straw Yield (Q Per Ha) | Reference |
| Clay Loam | Control | 35.61 | 31.34 | 15.70 | 12.3 | 5.2 | 7.6 | 8.1 | 21.4 | Patel <i>et al.</i> ,2018 |
| | 60 | 33.89 | 33.12 | 16.93 | 20.4 | 10.6 | 11.4 | 12.3 | 26.3 | |
| PIGEON PEA | | | | | | | | | | |
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | No Of Pods Per Plant | No. of Grains Per Pod | Grain Yield Per Plant (Kg Per Ha) | Straw Yield Per Plant (kg Per Ha) | Grain Yield (Q per Ha) | Straw Yield (Q per Ha) | Test Weight Of 100 Seeds (g) | Crude Protein % | Reference |
| Clayey | Control | 100.62 | 3.28 | 22.80 | 74.68 | 10.08 | 33.19 | 9.666 | 20.993 | Deshbhrataret <i>al.</i> ,2010 |
| | 40 | 105.80 | 3.29 | 24.75 | 77.64 | 11.05 | 34.50 | 9.908 | 21.040 | |
| GREEN GRAM | | | | | | | | | | |
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | Plant Height (cm) | Branches per Plant | Nodules Per Plant 30 DAS | Test Weight (g) | Grain Yield Q Per ha | Straw Yield Q Per ha | Protein Grain % | Protein Yield Kg per Ha | Reference |
| Alluvial | Control | 52 | 22 | 15 | 37.5 | 8.37 | 22.60 | 18.10 | 151.5 | Singh <i>et al.</i> , 2017 |
| | 40 | 56.4 | 29 | 20.8 | 40.1 | 10.60 | 28.09 | 20.31 | 215.3 | |

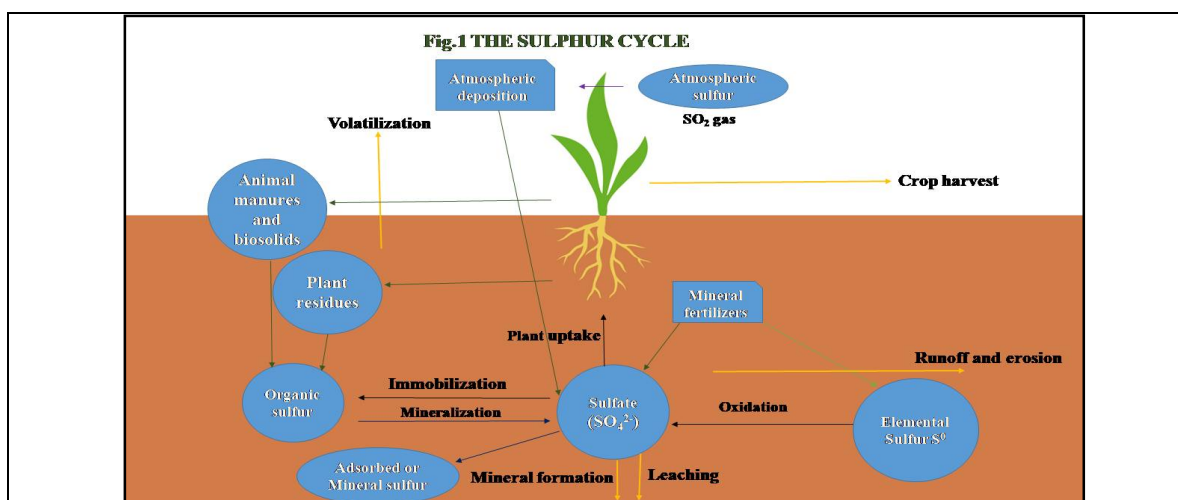




Karthika Vishnu Priya and Abha Manohar

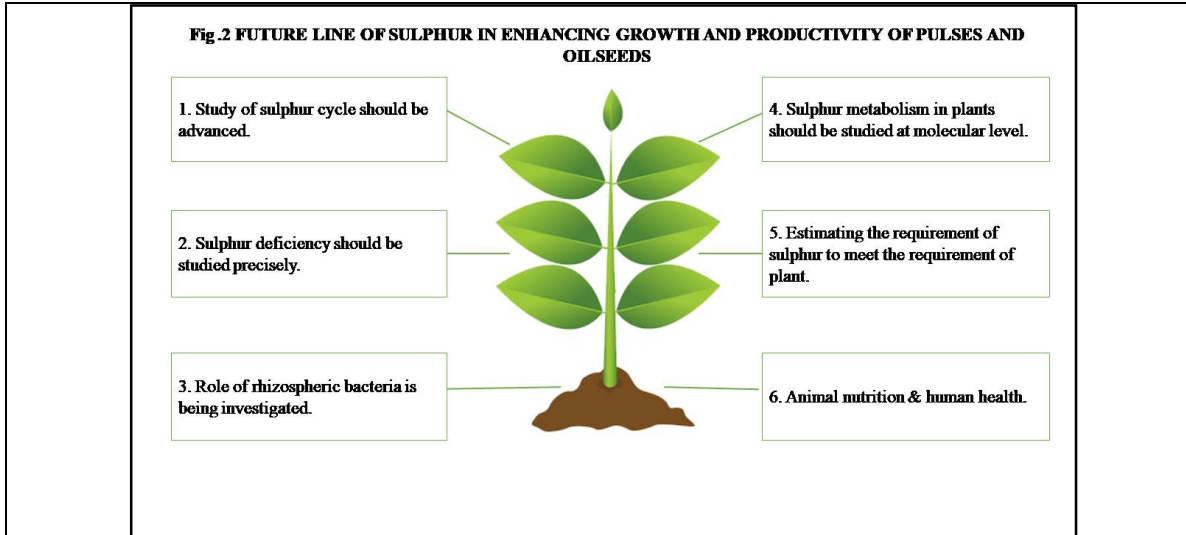
Table 2. Some case studies on oilseed crop

| SUNFLOWER | | | | | | | | | | |
|-----------------|-------------------------|-------------------------------|------------------------------|---------------------------|---------------------------|-----------------------|-----------------|-----------------------|-------------------|----------------------------|
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | Plant Height (cm) | Stem Girth (cm) | Flower Head Diameter (cm) | No.OfA chen per Head | 1000 Seed Weight(gm) | Oil Content (%) | Achene Yield (Kg/Ha) | S% In Plant Straw | Reference |
| Clay Loam | Control | 156.37 | 3.90 | 14.30 | 679 | 47 | 39.30 | 570 | 0.172 | Saleem <i>et al.</i> ,2019 |
| | 20 | 161.80 | 4.80 | 15.40 | 787 | 50.29 | 42.20 | 650.33 | 0.225 | |
| SESAME | | | | | | | | | | |
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | Plant Height (cm) At Harvest | No. of Capsul per plant | Capsule Length (cm) | No. Of Seeds per Capsul e | Seed Yield Kg/Ha | Oil Content (%) | Stalk Yield (Kg/Ha) | Oil Yield Kg/Ha | Referenc e |
| Clayey | Control | 85.76 | 35.41 | 4.48 | 49.75 | 689.19 | 43.46 | 1616.84 | 299.52 | Pamaret <i>al.</i> ,(2018) |
| | 30 | 96.26 | 38.19 | 6.77 | 52.13 | 824.73 | 48.19 | 1837.49 | 397.43 | |
| GROUNDNUT | | | | | | | | | | |
| SOIL TYPE | Sulphur Rates (Kg S/Ha) | Plant Height (cm) At Harve st | No. of Filled Pods per plant | Pod Yield (Kg/ha) | Haulm Yield (Kg/ha) | 100 Pod Weight (g) | Oil Content (%) | 100 Kernel Weight (g) | Shellin g % | Referenc e |
| Sandy Clay Loam | Contro l | 60.74 | 12.94 | 801 | 1509 | 71.15 | 45.89 | 33.91 | 62.70 | Rao <i>et al.</i> ,2013 |
| | 45 | 69.35 | 17.83 | 1026 | 1758 | 77.19 | 49.57 | 39.54 | 68.42 | |





Karthika Vishnu Priya and Abha Manohar





Surface Roughness in Low Carbon Steel Turning Process

Manas Ranjan Puthal and Dillip Kumar Mohanta*

Department of Mechanical Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 09 Mar 2022

Revised: 12 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Dillip Kumar Mohanta

Department of Mechanical Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: dillip.mohanta@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The surface roughness of AISI 1030 steel work pieces was reduced utilizing uncoated ISO P40 and multilayer TiN-TiCN-Al₂O₃-ZrCN cemented carbide cutting tools. The effect of cutting velocity, feed rate, and depth of cut on surface roughness is examined. In this case, Taguchi's design of the experiment is applied. The feed rate is found to be more important than speed in reducing surface roughness. Cut depth has little impact on surface roughness. As a result of the Taguchi approach, cutting speeds of 120 m/min, feed rates of 0.08 mm/rev, and cut depths of 0.12mm should be maintained for both coated and uncoated tools. Due to the complexity of experiments, it is important to offer a valid yet simple model to estimate the reaction. This paper proposes a fuzzy inference system based on designer and shop floor manager expertise. This method can efficiently handle the uncertainties and fuzziness associated with experimentation. The average absolute error for uncoated and coated inserts is 0.59.

Keywords: Surface roughness; Carbide insert; Taguchi method; Fuzzy inference system

INTRODUCTION

Researchers and manufacturing engineers are increasingly interested in predicting surface roughness and determining the best values for process parameters in manufacturing. Modern machining requires a focus on achieving high quality in terms of work piece dimensional precision, surface quality, high production rate, reduced cutting tool wear, and machining economy. Surface roughness is an unavoidable customer requirement in product development. Roughness is the dominant magnitude related to the machine ability of the processed material, the tool form, the machining conditions, and the tolerance requirements. Therefore, attempt should be made to minimize surface roughness because higher unevenness leads to functional discrepancies. R_a value, the arithmetic average roughness (center line average), determined from deviations about the center line within the evaluation length is the most popular parameter for a machining process and product quality control. This parameter is easy to define, easy



**Manas Ranjan Puthal and Dillip Kumar Mohanta**

to measure even in the least suitable profile-meters and gives a general description of surface amplitude. Though it lacks physical significance, it is established in almost every national standard for measuring roughness [1]. Taguchi's design of experiment methodology is a convenient tool to optimize the cutting parameters with less experimental runs [2]. Taguchi primarily recommends experimental design as a tool to make products more robust – to make them less sensitive to noise factors. The experimental design procedure is suitable tool for reducing the effect of variation on product and process quality characteristics [3]. Analysis of Variance (ANOVA) can be employed to identify the most significant variables and interaction effects [4]

In turning, many researchers have modeled surface roughness. Davim [5] has presented a study of the influence of cutting parameters on the surface roughness obtained in turning of free machining steel using Taguchi design and shown that the cutting velocity has a greater influence on the roughness followed by the feed rate. Lin et al. [6] have shown that feed rate is the critical parameter in turning to affect the surface roughness as increase of feed rate increases the surface roughness. Suresh *et al.* [7] have shown that surface roughness decreases with an increase in cutting speed in turning of mild steel. Arbizu and Perez [8] have developed models to determine surface quality of parts obtained through turning processes and shown that surface roughness increases with increase in depth of cut and feed rate. Sahin and Motorcu [9] have developed a surface roughness model for turning of mild steel with coated carbide tools and shown that feed rate is the main influencing factor on surface roughness. Surface roughness increases with increase in feed rate but decreases with increase in cutting speed and depth of cut. The literature survey shows that mainly three cutting parameters viz. cutting speed, feed rate and depth of cut are the common parameters considered for most of the studies.

The present research has two purposes. The first is to demonstrate the use of Taguchi's parameter design in order to identify the optimum parametric combination to minimize surface roughness. The second is to propose a predictive methodology for estimating surface roughness using data obtained during experimentation conducted as per Taguchi design.

Experimental Details**Work Piece Material**

The work piece material used was AISI 1020 steel in the form of cylindrical bar of diameter 80mm and length 250mm. The composition of AISI 1020 is listed in weight percentage as C 0.23%, Mn 0.60%, P 0.04%, S 0.5% and Fe remaining.

Cutting Tool Material

The cutting tool is P30 cemented carbide inserts (Make: Widia) having Insert designation as SCMT 12 04 08 and tool geometry -60, -60, 60, 60, 150, 750, 0.8 mm. P 30 grade of cemented carbide has excellent hardness, wear resistance and toughness [10]. The composition of P30 carbide inserts WC 74.25%, TiC 8.25%, Ta +NbC 8.80%, and Co 8.70%

Machine Tool

The turning operations were carried out in a rigid HMT NH26 lathe machine. The tool holder used for machining is SSBCR 220K12 (Kennametal, India).

Surface Roughness Measurement

Surface roughness was measured using a portable stylus-type profilometer, Talysurf (Taylor Hobson, Surtronic 3+, UK)

Experimentation

Three cutting parameters with their levels are shown in Table 1. A L_9 orthogonal array was chosen for conducting experiments [11, 12]. The complete experimental plan along with response (surface roughness) for coated and uncoated tools is shown in Table 2. The responses are converted into signal-to-noise ratio (S/N ratio) for lower-the-





Manas Ranjan Puthal and Dillip Kumar Mohanta

better quality characteristic. Analysis of responses is carried out by MINITAB 19 software. S/N ratio for ‘lower the better’ type response is given by

$$S/N \text{ ratio} = -10 \log \left[\frac{1}{n} (y_1^2 + y_2^2 + \dots + y_n^2) \right] \quad (2)$$

where y_1, y_2, \dots, y_n are the responses of values of quality characteristic for the trial condition repeated ‘n’ times.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) conducted on responses obtained using coated and uncoated tools are shown in Table 3 and 4 respectively. It is to be noted that feed rate has significant effect on the surface roughness than other parameters in both cases. However, percentage contribution of feed rate in case of uncoated tool is marginally higher. The regression equation for coated inserts is as follows.

$$Ra = 1.55 - 0.00761 * Vc + 0.018 * d + 13.1 * f \quad (3)$$

Similarly, the regression equation for uncoated inserts is given as follows.

$$Ra = 1.74 - 0.00964 * Vc + 0.009 * d + 19.2 * f \quad (4)$$

The R²-value (coefficient of determination) is obtained as 98.1% and 98.4% for coated and uncoated inserts respectively.

The residual plots are shown in Figure 2 and 3 for coated and uncoated inserts respectively. It is evident from these figures that the residuals follow approximately in a normal distribution. It indicates that ANOVA has proceeded in a correct manner. The main effect plots are shown in Figures 4 and 5 respectively for coated and uncoated inserts. The best parameter setting for minimizing surface roughness is found as cutting velocity of 120 m/min, feed rate of 0.08 mm/rev and depth of cut of 0.12 mm for both types of inserts. A confirmatory experiment has been conducted by selecting a parametric combination other than optimal settings. The difference between experimental surface roughness and predicted values through ANOVA is found to be 10%. Therefore, it is concluded that Taguchi experimental analysis has been conducted in a correct way.

In order to predict surface roughness in turning operation, fuzzy logic technique is adopted so that uncertainty and fuzziness involved during experimentation can be taken into account. Further, fuzzy logic is capable of establishing mapping relation between inputs and outputs if non-linear relation among them exists. Fuzzy logic hardly demands any rigorous mathematical computation; rather, judgment of the experts can be used to obtain predictions in an efficient and accurate manner. Application of fuzzy logic requires the following three steps:

1. Fuzzification – convert classical data or crisp data into fuzzy data or Membership Functions (MFs)
2. Fuzzy Inference Process – combine membership functions with the control rules to derive the fuzzy output
3. Defuzzification – use different methods to calculate each associated output and put them into a table: the lookup table. Pick up the output from the lookup table based on the current input during an application.

Initially, the fuzzifier uses membership functions to fuzzyfy the signal-to-noise ratios. Then, the inference engine performs fuzzy reasoning on fuzzy rules to generate a fuzzy value. Lastly, the defuzzifier converts the fuzzy value into predictive output.

The fuzzy rule base consists of a group of *if-then* control rules with the three inputs, and one output, that is:

Rule 1: if x_1 is A_1, x_2 is B_1 and x_3 is C_1 then y is Z_1 else

Rule 2: if x_1 is A_2, x_2 is B_2 and x_3 is C_2 then y is Z_2 else

: : :

Rule 13: if x_1 is A_n, x_2 is B_n and x_3 is C_n then y is Z_n .

where A_i, B_i, C_i and Z_i are fuzzy subsets of corresponding membership functions [13]. In this paper, three membership functions denoted as low, medium, and high using triangular function are used for inputs (Figures 7, 8 and 9). Five membership functions denoted as very low, low, medium, high, and very high are assigned to output using triangular function (Figure 10). Total number of thirteen fuzzy rules is used as shown in Figure 11.

The membership function of the fuzzy logic unit of the output of fuzzy reasoning can be expressed as:





Manas Ranjan Puthal and Dillip Kumar Mohanta

$\mu_{C_0}(y) = (\mu_{A_1}(X_1) \wedge \mu_{B_1}(X_2) \wedge \dots \wedge \mu_{C_1}(y) \vee \dots$ where \wedge is the minimum operation and \vee is the maximum operation. Finally, a defuzzification method, called the centre of gravity method [9], is adopted here to transform the fuzzy inference output $\mu_{C_0}(y)$ into a non-fuzzy (crisp) value y_0 , that is

$$y_0 = \frac{\sum y \mu_{C_0}(y)}{\sum \mu_{C_0}(y)}$$

The non-fuzzy value y_0 is called a multi-response performance characteristic index (MPCI).

The experimental and predicted values of surface roughness are shown in Table 5 for both coated and uncoated tools. It is found that mean absolute difference between actual and predicted values are 0.44 and 0.59 for coated and uncoated tools respectively.

CONCLUSION

Taguchi's approach, along with fuzzy logic, is an effortless and efficient way to determine the optimality condition and its predicted value. In this work, the optimal cutting parameters are:

- The velocity of 120 m/min.
- The feed rate of 0.08 mm/rev.

Depth of cut of 0.12 mm for minimizing surface roughness while turning mild steel with coated carbide and uncoated tool. With this particular combination of input parameters, the roughness value is 2.01, 2.56 for coated and uncoated, respectively, and the predictive value is 2.54 and 3.56, respectively. Analysis of variance indicates that feed rate is the most influencing parameter for minimizing surface roughness in both the tool conditions.

REFERENCES

1. Australian Standard, AS2536 Surface Texture, Standards Association of Australia, 1982.
2. R.HLocner, J.E.Matar, 1990, Designing for quality, Productivity Press.
3. T.P Ryan, 2000, Statistical Methods for Quality Improvement, 2nd Edn. John Wiley and Sons, USA., ISBN: 10: 0471197750, pp: 592.
4. G.R Henderson, 2006, "Six Sigma: Quality Improvement with MINITAB". John Wiley and Sons, England, ISBN: 10: 0470011556, pp: 452.
5. J.P Davim, 2001, "A note on the determination of optimal cutting conditions for surface finish obtained in turning using design of experiments". J Mater Process Technol, 116:305–308.
6. W.S Lin, B.Y Lee, C.L Wu, 2001, "Modeling the surface roughness and cutting force for turning". J Mater Process Technol, 108:286–293.
7. P.V.SSuresh, P.V Rao, S.G Deshmukh, 2002, "A genetic algorithm approach for optimization of surface roughness prediction model". Int J Mach Tools Manuf 42:675–680.
8. I.PArbizu, C.J.LPérez, 2003, "Surface roughness prediction by factorial design of experiments in turning processes". J Mater Process Technol 143–144:390–396.
9. Y. Sahin, A.RMotorcu, 2005, "Surface roughness model for machining mild steel with coated carbide tool". Mater Des 26:321–326.
10. E.M Trent, P.K Wright, 2000, Metal Cutting, Butterworth -Hinemann, Boston, 2000, p. 23.
11. P. J Ross, 1996, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, New York.
12. S. S Mahapatra, A. Patnaik, P.K Patnaik, 2006, "Parametric Analysis and Optimization of Cutting Parameters for Turning Operations based on Taguchi Method" Proceedings of the International Conference on Global Manufacturing and Innovation, pp. 1–8, July.
13. Y. S Tarn, W. H Yang, S. C Juang, 2000, "The Use of Fuzzy Logic in the Taguchi Method for the Optimization of the Submerged Arc Welding Process", International Journal of advanced manufacturing technology, 16:668-694.





Manas Ranjan Puthal and Dillip Kumar Mohanta

Table 1: The cutting parameters with their levels

| Input Parameters | Symbols | Levels | | |
|-----------------------|---------|--------|------|------|
| Cutting speed (m/min) | V_c | 70 | 90 | 120 |
| Feed Rate (mm/rev) | f | 0.08 | 0.12 | 0.14 |
| Depth of Cut (mm) | d | 0.1 | 0.4 | 0.8 |
| Machining Duration | s | 120 | | |

Table 2: Parameters and their levels

| Cutting Velocity V_c (m/min) | Depth of cut d (mm) | Feed Rate, f (mm/rev) | Surface Roughness R_a | | SN Ratio | |
|--------------------------------|-----------------------|-------------------------|-------------------------|----------|----------|----------|
| | | | Coated | Uncoated | Coated | Uncoated |
| 70 | 0.1 | 0.08 | 1.79 | 2.24 | -5.057 | -7.005 |
| 70 | 0.4 | 0.12 | 2.41 | 3.1 | -7.6403 | -9.8272 |
| 70 | 0.8 | 0.14 | 2.73 | 3.6 | -8.7232 | -11.1261 |
| 90 | 0.1 | 0.12 | 2.8 | 3.61 | -8.9431 | -11.1501 |
| 90 | 0.4 | 0.14 | 3.13 | 4.12 | -9.9108 | -12.2979 |
| 90 | 0.8 | 0.08 | 2.15 | 2.76 | -6.6487 | -8.8182 |
| 120 | 0.1 | 0.14 | 2.22 | 3 | -6.927 | -9.5424 |
| 120 | 0.4 | 0.08 | 1.76 | 2.2 | -4.9102 | -6.8485 |
| 120 | 0.8 | 0.12 | 2.01 | 2.56 | -6.0639 | -8.1648 |

Table 3: Analysis of variance for S/N ratios(coated inserts)

| Source | SS | MS | F | P | C % |
|----------------|---------|--------|-------|-------|--------|
| VC | 9.6483 | 4.8241 | 20.33 | 0.047 | 39.532 |
| d | 0.4071 | 0.2036 | 0.86 | 0.538 | 1.668 |
| f | 13.8758 | 6.9379 | 29.24 | 0.033 | 56.854 |
| Residual Error | 0.4746 | 0.2373 | | | 1.944 |
| Total | | | | | 100 |

Table 4: Analysis of variance for S/N ratios(Uncoated inserts)

| Source | SS | MS | F | P | C% |
|----------------|--------|--------|-------|-------|--------|
| VC | 9.9544 | 4.9772 | 21.63 | 0.044 | 34.623 |
| d | 0.2828 | 0.1414 | 0.61 | 0.619 | 0.983 |
| f | 18.053 | 9.0265 | 39.23 | 0.025 | 62.792 |
| Residual Error | 0.4602 | 0.2301 | | | 1.6 |
| Total | | | | | 100 |





Manas Ranjan Puthal and Dillip Kumar Mohanta

Table 5: Comparison of experimental and fuzzy results of Ra

| Vc | d | f | Coated inserts | | | Uncoated inserts | | |
|-------------------------------|-----|------|-----------------|--------------------------------|------------|------------------|--------------------------------|------------|
| | | | Experimental Ra | Predicted Ra using Fuzzy Model | Difference | Experimental Ra | Predicted Ra using Fuzzy Model | Difference |
| 70 | 0.1 | 0.08 | 1.79 | 2.06 | -0.27 | 2.24 | 2.36 | -0.12 |
| 70 | 0.4 | 0.12 | 2.41 | 2.33 | 0.08 | 3.1 | 2.81 | 0.29 |
| 70 | 0.8 | 0.14 | 2.73 | 2.54 | 0.19 | 3.6 | 3.16 | 0.44 |
| 90 | 0.1 | 0.12 | 2.8 | 2.09 | 0.71 | 3.61 | 2.41 | 1.2 |
| 90 | 0.4 | 0.14 | 3.13 | 2.42 | 0.71 | 4.12 | 2.95 | 1.17 |
| 90 | 0.8 | 0.08 | 2.15 | 2.54 | -0.39 | 2.76 | 3.16 | -0.4 |
| 120 | 0.1 | 0.14 | 2.22 | 2.54 | -0.32 | 3 | 3.16 | -0.16 |
| 120 | 0.4 | 0.08 | 1.76 | 2.54 | -0.78 | 2.2 | 3.16 | -0.96 |
| 120 | 0.8 | 0.12 | 2.01 | 2.54 | -0.53 | 2.56 | 3.16 | -0.6 |
| Average absolute error | | | 0.44 | | | 0.59 | | |

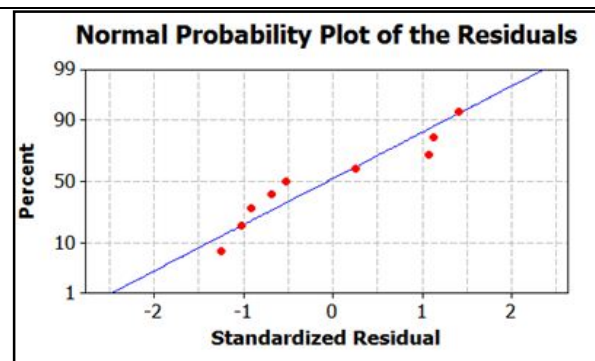


Figure 1 Normal probability plot (coated inserts)

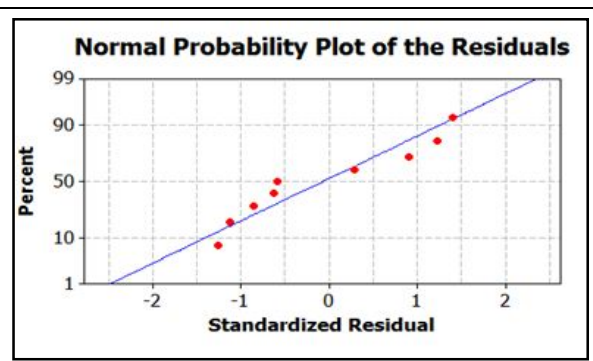


Figure 3: Normal probability plot (uncoated inserts)

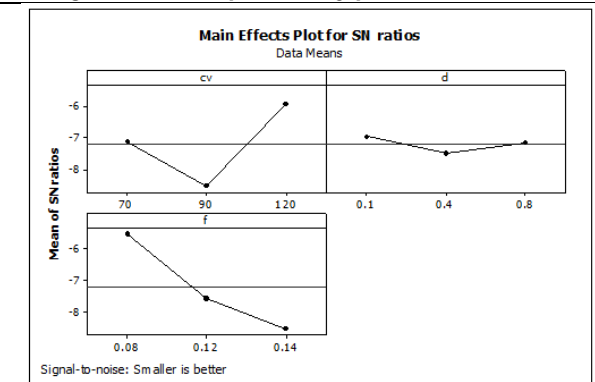


Figure 4: Main effect plot (coated inserts)

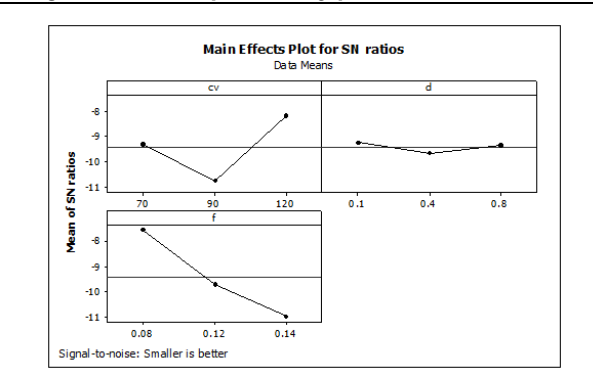


Figure 5: Main effect plot (uncoated inserts)





Manas Ranjan Puthal and Dillip Kumar Mohanta

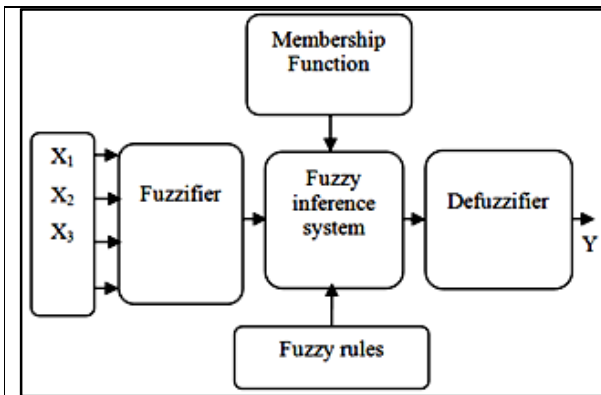


Figure 6: Structure of the fuzzy logic unit (x_1, x_2, x_3 :cutting velocity, depth of cut, feed; y : performance index)

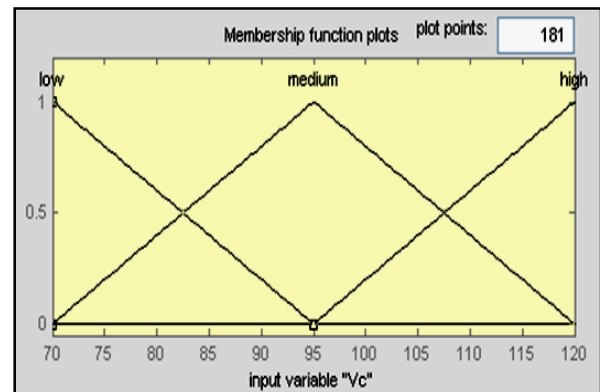


Figure 7: Membership function for V_c

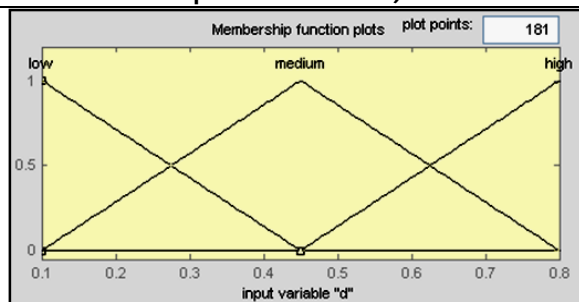


Figure 8: Membership function for d

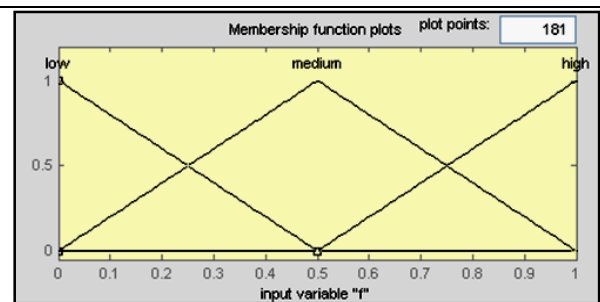


Figure 9: Membership function for f

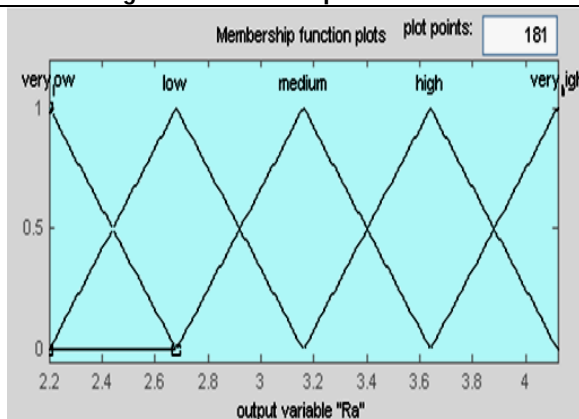


Figure 10: Membership function for R_a

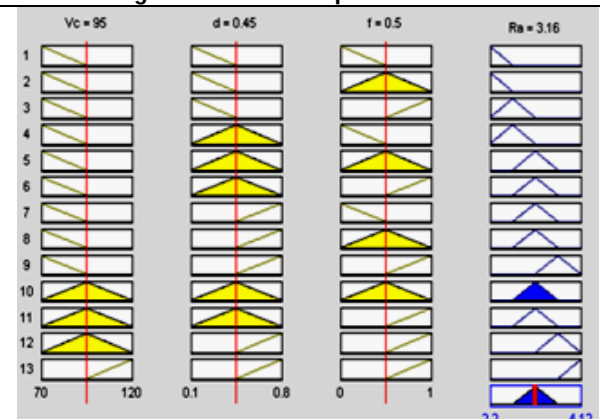


Figure 11: MATLAB output for FIS





Study on Growth and Yield Variability of Different Lentil Genotypes under Red and Lateritic Zone of West Bengal

Tufleuddin Biswas¹, Swarnali Duary^{1*}, Mousumi Ghose³ and Rajib Nath²

¹Assistant Professor, Centurion University of Technology and Management, Odisha, India.

²Bidhan Chandra Krishi Viswa-Vidyalaya, West Bengal-741252

³Joint Director of Agriculture (P), Bio- Control Laboratory, Dept. of Plant Protection, Agriculture, Govt. of West Bengal

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Swarnali Duary

Assistant Professor,

Centurion University of Technology and Management,
Odisha, India.

