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*Chief Editor*

**Prof. (Dr.) Jyoti Kumar**

**RANCHI UNIVERSITY**

**Ranchi- 834008, Jharkhand, India**

# RANCHI UNIVERSITY, RANCHI

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# *From Editor's Desk:*

When a thought that has been enduring in mind becomes real, it is truly an interesting and exciting experience. This new assignment of mine as Chief Editor is one such cherished work which I have fulfilled to the best of my abilities. It is a matter of immense pleasure and great honour that our prestigious University Science Journal **RUJOST (Ranchi University Journal of Science and Technology, ISSN:2319-4227), Vol 5 & 6, No. 1 & 2, January & July, 2020-2021** issue is being brought to you as a result of continuous exercise of the editorial team and office of the Dean, Faculty of Science, Ranchi University, Ranchi.

The Journal mainly covers the research articles of all the six science University Departments - Botany, Chemistry, Geology, Mathematics, Physics & Zoology with the acronym **BCGMPZ**. I shall assure all our readers that our consistent efforts will be aimed towards increasing the visibility, impact and citations. For maintaining the overall quality of our journal RUJOST (Ranchi University Journal of Science and Technology), the process of enlistment in the UGC CARE List has been already initiated and the application has already been transmitted to UGC, New Delhi for the same.

The layout of the cover page having the hexagons symbolize six different University Science Departments - **BCGMPZ**, which has been established as the copyright front page design of RUJOST and it is being maintained as the first look identity of the Journal.

On behalf of RUJOST, the Editorial Board and the Editorial Team of our Journal, I would like to wish all authors, patrons and readers, a safe and healthy time ahead. In the spirit of continuous improvement, any constructive input on streamlining our processes is very welcome.

***Stay Safe & Best Wishes!***

*Chief Editor*
**Prof. (Dr.) Jyoti Kumar**
University Professor and Head
University, Department of Botany
Dean, Faculty of Sciences,
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# Ranchi University Journal of Science and Technology (RUJOST)

The Ranchi University Journal of Science and Technology (RUJOST) is a medium to provide upto date information on all scientific investigations together with their applications. The journal includes full length and mini reviews, original articles and scientific reports submitted to the Chief Editor. The journal hopes to attract the most important and highly innovative papers from the current research from academic and research communities, most importantly from young investigators and students, RUJOST features scholarly articles in rapidly moving science and technology related research areas like Botany, Zoology, Agriculture, Ethnobotany, Microbiology, Genetics, Molecular Biology, Biotechnology, Biochemistry, Geology, Physics, Mathematics, Bioinformatics, Pharmacology, Chemistry, Physiology and other sciences, which will be published subject to acceptability after referee and editorial assessment.

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**Botany**

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# *Aloe vera*: Ethno-medicine to Modern medicine

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**Abstract:** Attempt has been made to gather the complete information of *Aloe* regarding its recent classification to cultivation and medicinal uses due to the presence of various phytochemicals. Further, the relationship of *Aloe* with the aboriginals and its use in the present day pharmaceuticals and drug industries have been reviewed to show the importance in the health care management that ultimately affects the life of human beings.

**Keywords: *Aloe*, Ethnobotany, Ethno-medicine, Modern medicine.**

## INTRODUCTION

Ethnobotany is the word which reflects the direct relationship of human beings with the plants. The term was coined by Harshberger in the year 1895 and specified the uses of plants by the aboriginals in the field of medicines and various other things. Ethnobotany includes a vast area in which various research work are associated with it. One such area is ethno-medicine which is related to the researches that gives a clear idea regarding the medicines derived from plants and used in various ailments and diseases by the indigenous practitioners and vaidyas, folk lore and herbal charms in the ancient times. On the other hand, the modern medicines are the natural products derived from plants and animals by various chemical processes and by the involvement of huge machines and technical assistance.

From time immemorial medicinal plants have provided a great base in the field of medication by providing a proper health care for human beings by curing many diseases[1]. In India, Indian Systems of Medicine is considered to be Indian in origin, which came to India from outside and got assimilated into Indian culture[2]. India has six recognized system of medicines viz.: Ayurveda, Siddha, Unani, Yoga, Naturopathy and Homoeopathy. In global traditional systems of medicine, the Indian System of Medicines is well known. Among the six categories, Ayurveda is the traditional systems of medicine in India which have their roots in folk medicine and is the first medicinal system in India[1]. The origin of Ayurveda is noticed from Atharavaveda (1000 B. C.)[3]. Ayurveda literally means the Science of life and its philosophical based derived from 'Samkhya' and 'Nyaya Vaisheshika' of Indian Philosophy[1,4].

**General description of plant:**

*Aloe* is a succulent and Crassulacean Acid Metabolism (CAM) plant[5-9]. The main characteristic feature for the identification of the species of these genera is the nature of perianth. Africa is considered as the centre of origin of large number of succulents where water stress is very eminent. This was the reason for the development of fleshy leaves and shallow root system. This is another characteristic feature of CAM plants where they minimize the loss of water content stored in them. This is mainly achieved by the factors which include low stomatal densities, size of stomatal pore, deeply sunken stomata and opening of stomata only at the night time[10]. The succulents are usually cultured in garden or green house and are of ornamental values. These plants are adapted to mostly dry desert localities and can withstand to drought

conditions as they store sufficient moisture in their succulent body parts. These plants grow well in cool, humid and partially shaded conditions. The growing medium must have perfect drainage, must be porous and should be poor in organic matter. It requires more frequent watering than cactus, plenty of air, sunshine, a porous compost and dry atmosphere.

The members of genus *Aloe* includes perennial herbs or shrubs[11] and is native to Africa[12,13] which are found to be spread in entire tropical and sub-tropical regions[14]. Few species of this genus are nearly threatened and vulnerable in South Africa[15]. In India, the plants are largely cultivated in Tamil Nadu, Maharashtra, Gujarat etc. and found as a wild herb along the coastal area of South India[16]. The word *Aloe* is picked from the Arabic language "Alloeh" and Hebrew language "Halal" which means shining bitter substance[17]. It is also known as silent healer[18]. Its vernacular name is "Ghrit Kumari" and Sanskrit name is "Ghee Kunwar". The Egyptians called *Aloe* "The plant of immortality". They have small to large thick and spotted fleshy leaves in a rosette fashion with or without stem. Flowers are arranged at the apex of a long stalk that are densely clustered and pendant. Species of *Aloe* also shows the self-incompatibility process and have many pollinators that disperse the pollen grains[19].

**History:**

*Aloe* marked its presence in the history as a medicinal plant in the 4$^{th}$ century B.C. The ancient Greek doctors identified and found the plants from the Islands of Socotra in the Indian Ocean. The plants were used in the beauty regimes and medicines by Queen Cleopatra VII (69-30 BCE) due to which the Alexander the Great was persuaded by his mentor Aristotle in 333 B.C. and captured the Islands of Socotra in the Indian Ocean which was famous for the *Aloe*. Aristotle then utilized the medicinal properties of *Aloe* for his army to treats the wounds of soldiers. Similarly, the ancient Nile Valley civilization of Kemet had been recorded with the usage of *Aloe* for the medical treatments and beauty care as well as for embalming[20]. The medicinal uses of *Aloe* have been recorded in the collections of Sumerian clay tablets which is as much old as more than 4000 years ago dated 2100 B.C. and in the Egyptian Papyrus Ebers, as a laxative, from 1552 B.C.

**Classification:**

According to the recent system of classification, i.e., Angiosperm Phylogeny Group IV (APG IV) classification, it has been placed to new family Asphodelaceae[21]. In APG III (2009), these genera were placed in the family Xanthorrhoeaceae. The shifting of these genera in the family Asphodelaceae has been approved by the Nomenclature Committee for Vascular Plants[22]. Later on, it was approved by the General Committee and the Nomenclature Section in 2017 of XIX International Botanical Congress in Shenzhen. These genera have been placed in order Asparagales, family Liliales and in one tribe, viz. the Aloineae according to the classification of Hutchinson (1959)[23] or Aloeae according to the classification of Engler and Prantle (1930)[24].

**Cultivation:**

Succulents are mostly cultivated in green houses or poly houses by nurseries, institutions, botanic gardens and individuals throughout India under various climatic conditions and different geographical situations[25].

The genus *Aloe* is xerophytic and commonly found in the tropical[26] and sub-temperate zones and is cultivated for ornamental purpose throughout the world. Succulents require very less water for their growth[27] and they should be watered at an interval of 2-3 days during summer and 4-5 days in winter when the medium is completely dried up, in which it is growing. Succulents are mainly propagated by cuttings, grafting and sometimes by seeds also in a few cases. The ideal temperature required for its proper germination is 30-35°C and a relative humidity of above 70%.

**Harvesting:**

The leaves of *Aloe* are harvested after the 7-8 months of planting. For this, a sharp knife is used to properly remove the leaves from the stalk. Care should be taken to avoid any type of injury and damage to the leaves and to reduce the loss of juice and exudates to prevent any chance of microbial contamination. Unhealthy leaves are not used in the harvesting process. The ideal time for harvesting is October to November and flowers are collected in the month of December and January. The harvested leaves and flowers are shade dried and the kept in Sun for few hours before the storage. After this, the dried samples are refrigerated till its processing.

**Cytology:**

The members of family Asphodelaceae has the basic chromosome number of x=7 and 2n=14[28-30]. Beside this many variations have been recorded in the members and even the case of polyploidy has been detected in few

members of *Aloe*. Bimodal karyotype was recorded in many species of this family[31-34]. Few exception are also there in which plants were recorded with basic set of x=6, 2n=12 chromosomes[35,36].

**Ethno-medicinal uses:**

• *Trachyspermum ammi* is soaked in the juice of *Aloe vera* and then it is dried and powdered. The powder is given thrice a day for constipation, digestive troubles and inflammation of the abdominal viscera.

• Pulp of the leaf and *Cichorium intybus* are soaked in water at night and this water mixture is given to the patients to get relief from irritant and itching skin.

• The pulp is fried in equal quantity of clarified butter and mixed with flour and candy. This mixture is used in rheumatic pain and as a general tonic.

• The dried juice is mixed with dried grapes and dried bitter cucumber. This mixture is effective in constipation, piles and rheumatic pain.

• The fresh piece of the pulp is kept open in earthen pot at night. This is given in dose of approximately 10 gram daily in early morning before breakfast for jaundice.

• The pulp is externally applied to relieve the pain and inflammation of piles.

• Fresh gel is also applied for relief of burns, cuts and wounds.

• The pulp and turmeric are slightly warmed and used as poultice for tonsils, inflamed joints and other local pains[37].

**Phytochemical constituents:**

In modern systems of study *Aloe* has been recorded with various phytochemicals such as aloesin, aloin, antrokinon, alkaloids, anthrones, active phenolic compounds, chromones, coumarins, pyrones, anthraquinone, glycosides, saponin, steriods and flavonoids[38-49].

**Table 1- Chemical composition of *Aloe vera*[50]**

| Class | Compound | Properties |
|---|---|---|
| Anthraquinones/ Anthrones | Aloe-emodin, aloetic-acid, anthranol, barbaloin, isobarbaloin, emodin, ester of cinnamic acid. | Aloin and emodin acts as analgesics, antibacterials and antivirals. |
| Carbohydrates | Pure mannan, acetylated mannan, acetylated glucomannan, glucogalactomannan, galactan, galactogalacturan, arabinogalactan, galactoglucoarabinomannan, pectic substance, xylan, cellulose | A glycoprotein with antiallergic properties, called alprogen and novel anti-inflammatory compound. |
| Chromones | 8-C-glusoly-(2'-O-cinnamoly)-7-O-methlyaloediol A, 8-C-glucosyl-(S)-aloesol, 8-C-glucosyl-7-O-methylaloediol A, 8-C-glucosyl-7-0-methylaloediol, 8-C-glucosyl-noreugenin, isoaloeresin D, isorabaichromone, neoalosin A | The novel anti-inflammatory commands. |
| Enzymes | Alkaline phosphatese, amylase, bradykinase, carboxypeptidase, catalase, cyclooxidase, cyclooxygenase, lipase, oxidase, phosphoenolpyruvate, carboxylase, superoxide dismutase | Bradykinase helps to reduce excessive inflammation when applied to the skin topically, while others help in the breakdown of sugars and fats. |
| Inorganic compounds | Calcium, chlorine, chromium, copper, iron, magnesium, manganese, potassium, phosphorous, sodium, Zinc | They are essential for the proper functioning of various enzymes systems in different metabolic pathways and few are antioxidants |
| Miscellaneous including organic compounds and lipids | Arachidonic acid, Y-linolenic acid, steroids (campestrol, cholesterol, Bsitosterol), triglycerides, triterpenoid, gibberillin, lignins, potassium sorbate, salicylic acid, uric acid | |

| | | |
|---|---|---|
| Proteins | Lectins, lectin-like substance | It also contains salicylic acid that possesses anti-inflammatory and antibacterial properties. Lignin, an inert substance, when included in topical preparations, enhances penetrative effect of the other ingredients into skin. Saponins that are the soapy substances from about 3% of the gel and have cleansing and antiseptic properties. |
| Saccharides | Mannose, glucose, L-rhamnose, aldopentose | |
| Vitamins | Vitamin A, B12, C, E, choline and folic acid | Vitamin A, C and E are antioxidants and antioxidant neutralizes free radicals. |
| Hormones | Auxins and gibberellins | That helps in wound healing and have Anti-inflammatory action. |

**Modern medicinal uses:**

Five unique benefits of *Aloe* are[51]:

a) It has the ability to penetrate deep into the tissues of body because it is hydrating in nature and not greasy.

b) It has been recorded with 6 antiseptic agent viz., lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulfur that inhibit the growth of microbes.

c) It rejuvenates or stimulates the birth of new cells. Since it contains a large number of amino acids, enzymes and minerals like calcium and magnesium that supports to youthful and vibrant skins.

d) It settles down our nervous system via antioxidant and anti-inflammatory properties due to the presence of acetylated mannose, glutathione peroxidase, superoxide dismutase and phenolic antioxidant.

e) It is widely used as a detoxifier and normalizes the metabolism process in our body with the help of glycoproteins and polysaccharides.

The plant has been recorded with many medicinal properties. It has been reported to cure cancers[52-56]. It is generally used for the treatment of constipation, burns and skin disorder[57-59]. It is used in the cosmetic products since it has moisturizing and soothing properties[60-62]. It enhances the immunity, liver functions, act as anti-inflammatory, anti-ulcer, anti-diabetes, anti-hypertension, anti-fungal, anti-bacterial, anti-viral, anti-ageing, anti-oxidant and prevents asthama[63-67]. The dried leaf powder is used to stimulate the digestive system and used for the stomachic and anthelminthic properties[68]. It is also used as a strong laxative and purgative[69,70]. It has the healing property for thermal wounds and radiation injury[71,72]. This genus has also the ability to treat skin cancer, sexually, transmitted disease, eye aliment, arthritis, rheumatism, psoriasis[73-77].

Besides this, many clinical studies are going on to explore the hepatoprotective, nephroprotective, gastrointestinal protective, upper respiratory protective, skin protective, eye protective and hair protective activities of *Aloe vera* under *in-vivo* and *in-vitro* conditions. Researchers are also going on for the protective activity of *Aloe vera* on peripheral and central nervous system and on genital organs in *in-vivo* and *in-vitro* studies.

## CONCLUSION

*Aloe vera* is medicinal herb that had been used form a very long time of history till the present day. The plant shows a wide range of application in the medical field as well as in naturopathy for beauty clinics. The plant has been recorded in the developmental study in treating Cancer and AIDS by Food and Administrative Drugs of USA. No doubt, this plant has played a major role in the proper health care management of human and is such a precious gift to us by our mother nature.

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# Study of ethnomedicinal uses of plants found in Khunti district of Jharkhand for relieving chronic kidney disease

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**Abstract:** The kidneys are two bean-shaped organs that filter waste from the blood, balance body fluids, produce urine, and assist in a variety of other body activities. Chronic kidney failure has become a major issue in modern life. If this is not taken care of, it is really concerning. After that to maintain life, the kidney can fail and require dialysis or kidney transplantation. Plants have been the basis for medical treatments through much of human history, and such traditional medicine is still widely practiced today. An ethnobotanical survey was carried out in a specific area in India to collect information on plants used for relieving chronic kidney disease among the inhabitants of the Khunti District of Jharkhand. A total of 8 species of medicinal plants belonging to 8 different families (Moraceae, Lauraceae, Apiaceae etc.) have been documented to be used by rural, tribal and non-tribal communities from 4 blocks of Khunti district (Jharkhand). In this research, A total of 60 informants were interviewed regarding the medicinal plants utilized for this medicinal purpose. The medicinal preparations include powder, decoction, juice, etc. Future work with modern assays should confirm such methods, as then the importance of their conventional herbal practices in treating or appearing to cure chronic kidney diseases in some cases will offer major benefits to society.

**Keywords: Chronic kidney disease, Indigenous medicinal plant, Herbal treatment, Khunti**

## INTRODUCTION

More than one-fifth of persons over the age of 65 have chronic kidney disease (CKD) in some form.[1] According to the World Health Organization, 75% of the world population, mostly in the developing world, depend on botanical medicines for their basic health care needs.[2] About 60-85% of the population in every country of the developing world has to rely on traditional medicine. The practice of traditional medicine is widespread in China, India, Japan, Pakistan, Sri Lanka, Thailand, and Korea.[3] The value and importance of traditional ethnobotanical knowledge is acknowledged all over the world. Plants are used to cure many diseases, one of which includes kidney related ailments. The important role of kidneys in normal physiology comprises plasma filtration of metabolic waste products, regulation of plasma volume, hormone secretion and acid-base balance. Any changes in the above indicators lead to a large number of diverse, life-threatening renal diseases.[4]

Worldwide chronic kidney disease has become a major cause for disability and in worst circumstances leads to death. Chronic kidney disease is a gradual loss over a period of months to years of kidney function. This condition is characterized as decreased renal function showing a glomerular filtration rate (GFR) of less than 60 ml/min per 1.73 $m^2$ or a kidney damage marker, or both of at least 3 months length, irrespective of the underlying cause.[5] CKD may cause kidney failure or end-stage kidney disease, in which kidney may stop working.[6] People with CKD are more prone to cardiovascular disorders (CVD) rather than to reach end-stage renal disease (ESRD).[7] Diabetic nephropathy is the major culprit, but lupus nephritis and other immunologic nephritides, chronic urinary tract

obstruction (such as that caused by Benign Prostatic Hypertrophy [BPH], and chronic overuse of nonsteroidal anti-inflammatory drugs and aspirin are also significant contributors. Hypertension is believed to contribute to renal failure.[8] Other diseases and conditions may lead to CKD as part of their natural progression. These include Alport syndrome, which is a rare kidney disease that causes kidney failure and hearing loss, lupus erythematosus, connective tissue diseases, kidney cancer, liver disease (cirrhosis), nephrolithiasis, polycystic kidney disease, Obesity, smoking, Anaemia, malnutrition and abnormalities present at or before birth (congenital abnormalities). The only treatment for the last stage of kidney failure is dialysis, hemodialysis and kidney transplant, but these therapies are too expensive. The tests to diagnose CKD are Glomerular filtration rate (GFR), Urine test checks for albumin, Blood test measures the creatinine level, Imagine studies, Kidney biopsy. The lack of money leads many people to lose their lives.

Even in developed nations, chronic diseases have been a significant cause of global morbidity and mortality. 4 out of 5 chronic disease deaths now occur in low- and middle-income countries, historically considered to be a health issue only in developed countries. The predicted number of deaths from chronic diseases in India will rise from 3.78 million in 1990 (40.4% of all fatalities) to a projected 7.63 million in 2020 (66.7 percent of all deaths). Diabetic nephropathy is the most common cause of CKD in population-based trials.[9,10]

About 80% of the world's population uses herbs for medicinal purposes.[11] Botanical medicine can be used to help forestall the need for dialysis by treating the causes and effects of renal failure, as well as reducing the many adverse effects of dialysis itself. Ethnomedicinal plants serve an important role in this circumstance, helping to save the lives of those suffering from kidney disease. The medicinal system is passed down from generation to generation in several tribal families in Khunti district of Jharkhand, either by words or through practice. Herbal knowledge is currently restricted to a few tribal households in distant parts of the region. Natural plants have been used for kidney disorders and their complications as alternative therapies. For the preparation of traditional medicines, different plant components are used. It is found that some commonly used Nephroprotective drugs are Milk thistle (*Silybum marianum*) seeds, Picroliv (*Picrorhiza kurroa*), Astragalus (*Astragalus membranaceus*), Cordyceps (*Cordyceps sinensis*), *Salvia miltiorrhiza* root extracts, *Herniaria hirsute* aqueous extracts. In a study, it is found that one gram of Chinese rhubarb root extract per day resulted in significant reductions in blood BUN and creatinine in 38 patients with moderate chronic renal failure.[12] Continued efforts are required to identify and develop traditionally used medicinal plants in renal diseases so that more effective treatments are available from plants that have been known for their efficacy for hundreds of years.[13] The present communication records documentation and compilation of fragmentary ethnic knowledge about the medicinal and nutritional indigenous plants.[14] In near future it may lead to the discovery of new medicines and help in relieving chronic kidney disease (CKD).

## MATERIALS & METHODS

The ethnobotanical survey was conducted in the four different blocks of Khunti district of Jharkhand namely, Khunti, Murhu, Torpa and Karra Block as shown in Fig. 1. Khunti the 23rd district of the State Jharkhand, is located at 23.08 °N and 85.28 °E, at an average elevation of 611 m (2,005 ft.) above the sea level. It has almost southern location in the State of Jharkhand. Khunti district is spread in about 2,467 Sq. Kms. areas.

The district is endowed with heterogeneous landscapes, huge natural resources, numerous small rivers, rivulets, streams and waterfalls, picturesque spots, cultural centers, historical sites, with dominance of aboriginal's habitats and their cultures. The region is covered with dense deciduous forest. It is estimated that approximately 40% of the total area is covered by forest. The Mundas are the major tribal community, but other tribes like Pahariya, Asur, Birhor, Oraons etc. are also present.

The requisite ethnomedicinal properties of different plants were recorded through a semi-structured interview with the local people, healers, knowledgeable persons, vaidyas and local practitioners on the basis of their traditional knowledge, which they were prescribed to their patients.[15] This semi-structured interview was composed of questions on medicinal plants, its utilization as traditional medicine, the diseases treated by the plants, the plants used for chronic kidney disease, the parts used, how the parts of plant consumed and method of use of plant against other kidney ailments etc. All the information's carried out was carried out to enhance understanding about traditional knowledge and about different species of plants used in kidney related problems like kidney stones, kidney

inflammation, cysts on kidney and all those problems, which are cause to chronic kidney disease. As a result of discussion local names of the plants, plant parts used and their mode of usage were recorded. The botanical names and families of the plants obtained were identified using literature and Book of Botany of Bihar and Orissa (Haines, 1921-25)[16]. Herbarium specimens were prepared using scientific processes and stored in the University Department of Botany. During field trips, various plants were photographed. In general, tribal people are conservative.[17-18] As a result, people are wary about disclosing their valuable information.