Email: swarnali.duary@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Lentil is the most important winter grain legume crop of India. Stability of a lentil genotype over environments is an important component for crop adoption. The field investigation was performed at Agricultural Farm under Institute of Agriculture, Visva-Bharati, West Bengal. The aim of the experiment was to evaluate the variability of growth and yield of twelve lentil genotypes and a local check variety. All the genotypes were evaluated using randomized complete block design (RCBD) and replicated thrice. It was found from the experiment that yield and other yield related parameters are significantly different. Most important traits in selection of lentil genotypes are plant height, secondary branches, number of pods per plant, number of seed per pod which exerted positive effect on yield. Maximum grain yield (2.064 t/ha) was recorded from BL-9 (947.67 kg/ha) followed by BL-1 (892.89 kg/ha), BL-10 (838.67 kg/ha).

Keywords: Lentil, Genotype, Growth, Yield

INTRODUCTION

India records the majority of the world's pulses zone, it should be strengthened in order to meet the demand through increased domestic output According to the FAO and WHO-for a non-vegetarian person 55 g of pulse per head should be consumed whereas for a vegetarian, the amount should be 80 g. Lentil (*Lens culinaris* L Medik.), popularly known as Masur (Kamaluddinet *al.*, 2020), is an annual, self-pollinated, pulse crop belonging to the Leguminosae (Fabaceae) family (Sellamiet *al.*, 2021; Zikeet *al.*, 2017; Tahir *et al.*, 2021). It is one of the oldest edible crops generally grown as rabi crop during rabi season (Rana *et al.*, 2020; Pant *et al.*, 2019;). The most common way to eat it is as a 'dal.' Some of the dishes also include whole grain. Lentil is the heavy source of calcium (56 mg/100



**Tufleuddin Biswas et al.,**

gmseeds), niacin (2.65 mg/100 gm seeds) and iron (7.54 mg/100 gm seeds) (Vanaveet *et al.*, 2019). Lentils are strong in protein, a key source of complex carbs, high in fibres, and rich in vitamins A and B, according to nutritionists (Sharma *et al.*, 2014; Mondalet *et al.*, 2013; Ghosh *et al.*, 2020). It has a lot of phosphate and carotene. On marginal lands, it is typically farmed as a rain-fed crop. In West Bengal generally relay cropping is practice where lentil seeds are dispersed in the standing rice crop 7-10 days before harvesting to take advantage of residual soil moisture, ensure timely seeding, and avoid tillage operations when growing lentils. In the lower Gangetic plains, particularly in mono-cropped areas such as the coastal belt, old alluvial, and terai zones of West Bengal, there is significant potential for cultivating lentil as a paira cropping system. For all of the traits studied, there was a broad range of variation in genotype mean performance. Various environmental factors affect plant growth at different stages of plant development (Mandalet *et al.*, 2018; Abbas *et al.*, 2019).

MATERIALS AND METHODS

The field experiment was designed at Agricultural Farm, Visva-Bharati, West Bengal. The study evaluated twelve genotypes (BL-1, BL-2, BL-3, BL-4, BL-5, BL-6, BL-7, BL-8, BL-9, BL-10, BL-11), local Check collected from International Centre for Agriculture research in Dry areas (ICARDA). The experiment was conducted during in 2017-18 season and laid out with randomized complete block design (RCBD) having three replication with the gross plot size 5 m x 4 m (20 m²). All crop production practices like hoeing, weeding, thinning and plant protection measures were adopted homogeneously for all plots to achieve full potential of the lentil genotypes. The experimental area was irrigated 15 days before planting and plowed accordingly at suitable shape of moisture state. The crop was sown during the middle of November through a single row hand drill machine. To prepare the seed bed for sowing the crop, two plowings were used, followed by planking. Throughout the crop's growing phase, all cultural practices (Viz., hoeing, plant protection measures, and correct irrigation) for lentil cultivation were ensured. By the end of March, the crop was harvested. Data from each plot regarding days to 50% flowering and days to maturity were recorded... Five plants from middle row in each plot were used to collect the plant height, root length (cm), no of primary and secondary branches plant⁻¹, no of pods plant⁻¹, no of seeds pod⁻¹. The data analysis was performed using analysis of variance (ANOVA) method of randomized block design set up using MS excel. Again, the least Significant Difference (LSD) test was also entertained to test the level of significance among different combination of treatment means (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Phenological observation: Flowering time is an important attribute for adaptation of crop in any area. Early flowering confirms the maturity of crops in a comparatively short durational period, thus avoiding losses due to high temperature during the grain filling and maturity period. The range of the day duration for 50% flowering (Fig 1) was minimum for BL-3 (47 DAS) and maximum for BL 10 (57 DAS). Analysis showed that BL-1 to BL-3 and BL-11) and local check were flowered early whereas BL-4, BL-5, BL-6, BL-7, BL-8, BL-9 took more than 50 days to flower. A similar findings were also stated by Daralet *et al.*, 2017; Adhikaryet *et al.*, 2018; Neupane, 2013; Dugassaet *et al.*, 2014; Yadavet *et al.*, 2016). Several ranges of variability was detected for date of maturity among all-lentil genotypes. From this experiment it is concluded that days to maturity (Fig 2) varies significantly. The early mature genotype was local check (97 days) followed by BL-9 (98 days), BL-4 (99 days) and BL-5 (102 days). Whereas the late mature variety was BL-3 (110 days). It could be the result of the inherent genetic alteration amid the genotypes of lentil and variability in phenological attributes. Variation in maturity of different genotype of lentil was found by Siddique *et al.* (2020).

Plant height: In this experiment the plant height (Table no. 1) remained significantly different due to various lentil genotypes and the values ranges from 21.83 to 34.37 cm. Maximum plant height was recorded by BL-8 and BL-4 recoded minimum plant height followed by BL-9. (Rahman *et al.*, 2015). A significant variabilities on plant height of several lentil genotypes were also informed by several investigators (Dugassaet *et al.*, 2014; Mekonnenet *et al.*, 2014; Yadavet *et al.*, 2016).



**Tufleuddin Biswas et al.,**

Root length (cm): From the experiment the root length is presented in table no 1. Due to genetic variation root length also varies significantly and the value ranges from 9.27 cm to 4.13 cm. Among lentil genotypes BL-5 recorded highest root length compare to the other genotypes. Variation in root length was also observed by different researchers like Gorim and Vandenberg, (2017); Sood et al. (2017).

No of primary & secondary branches plant⁻¹: An important yield contributing parameter of lentil is total number of branches plant⁻¹. There were significant differences among most of the lentil genotypes. BL-7 recorded maximum (13.17) no of primary & secondary branches plant⁻¹ followed by BL-5, BL-8, BL-6 and BL-3 where as Local check variety recorded lowest value (2.90). Zikeet et al. (2017) also confirmed the variability in the number of branches in lentil genotypes.

No of pods plant⁻¹: One of the important yields determining character of lentil is the number of pods per plant, which also important features to separate each genotype from other. Data analysis (Table 2) revealed that number of pods plant⁻¹ ranged from 12 to 43.33. BL-9 genotype recorded highest no of pods plant⁻¹ (43.33) followed by BL-8 (42.73) and BL-3 (41.53). Similar findings also reported by Çolkesenet et al. (2014).

No of grains pod⁻¹: No significant difference among twelve lentil genotypes and no of grains pod⁻¹ (Table no. 2) varies from 1.25 to 1.83. BL-9, BL-6, BL-7 recorded highest value (1.83) and BL-11 recorded lowest value (1.25).

Test weight (g): Test weight is one of the vital character for potential genotypes selection. Test weight of lentil varies significantly among different lentil genotypes. Test weight (Table no. 2) varies from 32.03 (BL-9) to 13.80 (BL-11). Similar results also concluded by Siddiqui et al. (2020).

Seed yield (kg ha⁻¹): Seed yield of lentil genotype varies between 430.33 kg/ha to 947.67 kg/ha. Out of 12 genotypes, BL-9 recorded highest seed yield followed by BL-1 and BL-10 may be due to a greater number of pods per plant, test weight. Significant difference among lentil genotypes for the yield and other yield components were confirmed by Dugassa et al., (2014) and Adhikari et al., (2018) and so on. On the other hand, lowest seed yield recorded by the genotypes BL-2, BL-6, Local check. The high seed yield was associated with early maturity, a long reproductive period. Similar results reported by Shrestha et al. (2005).

CONCLUSION

Plant breeders need genetic variety to improve the genetical components of any crop. It's crucial to understand the genetic variability of available genotypes and the links between economic yield and yield linked qualities, as well as their potential application in breeding programmers. The results of this investigation revealed that the genotypes tested had high genetic diversity. As a result, in lentil breeding, selection based on these yield-contributing traits could be beneficial. BL-3 is a good genotype for early flowering, local check for early maturity, and BL-4 for dwarf plants. For the number of primary and secondary branches per plant and the genotype BL-7 is preferred over the others. Whereas for genotype BL-9, the number of seeds per pod⁻¹, yields, test weight and number of pods per plant⁻¹, are the promising.

REFERENCES

1. Abbas, G., Asghar, M. J., Shahid, M., Hussain, J., Akram, M. and Ahmad, F. (2019). Yield performance of some lentil genotypes over different environments. *Agrosystems, Geosciences & Environment*, **2**(1):1-3.
2. Adhikary, B. N., Shrestha, J., Joshi, B. P. and Bhatta, N. R. (2018). Agronomic traits evaluation and correlation study in lentil (*Lens culinaris* Medikus) genotypes. *International Journal of Advanced Research in Biological Sciences*, **5**(12): 1-10.





Tufleuddin Biswas et al.,

3. Çolkese, M., Idikut, L., Zulkadir, G., Cokkizgin, A., Girgel, U. and Boylu, O. A. (2014). Determination of yield and yield components of various winter lentil genotypes (*Lens culinaris* Medic.) in kahramanmaras conditions. *Türk Tarım ve Doğa Bilimleri Dergisi*, 1(Özel Sayı-1), 1247-1253.
4. Darai, R., Sarker, A. Sah, R. P., Pokhrel, K. and Chaudhary, R. (2017). AMMI biplot analysis for genotype X environment interaction on yield trait of high Fe content lentil genotypes in terai and mid-hill environment of Nepal. *Ann. Agric. Crop Science*, 2(1): 1026-1030.
5. Dugassa, A., Legesse, H. and Geleta, N. (2014). Genetic variability, yield and yield associations of lentil (*Lens culinaris* Medik.) genotypes grown at GitiloNajo, western Ethiopia. *Science, Technology and Arts Research Journal*, 3(4): 10-18.
6. Ghosh, A., Reja, M. H., Nalia, A., Mukherjee, B., Maitra, S., Sarker, A. and Nath, R. (2020). Performance of Early Maturing Lentil Cultivars in New Alluvial Zone of West Bengal. *International Journal of Current Microbiology and Applied Science*, 9(07): 1776-1781.
7. Gorim, L. Y. and Vandenberg, A. (2017). Root traits, nodulation and root distribution in soil for five wild lentil species and *Lens culinaris* (Medik.) grown under well-watered conditions. *Frontiers in Plant Science*, 8:1632.
8. Jawad, M., Malik, S. R., Sarwar, M. A., Asadullah, M., Hussain, I. and Khalid, R. (2019). Genetic analysis of lentil (*Lens culinaris*) exotic germplasm to identify genotypes suitable for mechanical harvesting. *Pakistan Journal of Agricultural Research*, 32(1):152.
9. Kamaluddin, R. K., Sharma, V., Saini, H. K. and Shukla, G. (2020). Variability studies for yield and its component traits in Lentil (*Lens culinaris* Medikus spp. *Culinaris*) under Bundelkhand region. *Journal of Pharmacognosy and Phytochemistry*, 9(6):1436-1441.
10. Mekonnen, F., Mekbib, F., Kumar, S., Ahmed, S. and Sharma, T. R. (2014). Agromorphological traits variability of the Ethiopian lentil and exotic genotypes. *Advances in Agriculture*, vol. 2014. Retrieved from <http://dx.doi.org/10.1155/2014/870864>.
11. Mandal T.K., Puste A.M. and Maitra S. 2018. Influence of irrigation and mulching on yield attributes, yield and quality of lentil (*Lens esculentum* L.) grown as intercrop under limited water conditions, *International Journal of Bioresource Science*, 5 (1):61-64.
12. Mondal, M. M. A., Puteh, A. B., Malek, M. A., Roy, S. and Yusop, M. R. (2013). Contribution of morpho-physiological traits on yield of lentil ('*Lens culinaris*' medik). *Australian Journal of Crop Science*, 7(8):1167-1172.
13. Pant, K. R., Gurung, S. B., Dharmi, N. B., Shrestha, J., Aryal, L. and Darai, R. (2019). Agro-morphological traits variability of lentil genotypes. *Nepalese Journal of Agricultural Sciences*, 18:108-114.
14. Rahman, M. M., Islam, M. M., Hoque, M. E., Ahmed, B. and Rahman, M. M. (2015). Performance of advanced lentil genotypes in different pulse growing regions of Bangladesh. *Eco-Friendly Agric. J.* 8:116-120.
15. Rana, S. Sharma, R., Pramesh, Sinha, B. and Singh, G. (2020). Genetic Variability of Lentil (*Lens culinaris* M.) Genotypes in Acidic Soil of Manipur. *Int. J. Current Microbiology App. Science*, 9(10): 1550-1556.
16. Sellami, M. H., Pulvento, C. and Lavini, A. (2021). Selection of Suitable Genotypes of Lentil (*Lens culinaris* Medik.) under Rainfed Conditions in South Italy Using Multi-Trait Stability Index (MTSI). *Agronomy*, 11(9):1807.
17. Sharma, V., Deepak and Prasad, S. (2014). Mean performance of lentil genotypes for Seed yield and its component traits, *Advances in Life Sciences*, 3(1): 49-52.
18. Shrestha, R., Siddique, K. H. M., Turner, N. C., Turner, D. W. and Berger, J. D. (2005). Growth and seed yield of lentil (*Lens culinaris* Medikus) genotypes of West Asian and South Asian origin and crossbreds between the two under rainfed conditions in Nepal. *Australian Journal of Agricultural Research*, 56(9): 971-981.
19. Siddiqui, M. A., Khan, M. T., Nizamani, G. S., Yasmeen, S., Khan, I. A., Khatri, A. and Soomro, N. S. (2020). Field evaluation of high yielding genotypes of lentil (*Lens culinaris* Medik.) developed through induced mutagenesis. *Pakistan Journal of Agricultural Research*, 33(1):164-169.
20. Sood, A., Surinder K Sandhu, S. K. and Singh, S. (2017). Assessment of variability for root and shoot attributes in recombinant inbred lines of lentil (*Lens culinaris* L. medik.) 2017 Agric Res J 54 (2): 176-181.
21. Tahir, A., Akhtar, M., Rashid, G. and Kaukab, S. (2021). Screening of lentil (*Lens culinaris* medik.) Genotypes in relation to morphological and physiological parameters for drought tolerance under normal and water deficit conditions. *Plant cell biotechnology and molecular biology*, 127-134.





Tufleuddin Biswas et al.,

22. Vanave, P. B., Jadhav, A. H., Mane, A. V., Mahadik, S. G., Palshetkar, M. G. and Bhawe, S. G. (2019). Genetic variability studies in lentil (*Lens culinaris* Medic.) genotypes for seed yield and attributes. *Electronic Journal of Plant Breeding*, **10**(2): 685-691.
23. Yadav, N.K., Ghimire, S. K., Sah, B. P., Sarker, A. Shrestha, S. M. and Sah, S. K. (2016). Genotype x environment interaction and stability analysis in lentil (*Lens culinaris* Medik.) International Journal of Environment, Agriculture and Biotechnology, **1**(3): 354-61.
24. Zike, T., Abera, T. and Hamza, I. (2017). Response of improved lentil (*Lens culinaris* Medik) varieties to phosphorus nutrition on vertisols of West Showa, Central Highlands of Ethiopia. *J. Adv. Crop. Sci. Tech*, **5**(6):11-13.

Table 1: Variation in growth parameters of lentil due to genotype

| Treatments | Plant height (cm) | Root length (cm) | No of primary & secondary branches plant ⁻¹ |
|-------------|-------------------|------------------|--|
| BL-1 | 34.90 | 6.38 | 12.40 |
| BL-2 | 30.73 | 8.13 | 6.30 |
| BL-3 | 33.00 | 7.70 | 10.13 |
| BL-4 | 21.83 | 7.12 | 9.32 |
| BL-5 | 31.07 | 9.27 | 12.73 |
| BL-6 | 34.07 | 8.68 | 10.98 |
| BL-7 | 33.11 | 7.95 | 13.17 |
| BL-8 | 34.37 | 7.82 | 11.75 |
| BL-9 | 23.30 | 5.63 | 9.23 |
| BL-10 | 32.27 | 7.27 | 7.05 |
| BL-11 | 34.15 | 8.08 | 8.33 |
| Local Check | 27.13 | 4.13 | 2.90 |
| Sem (±) | 2.50 | 0.72 | 2.01 |
| CD at 5% | 7.32 | 2.12 | 5.88 |
| CV | 18.16 | 23.40 | 42.43 |

Table 2: Variation in yield components and seed yield of lentil genotypes

| Treatments | No. of pods plant ⁻¹ | No. of grains pod ⁻¹ | Test weight (g) | Seed yield (kg ha ⁻¹) |
|-------------|---------------------------------|---------------------------------|-----------------|-----------------------------------|
| BL-1 | 41.30 | 1.67 | 20.51 | 892.89 |
| BL-2 | 34.67 | 1.67 | 18.63 | 430.33 |
| BL-3 | 41.53 | 1.67 | 18.53 | 515.11 |
| BL-4 | 33.17 | 1.50 | 17.32 | 547.00 |
| BL-5 | 32.67 | 1.58 | 18.24 | 487.56 |
| BL-6 | 41.00 | 1.83 | 15.10 | 437.33 |
| BL-7 | 38.90 | 1.83 | 19.25 | 655.00 |
| BL-8 | 39.17 | 1.67 | 26.09 | 773.33 |
| BL-9 | 43.33 | 1.83 | 32.03 | 947.67 |
| BL-10 | 42.73 | 1.75 | 27.78 | 838.67 |
| BL-11 | 40.23 | 1.25 | 13.80 | 711.67 |
| Local Check | 12.00 | 1.50 | 19.13 | 442.33 |
| Sem(±) | 5.39 | 0.14 | 0.16 | 91.72 |
| CD at 5% | 15.80 | NS | 0.46 | 269.01 |
| CV | 31.33 | 15.98 | 25.42 | 35.85 |





Tufleuddin Biswas et al.,

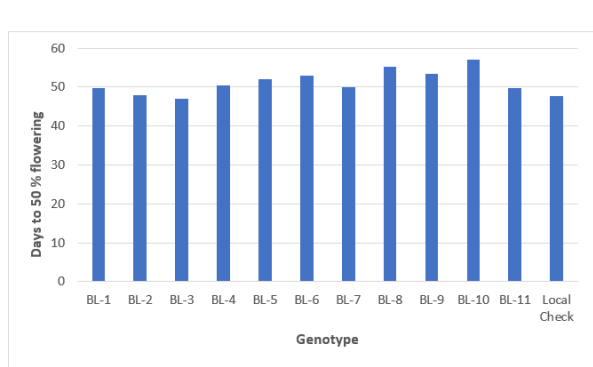


Fig 1: Days to flower 50% of different lentil genotype

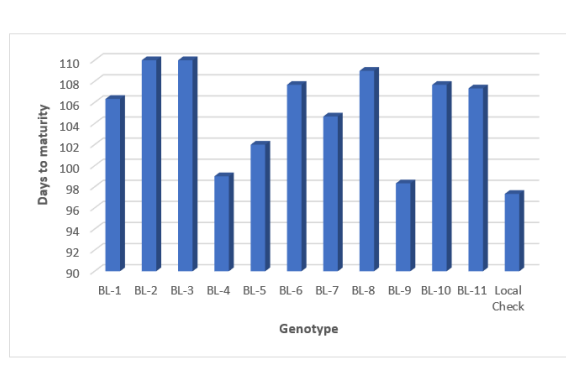


Fig 2: Days to maturity of different lentil genotype





Residual Effects of Integrated Nutrient Management on Summer Green Gram (*Vignaradiata* L.) Crop

Rajesh S Kalasare*, Sameer Mahapatro, Ashirbachan Mahapatra and Manish Kumar Yadav

MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati, Odisha, India.

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Rajesh S Kalasare

MS Swaminathan School of Agriculture,
Centurion University of Technology and Management,
Paralakhemundi, Gajapati, Odisha, India.
Email: rajesh.kalasare@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

An experiment was conducted during the summer to find out the residual effect of various integrated nutrient combination on summer green gram (*Vignaradiata* L.) crop. For this experiment, a total number of 12 treatments were selected namely; RDF 100%+ *Azospirillum* + Vermicompost @ 2 t ha⁻¹, RDF 50% + *Azospirillum* + Vermicompost @ 2 t ha⁻¹, RDF 100% + *Azospirillum* + Phosphate Solubilizing Bacteria + Vermicompost @ 2 t ha⁻¹, RDF 50% + *Azospirillum* + Phosphate Solubilizing Bacteria + Vermicompost @ 2 t ha⁻¹, RDF 100% + vermiwash 02 spray @ 50 lit ha⁻¹ at 45 and 75 DAS, RDF 50 % + vermiwash 02 spray @ 50 lit ha⁻¹ at 45 and 75 DAS, RDF 100% + Humic acid 15 kg ha⁻¹, RDF 50% + Humic acid 15 kg ha⁻¹, RDF 50 % + NADEP @ 5 t ha⁻¹ + Humic acid 15 kg ha⁻¹, RDF 100% + NADEP @ 5 t ha⁻¹ and 50 % RDF + NADEP @ 5 t ha⁻¹ that were applied on the main crop and then the green gram crop was sown after the harvesting of main crop to assess the residual effect of various treatments on green gram crop. The result revealed that the nitrogen, phosphorus and potassium available in soil were significantly increased due to residual effect of integrated nutrient management practices. The nitrogen in soil was recorded significantly higher with the application of treatment T₄ (RDF 100% + *Azospirillum* + Phosphate Solubilizing Bacteria + Vermicompost @ 2 t ha⁻¹) which was at par with treatment T₁₁ (RDF 100 % + NADEP @ 5 t ha⁻¹) and treatment T₂ (RDF 100% + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹) and also similar in these treatments with respect to phosphorus contents in soil. The potassium content in soil significantly higher under treatment T₄ (RDF 100% + *Azospirillum* + Phosphate Solubilizing Bacteria + Vermi-compost @ 2 t ha⁻¹) and was at par with treatments T₁₁, T₅, T₃, T₂, T₁₀, T₁₂ and T₈ respectively. The Recommended dose of fertilizer of NPK @ 90:30:00 kg ha⁻¹ was taken into consideration for the application respectively. This experiment represents the effects of integrated nutrient management as well as its benefiting residual effects on the succeeding green gram crop. This experiment also represents the increased N, P, K availability and



**Rajesh S Kalasare et al.,**

restoration in the soil due to INM practices and growing of a pulse crop as the succeeding crop thereby focusing on the importance and benefits of opting INM practices for different crops.

Keywords: Moong, Green gram, Residual, Nutrient, Vermicompost, RDF, Humic acid.

INTRODUCTION

India being an agrarian economy has paved a long path in the production of different cereals, pulses and oilseed crops. Among all the pulse crops cultivated, Green gram (*Vignaradiata*) and black gram (*Vignamungo*) are mostly cultivated in many areas and also regarded as important pulse crops in India. They are also cultivated in southern Asian countries including a smaller extent in eastern part of African countries too. Both the crop has originated in India whereas the *Munger* district of Bihar state has been recognized as the secondary origin place of green gram. Mungbean is also considered the predominant crop of South East Asia and Indian Sub-continent. These two crops are considered as oldest pulse crops ever discovered from ancient times and most particularly in Asia and in Europe. The major mung bean growing countries with greater contribution in yield and productivity are India, China, Myanmar, Indonesia, Thailand and Bangladesh. Globally, moong mean is cultivated area of around 7.3 million ha and production of about 5.3 million tons (2017-18) has been witnessed with India and Myanmar each contributing about 30% in the total production. India leads as one of the largest mungbean producing country as its cultivated in almost all states i.e., Rajasthan, Maharashtra, Karnataka, Madhya Pradesh, Odisha, Bihar and Gujarat in the country (Amin, 1997). Mung bean is mostly cultivated during Kharif season in Northern India and as a Rabi crop in southern states due to mild temperature in winter. Mungbean crop suits to loamy well-drained or sandy loam soils witnessing mean temperature ranging 20-40°C. The plants of this crop grow with erect or semi-erect stems with twin leaves in the upper branches. Leaves look trifoliolate with long petioles. The dried beans can be used for cooking purposes as Dal.

The content of proteins, carbohydrates, water, fat, fibre are also high in this crop. Mungbean protein is very rich in lysine protein and acts as an excellent complement crop with rice. The major awareness has been paid by Plant Breeders to develop improved varieties of the crop due to its nutritional value (Adak et al., 2006; Akhaniet al., 2012). The crop is always considered as the first choice among pulses particularly in northern parts of the country due to its very delicious quality. The major advantage being a very short duration crop with zero photo-sensitive nature and a dense crop canopy, highlighting its importance among all other pulses. The health advantageous factors of this crop make it a very recommendable diet by doctors for children, old persons and patients. Being a leguminous crop with good nitrogen fixing capacity, helps in preventing soil erosion and capturing different essential elements (Ashiwathet al., 2010; Azzazet al., 2009; Jena et al., 2022). Among the pulses, green gram (*Vignaradiata* L.) is also one of the most important, low nutrient requiring and capable of fixing atmospheric nitrogen and extensively cultivated pulse crops and can also grow as a relay crop (Choudhary et al., 2006). The residual effects of vermicompost and bio-fertilizer on subsequent crops have been found to be very much beneficial. Moreover, integrated nutrient application builds up the soil fertility. To evaluate the residual fertility status of the treatments, green gram crop was cultivated in this experiment. With this background the study was entitled and the research on Residual Effects of combination of different Integrated Nutrient Management on Summer Green Gram, (*Vignaradiata* L.) Crop was conducted. Out of the 17 SDGs suggested by UNDP, has residual effects of integrated nutrient management on summer green gram potential to fulfill SDG 2, 3 and 15 (FAO, 2021).

MATERIALS AND METHODS

A field experiment was conducted at the Agronomy Farm, College of Agriculture, AAU, Anand, Gujarat. The soil composition of this experiment site was found to be loamy sand in nature, favouring better crop growth. "The soil had a deeper and better moisture retentive capacity and the physical and chemical properties of the research plot





Rajesh S Kalasare et al.,

were determined after collecting the soil sample". The research was laid out following the standardized statistical method of Randomized Block Design. At the time of analysis, the actual value of F was calculated and was compared with the value of table F at 5% level of significance.

For this experiment, a total number of 12 treatments were taken, namely; RDF 100%+ *Azospirillum* + Vermicompost @ 2 t ha⁻¹, RDF 50% + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹, RDF 100% + *Azospirillum* + Phosphorous solubilizing bacteria (PSB) + Vermicompost @ 2 t ha⁻¹, RDF 50% + *Azospirillum* + Phosphorous solubilizing bacteria + Vermicompost @ 2 t ha⁻¹, RDF 100% + Vermi wash 02 spray @ 50 lit ha⁻¹ at 45 and 75 DAS, RDF 50 % + Vermiwash 02 spray @ 50 lit ha⁻¹ at 45 and 75 DAS, RDF 100% + Humic acid 15 kg ha⁻¹, RDF 50% + Humic acid 15 kg ha⁻¹, RDF 50 % + NADEP @ 5 t ha⁻¹ + Humic acid 15 kg ha⁻¹, RDF 100% + NADEP @ 5 t ha⁻¹ and RDF 50 % + NADEP @ 5 t ha⁻¹ have been applied on main crops and the green gram has been sown after the harvesting of main crop to find out the residual effect of various treatments on it. The RDF for the crop was 90:30:00 NPK kg ha⁻¹, respectively.

The following parameters mentioned below were used to find the data from the succeeding green gram crop.

- Estimation of Plant height
- Counting the total number of pods
- Calculating the total number of seeds per pod
- Measuring the Pod length
- Finding the Test weight
- Calculating the total Yield

RESULTS AND DISCUSSION

The average data on various plant morphological traits of succeeding green gram, influenced by residual effect of integrated nutrient management practices were recorded at various intervals and are presented and furnished in Table 1.0. The Table 1.0 represents the height of crop under various treatment combinations in which maximum height was recorded in treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria (PSB) + Vermicompost @ 2 t ha⁻¹) which was at par with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹). The highest plant height recorded under treatment T₄ at harvest was 50.86, 52.19 and 51.53 cm. Data on number of pods plant⁻¹ presented in (Table 1.0) indicates that the residual outcome of integrated nutrient management practices on number of pods plant⁻¹ was found to be significant. Treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria (PSB) + Vermicompost @ 2 t ha⁻¹) being similar with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹). T₁₁(100 % RDF + NADEP @ 5 t ha⁻¹) produced significantly higher number of pods plant⁻¹. These findings are also supported by previous researchers namely Darzi et al., (2005); Darzi, (2011); Darzi, (2015) and Desai et al., (1999).

It is clear from the data represented in Table 1.0 that number of seeds pod⁻¹ was significantly affect due to residual effect of integrated nutrient management practices. Among different treatments, treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria (PSB) + Vermicompost @ 2 t ha⁻¹) recorded significantly highest number of seeds pod⁻¹ as compared to the other treatments even though T₄ being equal with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹). These findings are also supported by previous researchers like Doa, (2011); Jain et al., (2007); Jain, (2004); Jain (2001) and Kalyaniet al., (1995). A perusal of data given in (Table 1.0) reveals that treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria + Vermicompost @ 2 t ha⁻¹) being equal with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹) also registered outstandingly higher pod length (cm) over rest of the other treatments. The pod lengths noted under treatment T₄ were 5.9, 6.7 and 6.27 cm. These findings are also supported by previous researchers like Manivannan, (2003); Khoja, (2004); Mahfouz and Eldin, (2007); Malhotra et al., (2006); Mahnaz et al., (2012) and Meena et al., (2013). Results given in the Table 1.0 also reveals the test weight of green gram was significantly higher due to the residual effect of different combinations of integrated nutrient management practices being maximum in treatment T₄ (RDF 100% +





Rajesh S Kalasare et al.,

Azospirillum+ Phosphorous solubilising bacteria (PSB) + Vermi-compost @ 2 t ha⁻¹) which was at par with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹). The values of test weight recorded under treatment T₄ were 37.25, 37.56 and 37.40 gm respectively. Data given in (Table 1.0) indicated that the seed yield of succeeding summer green gram was also significantly influenced due to residual effect of integrated nutrient management practices on pooled basis.

Treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria + Vermi-compost @ 2 t ha⁻¹) being similar with treatment T₂ (RDF 100 % + *Azospirillum* + Vermi-compost @ 2 t ha⁻¹). T₁₁(RDF 100 % + NADEP @ 5 t ha⁻¹) produced significantly higher seed yield of summer green gram as compared to rest of the treatments. Seed yield of green gram recorded under treatment T₄ was 745, 795 and 770 kg ha⁻¹ respectively. These findings are also supported by previous researchers namely Moradiet al., (2011); Singh, (2011); Naidu et al., (2009); Pandey et al., (2006); Parakhia et al., (2000); Patel et al., 2004 and Patel et al., (2013).

CONCLUSION

This experiment with a total number of 12 treatments and testing the residual effect of various treatments on green gram crop revealed that the content of nitrogen, phosphorus and potassium in soil were significantly influenced with the residual effects of integrated nutrient management practices. The nitrogen in soil was recorded significantly high with the treatment combination of RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria + Vermicompost @ 2 t ha⁻¹ (T₄) which was similar with treatment T₁₁ (RDF 100 % + NADEP @ 5 t ha⁻¹) and treatment T₂ (RDF 100% + *Azospirillum* + Vermicompost @ 2 t ha⁻¹). These treatments were also at par with respect to phosphorus in the soil. The potassium content in soil was highest under treatment T₄ (RDF 100% + *Azospirillum* + Phosphorous solubilising bacteria + Vermi-compost @ 2 t ha⁻¹) being at par with treatment T₁₁, T₅, T₃, T₂, T₁₀, T₁₂ and T₈ respectively.

REFERENCES

1. Adak, T., Singh, S. and Sachan, R.S. 2006. Influence of integrated management of bio-fertilizers and chemical fertilizer on post harvest soil fertility status in fenugreek on mollisol. *Environment and ecology* 24 (4): 796-802.
2. Akhiani, A., Mohammad T.D. and Mohammadreza H.H. 2012. Effects of Biofertilizer and plant density on yield components and seed yield of components and seed yield of coriander (*Coriandrum sativum*). *International Journal of Agriculture and Crop Sciences* 4 (16): 1205-1211.
3. Amin, I.S. 1997. Effect of bio and chemical fertilization on growth and production of (*Coriandrum sativum*, *Foeniculum vulgare* and *Carum carvi* L.) plants. *Annals of Agriculture Sciences* 35 (4): 2327-2334.
4. Ashiwith, O.P., Khurana, H.S. and M.M. 2010. - A Review on the effect of Integrated Nutrient Management on Yield quality of major seed spices crops in India. *Better Crops South Asia*.
5. Azzaz, N.A., Hasan, E.A. and Hamad, E.H. 2009. The chemical constituent and vegetative and yielding characteristics of fennel plants treated with organic and bio-fertilizer instead of mineral fertilizer. *Australian Journal of Basic and Applied Sciences* 3(2):579-587
6. Choudhary, G.R., Jain, N.K. and Jat, N.L. 2006. Response of cumin (*Cuminum cyminum*) to inorganic nitrogen, farmyard manure and biofertilizer. *Indian Journal of Agronomy* 51 (4): 334-336.
7. Darzi, M.T., Ghalavand, A., Rejali, F. and Sefidkon, F. 2005. Effect of vermicompost application on yield and yield components in fennel (*Foeniculum vulgare mill.*) *Iranian J. of medicinal and aromatic plants*, 22(4): 277-292.
8. Darzi, M.T. 2011. Influence of Organic Fertilizer and biostimulant on the growth and biomass of dill (*Anethum graveolens*). *Intl. J. Agri. Crop Sci.* 4 (3): 98-102.
9. Darzi, M.T. 2012. Influence of organic and bacterium of *Bacillus Circulans* on yield and essential oil concentration in Anise (*Pimpinella Anisum*). *International Journal of Agriculture and Crop Sciences* 4 (2): 64-69.
10. Darzi, M.T. and Mohammadreza, H.H. 2012. Effects of the application of organic manure and biofertilizer on the fruit yield and yield component in dill. *Journal of Medicinal Plants Research* 6 (17): 3345-3350.





Rajesh S Kalasare et al.,

11. Darzi, M. T., Shirkhodaei, M. and Mohammadreza H.H. 2013. Effects of vermicompost and Azotobacter and azospirillum bacteria on quantity and quality of essential oil of coriander (*Coriandrum sativum* L.). *International Journal of Farming and Allied Sciences* 2 (5): 1277-1283.
12. Desai, V.R., Sabale, R.N. and Raundal, P.U. 1999. Integrated nitrogen management in wheat-coriander cropping system. *Journal of Maharashtra agricultural universities* 24 (3): 273-275.
13. DOA. 2011. "District-wise Area, Production and Productivity of Spices Crops. Directorate of Agriculture, Gujarat state, Gandhinagar.
14. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 3rd May, 2022).
15. Jain, N.K., Jat, N.L. and Chaudhary, G.R. (2007). Response of fennel (*Foeniculum vulgare*) to inorganic nitrogen farmyard manure and *Azospirillum*. *Indian Journal of Agricultural Sciences* 77 (6): 376-378.
16. Jat, B.L. 2004. Effect of phosphorus, sulphur and biofertilizers on growth characters of fenugreek (*Trigonellifoenum-graecum* L.). *Legume Research* 27 (1): 37-41.
17. Jat, B.L. and Shaktawat. 2001. Effect of phosphorus, sulphur and biofertilizers on yield attributes and yield of fenugreek and its residual effect of pearl millet. *Indian J. of Agron.* 46(4):627-634 (December 2001).
18. Jena, J., Maitra, S., Hossain, A., Pramanick, B., Gitari, H.I., Praharaj, S., Shankar, T., Palai, J. B., Rathore, A., Mandal, T. K. & Jatav, H. S. 2022. Role of Legumes in Cropping Systems for Soil Ecosystem Improvement. In: *Ecosystem Services*, Jatav, H. S., Nova Science Publishers, USA, pp.1-21.
19. Kalyani, D.P., Ravi Sankar, C. and Manohar Prasad, D. 1995. Studies on the effect of nitrogen and *Azospirillum* on growth and yield of cauliflower. *South Indian Horticulture* 44 (5&6): 147-149.
20. Kamalakannan, S. and Manivannan, K. 2003. Response of radish for graded levels of nitrogen and phosphorus with biofertilizers. *South Indian Horticulture* 51 (1-6): 199-203.
21. Khoja, J.R. 2004. Effect of sowing time and sources of nitrogen on growth, thermal requirement, yield and quality of coriander [*Coriandrum sativum*(L.)]. Ph.D. Thesis Rajasthan Agricultural University, Campus-Jobner.
22. Mahfouz, S.A., and Sharaf-Eldin, M.A. 2007. Effect of mineral and bio-fertilizer on growth, yield and essential oil content of fennel (*Foeniculum vulgare* Mill.) *International Agro-physics* 21: 361-366.
23. Malhotra, S.K., Vashishtha, B.B and Apparao, V. V. 2006. Influence of nitrogen, *Azospirillum* sp. And farmyard manure on growth, yield and incidence of stem gall disease in coriander (*Coriandrum sativum* L.). *J. Spices and Aromatic Crops*, 15(2): 115-117.
24. Mahnaz Shirkhodaei, Mohammad Taghil Darzi, Mohammadreza Haj Seyed Hadi. 2012. Influence of vermicompost and Biostimulant on the growth and biomass of coriander (*Coriandrum sativum*). *International Journal of Advanced Biological and Biomedical Research* 2 (3): 706-714.
25. Meena, S.K., Bhuri Singh and Meena, A.K. 2013. Variability in fennel (*Foeniculum vulgare* mill.) For yield & yield attributes. *Indian Research Journal of Genetics and Biotechnology* 5 (2): 117-124.
26. Moradi, R., Rezvani Moghaddam, P., Najiri Mahallati, M. and A. Nezhadali (2011). Effects of organic and biological fertilizers on fruit yield and essential oil of sweet fennel (*Foeniculum vulgare* var. *dulce*). *Spanish Journal of Agriculture Research* 9 (2): 546-553.
27. Munnu Singh. (2011). Effect of vermicompost and Chemical Fertilizers on growth, yield and quality of coriander (*Coriandrum sativum* L.) in semi-arid tropical climate. *Journal of spices and Aromatic crops*, 20 (1): 30-33.
28. Naidu, K. D., Radder, B, M., Patil, P. L., Hebsur. and Alagundagi, S. C. (2009). The effect of Integrated Nutrient Management on nutrient uptake by chilli (Cv. Byadgidabbi) and residual fertility in a vertisol. *Karnataka J. Agric. Sci.*, 22 (2) : 306-309.
29. Pandey, S.T., Singh, P. and Pandey, P. 2006. Site specific nutrient management in European dill (*Anethum graveolens* L.) at subtropical belt of Uttaranchal. *International Journal of Agricultural Science*, 2 (2): 566-569.
30. Parakhia, A.M., Akbari, L.F. and Andharia. J.H. 2000. Seed bacterization for better quality and more yield of fenugreek. *Gujarat Agricultural University Research Journal*, 25 (2): 34-38.
31. Patel, B.S., Amin, A.U. and Patel, K.P. 2004. Response of cumin (*Cuminum cyminum*) to integrated nutrient management. *Indian Journal of Agronomy*, 49 (3): 205-206.





Rajesh S Kalasare et al.,

32. Patel, S.G., Amin, A.V., Patel, S.P. Agalodiya and Patel, S.M. 2013. Center for Research on seed spices SardarKrushinagar, Dantiwada Agriculture University Jagudan, Gujarat. *International Journal of Seed Spice*, 3 (2).

Table 1. Residual effect of various fertilizer combinations on morphology and yields of succeeding green gram crop

| Treatments | Evaluation Parameters | | | | | |
|--|-----------------------|----------------|----------------------|---------------|----------------|------------|
| | Plant height cm | Number of pods | No. of Seeds per Pod | Pod Length cm | Test Weight gm | Yield t/ha |
| T ₁ - Recommended Dose of Fertilizer (RDF -90:30:00 NPK kg ha ⁻¹) | 48.22 | 13.27 | 7.64 | 5.29 | 31.11 | 474 |
| T ₂ - RDF100% + <i>Azospirillum</i> + Vermi-compost @ 2 t ha ⁻¹ | 50.59 | 15.81 | 8.21 | 5.93 | 36.16 | 742 |
| T ₃ - RDF 50% + <i>Azospirillum</i> + Vermi-compost @ 2 t ha ⁻¹ | 49.65 | 14.77 | 8.04 | 5.62 | 34.18 | 618 |
| T ₄ - RDF 100% + <i>Azospirillum</i> + Phosphorous solubilising bacteria (PSB) + Vermi-compost @ 2 t ha ⁻¹ | 51.53 | 16.43 | 8.71 | 6.27 | 37.40 | 770 |
| T ₅ - RDF 50% + <i>Azospirillum</i> + Phosphorous solubilising bacteria (PSB) + Vermi-compost @ 2 t ha ⁻¹ | 50.03 | 15.00 | 8.09 | 5.65 | 34.28 | 655 |
| T ₆ - RDF 100% + Vermiwash 02 spray @ 50 lit ha ⁻¹ at 45 and 75 DAS | 48.52 | 13.44 | 7.69 | 5.34 | 31.51 | 498 |
| T ₇ - RDF 50% + Vermiwash 02 spray @ 50 lit ha ⁻¹ at 45 and 75 DAS | 47.89 | 13.04 | 7.64 | 5.22 | 29.93 | 450 |
| T ₈ - RDF 100% + Humic acid 15 kg ha ⁻¹ | 48.80 | 14.08 | 7.89 | 5.53 | 33.75 | 589 |
| T ₉ - RDF 50% + Humic acid 15 kg ha ⁻¹ | 49.27 | 13.93 | 7.69 | 5.48 | 32.34 | 544 |
| T ₁₀ - RDF 50% + NADEP @ 5 t ha ⁻¹ + Humic acid 15 kg ha ⁻¹ | 48.49 | 14.50 | 8.01 | 5.54 | 33.97 | 630 |
| T ₁₁ - RDF 100% + NADEP @ 5 t ha ⁻¹ | 49.97 | 15.57 | 8.14 | 5.78 | 35.08 | 721 |
| T ₁₂ - RDF 50% + NADEP @ 5 t ha ⁻¹ | 48.51 | 14.49 | 7.79 | 5.49 | 32.94 | 594 |
| S. Em. ± | 0.49 | 0.40 | 0.11 | 0.13 | 0.66 | 18.30 |
| C. D. (P=0.05) | 1.39 | 1.12 | 0.31 | 0.38 | 1.88 | 51.66 |





Effects of Nano Potassium in Rice: A Review

Pooja C. A¹, Vidyashree B. S¹, Shivashankar K¹, Kiran Emmiganur¹ and Ashwini T. R^{2*}

¹Department of Agronomy, University of Agricultural Sciences, Dharwad, Karnataka, India.

²Centurion University of Technology and Management, Odisha, India

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Ashwini T. R

Centurion University of Technology and Management,
Odisha, India

Email: ashwini.tr@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Nano-fertilizers suggest new crop management strategies. Although potassium (K) is difficult to incorporate into organic materials, it helps to increase rice crop quality. Paddy yield and quality are determined by the time of fertilization and harvesting (days after flowering) in the field. Because nanoparticles have a better mobility, they can transfer nano formulated nutrients to all regions of the plant. Nano-fertilizers outperform even the most creative modern conventional fertilizers because to their high surface area to volume ratio. Despite the fact that K is not a component of any plant structure or chemical, it is necessary for several critical regulatory processes in the plant, such as rice grain quality. This review focuses on the importance of nano potassium nutrition for rice crop sustainability.

Keywords: Rice, potassium, nano-fertilizer, quality

INTRODUCTION

Field crops absorb potassium (K) faster than nitrogen (N) or phosphorous (P), with K playing an important role in ensuring efficient N use (Anjana et al., 2018). Rice (*Oryza sativa* L.) is the primary food crop for almost half of the world's population. It is the world's second most valuable commodity. Rice dominates overall crop output and food consumption in China more than anywhere else on the planet. China and India are by far the world's greatest rice producers. Although its harvested area is smaller than India's, China's rice production is larger due to higher yields, as virtually all of China's rice land is irrigated, whereas India's rice area is less than half irrigated. Paddy is farmed all over the world and is one of the most significant cereal crops. China is the largest producer (149.00 million tonnes) of the world followed by India with 121.00 million tonnes (Fig. 1). In India, as per the Ministry of agriculture (2021), *rabi* rice acreage was increased by 16.62 per cent to 35.23 lakh hectares (87.05 lakh acres) as compared to 30.21 lakh hectares (74.64 lakh acres). In India higher acreage was covered in Telangana 11.31 lakh ha (27.95 lakh acres), Tamil Nadu 10.51 lakh ha (25.97 lakh acres), Andhra Pradesh 6.82 lakh ha (16.85 lakh acres), West Bengal 2.52 lakh ha (6.23 lakh acres), Assam 1.43 lakh ha (3.53 lakh acres), Odisha 1.00 lakh ha (2.47 lakh acres) and Kerala 0.78 lakh ha (1.93 lakh acres). Nitrogen and Potassium (K) are the main macronutrients that are taken by the plants in comparatively



**Poojaet al.,**

large quantities and these are usually deficient in most soil (Hasinaet al., 2011). Potassium is essential for meristematic tissue growth and for the preservation of cell turgor pressure, which is necessary for cell expansion. The use of K is especially important where high rate of nitrogen and phosphorus are used and when high yield is expected. Dev and Herbert (2008) revealed that potassium is classified as an essential macronutrient for all plants. Many of the diverse roles of K in plant cells depend on the transport of K through specific membrane bound transport proteins.

One of the limiting elements affecting rice output is potassium in rice-growing soils. It is a significant inorganic solute that plays an important function in plant water balance. It also increases crop quality and shelf life by reducing lodging and imparting disease resistance. Providing the crop with a balanced K diet ensures that the plants are healthy, strong, and resistant to pests and diseases. Potassium plays a role in several physiological processes, including osmoregulation, cation-anion balance, protein synthesis, and enzyme activation. Rice is extremely susceptible to water stress, therefore any attempt to limit water input could reduce genuine yield potential. K supplementation has been demonstrated to improve photosynthetic rate, plant growth and yield, and drought resistance. As a result, maintaining a sufficient K supply can be a good nutritional strategy for reducing drought-related losses (Santosh et al., 2018). Potassium is essential for rice glucose transport and is advantageous to plant metabolism and stress tolerance. Potassium act as an activator of various enzymes is involved in the intracellular osmotic regulation and membrane protein transport (Tinghonget al., 2019). In submerged rice, greater doses of K enhance non-structural carbohydrates (NSC) content, photosynthetic pigment concentration, antioxidative activity, and lipid peroxidation (Mirzaetal., 2018).

Nanotechnology is a new frontier for the scientific community, and it can be used as an alternative strategy in a variety of fields, including agriculture (Bhattacharyayet al., 2020). In this context, nanotechnology, such as the use of nanoscale fertilizers, suggests novel crop management strategies (Hossain et al., 2021; Seyedet al., 2021; Durgudeet al., 2022). In recent years, there has been a lot of focus on using nanotechnologies and plant biotechnology in agriculture to increase plant production, improve plant tolerance to environmental stress, improve nutrient use efficiency, and mitigate hazardous environmental effects, as opposed to traditional bulk materials methods (Abdel et al., 2022). The nano particles have the potential to make plants use fertilizers more efficiently and environmentally benign since their nano-scales enable for uptake through stomata and the base of trichomes, increasing fertilizer use efficiency. The most important use of nanotechnology in agricultural crop production is the field of nano fertilizers, which, unlike traditional fertilizers, can feed plants gradually and in a controlled manner. These nano fertilizers have the potential to be more effective, reducing soil pollution and other environmental problems associated with chemical fertilizers (Salhyet al., 2021).

By foliar or soil application, nanofertilisers play a significant role in plant nutrition. Its slow release contributes in provide plant with nutrients which ensure the maintenance of metabolic processes and improve the yield of the crops (Abdulrahmanet al., 2019). Nano fertilisers may outperform even the most creative polymer coated traditional fertilisers, which have experienced minimal development in the last ten years, due to their high surface area to volume ratio (Abdel et al., 2020).For nitrogen, phosphorous, and potassium, conventional fertilisers have efficiency of just 30-35 percent, 18.20 percent, and 35-40 percent, respectively, which has been steady for decades (Sohairet al., 2018). Nano-fertilizers are designed to boost nutrient utilisation efficiencies by utilizing the unique features of nano-particles with nano dimensions ranging from 1-100 nm Furthermore, optimising the use of chemical fertilisation for crop nutrient requirements is critical in order to reduce the risk of environmental pollution by testing alternative fertilisation methods such as nano-fertilizers, which are rapidly and completely absorbed by plants, reducing fertiliser consumption and pollution while maintaining sustainable farm productivity.

With a growing population, increased occurrences of hunger, and dwindling agricultural grounds for grain production, an innovative strategy is essential. It would be extremely beneficial if we could employ nano-fertilizer for certain crops like rice to reduce the potential negative impacts of significant chemical inputs while maintaining productivity and nutritional benefits. Rice yield largely depends on soil conditions and also on the supply of the



**Poojaet al.,**

available nutrients like nitrogen, phosphorus, potassium, sulphur and zinc. Potassium is the third most important nutrient for plants and crops after nitrogen and phosphorus. Potash is beneficial to agriculture because it boosts water retention, yield, nutrient value, flavour, colour, texture, and disease resistance in food crops. In order to fulfil the rising demand for food, fertiliser usage and consumption are rapidly increasing. Because current consumption patterns, particularly for potassium (Table 1), are rising over time, nano potassium can be used as a source of potassium nutrition for crop productivity.

Potassium balance sheet

The nutrient addition, removal, balance and nutrient mining index for India and for different states covering alluvial, black, red, lateritic and desertic soil regions indicated that K removal by crops far exceeded than the K addition through fertilizers. At national level, the K depletion was about 10.2 mt per year and mining index for K was 8.0 (Ramamurthy *et al.*, 2017).

Nano potassium effect on growth parameters

Plant height and total shoot dry weight increased when the entire recommended rate of nano fertilizer was applied. Plant height and total shoot dry weight grew in lockstep with rice chlorophyll content. However, employing nano fertilizer clearly improved these results. This is owing to the fact that nano fertilizers can either deliver nutrients to the plant or aid in the transportation or absorption of available nutrients, resulting in improved crop development (Benzonet *et al.*, 2015). When using nanoparticle, Mehrdadet *al.* (2017) found that the plant height for TaromHashemi (143.14 cm) was higher than the TarommMahalli cultivar of rice (130.08 cm) (nano potassium and nano silicon). Spraying by potassium nanoparticles with highest concentration of 8 m L⁻¹, showed a significant increases in growth of wheat with highest mean of chlorophyll content (194.56 mg m²) and plant height (98.24 cm) was revealed by Noaemaet *al.* (2020) and the soil application of K₂O at 15 kg ha⁻¹ + nano potassium foliar spray in maize at 2500 ppm resulted significantly higher cob length (17.9 cm), cob girth (17.2 cm), number of rows cob⁻¹ (16.8), number of kernels per row (41.3), number kernels per cob (694.8), weight of kernels per cob (188.4 g), test (34.80 g), kernel yield (9051 kg ha⁻¹), straw yield (11667 kg ha⁻¹) (Beerasha and Jayadeva, 2020). The application rates of NPK nano fertilizers in cotton had a substantial impact on fibre characteristics. Fiber length and length uniformity index were also affected by application times and procedures (Sohairat *et al.*, 2018). Plant height (cm), leaves number, leaves area (dm²), chlorophyll (mg 100 gm⁻¹), dry weight (g), and eggplant leaf content were the vegetative metrics with the greatest values using nano potassium fertiliser at 1.5 gm L⁻¹ concentration (Abdulrahmanet *al.*, 2019).

Nano potassium effect on yield parameters

Mehrdadet *al.* (2017) found that TaromHashemi had greater total tiller per hill and fruitful tiller per hill than TaromMahalli. TaromHashemi had the highest paddy production in both years, owing to the cultivar's growing panicle length and fruitful tiller quantity. With 34 kg N ha⁻¹ and nano potassium treatment, TaromHashemi produced the maximum paddy yield (5000 kg ha⁻¹). With nitroxin and nano potassium consumption, the greatest paddy yield of 4657 kg ha⁻¹ was obtained for TaromMahalli. According to Hiraket *al.* (2018) potassium fertilization has a substantial impact on hybrid rice yield components including number of filled seeds panicle, number of empty seeds panicle⁻¹, and panicle weight. K treatment of 90 kg K₂O ha⁻¹ resulted in a 26.4 percent increase in the quantity of filled seeds panicle⁻¹ compared to K omission. Panicle weight increased as the K dose was increased up to 60 kg ha⁻¹, remained constant at 90 kg ha⁻¹, and dropped as the K dose was increased further. The lowest value was noticed in control plot with respect to panicle weight. Ali *et al.* (2020) revealed that the highest grain yields obtained when rice plants were sprayed with nano and conventional potassium fertilizer. Ali *et al.* (2020) indicated that spraying 500 mg l⁻¹ of nano potassium + 150 kg ha⁻¹ of potassium fertilizer was superior in grain yield and biological yield of maize (7.07 t ha⁻¹ and 19.29 t ha⁻¹, respectively), while spraying of 1500 mg of nano potassium + 50 kg L⁻¹ potassium fertilizer gave the highest weight of 100 grains weight (32.3 g). Potassium deficient plants tend to be more susceptible to infection than those with an adequate supply of K. For example, the rate of rice borer infestation was greatest when there was no supply of K, but decreased rapidly as the K concentration increased (Table 2) and it was reported by Wang *et al.* (2013).





Pooja et al.,

Nano potassium use efficiency in rice

Potassium is an essential nutrient for plant growth. Potassium plays an essential role in controlling many things in plants. For growth and reproduction, it is necessary in almost all processes. According to the author's argument (Hayyawiet *et al.*, 2021), potassium is the only element that has been decreased from soil. It is suggested that slow and steady release of K from zeolites has the benefits of providing plant roots with additional nutrients at the same time. Without depending on chemical fertilizers, nanotechnology can help to further increase the abundance of potassium in soil. Potassium increases the number of spikelets per panicle in rice and the percentage of filled grains. It helps rice plants to overcome iron toxicity from high ferrous iron containing soils and improves the rigidity of pseudostems and stalks thus reducing lodging and also improves the quality of crop produced. For enhanced K usage efficiency (KUE) of hybrid rice, appropriate K fertilization strategies should be employed to fine tune the supply–demand balance of the crop and soil. Regular K application to the crop improved total tillers, dry matter buildup, effective tillers, number and weight of filled grains and KUE, as well as enhancing soil characteristics and grain yield. Hiraket *et al.* (2018) also found that increased K intake enhanced carbohydrate metabolism in plants, and that enough K enhances N translocation to the grain during grain filling, enhancing N efficiency. Potassium helps the panicle cope with the stresses that are typical in the region, and high K uptake in the panicle, especially early in development, reduces the deleterious effects of salt uptake by the panicles.

Effect of nano potassium on rice quality parameters

Potassium is difficult to absorb into organic materials, yet it aids rice quality. The timing of fertilization and harvesting (days after flowering) in the field determines rice production and quality. Two types of milling quality such as brown rice rate (BRR) and head rice rate (HRR) are considered the most important physical quality parameters when determining the rice quality. However, from the consumer's perspective, the head rice yield is the most critical parameter. When compared to the K (traditional K) therapy, Seyedet *et al.* (2021) found that nano potassium considerably raised the BRR and HRR. The elongation ratio was raised by using conventional and nano-fertilizers (0.51-19.41 percent and 0.29-14.80 percent for Tarom and Shiroudi, respectively). Their findings also demonstrated that Shiroudi's gel consistency (GC) was much higher than that of the Tarom cultivar. As a result, the average GC for Shiroudi and Tarom was 76.6 and 77.8 mm, respectively. This is primarily due to the fact that application of potassium nano particles could improve milling quality Seyedet *et al.* (2021), which primarily increases the gliadin content in grains, and according to them, application of nano based fertilizers can be an effective approach to achieve a balance between rice yield and quality while maintaining fertiliser efficiency. Grain production and quality are determined by harvesting decisions made correctly. To produce a better milling output with good quality grains and a higher value for the production, proper harvesting timing is critical. When rice was harvested between 30 and 35 days after 50 % blooming, true density (TD) increased and reached a high of 1.521.511 g/cm³ (DAFF). The crude protein (CP) content increased significantly when the rate of MOP fertilizer applied at the time of rice plant heading and the age of paddy harvested increased. With the application of 37.5 kg MOP per ha at the time of heading and harvesting at 40 DAFF (Anjana *et al.*, 2018), the maximum CP content obtained in this study was 6.24 per cent.

Pros and cons of use of nano particles

Nanocarriers supply nutrients at the proper time and place, reducing the amount of active compounds deposited in the plant system and improving nutrient utilization efficiency. Nano fertilizers have high surface area, sorption capacity and controlled-release kinetics to targeted sites, and have been considered as smart delivery system (Iyarin and Aravinda, 2019). Shweta and Pragya (2014) reported that toxicological studies of fibrous and tubular nanostructures have shown that at extremely high doses of nano particles are associated with fibrotic lung responses and result in inflammation and an increased risk of carcinogenesis. Single walled carbon nanotubes have been shown to inhibit the proliferation of kidney cells in cell culture by inducing cell apoptosis and decreasing cellular adhesive ability. In addition, they cause inflammation in the lungs.





Poojaet al.,

CONCLUSION

Water shortages at any key stage of crop development significantly limited crop growth and production. Potassium use at all crucial phases enhanced all yield components, including grain filling stage responsiveness. Optimal K⁺ nutrition status contributes to drought-resistant crop development, production, and quality by maintaining cellular membrane stability, osmotic adjustments, and detoxification of reactive oxygen species.

REFERENCES

1. Abdel, W. M. M., Mahmoud, M. S., Hoda, S, Rasha, R. E., Hassan, M. R. and Abdeldaym, E. A. (2022). Nanopotassium, nanosilicon, and biochar applications improve potato salt tolerance by modulating photosynthesis, water status, and biochemical constituents. *Sust.* 14:723-746.
2. Abdel, W. M., M. and Swaefy, H. M. (2020). Comparison between commercial and nano NPK in presence of nano zeolite on sage plant yield and its components under water stress. *Agric.* 66(1):24-39.
3. Abdulrahman, J. J., Al-Fahdawi and Mohammed, M. A. (2019). Impact of biofertilizers and nano potassium on growth and yield of eggplant (*Solanum Melongena* L.). *Plant Arch.* 19(2): 1809-1815.
4. Ali, H. J., Husain, S. R. and Mohammed, H. H. (2020). Effect of skip irrigation and nano potassium treatments on maize yield. *Eco. Env. Cons.* 26(3):10-15.
5. Anjana, J., Atapattu, B. D., Rohitha, P., Amaratunga, K. S. P. and Buddhi, M. (2018). The quality of direct seeded rice is improved by using more potassium fertiliser at the time of heading. *Chem. Biol. Technol. Agric.* 5(1):22.
6. Beerasha, K. J. and Jayadeva, H. M. (2020). Effect of Nano-Potassium Fertilizer on Yield and Economics of Maize (*Zea mays* L.). *Mysore J. Agric. Sci.*, 54 (1): 28-32.
7. Benzon, H. R. L., MaRosnah, U. R., Venecio, U. U., Sang, C. L. (2015). Nano-fertilizer affects the growth, development, and chemical properties of rice. *Int. J. Agron Agric. Res.* 7(1):105-117.
8. Bhattacharyay, D., Maitra, S., Pine, S., Shankar, T. and PeddaGhousePeera, S. K. (2020). Future of Precision Agriculture in India. In: *Protected Cultivation and Smart Agriculture*, Eds. Maitra et al., New Delhi Publishers, India, pp. 289-299.
9. Dev, T. B. and Herbert, J. K. (2008). Cellular mechanisms of potassium transport in plants. *Physiol. Plantarum.* 133:637-650
10. Durgude, S.A., Ram, S., Kumar, R., Singh, S.V., Singh, V., Durgude, A.G., Pramanick, B., Maitra, S., Gaber, A. and Hossain, A. (2022). Synthesis of Mesoporous Silica and Graphene-Based FeO and ZnONanocomposites for Nutritional Biofortification and Sustained the Productivity of Rice (*Oryza sativa* L.). *Journal of Nanomaterials.* 2022:1-15.
11. Hasina, G., Ahmad, S., Beena, S., Fida, M. and Ijaz, A. (2011). Effect of foliar application of nitrogen, potassium and zinc on wheat growth. *J Agric. Biol. Sci.* 6(4):56-59.
12. Hayyawi, W. A., Al-Juthery, Nabil R. L. and Rand A. H. G. Al-Tae, (2021). Intelligent, nano-fertilizers: A new technology for improvement nutrient use efficiency. *Earth Environ. Sci.* 735:1-10.
13. Hirak, B., Krishnendu, R., Sudarshan, K. D., Kaushik, M., Talatam, S. and Jagadish, T. (2018). Optimizing potassium application for hybrid rice (*Oryza sativa* L.) in coastal saline soils of West Bengal, India. *Agron.* 8(1):1-14.
14. Hossain, A., Skalicky, M., Brestic, M., Mahari, S., Kerry, R.G., Maitra, S., Sarkar, S., Saha, S., Bhadra, P., Popov, M. and Islam, M. (2021). Application of Nanomaterials to Ensure Quality and Nutritional Safety of Food. *Journal of Nanomaterials.* 2021:1-25. <https://doi.org/10.1155/2021/9336082>.
15. Iyarin, T. M. E. and Aravinda, K. B. N. (2019). Foliar application of nanofertilizers in agricultural crops-A review. *J. Farm Sci.*, 32(3): 239-249.
16. Mehrdad, G. L., Ghorban, N., Hamid, M., Hussein, H. S. A. and Hamid, R. M. (2017). Two iranian rice cultivars response to nitrogen and nano-fertilizer. *J. Ecology.* 7(1):591-603.
17. Mirza, H., Borhannuddin, M. H. M., Bhuyan, I. D., Kamrun, N., Shahadat, H. M., Jubayer, A. M., Shahadat, H. M., Abdul, A. C. M. and Masayuki F, M (2018). Potassium: A vital regulator of plant responses and tolerance to abiotic stresses. *Agron.* 8(31):1-29.





Poojaet al.,

18. Noaema, A. H., Haider, R. L. and Alhasany, A. R., (2020). Effect of spraying nano fertilizers of potassium and boron on growth and yield of wheat (*Triticum aestivum* L.). The First *International Conference of Pure and Engineering Sciences*. pp: 1-10.
19. Ramamurthy, V., Naidu, L. G. K., Ravindra, C. G., Mamatha, D. and Singh, S. K. (2017). Potassium status of Indian soils: Need for rethinking in research, recommendation and policy. *Int. J. Curr. Microbiol. App. Sci*, 6(12):1529-1540.
20. Salhy, A. M., Al-Wasfy, M. M., Badawy, E. F. M., Gouda, F. M. and Shamroukh, A. A. (2021). Effect of nano-potassium fertilization on fruiting of Zaghloul date palm. *Int. J. Agric. Sci* 3 (1): 1-9.
21. Santosh, K., Dwivedi, S. K., Rao, K. K., Mishra, J. S., Singh, A. K., Narayan, B., Prakash, V., Shishir, K. S. and VirendarKand Bhatt, B. P. (2018). Optimizing dosage and mode of potassium application for rice in drought-prone rainfed ecology of middle indo-gangetic plains. *Agric Res*. 1-11.
22. Seyed, T. S. V., Yousef, N., Hormoz, F. A. and Davood, B. T. (2020). Rice output and quality in response to nano-fertilizers versus traditional fertilisers. *J. Plant Nutrition*. DOI: 10.1080/01904167.2021.1884701
23. Shweta, A. and Pragya, R. (2014). Nanotechnology Pros and Cons to Agriculture: A Review. *Int. J. Curr. Microbiol. App. Sci*, 3(3): 43-5.
24. Sohair, E. E. D., Abdall, A. A., Amany, A. M., Hossain, M. F. and Houda, R. A. (2018). The effects of nitrogen, phosphorus, and potassium nano-fertilizers on Egyptian cotton production, yield components, and fibre qualities (*Gossypium barbadense* L.). *J. Plant Sci. Crop Prot*. 1-10.
25. Tinghong, Y. E., Yuwei, L. I., Jianglin, Z., Wenfeng, H., Weifeng, Z., Jianwei, Lu., Yongzhong, X. and Xiaokun, L. I. (2019). Nitrogen, phosphorous and potassium fertilization affects the flowering time of rice (*Oryza sativa* L.). *Global Ecol. Con*. 20:1-9.
26. Vijayakumar, S., Dinesh, K., Kulasekaran, R., Prabhu, G., Dinesh, J., Rubina, K., Saravanane, P., Subramanian, E., Ekta, J., Sharma, V. K. and Sudhir, K. R. (2021). Potassium nutrition in rice: A review. *Oryza*. 58(3):341-353.
27. Wang, M., Qingsong, Z., Qirong, S. and Shiwei, G. (2013). The critical role of potassium in plant stress response. *Int. J. Mol. Sci*. 14(1):7370-7390.