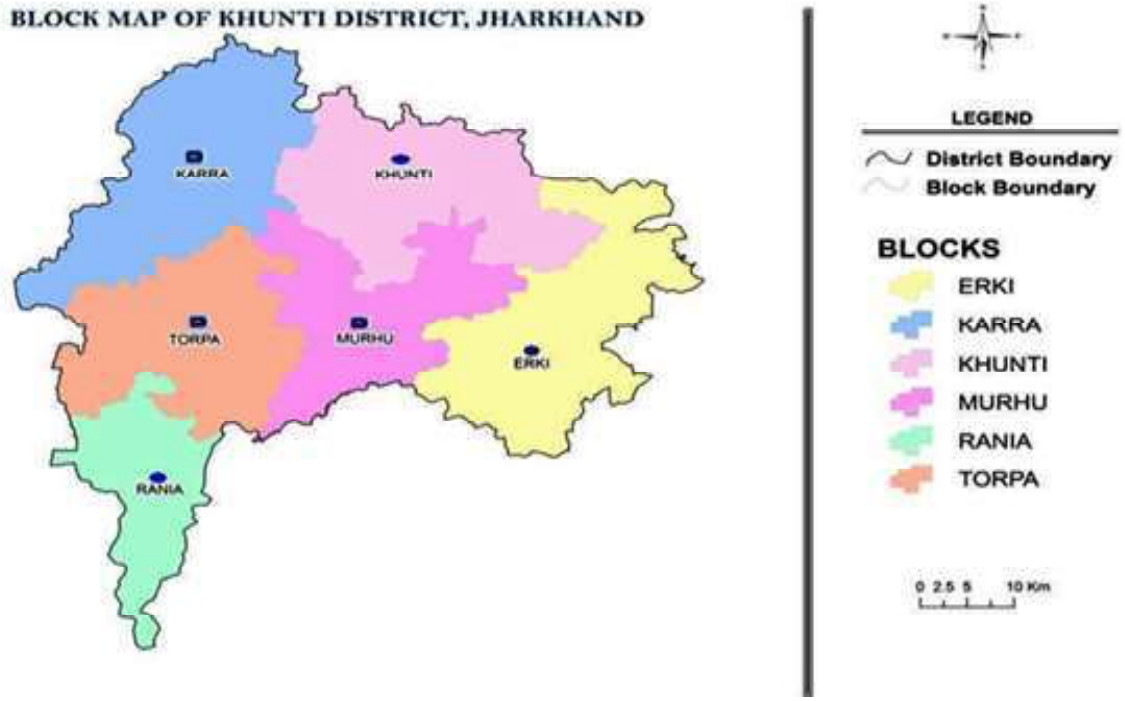


**Fig. 1: Block map of Khunti District of Jharkhand**

## RESULTS

Because of their limited land holdings and low land profitability, most tribal families in Khunti maintain a diverse range of jobs such as daily wage, handicraft, and small-scale businesses such as selling vegetables and staples at local markets. Forests, after agriculture, are the second most important source of income for Khunti's poor indigenous people. In this area, forests provide a diverse range of livelihood opportunities for rural tribal groups, including direct work, self-employment, and secondary employment.

The documentation has been done on the basis of information extracted from the knowledgeable local practitioners, the patients and the plant collectors of the area. They believe in natural treatment of chronic kidney disease. From the results it was observed that the use of traditional herbal medicine is an integral part of healthcare of the tribal and non-tribal communities of Khunti district of Jharkhand. It was also observed in the survey that their knowledge of medicinal plants was passed down from their ancestors through oral traditions. It was also observed in this study that most of the traditional healers belong to the older generation. There were very few young tribal people who are knowledgeable about chronic kidney disease and medicinal plants used for relieving in this problem. This can indicate a decline in knowledge of the use of medicinal plants that pose a potential disappearance of this knowledge in the future. A list of 8 plants (belonging to 8 families-Capparidaceae, Fabaceae, Poaceae, Zygophyllaceae, Moraceae, Lauraceae, Apiaceae) and their uses has been presented in Table 1 in alphabetical order giving their Family, followed by botanical name, vernacular or local name, plant's part used and medicinal uses in chronic kidney disease.

**Table 1- List of important medicinal plants in Khunti district and their uses for relieving chronic kidney**

| Sl. No. | Family | Scientific Name | Vernacular Name | Plant's part used | Disease to be treated |
|---|---|---|---|---|---|
| 1. | Apiaceae | *Coriandrum sativum* | Dhaniya, coriander | Seeds | Improving the filtration rate of kidney, urinary tract infections. |
| 2. | Capparaceae | *Crateva nurvala* | Varuna, Eksira | Stem, bark | Renal failure, polycystic kidney disease,[19] kidney inflammation. |
| 3. | Fabaceae | *Albizia lebback* | Koko, siris | Leaves, seeds, flower, bark | Renal failure, Nephrolithiasis, kidney inflammation. |
| 4. | Lauraceae | *Cinnamomum cassia* | Dalchini, cassia bark | Bark | Urinary tract infections, kidney pain, diabetes, kidney problems |
| 5. | Moraceae | *Ficus religiosa* | Pipal | Bark | Kidney and urinary problem, immune complex nephritis.[20] |
| 6. | Pinaceae | *Pinus roxburghii* | Pine tree, chir | Bark, twig | Kidney and urinary problem. |
| 7. | Poaceae | *Zea mays* | Maize, makai | Corn silk | Kidney stone, hypertension, glomerulonephritis,[21-23] diabetes, inflammation of urinary system. |
| 8. | Zygophyllaceae | *Tribulus terrestris* | Gokharu, caltrap | Fruit, Seed | Renal failure, polycystic kidney disease, kidney stones and pain.[24] |


**Fig. 2: Ethnomedicinal plants for relieving chronic kidney disease in Khunti, Jharkhand**
**(a) *Tribulus terrestris*, (b) *Zea mays*, (c) *Coriandrum sativum.***


**Fig. 3: Ethnomedicinal plants for relieving chronic kidney disease in Khunti, Jharkhand**
**(a) *Ficus religiosa*, (b) *Albizia lebback*, (c) *Crateva nurvala.***


**Fig. 4: Ethnomedicinal plants for relieving chronic kidney disease in Khunti, Jharkhand (a) *Pinus roxbeurghii* (b) *Cinnamomum cassia.***

Some renal conditions reported to respond to plant therapy are glomerulonephritis, glomerulosclerosis, immune complex nephritis, nephrotic syndrome, kidney stones etc. This is very important in order to establish the reliability of the results even with low number of informants.

Study made sure that the informants are reliable and competent in terms of their knowledge in medicinal plants. Various parts of the plant species enumerated in the present paper are effectively used by the tribals of Khunti.

## DISCUSSION

Many people are suffering from chronic kidney disease, but are unaware of their condition.[25] Early symptoms of kidney disease seem so minor and unimportant, so, people may live many years with these symptoms and do not complain, but these small problems can lead to kidney failure.[26-29] In Khunti district, fewer people suffer from chronic kidney disease. Natural and medicinal herbs are naturally rich in active substances, and have fewer side effects because they have a natural origin and are more compatible with the organism of the body. They also have multiple functions that can be used for multiple diseases. That's why people of Khunti district prefer it more. Different types of preparations were used here from plant species by tribal and non-tribal communities that included juice, paste, decoction, powder and whole plant extract. In this study, it was found that varun, siris, makkai, pine, gokharu, dalchini, dhaniya and pipal are medicinal plants effective in reducing kidney diseases.

Listed selected plants as like in table are used by tribes of Khunti for kidney related diseases. Mostly, these are used for diuresis, renal stones and cleansing the kidneys, so that the kidney remains healthy and it would not have to face dialysis. However, the therapeutic importance of these plant species has less information on their active phytochemical and therefore, the active principles responsible for pharmacological action requires further investigation at scientific level to validate the claim.[30-33] The proposed inquiry would lead to family welfare as well as plant safety and conservation, thus establishing an environmentally sustainable state and a need for society.

## CONCLUSION

Traditional medicine offers many interesting possibilities to help prevent or treat Chronic Renal Failure (CKD).[34] Plants have been selected and used empirically as drug for centuries, initially as traditional preparation then as pure active principle.[35] These traditional medicines of indigenous origin may be integrating with national health care system.[36] People of Khunti have a strong faith in the efficacy and success of traditional medicine and the results of the present study provide evidence that the medicinal plants continued to play a vital role in the kidney function of tribal and non-tribal community of Khunti. People who live in this area have a long and close relationship with the indigenous flora, which they rely on for their basic necessities and cultural activities. For the treatment of ailments and respite from suffering, they rely on the native flora. Through this study the medicinal plant documentation would make a huge contribution to solving these kidney failure-related problems. And this would undoubtedly increase our knowledge of nature for the protection of certain medicinal plants. The data could help the policymakers in promoting these local plants in order to increase food and nutrition security to maintain kidney health.

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# Floristic growth of hydrophytes in Basargadh Pond, Tupudana, Ranchi

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**Abstract:** The present study deals with the growth of hydrophytes in Basargadh Pond, Tupudana, Ranchi.This pond favors great seasonal growth of various aquatic and semi aquatic plants. These plants spend at least a part of their life cycle in water. The study was conducted in the year 2019 and 2020.A total number of 25 hydrophytes have been collected and reported followed by identification with the help of experts and pertinent literatures.

**Keywords: Floristic growth, hydrophytes, dicotyledones, monocotyledons.**

## INTRODUCTION

Aquatic plants are important to maintain the aquatic ecosystem. They undergo their vegetative and reproductive growth seasonally. This study was conducted in such a manner that most of the plants were collected in flowering and fruiting conditions. To make the accurate and intensive study, the study area was visited at regular intervals[1-3], twice and thrice in every season. During study, plants were observed carefully and then collected in suitable carry bags. The collected and reported specimens have been identified by suitable resources.[1-4]

## MATERIALS & METHODS

During the course of study the specimens were collected from the study area. After collection these specimens were soaked in formaldehyde solution and dried with the help of heavy herbarium press. After drying herbarium sheets were pressed and identified with the help of experts and suitable literatures.[5] To make the study more accurate regular pond visit was taken into account.[1-3]

## RESULTS & DISCUSSION

The result is the outcome of the survey conducted in the year 2019-2020. A total number of 25 aquatic and semi aquatic species were reported from the pond belonging to 23 families. Out of these 15 families belong to dicot and 10 families belong to monocot. Name of all the plants are given below. In the table "M" stands for Monocotyledons and "D" stands for Dicotyledons.

## CONCLUSION

The plants like *Nymphoides hydrophilla, Nelumbo nucifera, Nymphaea stellata* Wild, *Commenlina bengalensis* Linn. shows extensive growth in the month of July to November. The plants like *Ranunculus sceleratus* Linn. *Vallisneria spirallis* L., *Hydrilla verticilata* grow in the month of November to February.

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| Sl.No. | Name of Plants | Type | Family | Flowering/ Fruiting time |
|---|---|---|---|---|
| 1. | *Ipomea aquatica* Forsk | D | Convolvulaceae | Sep-Feb |
| 2. | *Nelumbo nucifera* Geartn. | D | Nelumbonaceae | July-Nov. |
| 3. | *Nymphaea stellata* Wild | D | Nymphaeaceae | Aug-Nov. |
| 4. | *Nymphaea nouchali* Burm f. | D | Nymphaeaceae | Aug-Nov. |
| 5. | *Nyphoides indica* (Linn.) Kuntze | D | Menyanthaceae | Whole year |
| 6. | *Nymphoides hydrophilla* Lour. | D | Menyanthaceae | July-Nov. |
| 7. | *Eichhornia crassipes* Mart. | M | Pontideriaceae | April-Nov |
| 8. | *Utricularia stellaris* Linn. | D | Lentibulariaceae | Sep-Nov. |
| 9. | *Utricularis aurea* Lour. | D | Lentibulariaceae | Sep- Nov. |
| 10. | *Ranunculus sceleratus* Linn. | D | Ranunculaceae | Nov-Feb. |
| 11. | *Commenlina benghalensis* Linn. | M | Commelinaceae | July-Nov. |
| 12. | *Ludwigia adsendens* Linn. | D | Onagraceae | Whole year |
| 13. | *Enhydra fluctuans* Lour. | D | Asteraceae | Dec-March |
| 14. | *Centella asiatica* L. | D | Apiaceae | Aug-Dec |
| 15. | *Colocasia esculenta* L. | M | Araceae | Apr-July |
| 16. | *Wolfia arrhiza* (I) Hackel | M | Lemnaceae | April-Sept |
| 17. | *Pistia stratoites* L. | M | Araceae | Dec-June |
| 18. | *Cyperus rotundus* L. | M | Cyperaceae | Mar-June |
| 19. | *Alternanthera sessilis* L. | D | Amaranthaceae | Whole year |
| 20. | *Hygrophila auriculata* (Schcm.) | D | Acanthaceae | Oct-April |
| 21. | *Vallisneria spirallis* L. | M | Hydrocharitaceae | June-Jan. |
| 22. | *Typha angustata* Borey & Chau. | M | Typhaceae | Dec-March |
| 23. | *Oxalis corniculata* L. | D | Oxalidaceae | Oct-April |
| 24. | *Hydrilla verticilata* | M | Hydrocharitaceae | Nov.-March |
| 25. | *Cyperus iria* L. | M | Cyperaceae | April-June |

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# Bio-prospecting of some of the Wild Edible Plants (WEPs), Medicinal and Aromatic Plants (MAPs) of Jharkhand: A Review

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**Abstract:** The tribal people and villagers of Jharkhand are completely depended on natural resources to fulfil their basics and daily requirements. This review paper was undertaken to assess medicinal uses of WEPs and MAPs of Jharkhand. More than 50 different types of herbs, shrubs and small trees have been recorded belonging to different families. Out of all these many of these are edible either in the form of vegetables or as a medicine. The tribal, villagers has an enormous knowledge of these WEPs and MAPs and their utilizations. But with the rapid development over exploitation, grazing, deforestation, anthropogenic fire the diversity of Jharkhand is depleted at an alarming rate. Therefore, there is an urgent need to conserve these valuable WEPs and MAPs and use it in a longevity manner in future also. Besides, this also further research is also done to explore the therapeutic potentials as well as nutritive values of WEPs and MAPs, so that it can give a scientific basis for the development of herbal drugs and traditional foods in future.

**Keywords: Jharkhand, Bio-prospecting, WEPS, MAPs, Tribal people, Medicinal uses, Natural resources.**

## INTRODUCTION

Bio-prospecting is generally known as Biodiversity Prospecting. It is defined as an orderly and well organized search for beneficial / valuable products which are derived from bio resources that includes plants, animals, micro-organisms etc.

In simple terms it is also defined as an exploration of living things to get a glimpse of how they can be commercially useful for human beings. These valuable products which are derived from bio resources plays an important role in agriculture[1,2], aquaculture[3,4], bio remediation[3,5], cosmetics[6,7], nanotechnology[3,8] and pharmaceutical industries[1,9]. The resources which are derived from bio-prospecting and the products which are used in agriculture include biofertilizers, biopesticides and antibiotics. Rhizobium is used as a biofertilizers, *Bacillus thuringiensis* and the annonins (which are obtained from the seeds of *Annona squamosa*) are used as a biopesticides.

India is a land of medicinally rich plant diversity and it is very well known for its endowment of herbal medicinal knowledge. The ethnic people and the tribal people living in the remote rural or forest areas are still relying on this traditional herbal medicine. Inspite of development in the field of medicine, science and health care in the 19$^{th}$ and 20$^{th}$ century, almost 80% of the world population, especially those who are living in remote areas are still continues to depend on these plant based remedies for their healthcare.

In India the per capita annual consumption of modern drugs is the lowest in the world, mainly because of the medicinal plants are used by the majority of people for their treatment. In most of the developing countries traditional medicine is still practiced widely. In developed countries also it is given much more attention now, because it is used as an alternative to those of high cost modern drugs. They are being less toxic with no or fewer side

effects than those of modern drugs. Medicinal plant plays an important role in the health care of human race. Three lakhs species of angiosperms are documented all over the world, which are used for medicinal purpose by the people of different cultures all over the world. Now-a-days medicinal plants are given much more attention in medicinal field because of the fact that in past times a large number of useful and promising drugs have been developed from them, which are based on traditional knowledge and new perception gained by present day methods of research and scientific advancement in modern system of medicine.

Jharkhand is one of the richest states of India in terms of biodiversity because of its origin, diversified physiographic and climatic conditions.[10] Besides this also, Jharkhand is also known for its abundant mineral resources comprising of over 40% of the total country's mineral reserves. The forest of Jharkhand is mainly tropical deciduous forest rich in species.[11] In Jharkhand there resides a large tribal population having 30 tribes and sub-tribes, who have been living here for thousands of years without changing their lifestyle and culture till now.

**Wild Edible Plants (WEPs)**

WEPs are those plants which are grown naturally and their parts like roots, shoots, leaf, fruits, nuts, grains, seeds are used as a food if they are collected at their proper stage of growth.[12] They are frequently grown in fields, forests, agricultural fields, roadsides, drains and on wastelands also. WEPs may be herbs, shrubs or trees. They are used in several ways like in the form of timbers, foods, wild vegetables, spices, fuel woods, wild fruits, as raw materials for industries and mostly used as traditional medicines. WEPs mainly the leafy vegetables have high nutritive and medicinal values.[13] and it is an integral part of their daily diet of indigenous people of Jharkhand, Odisha, and West Bengal.[14]

**Medicinal Plants**

According to Jha (2001), medicinal plants such as *Mucuna monosperma, Argemone mexicana, Acalypha indica, Datura metel* are used for the treatment of Asthma. In the region of Bharagora block of Jharkhand and its neighboring border areas of West Bengal and Odisha, many medicinal plants were depleted and 4 had been completely lost from that area. There are many medicinal plants which are found in Jharkhand for the treatment of many diseases like *Tinospora cordifolia* for the treatment of cancer, *Rauwolfia serpentina* for the treatment of blood pressure, *Commelina benghalensis* for the treatment of leprosy, *Abutilon indicum* for the treatment of fever and many more.

From the time immemorial people are using ethno-medicinal plants. Because of fewer side effects, low cost, easily available and easy to make the people of Jharkhand are moving towards these ethno medicinal plants, as these ethno medicinal plants are found in abundant amount in the state.

Jharkhand has an affluent ethnobotanical knowledge but with the rapid development and modernization does not affected/ changes their food habit, lifestyles, and way of curing their diseases, religious practices, rituals e.t.c of these tribal communities. However, the knowledge in this field is vanishing at an alarming speed, so it is very necessary to collect information from these local communities and collect plant species for their correct identity.

Bio-prospecting of medicinal plants from wild species and finding the proper quantity of ethno-pharmacognostic preparations from different plant parts such as roots, rhizomes, bark, wood, fruit, leaves, flower, seeds etc. are advise as a remedy for different diseases. Some of the literature discloses that information on ethnobotany is still lacking in some of the district of Jharkhand. As these wild species plants provides a clues to some new or lesser known medicinal plants which may serves as a potential sources for raw materials to derive a new active chemical principles of therapeutic values.

Contribution of Bio-Prospecting in development

- Bio- Prospecting of WEPs and MAPs contribute to sustainable management of traditional knowledge and natural resources, reduces poverty and helps in economic development.
- It can legitimize our traditional knowledge and provide us naturally occurring bioactive compounds with less side effects.
- Develop more alternative ways of treatment.
- Generate new alternatives way of revenues from intellectual outputs with monetary benefits such as farming, forestry, grazing, and fisheries along with foods, fibers, medicines, and industrial development that is in Bio-remediation, ecological restoration etc.

**Table 1- List of some of the Wild edible plants (WEPs) of Jharkhand for curing various ailments**

| S.No. | Botanical Name | Common Name | Family | Plant parts used | Uses |
|---|---|---|---|---|---|
| 1. | *Abutilon indicum* (L.) | Kantura, Indian mallow | Malvaceae | Leaves and roots | Paste of 150gm of leaves by adding 25gm of alum, 2000ml of water, and 50gm of yellow clay and boiled it till the water becomes 400ml and applied it on fractured bone. Roots powder along with cow milk is used in cough.[15] |
| 2. | *Acacia nilotica* (L.) | Babul | Mimosaceae | Twigs and pods | Branches of twigs are used as a toothbrush and are chewed to clean the teeth. The pods are used for goats and sheep in case of scarcity of fodder and in increasing the milk production .[15] |
| 3. | *Adhatoda zeylanica* | Malabar nut | Acanthaceae | Leaves and roots | Leaves and roots are used as an expectorant and antispasmodic .[15] |
| 4. | *Alternanthera sessilis* (L.) | Salanti saag | Amaranthaceae | Shoot | It is used as a vegetable having high nutritive value.[15] |
| 5. | *Amaranthus spinosus* (L.) | Laal saag | Amaranthaceae | Leaves and stem | Leaves and stem are cooked and are taken in the form of vegetables .[15] |
| 6. | *Agaricus bisporus* | Button mushroom | Agaricaceae | Whole plant | It is used as a Antimicrobial, and anticandidal.[16, 17] |
| 7. | *Agave americana* (L.) | American aloe, Century plant | Agavaceae | Leaves, sap, seeds | It is used as an Antibacterial and antifungal.[18] |
| 8. | *Ageratum conyzoides* (L.) | Chick weed, goat weed, white weed | Asteraceae | Whole plant | It is used as an Antibacterial and antifungal.[19] |
| 9. | *Andrographis paniculata* | chiretta | Acanthaceae | Whole plant | It is used as an anticancer and antimicrobial.[20] |
| 10. | *Asparagus densiflorus* | Fox tail fern | Asperagaceae | Leaves, Tubers | It is used for the treatment of diarrhoea.[21] |
| 11. | *Bacopa monnieri* (L.) | Brahmi saag | Scrophulariaceae | Whole plant | The leaves and stem are used as green leafy vegetables by the asthma people .[15] |
| 12. | *Bambusa arundinacea* (L.) | Baunasa | Poaceae | Young shoots and stems | Twigs of young shoots are used in the form of vegetables. Leaves and stem are used for making baskets.[15] |
| 13. | *Basella alba* (L.) | Poi saag | Basellaceae | Shoot | It is used as vegetables. |
| 14. | *Bauhinia purpurea* (L.) | Banithari saag | Caesalpiniaceae | Buds, flowers and leaves | The flower and flower buds are edible. Leaves are used as green leafy vegetables and leaves are used as a fodder for animals.[15] |
| 15. | *Bauhinia variegata* (L.) | Kanchana | caesalpiniaceae | Flower and flower buds | Flower and flower buds are edible.[15] |

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| 16. | *Boerhavia diffusa* (L.) | Punarnava saag | Nyctaginiaceae | Leaves | The leaves are used as green leafy vegetables. It improves the eye sight. It is used by the diabetic people to lower their blood sugar level .[15] |
| 17. | *Bombax ceiba* (L.) | semal | Bombacaceae | Flower bud | Young flower bud are cooked and eaten as vegetables .[15] |
| 18. | *Butea monosperma* (Lam.) | Palas | Fabaceae | Gum and Leaves | Gum are used in the treatment of diarrhoea.[15] |
| 19. | *Carissa opaca* | Granda, Gorna | Apocynaceae | Leaves, Roots | It is used in jaundice and hepatitis .[22] |
| 20. | *Chenopodium album* (L.) | Bathua, fat hen | Amaranthaceae | Leaves, Shoots, Seeds, Flowers | It is used for the treatment of abdominal pains, eye disease, and throat troubles.[23] |
| 21. | *Cissus quadrangularis* (L.) | Devil's backbone, bone setter | Vitaceae | Whole plant | It is used for healing the wounds. |
| 22. | *Coccinia grandis* (L.) | Tindora, Scarlet gourd | Cucurbitaceae | Whole plant | It is used for the treatment of diabetics. |
| 23. | *Curculigo orchioides* | Golden eye-grass | Hypoxidaceae | Tubers | It is used for the treatment of piles, diarrhoea, skin diseases, impotence and leucorrhoea.[24] |
| 24. | *Curcuma aromatic* | Wild turmeric | Zingiberaceae | Rhizomes | It is used in bruises, sprain cough wound healing .[25] |
| 25. | *Cynodon dactylon* (L.) | Bermuda grass, Dhoob | Poaceae | Whole plant,roots | In India it is used to control the diabetes.[26] |
| 26. | *Cyperus rotundus* (L.) | Nut grass, Purple nut sedge | Cypraceae | Leaves, Tubers | It is used to control the weight .[27] |
| 27. | *Dendrocalamus strictus* | Bansi | Poaceae | Young shoot, twigs | Young shoot are edible and are used as a vegetables with fermented rice water. Twigs are used as a tooth brush.[15] |
| 28. | *Diospyros melanoxylon* Roxb. | Kendu | Ebenaceae | Fruits, oils, bark and seeds | Oils are given for curing diarrhoea and dysentery. Bark is used for the treatment of fever.[15] |
| 29. | *Ficus glomerata* Roxb. | Loa | Moraceae | Leaves and fruits | Leaves are used as a fodder for animals. Fruits are eaten for curing the teeth ache.[15] |
| 30. | *Gardenia gummifera* (L.) | Bruru | Rubiaceae | Fruits and resins | Resins are used externally as an antiseptic, and fruits are used for eating purpose.[15] |
| 31. | *Gloriosa superb* (L.) | Nagola | Liliaceae | Root | The grinded roots are applied on the cut of body parts .[15] |
| 32. | *Hollarrhena pubescens* | Indrani | Apocynaceae | Bark | The crushed young bark along with water is taken in dysentery.[15] |
| 33. | *Ipomoea aquatica* | Kalmi saag | Convolvulaceae | Shoot | The shoots are eaten by the people. |
| 34. | *Jatropha gossypifolia* (L.) | Pahar | Euphorbiaceae | Stem | Young stem are used as a tooth brush for cleaning the teeth. |

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| 35. | *Marsilea quadrifolia* (L.) | Sushni saag | Marsileaceae | Shoot and whole plant | It is used for the treatment of insomnia, nervous disorders, all types of body aches, hypertension.[15] |
| 36. | *Moringa oleifera* | sahajan | Moringaceae | Leaves, flowers and fruits | Juice of leaves is given to high blood pressure patients. Its leaves, fruits and flowers are edible.[15] |
| 37. | *Nyctanthes arbortris* (L.) | Silli | Oleaceae | Flowers and leaves | Leaves are grinded with water and its extract is very useful in treatment of intermittent fever, headache. Flowers are used for religious purpose. |
| 38. | *Oldenlandia corymbosa* (L.) | Diamond flower | Rubiaceae | Whole plant | It is used in the treatment of skin sores, sore throat and pelvic inflammatory diseases.[28] |
| 39. | *Oxalis corniculata* (L.) | Creeping woodsorrel, sleeping beauty | Oxalidaceae | Leaves | It is used as an anticancer, antihelmintic and diuretic.[29] |
| 40. | *Phoenix dactylifera* (L.) | khajur | Arecaceae | Stem, leaves and fruits | The fermented stem sap is used in the form of liquor. In local it is known as toddy. The paste of leaf is mixed with little amount of saliva is applied inside the eyes of cattle to cure eye inflammation. Leaves are used for making mats.[15] |
| 41. | *Phyllanthus emblica* (L.) | Amla | Euphorbiaceae | Fruits | It is one of the main ingredients of Triphala and Chawanprash. The fruit juice is given to cure cough.[15] |
| 42. | *Psidium guajava* | Amrudh | Myrtaceae | Twigs | Twigs are used as a tooth brush for cleaning the teeth.[15] |
| 43. | *Quisqualis indica* (L.) | Madhavi | Combretaceae | Flowers | The flowers are used to know that whether a child born is male or a female. White flowers are used for female child while red flower is used for male child.[15] |
| 44. | *Semecarpus anacardium* (L.) | Bhela | Anacardiaceae | Ripe fruits. | Ripe fruits are useful in dyspepsia.[15] |
| 45. | *Sida acuta* Burm.f. | Bari | Malvaceae | Stem | It is used as a toothbrush for cleaning the teeth.[15] |
| 46. | *Spondias pinnata* | Amra | Anacardiaceae | Fruits | Fruits are used to make chutney and also used as a spice.[15] |
| 47. | *Streblus asper* Lour | kakasa | Moraceae | Twigs and Leaves | Leaves are used as a food for goats. Twigs are used to make baskets.[15] |
| 48. | *Syzygium cumuni* (L.) | Jamun | Myrtaceae | Fruits and Leaves | Fruits are used as a medicine for sugar patients. Leaves are used as a fodder for animals.[15] |

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| 49. | *Shorea robusta* | sal | Dipterocarpaceae | Leaves and Flowers | It is used for the treatment of circulatory, digestive, endocrine, respiratory diseases along with infectious diseases.[30] |
| 50. | *Thespesia lampas* | Ban kapas | Malvaceae | Whole plant | It is used for the treatment of diabetes.[31] |
| 51. | *Tinospora cordifolia* (Willd.) | Giloe | Menispermaceae | Whole plant | It is used for the treatment of cancer.[32, 33] |
| 52. | *Tamarindus indica* (L.) | Imli | Caesalpiniaceae | Leaves and fruits | Leaves are used as a fodder for goats. The pulp of the fruit mixed with common salt and made a paste this paste is given to cattle to check dysentery.[15] |
| 53. | *Terminalia arjuna* | Arjuna | Combretaceae | Twigs and Barks | Twigs are used as a tooth brush to clean the teeth and to get relief from throat problems. It is also used to normalize the heart beat.[15] |
| 54. | *Tridax procumbens* (L.) | Bundila | Asteraceae | Whole plant | Leaves, stems and fruits possess the medicinal properties. The plant paste is used for the treatment of cuts and wounds.[15] |
| 55. | *Vitex negundo* (L.) | Nirgundi | Verbenaceae | Leaves, twigs | Twigs are used as a tooth brush. Dried leaves are used as insecticides.[15] |
| 56. | *Woodfordia fruticosa* (L.) | Dhalu | Lythraceae | Flowers | It is used for the treatment of dysentery.[15] |
| 57. | *Xanthium indicum* (L.) | Chhota-gokhru | Asteraceae | Whole plant | The whole plant especially roots and fruit is used as a medicine to treat poisonous bites of insects, epilepsy, and fever.[15] |
| 58. | *Ziziphus mauritiana* Lamk. | Kuruch | Rhamnaceae | Fruits and bark | Fruits are edible. Decoction of bark is given in diarrhoea. The juice of the bark is mixed with milk and it is given to pregnant women to overcome the weakness.[15] |

**Table 2- List of some of the Medicinal Plants found in Jharkhand for curing various aliments[34]**

| S.No. | Botanical Name | Common Name | Family | Parts used | Uses |
|---|---|---|---|---|---|
| 1. | *Aloe barbadensis* | Aloe vera | Liliaceae | Leaves | It is used on wound healing, skin, burns, and ulcer. |
| 2. | *Aegle marmelous* | Bael | Rutaceae | Fruit, Bark | For curing Diarrhoea, Dysentry, Constipation. |
| 3. | *Argemone mexicana* | Mexican poppy | Papaveraceae | Whole plant, seeds, Flowers, Latex, Roots, Leaves | It is used for curing Skin Diseases, Leprosy, Malarial Fever, Wounds, Jaundice, Asthma, Constipation, Leprosy. |

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| 4. | *Asparagus racemosus* | Satavwari, shatamull | Liliaceae | Tuber, Root | It is used for curing Fatigue, Cough, Weakness and enhancing lactation. |
| 5. | *Azardirchata indica* | Neem | Meliaceae | Rhizome | It is used to cure Epilepsy, Sedatives, Hypertension. |
| 6. | *Bombax ceiba* | Cotton tree , Malabar silk-cotton tree | Bombacaceae | Young Root, Gum, Leaves, Shoots, Barks | It is used for the treatment of Diarrhoea, Asthma, Wounds, Leprosy, Pimples, and many other skin diseases. |
| 7. | *Butea monosperma* | Palas | Fabaceae | Gum and Leaves | Gums are used in the treatment of Diarrhoea. |
| 8. | *Bacopa monnieri* | Brahmi saag | Scrophulariaceae | Whole plant | The leaves and stem are used as green leafy vegetables by the asthma people. |
| 9. | *Centella asiatica* | Gotu kola, Brahmi | Apiaceae | Leaves, Herbs | It is used to repair nervous tissue, neuromuscular disorders, and it is used to increase brain function and memory. |
| 10. | *Curcuma longa* | Turmeric | Zingiberaceae | Rhizomes | It is used in bruises, sprain cough wound healing. |
| 11. | *Cinnamomum zeylanicum* | Cinnamon | Lauraceae | Barks, Leaves, Flower, Fruits and Roots | It is used for respiratory, digestive and gynecological ailments. |
| 12. | *Calotropis procera* | Rubber bush, rubber tree, king's crown | Apocynaceae | Bark and Root bark | It is used for digestive disorders including Diarrhoea, Constipation, and Stomach ulcers, in painful conditions also like Toothache, Cramps, and Joint pain. |
| 13. | *Datura metel* | Sada Dhatura | Solanaceae | Seeds, Flowers and Leaves | Level of Poison likes Tropane, Atropine, Alkaloids, Hyoscyamine are considered as Deliriants or Anticholinergics. |
| 14. | *Eclipta alba* | Bringraj | compositae | Seeds or whole plants are used | It is used as a Hair tonic, Digestive problems, and Anti-Inflammatory. |
| 15. | *Emblica officinalis* | Amla | Euphorbiaceae | Fruit | It is a good source of Vit-C, cure Cold and Cough, Diabetes. |
| 16. | *Gloriosa superba* | Flame Lily, Climbing Lily, Creeping Lily | Liliaceae | Seed, Tuber | It is used for the treatment of skin diseases, Labour Pain, Abortion. |
| 17. | *Mucuna pruriens* | Monkey tamarind, Velvet bean | Fabaceae | Root, Seeds, Leaf | It is used in the treatment of Nervous Disorders, constipation, Dropsy. |

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| 18. | *Mucuna monosperma* | Negro bean | Fabaceae | Stem, Leaf | It is used to purify the blood, Menstrual disorders, Asthma, Urinary problem, also used as an Immunity Booster. |
| 19. | *Moringa oleifera* | sahajan | Moringaceae | Leaves, flowers and fruits | Juice of leaves is given to high blood pressure patients. Its leaves, fruits and flowers are edible. |
| 20. | *Ocimum sanctum* | Holy basil, Tulsi | Lamiaceae | Leaves, Seeds | It is used in cold and cough, Bronchitis. |
| 21. | *Plumbago indica* | Rakta chitrak | Plumbaginaceae | Root bark, Root | It is used in the treatment of Indyspeipsia, colic, Cough. |
| 22. | *Pongamia pinnata* | Indian beech, Pongam Oiltree | Fabaceae | Root | It is used in treatment of Tumors, Piles, Skin disease, Ulcers, Skin diseases, Gonorrhea, Cleaning gums. |
| 23. | *Rawolfia serpentina* | Sarpa Gandha | Apocynaceae | Root | It is used in the treatment of High Blood Pressure, Insomnia, Hypertension. |
| 24. | *Strychinos nuxvomica* | Kochila | Logniaceae | Seeds | It is used in Healing the wounds, Paralysis. |
| 25. | *Solanum nigrum* | Makoi | Solanaceae | Fruit, Whole plant | It is used in the treatment of Dropsy, General Debility, and Diuretic. |
| 26. | *Saraca asoca* | Ashoka | Caesalpiniaceae | Bark, Flower | It is used in Menstrual pain, Uterine disorder, Diabetes. |
| 27. | *Tinospora cordifolia* | Giloe | Menispermaceae | Whole plant | It is used for the treatment of cancer. |
| 28. | *Terminalia arjuna* | Arjun | Combretaceae | Leaves, Bark | It is used in the treatment of Heart diseases, Wounds, Ulcers. |
| 29. | *Vetiveria ziziinoides* | Khus khus | Graminae | Root | Its paste is applied on Burnt. For treating Ulcers, Skin problems, Vomiting. |
| 30. | *Withania somnifera* | Aswangandha | Solanaceae | Root, Leaves | It is used in the treatment of Nervous disorders, Stress. |

**Why Bio- Prospecting is needed ?**

- It is needed to find a new resources and products from nature which are used by human beings.
- It helps in refining the human health through both medicine and better nutrition.
- It plays an important role in discovering new drugs with fewer side effects.
- In a study between 1983-2003 it showed that almost two-third of anti-cancer agents were derived from natural products.

## CONCLUSION

Forests play an important role in the livelihoods of tribal people through immense goods (WEPs and MAPs in the forms of vegetables, fruits, medicine, timbers etc.). In Jharkhand there is a huge diversity of WEPs and MAPs. But the diversity of these plants in Jharkhand is depleting at an alarming rate due to overexploitation, unsustainable harvesting of foods, medicines, deforestation, destruction of their natural habitats due to overgrazing, unplanned developmental activities. Further authentic elaborate research work is required to compile detailed inventories of WEPs and MAPs of this mineral rich state of India to determine and screen their Phytochemical constituents and substantiate their uses through clinical analysis. Create awareness among the tribal people of rare medicinal plant species and their conservation through in- situ and ex-situ methods at regional level is highly recommended for those species which are declining in their distribution in Jharkhand.

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# Studies on the use of plant diversity in the rituals of Munda Tribe of Khunti District, Jharkhand

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**Abstract:** Jharkhand is the land of forest, where various ethnic groups like Santhal, Oraon, Munda, Ho, Kharia, Bhumij, Paharia, Kharwar, Gond, Kol and Savar etc. are residing. Khunti is the 23rd district of Jharkhand and it is Munda dominated district. The Munda tribal community believes that the creator of this earth and all living things are the Almighty God and Deities who reside in nature and some sacred plants. So, their all rituals, festivals, cultures and customs are closely related to plants. They celebrate many rituals like birth and naming ceremony of a child, kanbhedi, marriage, godna and death rituals etc. and festivals like Mage, Phagu, Baa parab, Batauli, Her puna, Rowa puna Karam, Soso karam, Jom nawa and Sohrai etc. Present study deals with the different plants used in the rituals of Munda tribe.

**Keywords: Jharkhand, Khunti, Munda, Sacred plants, Rituals and Festivals.**

## INTRODUCTION

A group of indigenous people that have same language and customs and that have a leader is called tribe. India is one of the significant biodiversity communities with the nearest of more than 45000 distinctive plant species. Of these, around 15000-20000 plants have therapeutic worth. In any case, just 7000-7500 species are utilized for their medicinal qualities by ethnic people[1].

The state of Jharkhand is rich in forest and mineral resources. Parts of South Chotanagpur Commissionary, Khunti is the 23rd district of Jharkhand State. It has a total area of about 2,611 sq.km. and around 40% of the total area is covered by forest. The average annual temperature of Khunti is 23.9°C. It is 40 km south from the Capital of Jharkhand, Ranchi and it has 6 Blocks. As per 2011 Census of India, Khunti district has the population of 5,31,885 in which 91.49% of population of Khunti district lives in rural areas and 74% of the population are tribals. The Mundas are the major tribal community of the place who are from South East Asia. Their main occupation is agriculture. Hunting, Fishing and Animal husbandry are subsidiary to agriculture. Agriculture is mostly rain fed as irrigation is not well developed in the district. Paddy is the major crop as it contributes to a great extent to the district economy. Other crops are maize, finger millet, pulses like arhar, urad, gram and kulthi bean etc.

A ritual is a religious ceremony which includes a sequence of actions performed in a systematic order. The Mundas believe in many Gods and Deities. Their prime God is called 'Singbonga' means Sun God. They believe that God resides in the Sun and some Sacred Trees. There is very close relationship between the Munda tribals and plants. Plants have a very important role to play in almost all the rituals and festivals which are celebrated in their community. The Munda people have to follow many rituals to celebrate the birth and naming of the child, engagement, marriage, godai (godna), death and their agricultural work. A study reveals that almost all the festivals are related to a plant or a crop and all these plants have nutritional and

medicinal values[2]. Throughout the year they perform and celebrate different rituals and festivals on different occasions like

**Mage Parab**- This festival is celebrated in the Pus Magh (January). The reason of this festival is to thank the Almighty God for all the blessings received in agricultural work and the good health of the people of whole community.

**Phagu Parab-** This festival is celebrated in the month of Chait-baisakh (March-April) after the Mage parab. On this festival, all male member of the community perform their hunting skill in the forest.

**Baa Parab (Sarhul)**- In the month of Chait-baisakh (March-April) they celebrate Sarhul. It is an important festival of Mundas. It is a festival of flowers. On this occasion they bring branches of *Shorea robusta* (Sal) tree to the Sarna sthal (Place of worship) and their main priest (Pahan) performs the religious ceremony. After the prayer they enjoy the festival by having group dance, food and drinks etc.

**Batauli Parab**- This festival is celebrated in the beginning of Aasad (June) month, for good rainfall and farming.

**Karam-** Karam festival is celebrated usually on Bhado Ekadashi, on the eleventh day of bright full moon of the month of Bhado (August-September). A sapling of *Haldina cordifolia* (Karam) is the centre of the festival. On this festival they plant a branch of *Haldina cordifolia* in their paddy field.

**Jom Nawa Parab-** This festival is celebrated after threshing the new crops, to thank God for the crops received. During this festival they eat the first food of the crop received.

**Sohrai-** This festival is celebrated in the month of Kuvar-Kartik (September-October). On this festival they worship their domestic animals and prepared special food for them.

Along with these festivals they accomplish many rituals like birth and naming ceremony of a child, kanbhedi, marriage, godna and death rituals etc. They use different parts of the plant and crops in all rituals and festivals. In each and every festival they use Alcoholic drinks 'Modh' and 'Handia'. Modh is made of *Madhuca indica* (Mahuwa) and Handia is made of *Oryza sativa* (Rice). The knowledge about these plants which have been transferred from one generation to other is orally or by folklore. Because of this they have deep knowledge about the plants habitat, time and season for its best growth. They know their common names and uses in day today life as household products as well as medicine, cultivation of the crops etc. The knowledge about the ethno botanical uses of plants is associated all over the socio-economical cultural life of the tribals. The Pahan (priest) performs all the rituals and festivals of the community. Some studies have been done on the tribals of India which reveals that the tribal people group of Malkangiri have a social natural legacy as this protection practice, the information on which should be saved and appreciated[3]. Various religious beliefs and myths are attributed to conserve the biodiversity of the region. Tribal communities of Banswara have a cultural ecological heritage in the form of this *in-situ* conservation practice, the knowledge of which needs to be preserved and appreciated[4]. Dhenkanal district is rich in wide variety of plants and the tribal people are not only familiar with the knowledge of plants species in their ecosystem, but also understand the ecological interactions for the various components of their resources[5]. Some studies have been done on the tribals of Khunti district and it reveals that they have rich traditional knowledge about wild edibles yams, aquatic and marshy wild edibles plants and less known wild herbaceous plants[6-8]. So, the objective of the present study is to explore the plants used in the rituals of Munda tribe of Khunti district.

## MATERIALS & METHODS

The proposed study was based on personal interviews of different village headmen, spiritual leaders, priests, knowledgeable experienced persons and some local people for recording local names and their habitat, parts of the plant in households use, as medicine and for ritual purposes. Four blocks of the district (Khunti, Karra, Torpa and Murhu) were selected for study which have rich forest. Field trips were conducted at regular intervals in different seasons and occasions in the year 2020-2021. The data collected through questionnaire in local language (Mundari) from different personals. During the study, daily activities, rituals and festivals were being observed. Identification of plants was done with the help of local Flora and literature[9]. The plants collected are listed with their botanical names followed by family name, their local names in Mundari and the parts used in rituals, household use and medicinal purpose.

**Table 1. List of plants used in the rituals of Munda tribal people of Khunti district.**

| Sl.No. | Botanical Name | Family | Local Name | Parts used | Ethnic use |
|---|---|---|---|---|---|
| 1. | *Achyranthus aspera* L | Amaranthaceae | Chirchiti | Whole plant | juice- to remove abscess |
| 2. | *Bambusa bambos* L. | Poaceae | Ma-an | Stem, young branch | making basket,mat tray, |
| 3. | *Brassica nigra* | Brassicsceae | Mani | Seeds and oil | cold,back pain,ring worm |
| 4. | *Curcuma longa* L. | Zingiberaceae | Sasang | Rhizom | worm in stomach,wound |
| 5. | *Cynodon dactylon* L. | Poaceae | Dub | Whole plant | juice-strengthen the skull of baby |
| 6. | *Eleusine coracana* | Poaceae | Kode | seeds and leaves | rich source of iron |
| 7. | *Maduca indica* | Sapotaceae | Maducam | Whole plant | Alcoholic drink |
| 8. | *Mangifera indica* | Anacardiaceae | Uli | Whole plant | loo,diabetes,jaundice |
| 9. | *Milletia pinnata* | Fabaceae | Koronjo | Seeds | oil - wound |
| 10. | *Musa acuminate* | Musaceae | Kera | Leaves, flower and stem | dysentery,vomiting |
| 11. | *Oriza sativa* L. | Poaceae | Baba | Whole plant | rice beer in jaundice |
| 12. | *Plumeria obtusa* | Apocynaceae | Golainchi | Whole plant | ulcerous wound at finger |
| 13. | *Semecarpus anacardium* L. | Anacardiaceae | Soso | Branches with leaves | as insecticide |
| 14. | *Shorea robusta* Gaert. | Dipterocarpaceae | Sarjom | Whole plant | dysentery, leucorrhoea |
| 15. | *Tamarindus indica* | Fabaceae | Jojo | Fruit and leaves | loo and dysentry |
| 16. | *Vitex negundo* L. | Vitaceae | Huhdi | Branches with leaves | as insecticide |

## RESULT & DISCUSSION

Present study reveals that 16 plant species belonging to 11 families used by the Munda tribes in different rituals and festivals. The religion of the tribal community is the resultant of traditions and beliefs that have come down to them from their ancestors. The traditional use of plants for various occasions is strictly based on folklore. They are expert in utilizing different plants wild as well as cultivated plants for their livelihood.

## CONCLUSION

It can be concluded that the Khunti district is rich in wide variety of plants and the tribal people are not only familiar with the knowledge of plant species in their surroundings but also understand the importance of plants in their lives. Their socio cultural activities and rituals shows the interdependency. They are related with the cultivated crops as well as wild plants. Their traditional knowledge about these plants should be conserved and protected.

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# Study of some promising ethnomedicinal plants used as anti-cholelithiatic agent (gall bladder stone) in Ranchi district of Jharkhand

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**Abstract:** Contemporary ethnobotany shares a holistic and multidisciplinary approach towards advancement of human well being. District Ranchi of Jharkhand state is geographically located in the South Chotanagpur plateau, with an elevation of 2000m from the sea level. It is full of vegetation and inhabited by a mixture of races and ethnic tribes like, Munda, Ho, Santhal, etc.[1] Cholelithiasis is a most common gall bladder problem worldwide; its common names are gall bladder stones, gall-stones, etc. This is the problem related to the stone formation inside the gall bladder- a sac-like storage organ of bile juice, lies beneath the liver in our body: Cholesterol- composing gall- stones are very common among the cholelithiatic patients. Other types of stone based on various chemical compositions are pigment stone, biliary sludge, etc. are also known. Size and location of the gall-stones can vary. Various risk-factors are involving in the cause of this disease are, age, gender, diet, obesity, oral contraceptives, pregnancy in women, also genetic and environmental factors too. Cholelithiasis, may be either asymptomatic or symptomatic. About 80% cases are asymptomatic. The symptomatic cases suffer with worst pain in the abdominal region with nausea, vomiting and sweating. This disease can worsen with time leading to jaundice, pancreatitis, typhoid and other liver ailments. The modern treatment includes pharmacotherapy and surgery. These passes risk to patients - a lot of side effects and a life-long restricted diet without lipids. Ethnic people of Ranchi use many promising medicinal plants to manage cholelithiasis successfully. This research is on procuring those ethnomedicinal values of such plants; found and used by locals of Ranchi district; these are- Rosemary (*Rosmarinus officinalis* L.), Pattharchatta (*Kalanchoe pinnata*), Isabgol (*Plantago* spp.), Blue ginger (*Curcuma aeruginosa*), Pudina (*Mentha* spp.). etc. For that, interviews & questionnaires with eminents & case studies on patients with gall-stones were conducted. This proves the efficacy of ethnomedicinal benefits in cholelithiasis. The study has an aim to explore the valuable traditional knowledge of herbal plants, their credence and easy access of the needies.