Table 1: All India consumption of fertilizers in terms of nutrients (N, P and K in thousand tonnes)

| Year | N | P | K | Total |
|---------|---------|--------|--------|---------|
| 2013-14 | 16750.1 | 5633.5 | 2098.9 | 24482.4 |
| 2014-15 | 16945.4 | 6098.4 | 2532.3 | 25576.1 |
| 2015-16 | 17372.3 | 6978.8 | 2401.5 | 26752.6 |
| 2016-17 | 16735.4 | 6705.4 | 2508.3 | 25949.2 |
| 2017-18 | 16958.0 | 6854.1 | 2778.8 | 26590.9 |
| 2018-19 | 17637.8 | 6910.2 | 2680.3 | 27228.2 |
| 2019-20 | 18863.9 | 7464.8 | 2640.9 | 28969.6 |

Source: Department of Agriculture, Cooperation & Farmers Welfare

Table 2: Impacts of soil potassium build-up on rice stem borers and grain yield within a rice field

| Potassium treatments (kg ha ⁻¹) | Stem borer infestation (%) | | Yield (kg ha ⁻¹) |
|---|----------------------------|-------------|------------------------------|
| | Dead heart | White heads | |
| 40 | 3.05 b | 5.37 b | 6379.66 |
| 50 | 2.64 bc | 3.58 c | 7623.33 |
| 60 | 2.40 c | 3.37 c | 7723.33 |
| Control | 4.33 a | 7.12 a | 5633.33 |
| LSD value | 0.619 | 0.561 | |





Pooja et al.,

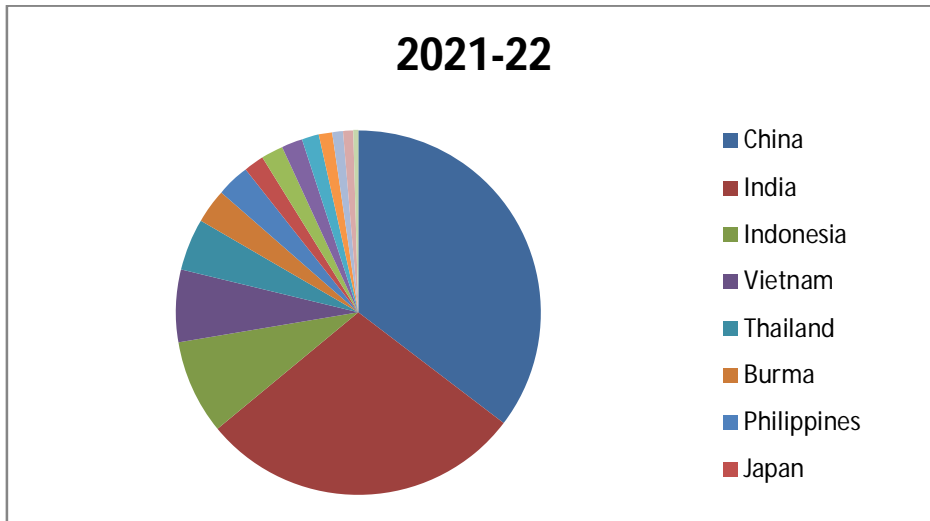


Fig 1: Major Rice Producing Countries in the World (Milled production in million tonnes) Source: www.usda.gov.





Resource Conservation Technologies in Rice Cultivation

Nongmaithem Alena and Ashirbachan Mahapatra*

Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Ashirbachan Mahapatra

Centurion University of Technology and Management,
Odisha, India.

Email: ashirbachan@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Rice has become an integral part of life for people of Asia. Its production and consumption contribute to food security in South Asia. The conventional practice of rice crop husbandry has always been a time, cost, labour and energy intensive method for the farmers which has led them to avoid this crop in the progressive time. But this is a threat to food security in this region. Increased cost of cultivation due to high labour wages, cost of agrochemicals, agro-inputs and petroleum has led rice cultivation unprofitable. So the need of the time is to establish some improved technologies which not only reduce and conserve the resources but also bring increased productivity and profitability to the farmers. Resource conservation technologies (RCTs) are those which conserve any resources viz. water, fertilizer, time, cost, labour, energy and agrochemical load on the environment. RCTs in rice include different crop establishment technologies like System of Rice Intensification, direct, aerobic rice, direct seeded rice and other cultural methods like use of leaf colour chart, brown manuring, alternate wetting and drying, stale seed bed, mulching and crop residue management. RCTs in rice cultivation will ensure profitability as well as sustainability to the system.

Keywords: Resource conservation technology, Rice, Sustainability, Direct seeded rice

INTRODUCTION

Rice (*Oryzasativa* L.) is a staple food of more than 60% of the world's population (Khushet *al.*, 2009; Mangarajet *al.*, 2021; Pattanayaket *al.*, 2022). The crop is grown in about 43.8 million ha, with a production of 118.4 million tonnes and average productivity of 2.7 t ha⁻¹ in the year 2019-20 (Annual Report 2020-21, Department of Agriculture, Cooperation & Farmers' Welfare Ministry of Agriculture & Farmers' Welfare, Government of India). Rice contributes the most to food security especially in South Asia. Rice is primarily a high-energy or high calorie food as it contains less protein than wheat (Khatiket *al.*, 2012). Due to water scarcity and urbanisation in India, the area under rice is predicted to reduce to around 40 million hectares in the next 15-20 years (Wiket *al.*, 2008). But rice is one of the most water, labour, energy and cost intensive crops. The traditional method of rice growing is transplanted rice which requires puddling, nursery raising and transplanting that require more time, energy, labour and water. Agriculture

43209



**Nongmaithem Alena and Ashirbachan Mahapatra**

consumes more than 80% of fresh water, with rice growing accounting for 50% of that (Bouman, 2001; Zamanet *al.*, 2017; Maitra and Pine, 2020). Rice requires around 3000–5000 litres of water to produce 1 kg of rice (IRRI 2001). Rice production may be threatened by water scarcity, needing the development and adoption of water-saving techniques in order to maintain high levels of production and productivity despite the impending water crisis. Moreover, the cultivation of rice is becoming unprofitable because of rising input costs, high labour costs, limited input responsiveness and lack of diversification. As a result, farmers it is essential to establish an appropriate culture system that is not only cost-effective and beneficial for improved growth and development, but also allows for efficient use and conservation of vital resources. The primary goal of resource conservation technologies (RCTs) in rice is to save every possible resource by reducing its inputs like tillage, water, fertilizer, agricultural chemicals, time, cost of cultivation and labour maintaining soil nutrients and moisture and without hampering the productivity and profitability. Among 17 SDGs suggested by UNDP, rice-based cropping system with resource conservation technologies has potential to fulfill SDG 2 and 3 (FAO, 2021). Some of the RCTs those can be utilized in rice cultivation have been explained in this paper.

Why Resource conservation technology is required?

The techniques that help to conserve those resource on which sustainability depends, are known as the RCTs (Hobbs and Gupta, 2003). RCTs are the methods that improve resources and input-use efficiency, such as new nitrogen-efficient cultivars, minimum tillage practices that save fuel and improve water productivity, land levelling practises that conserve water. RCTs have developed as a new way to keep agricultural productivity increasing. RCT is a resource saving agricultural crop production strategy that thrives on achieving acceptable profitability while maintaining high and consistent output levels while also protecting the environment. RCT is based on the development of both above and below ground natural biological processes, in this process mechanical tillage is reduced to bare minimum while external inputs such as agrochemicals, minerals and organic fertilizers are given at an optimal level that does not interrupt or interfere with the biological process. As rice is a nutrient depleted crop, its intensive cultivation has degraded overall soil quality, such as soil nitrogen and moisture retention capacity. Leaching, volatilization, and denitrification all contribute to nutrient losses in rice crop lowering the productivity. As a result, crop yield and farmer profitability have declined as a result of the increased pressure of biotic and abiotic challenges as a result of soil degradation. In comparison to farmers' cultural methods, current initiatives have aimed to developed and carry out RCTs with efficient and sustainable tillage or crop establishment and water management.

System of rice intensification (SRI)

SRI is an improved method of rice cultivation developed through participatory on-farm research conducted at Madagascar during 1980s by father Henri de Laulanie, a Jesuit priest in close collaboration with farmers to overcome the problems of rice cultivation in predominantly acidic soil of Madagascar (Stoop *et al.*, 2002). SRI is a set of procedures that involves adjustments in nursery management, transplanting timing, and water, nutrient, and weed management. SRI is a rice-growing technique based on concepts that are different from the standard rice growing method. The main characteristics include transplanting immature seedlings between 8 and 12 days old to preserve tillering and rooting potential. In this method, single seedlings of rice plant are planted carefully rather than in conventional methods of transplanting. SRI is not a new method as it is the alteration of the management practice more productive phenotype from the same genotype of the plant. It includes selection of site, size of bed, seed rate, bed preparation, seed rate and mulching. In this method continuous flooding is not required as Irrigation is used to keep the soil moist but not saturated, and water is allowed in when the surface soil exhibits hairline cracks.

Direct seeded rice (DSR)

DSR has been emerging as a feasible alternative to the resource crises being faced in the conventional rice cultivation. DSR has advantages of fast and convenient planting, less labour due to crop maturity being 7 to 10 days earlier, more effective water usage and high tolerance of water shortages, lower methane, and also increases profits in place with a steady water supply. DSR is a major crop in the high rainfall areas of the Western Ghats, but it is vulnerable to the vagaries of rainfall. RCTs that maintain top soil, increase water holding capacity, and optimise



**Nongmaithem Alena and Ashirbachan Mahapatra**

nutrient cycling are critical to increasing productivity. Due to labour and water restrictions, as well as soil fertility difficulties, there is a growing interest in switching from puddling and transplanting to DSR. Adequate availability of water and labour on low wage favours transplanting whereas, shortage of labour or high labour wage as well as less availability of water favours farmers to go for DSR (Pandey and Velasco, 2005). Labour shortages and rising wages have prompted a recent move from transplanting to DSR in some part of the Southeast Asian countries. DSR can be cheaper than transplanted rice by saving 50% labour cost (Santhiet *et al.*, 1998).

Aerobic Rice

To solve the problem of water scarcity in agriculture, the International Rice Research Institute (IRRI) created "aerobic rice technology". In aerobic rice technology, we save water losses by reducing percolation, seepage and evaporation (Bouman *et al.*, 2002). Aerobic rice is a type of production technique in which specifically developed, input-response rice varieties with aerobic adaptation are grown without the use of ponded water in well-drained, non-puddled, and unsaturated soils. The efficient use of water is the main driving force behind aerobic rice. Kadiyala *et al.* (2012) reported that the total amount of water applied (including rainfall) in the aerobic plots was 967 and 645 mm compared to 1546 and 1181 mm in flooded rice system, during 2009 and 2010, respectively. Therefore, farmers can go for aerobic rice instead of other rice cultures where water requirement is more which will save their resources. Rice is grown in the irrigated upland crop like wheat or maize, which is a fundamental technique to reducing water inputs. Aerobic rice varieties created for this purpose yield as much as irrigated puddled rice kinds grown in rice paddies traditionally.

Leaf colour chart (LCC)

The nitrogen status of plant can be determined using leaf colour chart (LCC). Nitrogen utilization can be maximized by matching nitrogen supply to crops demand indicated by changes in leaf chlorophyll concentration and colour (Jena *et al.*, 2020). It is a simple handy, pocket tool which consists of 6 strips of different shades of green from pale green to dark green. The LCC has been developed by International Rice Research Institute (IRRI). The use of LCC helps in identifying the appropriate time to apply nitrogen as well as to avoid excessive application of fertilizers. Using of LCC is simple as it is easy to use and affordable in all the situations. The studies indicate that the nitrogen can be saved from 10 – 15% by using the LCC (Sharma *et al.* 2008). In three splits in rice, N management by LCC outperformed locally advised N application in hybrid and inbred rice. Some advantages of LCC are increase crop yield, it is affordable, it avoids the disease which will cause by lack of nitrogen and it also help in the reduction of the GHG emission.

Alternate wetting and drying (AWD)

For more than a decade, farmers have been using AWD as water saving technology. In this methods soil is allowed to dry and wet alternatively for some days within the irrigation schedule considering the developmental stage of the crop. Savings in irrigation water in the AWD treatments were 53– 87 mm (13–16%) compared with the continuously submerged regime (deVries *et al.*, 2010). Water productivity was significantly higher in the AWD regime than in the continuously submerged regime (Belder *et al.*, 2004). It is a water-saving technology (saves water upto 30%. In AWD, irrigation water is delivered a few days after ponded water has vanished, causing the land to alternately flood and non-flood. Though, water usage is still significant in AWD due to the requirement that the soil be submerged at least throughout the irrigation period, it can still be classified as RCT in rice farming. For rice farmers all across the world, AWD is a promising, productive, and environmentally friendly technology. The AWD method is used in all major rice producing regions, but it is not generally adopted, partly because of the complex interrelationships of agricultural and socioeconomic systems as well as a lack of institutional backing.

Brown manuring

Brown manuring is a technique to grow Sesbania crop in standing rice crop and kill them with the help of herbicide for manuring (Maitra and Zaman, 2017). This method is beneficial in many ways as it helps in moisture conservation, adds organic matter in the soil and also helps in fixing atmospheric nitrogen in direct seeded rice with brown



**Nongmaithem Alena and Ashirbachan Mahapatra**

manuring, zero till wheat and rice residue gives superior crop productivity and water productivity as compared to transplanted rice-wheat system (Das *et al.*, 2013). Rice and sesbania are grown together and allowed to grow for 25-30 days in brown manuring. This method can be used with maize, pearl millet, and sorghum. Although 2,4-D cannot be utilized on a broad scale on crops like soybean, Sesbania can be cut manually and placed as mulch between crop rows to suppress weeds and conserve moisture and nutrients. Brown manuring not only adds organic matter content but also improves the physio-chemical and biological properties of the soil (Midya *et al.*, 2021).

Mulching/Crop residue management in rice

Crop residues are part of plants left in the field after the crops have been harvested and threshed (Goswami *et al.*, 2020). Stalk, stem, stubbles and leaves are example. Crop residues can help preserve soil moisture, increasing the fertility of the soil and also help in weed control when utilized as mulches in direct seeded system. Mulching increased rice water production, spikelet fertility, paddy output, and rice quality by retaining moisture in soil (GhousePeera *et al.*, 2020). This emphasises the necessity of mulching in rice cultivation systems that conserve water. It's through the chain of events of crop residues management, it also regulates the efficiency with which fertilizer, water and other reserves are used in a cropping system (Singh *et al.*, 2005). Mulch application also helped to reduce the amount sterile spikelet and non-productive tillers as well as increase the number of productive tillers, kernel size, and quality. Plastic mulch performs better than straw mulch in terms of increasing water retention, production, as well as in minimizing spikelet sterility (Singh *et al.*, 2021). Finally, mulching increased soil moisture retention, which improved the spikelet fertility, rice water production, rice quality as well as the paddy yield. Therefore, implementing the mulching as a RCT has been ascertained to have a huge potential in sustainable agricultural production and food security.

Stale seed bed

A weed management technique known as the stale seed bed or false seed bed approach is employed on both agricultural and garden scales. In this method, Weeds are permitted to germinate by providing light irrigation or rainfall, and then emergent weed seedlings are killed by non-selective herbicides such as glyphosate, shallow tillage, or flooding. To accomplish so, we must carry out tillage activities. If the soil condition is acceptable then plant the crops without any further tillage as tillage may bring more weed seed to the surface of the soil which may result in weed germination. Stale seed bed technique is another cultural management strategy that can be used before rice crop to reduce the weed seed bank.

CONCLUSION

The use of various RCTs contributes to long-term improvements by enhancing soil health, nutrient efficiency, and water efficiency, as well as improved long-term yields. RCTs save cultivation costs by conserving labour, diesel, time, fertilizers, pesticides, and farm electricity, as well as lowering environmental impact and pollution. Furthermore, it enhances natural resource efficiency, benefits the environment. As a result, combining the usage of these RCTs will help to increase agricultural productivity while also maintaining soil health and ecological balance in a long-term way.

REFERENCES

1. Belder, P., Bouman, B.A.M., Cabangon, R., Guoan, L., Quilang, E.J.P., Yuanhua, L., Spiertz, J.H.J and Tuong, T.P. (2004). Effect of water-saving irrigation on rice yield and water use in typical lowland conditions in Asia. *Agricultural water management*, 65(3): 1933-210.
2. Bouman, B.A.M. (2001). Water efficient management strategies in rice production. *International Rice Research Notes*, 26(2):1-1.





Nongmaithem Alena and Ashirbachan Mahapatra

3. Bouman, B.A.M., Xiaoguang, Y., Huaqi, W., Zhiming, W., Junfang, Z., Junfang, Z., Changgui, W. and Bin, C. (2002) Aerobic rice(Han Dao) a new way of growing rice in water-short areas. *In proceedings of the 12th international conservation organization conference* (vol. 26,p. 31).Beijing, China. Tsinghua University Press.
4. Das, T.K. (2013). Conservation agriculture for enhancing productivity and resource –use efficiency. Annual Reports 2012-13 (IARI – CIMMYT Challenge Program me), Division of Agronomy, Indian Agricultural Research Institute, New Delhi, 45 pp.
5. deVries, M.E., Rodenburg, J., Bado, B.V., Sow, A., Leffelaar, P.A. and Giller, K.E. (2010). Rice production with less irrigation water is possible in a Sahelian environment. *Field Crops Research*, 116(1-2): 154-164.
6. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 30th April, 2022).
7. GhousePeera, P. S. K., Debnath, S. and Maitra, S. 2020. Mulching: Materials, Advantages and Crop Production, *In: Eds. Maitra, S., Dinkar J Gaikwad, D. J. and Shankar, T., Protected Cultivation and Smart Agriculture*, New Delhi Publishers, India, pp. 55-66.
8. Goswami, S.B., Mondal, R. and Mandi, S.K. (2020). Crop residue management options in rice–rice system: a review. *Archives of Agronomy and Soil Science*, 66(9): 1218-1234.
9. Hobbs, P.R. and Gupta, R.K. (2003). Resource-Conserving Technologies for Wheat in the Rice–Wheat System. *Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and Impacts*, 65: 149-171.
10. Jena, J., Palai, J. B. and Maitra, S. (2020). Modern Concepts of Fertilizer Application, *In: Advanced Agriculture*, Eds. Maitra, S. and Pramanick, B., New Delhi Publishers, New Delhi, pp. 388-403.
11. Kadiyala, M.D.M., Mylavarapu, R.S., Li, Y.C., Reddy, G.B. and Reddy, M.D. (2012). Impact of Aerobic Rice Cultivation on Growth, Yield, and Water Productivity of Rice–Maize Rotation in Semiarid Tropics. *Agronomy Journal*, 104(6): 1751- 1765.
12. Khatik, R.L., Bhimawat, B.S. and Upadhyay, B. (2012). Knowledge of improved rice production technology by the farmers in Dungarpur District of Rajasthan. *Rajasthan Journal Extension Education*, 20: 97-101.
13. Khush, G.S. and Jena, K.K. (2009). Current status and future prospects for research on blast resistance in rice (*Oryza sativa* L.). *In: Advances in genetics, genomics and control of rice blast disease*, Springer, Dordrecht, pp. 1-10.
14. Maitra, S. and Pine S. (2020). Smart Irrigation for Food Security and Agricultural Sustainability. *Indian Journal of Natural Sciences*, 10(60): 20435-20439.
15. Maitra, S. and Zaman, A., (2017). Brown manuring, an effective technique for yield sustainability and weed management of cereal crops: a review. *International Journal of Bioresource Science*, 4(1), 1-6.
16. Mangaraj, S., Paikaray, R.K., Maitra, S., Pradhan, S.R., Garnayak, L.M., Satapathy, M., Swain, B., Jena, S., Nayak, B., Shankar, T., Alorabi, M., Gaber, A. and Hossain, A. (2022). Integrated Nutrient Management Improves the Growth and Yield of Rice and Greengram in a Rice—Greengram Cropping System under the Coastal Plain Agro-Climatic Condition. *Plants*, 11: 142. <https://doi.org/10.3390/plants11010142>
17. Midya, A., Saren, B.K., Dey, J.K., Maitra, S., Praharaaj, S., Gaikwad, D.J., Gaber, A., Alsanie, W.F., Hossain, A. (2021). Crop Establishment Methods and Integrated Nutrient Management Improve: Part I. Crop Performance, Water Productivity and Profitability of Rice (*Oryza sativa* L.) in the Lower Indo-Gangetic Plain, India. *Agronomy* 11: 1860. doi: 10.3390/agronomy11091860
18. Pandey, S. and Velasco, L. (2005). Trends in crop establishment methods in Asia and research issues. *Rice is life: Scientific perspectives for the 21st century*, pp. 178-181.
19. Pattanayak, S., Jena, S., Das, P., Maitra, S., Shankar, T., Praharaaj, S., Mishra, P., Mohanty, S., Pradhan, M., Swain, D.K., Pramanick, B., Gaber, A., Hossain, A. (2022). Weed Management and Crop Establishment Methods in Rice (*Oryza sativa* L.) Influence the Soil Microbial and Enzymatic Activity in Sub-Tropical Environment. *Plants* 11: 1071.
20. Santhi, P.K., Ponnuswamy, K. and Kempuchetty, N. (1998). A labour-saving technique in direct-sown and transplanted rice. *International Rice Research Notes* 23: 35-36.
21. Sharma, R.K., Chhokar, R.S. and Gill, S.C. (2008) Resource conservation technologies under rice-wheat cropping system. Compendium on Advances in genetic enhancement and resource conservation technologies for enhanced productivity, sustainability and profitability in rice-wheat cropping system, 10-30 January, DWR, Karnal, pp. 144-150.





Nongmaithem Alena and Ashirbachan Mahapatra

22. Singh, S.P., Mahapatra, B.S., Pramanick, B. and Yadav, V.R. (2021). Effect of irrigation levels, planting methods and mulching on nutrient uptake, yield, quality, water and fertilizer productivity of field mustard (*Brassica rapa* L.) under sandy loam soil. *Agricultural Water Management*, 244: 106539. <https://doi.org/10.1016/j.agwat.2020.106539>
23. Singh, Y., Singh, B. and Timsina, J. (2005). Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping system in the tropics. *Advances in Agronomy*, 85: 269-407.
24. Stoop, W.A., Uphoff, N. and Kassam, A., (2002). A review of agricultural research issues raised by the system of rice intensification (SRI) from Madagascar: opportunities for improving farming systems for resource-poor farmers. *Agricultural systems*, 71(3): 249-274.
25. Wik, M., Pingali, P. and Brocai, S. (2008). Global Agricultural Performance: Past Trends and Future Prospects. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/9122> License: CC BY 3.0 IGO
26. Zaman, A., Zaman, P. and Maitra, S. (2017). Water resource development and management for agricultural sustainability. *Journal of Applied and Advanced Research*. 2 (2):73-77.





New Approach to Face Leakage Challenge due to Technology Scaling.

Sandipan Pine*, Satyanarayan Padhy, Rajesh Kumar Mishra, Prabhat Kumar Patnaik and N.Jeevaratnam

Department of Electronics and Communication Engineering, Centurion University of Technology and Management, Odisha, India.

Received: 06 Mar 2022

Revised: 09 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Sandipan Pine

Department of Electronics and Communication Engineering,
Centurion University of Technology and Management,
Odisha, India.

Email: sandipan@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

When we go for new technology leakage is a problem. Technology scaling enhances clock speeds, functional integration, and power density. It makes the performance better by improving density of transistor and chip functionality. When we scale down the supply voltage, threshold voltage is also reduced but the main problem is the leakage current also exponentially increases with this supply voltage scaling. Leakage is directly proportional to the thickness of the gate oxide. As of now leakage power dissipation has become the leading issue in VLSI design. Leakage current contributes to around 40 percent of total loss when we talk about of 65 nanometer or less technology. Although there are a lot of technology available to reduce the leakage dissipation, we have proposed a completely new method to minimize the leakage. While there are several process technology and circuit-level solutions to reduce leakage in processors, we propose new technique to reduce the leakage.

Keywords: Leakage, power dissipation, MOSFET Scaling, Tunneling, DIBL, Punch through

INTRODUCTION

Nowadays leakage power dissipation has become an increasing concern for VLSI engineers. Leakage power dissipation will dominate total power consumption in near future [1]. Power dissipation has dynamic and static parts. Dynamic power dissipates during switching, and static power during rest of the time. Until 180nm technology dynamic power consumption was the largest but as technology scaling goes on static power consumption also has become a great challenge. Various sources of leakage is shown in fig-1. They are:

- DIBL (Drain induced barrier lowering)
- Channel punch through
- Gate oxide leakage (Tunneling current)
- Sub-threshold leakage (weak inversion current)



**Sandipan Pine et al.,**

Drain induced barrier lowering occurs when at very high drain voltage, threshold voltage is reduced. As drain voltage is increased, the depletion region of the p-n junction between the drain and body increases in size and extends under the gate, so the drain assumes a greater portion of the burden of balancing depletion region charge, leaving a smaller burden for the gate. As a result, the charge present on the gate retains charge balance by attracting more carriers into the channel, an effect equivalent to lowering the threshold voltage of the device. In very less channel distance the depletion region around the source region and the depletion region around drain region touches each other. This case of MOSFET is known as punch through. So the channel field is completely dependent on V_{DS} and I_D now. So when V_{DS} changes, a sharp increase in I_D observed. Gate oxide leakage is also known as tunneling current. When we reduce the thickness of oxide layer to enhance performance, simultaneously it reduces the barrier voltage of the gate oxide layer. Hence we found a flow of current through the gate oxide. This phenomenon is called as tunneling or gate oxide leakage. When gate to source voltage is below the threshold voltage of the MOSFET, the transistor is said to be in weak inversion region. In this scenario the flow between source and drain is called sub-threshold leakage.

Problem Declaration

As feature size in VLSI technology is reducing regularly, power dissipation has become a big challenge. Initially dynamic power was a major concern but now static power itself leads the role. Previously this issue was attended by scaling the supply voltage to minimize the leakage power. But performance got degraded as waiting time is increased for restoring the lost state. So state need to be retained for fast response system, even during inactive state also. Main general approaches are either sleepy keeper or sleepy stack approach. Each one are fairly good in this context. In sleepy stack, dynamic and static power dissipation is very low. However area and delay are a bit of concern in this process. In the other hand speed in sleepy keeper technique is considerably high but again static and dynamic loss is more here compare to sleepy stack approach. The aim of this work is to find out a solution among these limitations and hence to get a solution for all criterion, minimum static and dynamic loss, minimum area with maximum speed.

Motivation

In VLSI design one of the leading technology is CMOS. When we go for technology scaling leakage is a problem. Technology scaling enhances clock speeds, functional integration, and power density. It makes the performance better by improving density of transistor and chip functionality. When we scale down the supply voltage, threshold voltage is also reduced but the main problem is the leakage current also exponentially increases with this supply voltage scaling. Leakage is directly proportional to the thickness of the gate oxide. As of now leakage power dissipation has become the leading issue in VLSI design [8][9]. Leakage current contributes to around 40 percent of total loss when we talk about of 65 nanometer or less technology. Although there are a lot of technology available to reduce the leakage dissipation, we have proposed a completely new method to minimize the leakage. The aim of this work is to find out a solution for minimum static and dynamic loss, minimum area with maximum speed. While there are several process technology and circuit-level solutions to reduce leakage in processors, we propose new technique to reduce the leakage.

Present Approaches

The approaches that are adopted presently are

Base Case: It is the initial design, contains a NMOS as driver and a PMOS as load. Area requirement is very minimum here and it's a state saving design. To minimize leakage, no method is adopted here. A base case inverter is shown Figure 2.

Sleep Transistor Technique: As shown in fig-3, in this method both driver and load circuit is designed by sleep transistors. Another name of this method is gated supply gated ground method. Mutoh et al. propose a technique





Sandipan Pine *et al.*,

they call Multi-Threshold- Voltage CMOS (MTCMOS) [2], which adds high-threshold sleep transistors between load circuit and supply voltage and between driver circuit and ground.

Forced Stack:This method uses stack of transistor to reduce the leakage as shown in fig-4 [3]. As a result of transistor stack, sub threshold leakage is controlled. Hence the method is useful.

Sleepy track approach:Fig 5 shows sleepy track approach. This method combines forced stack method with sleep transistor technique [4].So the name has been given sleepy track.

Sleepy keeper approach:The approach is shown in fig-6[5]. It opposes the conventional CMOS technology by adding a combination of NMOS and PMOS in driver as well as load network.

Dual sleep approach:Design of dual sleep network is shown in fig-7 [6]. To minimize the leakage it has used a different method. In each driver and load block, it has used one sleep transistor. At a particular time anyone will be on, hence no static leakage.

Proposed work

Forced sleep Method:Proposed design is shown in fig-8. It's a combination of sleep transistor and forced stack technique. Although delay is bit concern here but other parameters are far improved in this method. The leakage becomes ultra-low. The aspect ratio of PMOS and NMOS are 3 and 1.5 for the forced sleep method, while in general inverter it is 6 and 3. After that sleep transistors are connected in series with each set of two stacked transistors.

Stacked sleep Method:This method is shown in fig-9. Here in both load and driver circuit 2 stacked sleep transistor are used. So here both stack effect [7] and sleep transistor effect help to reduce the leakage power. Although we know that PMOS is a weak ground passer and NMOS is a weak supply passer, here in this design PMOS are used as driver and NMOS are used as load. This method helped to maintain exact logic in sleep mode. In this technique NMOS and PMOS aspect ratio is maintained at 3 and 6 respectively for the inverter design. For the stacked sleep transistor this technique uses aspect ratio =1 for both. The extra two transistors of the design for maintaining the logic state during sleep mode also use aspect ratio =1.

Variable body bias technique: The design is shown in fig-10. It consists of 2 sleep transistors, parallelly connected to ground. To eliminate body bias effect source of one transistor is tied to the body of the other. So variable body biasing effect is added here with sleep transistor effect to eliminate leakage at its most.

SIMULATION RESULT

All the previous designs as well as proposed designs are compared in terms of power consumption (dynamic and static), delay and area. Synopsis HSPICE is used for simulation purpose to estimate delay and power consumption. Micro wind software is used for area calculation. All considered approaches are evaluated for performance by using a single, low- V_{th} for all transistors. Transistors in the forced stack approach are sized to half of the size of the base case transistors, e.g., transistors used in pull-up and pull-down of the base case inverter chain have aspect ratio =3 and 1.5 respectively. Similarly, transistors, including sleep transistors, in the sleepy stack approach are sized to half of the size of the base case transistors. Variable body biasing technique uses aspect ratio =3 and 6 for NMOS and PMOS. Table 1 shows the result of different methods using 32 nm technologies. Figure 11 shows the static power dissipation of a chain of four inverters in different technologies. In case of 32 nm technology stacked sleep approach gives 83.41% and variable body biasing technique gives 69.29% good results than the dual sleep approach. The forced sleep approach shows a 99.49% satisfactory result rather than the dual sleep approach. Figure 12 shows the dynamic power dissipation of a chain of four inverters in different technologies. In case of 32 nm technology stacked sleep approach gives 65.49% and variable body biasing technique gives 50.44% good results than the dual sleep



**Sandipan Pine et al.,**

approach. Forced sleep approach also shows a 93.53% good result than the dual sleep approach. Figure 13 shows the propagation delay of a chain of four inverters in different technologies. In case of 32 nm technology stacked sleep approach gives -238.08% worst and variable body biasing technique gives -102.49% worst results compare to the dual sleep approach. Figure 14 shows the area of a chain of four inverters in different technologies. In case of 32 nm technology both the stacked sleep approach and the variable body biasing technique gives -20.31% worst result than the dual sleep approach. Forced sleep approach gives -39% worst results than the dual sleep method.

CONCLUSION

In case of a chain of four inverters, sleepy stack method shows 7.5802% improvement and 92.8275%, 58.8095% degraded performance than stacked sleep method in propagation delay, dynamic power and static power, respectively. When compared to variable body biasing technique, sleepy stack method shows 49.1254%, 87.6638% & 42.7778% degraded performance in propagation delay, static power and dynamic power, respectively. Again in comparison with sleepy stack approach, forced sleep technique gives 93.35% degraded performance in propagation delay, but gives comparatively good performance in static and dynamic power. In comparison with dual sleep approach, stacked sleep shows 64.4665% degraded and 582.81%, 195.96% improved performance in propagation delay, static and dynamic power respectively. Variable body bias technique shows 40.0423% degraded but 283.66% and 114.240% improved performance in propagation delay, static and dynamic power respectively. Forced sleep technique also gives good performance in static and dynamic power but degraded performance in propagation delay. So the novel stacked sleep, variable body bias and forced sleep technique shows better performance when compared to the sleepy stack and dual sleep method. Finally, these proposed methods show the least speed power product among all methods. Moreover, the novel stacked sleep, variable body bias and forced sleep method shows best performance as far as area requirement and speed are concerned.

REFERENCES

1. International Technology Roadmap for Semiconductors by Semiconductor Industry Association, 2002. [Online] Available <http://public.itrs.net>
2. S. Mutoh et al., "1-V Power Supply High-speed Digital Circuit Technology with Multithreshold-Voltage CMOS," IEEE Journal of Solid-State Circuits, Vol. 30, No. 8, pp. 847-854, August 1995.
3. Narendra, S., S. Borkar, V. D., Antoniadis, D., and Chandrakasan, A., "Scaling of Stack Effect and its Application for Leakage Reduction," Proceedings of 148 the International Symposium on Low Power Electronics and Design, pp. 195-200, August 2001.
4. J.C. Park, V. J. Mooney III and P. Pfeifferberger, "Sleepy Stack Reduction of Leakage Power," Proceeding of the International Workshop on Power and Timing Modeling, Optimization and Simulation, pp. 148-158, September 2004.
5. J. Kao and A. Chandrakasan, "MTCMOS sequential circuits, Proceedings of European Solid-State Circuits Conference, pp 332-335, September 2001.
6. Nittaranjan Karmakar, Mehdi Z. Sadi, Md. Khorshed Alam and M. S. Islam, "A Novel Dual Sleep Approach to Low Leakage and Area Efficient VLSI Design" IEEE-RSM Proc. 2009, Kota Bahru, Malaysia
7. Johnson, M., Somasekhar, D., Chiou, L.-Y., and Roy, K., "Leakage Control with Efficient Use of Transistor Stacks in Single Threshold CMOS," IEEE Transactions on VLSI Systems, vol. 10, no. 1, pp. 1-5, February 2002.
8. Siba Prasad Rath, Sandipan Pine "Design and Logic Optimization of High Speed Adder Circuits Using FPGA," in IFRSA International Journal of Advanced Engineering, vol. 1, issue 1, pp. 67-75, March 2015.
9. Ranjan Kumar Mahapatro, Sandipan Pine "Design of a Low Power Current Steering Digital to Analog Converter in CMOS," in International Journal of Engineering Research & Technology (IJERT), vol. 4, issue 4, pp. 870-874, April 2015.