**Keywords: Ethnobotany, cholelithiasis, gall bladder stone, cholestrol, symptomatic.**

## INTRODUCTION

Ranchi, capital city of Jharkhand with subtropical geographical location, felicitated with exquisite life forms as flora, having ethnomedicinal values. From ages the endemic - ethnic group uses the indigenous plants as medicine in various ailments, one of them is - Gall Bladder stone management. Gall bladder is a sac-like organ lying beneath the liver, which facilitates storage & concentration of bile juices (secreted by liver). Any disturbance in normal functioning of gall bladder can lead to one of the major problems of gall bladder, i.e. gall stones. As it is unusual for the gall bladder to be diseased in the absence of gall stones.[2]

The types of gall stones can be cholesterol gall stones (>90%), Pegment stones [black or brown] (<20%) or Biliary sludge. It may be either asymptomatic (80%) or symptomatic. Some ethnomedicinal plants have proven records of curing this. Epidemiological study revealed that gall stones disease is three-times more common in females, less than 40 yrs of age. Some of the risk factors related to form gall stone are[3]:-

- increased cholesterol production,
- decreased bile salt secretion, and
- impaired gall bladder emptying.

## MATERIALS & METHODS

District Ranchi of Jharkhand is lying between 23°15'N to 23°25' N latitude and 85°15' to 85°24' longitude.

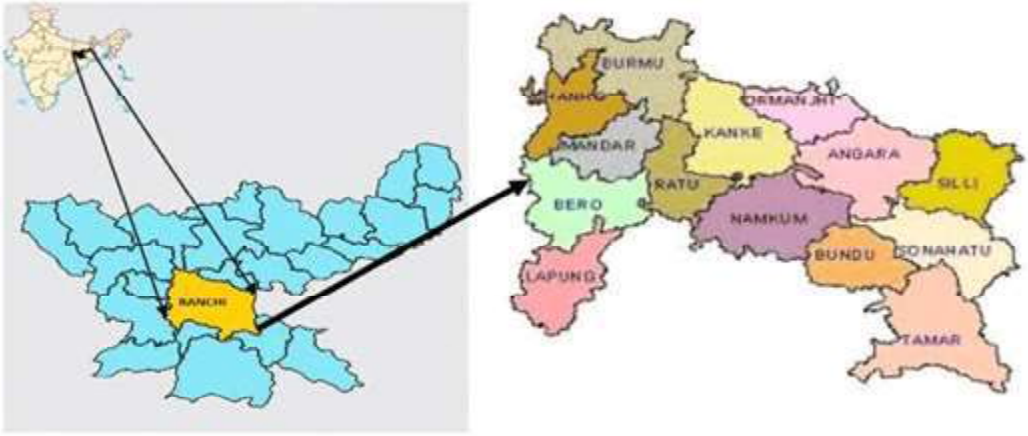


**Fig. 1- Map showing study area**

**Field survey** - Various tribal rich area and different ayurvedic hospitals situated in this area were surveyed frequently.

**Data Recording** - The whole information about the plants, dosages, duration, process of preparation, mode of administration, precaution to be taken etc. was recorded in standard questionnaires. Meetings with Vaidyas, Ayurvedacharyas, and Knowledgeable persons of the local healers provided us a vast knowledge regarding the occurrence, recurrence and management of the cholelithiasis disease in this region. Case studies on the patient with gall stones were also conducted.

The plant specimens were photographed and identified with the help of different flora.[4]

The herbarium of collected specimens were also made by proper methods.[5] Chemical constituents of investigated plants were studied by reference books of eminent authors.

## RESULT

This research is on procuring those ethnomedicinal values of such plants, found and used by locals of Ranchi, Jharkhand. That revealed the following promising herbs, used as anticholelithiatic agents-

Botanical name - *Kalanchoe pinnata* [6]

Family - Crassulaceae

Local name - Pattharchatta

Habit - Herb

Parts used - Leaves

Active Phytochemical - Alkaloids, Triterpenes, Glycosides, Flavonoids, Steroids, Bufadienolides, Isocitric acid, Caffeic acid, Malic acid etc.

Use - Fresh leaves juice, chutney.

| | |
|---|---|
|  | Botanical name – *Rosemarinus officinalis* L. [7]<br>Family- Lamiaceae<br>Local name- Gulmehandi<br>Habit – Perennial herb<br>Parts used- Leaves<br>Active Phytochemical- Rosmarinic acid, Camphor, Caffei acid, Urosolic acid, Betulinic acid, Carnosol, Alkaloids etc.<br>Use- 5-10 fresh leaves are taken in empty stomach, decoction of leaves. |
|  | Botanical name – *Phyllanthus amarus*<br>Family - Amaranthaceae<br>Local name - Bhuiamla<br>Habit - Herb<br>Parts used – Whole plant<br>Active Phytochemica – Flavonoids, Alkaloids , Terpenoids, Lignans, Polyphenols, Tannins, Coumarins, Scponins etc.<br>Use – fresh juice or decoction |
|  | Botanical name – *Plantago* spp. [8,9]<br>Family - Plantaginaceae<br>Local name – Isabgol/Psyllium husks<br>Habit – Herb<br>Parts used – Husk (Seed coat)<br>Active Phytochemical – Soluble fiber of polysaccharide heteroxylan, a hemicellouse (colourless mucilage)<br>Use – 1-3 teaspoons in 300 ml of water before bed in night for 3 weeks or more. |
|  | Botanical name – *Curcuma aeruginosa*<br>Family - Zingiberaceae<br>Local name –Neelkanth/ Blue ginger<br>Habit - Herb<br>Parts used - Rhizome<br>Active Phytochemical – Monoterpenoids, Sesquiterpenoids, Flavonoids, Phenylpropanoids etc. |

## DISCUSSION & CONCLUSION

From this research work, it can be concluded that geography of certain places promote the richness of floras and leads to remedies of various human ailments. The endemic-ethnic group of Ranchi, Jharkhand are successful in unravelling and utilizing the richness of flora for the cure of gall stones.

The modern medicine comes with surgical removal of gall bladder[10] along with other side effects but the traditional medicines promises to cure without any severe loss.

Thus, research works on surrounding flora & local-remedies, using ethnomedicinal plants should be encouraged and promoted.

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# Present status of underutilized ethnomedicinal weed of *Ipomoea* sp. found in Jharkhand

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**Abstract:** The plant *Ipomoea* of Convovulaceae family has a wide distribution (tropical and subtropical regions) with 600-700 species. The plants of this genus has been used in folk and traditional medicine for the treatment of wide variety of pathological conditions and to cure diseases like kidney infections, urinary infections, digestive disorders etc by the ethnic people throughout the world. Several species of *Ipomoea* has also been used as ornamental plants and in the religious rituals by the tribal people. Recent report on *Ipomoea* reveals its antioxidant and anti-inflammatory properties. The plant also shows antibacterial, antiviral, antifungal and anticancer activity. Different species of *Ipomoea* are also cultivated for food and for the generation of household income. In Jharkhand, many species of *Ipomoea* (*I.carnea, I.cairica, I.alba, I.digitata, I.aquatica, I.quamoclit* etc.) are found growing on waste area generally disturbed soil, forest margin, open road lands, fences and growing near water waste as weed. In Jharkhand various species of *Ipomoea* shows luxuriant growth and are also used as a conventional nutritional supplement. But most of the species are still underutilized and are being destroyed rapidly from various places. Reason may be treating the plant as weed, changing climate and its less economic exploitation, urbanization, industrialization and lack of knowledge about its utility. So in order to access the diversity of the priority species and to establish their research need, survey of *Ipomoea* species was conducted in and around Ranchi district. The study revealed 10 *Ipomoea species* as Neglected and Underutilized Weed Species (NUWS) having ethno medicinal and nutritional values. It was found that neglect and underutilization of these species varied and mostly depend upon the topography of the region and on the nature of the ethnic tribal people of the area. The present study also revealed the distribution traditional use and active ingredients of all 10 species of *Ipomoea* and illustrates the potential of the genus as a source of therapeutic agent.

**Keywords: *Ipomoea*, ethnomedicine, antimicrobial, anticancer, anti-inflammatory, active ingredients NUWS**

## INTRODUCTION

Plants play a major role for the survival and development of human beings since the initiation of human civilization. It is the prime source of traditional medicines to cure various diseases all over the world[1]. Ayurveda, Siddha, Unani and many other medicine systems are present in India and other countries[2]. Atharva veda (~1000BC), Charak Samhita (~700BC) and Sushruta Samhita (~200BC) are the major manuscripts which describes about 1200 herbs used to cure various diseases[3]. WHO describes that 80% of the World's population depends on traditional medicine for their primary health care. Herbal medicines are becoming more popular due to their less or no side effects[4].

Genus *Ipomoea* belongs to the family Convovulaceae with approximately 600 species[5] which is distributed all over the world mainly in the tropical and sub tropical region[6]. The species are mainly used by the tribal communities for the treatment of various diseases. Some species showed antimicrobial, anticoagulant, analgesic, hypoglycemic and anticancer activity[7]. Species of *Ipomoea* play a crucial role in the food security, nutrition, and income generation of the rural poor but still most of them

are neglected and underutilized their potential value is underestimated and underexploited due to negligence by research and conservation[8]. Lack of attention also places them in danger of continued genetic erosion and disappearance. Many Neglected and Underutilized Weed Species (NUWS) are nutritionally rich but the erosion can have immediate consequences on the nutritional status and food security of the poor. The enhanced use of these species can bring about better nutrition and fight hidden hunger. The significance of these species is not known to outside world and they are not documented in authentic literature. The present study deals the ethnomedicinal uses and about the active ingredients present in 10 different species of genus *Ipomoea* found in Jharkhand.

## METHODOLOGY

**Study Area**

The study was conducted in Ranchi district of Jharkhand and its surrounding native area (Ratu, Kanke, Dhurwa, Birsa chowk, Nagri). Ranchi lies at $23^0 22'$N $85^0$ 20' E near to the Tropic of Cancer. The city covers an area of 175 $km^2$ (68 sq mi) and its average elevation is 651m above sea level. Ranchi is located in the southern part of the Chota Nagpur plateau, which is the eastern section of the Deccan plateau. The survey was carried out in 5 blocks of Ranchi district and location near Ranchi University campus. The data of ethnomedicinal properties regarding species of *Ipomoea* collected and are based on the traditional knowledge of local tribal people the pharmacological activity, isolated and identified from 10 *Ipomoea* species by the search tool Sci Finder. The information is based upon Chemical Abstract Service (CAS) and database MEDLINE of the National Library of Medicine. For the biochemical compound reference database CAplusSM , CAS database were taken. The data used for pharmacological activity and biochemical compound were updated from these databases in 2015 using biological activity or chemical constituents of *Ipomoea* as keywords.

**1. *Ipomoea aquatic* Forsk.**

**Synonym**: – *Ipomoea reptana,* Poir.

**Common name**:- River spinach, Water morning glory Swamp cabbage.

**Hindi Name** :-KalmiSaag, Kalambi, Kurni

**Active Ingredients**:– Vitamins, Carotene, Tocopherol beta-Carotene, Xanthophylls and glycosides, isochlorogeic acid a, b and c[9].

**Ethnomedicinal and traditional use:-** The plants used as blood purifier, roots are used for the inhibition of prostaglandin synthesis[10.] Plants are used to treat diabetes and obesity[9], blood purifier, Urinary tract infection, emetic, mild, purgative and used as antidote for opium and arsenic poisoning. It is used against liver complaints, nosebleed and high blood pressure[11].

**2. *Ipomoea alba* (L).**

**Synonym**:- *Ipomoea grandiflora,* Roxb*, Ipomoea, longiflora, Ipomoea noctiflora, Colonyction aculeatum, Ipomoea carinata* Endl*., Ipomoea ambigua* Endl.

**Common Name**:- Moon vine, Moonflower, Chandra pushpa, Munda-valli, Gulchandi, Naganamukkorai, Naagaramukkatte, Tropical white morning- glory.

**Hindi Name** :- Dudhiakalmi

**Active Ingredients**: - Tannic Acid, Oxalate, phytic acid, glycoside, cynogenic glucoside, pentasaccharide glucoside of ethyle-II-hydroxy hexadecanoate[11]. It also contains Albinosides I-III and Albinosinicacid[12]. The seeds contain alkaloids, ipomine, isoipomine, methoxyipomine, dimethoxyipomine, ipalkidinium, ipalbidine and ipalbine[13].

**Ethnomedicinal and traditional use: -** The whole herbs are used to treat snakebite. Root bark and leaves are used to cure filariasis flower infusion used asblood purifier[14], dermatitis against itching and to treat headache[15]; Herb has antibacterial, purgative and emetic activities[16].

**3. *Ipomoea batata* (L) Poir.**

**Synonym**: - *Ipomoea fastigate* Choisy.

**Common Name**: - Sweet Potato, Milky Yam

**Hindi Name**:-Shakarkand, Meetha Aalo

**Active Ingredients**:- Vitamins, iron, copper, potassium, manganese, vitamin A, vitamin B6 and vitamin C. It contains alkaloids, saponins, tannins, steroids, anthocyanins, flavonoids, anthroquinones and Caffic acid derivative. The main constituents of oil are abietadiene, β caryophyllebe, trans-(Z)-α-bergamotol, abieta 8, 11, 13-triene, cissabinene and spathulenol[17].

**Ethnomedicinal and traditional use:-** Leaves can be used as effective and eco friendly control of mosquitoes causing dengue, Urinary tract infection, Malaria and filariasis. It is folk therapy for asthma bug bites, burns, fever, ciguatera, diarrhea, nausea, spleenosis, stomach distress tumors and whitlows[18]. It possess wound healing, antioxidant, anti-diabetic, anti-ulcer, anti-bacterial, anti-cancerous and antimutagenic activities[19,20].

**4. *Ipomoea cairica* (L.) Sweet.**

**Synonym**: - *Ipomoea palmate* Forsk*, Ipomoea stipulacca* Jacq., *Ipomoea tuberculate* (Desr.) Roem. *Persicaria perfoliata.*

**Common Name**: - Milea minute vine, Messing creeper, Cairo Morning glory, Railroad creeper, Coast morning glory, Panj-pani-poti-aal.

**Hindi Name**:-Giriaval , Chatribel.

**Active Ingredients**:-Alkaloids, flavonoids, steroids, terpenoids, saponin, tannin, reducing sugar, methoxy cairicate and myristyl alcohol also reported[20,21,22].

**Ethnomedicinal and traditional use:-** Aqueous extract showedanti-RSV (Respiratory syncytial virus) activity[23] Ethanolic extract presents antinociceptive effect[24,25]. It posses antioxidant and anti-inflammatory activity. It inhabited the replication of human immuno deficiency virus[26]. Medicinally it is used as an antioxidant, anti-inflammatory, antiviral and highly potent against malaria[27].

**5. *Ipomoea carnea* Jacq.**

**Synonym**: - *Ipomoea fistulosa* (Mart ex Choisy), D.F. Austin *I. crassiccaulis* (Benth)

**Common Name**: - Bush morning glory, pink morning glory.

**Hindi Name**:-Behya, Beshram.

**Habit**- It is evergreen shrubs.

**Active Ingredients**: - Glycosides, reducing sugar, alkaloid, flavonoids fatty acids, saponin, alcohol & tannin.[28,29,31]

**Ethnomedicinal and traditional use: -** The plant posses antioxidant, antifungal, antibacterial, antimicrobial, anti-diabetic, anticancer, anti-inflammatory, Immune modulatory, wound healing and embryo toxic activities. Leaf paste is applied on Haja (A kind of sore between toes and fingers due to fungal infection)[28,22].

**6. *Ipomoea quamoclit* (L).**

**Synonym :-***Quamoclit pennata* (Desh) Bojer. *Quamoclit vulgasis* Choisy.

**Common Name** :- Cypress vine, Cardinal creeper, Cypress vine morning glory, cardinal vine, star glory, humming bird vine.

**Hindi Name**:-Longlata, kaamlata, Ganesh vel, Kamini.

**Habit**:- It is an annual or perennial, herbaceous, twining vine

**Active Ingredients**:- Palmiticacid, stearicacid, Leaves & stem contain alkaloid and cyanogenetic glycosides in small amount. Seeds contain the resin glycosides, quamoclins I-IV and jalapin; 7-O-β-D-glucopyranosyl-dihydroquer centin-3-O-αD Glucopyranosi [20,29,30].

**Ethnomedicinal and traditional use:-**Plant is less studied[32] and known to be useful in haemorrhoids, carbuncles. Piles, diabetes, leaf paste is used to cure bleeding piles. Leafjuice is useful in fever, diabetes. It also shows antioxidant & antimicrobial activity[33,34,35,30] .

**7. *Ipomoea digitata Linn.***

**Synonym**:- *Ipomoea mauritiana* Jacq*, Ipomoea paniculata* (Linn) R. Br. I. Cherophylla O Donell.

**Common Name**:- Bhumi- Kushmanda, Bhuin, Kakhaaru, Milky Yam, Aligatoryam. Giant Potato.

**Hindi Name**:- VidhaiKhand, Bhumi-Kumra, Ksheervidhari.

**Habit**:- smooth, perennial, climber with elongated & tuberous root system.

**Active Ingredients**:- Rhizome contain sitosterol and taraxerol acetate, cinnamic acid glycosidic acid, quamoclinic acid A and operculinic acid A[36,37] .

**Ethnomedicinal and traditional use:-** Herb used in the treatment of enlarged liver & spleen and helpful in heavy bleeding during menses and menorrhea[38,39]. Herb tonic is used in gastrointestinal disorders cough, lactostimulant libido-inhanceranduseful in Alzheimer's disease[40], Decoction of root is used against constipation[37].

**8. *Ipomoea eriocarpa R.Br.***

**Synonym***:-* *Ipomoea hispida* Roem and Schult *Ipomoea sessiliflora, Ipomoea ligulafa, Ipomoea horsefieldiana* Miq.

**Common Name** :- Tiny morning glory, Wooly fruited morning glory, Khudkalmoughorakalami, buta, maalghanti, ranbhovaari, bhanwarnakhari, Aakhukarni, sheetavalli.

**Hindi Name** :-Ranbhovaari, Maalghanti.

**Habitat:** Found in bushveld, savanna and grassland.

**Active Ingredients**:- Carbohydrate, Protein, Alkaloid, Flavonoid, Saponin and Glycosides[41].

**Ethnomedicinal and traditional use: -** Plant Oil extract is used in external applications such as treatment of headache, Rheumatism, Leprosy, Epilepsy, Ulcer & fever. Root decoction used to cure menstrual pain. Oil extract also used to cure wounds of cattle[39].Whole plant is used fever, ulcer, rheumatism & have anti-diabetic activity[42].

**9. *Ipomoea indica* (Burm.) Merr.**

**Synonym**:- *Ipomoea acuminate* (Vahl) Roem & Schult, *Ipomoea cathartica* Poir*, Ipomoea congesta* R.Br*, Ipomoea learii* Lindl*. Ipomoea mutabilis* Lindl.

**Common Name**:- Blue down flower, Ocean blue morning glory, Koaliawa, Blue morning glory, Common morning glory.

**Hindi Name**:-Bhamardi, Ghagula, Gariya.

**Habit-** Tender perennial wine

**Active Ingredients**:-Alkaloid, flavonoids, glycoside, saponins, steroids, tannin, phlobatannin and terpenoid[29].

**Ethnomedicinal and traditional use**:- It has been reported for antimicrobial, antiviral and anti-inflammatory, anti-pyretic and anti-cancerous activities. Leaf sap is used to cure dysentery. Root paste apple applied to backaches and sore muscle[43]. Silver nanoparticles of *I. indica* are effective in inhabiting inflammations and may used to treat inflammatory diseases[44].

**10. *Ipomoea sepiaria* Koeng ex Roxb.**

**Synonym**: -*Ipomoea maxima* (Linn. F) G. Don, *Ipomoea stipulaceae* Clarke, *Ipomoea sagittiflolia* Burm,F., *Ipomoea littoralis* Blune.

**Common Name** :-Lakhmana, Manjika, Hedgebind weed.

**Hindi Name**:-Hanumann Vel.

**Habit:-** Prostrate climbers, sparsely hirsute.

**Active Ingredients**:-Terpenoids, Saponin, glycosides, rasin, flavonoids, Alkaloids, tannin, phytosterols, and phenolic compounds[45,46].

**Ethnomedicinal and traditional use:-** Aphrodisiac a good antidote to arsenic rejuvenating diuretic, laxative, burning sensitive, hyperdipsia, general debility & sternity in women & indiuretic, hypotensive uterine tonic antidote to arsenic poising. Seeds are cardia depressant spasmolytic antidote for arsenic poisoning[45,46,47].

## RESULT & DISCUSSION

In the survey 10 species of *Ipomoea* were collected. Authentication of the plant was done by Taxonomy Department, University Department of Botany, Ranchi University, Ranchi. Based upon the survey 10 species of *Ipomoea* [*I. aquatica* Forsk., *I. alba* (L.), *Ipomoea batata* (L.) Poir., *Ipomoea cairica* (L.) Sweet, *Ipomoea carnea* Jacq., *Ipomoea quamoclit* (L.), *Ipomoea digitata* Linn., *Ipomoea eriocarpa* R.Br., *Ipomoea indica* (Burm.)Merr., *Ipomoea sepiaria* Koeng ex Roxb.] were identified. The plants of genus *Ipomoea* have long been used in folk medicine for the treatment of various types of diseases like kidney ailment[26], inflammatory[44] and algesic process, constipation digestive disorders[40] etc. Some of the species showed antimicrobial, antibacterial and antiviral activity[27]. In recent years the scientific interest in the species of genus *Ipomoea* has greatly increased. In Jharkhand, the genus showed luxuriant growth but still most of the species are treated as weeds due to lack of knowledge and avoidance by the researchers. The studied species comes under the category of Neglected Underutilized Weed Species (NUSW). Out of 10 species found and studied in Jharkhand *I.batata* are used for nutritional purpose and are cultivated and consumed throughout the world[48]. Almost all the species identified have the property of phytotoxicity and so they are included in invasive weed. Due to presence of alkaloid, flavonoid, glycolipid and other secondary metabolites these species show antimicrobial and other disease compressing activity. For example, antinociceptive action of *I. pescaprae*[49]. Other study confirmed the presence of active substances which exert a vasorelaxant effect confirming popular use of *I. stans* as an antispasmodic agent.[50]

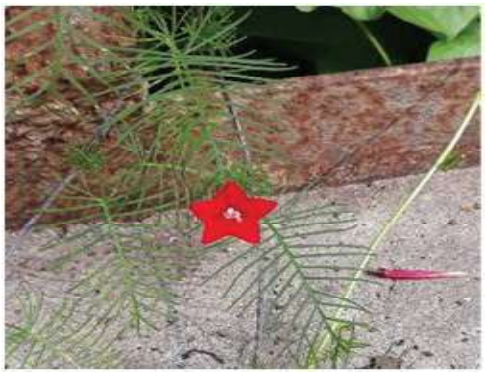
## CONCLUSION

The study revealed that no document, publication, or project has developed list of neglected and underutilized weed species of *Ipomoea* in Jharkhand. Based on the information gathered from the interviewees of tribal people and knowledgeable practitioners, about 10 neglected and underutilized *Ipomoea* species were identified as of priority based on 10 criteria which included their extent and degree of consumption as NUWS. It was found that neglect and underutilization of these species varied geographically and mostly depend upon the topography of the region and on the nature and types of the ethnic tribal people of the area. Market survey showed that many species of NUWS (neglected underutilized weed species) are important source of tribal income. But still there is a wide gap in knowledge; research and motivational steps are needed to raise the status of this plant from underutilized to pharmaceutically important plant. Basic ethnobotanical investigation of the work for concrete scientific data will help the scientists and the students willing to conduct research on NUWS in Jharkhand. But the lack of knowledge of this genus had made many useful medicinal plant endangered and at the verge of extinction consequently broad field of future research remains possible in which isolation of new active principles and formation of nanoparticles from these species would be of great scientific merit.

***Ipomoea aquatica* Fossk.**

***Ipomoea batata* (L) Poir**

***Ipomoea alba* L.**



***Ipomoea quamoclit* L**

***Ipomoea cairica* L.**

***Ipomoea digitata* Linn.**

***Ipomoea carnea* Jacq.**

***Ipomoea eriocarpa* R.Br.**

***Ipomoea indica* (Burm.) Merr.**

***Ipomoea sepiaria* Koening ex Roxb.**

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# Medicinal potential of some aquatic and semi- aquatic plants found in Jharkhand: A Review

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**Abstract:** Medicinal plants play vital role in curing diseases and have been used traditionally in healthcare from ages. Aquatic and semi- aquatic plants are globally well known for their problematic water bodies' infestation. Usefulness of these plants in terms of medicinal purposes is rarely discussed. Numerous amount of species of aquatic and semi-aquatic plant exists, out of which majority of them are unexplored in terms of medicinal value as they are generally considered as weeds. However, nutraceutical aspects of aquatic and semi- aquatic plants have been discussed by some researchers which show that these so called weeds can be put to good use. These plants are rich repositories of therapeutics and nutrients which makes it cheap and easily available supplement of synthetic drugs and a healthy food to consume as well. Jharkhand is known to be rich in flora, fauna and mineral resources. Various large and small water bodies are also found here which makes it rich in aquatic vegetation. This present review compiles medicinal potential of some aquatic and semi- aquatic plants found in Jharkhand.

**Keywords: Aquatic plants, semi- aquatic plants, Jharkhand, medicinal potential, waterbodies**

## INTRODUCTION

Aquatic plants have both ecological importance and economic importance as it plays important role in ecological balance being the one of the important composition of aquatic ecosystem and for providing livelihoods to large section of people across the world. Semi- aquatic plant belongs to productive and high yielding plant communities as they are not bonded with any limitation of high water requirements although water scarcity limits their natural growth potential. Jharkhand being the tribal dominated state, these aquatic and semi- aquatic plants plays vital role in their day to day life in terms of food, fodder, compost, fertilizers and medicines. These aquatic and semi-aquatic plants may be floating, emerged, marginal and submerged and can be found in various water bodies like ponds, lake, wetlands, rivers, paddy fields, ditches etc. A large section of these aquatic and semi aquatic plant are used for medicinal purposes by the locals and tribal of state. They use plant parts like rhizome, roots, stem, fruits, leaves or whole plant for their medicinal usage. They are rich in crude proteins, mineral elements, anti- oxidant elements which makes them powerful nutraceutical plants.[1] Apart from food and medicinal aspects these aquatic and semi- aquatic plants also helps in removing toxic heavy metals from the water resources which directly or indirectly contributes in maintaining good environment hence, good health.[2]

Various works have been done on aquatic and semi-aquatic plants of Jharkhand viz. Verma and Pandey, (2008)[3], Mukherjee and Kumar, (2017)[4], Mukherjee and Kumar (2019)[5], Mukherjee and Ghosh (2015)[6] have done enormous work on aquatic and semi- aquatic angiosperms of Jharkhand. Mukherjee and Kumar (2016)[7], (Mukherjee and Kumar (2019)[8] also worked on cultivation of the same, which will be of great help in future for the commercial use and for medicinal use as well. Lal and Mishra (2012)[9], Marandi and Britto (2015)[10] worked on medicinal aspect of aquatic and semi-aquatic plants of Jharkhand. This review article presents some of the aquatic and semi-

aquatic plants and their medicinal potential along with their common name and family followed by habit and habitat.

**ENUMERATION**

***Acorus calamus* L.**

**Common Name:**Sweet Flag

**Family:** Acoraceae

**Habit & Habitat:** It is a perennial, monocot, aromatic and hermaphrodite herb and has a creeping rhizome. It can be up to 2.5 cm in thickness and grow up to 2 m high. Leaves can be 0.7 to 1.7 cm broad and is bright green in colour. Plant flowers in early summer to late summer depending upon the region. It can be found in edges of water bodies like pond, river, wetlands, lakes and swamps. It is generally found in India, Siberia, Europe, Southern Russia and Central Asia.

**Medicinal Potential:** Rhizomes of plant used in treatment of insomnia, epilepsy, neurosis and other diseases. It can be used in treatment of hyperlipidaemia and is used in treatment of tuberculosis by the Oraon tribals of Jharkhand.[11-14]

***Alternanthera sessilis* (L.)R.Br. ex DC.**

**Common Name:** Joyweed

**Family:** Amaranthaceae

**Habit & Habitat:** Herbaceous cylindrical weak plant with sessile leaves and flowers. Plant has no characteristic taste and odour. Found in places with high humidity and in association with various other aquatic plant species. Plant occurs in Asian countries like India, Sri Lanka and also found in central and Southern America.

**Medicinal Potential**: It can be used in treatment of diabetes, rheumatoid arthritis, dysentery, colon cancer, ulcer, bronchitis, hepatic disease, anaemia, hepatitis, night blindness, hypertension, asthma, diarrhoea.[15-25]

***Bacopa monnieri* (L.) Pennel**

**Common Name:** Water hyssop

**Family:** Scrophulariaceae

**Habit & Habitat:** Perennial creeping non- aromatic herb containing succulent thick leaves and possesses small white and purple flowers found in marshy and warm wetlands. It grows in wetland and marshy areas of Eastern and southern India and other Asian countries like Nepal, Pakistan, Vietnam, China, and Taiwan. It is also found in Europe, Australia and Africa.

**Medicinal Potential:** It helps in treatment of cancer, epilepsy, alzheimer's disease, allergies, asthma and bronchitis, anxiety, ulcer. Various studies have shown *B.monnieri* (L.) pennel.as memory enhancer plant.[26-36]

***Centella asiatica* (L.) Urban**

**Common Name:** Indian pennywort

**Family:** Apiaceae

**Habit & Habitat:** Perennial creeping herbaceous plant, colour ranging from green to reddish- green. It is mainly found in tropical and temperate swampy region. Leaves are green and around 2 cm long and broad and takes about three months to fully mature as plants. Plants are generally found in countries of Southeast Asia and Southern US.

**Medicinal Potential:**It cures jaundice, epilepsy and hysteria. It is used in treatment of skin diseases, neuromuscular disorder. It is also used in treatment of ailments like ulcer, leprosy, Syphilis, urethritis, leprosy, elephantiasis, leucorrhoea and in kidney troubles.[37-41]

***Coldenia procumbens* L.**

**Common Name:** Creeping coldenia

**Family**: Boraginaceae

**Habit & Habitat:** Flat prostrate herb having 10- 50 cm long stem with numerous branches. Leaves are oblong to obovate in shape, short, alternate, and sessile having round apex. Flowers are small in size, approx. 3-4 mm long, white in colour having 5 petals, 5 stamens and 2 inserted styles. Plant in sub- tropical and tropical zone and widely found in south India.

**Medicinal Potential:** It is used to cure rheumatic pains, dysfunction of liver or liver injury, piles.[42-44]

***Colocasia esculenta* (L.) Schott**

**Common Name:** Taro

**Family:** Araceae

**Habit & Habitat:** Monocotyledonous perennial herb, grows up to 1-2 m high, consists of heart shape leaves green and purple in colour. Central corm is present below the soil surface. It is found in South Asian countries like Nepal, East India and Bangladesh. It is also found in Malaysia, Australia, Turkey and parts of southeastern US like Houstan and Texas.

**Medicinal Potential:** It is used for the treatment of alopecia, haemorrhoids, constipation, stomatitis, mycobacterial infections, diabetes, metastatic disease, and liver diseases[45- 55].

***Commelina benghalensis* L.**

**Common Name:** Benghal dayflower

**Family:** Commelinaceae

**Habit & Habitat:** Perennial herb which appears once every year mostly found in moist locations. Leaves are about 4-7 cm long, dark green in colour. Flowers are little in size and bluish purple in colour. It can grow up to 40 cm in height.

**Medicinal Potential:** It is used in treatment of malignant growth, leprosy, burns, male infertility, diarrhoea and mental disorders like insanity, psychosis, epilepsy, and anxiety. Plant also prevents age related various diseases and is also used as laxative and demulcent.[56-62]

***Cyathocline purpurea* (Buch.- Ham ex D. Don) Kuntze**

**Common Name:** Purple bane

**Family:** Asteraceae

**Habit & Habitat:** Annual, erect, aromatic herb which grows 20- 50 cm in height consists of stem and leaves covered with soft hair. Flowers are purple in colour and appear at end part of the branches. It is generally found in freshwater and wet regions. It grows in Himalaya and found in India, China, Thailand, and Burma.

**Medicinal Potential**: It is used to treat inflammation pain, cancer, rheumatoid arthritis and in indigestion.[63-68]

***Cyperus rotundus* L.**

**Common Name:** Nut grass

**Family:** Cyperaceae

**Habit & Habitat:** Perennial, erect, slender plant grows up to 140 cm long in height. Leaves are narrow and long, shiny, smooth, dark green in colour with a sharp tip. Its width is 0.2 to 1 cm whereas length ranges from 20 -30 cm. Flowers of plant is bisexual and occurs at a tip of the stem. The inflorescence consists of purple to reddish-brown spikelets which is about 3.5 cm long. It grows in moist locations, crop fields, and wasteland and can also be found in dry regions. It is found in Eastern Asia, Middle Asia, Southern Asia, Northern America, Southern America and in Europe.

**Medicinal Potential:** It is used in treatment of digestion problem, malaria, dysuria, rheumatism, obesity, inflammations. It is used as diaphoretic and diuretic. It is also used in antivenom against *Bangarus caeruleus* & *Bangarus fasciatus* (Kraits), *Ahaetulla nasuta, Echis carinatus* & *Daboia russelii* (Vipers) and various other venomous Snakes.[67-69]

***Dentella repens* (L.) J. R. Frost. & G. Forst.**

**Common Name:** Creeping lickstoop

**Family:** Rubiaceae

**Habit & Habitat:** Creeping herb with pointed leaves at the both of the ends which can be 4mm wide and 1 cm long. Flowers are small in size and white in colour and can be 1 cm long. Fruits are 3- 4mm long and are angular in size. It is found in muddy and marshy areas like in rice fields, pool sides and river banks. It is found in India and Malaysia.

**Medicinal Potential:** Used in the treatment of loose motion, blood pressure, constipation, eczema, sores, conjunctivitis, and diabetes. It can also be used as poultice.[70- 71]

***Eclipta prostrata* (L.) L.**

**Common Name:** False daisy

**Family:** Asteraceae

**Habit & Habitat:** Prostrate, multibranched, annual herb grows up to 60 cm long in height. It consists of oblong, opposite, sub-sessile to sessile leaves which are 0.8–2 cm in width and 4–10 cm long. Leaves are general white in colour. Plant grows in wet, marshy and moist places. It is found in subtropical and tropical regions as Countries like India, China, Nepal and Thailand of Asia and found in Africa and South America as well.

**Medicinal Potential:** It is used in the treatment of spermatorrhoea, bleeding, greying of hair, jaundice, hepatitis, Body pain, skin diseases, high blood pressure, pneumonia, asthma, fever, dysentery, loss of appetite, diarrhoea, bronchitis, constipation, hypertension. It also helps to cure tongue boils.[77- 79]

***Glinus oppositifoilius* (L.) Aug. DC.**

**Common Name:** Indian Chickweed

**Family:** Aizoaceae

**Habit & Habitat:** Prostrate, annual, glabrous, spreading herb grows up to 40 cm tall in height. Leaves are sub- sessile and unequal. Plant grows in stream banks and lakeshores. It is found in tropical Africa, tropical Asia and Australia.

**Medicinal Potential:** Used in treatment of malaria, wounds, inflammations, joint pains, intestinal parasites, skin disorders, fever, diarrhoea, diabetes.[80-83]

***Grangea maderaspatana* (L.)Poir**

**Common Name:** Madras carpet

**Family:** Asteraceae

**Habit & Habitat:** Prostrate, branched, hairy herb about 70 cm tall in height. Leaves are sessile, alternate and stalkless. Flowers are small, short- stalked and numerous, round in size and yellow in colour. It grows in moist places like dry river, pond beds and harvested fields. It is found in India, Nepal, Malaysia and Africa.

**Medicinal Potential:** It helps in reducing pain, inflammation, spasms and also helps in regulating menses. It also helps in treatment of indigestion and arthritis.[84-86]

***Heliotropium indicum* L.**

**Common Name:** Indian heliotrope

**Family:** Boraginaceae

**Habit & Habitat**: Erect, annual, branched herb of about 15 to 50 cm long. It consists of oblong to ovate, alternate or opposite leaves and violet or white coloured sessile, regular flowers having 5 free, linear and green sepals which is 2.5 mm long. It grows in waste places and is found throughout Asia and Africa.

**Medicinal Potential:** It helps in treatment of wounds, skin disorders, scabies, eczema, poison bites, nervous disorders, stomach ache.[87-88]

***Hydrolea zeylanica* (L.)Vahl**

**Common Name:** Blue water leaf or Water olive

**Family:** Hydrophyllaceae

**Habit & Habitat:** Annual, prostrate branched herb, grows up to 1.2 meters in height. Leaves are pointed, lanceolate, and 4-10 mm long in length. Flowers are in raceme pattern, numerous and blue in colour. Green sepals are present, 5 mm in length, hairy and linear- oblong in shape. It is found in India, Taiwan, China, Africa and Malaysia,

**Medicinal Potential:** It is used as poultice and used in treatment of ulcers and inflammation. It is used in healing of wound and skin diseases.[89-90]

***Ipomoea aquatic* Forssk.**

**Common Name:**Water morning glory or Swamp cabbage or Water spinach

**Family:** Convolvulaceae

**Habit & Habitat:** It is a tropical plant found in semi-aquatic region. It consists of hollow stem of 2-3 metres long. Leaves are 5-15 cm long and width is 2-8 cm. It is lanceolate or sagittate in shape. Flowers are in trumpet like shape and white in colour with purple pattern in centre. It grows in edges of ditches, ponds, lakes and wet rice field. It is found and cultivated in East and South Asia, Africa and in parts of Southern US.

**Medicinal Potential:** It is used in treatment of gonorrhoea, rheumatism, inflammations and used as blood purifier, purgative, emetic, poison antidote.

***Limnophila indica* (L.) Druce**

**Common Name:** Indian marshweed

**Family:** Plantaginaceae

**Habit & Habitat:** Perennial herb having hairless, branched and submerged stem up to 15 cm tall. Leaves are also submerged and 1.5-2.5 cm long. Flowers are purple and white in colour with red spots. Plant can live in both water and land. It is found throughout India.

**Medicinal Potential:** It is used in treatment of dysentery, fevers, elephantiasis.[91]

***Lindernia anagallis* (Burm.f.) Pennell**

**Common Name:** Pimpernel Lindernia

**Family:** Linderniaceae

**Habit & Habitat:** Annual herb grows up to 10- 40cm tall with branched, hairless and creeping stems. Leaves are stalkless or short- stalked having oblong or ovate in shape. Flowers are white and purple in colour having lower lip smaller than upper lip. It grows in marshy places, riverside, rice fields and bank of ponds. It is found in India, Bangladesh, and Australia

**Medicinal Potential:** Used in treatment of gonorrhoea and digestive disorders.[92]

***Lindernia ciliate* (Colsm.) Pennell**

**Common Name:** Fringed Lindernia

**Family:** Linderniaceae

**Habit & Habitat:** Annual, prostrate herb grows up to 13 cm tall. Leaves have spiny teeth, simple and short-stalked or stalkless with acute or obtuse tip. Flowers are in raceme pattern, white and purple in colour with upper lip and lower lip same in size. Plant commonly grows in open wet areas and in edges or periphery of moist or wet deciduous forest. It is found in India, Taiwan, China, Australia and Malaysia.

**Medicinal Potential:** It is used in treatment of jaundice, liver diseases, gonorrhoea, constipation, asthma, bronchitis, skin diseases, cough, loss of appetite, spleen diseases, dysuria and fever.[93-95]

***Lindernia crustacea* (L.) F. Muell.**

**Common Name:** Malaysian false Pimpernel

**Family:** Linderniaceae

**Habit & Habitat:** Perennial herb having prostrate branched stem which is 10- 20 cm long. Leaves are stalked, toothed, smooth and oblong to heart shaped. Flowers have 0.5- 2.5 cm long stalk, small in size, blue, purple and yellowish in colour, consists of 2- lobed upper lip, 3- lobed lower lip and a larger middle lobe. It mostly grows in Sub- tropical and tropical Asia, America and Africa.

**Medicinal Potential:** It is used in treatment of dysentery, indigestion, ringworm infections.

***Ludwigia adscendens* (L.) H. Hara**

**Common Name:** Water primose

**Family:** Onagraceae

**Habit & Habitat:** Free- floating, perennial, aquatic and semi- aquatic herb. Leaves are alternate, round apex, oblong with entire margin. Flower consists of 5 petals, 5 sepals and 10 stamens and white in colour. It is generally found in freshwater. It is found in India, Malaysia, China, South America, Africa and Australia.

**Medicinal Potential:** It is used as poultices and is used in treatment of pimples.

***Ludwigia octovalvis* (Jacq.) P. H. Raven**

**Common Name:** Willow primose

**Family:** Onagraceae

**Habit & Habitat:** Well branched, erect herb, brownish- red stem grows up to 4 m tall. Leaves are alternate, ovate, 15 cm long with narrow tip and base and green in colour. Flowers are yellowish in colour. It can be found in Southeast Asia, Middle East, Central Africa, Australia and Central America.

**Medicinal Potential:** It is used in treatment of skin disorders and eczema, nephritis, diabetes, hypotension and infection diseases.[96-98]

***Marsilea minuta* L.**

**Common Name:** Waterclover

**Family:** Marsileaceae

**Habit & Habitat:** Creeping submerged plant which is perennial and sometimes annual with green to light brown rhizomes. Leaves are erect and above water surface and have petioles about 5- 13 cm long. It grows in brackish water, ponds, paddy fields and ditches. It is found in Asia and Africa.

**Medicinal Potential:** It helps in relieving headache, insomnia, hypertension, nervous disorders, body aches. It helps in treatment of infantile diarrhoea, epilepsy, migraine, bronchitis, sedation, fever, psychopathy, leprosy, strangury, dyspepsia, haemorrhoids and ophthalmia.[99-100]

***Monochoria vaginalis* (Burm.f.) C. Presi ex Kunth**

**Common Name:** Oval leafed pondweed

**Family:** Pontederiaceae

**Habit & Habitat:** Aquatic, perennial or annual herb with emerged leaves grows upto 50 cm long in height. Leaves are floating, lanceolate, shiny, hollow petioles, ovate to oblong, 2-12.5 cm and 0.5-10 cm in length and width and dark green in colour. Flowers are purple and bluish in colour. It is commonly grows in rice fields. It is found in India, China and Australia.

**Medicinal Potential:** It is used to cure Burning sensation of body, Toothache, Constipation, Hemorrhoids, Urinary calculi, anuria, wounds, skin diseases, ulcers[101].

***Nelumbo nucifera* Gaertn.**

**Common Name:** Indian lotus or sacred lotus

**Family:** Nelumboaceae

**Habit & Habitat:** Perennial, rooted herb consists of thick stem and floating leaves. Petioles can grow up to 200 cm long. Leaves are large, short tip, entire, stout, and 80 cm in diameter whereas flowers can grow up to 30 cm in diameter and white- pink or pinkish in colour. Stamens and petals are arranged spirally. It generally grows in slow moving water bodies. It can be found in New Guinea, Southern Asia, Eastern and Northern Australia.

**Medicinal Potential:** It is used against cancer and is used in treatment of anaemia. It is used to cure white discharge in females, skin diseases, dysentery and diarrhea. It is also used in treatment of ring worm infection, piles, vomiting and fracture bones.[102-105]

***Nymphaea nouchali* Burm.f.**

**Common Name:** Blue water lily or blue lotus or star lotus

**Family:** Nymphaeaceae

**Habit & Habitat:** Aquatic, rhizomatous, nonviviparous, day-blooming plants having submerged roots and stems. Leaves are broad, round, green in colour and about 20-23 cm in size. The flower is usually blue, purple and reddish in colour. It is found in Afghanistan, India, Thailand, Taiwan, Myanmar and Australia.

**Medicinal Potential:** It is used in treatment of urination problems, leucorrhoea, piles, haemorrhage, vomiting, diabetes, dysentery.

***Phyla nodiflora* (L.) Greene**

**Common Name:** Frog fruit

**Family:** Verbenaceae

**Habit & Habitat:** Prostrate, perennial herb with spathulate to obovate, sessile to sub- sessile, glabrous and fleshy leaves which is 4-20 mm in width and 5-40 mm long. Flowers are small and white- pinkish in colour. It is found in Africa, Europe, Asia, Southern America and Australia.

**Medicinal Potential:** It is used in bowel problems, bladder problems, piles, gonorrhoea, kidney stone problems. It is also used as blood purifier and as hair growth promoter.[106-110]

***Pistia stratiotes* L.**

**Common Name:** Water cabbage

**Family:** Araceae

**Habit & Habitat:** Perennial, stoloniferous, floating, without stem, rosette forming herb. Leaves are 14 cm long with short hairs, wavy margins, parallel veins and green in colour. Flowers are dioecious in nature and are hidden among the leaves. Plant commonly grows in streams, lime-rich water, lakes and stagnant water. It is found in sub- tropical and tropical regions of Asia, America and Africa.

**Medicinal Potential:** It is used to cure skin diseases, ring worm infection and headache, ulcers, syphilis, eczema, leprosy and piles.[111]

***Polygonum glabrum* Willd.**

**Common Name:** Common marsh buckwheat or dense flower knotweed

**Family:** Polygonaceae

**Habit & Habitat:** Perennial or annual, glabrous, rarely branched, ascending 5-15 cm long herb with swollen red stem. Leaves are stipulate, simple, alternate, acute base, entire margin, oblong to laceolate in shape and have spiral arrangement. Flowers are pedicellate, bisexual and white to pinkish in colour. It is an amphibious plant found in or near the various water bodies. It is generally found in East Asian countries like Philippines, India, Vietnam, and Thailand.

**Medicinal Potential:** It is used in treatment of jaundice, fever, colic pain, debility.[112]

***Polygonum plebeium* R. Br.**

**Common Name:** Small knotweed

**Family:** Polygonaceae

**Habit & Habitat:** Annual, Prostrate, branched herb with stalkless, entire, elliptical leaves present. Flowers are present in clusters and pink in colour. It is found in South Asia, Madagascar, Australia and United states.

**Medicinal Potential:** It is used in treatment of digestive disorders, pneumonia, baldness, skin diseases, heartburn, eczema, blood pressure.[113-114]

***Sphaeranthus indicus* L.**

**Common Name:** East Indian globe thistle

**Family:** Asteraceae

**Habit & Habitat:** Annual, scented, erect, branched herb with cylindrical stems. Leaves are decurrent, obovate to oblong, subacute to round, hairy, glandular, sessile, 2-7 cm long and 1- 1.5 cm wide. It is brown greenish in colour. Flowers are solitary, terminal and purple in colour. It grows in wet locations like rice fields, ditches. It is found in South Asia, Africa and northern Australia.

**Medicinal Potential:** It is used in treatment of epilepsy, hepatopathy, dyspepsia, hernia, pectoralgia, gastropathy, helminthiasis, skin diseases, leprosy, cough, hepatopathy, mental illness, diabetes, jaundice and hemicranias.

***Spilanthes calva* DC.**

**Common Name:** Toothache plant

**Family:** Asteraceae

**Habit & Habitat:** Erect or prostrate plant with hairless, reddish stem. Leaves are 4- 8 cm wide and 5- 11 cm long with sharp tip, broad and sometimes triangular in size. Flowers are elongated and conical in shape. Its colour ranges from orange- yellowish to golden- reddish. It is found in India, Brazil, Sri Lanka, America, Australia and Africa.