Sandipan Pine et al.,

Table 1: Data for 32 nm technology

| Method | Propagation Delay(s) | Static Power(w) | Dynamic Power(w) | Area(μm^2) |
|-----------------------|----------------------|-----------------|------------------|-------------------------|
| Base Case | 2.4484E-11 | 8.7649E-08 | 3.6138E-06 | 1.20 |
| sleep | 3.6201E-11 | 1.6272E-09 | 2.7774E-06 | 2.45 |
| Forced Stack | 1.3511E-10 | 3.9920E-10 | 8.0436E-07 | 1.38 |
| Sleepy Stack | 5.8477E-11 | 7.0533E-10 | 1.4503E-06 | 2.07 |
| Sleepy Keeper | 4.0711E-11 | 1.4976E-09 | 2.8465E-06 | 1.83 |
| Dual sleep | 3.8831E-11 | 1.1840E-09 | 2.0870E-06 | 1.28 |
| Stacked sleep | 1.3128E-10 | 1.9640E-10 | 7.2014E-07 | 1.54 |
| Variable body biasing | 7.8629E-11 | 3.6360E-10 | 1.0344E-06 | 1.54 |
| Forced sleep | 3.3781E-09 | 5.9908E-12 | 1.3517E-07 | 1.78 |

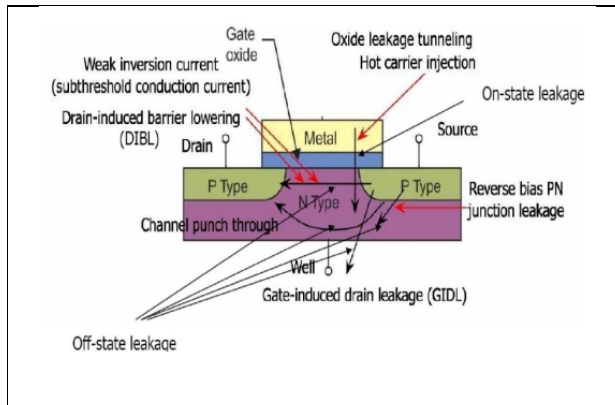


Fig 1: Various sources of leakage

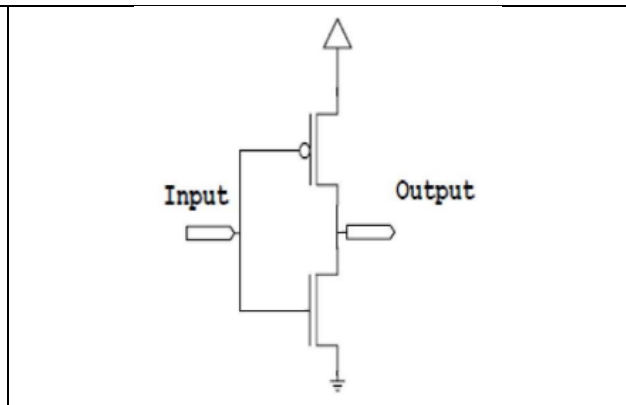


Fig 2: Base case inverter.

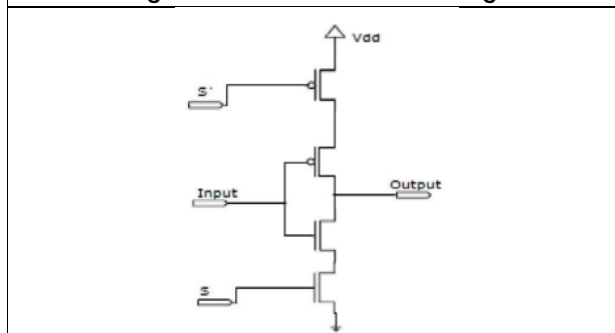


Fig 3: Sleep Transistor Technique

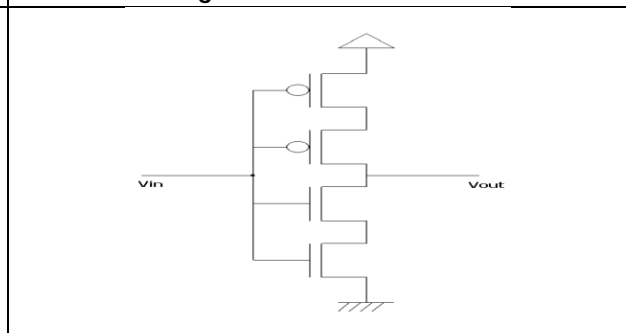


Fig 4: Forced Stack

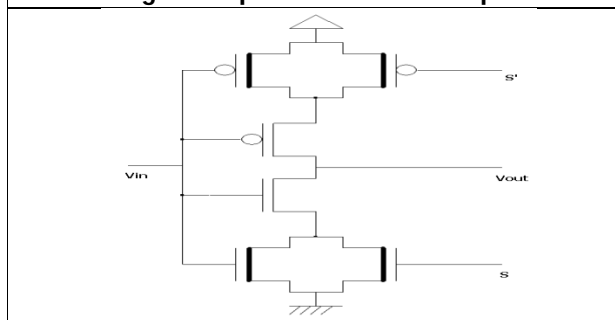


Fig 5: Sleepy stack approach

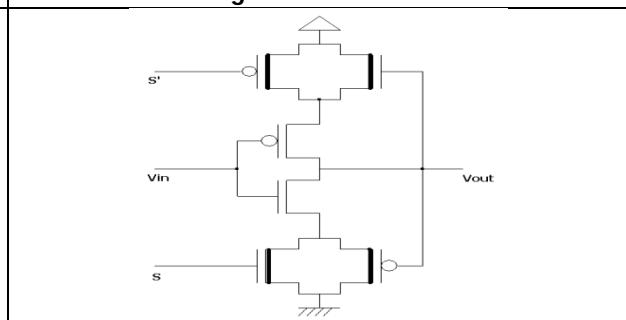


Fig 6: Sleepy keeper approach





Sandipan Pine et al.,

| | |
|--|---|
| | |
| <p>Fig 7: Dual sleep method</p> | <p>Fig 8: Forced sleep method</p> |
| | |
| <p>Fig 9: Stacked sleep method</p> | <p>Fig 10: Variable body bias technique</p> |
| | |
| <p>Figure 11: Comparison of Static power dissipation of a chain of four inverters</p> | <p>Figure 12: Dynamic power dissipation of a chain of four inverters</p> |
| | |
| <p>Figure 13: Propagation delay of a chain of four inverters</p> | <p>Figure 14: Area of a chain of four inverters</p> |





A Review: Agronomic Biofortification with Zinc

Abhrajyoti Dalal and Swarnali Duary*

Department of Agronomy, Centurion University of Technology and Management, Odisha, India.

Received: 05 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Swarnali Duary

Department of Agronomy,
Centurion University of Technology and Management,
Odisha, India.

Email: swarnali.duary@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Micronutrient malnutrition has become a serious health issue over recent decades and it needs an immediate remedy. Major causes of malnutrition are food insecurity, poor nutritional value of food, imbalance diet, lack of dietary diversity etc. Globally nearly two billion people are affected by the deficiency of the micronutrient. Deficiency of zinc in the soil results into poor intake of zinc by human in their daily diet and reduction of zinc bioavailability. To get rid of this condition some strategies like consumption of diversified diet, diet supplementation and fortification can be adopted. But these are not economical and rural communities cannot afford them. In this regard, biofortification is a sustainable process to reduce the micronutrient deficiency in the population, especially for the population of low-income countries. Agronomic biofortification with zinc is a measure to increase the concentration of zinc in food grain. It is a cheap and easy method to ensure grain zinc enhancement. Genetic biofortification is also there to reduce micronutrient deficiency but it is a time taking but highly effective process. Therefore, agronomic as well as genetic biofortification can be very helpful to reduce the micronutrient deficiency and will also help to increase the micronutrient in the food basket.

Keywords: Agronomic biofortification, Genetic biofortification, Micronutrient, Malnutrition, Zinc

INTRODUCTION

The main keys for human health are proper food with proper nutrition. Improper food, imbalanced diet, consumption of low nutritional food etc. adversely affect the human health (Gundersen and Ziliak, 2015). People of low-income countries largely rely on staple food rather than the fruits, vegetables, food from animal sources as compare to high income countries. Because of insufficient amount of micronutrient in diet micronutrient malnutrition occur which results in serious but sometime invisible health issue referred to as hidden hunger. Micronutrients are not only important for improved crop productivity but also essential for human and animal health. But the Indian soils are mostly deficit in micronutrient zinc. These soils are actually using for crop production



**Abhrajyoti Dalal and Swarnali Duary**

and the availability of the micronutrient is getting decreased in the grain to many folds. Due to an inadequate intake of essential micronutrient in daily diet, nearly two billion people around the world have been suffering from the deficiency of the micronutrient (Zamanet *et al.*, 2018). Nearly half of the populations of the world who are suffering from nutrient deficiency live in India. In India more than 6000 children below the age of five die every day and among those nearly half of the deaths account for the lack of zinc, iron, iodine, folic acid, vitamin A which accounts to the loss of about three million young lives in a year (Kotecha, 2008). Besides that, various other health problems like infection, improper mental development, weakness, anemia, poor physical growth, damage of DNA, cancer etc are due to the deficiency of zinc. To fight against this condition some adoptions can be made like adoption of nutrient specific approach i.e., consumption of diversified diet, supplementation, fortification and the nutrient sensitive approach i.e., biofortification. Biofortification approach refers to the enhancement of concentration of the nutrient in healthy edible portion of plant through genetic or agronomic approach. So biofortification is needed to make nutritionally superior food for every person in the world at an affordable price and biofortification of the food grain with zinc will help to reduce the impact of hidden hunger which ultimately leads to alleviate zinc malnutrition. Out of the 17 SDGs recommended by UNDP, agronomic biofortification with zinc has enough potential to fulfill SDG 2 and 3 (FAO, 2021).

Biofortification

The term biofortification is derived from Greek word “Bios” means life and Latin word “Fortificare” means making strong (Bagde and Borkar, 2103). Therefore, biofortification means enhancement of nutritional value of food crop with increased bioavailability to human population (Hossain *et al.*, 2021). One of the important threats faced by world is micronutrient deficiency. Biofortification is the process which provides sustainable, cost effective and long term means to deliver micronutrient which is one of the mitigation processes of malnutrition or hidden hunger.

Approaches of biofortification**Agronomic biofortification**

Agronomic biofortification is the way of enhancing the density of the mineral in food grain and fruits by fertilization process at responsive growth stages of crop plant (Hossain *et al.*, 2019; Lakshmi *et al.*, 2021; Praharajet *et al.*, 2021). This practice helps to enhance the density of mineral in crop by foliar application, soil application, seed treatment, use of soil amendments. This is an inexpensive and easy method to increase the concentration of micronutrient in food crop as well as decrease dietary deficiency. Application of zinc and iron especially in cereal crop is an ideal strategy to reduce the deficiency of micronutrient. For this purpose, it is very important to have knowledge about various forms of zinc fertilizer and their time of application. The recent introduction of nano fertilizers can also be included for agronomic biofortification (Durgudeet *et al.*, 2022).

Genetic biofortification

Another approach to increase the mineral concentration in crop is genetic biofortification. In case of conventional breeding, breeding of the crop is done for the varieties with high micronutrient content. One of the most important tools in crop biofortification is to take advantage of the genetic variation in crop for micronutrient concentration. But the transgenic/biotechnological approach is different from plant breeding approach. In this approach the transfer of heritable traits is allowed between completely unrelated species. In recent years, new traits into commercially important plants have been introduced by genetic engineering techniques which have helped to produce combination of features that was impossible to achieve by traditional breeding.

Role of zinc in human health

For maintaining the human health zinc is very important nutrient. Over 300 enzymes are dependent on zinc for their function. Zinc is also very important for growth, development, reproductive health, immune function etc. Sometime various symptoms also appear due to the deficiency of zinc and the negative impact may vary with age. In case of early infant diarrhea is one of the most common symptoms. In case of school-aged children, they suffer from skin problem, infection and dwarfing. Adults also suffer from zinc deficiency which includes infection, non-healing leg



**Abhrajyoti Dalal and Swarnali Duary**

ulcers and adverse pregnancy outcomes. Zinc deficiency is more effective especially in the time period of infancy, pregnancy and puberty. Intake of zinc supplements help to reduce the risk of diarrhea, pneumonia, malaria etc. Therefore, zinc is very important for human health and to enhance the bioavailability of zinc various strategies have been made for improving the intake of zinc among human. Thus not only the intake of zinc but also its bioavailability is very much important to improve the zinc nutrition.

Role of zinc in crop

Zinc is one of the important essential plant nutrients and it is required in low amount so it is known as micronutrient. It has a significant role in the overall growth and development of plant. Zinc is present in plant may be in the ionic form or bound with low molecular weight compound. For carbohydrate metabolism, lipid and nucleic acid metabolism zinc is essential. Zinc is also involved in various biochemical processes like chlorophyll synthesis, auxin metabolism etc. Zinc is responsible for activation of different enzyme. It has been reported that zinc plays an important role in uptake of water and transport in plants. Zinc induces heat tolerant and stress tolerant characteristics in the plant for a short term of period. Zinc also induces a defensive characteristic in plant against pathogen and herbivores. Chlorophyll content decreases significantly due to zinc deficiency which leads to the abnormal structure of chloroplast; thus, photosynthesis is negatively affected. Deficiency of zinc in plant also results into the damage of membrane integrity and thus the leakiness of membrane increases.

Agronomic biofortification with zinc: The concept

The yield of the crop and the nutritional quality of grain is affected due to zinc deficiency. In developing countries cereals have an important role to supply daily calorific need but those cereals are usually low in zinc concentration. When the crops are grown in the soil with zinc deficiency, zinc concentration get reduced in the crop. This reduction of micronutrient in the soil might be due to lower application of micronutrient fertilizer, addition of less amount of organic matter in soil or due to intensive agriculture that results into the removal large amount of nutrient as well as micronutrient. For a successful biofortification it is very important to understand the physiological importance of micronutrients accumulation in the grain, therefore biofortification has made trial to improve the interrelationship between the soil-crop-human in such a way that the zinc deficiency can be alleviated in human.

Effect of various method of zinc application on grain zinc enrichment

Zinc is applied to the crop through various methods like foliar application, soil application and seed application or may be applied through the combination of all these methods. All these application methods are having some advantages and disadvantages respectively. Most commonly used method is soil application method where soil environment (soil pH, soil moisture etc) determines the efficacy of soil applied fertilizer. But in case of foliar application the crop determines the uptake and translocation of nutrient.

Soil Application

One of the most common practices to increase the productivity in agricultural soils which are deficient in zinc is soil application of zinc fertilizer. The main motto of such application is to maintain the zinc concentration in human body by increasing the concentration of zinc in the edible part of food crop. Soil pH determines the efficiency of soil applied zinc fertilizer. The availability of zinc has been found to be higher in acidic soil. But application of lime to acidic soil reduces the bioavailability of zinc. In alkaline soil zinc is less available. As transportation of zinc to the plant root takes place through diffusion, zinc availability to the plant will be reduced by moisture deficiency and low organic matter. Thus, the efficiency of soil applied zinc fertilizer is more affected under rainfed condition than under irrigated condition. Not only the chemical characters, biological characters also play an important role in determining the availability of zinc to plants. PGPRs refers to the group of bacteria have the capacity to improve the uptake and mobility of the nutrients to the plants. The source as well as the dose of zinc application affects the yield and grain quality. Therefore, to avoid the zinc toxicity to plants, dose of zinc application should be recommended carefully.



**Abhrajyoti Dalal and Swarnali Duary****Foliar Application**

Various factors like type of fertilizer, characteristics of crop, characteristics of leaf etc determine the efficiency of foliar zinc application. Comparatively less requirement of fertilizer, reduction in zinc fixation etc are the several advantages provided by foliar application. To get effective foliar application of zinc fertilizer it is very important to select the proper time of fertilizer application. Application of zinc at a later growth stage enriches the seed zinc content. If zinc fertilizer is applied at heading and early milk stage it will be more effective than foliar application of zinc at stem elongation and booting stage. Foliar application of zinc is also helpful to increase grain productivity under drought conditions.

Seed Application

Those seeds which are containing large amount of zinc are capable to improve the crop stand and seed vigour and in the field. If plants grow in an area which is deficient in nutrient, then nutrient deficiency will also be observed in the produced seed and further use of such seed in a nutrient deficient area will lead to reduction in seedling vigour, growth and yield of the plant. As transportation of zinc to the plant root takes place through diffusion, zinc availability to the plant will be affected by moisture deficiency. In case of rainfed condition where the soil moisture is totally depending on rainfall, zinc nutrient is highly inconsistent. Therefore, to increase the yield and plant growth under rainfed condition or zinc deficient area zinc rich seed are required.

Combinations of application method

Different combination of soil, foliar and seed application method has been found effective to improve the zinc concentration (Mathpalet *et al.*, 2015). In few experimental locations a combination of foliar and soil application of zinc has been recorded more effective in enhancing grain zinc density in exchange of individual soil or foliar application. In case of durum wheat soil application is less effective to increase the grain zinc concentration. But a combine application of soil and foliar application in durum wheat effectively improve the grain zinc concentration (Cakmak *et al.*, 2010).

Distribution and uptake of zinc in plant organs

Zinc is dispersed unevenly within the plant. Root crops and leafy vegetables have higher zinc contents than seed, grain, fruit, or tuber crops (Pfeiffer and McClafferty, 2007). Zinc is preferentially deposited by particular cell types within each organ. Zinc, for example, is concentrated in the pericycle of monocotyledonous species and endodermal cells of dicotyledonous species and is found in exclusive areas within the root, such as the elongation zone (Van Steveninck *et al.*, 1994). Plant species have different zinc distributions in their shoots and leaves. Zinc accumulates preferentially in the embryo, husk and aleurone layers of cereal seeds (Hansen *et al.*, 2009). When polished grains or peeled tubers are ingested, the distribution of zinc within tubers and cereal seeds reduces possible dietary zinc intake from these crops. Zinc accumulates in soluble as well as insoluble forms in plant tissues. Much of the soluble zinc in agricultural crop is complexed with organic molecules. Carboxylic acids, such as citrate and malate, amino acids, such as histidine and asparagine and proteins are among these molecules. Zinc is also found as phosphate salts like $Zn_3(PO_4)_2$ and organic Zn-phytates. Zinc is mostly found in the vacuoles of root and leaf cells as Zn^{2+} and Zn-organic acid complexes. Zinc is also found in the xylem, primarily as Zn^{2+} and as complexes with carboxylic acids like citrate and malate (Broadley *et al.*, 2007; Terzano *et al.*, 2008). Phloem sap, on the other hand, has very little Zn^{2+} , and it is hypothesized that zinc is delivered in complexes with nicotianamine or small proteins (Curie *et al.*, 2009; Waters and Sankaran, 2011).

Economic and environmental concern of fertilizer strategy for biofortification

A probable demerit of fertilizer strategy for biofortification is the extra cost of zinc fertilizer application. Based on the intensity of zinc deficiency in the soil, zinc fertilizer should be applied to increase the grain production as well as the zinc concentration in grain. Foliar application of zinc fertilizer is a cost-effective method to enhance zinc density in food grain. But the application itself costs a huge amount, i.e., more than 90% of the total foliar zinc fertilizer application. This can be controlled by the combine application of zinc fertilizer and pesticide together (Ortiz-



**Abhrajyoti Dalal and Swarnali Duary**

Monasterio *et al.*, 2015; Wang *et al.*, 2015, 2016; Ram *et al.*, 2016). In this situation there are no such compatibility issues and pesticide does not affect the fertilizer application. So farmers can adopt this fertilizer strategy in agronomic biofortification not only to increase the yield but also to improve the seedling vigour, disease and stress resistance capacity (Huber and Graham, 1999; Welch, 1999; Cakmak, 2008). Zinc is an essential nutrient as well as a heavy metal. So care should be taken during application to avoid toxicity. It is quite rare for the soil and crop plants to be affected by zinc toxicity. But sometimes due to soil contamination by excessive treatment of soil with high zinc sewage sludge, mining, smelting activity, crop plants are bound to face zinc toxicity. However, zinc is reported as less toxic than cadmium or copper.

Future Scopes

Even though different researches have been carried out on biofortification, some key points should keep in mind for further improvement. They are highlighted below:

- A 4R approach i.e. right place, right time, right source and right dose can be developed to achieve high grain zinc concentration in different crops.
- It is important to identify the major physiological constraints of grain zinc accumulation for several crops under several conditions and for the improvement of zinc concentration agronomic and genetic approaches should be applied to overcome these constraints.
- Biofortification must be studied under stressed condition and evaluation of the effect of this condition should be done. As the climatic change brings more weather irregularities, a stress proof biofortification system is very important to be developed.
- Evaluate the performance of zinc efficient genotype under the different availability of zinc in soil. It is also very important to study whether the combination of agronomic and genetic biofortification are beneficial or not.
- The foliar application of zinc to the crop should be compared with other application method. To increase the bioavailability of zinc various agronomic management practices should be studied.

CONCLUSION

Biofortification aids in the treatment of malnutrition in humans as well as the improvement of nutritional quality in regular diets. This technique is cost effective, making it a viable choice for low income countries. Agronomic biofortification through soil and foliar application of fertilizer and micronutrients would be a very quick and practical way to increase mineral uptake and accumulation of mineral in food crops. Agronomic biofortification not only enhances grain zinc content, which is beneficial to health, but it can also help to reduce the amount of zinc insufficiency, particularly in areas where intensive cropping systems are used and micronutrient treatment is neglected. Thus it would be a highly appealing and useful technique for efficiently addressing the global problem of zinc deficiency.

REFERENCES

1. Bagde, V.L. and Borkar, D.B., (2013). Biotechnological Interventions for Biofortification. *Biotechnology*, 2(10),35-37
2. Broadley, M. R., White, P. J., Hammond, J. P., Zelko, I. and Lux, A. (2007). Zinc in plants. *New Phytologist*, 173(4),677-702.
3. Cakmak, I., Pfeiffer, W. H., & McClafferty, B. (2010). Biofortification of durum wheat with zinc and iron. *Cereal chemistry*, 87(1),10-20.
4. Curie, C., Cassin, G., Couch, D., Divol, F., Higuchi, K., Le Jean, M., Misson, J., Schikora, A., Czernic, P. and Mari, S. (2009). Metal movement within the plant: contribution of nicotianamine and yellow stripe 1-like transporters. *Annals of botany*, 103(1),1-11.
5. Das, S., Jahiruddin, M., Islam, M. R., Mahmud, A. A., Hossain, A. and Laing, A. M. (2020). Zinc biofortification in the grains of two wheat (*Triticumaestivum* L.) varieties through fertilization. *ActaAgrobotanica*, 73(1),13.
6. Durgude, S.A., Ram, S., Kumar, R., Singh, S.V., Singh, V., Durgude, A.G., Pramanick, B., Maitra, S., Gaber, A. and Hossain, A. (2022). Synthesis of Mesoporous Silica and Graphene-Based FeO and ZnONanocomposites for





Abhrajyoti Dalal and Swarnali Duary

- Nutritional Biofortification and Sustained the Productivity of Rice (*Oryza sativa* L.). *Journal of Nanomaterials*.2022:1-15.
7. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 13th May, 2022).
 8. Gundersen, C. and Ziliak, J. P. (2015). Food insecurity and health outcomes. *Health affairs*, 34(11),1830-1839.
 9. Hansen, T. H., Laursen, K. H., Persson, D. P., Pedas, P., Husted, S. and Schjoerring, J. K. (2009). Micro-scaled high-throughput digestion of plant tissue samples for multi-elemental analysis. *Plant Methods*, 5(1),1-11.
 10. Hossain, A., Skalicky, M., Brestic, M., Maitra, S., Sarkar, S., Ahmad, Z., Vemuri, H., Garai, S., Mondal, M., Bhatt, R., Kumar, P., Banerjee, P., Saha, S., Islam, T. and Laing, A.M. (2021) Selenium Biofortification: Roles, Mechanisms, Responses and Prospects. *Molecules*, 2021, 26, 881. <https://doi.org/10.3390/molecules26040881>
 11. Hossain, A., Mottaleb, K. A., Fafhad, M. and Barma, N. C. D. (2019). Mitigating the twin problems of malnutrition and wheat blast by one wheat variety, "BARI Gom 33", in Bangladesh. *ActaAgrobotanica*, 72(2),1-17
 12. Huber, D. M., & Graham, R. D. (1999). The role of nutrition in crop resistance. *Mineral Nutrition of Crops: Fundamental Mechanisms and Implications*, 18(12),169.
 13. Kotecha, P. V. (2008). Micronutrient malnutrition in India: Let us say "no" to it now. *Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine*, 33(1), 9.
 14. Lakshmi, P.V., Singh, S.K., Pramanick, B., Kumar, M., Laik, R., Kumari, A., Shukla, A.K., Abdel Latef, A.A.H., Ali, O.M., Hossain, A. (2021). Long term zinc fertilization in calcareous soils improves wheat (*Triticumaestivum* L.) productivity and soil zinc status in the rice-wheat cropping system. *Agronomy*, 11: 1306. <https://doi.org/10.3390/agronomy11071306>
 15. Mathpal, B., Srivastava, P. C., Shankhdhar, D. and Shankhdhar, S. C. (2015). Zinc enrichment in wheat genotypes under various methods of zinc application. *Plant, Soil and Environment*, 61(4),171-175.
 16. Ortiz, I., Monasterio, M. E. C. and Cakmak, I. (2015). Zinc Biofortification in Wheat through Foliar Fertilization Combined with Pesticides. In *OF ABSTRACTS*. pp. 56.
 17. Praharaj, S., Skalicky, M., Maitra, S., Bhadra, P., Shankar, T., Brestic, M., Hejnak, V., Vachova, P., Hossain, A. (2021). Zinc biofortification in food crops could alleviate the zinc malnutrition in human health. *Molecules*, 26, 3509. <https://doi.org/10.3390/molecules26123509>
 18. Ram, H., Rashid, A., Zhang, W., Duarte, A. A., Phattarakul, N., Simunji, S., Kalayci, M., Freitas, R., Rerkasem, B., Bal, R.S. and Mahmood, K. (2016). Biofortification of wheat, rice and common bean by applying foliar zinc fertilizer along with pesticides in seven countries. *Plant and Soil*, 403(1),389-401.
 19. Terzano, R., Al Chami, Z., Vekemans, B., Janssens, K., Miano, T. and Ruggiero, P. (2008). Zinc distribution and speciation within rocket plants (*Eruca vesicaria* L. Cavaleri) grown on a polluted soil amended with compost as determined by XRF microtomography and micro-XANES. *Journal of Agricultural and Food Chemistry*, 56(9),222-3231.
 20. Van Steveninck, R. F. M., Babare, A., Fernando, D. R. and Van Steveninck, M. E. (1994). The binding of zinc, but not cadmium, by phytic acid in roots of crop plants. *Plant and Soil*, 167(1),157-164.
 21. Wang, Y. H., Zou, C. Q., Mirza, Z., Li, H., Zhang, Z. Z., Li, D. P., Xu, C.L., Zhou, X.B., Shi, X.J., Xie, D.T. and He, X.H. (2016). Cost of agronomic biofortification of wheat with zinc in China. *Agronomy for Sustainable Development*, 36(3),1-7.
 22. Waters, B. M. and Sankaran, R. P. (2011). Moving micronutrients from the soil to the seeds: genes and physiological processes from a biofortification perspective. *Plant Science*, 180(4),562-574.
 23. Welch, R. M. and Graham, R. D. (2005). Agriculture: the real nexus for enhancing bioavailable micronutrients in food crops. *Journal of Trace Elements in Medicine and Biology*, 18(4), 299-307.
 24. Welch, R. M., Hart, J. J., Norvell, W. A., Sullivan, L. A. and Kochian, L. V. (1999). Effects of nutrient solution zinc activity on net uptake, translocation, and root export of cadmium and zinc by separated sections of intact durum wheat (*Triticumturgidum* L. var durum) seedling roots. *Plant and Soil*, 208(2),243-250.
 25. Yadav, R. S., Patel, A. M., Dodia, I. N., Aglodiya, A. V., Patel, G. A. and Augustine, N. (2011). Agronomic biofortification of wheat (*Triticumaestivum* L.) through iron and zinc enriched organics. *Journal of Wheat Research*, 3(1),46-51.




Abhrajyoti Dalal and Swarnali Duary

26. Zaman, Q. U., Aslam, Z., Yaseen, M., Ihsan, M. Z., Khaliq, A., Fahad, S., Bashir, S., Ramzani, P.M.A. and Naeem, M. 2018. Zinc biofortification in rice: leveraging agriculture to moderate hidden hunger in developing countries. *Archives of Agronomy and Soil Science*, 64(2),147-161.

Table 1: Recommended dietary allowance of zinc for Indians (Source: ICMR, 2020)

| S. No. | Category | Age group | Zinc (mg/day) |
|--------|----------|----------------|---------------|
| 1 | Man | Heavy | 19 |
| | | Moderate | |
| | | Sedentary | |
| 2 | Woman | Lactation | 23 |
| | | Pregnant Woman | 40 |
| | | Heavy | |
| | | Moderate | |
| | | Sedentary | 29 |
| 3 | Infants | 0–6 months | 3 |
| | | 6–12 month | |
| 4 | Children | 7–9 year | 15 |
| | | 4–6 year | 11 |
| | | 1–3 year | 8 |
| 5 | Girls | 10–12 year | 28 |
| 6 | Girls | 15–17 year | 30 |
| 7 | Girls | 16–18 year | 32 |
| 8 | Boys | 10–12 year | 16 |
| 9 | Boys | 15–17 year | 22 |
| 10 | Boys | 16–18 year | 26 |

Table 2: Varieties with Improved Quality Released in Some Crop Plants in India (Yadav et al., 2011)

| Crop | Variety | Quality Character | Developed by |
|--------------|-----------------|--|-------------------------------|
| Rice | CR DHAN 310 | High protein (10.3%) | NRRI, Cuttack |
| | CR DHAN 311 | High protein (10.1%), Iron (20ppm) | NRRI, Cuttack |
| Mustard | Pusa Mustard 30 | Erucic acid <2% | IARI, New Delhi |
| Wheat | WB 02 | High zinc (42 ppm), Iron (40 ppm) | IIWBR, Karnal |
| | HPBW 01 | High zinc (40.6 ppm), Iron (40 ppm) | PAU, Ludhiana |
| Sorghum | Pusa Shakti | High iron (45 ppm), Zinc (32 ppm) | VNM KV, Parbhani with ICRISAT |
| Maize | PusaVivek QPM 9 | Pro vitamin-A (8.15 ppm), Lysine (2.67%), Tryptophan (0.74%) | IARI, New Delhi |
| Pearl Millet | HHB 299 | High iron (73 ppm), Zinc (41 ppm) | HAU, Haryana with ICRISAT |





Morpho-Physiological Responses Associated with Hydroponically Grown Maize Fodder

Dinkar J Gaikwad^{1*}, R S Kalasare¹, D.S. Jaswanth¹, P. Sai Sarvani¹ and Sankar Pramanik²

¹Centurion University of Technology and Management, Odisha, India.

²Bidhan Chandra Krishi Viswavidyala Mohanpur, West Bengal, India.

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Dinkar J Gaikwad

Centurion University of Technology and Management,
Odisha, India.

Email: gaikwad@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

The present experiment was conducted at hydroponics fodder unit under the research centre for smart agriculture, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha during January to April, 2021. Investigation was aimed to find out the morphological and physiological changes associated with hydroponically grown maize fodder. Parameters under the study were seedling length, fresh and dry weight of seedlings, fresh and dry weight of remanent, chlorophyll content, crude fibre content, total ash content and yield. Results of investigation revealed that all morphological and physiological parameters shown increasing trend except remanent weight. Highest seedling growth was observed on 8th day after sprouting. Similar trend has been observed in the remaining parameters like fresh and dry weight of root and shoot, total chlorophyll content, crude fibre content and yield of hydroponically grown seedlings. Remanent weight shown decreasing trend with increase in growing days.

Keywords: Hydroponics, maize, fodder, nutrition, yield

INTRODUCTION

Significant fodder production cannot easily be achieved mainly due to the pressure on arable land for the production of staple food crops to feed the ever-increasing human population across the globe. To meet the parallel increasing demand for green fodder, one of the best alternatives is hydroponics (Bulcha et al., 2022, Naik et al., 2015). Hydroponics is the advance technique of growing the plants in nutrient rich solution without soil. Crops can be grown either using of non-soil growing media like sawdust, cocopeat, perlite, vermiculite and potting mix or no growing medium at all. (Gaikwad et al. 2020). Hydroponics is the fastest growing sector of agriculture, and it could



**Dinkar J Gaikwad et al.,**

very well dominate sustainable food and green forage production in the future(Gaikwad and Maitra,2020). Hydroponics technology is successfully used to grow various high value crops like lettuce, pak choi, broccoli, kale, dill, parsley strawberry, saffron, cherry tomatoes etc. Earliest studies have proven that different types of fodder crops such as barley (Reddy et al., 1988), oats, wheat (Snow et al., 2008); sorghum, alfalfa, cowpea (Al-Karaki and Al-Hashimi, 2012) and maize (Naik et al., 2012) can be grown using this advance technology. Green fodder is the foremost feed for ruminants used in supporting ruminant productivity both in fulfilling the basic requirement, reproduction and production. Green fodder plays very much important role for the cattle's and its regular availability is needed (Ndaru 2020). Fodder produced using hydroponics technology is more nutritious than conventional fodder as it contains more crude proteins Naik et al, 2013. Hydroponics fodder is more palatable, easily digestible highly nutritious and good source of chlorophyll which gives additional health benefits to the animals. Hydroponics fodder production provides several benefits like high water use efficiency, less space requirement, minimum labour requirement, regular year around production and less growing time. Hydroponics fodder is generally harvested within 8 to 9 days after germination and fed to the ruminants. Sprouted grains are richest source of antioxidants in the form β -carotene, vitamin-C, E and related minor minerals such as selenium and Zn. Enzyme-rich feeds are generally alkaline in nature, feeding of the sprouted grains improve the animal's productivity by developing a stronger immune system due to neutralization of the acidic condition (Chavan and Kadam, 1989). These young sprouted seedlings are considered as a good source of total chlorophylls and which helps to improve the performance of the cattle's (Sneath and McIntosh, 2003; Shipard, 2005) Maize has been the preferred crop for hydroponics fodder production in India (Naik and Singh 2014). Adebisi et al (2018) in his study shown that feeding of hydroponics maize fodder helps to improve the performance and nutrient digestibility in animals. So present study was conducted to investigate the morphological and physiological response associated with hydroponically grown maize fodder.

MATERIALS AND METHODS

Present investigation was carried out in the hydroponics fodder unit at M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha during January to April, 2021 to find out the morphological and physiological changes associated with hydroponics maize fodder. To conduct this experiment, good quality maize seeds were purchased from local market having germination percentage around 70-75%. Seeds were washed in tap water 2-3 times to remove chaffs and dirt's and soaked in the water for 8-10 hrs. Water was then drained and the seeds were wrapped in gunny bags overnight for sprouting. Next day 350g partially sprouted seeds were uniformly spread over the trays having dimension 2ft x1ft. and allowed for seedling growth. Suitable light and moisture were maintained in the trays throughout the growing period. After the cycle of eight days growth period, data was recorded on shoot length, root length, total seedling length, fresh and dry weight of 100 shoot, root and remnants yield per tray after every 24 hours. At the same time samples were analysed for crude fibre (CF), total ash (TA), chl-a, chl-b and total chlorophyll content. The root and shoot length and total seedling length of different hydroponic green fodders were measured everyday using a meter scale during the entire growth period. Individual seedlings were cautiously removed from the sprout mat for the measurement. The maximum root and shoot length were measured from the base of hypocotyls. For calculation of biomass yield, the shoots were separated from the roots and seeds by cutting at the base of the hypocotyls. The fresh weight of root, shoot and remnant were quantified separately. Respective samples were kept in hot air oven at 60°C for five days and dry weight was measured. Quantity of fresh biomass was recorded by measuring the weight of trays on daily basis. Crude fibre (CF) and total ash (TA) were estimated by the process explained by Thimmaiah (2016). Photosynthetic pigments like Chl-a, Chl-b and Total Chlorophyll were extracted using 80% acetone and estimated using spectrophotometric method, absorbance was recorded at 645 and 663nm wavelengths.

Statistical Analysis

The data represent mean calculated from five replicates \pm standard error. One way ANOVA was employed to confirm the variability of data and validity of result ($P < 0.01$).



**Dinkar J Gaikwad et al.,**

RESULTS AND DISCUSSION

Growth performance of hydroponics maize seedlings are presented in Table 1. Shoot, root and total seedling lengths of hydroponics maize fodder were shown increasing trend and remained highest on 8th day of growth. Shoot length (12.11cm), root length (8.08cm) and total seedling length was achieved 20.19 cm growth after 8th day of initiation of sprouting. Initially root growth was more up to 5th day as compared to shoot growth. After 5th day speed of shoot growth was more. 100 shoot fresh weight was 32.3g and 100 root fresh weight was 12.1g. Fresh and dry weight of remnant shown decreasing trend. Initially fresh weight of remnant was 44.8g and it has been observed that after 8th day of seedling growth fresh weight of remnant was reduced to 25.30g. Dry matter production of shoot (7.60g) and root (4.3g) also shown increasing trend and was highest on 8th day. Dry weight of remnant also shown significant reduction in the weight. Values of remnant varied between 26.7g on first day of sprouting to 9.9g on 8th day of seedling growth. This significant decrease in remnant weight which might be due to the reserved food material in the cotyledon is used for the formation of new leaf growth and development of the seedling.

Values of Chl-a, Chl-b and total chlorophyll content are shown in fig 1. The values of total chlorophyll content of hydroponics maize fodder were significantly increased with growing days and ranged between 0.123 mg/g to 0.885mg/g. This chlorophyll rich diet helps to improve the digestibility performance in the livestock. The findings of chlorophyll content were similar to the findings of Naik et al., 2015. Values of crude fibre content is shown in fig 2. The gradual increase has been observed in Crude Fibre (CF) content. Initially, 1st day after sprouting, crude fibre content was 2.21% and it was increased up to 12.31% on 8th day of seedling growth. This increase in CF content of maize sprouts might be due to synthesis of structural carbohydrates such as cellulose and hemicellulose. Total ash content (Fig 3) of hydroponics maize ranged between 1.43% to 3.28%. It is an indication that total mineral content is increased in the fodder maize which helps ruminants to improve the quality and quantity of milk. Results of CF and total ash were similar to the findings of Jemimah (2018) and Abebiyi et al (2018). After 8th day of seedling growth, approximately 2.57 kg fresh green fodder yield (Fig5) was obtained from single tray where 350 g sprouted grains were uniformly spread at the beginning. Depending upon the quality of grain, green fodder yield of one kg seeds varies between 6-8 kg.

CONCLUSION

Green fodder is an essential component in the diet of livestock. Hydroponics green fodder is considered as one of the best alternatives to fulfil the increasing demand of green fodder. Hydroponics maize fodder have shown sizable increment in seedling growth and nutrients such as chl-a, chl-b, total chlorophyll, crude fibre content, total ash content and fresh fodder yield. Therefore, hydroponics maize fodder can be added in the diet of livestock to fulfil the nutritional requirements.

REFERENCES

1. Bulcha, B., Diba, D. and Gobena, G. (2022). Fodder yield and nutritive values of hydroponically grown local barley landraces. *Ethiop. J. Agric. Sci.*, 32(1):31-49.
2. Gaikwad, D.J., Priyadarsini, S. and Mallick, B. (2020). Effects of different hydroponics systems and growing media on physiological parameters of spinach. *Int.J.Curr.Microbiol.App.Sci.*, 9(5):1409-1414. <https://doi.org/10.20546/ijcmas.2020.905.160>.
3. Gaikwad, D.J. and Maitra, S. (2020). Hydroponics cultivation of crops. In: *Protected Cultivation and Smart Agriculture*, New Delhi Publishers, New Delhi. 279-287. DOI: 10.30954/NDP-PCSA.2020.31.
4. Naik, P. K., Swain, B. K. and Singh, N.P. (2015). Production and utilisation of hydroponics fodder. *Indian J. Anim. Nutr.*, 32 (1): 1-9.





Dinkar J Gaikwad et al.,

5. Ndaru, P.H., Huda, A.N., Marjuki., Prasetyo, R.D., Shofiatun, U., Nuningtyas, Y.F., Ndaru, R.K. and Kusmartono. (2020). Providing high quality forages with hydroponic fodder system. *Earth and Environmental Science*.478. 012054. doi:10.1088/1755-1315/478/1/012054.
6. Reddy, G. V. N., Reddy, M. R., Reddy, K. K. (1988). Nutrient utilization by milch cattle fed on rations containing artificially grown fodder. *Indian Journal of Animal Nutrition*, 5: 19-22.
7. Snow, A. M., Ghaly, A. E. and Snow, A. (2008) A comparative assessment of hydroponically grown cereal crops for the purification of aquaculture waste water and the production of fish feed. *American Journal of Agricultural and Biological Sciences*.3: 364-378.
8. Al-Karaki, G. N. and Al-Hashimi, M. (2012). Green fodder production and water use efficiency of some forage crops under hydroponic condition. *International Scholarly Research Notices Agronomy*. DOI: 10.5402/2012/924672.
9. Naik, P. K., Dhuri, R. B., Swain, B. K. and Singh, N. P. (2012). Nutrient changes with the growth of hydroponics fodder maize. *Indian Journal of Animal Nutrition* 29: 161-163.
10. Naik, P., Dhuri, R., Swain, B., Karunakaran, M., Chakurkar, E. and Singh, N et al. (2013) Analysis of existing dairy farming in Goa. *Indian Journal of Animal Sciences*. 83(3):299-303.
11. Chavan, J., Kadam, S.S. (1989). Nutritional improvement of cereals by sprouting. *Critical Reviews in Food Science and Nutrition*. 28:401-437.
12. Naik, P.K. and Singh, N. P. (2014). Production and feeding of hydroponics green fodder. *Indian Farming*. 64(6): 42–44.
13. Shipard, I. (2005). How can I grow and use sprouts as living food? *Stewart Publishing*.
14. Sneath, R. and McIntosh, F. (2003). Review of hydroponic fodder production for beef cattle. *Queensland Government, Department of Primary Industries, Dalby, Queensland*.

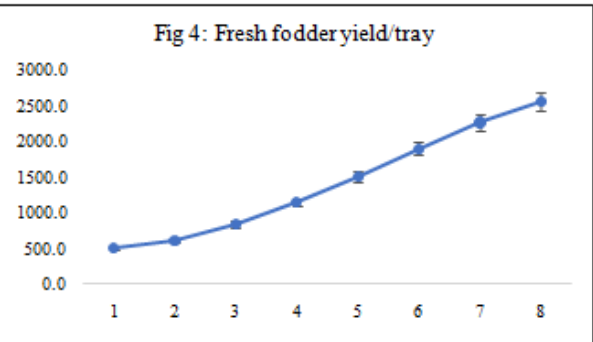
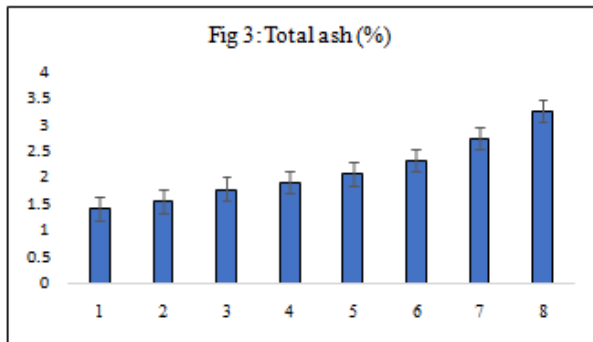
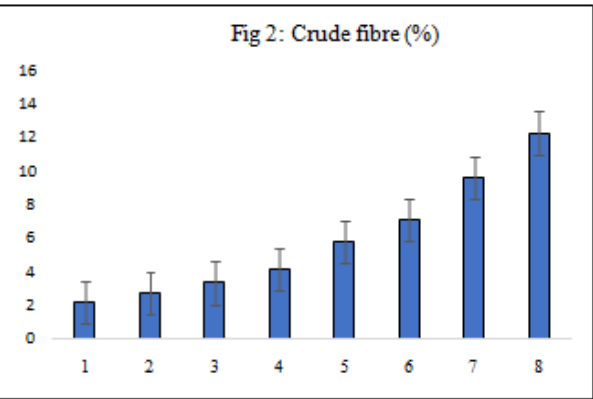
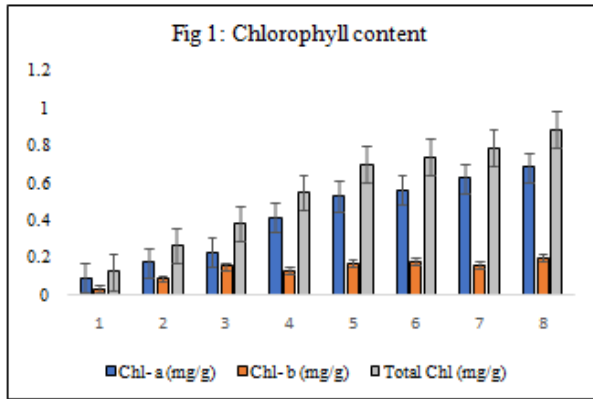
Table 1: Morphological changes associated with hydroponic maize fodder

| DAY | Shoot Length (cm) | Root length (cm) | Total seedling length (cm) | 100 Shoot frwt (g) | 100 Root frwt (g) | 100 Remnant Fresh Weight(g) | 100 Shoot dry wt (g) | 100 Root dry wt (g) | 100 Dry Wt Remnant (g) |
|-------|-------------------|------------------|----------------------------|--------------------|-------------------|-----------------------------|----------------------|---------------------|------------------------|
| 1 | 0.41 | 2.00 | 2.41 | 3.6 | 1.3 | 44.80 | 1.100 | 0.600 | 26.700 |
| 2 | 1.56 | 3.66 | 5.22 | 6.8 | 3.5 | 43.20 | 1.300 | 0.800 | 24.800 |
| 3 | 2.36 | 4.91 | 7.26 | 8.9 | 5.0 | 41.60 | 2.000 | 1.000 | 22.800 |
| 4 | 3.40 | 5.20 | 8.60 | 11.2 | 6.3 | 39.80 | 3.200 | 1.800 | 21.600 |
| 5 | 4.90 | 5.40 | 10.30 | 17.5 | 8.2 | 32.40 | 4.500 | 2.500 | 18.500 |
| 6 | 6.76 | 6.20 | 12.96 | 22.7 | 11.3 | 28.50 | 5.200 | 3.300 | 15.500 |
| 7 | 9.49 | 6.79 | 16.29 | 28.7 | 11.4 | 26.10 | 6.300 | 4.000 | 11.100 |
| 8 | 12.11 | 8.08 | 20.19 | 32.3 | 12.1 | 25.30 | 7.600 | 4.300 | 9.900 |
| C.D. | 0.721 | 0.347 | 0.915 | 1.374 | 0.568 | 1.832 | 0.234 | 0.132 | 0.745 |
| SE(m) | 0.248 | 0.119 | 0.314 | 0.472 | 0.195 | 0.629 | 0.080 | 0.045 | 0.256 |
| SE(d) | 0.350 | 0.168 | 0.444 | 0.667 | 0.276 | 0.890 | 0.114 | 0.064 | 0.362 |
| C.V. | 10.812 | 5.040 | 6.751 | 6.408 | 5.902 | 3.995 | 4.609 | 4.425 | 3.034 |





Dinkar J Gaikwad et al.,





Growth and Yield of Maize as Affected by Spacing and Nutrient Management – A Review

Mandapati Narendra Varma, Jnana Bharati Palai* and Akash Kumar Tudu

Centurion University of Technology and Management, Odisha, India.

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 12 May 2022

*Address for Correspondence

Jnana Bharati Palai

Centurion University of Technology and Management,
Odisha, India.

Email: jnana@cutm.ac.in



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Maize is the most important cereal crop grown throughout the world and it is adaptive developing crop, with a wide range of potential applications. It can be grown in climatic conditions like humid and sub-humid even in temperate, with adequate moisture conditions and warm climate. In India, maize is growing in all three season kharif, summer, and spring season hence for getting good yields it requires high amount of the nutrients mainly primary nutrients like nitrogen, phosphorus, potassium. Optimum plant density is the most important factor that for increasing the yield and also it captures the sunlight and improves the photosynthetic formation. Hence optimum plant densities combined with different levels of fertilizers plays an important role in growth and the yield of maize so farmers can get optimum yields.

Keywords: Maize, spacing, nutrient management, growth, yield

INTRODUCTION

Maize (*Zea mays* L.) is the commonly grown cereal crop that belongs to the *Poaceae* family and has chromosome number $2n=20$. It is originated from the Central America. Because of its genetic yield potential among other crops, maize is regarded as the "Queen of Cereals". After rice and wheat, maize is the third most important staple food crop in the world. Maize has been found to be used in production of alcohols, disposable containers, fabrics, sugars, papers, plastics, oils, starches, and proteins (Fattah *et al.*, 2019). Due to its versatility, maize is the most flexible cereal crop, and it is commonly grown on wide range of tropics and subtropics climates. The world's major maize producers are united states, china, South Africa, Argentina, Brazil and Mexico. Currently, over 170 countries produce 1147.7 million metric tonnes of maize on an area of 193.7 million ha with average yield of 5.75t/ha (FAOSTAT, 2020). In India, maize is grown all year on an area of 9.18 million ha with average yield of 2965kg/ha and total production of 27.23 million tonnes (ICAR-IIMR 2019-20). In Odisha, maize is grown under the area of 2.69 lakh ha with average productivity of 2791 kg/ha and production of 7.51 lakh mt (Maitra *et al.*, 2019).



**Mandapati Narendra Varma et al.,**

Plant development, yield attributing features, and crop production are all influenced by the optimum plant population. Plant density is critical cultural practices that influence grain yield and other key agronomic characteristics of maize (Shafiet al., 2012; Dharminder Singh et al., 2021; Das et al., 2021). Plant density increases, results in competition for light, moisture and nutrients. The yield of the crop will grow as the plant population increases; hence optimizing the plant population is critical for enhancing maize productivity. Because maize is a plant with individual productivity, plant population has substantial impact on yield (Pepo and Sarvari, 2013; Ghosh et al., 2020). One of the most important agronomic factors influencing crop yield is nutrient management. To achieve high yield, judicious fertilizer use is important. Crop response to fertilizers varies greatly from location to location, depending soil fertility level, environmental condition and genotype (Prasanna Kumar et al., 2019; Siddiqui et al., 2020; Lakshmi et al., 2021).

Among these fertilizer management plays an essential role on maize productivity. The essential plant nutrients Nitrogen, Potassium, Phosphorous play a critical role in crop growth and development. Maize is the exhaustive crop that necessitates a lot of nutrients during its growing cycle. Nitrogen is essential for crop yield and development and crucial element of chlorophyll and protoplasm as well as being linked to the functioning of living cells. The most critical major ingredient that maize requires in large amounts for high grain yield is nitrogen (Bender et al., 2013). Abubakaret al., (2019) reported that application of nitrogen increased significantly the physiological growth parameters of maize hybrids. Hybrid maize varieties are more nitrogen-responsive than local varieties (Shrestha et al., 2018; Nduwimanaet al., 2020; Ghosh et al., 2021).

Phosphorus is an intriguing plant nutrient. It is essential for plant metabolism and involved in various biochemical processes (Cheptoek et al., 2021). Potassium regulates cell membranes and retains protoplasm at the right hydration level, which helps to maintain cellular order. It involves in wide range of plant metabolism, which helps in cell division to develop a strong root system and ensuring crop ripening occurs on time and uniformly. It is most deficient during the seedling stage, but it is most needed during the flowering stage. Potassium is another primary essential nutrient which plays an important role in enzyme stimulation, stomatal movement, osmotic pressure regulation, photosynthesis, phloem transport, energy transfer, protein synthesis, cation-anion balance in soil, and stress resistance (Marschner, 2012). Proper and balanced application of NPK fertilizers is critical for enhancing maize yield (Asgharet al., 2010). This article justifies the 1st SDG goal “No poverty” by optimizing the input use and increasing the productivity.

Effect of spacing on maize**Growth**

Ijazet al.(2015) found that higher plant height (261.07) was recorded in treatment of 50,000 plants/ha during August, 2012 at The Islamia University of Bahawalpur, Pakistan. Sharifiet al. (2016) reported that maximum plant height (179.07 cm), dry matter (592 g m⁻²) during 83-91 DAS were observed with intra row spacing of 45cm, which included 11 plants m⁻².Mandic et al. (2016) reported that maximum plant density of (71429 plants/ha) recorded maximum plant height and low plant density of (51020 plants/ha) recorded less number of leaves in the experiment conducted on crop density of grain yield. Khan et al. (2017) found that moderate plant population of 9 plant/m² was decrease the plant height, leaf area of both maize and barnyard grass. According to Fattah et al. (2019), growth parameters like plant height (cm), number of leaves, dry matter content, were significant in plant population and organic nutrient management, as well as their interaction in almost all traits in both years. Salifuet al. (2019) mentioned that among the three plant densities (60,000 ha⁻¹, 72,500 ha⁻¹, and 85,000 ha⁻¹) there are significant differences in the plant height and leaf area index. Singh et al. (2019) founded thatthe spacing of 40cm X 15cm resulted in significantly superior plant height, dry matter content and LAI. Sibonginkosiet al. (2019) reported that PAN-53 hybrid with 44,444 plants/ha significantly decreased the leaf area index and increased the plant height. Djamanet al. (2022) mentioned that LAI and plant height was found to vary with spacing and sowing time.



**Mandapati Narendra Varma et al.,****Yield attributes**

Karkiet *et al.* (2015) reported that the planting density of 66666/ha produced highest number of cobs (73,177 and 67638/ha) was recorded in experiment conducted during 2013 and 2014 at National Maize Research Program, Rampur. Ijazet *et al.* (2015) reported that treatment of 50,000 plants/ha produced maximum number of grains per row (30.14), grains per cob (439.18) and higher cob length (18.6) while plant density of 70,000 plants/ha produced 1000-grain weight (388.22 g) and maximum grain weight per cob (156.29 g). Mandicet *et al.* (2016) reported that lower plant density of (51020 plants/ha) recorded maximum cob length, number of grains/cob, number of grain rows/cob, cob weight, number of grains per row, and 1000-seed weight in the experiment conducted on crop density of grain yield. Khan *et al.* (2017) reported that moderate plant population 9 plant/m² was decreased the grains per cob of maize with growth of barnyard grass in the experiment conducted on effect of plant densities on yield of barnyard grass. Fattah *et al.* (2019) reported that yield parameters such as number of row per cob, number of seed per row, com diameter (cm), number of cob per plant, cob length (cm), and seed number per cob were significant in plant density and organic fertilization, as well as their interaction in almost all traits in both years. Singh *et al.* (2019) reported that the yield attributes of cob length, cob girth, number of grain rows per cob, number of grains per row, and number of grains/cob were found to be higher in 50cm x 20cm spacing. Sibonginkosiet *et al.* (2019) reported that PAN-53 hybrid with 44,444 plants/ha reduced the number of cobs plant⁻¹, cob length and weight of 1000 seeds was more than the other treatments.

Yield

Karkiet *et al.* (2015) reported that significantly the highest grain yield of 9.24 t/ha in 2013 and 7.45 t/ha in 2014 at planting geometry of 65cm x 25cm were recorded. Ijazet *et al.* (2015) reported that higher grain yield (9338 kg ha⁻¹) was recorded in plant density of 70,000 plants ha⁻¹. Mananet *et al.* (2016) reported that PMH-1 hybrid gave maximum grain yield and cob yield at 20cm plant spacing. Mandicet *et al.* (2016) reported less plant density of (51020 plants/ha) recorded maximum grain yield in the experiment conducted on crop density of grain yield. Khan *et al.* (2017) mentioned that moderate plant density 9 plant/m² was decrease the grain yield of maize in the experiment conducted on effect of plant densities on yield of barnyard grass. Salifuet *et al.* (2019) reported that not significant affected in the three plant densities (60,000 ha⁻¹, 72,500 ha⁻¹, and 85,000 ha⁻¹). Sibonginkosiet *et al.* (2019) reported that PAN-53 hybrid with 44,444 plants/ha decrease the stover yield and grain yield than other treatments. Singh *et al.* (2019) mentioned that grain yield was higher in 50cm x 20cm spacing and stover yield was higher in the spacing of 40cm x 15cm. According to Djamanet *et al.* (2022) grain yield varies with plant densities and planting date, with highest grain yield (16.8 Mg/ ha) was observed in 2019 at a density 101,700 pph and the highest grain yield (17Mg /ha) was obtained in 2020, at a density of 88,000 pph on May 18 planting date.

Effect of Nutrient Management on Maize**Growth**

Dhaka *et al.* (2015) reported that higher leaf area index(3.3), dry matter accumulation(116.7 g/plant) by application of N 110 kg/ha and P₂O₅ 50kg/ha. Gulet *et al.* (2015) found that with applying of 75:50:30 N: P: K dose significantly increased growth parameters such as leaf area index, dry matter accumulation, and plant height. Jena *et al.* (2015) found that by applying N of 240kg/ha and P of 100 kg/ha recorded highest plant height (212.75 cm, 185.95 cm), leaf area index (3.89, 3.17), dry matter production (13432 kg/ ha, 10572 kg/ha). Omotosoet *et al.* (2015) mentioned that applying of N 90kg/ha and P 30kg/ha produced maximum plant height and leaf area. Pandey *et al.* (2016) found that treatment comprising of (2 maize+2 soyabean) is having highest growth attributes like plant height, number of leaves, leaf area index and dry weight of plant. Pal *et al.* (2017) found that highest plant height (165.28 cm, 159.16 cm), dry matter accumulation (153.09 g plant⁻¹, 146.52 g plant⁻¹) was produced with application of N 120 kg/ha and P₂O₅ 60 kg/ha. Jadhavet *et al.* (2018) reported that maximum plant height (175.8 cm), number of leaves per plant (13.5), leaf area per plant (4000 cm²) was recorded with combined application of *Azotobacter* + PSB+100 % RDF. Thoratet *et al.* (2016) found that significantly higher leaf area/ha, no of leaves, plant height, dry matter production plant/ha was produced by application of 150% RDF.



**Mandapati Narendra Varma et al.,****Yield attributes**

Dhaka *et al.* (2015) reported that highest green cob yield (92.9 q/ha), green fodder yield (204.0q/ha), by application of N 110 kg/ha and P₂O₅ 50kg/ha. Gulet *et al.*, (2015) found that with application of 75:50:30 N:P:K dose significantly increased the yield parameters such as number of cobs per plant, number of grains per cob, cob length, grain rows, and 100-grain weight. Omotoso *et al.* (2015) mentioned that applying of N 90kg/ha and P 30kg/ha produced maximum cob length and cob girth. Pal *et al.* (2017) reported that with application of N 120 kg/ha and P₂O₅ 60 kg/ha produced maximum number of grains per cob (283.19, 275.74), cob length (17.87 cm, 17.58 cm), cob girth (15.05 cm, 14.99 cm), number of cobs per plant (1.49, 1.47), 100 grain weight (26.70 g, 25.27 g). Raghavendra *et al.* (2018) reported that 50 percent Recommended Dose of Potassium + Potassium Solubilizing Bacteria resulted in statistically higher yield attributes for single cob weight (154.7, 169.4 g), cob length (16.4, 18.0 cm), and cob girth (15.3, 16.7 cm) in maize. Adhikary *et al.* (2020) found that yield attributes such as no. of kernel rows per cob, cob length, were found higher at fertilization rate of FYM 10 t/ha plus 180: 90: 60 kg NPK/ha so such fertilization rate is suitable for maize varieties.

Yield

Jena *et al.* (2015) reported that by applying N of 240kg/ha and P of 100 kg/ha recorded highest grain yield (6383 kg ha, 5010 kg ha) and stover yield (7050 kg ha, 5562 kg ha). Omotoso *et al.* (2015) reported that applying N 90kg/ha and P 30kg/ha produced higher grain yield in an experiment to evaluate the effects of nitrogen (N) and phosphorus (P) fertilizer application rates on maize performance. Pal *et al.* (2017) found that applying N 120 kg/ha and P₂O₅ 60 kg/ha resulted in the highest grain yield (4905 kg/ha, 4987 kg/ha), stover yield (8478 kg/ha, 8281 kg/ha), biological yield (13382 kg/ha, 13268 kg/ha). Thorat *et al.* (2016) found that significantly higher cob yield was recorded by application of 150% RDF (180:90:60 kg NPK/ha). According to Adhikary *et al.*, (2020) Rampur Composite had the highest grain yield (5195 kg/ha) followed by Manakamana-4 (5074 kg/ha) and Across 9942 × Across 9944 (5052 kg/ha) under treatment of application of FYM 10 t/ha plus NPK 180: 90: 60 kg/ha.

Interaction effect of spacing and nutrient management on maize**Growth**

Mahato *et al.* (2020) reported that highest plant height (212.7cm) was recorded in spacing of 60cm X 20cm with application of nutrient doses of (150:75:60). Kareem *et al.* (2020) found that combination of 120kgN/ha, DMR-ESR-Y and 47, 619 plants/ha resulted higher plant height, number of leaves and leaf area index.

Yield attributes

Mahato *et al.* (2020) reported that highest cob length (20.2cm) was recorded in spacing of 60cm x 30cm with application of nutrient doses of (150:75:60) in the experiment conducted on red laterite zone of West Bengal. Kareem *et al.* (2020) found that higher number of cobs, length of the cob with combination of 120kgN/ha, DMR-ESR-Y and 47, 619 plants/ha.

Yield

Kumar *et al.* (2015) reported that combination of hybrid 'NK-6240' under plant population of 111,111 plants/ha and N:P:K 300:5130:130 kg/ha resulted in significantly higher grain yield (12.14 t/ha), and stover yield (16.65 t/ha). According to Mahato *et al.* (2020) the highest grain yield (7.5 t/ha) was recorded in spacings of 60cm x 20cm with nutrient doses of (150:75:60).

CONCLUSION

The combination of spacing and the nutrient management is good in the cultivation of the maize. The lower plant density is giving good growth to the crop because of the less competition towards the water, space and nutrients between the crops. But in case of higher plant density yield is optimum because of the high plant density where the farmers get maximum yield from this. In case of different levels of fertilizers the low level fertilizer giving less growth as well as yield and the high level fertilizer was give high growth and yield. In interaction effect the higher plant with high level of fertilizer gives good yield compare to the low plant density with low level of fertilizer.





Mandapati Narendra Varma et al.,

REFERENCES

1. Abubakar, A. W., Manga, A. A., Kamara, A. Y., and Tofa, A. I. (2019). Physiological evaluations of maize hybrids under low nitrogen. *Advances in Agriculture*, 2019(1):1-6.
2. Adhikary, B. H., Baral, B. R., and Shrestha, J. (2020). Productivity of winter maize as affected by varieties and fertilizer levels. *International Journal of Applied Biology*, 4(1): 85-93.
3. Asghar, A., Ali, A., Syed, W. H., Asif, M., Khaliq, T., and Abid, A. A. (2010). Growth and yield of maize (*Zea mays* L.) cultivars affected by NPK application in different proportion. *Pakistan journal of Science*, 62(4): 211-216.
4. Bender, R. R., Haegele, J. W., Ruffo, M. L., and Below, F. E. (2013). Nutrient uptake, partitioning, and remobilization in modern, transgenic insect-protected maize hybrids. *Agronomy Journal*, 105(1): 161-170.
5. Cheptoek, R. P., Gitari, H. I., Mochoge, B., Kisaka, O. M., Otieno, E., Maitra, S., Nasar, J. & Seleiman, M. F. (2021). Maize Productivity, Economic Returns and Phosphorus Use Efficiency as Influenced by Lime, Minjingu Rock Phosphate and NPK Inorganic Fertilizer. *International Journal of Bioresource Science*, 8(01): 47-60.
6. Das, P., Pramanick, B., Goswami, S.B., Maitra, S., Ibrahim, S.M., Laing, A.M., Hossain, A. 2021. Innovative land arrangement in combination with irrigation methods improves the crop and water productivity of rice (*Oryza sativa* L.) grown with okra (*Abelmoschus esculentus* L.) under raised and sunken bed systems. *Agronomy*, 11: 2087.
7. Dhaka, S. K., Gupta, G. and Gupta, V. (2015) Effect of different fertility levels on growth parameters and yield of sweet corn (*zea mays* L. ssp. *saccharata*) varieties. The eco scan Special issue, 7: 279-282
8. Dharminder Singh, R.K., Kumar, V., Pramanick, B., Alsanie, W.F., Gaber, A., Hossain, A. 2021. The use of municipal solid waste compost in combination with proper irrigation scheduling influences the productivity, microbial activity and water use efficiency of direct seeded rice. *Agriculture*, 11: 941.
9. Djaman, K., Allen, S., Djaman, D. S., Koudahe, K., Irmak, S., Puppala, N. and Angadi, S. V. (2022). Planting date and plant density effects on maize growth, yield and water use efficiency. *Environmental Challenges*, 6:1-11.
10. FAOSTAT. 2020. Food and Agriculture Organization of the UN, Data, Crops. Available at: [http](http://www.fao.org/faostat) accessed on 05 June 2021.
11. Fattah, K. M., Şensoy, S., and Esmail, A. O. (2019). The effects of plant density and organic fertilizer on growth and yield of sweet corn (*Zea mays* L. var. *saccharata*Sturt). *YuzuncuYil University Journal of the Institute of Natural and Applied Sciences abbreviation*, 24(1): 43-55.
12. Ghosh, D., Brahmachari, K., Brestic, M., Ondrisik, P., Hossain, A., Skalicky, M., ...& Bell, R. W. (2020). Integrated weed and nutrient management improve yield, nutrient uptake and economics of maize in the rice-maize cropping system of Eastern India. *Agronomy*, 10, 1906, doi:10.3390/agronomy10121906
13. Ghosh, D., Brahmachari, K., Das, A., Hassan, M.M., Mukherjee, P.K., Sarkar, S., Dinda, N.K., Pramanick, B., Moullick, D., Maitra, S. & Hossain, A. (2021). Assessment of Energy Budgeting and Its Indicator for Sustainable Nutrient and Weed Management in a Rice-Maize-Green Gram Cropping System. *Agronomy*, 11, 166, <https://doi.org/10.3390/agronomy11010166>
14. Gul, S., Khan, M. H., Khanday, B. A., and Nabi, S. (2015). Effect of sowing methods and NPK levels on growth and yield of rainfed maize (*Zea mays* L.). *Scientifica*, 2015:1-6
15. ICAR-IIMR Director's report, 2019-20. ICAR-Indian Institute of Maize Research, PAU Campus, Ludhiana - 141004. <https://aicrpmaize.icar.gov.in/aicrp-news/>
16. Ijaz, M., Raza, M. A. S., Ali, S., Ghazi, K., Yasir, T. A., Saqib, M., and Naeem, M. (2015). Differential planting density influences growth and yield of hybrid maize (*Zea mays* L.). *Journal of Agriculture and Environmental Science*, 2(3): 1-5.
17. Jadav, V. M., Patel, P. M., Chaudhari, J. B., Patel, J. M., and Chaudhari, P. P. (2018). Effect of integrated nutrient management on growth and yield of rabi forage maize (*Zea mays* L.). *International Journal of Chemical Studies*, 6(1): 2160-2163.
18. Jena, N., Vani, K. P., Rao, V. P., and Sankar, A. S. (2015). Effect of nitrogen and phosphorus fertilizers on growth and yield of quality protein maize (QPM). *International Journal of Science and Research (IJSR)*, 4(12): 197-199.