**Medicinal Potential**: It is used to cure headache, sore throat, toothache, eye disorders.

***Vallisneria spiralis* L.**

**Common Name:** Tape-grass or eel grass

**Family:** Hydrocharitaceae

**Habit & Habitat:** It is a narrow, linear, monoecious leafy plant green to reddish in colour. It can grow up to 100 cm tall to 1.9 cm wide. It can be found in sub- tropical and tropical regions.

**Medicinal Potential:** It is used in treatment of leucorrhoea.

***Vetiveria zizanioides* (L.) Nash**

**Common Name:** Vetiver or khus

**Family:** Poaceae

**Habit & Habitat:** Prennial plant with erect and stiff stem which grows up to 1-2 m tall. Leaves of plants are 120-150 cm long and 0.8 cm wide. Its root can grow upto 200- 400 cm in depth.

**Medicinal Potential:**It is used in snakebite treatment, sore mouth, epilepsy, scorpion sting and also helps in releasing toothache, headache and other body pains [115].

## DISCUSSION & CONCLUSION

Aquatic and semi- aquatic plants are often viewed as weeds. Most of the previous researches have showed aquatic and semi- aquatic plants as of phytoremediation and of biomonitoring use. Potential medicinal aspect of these plants has been ignored and is still unexplored at modern level although they are familiar to tribal people as

these plants are traditionally used by them as part of their day to day life. They use it for the treatment of various diseases and disorders ranging from simple flu to chronic health conditions.

Due to rapid industrialization and urbanization, water bodies are in danger which will directly become threat to these aquatic and semi- aquatic medicinal plants. This review is an attempt to value these aquatic and semi- aquatic plants as potential medicinal plants which needs to be deeply explored and to be conserved.

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# Pollen studies of *Oxalis* species found in Jharkhand, India

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**Abstract:** The genus *Oxalis* is a small growing weeds with a large genus of flowering plants in the wood-sorrel family. During survey herbs like *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* and *Oxalis triangularis* are commen occurance in Jharkhand. In the current communication an endeavor is made to the morphological analysis, taxonomic key and species relationships among four species of genus *Oxalis*. Pollen morphology were spherical, and tricolpet in *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* whereas, cylindrical and tricolpet in *Oxalis triangularis* under SEM. Results support that small pollen size, with small flower may be closely related species of *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* in *Oxalis triangularis* with the largest flowers and largest pollen grains revealed that these taxa may be distant from the rest of the species.

**Keywords: *Oxalis*, Pollen, species, SEM.**

## INTRODUCTION

*Oxalis* is considered as the largest genus in the wood-sorrel family Oxalidaceae consisting of approximately 900 known species.[1, 2] The genus *Oxalis* was described by Linnaeus and named from the Greek word for acid and salt.[3] The genus *Oxalis* are mainly herbs, often with underground tubers and bulbs.[4] The genus occurs throughout most part of the world, except for the polar areas; species diversity is particularly rich in tropical Brazil, Mexico and South Africa. In India, it is represented by 10 species out of which 8 species are known to occur in Peninsular India. Amongst them 4 species were recorded from Kerala.[5] The genus has been monographed by Knuth. Small described a number of new taxa and brought the names into wide usage; it also treated *Corniculatae* as a separate genus, *Xanthoxalis small*.[6] The genus *Oxalis* is a small growing weed.[7] It prefers damp condition, and is widespread on heavier soils, and is considered as a troublesome weed that successfully grows in lawns, arable lands, waste places and gardens, greenhouses.[8] The family is characterized by the presence of pinnately or palmately compound leaves, pulvinate petiole, umbellate inflorescence, bisexual, acti-nomorphic, pentamerous and heterostylous flowers. There were 4 species of genus *Oxalis* growing in Jharkhand. They are two categories, those that reproduce mainly by seed and those by bulbils. The species *Oxalis corniculata* spread by seed dispersion where as other three species reproduce by bulbils.[9] It has been recognized that morphological variation leads to different survival strategies because it enables the plants to acclimatize in changing habitats. Hence, it is a matter of considerable interests to view pollen studies of *Oxalis* growing in Jharkhand. Jharkhand was created as a new state after carving it out from Bihar in the year 2000 with 24 districts. As the name indicates Jharkhand this is *Jhar* means plants and bushes and *Khand* means the piece of land, so the Jharkhand is the land full of vegetation. Jharkhand is separated into five Divisions namely South Chhotanagpur, North Chhotanagpur, Kolhan, Palamu and Santhal Parganas.[10] The land is eastern corner of Vindhya mountain series and has rich plant diversities. It lies

between latitude 22°00' and 24°37' N and longitude 83°15' and 87°01' E. Height of the Jharkhand plateau ranges between 1000 -3000 ft. above the mean sea level.[11] Jharkhand is surrounded by five states namely West Bengal, Chattisgarh, Odisha, Uttar Pradesh and Bihar.[12] All these districts have a variety of aquatic and semi aquatic plants. During the survey it was found that the genus *Oxalis* behaves as weed because it is successfully occupies and covers the large areas.

Pollen is well-known as the dusty substance from anthers in flowers.[13] Palynology is the study of pollen grains and spores.[14] It involves a study of both the structure and the formation of pollen grains and spores, their dispersal and their preservation under certain environmental conditions.[15] Palynology is applicable to a range of scientific studies, including taxonomy.[16] In this study we will explore the significance of pollen for the identification as well as taxonomical relationship among the species. The outer walls of pollen grains have different shapes and patterns. This makes it possible to identify grains with reference material of pollen collected from flowers of identified plants.

## MATERIALS & METHODS

To study the pollen morphology, mature flower buds were collected from different district of Jharkhand during 2018-2020. For scanning electron microscopy (SEM) studies, dried pollen grains were transferred on aluminum stubs and coated with platinum for 4 min in Auto fine sputter coater JFC-1600. Micromorphological observations were made in a JEOL JSM 6390LV. Scanning electron microscope at SEM Laboratory, **"The Central Instrumentation Facility"** B.I.T., Mesra, Ranchi, Jharkhand. The characteristics of each taxa were measured for 10 pollen grains per sample. Identification key for *Oxalis* species adopted from Moar, N. T., & Wilmshurst, J. M. (2003).[17]

## RESULTS

### Morphological analysis

Pollen grains of *Oxalis* showed variation in their morphological characters. Detailed information acquired from SEM for pollen grain is given in Table1 and 2. Pollen parameters for studied taxa are described as follows.

**Pollen Size**

The pollen grains of studied taxa are classified in two groups based on pollen size medium (30 to 33µm) in *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* and large (40µm) in *Oxalis triangularis.*

**Polarity**

All the four species namely *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* and *Oxalis triangularis* are isopolar with bilateral symmetry.

**Pollen shape**.

The shape of pollen in the species *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* are tricolpet and spherical in shape whereas *Oxalis triangularis* is of tricolpet cylindrical structure as observed at 1500X. The murus and reticulate lumen both are present in the species *Oxalis corniculata, Oxalis latifolia* and *Oxalis triangularis* whereas in the species *Oxalis debilis* the surface appears to be pitted at 6000X under SEM.

**Pollen sculpture**

The pollen grains of studied taxa show triporate type of aperture. Porus diameter varied from a average of 12.85 to 23.20µm. Smallest porus diameter was found in *Oxalis corniculata,*and largest in *Oxalis triangularis*. The pollen sculpture is tricolpet delta like can be seen at 4000X under SEM.

**Exine Ornamentation**

The study showed reticulate heterobrochate type of exine ornamentation was seen in *Oxalis corniculata, Oxalis latifolia* and *Oxalis triangularis*. Pitted hetrobrochate type of ornamentation was seen in *Oxalis debilis*. (Fig.10) Lumina shape is irregular polygonal in *Oxalis corniculata* and Lumina are granulating in *Oxalis debilis* (Fig. 4-9), pentagonal or hexagonal in *Oxalis latifolia* and *Oxalis triangularis*. Among the species studied lumen diameter were small in *Oxalis corniculata* whereas largest in *Oxalis triangularis* (Fig. 4 and 12)

**Taxonomic key**

Identification key for *Oxalis* species based on pollen morphology

| | |
|---|---|
| **A.** Spherical Pollen grains:- | *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* |
| **B.** Cylindrical Pollen grains:- | *Oxalis triangularis* |
| (a) Delta like colpus:- | *Oxalis latifolia* |
| (b) Exine surface with reticulate lumen- | *Oxalis corniculata* |
| (c) Exine surface with pitted Irregular lumen- | *Oxalis debilis* |

**Species relationships among four species of *Oxalis***

The comprises four species which are having small flower size with spreading habit has direct correlation between flower and pollen size. In the study, the correlation between flower and pollen size were seen in *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* which has got smaller flower and small pollen size. However, the species *Oxalis triangularis* with the largest flowers had relatively bigger pollen grains.

Hence, present result support that small pollen size, with small flower may be closely related species of *Oxalis corniculata, Oxalis latifolia, Oxalis debilis* in *Oxalis triangularis* with the largest flowers and largest pollen grains revealed that these taxa may be highly distant from rest of the species.

**Table 1- Pollen micromorphological characters in four species**

| Sl. No. | Taxon | Size | Polarity | Symmetry | Shape | Equatorial View | Polar View |
|---|---|---|---|---|---|---|---|
| 1 | *Oxalis corniculata* | 30 to 33µm | Isopolar | Bilateral | Prolate-spheroidal | Circular-Convex | Circular |
| 2 | *Oxalis latifolia* | 30 to 33µm | Isopolar | Bilateral | Prolate-spheroidal | Circular-Convex | Circular |
| 3 | *Oxalis debilis* | 30 to 33µm | Isopolar | Bilateral | Prolate-spheroidal | Circular-Convex | Circular |
| 4 | *Oxalis triangularis* | 40µm | Isopolar | Bilateral | Cylindrical | Triangular-Convex | Elliptical |

**Table 2. Pollen micromorphological characters in four species.**

| Sl. No | Taxon | Aperture | Sculpture | Lumina Shape |
|---|---|---|---|---|
| 1 | *Oxalis corniculata,* | tricolpet | Reticulate- heterobrochate | reticulate |
| 2 | *Oxalis latifolia* | tricolpet | Reticulate- heterobrochate | reticulate lumen |
| 3 | *Oxalis debilis* | tricolpet | Reticulate- heterobrochate | Irregular pitted |
| 4 | *Oxalis triangularis* | tricolpet | Reticulate- heterobrochate | pentagonal-hexagonal |

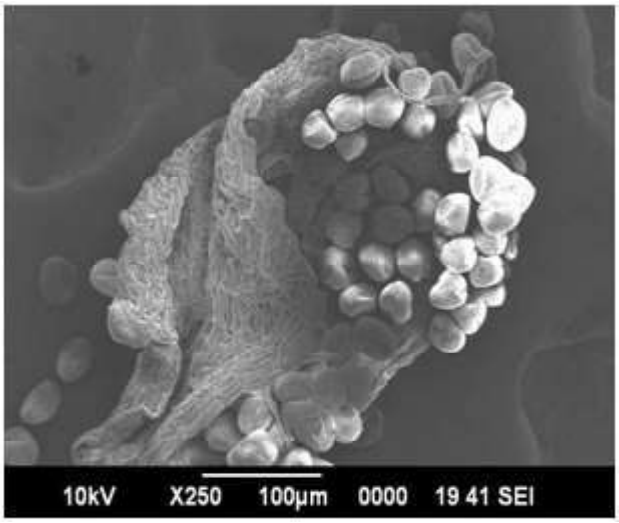


**Fig. 1- Pollen grains in the pollen sac of *Oxalis corniculata* under SEM (250X).**

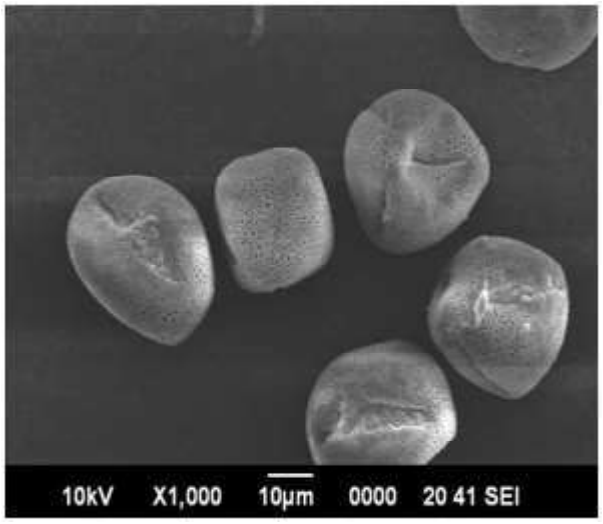


**Fig. 2- Colpus and exine in pollens of *Oxalis corniculata* under SEM (1000X).**

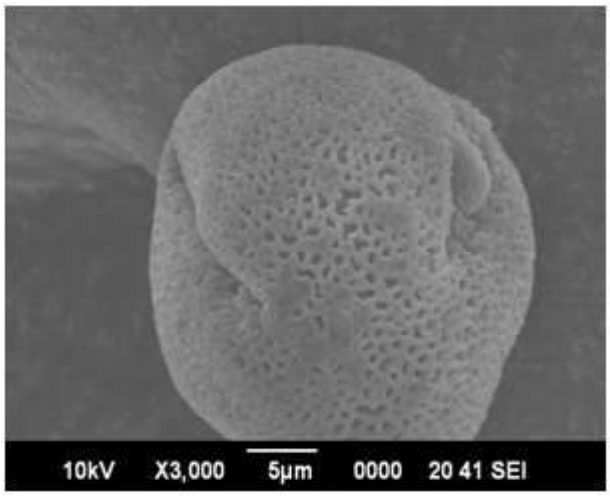


**Fig. 3- Colpus and exine in pollens of *Oxalis corniculata* under SEM (3000*X*).**

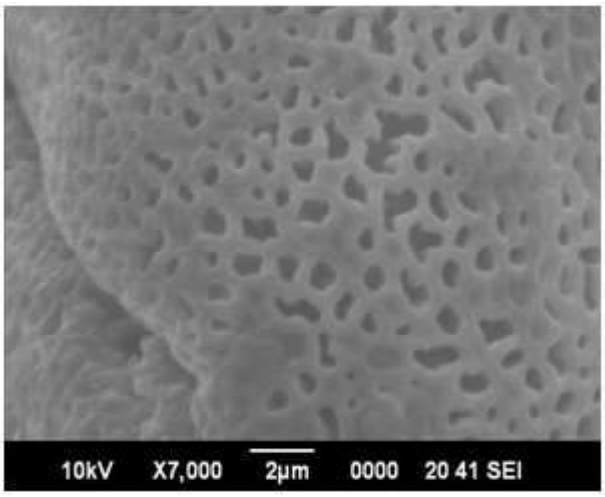


**Fig. 4- Colpus and exine architecture in detail of pollen of *Oxalis corniculata* under SEM (7000*X*).**

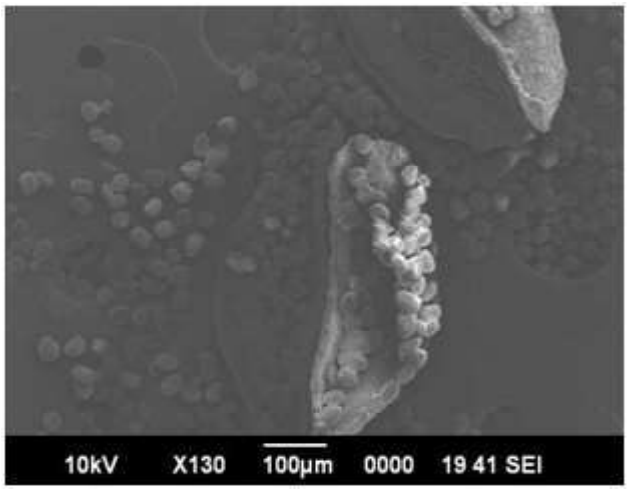


**Fig. 5- Pollen grains in the pollen sac of *Oxalis latifolia* under SEM (130*X*).**

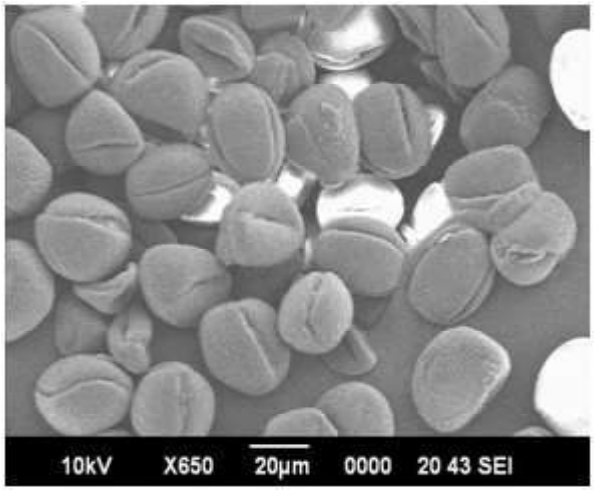


**Fig.6- Colpus and exine in pollens of *Oxalis latifolia* under SEM (650*X*).**

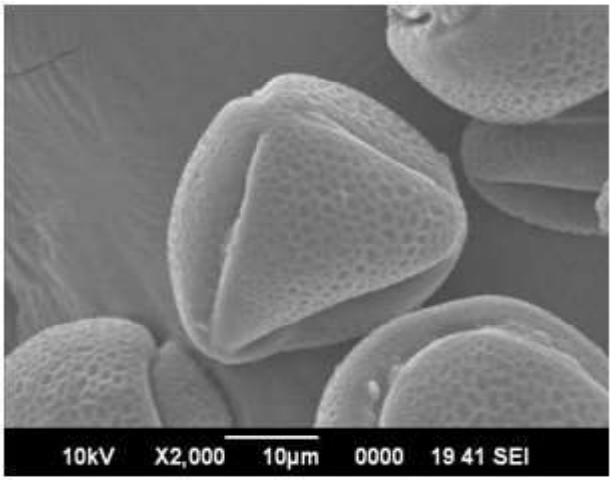


**Fig.7- Delta like Colpus and exine in pollens of *Oxalis latifolia* under SEM (2000*X*).**

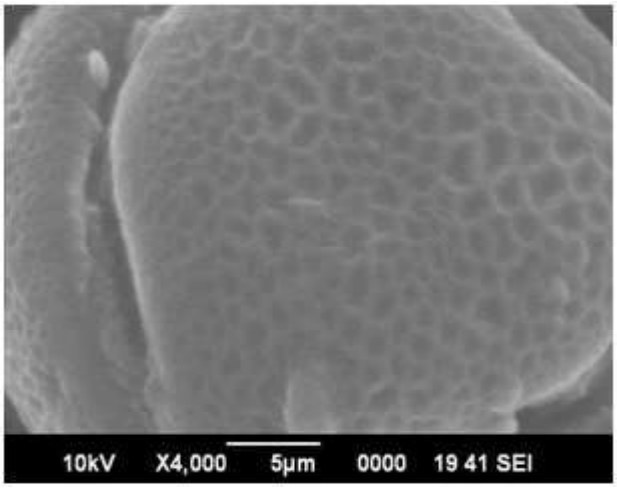


**Fig.8- Colpus and exine pattern of pollens of *Oxalis latifolia* under SEM (4000*X*).**

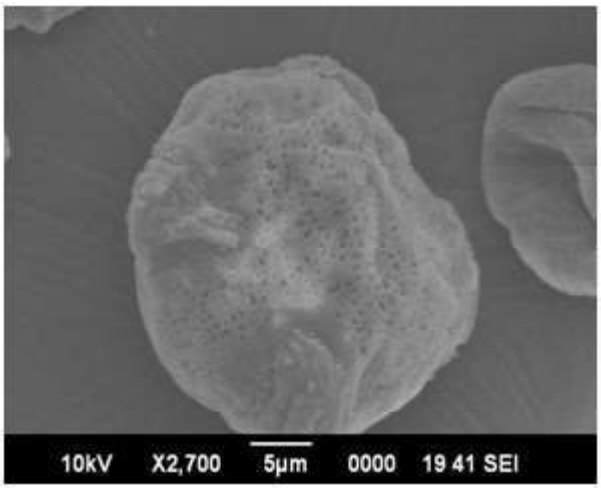


**Fig. 9- Colpus and exine in pollens of *Oxalis debilis* under SEM (2700*X*).**

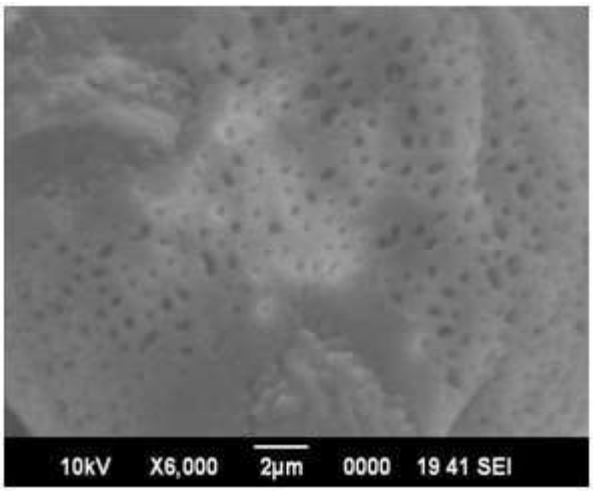


**Fig. 10- Colpus and exine pattern of pollen of *Oxalis debilis* under SEM (6000*X*).**

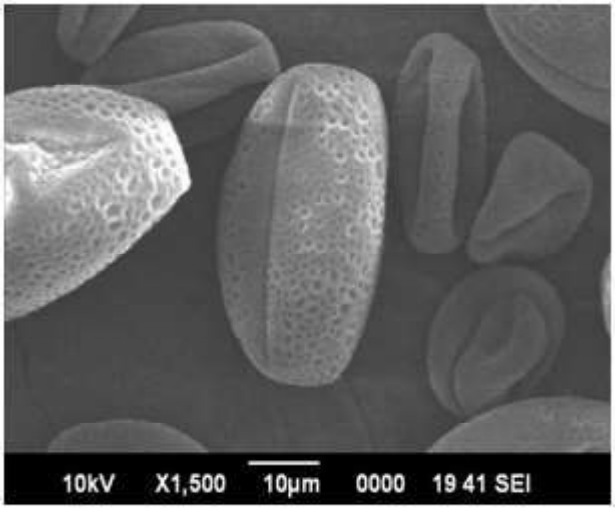


**Fig. 11- Colpus and exine in pollens of *Oxalis triangularis* under SEM (1500*X*).**

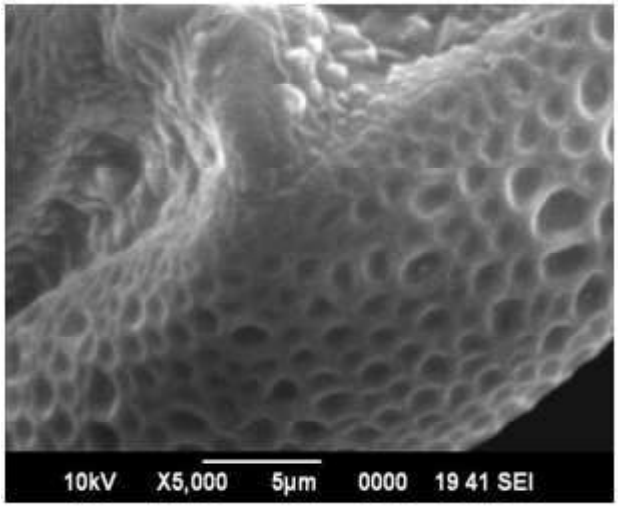


**Fig. 12- Colpus and exine pattern in pollen of *Oxalis triangularis* under SEM (5000*X*).**

## DISCUSSION

Pollen morphology of 3 species of genus *Oxalis* L. (Oxalidaceae*)* from Pakistan has been examined.[18] In which the shape and size symmetry of *Oxalis corniculata* and *Oxalis pescaprae* were acknowledged through Scanning Electron Microscope technique. A key of pollen and glossary of palynological terms is being mentioned.[17] Pollen are indexed and provided through 50 Photographs.[19] Similar results were also recorded by previous workers which confirms our results.[15,16]

## CONCLUSION

Oxalidaceae is an enigma family there are less scientific studies in this field, so it is urgent to explore identification and Documentation the species, According to the present study, species of *Oxalis* have pollen grains tricolpate, prolate spheroidal to oblate spheroidal. These characteristics coincide with those described for other *Oxalis* species. The results of this study allow us to contribute to the knowledge of this complex genus and to provide characters for differentiation of species in this particular section, complementing palynological and taxonomic studies.