Mandapati Narendra Varma et al.,

19. Kareem, I., Taiwo, O. S., Kareem, S. A., Oladosu, Y., Eifediyi, E. K., Abdulmalik, S. Y. and Olalekan, K. (2020). Growth and Yield of Two Maize Varieties under the Influence of Plant Density and NPK fertilization. *Journal of Applied Sciences and Environmental Management*, 24(3): 531-536.
20. Karki, T. B., Govind, K. C., Shrestha, J., and Jadav, J. P. (2015). Tillage and planting density affect the performance of maize hybrids in Chitwan, Nepal. *Journal of maize research and development*, 1(1): 10-20.
21. Khan, N., Khan, Z., and Khan, A. (2017). Effect of maize planting densities on various growth parameters of barnyard grass. *International Journal of Biology and Biotechnology*, 14(1): 123-128.
22. Kumar, R. M., Hiremath, S. M., and Nadagouda, B. T. (2015). Effect of single-cross hybrids, plant population and fertility levels on productivity and economics of maize (*Zea mays*). *Indian Journal of Agronomy*, 60(3): 431-435.
23. Lakshmi, P.V., Singh, S.K., Pramanick, B., Kumar, M., Laik, R., Kumari, A., Shukla, A.K., Abdel Latef, A.A.H., Ali, O.M., Hossain, A. 2021. Long term zinc fertilization in calcareous soils improves wheat (*Triticumaestivum* L.) productivity and soil zinc status in the rice-wheat cropping system. *Agronomy*, 11: 1306. <https://doi.org/10.3390/agronomy11071306>
24. Mahato, D. C., Dutta, D., Maity, L., Biswas, P., Mahato, B., Ghosh, C. and Patra, S. (2020). Response of Plant Spacing and Balanced Fertilization on Growth and Yield of Maize (*Zea mays* L.) in Red Laterite Zone of Purulia District of West Bengal. *Journal of Experimental Agriculture International*, 46(6):1-6
25. Maitra, S., Shankar, T., Manasa, P., and Sairam, M. (2019). Present status and future prospects of maize cultivation in south Odisha. *International Journal of Bioresource Science*, 6(1): 27-33.
26. Mandic, V., Bijelic, Z., Krnjaja, V., Tomic, Z., Stanojkovic-Sebic, A., Stanojkovic, A., and Caro Petrovic, V. (2016). The effect of crop density on maize grain yield. *Biotechnology in Animal Husbandry*, 32(1): 83-90.
27. Marschner, H. (3rd Ed.). (2012). Marschner's mineral nutrition of higher plants. Academic press.
28. Nduwimana, D., Mochoge, B., Danga, B., Masso, C., Maitra, S., &Gitari, H. (2020). Optimizing nitrogen use efficiency and maize yield under varying fertilizer rates in Kenya. *Int J BioresourceSci*, 7(2), 63-73.
29. Olusegun, O. S. (2015). Nitrogen (N) and phosphorus (P) fertilizer application on maize (*Zea mays* L.) growth and yield at Ado-Ekiti, South-West, Nigeria. *American Journal of Experimental Agriculture*, 6(1): 22.
30. Pal, B., Hirpara, D. S., Vora, V. D., Vekaria, P. D., Sutaria, G. S., Akbari, K. N., and Verma, H. P. (2017). Effect of Nitrogen and Phosphorus on Yield and Yield Attributes of Maize in South Saurashtra, India. *International Journal of Current Microbiology and Applied Sciences*, 6(3):1945-1949.
31. Pepo, P., and Sarvari, M. (2013). Special agrotechnical crop models for Martonvasar maize genotypes. 60 Years of Hungarian Hybrid Maize. Pannonian Plant Biotechnology Association, pp:55-62
32. Prasanna Kumar, D., Maitra, S., Shankar, T. and Ganesh, P. 2019. Effect of Crop Geometry and Age of Seedlings on Productivity and Nutrient Uptake of Finger Millet (*Eleusinecoracana* L. Gaertn.), *International Journal of Agriculture, Environment and Biotechnology*, 12(3): 267-272
33. Raghavendra, M., Singh, Y. V., Gaiind, S., Meena, M. C., and Das, T. K. (2018). Effect of potassium and crop residue levels on potassium solubilizers and crop yield under maize-wheat rotation. *International Journal of Current Microbiology and Applied Science*, 7: 424-435.
34. Salifu, M., and Doka, L. F. (2019). Effects of plant density on photosynthetic characteristics and yield of maize under irrigation condition. *ActaAgrariaDebreceniensis*, 1(1): 115-118.
35. Shafi, M., Bakht, J., Ali, S., Khan, H., Khan, M. A., and Sharif, M. (2012). Effect of planting density on phenology, growth and yield of maize (*Zeamays* L.). *Pakistan Journal of Botany*, 44(2): 691-696.
36. Sharifi, R. S., and Namvar, A. (2016). Plant density and intra-row spacing effects on phenology, dry matter accumulation and leaf area index of maize in second cropping. *Biologija*, 62(1):46-57.
37. Shrestha, J., Chaudhary, A., and Pokhrel, D. (2018). Application of nitrogen fertilizer in maize in Southern Asia: a review. *Peruvian Journal of Agronomy*, 2(2): 22-26.
38. Sibonginkosi, N., Mzwandile, M., and Tamado, T. (2019). Effect of Plant Density on Growth and Yield of Maize (*Zea mays* (L.) Hybrids at Luyengo, Middlelevel of Eswatini. *Asian Plant Research Journal*, 3(3-4): 1-9.
39. Siddiqui, D.A, Sharma, G.K., Chandrakar, T., Thakur, A.K. and Pradhan, A. 2020. Differential Levels of Fertilizer and Row Spacing Affects Growth and Yield of Brown Top Millet (*Brachiariaramosa* (L.) in Entisols of Bastar Plateau Zone of Chhattisgarh. *International Journal Current Microbiology Applied Science*, 9(08): 3459-3472





Mandapati Narendra Varma et al.,

40. Singh, P., Kumar, A., Gupta, V., Kumar, J., and Singh, B. (2019). Effect of high planting densities and cultivars on productivity of rainfed maize (*Zeamays* L.). *Indian Journal of Agricultural Sciences*, 89(9): 1513-1517.
41. Thorat, N. H., Dhonde, A. S., Shelar, D. N., and Mohite, A. B. (2016). Response of different sweet corn (*Zeamaysaccharata*Sturt) hybrids to various fertilizer levels in kharif season. *Ecology, Environment and Conservation Paper*, 22(1):301-304





Resource Conservation Technologies for Sustainable Production of Pulse Crop - A Review

Swarnali Duary¹, Sujay Kumar Paul^{2*}, Monalisa Sahoo¹ and Tufleuddin Biswas¹

¹Assistant Professor, Centurion University of Technology and Management, Odisha, India

²Assistant Professor (Agronomy), Department of Agriculture, MITS Institute of Professional Studies, Rayagada, Odisha, India

Received: 07 Mar 2022

Revised: 08 Apr 2022

Accepted: 10 May 2022

*Address for Correspondence

Sujay Kumar Paul

MITS Institute of Professional Studies,
Rayagada, Odisha, India

Email: sujay.paul39@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Pulses are the second most important crop in the world after cereals. Pulses are required to meet the nutritional security of any country and maintain the agriculture system's sustainability. To mitigate the increasing global demand for pulses, they should be included in the cropping system. Low productivity of pulses is a bottleneck towards increasing the production of pulses worldwide. Often higher use of natural resources leads to environmental hazards. Resource conservation technology can be a way out. Different resource conservation technologies include zero-tillage, Furrow Irrigated raised bed planting system (FIRB), Laser land levelling (LLB), pulse in rice fallow and crop residue management for pulse crop. These methods are practised either with sole crop or in sequence with rice crop, which deals with soil moisture preservation, improving soil structure, building up of soil organic matter and increasing the population of beneficial soil microorganisms.

Keywords: Resource conservation, Sustainability, Zero tillage, Pulses.

INTRODUCTION

Pulses are an essential crop for sustainable production and a crucial aspect of a vegetarian diet. India is the largest producer, consumer and importer of pulses globally. Farming of pulses is a consistent source of income and employment for small and marginal farmers, thus holding a premier position globally (Yadav *et al.*, 2019). The pulse requirement for the increasing population of India in 2030 A.D. is projected to be 32 million tonnes and 39 million tonnes by 2050 A.D. (Singh, 2018). Due to several reasons, pulses have very low productivity. The primary reason behind low productivity is cultivation of pulses in marginal and sub-marginal lands, crop getting higher exposure to abiotic stresses, lesser use of quality seeds for production, poor management practices (Bimbraw *et al.*, 2016). Mainly



**Swarnali Duary et al.,**

resource-poor farmers cultivate pulses with meagre input, taking high risks and using traditional low yielding varieties. But Indian agriculture has improved due to increased use efficiency of resources, increased area under irrigation, availability of quality seeds and proper maintenance soil and water resources (Mondal *et al.*, 2021). Resources need to be utilized carefully while maintaining sustainability to enhance crop productivity. Proper use of resources results in reduction of stress on resources, thus increasing productivity. These technologies are called as resource conservation technologies (RCTs) in agricultural production (Sirmour *et al.*, 2017). These technologies are essential to maintain ecological balance for supporting life and make the resources available for the present generation without hampering the future demand.

Different Resource conservation technologies (RCTs) for pulses

The term RCT involves practicing different techniques like zero tillage, improved high yielding varieties, broad bed and furrow, land levelling, crop residue management etc. All these contribute towards improved input use efficiency. Globally, RCT has been a deciding practice contributing towards sustainability over the past 2-3 decades, due to increased environmental degradation, pollution, production costs (Ghosh *et al.*, 2014). Improved tillage, seeding, irrigation, pest management, machinery and tools save fuel, human energy, and operations time, and new varieties that use nitrogen more efficiently may be considered RCTs (Verma *et al.*, 2014). Out of the 17 SDGs suggested by UNDP, rice-based cropping system with resource conservation technologies has potential to fulfill SDG 2, 3 and 15 (FAO, 2021).

Pulse in Rice-fallow

India will become self-sufficient in pulses production if rice-fallow areas are brought under pulse cultivation through innovative soil moisture and crop management approaches. Pulses are the best alternative in rice-fallows regions of the country due to their inherent capability of survival under adverse conditions and their ability to fix atmospheric nitrogen into plant-available form. Pulses in rice-fallows may enhance pulses production, which may help meet the country's nutritional demand (Kumar *et al.*, 2018). After rice harvest, pulses can be grown successfully on residual soil moisture following resource conservation technologies. The negative effect of continuous cultivation of the cereal-cereal system can be reversed by alternating a cereal with a pulse crop (Sing and Gangwar, 2018). It will also help to improve soil structure, organic matter build-up and microbial population (Sing and Gangwar, 2018).

Zero tillage

The extreme form of minimum tillage is called zero tillage, where primary tillage operations are avoided, and secondary tillage is done in the row zone only for seedbed preparation. The traditional method of broadcasting pulse seeds into a standing rice crop leads to poor plant growth and yield due to irregular plant population. But comparatively, zero tillage improves soil environment and also lowers costs due to reduced erosion and better use efficiency of resources (Amuthaselvi *et al.*, 2019). Another benefit of conservation or zero tillage pulse cultivation system is that the nitrogen fixation rate increases after multiple years (Singh *et al.*, 2016). Late sowing of winter season pulses results in lower crop yields, which may be due to reduced length of growing period and cold injuries in the early vegetative phase. Thus, practicing conservation tillage technologies helps in optimum time of sowing/planting and proper plant stand establishment in the rice-based cropping systems of India (Mishra and Kumar, 2018). Zero tillage has a direct mitigation effect by converting greenhouse gases from the atmosphere and soil organic matter enrichment (Venkateswarlu and Shanker, 2009).

Furrow Irrigated Raised Bed planting system (FIRB)

The Furrow Irrigated Raised Bed planting system is a useful water saving technology. It is equally suitable RCT for waterlogged as well as water deficit areas. FIRB increases nitrogen use efficiency, reduces weed infestation, improves soil physical status and decreases soil crustation problem as compared to other conventional practices (Fahong, Xuqing & Sayre, 2004). In FIRB planting system, irrigation water moves from the furrows horizontally towards the beds, which then moves upwards by capillary action towards the soil surface (Tomar *et al.*, 2020).



**Swarnali Duary et al.,****Laser Land Leveling (LLL)**

The laser land levelling was introduced in India by Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, in 2001 (Naresh *et al.*, 2014). In the conventional way, farmers generally use wooden planks which are fixed to a small tractor or animal for attaining levelled field. But, they are not so precise. So, new age technologies like laser land levelling, can efficiently be utilized for precisely levelling land and create a gentle slope of 0 to 0.2% (Jatet *et al.*, 2004). Some of the key advantages of using this technique is to attain proper leveled field surface reducing time required for irrigation. Proper land levelling leads to uniform water distribution, helping control soil salinity and water logging, increasing nutrient use efficiency, machinery usage efficiency, and increasing area available for cultivation by 2-5 % (Kumar *et al.*, 2012).

Crop Residues Management

By adopting conservation agriculture-based technologies crop residues can improve soil health, increase crop productivity, reduce pollution, and enhance the sustainability and resilience of agriculture. Crop residue retention on surface soil in pulses contributes to soil water conservation and evading drought condition (Ali *et al.*, 2014; Nandi *et al.*, 2022). This kind of RCT can improve overall resource use efficiency. Mulching is a practice of covering soil surface with either organic or inorganic materials (Ghouse Peera *et al.*, 2020; Santosh and Maitra, 2022). This gives enhanced time for surface water retention reducing leaching and evapotranspiration. Mulching with organic materials adds organic matter to soil and also reduces nutrient loss (Anand *et al.*, 2020; Singh *et al.*, 2021). Covering surface soil regulates soil temperature in a positive manner, thus enhancing crop production.

Precision farming

Precision agriculture aims to optimise profitability and protect the environment through efficient inputs based on temporal and spatial variability of soils and crops. Precision designates using appropriate inputs at proper time in appropriate amounts. This, in turn, increases productivity and maximizes yields (Bhattacharyay *et al.*, 2020). The benefits of precision farming include reducing the cost of production and reducing environmental pollution through reduced use of agrochemicals (Ramesh and Rana, 2016).

CONCLUSION

The foremost emphasis for long term sustainable crop production is to take special care about the soil health status. It can ensure a country's food security from crop cultivation. But, RCTs are site-specific. Hence, the need of the hour is to conduct large-scale testing before utilizing these technologies in wider manner over diversified production systems. As a result, resource conservation technologies are critical for widespread implementation. We must produce enough pulses and remain competitive to maintain the indigenous pulse industry. To encourage farmers to cultivate more pulses, we need to create and adopt more productive and efficient technology and favourable development strategies.

REFERENCES

1. Ali, M., Ghosh, P. K. and Hazra, K. K. (2014). Resource conservation technologies in rice fallow. *Resource conservation technology in pulses*, 83-88.
2. Amuthaselvi, G. Dhanushkodi, V. and Eswaran, S. (2019). Performance of zero till seed drill in raising black gram under rice fallow. *Journal of Crop and Weed*, 15(1): 195-197.
3. Anand, D. D., Singh, M. S., Lungdim, J., Devi, N. S. and Sing, N. G. (2020). Effect of mulching on growth and yield of soybean (*Glycine max* (L.) Merrill). *International Journal of Current Microbiology and Applied Sciences*, 9(9): 3313-3318.





Swarnali Duary et al.,

4. Bhattacharyay, D., Maitra, S., Pine, S., Shankar, T. and PeddaGhousePeera, S.K. (2020). Future of precision agriculture in India. In: *Protected Cultivation and Smart Agriculture*, Eds. Maitra, S., Gaikwad, D. J., Shankar, T., New Delhi Publishers, pp.289-299.
5. Bimbraw, A. S. (2016). Use of conservation technology for the improvement in production of chickpea in comparison to Wheat, *Current agriculture research journal*, 4(1):01-15.
6. Dhindwal, A. S., Hooda, I. S., Malik, R. K. and Kumar, S. (2006). Water productivity of furrow-irrigated rainy-season pulses planted on raised beds. *Indian Journal of Agronomy*, 51(1): 49-53.
7. Fahong, W., Xuqing, W., & Sayre, K. (2004). Comparison of conventional, flood irrigated, flat planting with furrow irrigated, raised bed planting for winter wheat in China. *Field Crops Research*, 87(1), 35-42.
8. FAO (2021). Sustainable Development Goals, 17 Goals to Transform Our World. <http://www.fao.org/3/i6583e/i6583e.pdf> (Accessed 30th April, 2022).
9. Ghosh, P. K., Kumar, N., Venkatesh, M. S., Hazra, K. K. and Nadarajan, N. (2014). *Resource Conservation Technology in Pulses*. Scientific Publishers.
10. GhousePeera, P. S. K., Debnath, S. and Maitra, S. (2020). Mulching: Materials, Advantages and Crop Production, In: Eds. Maitra, S., Dinkar, J., Gaikwad, D. J. and Shankar, T., In: *Protected Cultivation and Smart Agriculture*, New Delhi Publishers, India, pp. 55-66.
11. Jat, M. L., Pal, S. S., Rao, A. S., Sirohi, K., Sharma, S. K. and Gupta, R. K. (2004). Laser land leveling: the precursor technology for resource conservation in irrigated eco-system of India. In *Proceedings of the National Conference on Conservation Agriculture* (pp. 9-10).
12. Kumar, N., Singh, M. K., Ghosh, P. K., Venkatesh, M. S., Hazra, K. K., &Nadarajan, N. (2012). *Resource conservation technology in pulse based cropping systems*. Indian Institute of Pulses Research, Kanpur, 249-251.
13. Kumar, N., Yadav, A., Singh, S., & Yadav, S. L. (2018). Growing pulses in rice fallow: Ensuring nutritional security in India. *Conservation Agriculture for Advancing Food Security in Changing Climate*, 1, 107-122.
14. Mandal, T. M., Puste, A.M. and Maitra, S. (2018). Influence of irrigation and mulching on yield attributes, yield and quality of lentil (*Lens esculentum* L.) grown as intercrop under limited water conditions. *International Journal of Bioresource Science*, 5(1): 61-64.
15. Mishra, J. S. and Kumar, R. (2018). Zero Tillage Options for Establishment of Pulses in Rice-Based Cropping System. *Farm Mechanization for Production*, 122.
16. Mondal, k., Malik, G.C., Banerjee, M. and Jana, K. (2021). Resource conservation technology for sustainable production of wheat: A review. *International Journal of Ecology and Environmental Sciences*, 3(2): 209-2013.
17. Nandi, S., Panda, M., Sairam, M., Palai, J. B. and Upasana Sahoo, U. (2022). Suitable Options for Agricultural Waste Management in India, *Indian Journal of Natural Sciences*, 13:41421-41426.
18. Naresh, R. K., Singh, S. P., Misra, A. K., Tomar, S. S., Kumar, P., Kumar, V. and Kumar, S. (2014). Evaluation of the laser leveled land leveling technology on crop yield and water use productivity in Western Uttar Pradesh. *African Journal of Agricultural Research*, 9(4): 473-478.
19. Patil, M. B., Shanwad, U. K., Veeresh, H., Reddy, M., Rathod, P., Rajesh, B. G., Shailendrakumar, N. L., Hugar, L. B., Pujari, B. T. and Patil, B. V. (2013). Precision agriculture initiative for Karnataka: A new direction for strengthening farming community. *Scholarly Journal of Agricultural Science*, 3(10): 445-452.
20. Ramesh, N. S. C. and Rana, S. S. (2016). Resource Conservation Technologies (RCTs)-Needs and future prospects: A review. *Agric Rev*, 37(4):257-267.
21. Santosh D. T. and Maitra, S. (2022). Effect of drip irrigation and plastic mulch on yield and quality of ginger (*Zingiber officinale*), *Research on Crops*, 23 (1): 211-219, DOI: 10.31830/2348-7542.2022.030
22. Singh, N. P. (2018). Pulses as a candidate crops for doubling farmers' income. *Indian Farming*, 68(01): 36-43.
23. Singh, P., Singh, K.M. and Brajesh Shahi, B. (2016). Pulses for Sustainable Livelihood and Food Security.
24. Singh, S.P., Mahapatra, B.S., Pramanick, B. and Yadav, V.R. (2021). Effect of irrigation levels, planting methods and mulching on nutrient uptake, yield, quality, water and fertilizer productivity of field mustard (*Brassica rapa* L.) under sandy loam soil. *Agricultural Water Management*, 244: 106539. <https://doi.org/10.1016/j.agwat.2020.106539>
25. Singh, V. K. and Gangwar, B. (2018). *System Based Conservation Agriculture.*, Westville PublishingHouse, New Delhi. pp 272.





Swarnali Duary et al.,

26. Sirmour, A. Pandey, M. K. and Verma, A. (2017). Adoption of new resource conservation technology for sustainable production, *Journal of Pharmacognosy and Phytochemistry*, 655-661.
27. Tomar, S. S., Singh, Y. P., Naresh, R. K., Mrunalin, K., Gurjar, R. S., Yadav, R., & Sharma, D. (2020). Water-use Efficiency and the Effect of Water Deficits under Different Planting Techniques on Productivity and Profitability of Chickpea (*Cicer arietinum* L.) in Typic Ustochrept Soil of Morena Region of MP. *International Journal of Current Microbiology and Applied Science*, 9(8):709-719.
28. Venkateswarlu, B. and Shanker, A. K. (2009). Climate change and agriculture: adaptation and mitigation strategies. *Indian Journal of Agronomy*, 54(2):226-230.
29. Verma, V. K., Pyare, R., Singh, V., Chaudhary, S., Srivastava, A. K. and Singh, R. B. (2014). Agricultural profitability through resource Conservation technologies for resource poor Farmers of Uttar Pradesh: an overview, *Agriways*, 2(1) :12-18.
30. Yadav, A. S., Kumar, S., Kumar, N. and Ram, H. (2019). Pulses production and productivity: Status, potential and way forward for enhancing farmers income. *Int. J. Curr. Microbiol. App. Sci*, 8(4):2315-2322.

Table 1: Effect of FIRB on grain yield (q/ha) of different crop

| Planting methods | Crop | | |
|------------------|------------|--------------|------------|
| | Pigeon pea | Cluster bean | Green gram |
| Flat | 9.27 | 8.65 | 6.97 |
| FIRB | 11.31 | 9.34 | 8.02 |

[Dhindwal et al., 2006]

Table 2: Effect of FIRB on Benefit: Cost ratio, total water uses and water productivity of chickpea

| Planting methods | Benefit: Cost ratio | Total water use (water/m ³) | Water productivity (kg seed/m ³ water) |
|------------------|---------------------|---|---|
| Flat bed | 2.99 | 2100 | 0.75 |
| FIRB (60 cm) | 4.29 | 1480 | 2.10 |
| FIRB (120 cm) | 3.76 | 1070 | 1.34 |

[Tomar et al., 2020]

Table 3: Effect of crop residue incorporation on soil physical properties

| Crops | Bulk Density (g/cc) | Particle Density (g/cc) | WHC (%) | Pore space (%) |
|-----------|---------------------|-------------------------|---------|----------------|
| Mungbean | 1.38 | 2.42 | 37.3 | 45.5 |
| Blackgram | 1.39 | 2.39 | 38.3 | 44.65 |

[Source: Kumar et al., 2012]

Table 4: Effect of mulching on no. of pods per plant, seeds per plant, seed weight per plant (g) and seed yield (kg/ha) of lentil

| Treatments | Pod per plant | Seed per plant | Seed weight per plant (g) | Seed yield (kg/ha) |
|---------------------------------------|---------------|----------------|---------------------------|--------------------|
| No mulching | 62.93 | 101.84 | 1.75 | 695.66 |
| Straw mulching @ 5t rice straw per ha | 67.35 | 112.31 | 1.84 | 724.66 |

[Source: Mandal et al., 2018]





Swarnali Duary *et al.*,

Table 5: Effect of precision farming on yield of pigeon pea

| Type | Yield (Kg/ha) | | |
|-----------------|---------------|----------|-----------|
| | Raichur | Gulbarga | Gangavati |
| Non - Precision | 1172 | 472 | 817 |
| Precision | 1261 | 780 | 907 |

[Source: Patil *et al.*,2013]





Academic Procrastination, Self-Esteem, and Attachment Style: Correlational Study

Priyanka Bhati^{1*} and Gargi Sharma²

¹Research Scholar, Department of Psychology, Manipal University Jaipur, Jaipur, India.

²Assistant Professor, Department of Psychology, Manipal University Jaipur, Jaipur, India.

Received: 13 Apr 2022

Revised: 03 May 2022

Accepted: 19 May 2022

*Address for Correspondence

Priyanka Bhati

Research Scholar,

Department of Psychology,

Manipal University Jaipur,

Jaipur, India.

Email: youknowpriyanka@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Adolescence is a state of transition where an individual confronts the real world. This demanding phase can be eased by a little support and encouragement from parents. Much of the research has been directed to study and acknowledge the behavior of adolescents as this is the most vital phase in a person's life. Adolescence is a unique and formative time. It's the time the students are exposed to physical, mental, emotional, and social changes. This phase refines an individual's personality. The current piece of work is an effort to know the relationship among academic procrastination, self-esteem, and attachment style in adolescents. The sample consists of 100 adolescents. For assessing academic procrastination, self-esteem, and attachment style 'Procrastination scale', 'Rosenberg self-esteem scale' and 'Attachment style questionnaire' were used respectively. To find out the relationship between academic procrastination, self-esteem, and attachment style correlation analysis is used. The result shows that there is a significant correlation among academic procrastination, self-esteem, and attachment style in adolescents.

Keywords: Academic Procrastination, Adolescents, Attachment Style, Self-Esteem.

INTRODUCTION

Various researches have been conducted to understand the nature and behavior of adolescents. The current piece of work is an attempt to see the relationships among academic procrastination, self-esteem, and attachment style in adolescents. The result of this work will help the teachers, and parents deal with adolescents accordingly. It will help in predicting the behavior of adolescents for their careers and other areas of life, such as relationships.





Priyanka Bhati and Gargi Sharma

Academic Procrastination

It is the delay of activity. It is a tendency to delay what is required (Lay, 1986). Many studies have shown it as a trait than time allocation (Ferrari, Johnson, and McCown, 1995). Students procrastinate their academic activities like delays in assignments, project reports, work, etc. The outcome of procrastination can be very dangerous, i.e., those students who procrastinate their academic assignments, etc can be withdrawn from examinations. It is an intricate process having behavioral amalgam (Rothblum, Solomon, & Murakami, 1986). It is voluntarily postponing academic work to the point that student feels emotional issues giving rise to other behavioral problems. It is something that can never be helpful in any way. The purpose behind academic procrastination is that students think that later is better which leads to tomorrow. However, as tomorrow approaches, the pattern reappears and procrastinator students spare themselves by promising that they will do it later. Hence, it can be said that procrastination is a future syndrome (Knaus, 2002). Academic procrastination is observed as an irrational activity that promotes unfavorable results. (Klindsieck, 2013). The basic reason for academic procrastination is a behavioral intentional delay. A lot of literature shows it is a self-declared hindrance as measured by the procrastination scale (Svardal and Steel, 2017). Procrastination behavior surfaces in an individual due to the inability to regulate their behavior suggesting a gap between how they want to act versus how they act in reality. Academic procrastination leads to a reduction in productivity.

Reasons why people procrastinate in general:

Instant gratification- People engage in work that makes them feel satisfied at the moment and delay less satisfying work.

Perfectionism: Some people tend to do the work in the perfect way possible. Perfectionism leads to delay or avoiding work.

Unconscious fears: There are many unconscious fears that monitor or guide behavior. Unconscious fears such as fear of judgment, fear of failure, and fear of rejection are some of them.

Lack of interest: When the work is less interesting, one wants to avoid it at all costs. Boring, monotonous, or repeating work develops a lack of interest.

Overwhelmed feeling: When some tasks are too difficult or require a lot of energy, attention, and time people keep on postponing such work.

Self-esteem

It is confidence in one's abilities and potential. Self-worth leads to developing strong self-esteem. It is a subjective, personal evaluation of own self. It is generally a highly positive factor for well-being. When self-esteem is high in an individual, it helps in building life whereas if it's low, it prevents from pursuing goals. James (1980) stated self-esteem as satisfaction or dissatisfaction with oneself. It is a feeling of self-appreciation. Individuals' positive self-esteem can influence in many ways, from personal to professional success including having meaningful relationships to be successful at work. Those students who are low on self-esteem engage in delaying behaviors, which are further provoked by showing irresponsible tasks. Some studies consider procrastination as a way to defend self-esteem (Flett, Blankstein, and Martin, 1995; Klassen, Krawchuk, and Rajani, 2008). Alam (2013) suggests that students having high self-esteem shows high academic performance. It is a thoughtfully studied notion in the social sciences (Bleidorn, Hufer, Kandler, Hopwood, & Riemann, 2018).

Students having high self-esteem feel good about themselves. They are more resilient to facing problems. Characteristics of having stable self-esteem include strong willpower, self-confidence, originality, creativity, sanity, and sound mental health. Further, it also refers to a person's sense of value. The base of self-esteem is formed during the initial years of life. When a child feels valued and respected, self-esteem strengthens. On the contrary, when a child feels criticized for their ability or feels rejected, then their self-esteem remains low or weak. An increase or decrease in self-esteem generates strong emotional reactions. (Noronha, Monteiro, & Pinto, 2018). Low self-esteem leads to feelings of insecurity and self-doubt.





Priyanka Bhati and Gargi Sharma

There are various ways to improve self-esteem. Some of them are:

- a) Be nice to yourself: It is always important to listen to the little voice whispering inside the head.
- b) Physical activities: Doing exercises makes you feel good about yourself. Certain hormones are released in the body which strengthens the immune system and makes you feel confident.
- c) Celebrate the small things: Celebrating the small accomplishments boosts self-esteem. Small victories give a sense of satisfaction.
- d) Doing activities that make you happy: Scheduling every day in such a way to get enough time for recreational work. Activities or hobbies which uplift the mind. It can be anything, such as cooking, gardening, playing video games, meditation, etc.
- e) Helping others: Studies suggest helping others boosts mood and self-esteem.

Other factors are as follows:

- i) Learn a new skill.
- ii) Journaling accomplishments.
- iii) Leaving comfort zone.
- iv) Stop thinking about what others think about yourself.
- v) Developing a habit to read good books.
- vi) Avoiding people who make you feel unworthy or negative about yourself.
- vii) Understanding that failure is a part of life.

Attachment style

Attachments are an important part of life. It is a style in which one relates to others. The base for attachment style develops early in days. During the initial years of childhood, it develops between child and parent. The healthy development of a child occurs when the child develops a relationship with the primary caregiver. It further helps in developing emotional and social relationships. The early years of life are very crucial in an individual's life. The attachment style developed early in life often stays stable over a long period. Adult relationships are built based on attachment style. Attachment style can be termed as internal working models individuals use for forming a bond, or relationships with others.

There are four types of attachment styles. They are secure, fearful, preoccupied, and dismissing attachment style. A secure attachment style is when a person feels completely secure being close to someone. Love and trust come very easily in this type of attachment. There is no insecurity in a relationship like mistrust or being abandoned by others. Securely attached individuals have reported a positive impression of their childhood relationships. (Feeney and Noller, 1990). Secure attachment theory explains the positive mother-infant relationship. (Flaherty and Sadler, 2011). Securely attached children have good cognitive, emotional, social, and behavioral development whereas insecure children are more likely to have adverse outcomes. Such a relationship develops from the mother's tendency to be sensitive, giving, and responsible towards the newborn needs which further gives rise to the infants' evolution of trust towards her and building resilience in life later. (Karen, 1990). However, it's not easy to form a secure and trustworthy attachment.

A fearful attachment style is when a person fears rejection. They face high anxiety in relationships. Some studies suggest childhood trauma leads to a fearful attachment style. A traumatic incident with the caregiver leaves a child with the idea that they cannot see the caregiver as an attachment figure. It predicts negative outcomes (Reis and Grenyer, 2004). These people crave love and affection from others but are fearful to have such relations. Some of the behaviors that show fearful attachment style are elevated anxiety level, fear of intimacy in relation, having a hard time regulating emotions of self, negative self-perception & abandonment fear.

In the preoccupied type of attachment style, individuals often worry and are reluctant to get close to someone. They are preoccupied with the idea that the other person won't love them or don't remain close if they get very close. These individuals think highly of others but are often insecure about their worth. These individuals feel anxiety in a relationship. Bowlby (1950s) believed that childhood experiences with the primary caregivers influence the attachment style human form as an adult. Some common symptoms include difficulty trusting the other partner,





Priyanka Bhati and Gargi Sharma

constant fear of rejection and abandonment, negative self-worth, and hypersensitivity regarding the partner's mood and behavior.

Dismissing attachment style is when the person is nervous when anyone gets too close. Such a person finds it easy to avoid intimacy by doing solitary activities. Such people have a positive outlook on themselves but have a negative perception of others around them. These people highly value their independence. Common behaviors include suppressing emotions, avoiding emotional closeness in relation, withdrawing and coping with difficult situations alone, overly focused on their own needs.

RATIONALE OF THE STUDY

Less academic procrastination suggests consistency of work, industrialism, and success whereas more academic procrastination shows failure in areas of work, decision making, etc. High self-esteem suggests the value of self in regards to the overall approach towards everyday' s tasks. It suggests knowing and understanding one's strengths, and weaknesses. Whereas low self-esteem will suggest a lack of confidence. On the other hand, different attachment styles will suggest different upbringing styles resulting in various approaches to deal with personal and life issues.

METHOD

Objective-

To investigate the relationship among academic procrastination, self-esteem, and attachment style in adolescents.

Hypotheses-

- (1) There will be a significant relationship between self-esteem and academic procrastination in adolescents.
- (2) There will be a significant relationship between self-esteem and attachment style (i.e., secure, fearful, preoccupied, and dismissing) in adolescents.
- (3) There will be a significant relationship between academic procrastination and attachment style (i.e., secure, fearful, preoccupied, and dismissing) in adolescents.

Sample-

The sample consisted of 100 adolescents from various universities in Jaipur. The age range of the sample population was 18 to 25 years.

Tools-

The following research tools are taken for data collection:

Procrastination Scale- A scale is a self-report form developed by Lay in 1986 and consists of 20 items. The level of procrastination is assessed by using 5 subscales. The scale is highly reliable and valid, having a reliability of 0.87.

Rosenberg Self-esteem Scale- It has 10 questions. It measures self-esteem. It is designed by Rosenberg in 1965. Participants respond by using 5 points Likert-type scale. The scale is unidimensional. The reliability is 0.88.

Attachment Style Questionnaire (ASQ)-The ASQ scale which is constructed by Van OudenhovenHofstra and Bakker in 2003 consists of 22 items which are classified as secure attachment, fearful attachment, preoccupied attachment, and dismissing attachment style.

RESULT

The researcher attempts the appropriate method for collecting the data about various variables. An appropriate statistical technique is used to transform the raw data into meaningful results.



**Priyanka Bhati and Gargi Sharma**

The correlation technique is used among the three variables, i.e., academic procrastination, self-esteem, and attachment style. As per the result table mentioned on the last page, self-esteem is positively related to academic procrastination where the r-value to be found is 0.46 which is significant at a 0.01 level. Self-esteem is negatively related to secure attachment style, the r-value to be found is -0.24 which is significant at a 0.05 level. Self-esteem is positively related to fearful attachment style, the r-value to be found is 0.42 which is significant at a 0.01 level. Self-esteem is positively related to preoccupied attachment style, the r-value to be found is 0.56 which is significant at a 0.01 level. Self-esteem is negatively related to dismissing attachment style, the r-value to be found is -0.34 which is significant at a 0.01 level.

Academic procrastination is negatively related to secure attachment style, the r-value to be found is -0.04. Academic procrastination is positively related to fearful attachment style, the r-value to be found is 0.09. Academic procrastination is positively related to preoccupied attachment style, the r-value to be found is 0.32 which is significant at a 0.01 level. Academic procrastination is negatively related to dismissing attachment style, the r-value to be found is -0.29 which is significant at a 0.01 level. Secure attachment style is negatively related to fearful attachment style, the r-value to be found is -0.43 which is significant at a 0.01 level. Secure attachment style is negatively related to preoccupied attachment style, the r-value to be found is -0.10. Secure attachment style is positively related to dismissing attachment style, the r-value to be found is 0.01. Fearful attachment style is positively related to preoccupied attachment style, the r-value to be found is 0.35 which is significant at a 0.01 level. Fearful attachment style is positively related to dismissing attachment style, the r-value to be found is 0.02. Preoccupied attachment style is negatively related to dismissing attachment style, the r-value to be found is -0.22 which is significant at a 0.05 level.

FINDING

1. There is a significant relationship between self-esteem and academic procrastination in adolescents so the first hypothesis is accepted.
2. There is a significant relationship between self-esteem and attachment style in adolescents so the second hypothesis is also accepted.
3. There is a significant relationship between academic procrastination and attachment style in adolescents so the third hypothesis is also accepted.

DISCUSSION

A lot of studies are going on on the crucial issues of adolescents. The first hypothesis states that there is a significant relationship between self-esteem and academic procrastination. The result table shows that self-esteem is positively related to academic procrastination in adolescents. The result is consistent with the research of Tamini and Minakhany (2013) which shows self-esteem has a strong predictor of academic procrastination. It shows procrastination behavior is positively related to the self-esteem of adolescents. If self-esteem increases, procrastination also increases. Beck, Koons, and Milgrim (2000) revealed procrastination and self-esteem are connected. Babu, Chandra, Vanishree, and Amritha (2019) suggested that adolescents who are high in self-esteem procrastinate less as compared to those with low self-esteem.

The second hypothesis states that there is a significant relationship between self-esteem and attachment style in adolescents. The findings show that self-esteem is negatively related to secure attachment, self-esteem is positively related to fearful attachment, self-esteem is positively related to preoccupied attachment, and self-esteem is negatively related to dismissing attachment. The result is consistent with the research of Passanisi, Gervasi, Madonia, Guzzo, and Greco (2015) which shows the relationship between insecure attachment, low self-esteem, and shame. A study by Feeney and Noller (1990) suggests that attachment style is strongly related to self-esteem. Brennan and





Priyanka Bhati and Gargi Sharma

Bosson (1998) suggest the association of attachment with self-esteem. The third hypothesis is there is a significant relationship between academic procrastination and attachment style in adolescents. The result of the study shows academic procrastination is negatively related to secure and dismissing attachment, and academic procrastination is positively related to fearful and preoccupied attachment style. Celik and Odaci (2020) confirmed preoccupied attachment style has a positive effect on academic procrastination. Emadian and Pasha (2016) found no association between the two variables, i.e., attachment style and academic procrastination.

CONCLUSION

Based on the result, it can be concluded that academic procrastination is negatively related to secure and dismissing attachment style while academic procrastination is positively related to fearful and preoccupied attachment style. Self-esteem is negatively related to secure and dismissing attachment style. But self-esteem is positively related to fearful and preoccupied attachment style. Self-esteem is positively related to academic procrastination. Secure attachment is negatively related to fearful as well as preoccupied attachment styles. But it is positively related to dismissing attachment style. Fearful attachment style is positively related to the preoccupied and dismissing attachment style. Preoccupied attachment style is negatively related to dismissing attachment style.

Limitations

Although the result supported all three hypotheses, the present study is subject to a few limitations. The questionnaires were self-reported related to academic procrastination, self-esteem, and attachment style in the adolescents which could have led to social desirability bias. The total number of adolescents who participated in the research was limited. Therefore, for a more reliable and valid conclusion, the work requires a larger population. Other variables such as emotional maturity, self-worth, and emotional intelligence can also be studied to know their correlation with academic procrastination.

Recommendations

Many implications have surfaced based on the findings of the research. Academic procrastination leads to the loss of young students' valuable hours. It further decreases self-esteem as students are unable to work productively at the end of the day. The current piece of work points to therapeutic intervention for adolescents who delay every day's work which leads to dissatisfaction. Suggestions and guidance can be provided for improving self-esteem. Enhanced self-esteem helps to deal with academic procrastination in adolescents. Schools and colleges might organize time management courses to educate and guide students about the importance of time at their age. Adolescents who are self-motivated and organized can easily understand and interrupt such cognitive barriers. Encouraging self-regulation, and improving time management skills with the help of cognitive-behavioral interventions might help students to prevent academic procrastination. Counseling areas need to be set up in the academic centers to help and guide adolescents on time who face low self-esteem.

REFERENCES

1. Alam, M. M. (2013). A study of test anxiety, self-esteem and academic performance among adolescents. *Journal of Organizational Behavior*, 12(4), 33-43.
2. Babu, P., Chandra, K, M., Vanishree, M. K., & Amritha, N. (2019). Relationship between academic procrastination and self-esteem among dental students in Bengaluru City. *Journal of Indian Association of Public Health Dentistry*, 17(2), 146-151.
3. Balkis, M., & Duru, E. (2017). Gender Differences in the relationship between Academic Procrastination, Satisfaction with Academic Life and Academic Performance. *Electronic Journal of Research in Educational Psychology*, 15(1), 105-125.





Priyanka Bhati and Gargi Sharma

4. Beck, B.L., Koons, S.R., & Milgrim, D.L. (2000). Correlates and consequences of behavioral procrastination: The effect of academic procrastination, self-esteem, and self-handicapping. *Journal of Social Behaviour and Personality*, 15(5), 3-13.
5. Beutel, M. E., Klein, E. M., Aufenanger, S., Braehler, E., Dreier, M., Muller, K. W., Quiring, O., Reinecke, L., Schmutzer, G., Stark, B., & Wolfling, K. (2016). Procrastination, Distress and Life Satisfaction across the Age Range-A German Representative Community Study. *Plus one*, 11(2), 1-12.
6. Bleidorn, W., Hufer, A., Kandler, C., Hopwood, C. J., & Riemann, R. (2018). A nuclear twin family study of self-esteem. *European Journal of Personality*, 32(3), 221-232.
7. Bretherton, I. (1992). The Origins of Attachment Theory: John Bowlby and Mary Ainsworth, *Developmental Psychology*, 25(5), 759-775.
8. Brennan, K.A., & Bosson, J.K. (1998). Attachment style differences in attitudes toward and reactions to feedback from romantic partners: An exploration of the relational bases of self-esteem. *Personality and Social Psychology Bulletin*, 24(7), 699-714.
9. Celik, C.B., & Odaci, H. (2020). Subjective well-being in university students: what are the impacts of procrastination and attachment styles? *British Journal of Guidance & Counselling*, 1-14. <https://doi.org/10.1080/03069885.2020.1803211>
10. Emadian, S.O., & Pasha, N.F.Z. (2016). The relationship between attachment style, self-concept and academic procrastination. *International Academic Journal of Humanities*, 3(1), 32-38.
11. Feeney, J. A., & Noller, P. (1990). Attachment style as a predictor of adult romantic relationships. *Journal of Personality and Social Psychology*, 58(2), 281-291.
12. Ferrari, J. R., Johnson, J. L., & McCown, W. G. (Eds.). (1995). Procrastination and task avoidance: Theory research, and treatment. New York: Plenum Press.
13. Flaherty, S. C., Sadler, L. S. (2011). A review of attachment theory in the context of adolescent parenting. *Journal of pediatric health care: official publication of National Association of Pediatric Nurse Associates & Practitioners*, 114-121. <http://doi:10.1016/j.pedhc.2010.02.005>
14. Flett, G. L., Blankstein, K. R., & Martin, T. R. (1995). Procrastination, negative self-evaluation, and stress in depression and anxiety. *Procrastination and Task Avoidance: Theory, Research, and Treatment*, 137-167.
15. Hosogi, M., Okada, A., Fujii, C., Noguchi, K., & Watanabe, K. (2012). Importance and usefulness of evaluating self-esteem in children. *BioPsychoSocial Medicine*, 1-6, 6:9. <http://www.bpsmedicine.com/content/6/1/9>
16. James, W. (1980). The Principles of Psychology. New York: Henry Holt and Company.
17. Karen, R. (1990). Becoming Attached. *The Atlantic Monthly*, 35-70.
18. Klassen, R. M., Krawchuk, L. L., & Rajani, S. (2008). Academic procrastination of undergraduates: low self-efficacy to self-regulate predicts higher levels of procrastination. *Contemporary Educational Psychology*, 33(4), 915-931
19. Klingsieck, K. B. (2013). Procrastination: when good things don't come to those who wait. *European Psychology*, 18, 24-34. <https://doi:10.1027/1016-9040/a000138>
20. Knaus, W. (2002). The Procrastination Workbook. Oakland, CA: New Harbinger Publication Inc.
21. Lay, C. H. (1986). At least my research article on procrastination. *Journal of Research in Personality*, 20, 474-495.
22. Noronha, L., Monteiro, M., & Pinto, N. (2018). A Study on the Self-Esteem and Academic Performance Among the Students. *International Journal of Health Sciences and Pharmacy (IJHSP)*, 2(1).
23. Ozer, B. U., & Sackes, M. (2011). Effects of Academic Procrastination on College Students Life Satisfaction. *Procedia Social and Behavioral Sciences*, 12, 512-519.
24. Passanisi, A., Gervasi, A.M., & Madonia, C., Guzzo, G., & Greco, D. (2015). Attachment, Self-Esteem and Shame in Emerging Adulthood. *Procedia- Social and Behavioral Sciences*, 191, 342-346.
25. Reis, S., & Grenyer, B. F. S. (2004). Fearful attachment, working alliance and treatment response and treatment response for individuals with major depression. *Clinical Psychology & Psychotherapy: An International Journal of Theory & Practice*, 11(6), 414-424.
26. Rothblum, E. D., Solomon, L. J., & Murakami, J. (1986). Affective, cognitive, and behavioral differences between high and low procrastinators. *Journal of Counseling Psychology*, 33(4), 387-394.





Priyanka Bhati and Gargi Sharma

27. Rozental, A., & Carlbring, P. (2014). Understanding: a review of a common self-regulatory failure. *Psychology*, 5, 1488-1502. <https://doi:10.4236/psych.2014.513160>

28. Saleem, M., & Rafique, R. (2012). Procrastination and Self-Esteem among University Students. *Pakistan Journal of Social & Clinical Psychology*, 10(2), 50-53.

29. Solomon, L. J., & Rothblum, E. D. (1984). Academic procrastination: frequency and cognitive-behavioral correlates. *Journal of Counseling Psychology*, 31, 503-509.

30. Steel, P. (2007). The nature of procrastination: a meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, 133, 65-94. <https://doi:10.1037/0033-2909.133.1.65>

31. Svartdal, F., Granmo, S., & Faerevaag, F. S. (2018). On the Behavioral Side of Procrastination: Exploring Behavioral Delay in Real-Life Settings. *Frontiers in Psychology*, 9 (746), 1-11. <https://doi:10.3389/fpsyg.2018.00746>

32. Svartdal, F., & Steel, P. (2017). Irrational delay revisited: examining five procrastination scales in a global sample. *Frontiers in Psychology*, 8:1927. <https://doi:10.3389/fpsyg.2017.01927>

33. Tamini, B.K.T., & Minakhany, G. (2013). Academic Procrastination and its Relationship with Self-Esteem and Life Satisfaction. *International Journal of Psychology*, 7(1), 87-104.

34. Tan, J., Ma, Z., & Li, X. (2015). Global self-esteem mediates the effect of general self-efficacy on Chinese undergraduates' general procrastination. *Social Behavior and Personality: An International Journal*, 43(8), 1265-1271.

35. Vollmann, M., Sprang, S., & Brink, F. (2019). Adult attachment and relationship satisfaction: The mediating role of gratitude toward the partner. *Journal of Social and Personal Relationships*, 36(11), 3875-3886. <https://doi.org/10.1177/0265407519841712>

36. Yildiz, B., & Iskender, M. (2019). The secure attachment style oriented-educational program for reducing intolerance of uncertainty and academic procrastination. *Current Psychology*. <http://doi.org/10.1007/s12144-018-0112-4>

37. Young, L., Kolubinski, D. C., & Frings, D. (2020). Attachment style moderates the relationship between social media use and user mental health and wellbeing. *Heliyon* 6, 1-7. <https://doi.org/10.1016/j.heliyon.2020.e04056>

Table 1. Result

| Variables | Self-esteem | Academic Procrastination | Secure Attachment Style | Fearful Attachment Style | Preoccupied Attachment Style | Dismissing Attachment Style |
|------------------------------|-------------|--------------------------|-------------------------|--------------------------|------------------------------|-----------------------------|
| Self-esteem | 1 | | | | | |
| Academic Procrastination | 0.46** | 1 | | | | |
| Secure Attachment Style | -0.24* | -0.04 | 1 | | | |
| Fearful Attachment Style | 0.42** | 0.09 | -0.43** | 1 | | |
| Preoccupied Attachment Style | 0.56** | 0.32** | -0.10 | 0.35** | 1 | |
| Dismissing Attachment Style | -0.34** | -0.29** | 0.01 | 0.02 | -0.22* | 1 |

*P<.05, **P<.01





Scheduling Algorithms for Map reduce Task in a Cloud Environment

Debendra Maharana

Asst.prof. Department of Computer Science and Engineering, Centurion University of Technology and Management, Paralakhemundi, , Odisha, India

Received: 06 Mar 2022

Revised: 08 Apr 2022

Accepted: 27 May 2022

*Address for Correspondence

Debendra Maharana

Asst.prof.

Department of Computer Science and Engineering,
Centurion University of Technology and Management,
Paralakhemundi, Odisha, India.

Email: deben7@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

A Parallel massive data processing tool MapReduce has emerged as one of the most popular frameworks for data-intensive computing in the area where massive data analysis is required. Cloud Computing has emerged as a powerful technology for performing massive-scale and complex computing. Many recent researches have focused on improving the performance of MapReduce to support cloud-based data intensive applications which have strict deadlines. In this paper we explore the works of soft real-time MapReduce task scheduling with deadline constraint in a cloud environment. First, we reviewed the MapReduce parallel processing framework, and MapReduce optimization strategies. Second, the rise of Big-Data in cloud computing is reviewed. Finally, we discuss the open research issues and challenges, and explore the research direction on real-time task scheduling in MapReduce in Cloud Computing Environment.

Keywords: Real-Time Task, Scheduling, MapReduce, Cloud Computing, Big-Data

INTRODUCTION

In recent years, cloud computing has emerged as a large scale data processing environment using several data-parallel middleware platforms for example, MapReduce [14]. These middleware platforms provide powerful programming models, and are applied to a wide spectrum of domains where large scale data analysis is performed. Cloud computing is a model that enables on-demand network access to a shared pool of computing resources like storage, networks, servers and services which can be rapidly provisioned and released by the service provider with minimal management effort [18].



**Debendra Maharana**

To support soft real-time applications in the cloud environment, it is necessary to satisfy the reliability, response time, and high availability demands of such applications. Cloud Computing is adopted by many organizations and individuals to store, process, and analyze large amounts of datasets. Due to lack of available computing facilities in the local server, A large number of scientific applications are currently being deployed in the cloud which can reduced capital costs, and to support increasing volume of data produced for the doing analysis. MapReduce has emerged as one of the most popular frameworks for data-intensive distributed cloud computing.[9].

BIGDATA IN CLOUD COMPUTING

Big data refer to the increase in the volume of data that are difficult to store, process, and analyze through traditional database technologies. Big Data is defined many ways [13] specified that big data is characterized by the four Vs, namely, volume, variety, velocity, and value. This 4V definition is widely recognized because it highlights the meaning and necessity of big data.

Volume

Volume refers to the amount of all types of data generated from different sources and continue to expand. The benefit of gathering large amounts of data includes the creation of hidden information and patterns through data analysis.

Variety

Variety refers to the different types of data collected via sensors, smartphones, or social networks. These include image, video, text, audio, and data logs, in unstructured format.

Velocity:

Velocity refers to the speed of data transfer.

Value

Value refers to the process of discovering huge hidden values from large datasets with various types and rapid generation.[12].

Cloud Computing provides a distributed data processing platform through the use Hadoop to process distributed queries across multiple datasets in a timely manner. MapReduce allows for the parallel processing of large amounts of datasets stored in the cluster in cloud environment. Cluster computing exhibits good performance in distributed system environments, such as computer power, storage, and network communications.[14]. In a cloud environment, data are stored in structured, semi-structured, or unstructured format. Structured data are a programming language created for querying and managing data in RDBMS. Structured data are easy to query, input, store, and analyze. Examples of structured data include numbers, words, and dates. Semi-structured data are data that do not follow a conventional database system. Semi-structured data is a data that are not organized in relational database models, such as tables. Unstructured data, such as text messages, videos, and social media data, are data that do not follow a specified format.

MAPREDUCE**MapReduce Model**

MapReduce is a programming model as well as a framework that supports the model. The main idea of the MapReduce model is to hide details of parallel execution and allow users to focus only on data processing strategies. The MapReduce model consists of two primitive functions: Map and Reduce. The input for MapReduce is a list of (key1, value1) pairs and Map() is applied to each pair to compute intermediate key-value pairs, (key2, value2). The intermediate key-value pairs are then grouped together on the key equality basis, i.e. (key2, list(value2)). For each





Debendra Maharana

key2, Reduce() works on the list of all values, then produces zero or more aggregated results. Users can define the Map() and Reduce() functions however they want the MapReduce framework works. MapReduce utilizes the Google File System(GFS) as an underlying storage layer to read input and store output. GFS is a chunk-based distributed file system that supports fault-tolerance by data partitioning and replication. Apache Hadoop is an open-source Java implementation of MapReduce [15].

A single MapReduce(MR) job is performed in two phases: Map and Reduce stages. The master node picks any idle workers and assigns each one either a map or a reduce task according to the stage. An input file is loaded on the distributed file system before starting the Map task, . At the time of loading, the file is partitioned into multiple data blocks which have the same size, typically 64MB, and each block is triplicated to guarantee fault-tolerance. Each block is then assigned to a mapper, a worker which is assigned a map task, and the mapper applies Map() to each record in the data block. The intermediate outputs produced by the mappers are then sorted locally for grouping key-value pairs sharing the same key. After local sort, Combine () is optionally applied to perform pre-aggregation on the grouped key-value pairs so that the communication cost taken to transfer all the intermediate outputs to reducers is minimized. Then the mapped outputs are stored in local disks of the mappers, partitioned into R, where R is the number of Reduce tasks in the MR job. This partitioning is basically done by a hash function e.g. , hash(key) mod R.

When all the Map tasks are completed, the scheduler assigns Reduce tasks to workers and the intermediate results are assigned to reducers after shuffling via HTTPS protocol. Since all mapped outputs are stored in local disks after partitioned , and the shuffling is performed by each reducer by simply pulling its partition of the mapped outputs from mappers. The intermediate results are read by a Reducer and merges them by the intermediate keys, i.e. key2, and the values of the same key are grouped together by using external merge-sort.. Then Reduce () is applied by each reducer to the intermediate values for each key2 it encounters. and the output of reducers are stored and triplicated in HDFS. Each single Map task is assigned to a single block . However, no Map tasks or reduce tasks need to be executed simultaneously . Since the MapReduce tasks are executed based on runtime scheduling scheme, no execution plan is build by MapReduce to specifies which tasks will run on which nodes before execution. Executions plan in MapReduce is determined entirely at runtime. MapReduce achieves fault tolerance by using runtime scheduling, by detecting failures and reassigning tasks of failed nodes to other healthy nodes in the cluster. Nodes which have completed their tasks are assigned another input block. Furthermore, . The execution of Map and Reduce tasks are performed with no communication between other tasks. Thus, there is no contention arisen by synchronization and no communication cost between tasks during a MR job execution.[15].

MapReduce Task Model

The system consists of N MapReduce jobs J_1, J_2, \dots, J_N , with $N \in \mathbb{N}, N \geq 1$. Each job J_i consists of m_i map tasks ($J_i^1, J_i^2, \dots, J_i^{m_i}$) followed by r_i reduce tasks ($J_i^{m_i+1}, J_i^{m_i+2}, \dots, J_i^{m_i+r_i}$), with $m_i, r_i \in \mathbb{N}$ and $m_i + r_i > 0$, for all $1 \leq i \leq N$. J_i is released (i.e., when user submitted the job for execution) at an offset o_i (relative to the beginning of the system execution) and has a relative deadline of d_i (with respect to the release time), where $o_i, d_i \in \mathbb{N}, o_i \geq 0$ and $d_i > 0$. Each task J_i^k has the same release time and deadline as J_i does. We consider a mix of jobs with hard and soft deadlines. The first N_1 jobs have hard deadlines whereas the last $N - N_1$ jobs have soft deadlines, where $0 \leq N_1 \leq N$. As usual, all map (reduce) tasks of a job can execute in parallel. A reduce task can only execute after all the map tasks of the same job have completed.

SCHEDULING MAPREDUCE TASK IN CLOUD COMPUTING WITH DEADLINE CONSTRAINT

Our review of scheduling in MapReduce is primarily based on Hadoop's implementation. MapReduce uses a block-level runtime scheduling with a speculative execution. The terminology we adopt is as follows. In a MapReduce job, there are multiple map and reduce tasks, each of which is a single unit of work that can be performed in parallel at the map and reduce phases.



**Debendra Maharana****Scheduling MapReduce task in Hadoop**

Task scheduling in Hadoop is performed by a master node, which distributes work to a number of slave nodes. Each slave corresponds to one physical machine, and has a number of predefined map/reduce slots for executing Map and Reduce tasks. Typically, these slots can be more than the number of cores and the specific numbers of slots per machine are predefined as a configuration parameter. Scheduling of MapReduce jobs in Hadoop proceeds as follows. Periodically, slave nodes inform the master about the availability of free map/reduce slots. The master in this case will assign a pending task accordingly to a free slot based on a scheduling policy.

Existing Scheduling policies in Hadoop

The current Hadoop implementation includes three typical scheduling policies.

FIFO. In this policy scheduling maintains a FIFO waiting queue of jobs sorted by arrival time. Whenever a slot becomes available, the master simply selects a task from the next job on the waiting queue for execution. While FIFO is simple to implement, it does not prioritize particular MapReduce jobs, or ensure that all jobs get equal opportunities for making execution progress.

Fair. fair scheduling policy ensures that all submitted MapReduce jobs will get an equal opportunity for executing their tasks.

Capacity. This scheduler maintains multiple job queues, sorted by job arrival time. Each queue is given a fixed capacity in terms of maximum number of slots it can use, based on organizational resource needs. Once a job is selected, the scheduler will execute a task of the selected job that has input data closest to the free slot.[10].

To process a single data block a separate Map task is created. A node which finishes its task early gets more tasks. . The speculative task scheduling is implemented by Hadoop scheduler with a simple heuristic method which compares the progress of each task to the average progress. The lowest progress Tasks are compared to the average are selected for re-execution. However, this heuristic method is not well suited in a heterogeneous environment where each node has different computing power. To improve the response time of Hadoop , Longest Approximate Time to End(LATE) scheduling is devised in heterogeneous environments. This scheduling scheme is used to estimates the task progress with the progress rate..

DISCUSSION AND CHALLENGES

MapReduce is becoming ubiquitous, even though its efficiency and performance is controversial. There is nothing new about the principles used in MapReduce [10,14]. Due to runtime scheduling with speculative execution, MapReduce reveals low efficiency. However, for achieving high scalability and fault tolerance such methods would be necessary in massive data processing. Thus, its a major challenge ,how to increase efficiency guaranteeing the same level of scalability and fault tolerance. Job scheduling in multi-user environments is another issues that have not been well address yet as the size of MR clusters is continuously increasing. Managing resources in the clusters of that size in multi-user environment is also challenging. Energy efficiency in the clusters and achieving high utilizations of MR clusters are also important problems..

REFERENCES

1. Xiaomin Zhu, Laurence T. Yang, Huangke Chen, Ji Wang, Shu Yin, Xiaocheng Liu "Real-Time Tasks Oriented Energy-Aware Scheduling in Virtualized Clouds , IEEE Transactions On Cloud Computing, Vol.2, No. 2, 2014.
2. R. Buyya, J. Broberg, A. Goscinski. "CLOUD COMPUTING, Principles and Paradigms", A John Wiley & Sons, inc, Publication, 2011





Debendra Maharana

3. Steve Crago. Kyle Dunn.Patrick Eads. Lorin Hochstein. Dong-In Kang. Mikyung Kang.Devendra Modium.Karandeep Singh.Jinwoo Suh.John Paul Walters." Heterogeneous Cloud Computing", IEEE International Conference on Cluster Computing,2011.
4. Jia Wang. Xiaoping Li."Task Scheduling for MapReduce Based on Heterogeneous Networks", Springer International Publishing Switzerland, pp. 278–289,2015.
5. AshfaqA.Khokhar.Viktor K. Prasanna. Muhammad E. Shaaban.Cho-Li Wang."Heterogeneous Computing: Challenges and Opportunities", IEEE.1993.
6. M. Mattess. R. N. Calheiros. R. Buyya."Scaling MapReduce Applications across Hybrid Clouds to Meet Soft Deadlines". 27th International Conference on Advanced Information Networking and Applications (AINA) IEEE Computer Society, pp. 629-636. DOI: 10.1109/AINA.2013.51.,2013.
7. Zhuo Tang.Junqing Zhou.Kenli Li .Ruixuan Li.(2012),"A MapReduce task scheduling algorithm for deadline constraints",Springer Science,Cluster Computing,Volume 16, Issue 4, pp 651-662.
8. Linh T.X. Phan.; Zhuoyao Zhang.;Boon Thau Loo.; Insup Lee.(2010):Real-time MapReduce Scheduling ,University of Pennsylvania Department of Computer and Information Science, Technical Report No. MS-CIS-10-32.
9. Linh T.X. Phan.;Zhuoyao Zhang.;Qi Zheng.;Boon Thau Loo.;Insup Lee.(2011): An Empirical Analysis of Scheduling Techniques for Real-Time Cloud-Based Data Processing ,2011 IEEE International Conference on Service-Oriented Computing and Applications.
10. Changqing Ji.;Yuli,Wenming Qiu.; Yingwei Jin.; Yujie Xu.; Uchechukwu Awada.; Keqiu Li.(2012):BIG DATA PROCESSING: BIG CHALLENGES AND OPPORTUNITIES , Journal of Interconnection Networks Vol. 13, Nos. 3 & 4 ,1250009,19 pages.
11. Ibrahim Abaker Targio Hashem.; Ibrar Yaqoob.; Nor Badrul Anuar.; Salimah Mokhtar.; Abdullah Gani.; Samee Ullah Khan.(2015): The rise of big data on cloud computing: Review and open research issues, ELSEVIER,Information System 47,pp-98-115.
12. J. Gantz.; D.Reinsel.(2011):Extracting value from chaos , IDCi View, pp-1–12.
13. J. Dean.; S.Ghemawat.(2008):MapReduce: simplified data processing on large clusters,Commun.,ACM51pp-107–113.
14. Kyong-Ha Lee.;Hyunsik Choi.; Bongki Moon.(2011): Parallel Data Processing with MapReduce: A Survey, SIGMOD Record, vol. 40,No.4.
15. R. Buyya.; C.S. Yeo.; S. Venugopal.; J. Broberg.; and I. Brandic.(2009):Cloud Computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the Fifth Utility, Future Generation Computer Systems, vol. 25, no. 6, pp. 599-616.
16. S. Pandey.;S.Nepal.:(2013),Cloud computing and scientific applications – big data Scalable Anal. Beyond, Futur. Gener. Comput. Syst., 29,pp-1774–1776.
17. P.Mell.;T.Grance.(2011):The NIST Definition of Cloud Computing, NIST Special Publication 800-145,pp-7

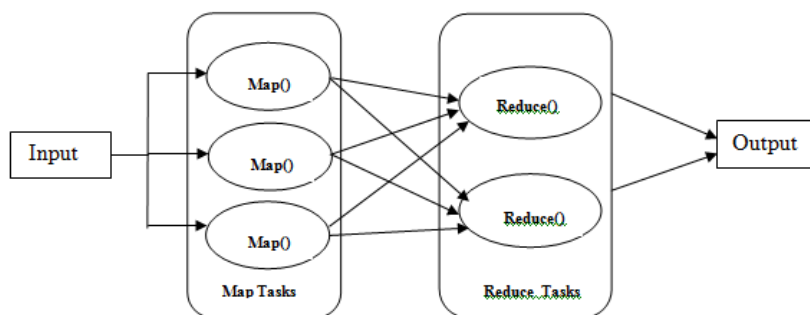


Fig-1: Map Reduce Model