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# Arbuscular mycorrhiza in combating abiotic stresses in some fleshy root crop production: An eco-friendly approach

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**Abstract:** Some fleshy root crop production is hampered by several abiotic stresses which are very common in this era of climate change. There is a huge pressure on the plants to survive and yield better results even in the prevalence of various environmental stresses such as cold stress, drought, heat stress, salinity etc. This necessitates the need of robust plant growth which is possible with mycorrhizal association. Mycorrhiza improves plants tolerance to several abiotic stresses by various physiological, functional and biochemical changes in plants. The application of arbuscular mycorrhiza (AM) as fleshy root crop production biofertilizers doesn't only influence the plant health, but moreover discursively it lowers the demand for harmful chemical fertilizers. Overall, it may be concluded that inoculation of fleshy root crop production with arbuscular mycorrhizal fungi can be used, as it easily guards plants against undesirable abiotic stresses. In this work, information is provided based on several examples from the literature based on the application of AM to combat harmful abiotic stresses in carrot production. This paper reviews the impacts of AM fungi on the plant parameters, its functional activities and molecular mechanisms which makes it more adaptable and underline the future prospects of using AM fungi as a biofertilizer in the stress condition.

**Keywords: Abiotic stress, Arbuscular mycorrhiza fungi, fleshy root crop production**

## INTRODUCTION

A nutritious and healthy diet is an important means to maintain good health. The nutritional security which is often less valued than food security by authorities can be achieved with the consumption of fleshy root crops. Low consumption is often linked with malnutrition in children and other susceptible group. Fleshy root crops are an importance source of nutrients namely vitamin A, C, K, thiamin, pyridoxine, folate, carotenes, minerals and trace elements etc. Carrots have essential bioactive compounds such as phenolics (flavonoids) and antioxidant activity which plays a significant role in prevention of chronic and degenerative diseases and maintaining health. World Health Organization (WHO) recommends an intake of 200–250 g of vegetables intake in a day but the average consumption of vegetables in the world lacks far behind the recommendations. There are several reports indicating the effect of low vegetable consumption on weight gain and thereby necessitates the consumption of fiber rich and low glycemic load having food[1].

Mainly due to limited arable land, fleshy root crops of brassicaceae and apocynaceae family are frequently cultivated in unfavourable conditions under thermal stress, drought, flooding and contaminated organic pollutant. The abiotic stress is mainly responsible for reducing yield loss causing more than 50% losses worldwide. These are often interrelated and cause significant distortion in the morphological, biochemical, physiological and molecular parameters of plants. Along with reducing yield, it has detrimental effect on the quality and nutritional status of fresh fruits and vegetables. There are certain indicators such as increased respiration, discoloration, flavor loss, off-odours developments, loss in weight, breakdown of membranes etc which shows the impression of abiotic stress. The serious abiotic stresses faced by the fleshy

root crops are drought, salinity, heat and cold. Around 96.5% of global rural land area is affected by abiotic stresses [2]. The drought can cause yield losses from 13% to 94% in several condition to the drought intensity and duration[3].

Mycorrhizal symbiosis is a reciprocally beneficial association between soil fungi with plant roots. Arbuscular mycorrhizal fungi start a symbiotic union with roots of 80% land crops[4]. In AMF, the plants symbiotically associate with glomeromycete fungi mainly developed to improve the uptake of nutrients and water by plants. Genus *Glomus* is one of the most abundant genera of AM fungi. AM fungi produce symbiotic signals (lipochitooligosaccharides) so as to stimulate better root growth and branching. The chitoologosaccharides triggers the calcium spiking which is perceived via kinases. The cells hereby accommodate the fungal infection in the cells and nutrients are being taken by arbuscules of the plant cells. Mycorrhizal symbiosis is one of the initial symbiotic relationships on earth. It helps in the growth and development of the plant by supplementing the plant growth with an appropriate supply of mineral, and in return, the fungi draw food from the plant roots. AM fungi have a positive impact on the plants' stress tolerance along with enhanced productivity. The fungi obtained sugars and carbohydrates from the plants and plants avert 20% of photosynthetic products to the fungi which is obligatory biotrophic[5]. By observing nature around us, people have slowly found extra benefits which mycorrhizal fungi have to host plants. AM fungus facilitates carbon sequestration and increases the carbon content of soil via aggregation and prevents decomposition of organic carbon. Nevertheless, we do not realize everything about mycorrhiza. Apart from providing nutrients and water to plants, mycorrhiza provides additional benefits of combating biotic and abiotic stresses[6]. Moreover, AM fungi associates with terrestrial plants and has significant role in nutrients (carbon, nitrogen and phosphorus) cycling of ecosystem. Mycorrhizal symbiosis is a remarkably complicated relationship. AM fungus also interact with growth promoting rhizobacteria, other soil microorganisms, mycorrhiza helper bacteria and deleterious bacteria which has a significant importance in agriculture. Although Mycorrhizal symbiosis is universal in nature. Previous investigations have mentioned that low temperature impact AM fungal development[7], while high temperature have a terrible or perhaps zero influence on mycorrhizal colonization.

Drought has a massive impact on plant productivity internationally and is more likely to enhance with climatic changes. Lots of ecophysiological studies indicate that arbuscular mycorrhizal (AM) symbiosis is a crucial component in helping plant life to cope with water demands. The fungi control the root water uptake by plants. It also enables the plants to maintain bigger organ hydration and turgor, which will sustain general cell natural activity, mainly linked to the photosynthetic machinery. Mycorrhizal fungi furthermore affect the hydraulic conductivity and gas exchange within the root and foliage. Molecular mechanisms activated by the effect of AM symbiosis in response to drought generally leads to favourable transport of water along with improved accessibility to nutrients. These fungi might be referred to as biotrophic symbionts that are powerless to exist without their growing partner and also cannot be artificially raised in vitro. The alleviating effect of AM symbiosis in response to drought generally is determined by the positive consequences of AM fungi on the uptake and transport of water along with improved nutrient absorption, especially of accessible soil phosphorus (P) along with other immobile minerals. It results in the hydration of developing tissues, sustainable physiology and a clear promotion of growth.

Soil salinization is one of the most detrimental abiotic stress globally which reduces the plant development and consequently decreases the overall agricultural production. The regions under the salt affected soils are increasing mainly due to various natural and anthropogenic factors such as low rainfall, high temperature, poor quality irrigation water. The anthropogenic factors responsible for soil salinization include unsustainable agricultural practices and industrial wastes. Along with natural and man-made factors, climate and climate change is also important driver of salinization in the changing environment[8]. Soil salinization is a major issue in arid and semi-arid areas which is mainly due to meagre precipitation, high temperature and increased rate of evaporation. The serious issue of salinity arises as the concentration of $Na^+$ and $Cl^-$ increases then the standard levels as it disturbs the plant physiology by altering the metabolic activities and osmotic functions required for growth and development. High salinity disrupts the ionic and osmotic balance of the cell. $Na^+$ and $Cl^-$ ions have toxic effects on plants and disrupt the enzymes structure, metabolic activities and damage cells' organelles and hinder protein

synthesis. Most vegetable crops are sensitive to salt stress as their salinity threshold is very low. The plants, however, have developed adaptive responses to salinity by modification at molecular, cellular, physiological and metabolic levels. AM fungi application to the soil helps to eliminate the salinity stress encountered by the vegetable crops. Inoculation with AM fungi led to higher amounts of electrolytes and a diminished level of electrolyte leakage under salt stress. Moreover, the advancement of proline, chlorophyll *a* and chlorophyll *b* were significantly impacted under salinity stress. AM fungi enhance plant growth by improved nutrient uptake, significantly P, in addition to inadequately soluble nutrients in the soil. AM fungi have the potential to lessen the detrimental effect of salinity stress on the growth parameters of the plants. The AM fungal association helps in enhanced plant growth by increasing their tolerance against saline stress by enhancing its photosynthetic activity, phosphatase activity, antioxidant enzymes and osmotic adjustments[9]. This paper overviews the role of arbuscular mycorrhizal fungus in enhancing abiotic stress tolerance of vegetable crops in this changing environment.

**Drought tolerance by AM inoculation in fleshy root crops production**

Water scarcity is a severe limiting factor to crop productivity and drought cause huge losses in productivity of vegetable crops mainly depending upon the duration and severity of the drought stress. Vegetables are considered very sensitive to droughts and droughts mainly complemented with high temperature increases evapotranspiration losses and effects photosynthesis of the plants thereby affecting the crops yield. The yield of indigenous leafy vegetable crops mainly consumed in water stressed conditions of Africa was significantly reduced as the drought reduced the fresh weight and dry weights of leaves. However the nutritional quality as assessed by phytonutrients accumulation such as α-carotene, β-carotene, ascorbic acid, α-tocopherol, zinc and iron per 100 g of edible portion was not significantly reduced or altered in water deficient conditions[10]. The drought stress mainly reduce the water potential, free water, bound water and transpiration rate of the plants thereby reducing the stomatal conductance, photosynthetic rate and intercellular $CO_2$ which ultimately reduces the yield. In drought conditions, plants generally generate reactive oxygen species (ROS) which leads to oxidative damage in plants. This oxidative damage to the lipids, nucleic acids and proteins was augmented by the production of antioxidant enzymes by plants in response to drought stress. The drought stress therefore can lead to serious physiological glitches in plant and can severely affect growth and yield of vegetable crops by affecting the biomass production.

**Effect of AM fungi inoculation on fleshy root crop production for drought tolerance**

AM fungi are vital for vegetable production since they affect plant water relations and therefore increase the drought tolerance of host plant life. Plants generally alter their cellular metabolism and incite the defence mechanisms so as to ensure their adaptability in drought conditions[11]. AM inoculation of plants increased the root hair density and root hair length in drought conditions. These plants also showed an increased concentration of methyl jasmonate, indole-3-acetic acid, calmodulin and nitric oxide content of roots so as to make them more adaptable to the drought stress. AMF helps in absorption and translocation of nutrients in plants outside the root zone (rhizosphere) and moreover bring changes in plant metabolism to tolerate drought stress. The AM fungi function as biofertilizers, bioprotectors and bioregulators and improve the nutrient composition of plants. Improved plant water stipulation along with modifications in a proper balance of osmotic minerals is especially critical for the growth of a vegetable. Studies in several vegetable crops have shown the direct or indirect mechanisms which control consuming water associations in AM fungus grown symbiotically with plants. In this direction, numerous studies have suggested several mechanisms whereby AM fungi alleviate drought stress either by enhancing the Water Use Efficiency (WUE) or increasing relative water content. Moreover, in several instances, significant changes in the antioxidant activities have been observed. The enhanced antioxidant activity in AM inoculated plants detoxifies the reactive oxygen species of plants and increases the nutritional quality of vegetable crops without reducing the growth and yield. AM inoculated plants showed improved performance and enhanced the inuin content of chicory plants and thereby reducing the damaging effect of drought stress.

The negative effect of drought on the vegetable plants was significantly decreased on inoculation of vegetable plants with mycorrhiza The mycorrhizal plants showed improved photosynthesis rate, water use efficiency,

stomatal conductance and increased chlorophyll content which significantly improved plant height, shoot length, plant biomass and ultimately yield of vegetable crops[12]. Along with it, there is enhanced accumulation of antioxidant enzymes, photosynthetic pigments, increased concentration of sugar and proteins and reduced proline content. The affirmative influence of mycorrhizal association with vegetable crops shows the increased potential of vegetable crop in drought affected areas. Moreover the reduced proline content in the plants shows that the impact of drought on the *Phaseolus vulgaris L.* can be considerable reduced on mycorrhizal inoculation of the vegetable.

## CONCLUSION & FUTURE PROSPECTS

With the recent climate change, a huge variation in weather parameters of an area is observed which is leading to huge stress on plants. Moreover, the drought and salinity affected proportion of our arable area is increasing gradually due to it. With inoculation of arbuscular mycorrhiza, plants are able to survive the drought stress, salinity stress along with the stress of temperature variation. The growth of plants in such an arena becomes very important so as to raise the plants productivity. The fertilizer application to support plant growth becomes an expensive matter. Moreover, the development of new tolerant or resistant varieties by breeding or biotechnology is an expensive approach which takes a lot of time and its adaptability and suitability to farm conditions also varies to some extent. So, an ecofriendly approach of inoculation of plants with arbuscular mycorrhiza becomes a suitable alternative. AM fungi are determined to improve plant growth and nutrient absorption of the fleshy root crops amid environmental stresses. Moreover, it also cause morphological and functional changes in the plants and increase the photosynthetic efficiency of the plants either by increasing photosynthetic pigments or by raising efficiency of photosystem II. AM fungi also raise the nutrient uptake by plants and raise the biomass production and cause yield increase of vegetables. An increase in the antioxidant activity is also observed in the plants inoculated with AM and raises the plant yield. AM fungi, therefore, has the potential to make the plants acclimatize in the changing environment and thereby helps in providing food and nutritional security to the world. Moreover, it also adds to the cost-effective cultivation of vegetables as AM fungi is a cheaper way for sustaining plant growth compared to fertilizers. Fertilizers losses are also very common in field situation whereas AM fungi remains in association with roots in rhizosphere and helps in vigorous growth of the roots so as to extract the available nutrients, thereby, making it an alternative to fertilizers for raising plants yield in abiotic stress conditions. The industrial provision of mycorrhizal inoculum has serious issues about the quality and efficiency of the mycorrhiza and its performance in field conditions so there needs a knowledge based diffusion of information to the farmers so as to identify the suitable and required AM fungi at a well-established and certified place. There is a need of detailed research of several mycorrhizal associations in various stress conditions so as to identify the best suited AM combination for a particular crop in a particular stress condition such as pH, salinity, drought, heat, cold, etc.

## CONFLICT OF INTEREST

Authors declare there is no conflict of interest.

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# Physico-chemical analysis of water of a few ponds of Lohardaga

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**Abstract:** The present paper deals with the physico-chemical analysis of water of five ponds of Lohardaga. Physical parameters like temperature (air and water), water depth and transparency while chemical parameters like pH, total hardness, calcium hardness, magnesium hardness, total suspended solids (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate, sulphate, phosphate, chloride, silicate, iron, zinc and fluoride were analysed. Water samples from the ponds were analysed in the year 2006 in three different periods viz. pre-monsoon period (April to June), monsoon period (July to September), and post- monsoon period (October to December). The detailed result has been tabulated and discussed.

**Keywords: Physico-chemical, parameters, TSS, DO, BOD, COD**

## INTRODUCTION

Water is one of the most valuable natural resource on earth[1]. Life can't be expected without water. It is an important natural resource for all living organisms, ecosystems, food production and economic development[2]. Water quality affects human health[3]. Both groundwater and surface water play a key role in functioning of ecosystems.

71 % of our earth is covered with water[4]. However, only 3% of water on the surface is fresh. Remaining 97% of the water resides in the oceans. 69 % of the freshwater is in glaciers, 30% is present underground and less than 1% is located in lakes, rivers and swamps[5]. There are various kinds of surface water sources present on the earth. Some of them include ponds, lakes, rivers, streams, seas, oceans etc[6]. A pond is a small, shallow standing water body[7]. It is itself an ecosystem. The sustainability of various organisms in a pond depends upon the physical, chemical, biological and radiological factors of water of the pond[8]. The physico-chemical and biological variables determine the water quality of a pond, and it fluctuates due to a variety of factors such as the source of water, the type of pollution, seasonal fluctuations, and nearby human intervention, all of which affect its quality and, as a result, its suitability for the distribution and production of fish and other aquatic animals.[9]

Lohardaga is one of the districts in the state of Jharkhand. It is situated between $23^0$30' N to $23^0$40' N latitudes and $84^0$40' E to $84^0$50' E longitudes[10]. It is famous for Bauxite mines and is also known as bauxite city of Jharkhand[11]. The total available surface water in Jharkhand state is 23789 MCM[12]. The aerial extent of wetlands in Lohardaga is estimated 2110 ha that includes the contribution from 294 wetlands. 66 % of area under wetlands in the district is contributed by rivers and streams.

14 % is contributed by smaller wetlands like ponds and dams[13]. There are many ponds in Lohardaga. BadaTalab (Victoria Lake) is the largest pond there. Some other ponds include Bauli Talab (Temple pond), Thakurain Talab, Bucha Talab, Chotka Bauli Talab etc[14]. Many of the ponds in the district are perennial fish ponds. BadaTalab is used for swimming, boating and water sports. It is also famous for fishery activities-net fishing and rod fishing. It is a big pond spreading over 17 acres. The other ponds are square and small in size. Bauli Talab and Thakurain Talab are also used for fishery activities. The present paper deals with the physico-chemical analysis of water of five ponds of Lohardaga which are mentioned above[15].

## OBJECTIVES

The main objectives of the research are as follows:

- To study the physico-chemical parameters of the pond water in the year 2006 in three periods i.e. pre monsoon period, monsoon period, and post monsoon period.
- To compare the physico-chemical parameters of the five ponds thus comparing their water quality.
- In order to know the suitability of water of different ponds for their uses concerned.

## MATERIALS & METHODS

For physico-chemical analysis of water of the ponds, plastic bottles of 1 L size was used. Water was collected from five ponds of Lohardaga- Bada Talab (Victoria Lake), Bauli Talab (Temple pond), Thakurain Talab, Bucha Talab and Chotki Bauli Talab.

Water samples were collected during three periods of the year 2006- pre monsoon period (April to June), monsoon period (July to September), and post monsoon period (October to December). Samples were stored according to the preservation procedure following AS/NZS 5667.1:1998. The samples were analysed in the Environmental Sciences Laboratory, CMPDI. The analysis was done by the standard methods given by National Environmental Engineering Research Institute (NEERI, 1986) and American Public Health Association's (APHA, 1992)[16].

The different physico-chemical parameters analysed were pH, temperature (air and water), water depth, transparency, total hardness, calcium hardness, magnesium hardness, total suspended solids (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate, sulphate, phosphate, chloride, silicate, iron, zinc and fluoride. The data after analysis were tabulated and compared with maximum tolerance limits.

## RESULTS

**Table 1- Seasonal variation of physico-chemical parameters of water of BadaTalab (Victoria Lake)**

| Parameters | Pre-Monsoon | Monsoon | Post-Monsoon |
|---|---|---|---|
| Air Temperature ($^0$C) | 35.00 | 29.00 | 22.50 |
| Water Temperature ($^0$C) | 33.00 | 26.00 | 21.50 |
| Water Depth (cm) | 136.55 | 157.91 | 145.20 |
| Transparency (cm) | 34.56 | 27.24 | 40.28 |
| pH | 7.00 | 7.70 | 7.10 |
| Total Hardness (ppm) | 20.50 | 40.00 | 42.50 |
| Calcium Hardness (ppm) | 16.00 | 24.20 | 30.70 |
| Magnesium Hardness (ppm) | 04.50 | 15.80 | 11.80 |
| TSS (mg/L) | 28.00 | 43.00 | 36.00 |
| D.O (mg/L) | 03.00 | 4.10 | 5.40 |
| B.O.D (mg/L) | 12.30 | 11.70 | 10.90 |
| C.O.D (mg/L) | 80.00 | 70.00 | 75.00 |
| Nitrate (mg/L) | 1.70 | 1.10 | 1.10 |
| Phosphate (mg/L) | 0.18 | 0.28 | 0.15 |
| Sulphate (mg/L) | 32.00 | 47.00 | 28.00 |
| Chloride (mg/L) | 28.00 | 25.00 | 26.00 |
| Silicate (mg/L) | 0.87 | 1.27 | 0.67 |
| Iron (mg/L) | 0.25 | 0.05 | 0.02 |
| Zinc (mg/L) | 0.008 | 0.002 | 0.002 |
| Fluoride (mg/L) | 0.15 | 0.10 | 0.13 |

**Table 2- Seasonal variation of physico-chemical parameters of water of Bauli Talab (Temple pond)**

| Parameters | Pre-Monsoon | Monsoon | Post-Monsoon |
|---|---|---|---|
| Air Temperature ($^0$C) | 34.50 | 28.00 | 24.00 |
| Water Temperature ($^0$C) | 33.00 | 28.00 | 23.00 |
| Water Depth (cm) | 83.48 | 97.19 | 90.00 |
| Transparency (cm) | 28.47 | 21.24 | 26.96 |
| pH | 7.20 | 7.20 | 7.40 |
| Total Hardness (ppm) | 59.20 | 52.80 | 35.60 |
| Calcium Hardness (ppm) | 33.20 | 35.90 | 27.60 |
| Magnesium Hardness (ppm) | 26.00 | 16.90 | 7.60 |
| TSS (mg/L) | 31.00 | 35.00 | 39.00 |
| D.O (mg/L) | 4.90 | 5.80 | 7.10 |
| B.O.D (mg/L) | 14.20 | 14.10 | 12.50 |
| C.O.D (mg/L) | 75.00 | 65.00 | 70.00 |
| Nitrate (mg/L) | 1.90 | 1.20 | 2.10 |
| Phosphate (mg/L) | 0.21 | 0.20 | 0.17 |
| Sulphate (mg/L) | 39.00 | 43.00 | 34.00 |
| Chloride (mg/L) | 31.00 | 22.00 | 27.00 |
| Silicate (mg/L) | 1.32 | 1.25 | 0.92 |
| Iron (mg/L) | 0.22 | 0.21 | 0.15 |
| Zinc (mg/L) | 0.001 | 0.001 | 0.002 |
| Fluoride (mg/L) | 0.03 | 0.04 | 0.04 |

**Table 3- Seasonal variation of physico-chemical parameters of water of Thakurain Talab**

| Parameters | Pre-Monsoon | Monsoon | Post-Monsoon |
|---|---|---|---|
| Air Temperature ($^0$C) | 33.00 | 28.50 | 25.50 |
| Water Temperature ($^0$C) | 32.00 | 27.00 | 23.50 |
| Water Depth (cm) | 125.90 | 137.45 | 130.21 |
| Transparency (cm) | 23.72 | 23.00 | 23.10 |
| pH | 7.20 | 7.20 | 7.20 |
| Total Hardness (ppm) | 37.00 | 65.00 | 37.50 |
| Calcium Hardness (ppm) | 28.60 | 52.00 | 22.80 |
| Magnesium Hardness (ppm) | 8.40 | 13.00 | 14.70 |
| TSS (mg/L) | 41.00 | 43.00 | 43.00 |
| D.O (mg/L) | 5.40 | 6.30 | 7.20 |
| B.O.D (mg/L) | 15.40 | 12.80 | 12.40 |
| C.O.D (mg/L) | 85.00 | 90.00 | 74.00 |
| Nitrate (mg/L) | 1.80 | 1.80 | 2.30 |
| Phosphate (mg/L) | 0.06 | 0.23 | 0.21 |
| Sulphate (mg/L) | 30.00 | 47.00 | 32.00 |
| Chloride (mg/L) | 28.00 | 21.00 | 23.00 |
| Silicate (mg/L) | 1.42 | 1.24 | 1.26 |
| Iron (mg/L) | 0.21 | 0.20 | 0.20 |
| Zinc (mg/L) | 0.002 | 0.001 | 0.001 |
| Fluoride (mg/L) | 0.04 | 0.03 | 0.03 |

**Table 4- Seasonal variation of physico-chemical parameters of water of BuchaTalab**

| Parameters | Pre-Monsoon | Monsoon | Post-Monsoon |
|---|---|---|---|
| Air Temperature ($^0$C) | 32.00 | 29.50 | 24.50 |
| Water Temperature ($^0$C) | 29.00 | 28.00 | 24.00 |
| Water Depth (cm) | 75.16 | 97.53 | 94.39 |
| Transparency (cm) | 27.45 | 19.44 | 37.40 |
| pH | 7.20 | 7.80 | 7.50 |
| Total Hardness (ppm) | 31.40 | 63.20 | 31.70 |
| Calcium Hardness (ppm) | 22.60 | 35.60 | 21.00 |
| Magnesium Hardness (ppm) | 8.80 | 27.60 | 10.70 |
| TSS (mg/L) | 38.00 | 39.00 | 38.00 |
| D.O (mg/L) | 3.90 | 4.80 | 5.90 |
| B.O.D (mg/L) | 16.20 | 15.90 | 15.80 |
| C.O.D (mg/L) | 88.00 | 79.00 | 68.00 |
| Nitrate (mg/L) | 1.60 | 1.40 | 1.30 |
| Phosphate (mg/L) | 0.05 | 0.25 | 1.10 |
| Sulphate (mg/L) | 32.00 | 38.00 | 31.00 |
| Chloride (mg/L) | 31.00 | 22.00 | 29.00 |
| Silicate (mg/L) | 1.34 | 1.23 | 1.35 |
| Iron (mg/L) | 0.22 | 0.28 | 0.21 |
| Zinc (mg/L) | 0.002 | 0.002 | 0.001 |
| Fluoride (mg/L) | 0.01 | 0.02 | 0.01 |

**Table 5- Seasonal variation of physico-chemical parameters of water of Chotka Bauli Tala**

| Parameters | Pre-Monsoon | Monsoon | Post-Monsoon |
|---|---|---|---|
| Air Temperature ($^0$C) | 33.50 | 30.00 | 25.00 |
| Water Temperature ($^0$C) | 32.50 | 28.00 | 23.50 |
| Water Depth (cm) | 151.61 | 201.61 | 178.10 |
| Transparency (cm) | 28.40 | 18.44 | 31.40 |
| pH | 7.40 | 7.40 | 7.50 |
| Total Hardness (ppm) | 41.60 | 37.60 | 37.40 |
| Calcium Hardness (ppm) | 24.30 | 26.40 | 20.50 |
| Magnesium Hardness (ppm) | 17.30 | 11.20 | 16.90 |
| TSS (mg/L) | 41.00 | 48.00 | 36.00 |
| D.O (mg/L) | 6.60 | 7.30 | 7.90 |
| B.O.D (mg/L) | 16.00 | 15.00 | 14.30 |
| C.O.D (mg/L) | 74.00 | 61.00 | 105.00 |
| Nitrate (mg/L) | 2.30 | 1.40 | 1.20 |
| Phosphate (mg/L) | 0.17 | 0.16 | 1.10 |
| Sulphate (mg/L) | 34.00 | 43.00 | 27.00 |
| Chloride (mg/L) | 33.00 | 25.00 | 31.00 |
| Silicate (mg/L) | 1.32 | 1.32 | 1.21 |
| Iron (mg/L) | 0.30 | 0.41 | 0.23 |
| Zinc (mg/L) | 0.002 | 0.020 | 0.001 |
| Fluoride (mg/L) | 0.05 | 0.01 | 0.04 |

## DISCUSSION

### Physical Parameters

Air temperature was maximum during the pre-monsoon period, moderate during the monsoon and minimum during the post-monsoon period. Of the five ponds, the air temperature above BadaTalab (Victoria Lake) was maximum (35$^0$C during pre-monsoon). The minimum value was also reported in the same pond during post-monsoon (22.50$^0$C). Water temperature in all the five ponds was maximum during the pre-monsoon period, moderate during the monsoon and minimum during the post-monsoon period. Bada Talab (Victoria Lake) and Bauli Talab (Temple pond) had the highest water temperature during the pre-monsoon period (33$^0$C). The minimum value was reported in the Bada Talab during post-monsoon (21.50$^0$C). Water depth was maximum in Chotka Bauli pond during the rainy season (201.61cm) and was minimum in Bucha Talab during the summer season (75.16cm). The transparency was highest in Bada Talab (Victoria Lake) during the winter (40.28cm) and the lowest was reported in ChotkaBauli pond during the rainy season (18.44cm).

**Chemical Parameters**

**pH**

The pH of all the five ponds did not show much fluctuations. The pH ranged from 7 to 7.8. The maximum pH value was reported in Bucha Talab during monsoon (7.8) and the minimum in Bada Talab during pre-monsoon. The optimum pH values of the pondwater should be in the range of 7.5 to 8.5.

**Total Hardness, Calcium Hardness and Magnesium Hardness**

It is the calcium and magnesium salts present in water that determines its hardness. The total hardness and magnesium hardness was highest in Thakurain Talab during the monsoon period (65.00mg/L and 52.00mg/L respectively) whereas the magnesium hardness was highest during the monsoon period in Bucha Talab. The minimum value of total hardness, calcium hardness and magnesium hardness was reported in Bada Talab during the pre-monsoon.

**Total Suspended solids (TSS)**

Total suspended solids (TSS) solids in water can be trapped by a filter. High concentration of TSS can harm aquatic life. The TSS concentration was highest in Chotka Bauli Pond during the monsoon period (48mg/L) and was minimum in Bada Talab (Victoria Lake) during the monsoon (28mg/L)

**Dissolved Oxygen (DO)**

Apart from pH and temperature DO plays a vital role in existence of aquatic life. Optimum DO levels in the pond water is crucial for aquaculture. The DO level in the five ponds ranged from 3.0 to 7.9-the minimum was in Bada Talab and the maximum in Chotka Bauli Talab. The DO was found high during the post-monsoon period and low during the pre-monsoon period.

**Biological Oxygen Demand (BOD)**

The BOD was highest in Bucha Talab during the pre-monsoon period (16.2mg/L) and was minimum in Bada Talab (Victoria Lake) during the post-monsoon (10.9mg/L). In all the five ponds the BOD was maximum during the pre-monsoon period and minimum during the post-monsoon period which was just the reverse of DO.

**Chemical Oxygen Demand (COD)**

COD is normally higher than BOD as more organic compounds can be chemically oxidized than biologically oxidized. The maximum and minimum value of COD was both found in Chotka Bauli Talab i.e. 61 mg/L and 101mg/L respectively.

**Table 6- Standard Tolerance limit for of water parameters as per classified use of water class A, B, C, D, E depending on various uses of water (Source: Indian Standard; ISI-IS: 2296- 1982).**

| SL. No | Water Parameter | A | B | C | D | E |
|---|---|---|---|---|---|---|
| 1. | pH | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.0 to 8.5 |
| 2. | Total Hardness (ppm) | 300 | - | - | - | - |
| 3. | Calcium Hardness (ppm) | 200 | - | - | - | - |
| 4. | Magnesium Hardness (ppm) | 100 | - | - | - | - |
| 5. | TSS (mg/L) | - | - | - | - | - |
| 6. | D.O (mg/L) | 6.0 | 5.0 | 4.0 | 4.0 | - |
| 7. | B.O.D (mg/L) | 2 | 3.0 | 3.0 | - | - |
| 8. | C.O.D (mg/L) | - | - | - | - | - |
| 9. | Nitrate (mg/L), Max | 20 | - | - | - | - |
| 10. | Phosphate (mg/L) | - | - | - | - | - |
| 11. | Sulphate (mg/L) | 400 | | 400 | - | 1000 |
| 12. | Chloride (mg/L) | 250 | | 600 | - | 600 |
| 13. | Silicate (mg/L) Max | - | - | - | - | - |
| 14. | Iron (mg/L) Max | 0.3 | - | 50 | - | - |
| 15. | Zinc (mg/L) Max | 15 | | 15 | - | - |
| 16 | Fluoride (mg/L) | 1.5 | 1.5 | 1.5 | - | - |

**Nitrate**

The concentration of nitrate in the ponds ranged from 1.1mg/L to 2.3mg/L. The lowest nitrate concentration was found during monsoon in Bada Talab (Victoria Lake). The highest concentration of nitrate was reported in Thakurain pond and Chotka Bauli pond.

**Phosphate**

Green water and blanket weed are due to increase in phosphate level of pond water. The growth of algae reduces at low phosphate levels. The minimum phosphate was found in Bucha Talab during pre-monsoon period (0.05 mg/L). The highest value was in Chotka Bauli pond and Bucha Talab during the post-monsoon periods (1.10mg/L).

**Sulphate**

The concentration of sulphate in the five ponds ranged from 27 mg/L to 47mg/L. The highest sulphate concentration was found during monsoon in Bada Talab (Victoria Lake) and Thakurain Talab. The lowest concentration of nitrate was reported in Chotka Bauli pond (post-monsoon).

**Chloride**

The chloride concentration was highest in Chotka Bauli Pond during the pre-monsoon period (33mg/L) and was minimum in Thakurain talab during the monsoon (21mg/L)

**Silicate**

The minimum silicate was found in Bada Talab during post-monsoon period (0.67 mg/L). The highest value was in Thakurain talab during the pre-monsoon periods (1.42mg/L).

**Iron**

The concentration of iron in the five ponds ranged from 0.02mg/L to 0.41mg/L. The minimum value was recorded in Bada Talab during post-monsoon period and the top value was in Chotka Bauli Pond during the monsoon period

**Zinc**

The concentration of zinc in the five ponds did not show much fluctuations except Chotka Bauli Pond where the concentration was maximum (0.20mg/L). Almost all ponds showed the zinc concentration as 0.001mg/L or 0.002mg/L.

**Fluoride**

The maximum permissible limit of fluoride in water is 1.5 mg/L. All the five ponds had their fluoride level within the maximum permissible limit. Fluoride concentration was maximum in Bada Talab and minimum in Bucha Talab but all within their permissible limits.

## CONCLUSION

Investigation of water quality parameters is important to understand the interactions between parameters and effects on aquatic life. An individual water parameter alone may not describe much about the water quality, but several parameters together can help in determining dynamic processes taking place in the pond. Almost all the parameters were within their tolerance limits as compared with the ISI-IS: 2296- 1982 values.

To conserve the aquatic life in the pond water there should be awareness programmes related to the protection of the pond. Hoardings should be placed around the ponds conveying the message not to clean clothes or to wash vehicles and utensils. Due to continuous misuse the existence of Bucha Talab and Chotka Bauli Talab is on the verge of extinction at present. It is almost covered with weeds and debris.

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# Isolation and Characterization of abiotic stress tolerant endophytic diazotrophic bacteria from landrace rice karhani of Jharkhand

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**Abstract:** Rice is an important grain food crop being a staple food for a large part of the world's human population including India. Plant growth-promoting bacteria with the ability to fix atmospheric nitrogen have importance in sustainable agriculture, chemical fertilizers, which are expensive, soil pollutant, increase toxicity to the soil and not eco-friendly. The present study reports on the isolation and characterization of nitrogen fixing endophytic bacteria associated with karhani rice. 5 isolates, namely R1, R2 and S1, S2, S3 were selected and subjected to the assessment of nitrogen fixation under different stress conditions. Nitrification activity by the selected isolates was observed at concentrations of NaCl and pH. Significant improvement in plant growth was observed on bacterization of seeds (rice) with all of the five selected isolates. R2 was the best in terms of nitrogen fixation and its response to various stresses. The ability of R2 and other isolates to exhibit Nitrification activity at high NaCl concentrations with different pH suggests their potential as efficient biofertilizer for growing plants in high salinity and acidic soil. Therefore, if used they would consequently enhance affordable production of Karhani rice. This will not only eradicate poverty and increase food security, but also help conserve microbial diversity.

**Keywords: Endophytes, Diazotroph, PGPA, Nitrification, Indigenous rice, pH tolerant, NaCl tolerant.**

## INTRODUCTION

Rice (*Oryza sativa*) is a major cereal crop. United states Department of Agriculture (USDA) estimated approximately 503.17 million metric tons in 2020-2021 worldwide. In 2020-2021 production of rice was 121.46 million tones in India. Jharkhand has total geographical area of 97.70 lakh hectare but rice is cultivated in only 1501.177-hectare area as per the recent state government data. In Jharkhand total Rice production was 4367.433 metric ton of paddy in 2020-2021. Karhani is a predominant rice variety of Jharkhand and tribal people used it for nutritional as well as medicinal need. Rice plants needs large amounts of nutrient including nitrogen for proper growth and development. Presently due to increasing in population of world, cause many problems including global warming. Increasing in temperature many species of microorganism cannot survive.[1] Due to increasing in population people's needs more foods. Chemical fertilizers used to increase the fertility of soil but it causes soil pollution and toxic effect to another microbiota.[2] Endophytes are bacteria which present inside the plant tissue root stem leaf or maybe inside the seed without damaging the host plants.[3] Endophytic bacteria are beneficial to plant it help in growth and development of plants, if it enters into plant tissues and acquire environment of plant and start the development growth and as a defense mechanism.[4-6] Diversity of endophytic bacteria depends on their ability to colonize allocation of plant resources and multiply vigorously in the inter or intercellular space of the cells. Stress tolerant endophytic bacteria under high pH, temperature and NaCl concentration to improve the growth and yielding of crops.[7-9] Bacteria interact with plant, generally associated with plants for their growth and mutual relationship called symbionts or rhizobium bacteria that could rhizosphere and also inside the tissue of plant

called endophytic bacteria they do not harm the plant, they make mutual relationship with plans to live and to enhance the growth of plant.[10-13] Many areas in Jharkhand and other states of India are heavily contaminated with toxic amounts of zinc due to mining and other human activities, which affects the soil microflora as well as plants growing in that region.[14] Moreover, the soil of Jharkhand faces other abiotic stresses like salt and high temperature, which restrict vegetation in these areas. Application of such bacteria will be of great importance in agricultural practice and also in bioremediation of soil.

## MATERIAL & METHODS

### Isolation of endophytic bacteria from rice

Plants were carefully removed, washed under tap water to remove soil. Different tissue (stem and root) samples were collected in separate beaker. Selected tissue was applying standard method for isolation of endophytic bacteria. Method of Barraquio *et al.* 1997 was used for isolation. One gram of root and stem was taken and washed in triple distilled water (TDS) with sterilized glass beads by vigorously shaking for 45 minutes. Stem and root were dipped in 70% ethanol for 3 minutes followed by three times washing with TDS to remove Ethanol. Therefore the tissues were treated with $HgCl_2$ (0.1% v/v) for 15 minutes and then washed thrice with triple distilled water. The last wash was stored and 100µl of it was plated on NA (Nutrient Agar) to ensure surface sterilization. The surface sterilize root and stem were crushed separately in mortar pestle and suspended in 1ml PBS (Phosphate Buffer Saline). The suspension was diluted to$10^{-5}$ and 100µl from each dilution was spread on Nitrogen free $JNFb^-$ and NA agar-agar medium to enrich in fixing population only for the estimation of total population another set of inoculums (100 µl) was plated on NA. The plates were incubated at $30^0$C for 48 hrs. Colonies appearing on $JNFb^-$ plates were counted and CFU was calculated. Colonies showing distinct morphological characters were selected and restrecked on $JNFb^-$ agar medium. Individual isolates were sub-cultured several times on $JNFb^-$ agar to insure the diazotrophic nature of isolates.

### Morphological studies

Morphological study was done on the basis of shape, elevation, texture, margin, colour and size of colonies of endophytic bacteria grown on specific medium and incubated at 28±2°C for 2-3 days. Cell motility and shape of single colony was observed under light microscope.

### Gram staining

Gram reaction was done to differentiate endophytic bacteria Gram positive and negative on the basis of standard staining protocols.

### Biochemical test

#### Catalase test

A drop of 1% $H_2O_2$ was taken on glass slide. Small amount of endophytic bacterial culture was mixed with inoculating needle. Rapid and sustained production of gas bubbles or effervescence constituted positive test.

#### Nitrate reduction test

5ml nitrate broth was inoculated with pure culture of the test organism. It was incubated at $28^0$C for 24- 48 hours. Equal volumes (0.5ml) of both reagents A and B were added. The development of red colour within 30 seconds indicated positive test.

#### Citrate utilization test

A good isolated colony was streaked on the surface of modified Simmon s citrate agar slants and incubated at 28±2°C for 24-48 hours. A positive test was indicated by the development of a streak of growth and change in the colour from green to deep blue.

## RESULT

### Isolation of endophytic bacteria from rice plants

Total five endophytic bacteria isolated from stem and root tissues of Karhani rice variety. Out of five different endophytes three stem and two from root. Bacterial colonies were carefully isolated and streaked on the agar plats surface in Jensons media for endophytic diazotrophic bacteria.

**Table 1- Isolation of endophytic diazotrops from stem and root**

| Sources | Tissues | Endophytic bacteria |
|---|---|---|
| Karhani | Root | R1 & R2 |
| Karhani | Stem | S1, S2, & S3 |

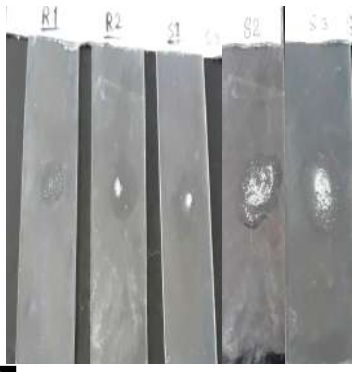



**Fig. 1- Catalase test**

**Fig. 2- Nitrate test**

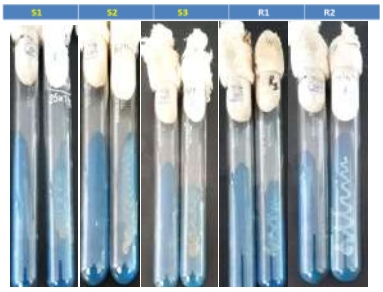



**Fig. 3- Citrate utilization**

**Table 2- Biochemical characterization of endophytic bacterial isolatesfrom rice**

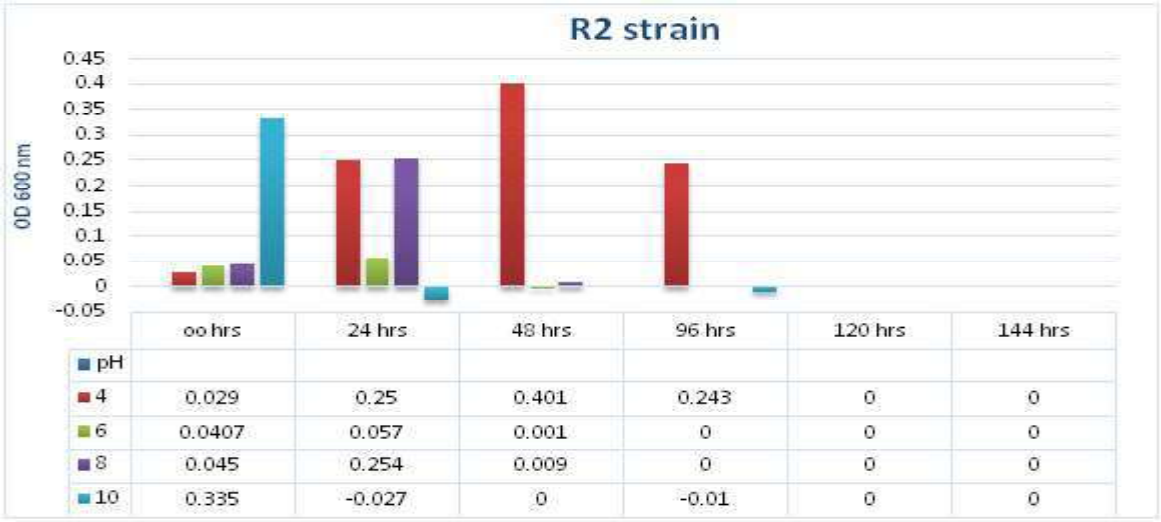
| Biochemical test | Endophytic bacteria | | | | |
|---|---|---|---|---|---|
| Gram's reaction | S1 | S2 | S3 | R1 | R2 |
| Catalase | Positive | Positive | Positive | Positive | Positive |
| Citrate utilization | Positive | Positive | Positive | Negative | Negative |
| Nitrate | Positive | positive | Positive | Positive | Positive |

Morphological study was done on the basis of shape, elevation, texture, margin, colour and size of colonies of endophytic bacteria grown on specific medium and incubated at 28±2°C for 2-3 days. Cell motility and shape of single colony was observed under light microscope.

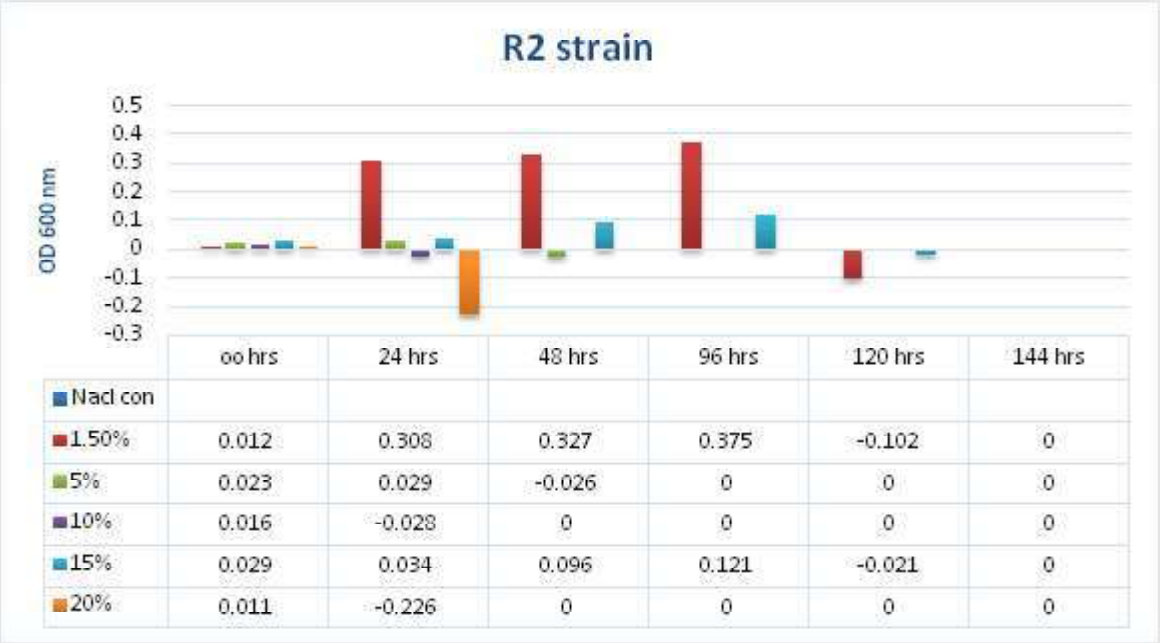
**Table 3- Morphological characteristics of endophytic bacterial isolates from karhani rice**

| Characteristics | Morphology of endophytic bacterial isolates | | | | |
|---|---|---|---|---|---|
| **Strains** | **S1** | **S2** | **S3** | **R1** | **R2** |
| **Cell shape** | Rod | Rod | Rod | Rod | Rod |
| **Colony shape** | Circular | Circular | Circular | Circular | Circular |
| **Elevation** | Convex | Convex | Convex | Convex | Convex |
| **Texture** | Smooth | Smooth | Smooth | Smooth | Smooth |
| **Margin** | Smooth | Smooth | Smooth | Smooth | Smooth |
| **Colour** | Off white | Off white | Off white | Off white | Off white |
| **Size** | medium | Large | Small | Large | Large |

**Growth of endophytic bacterial in different stress condition**

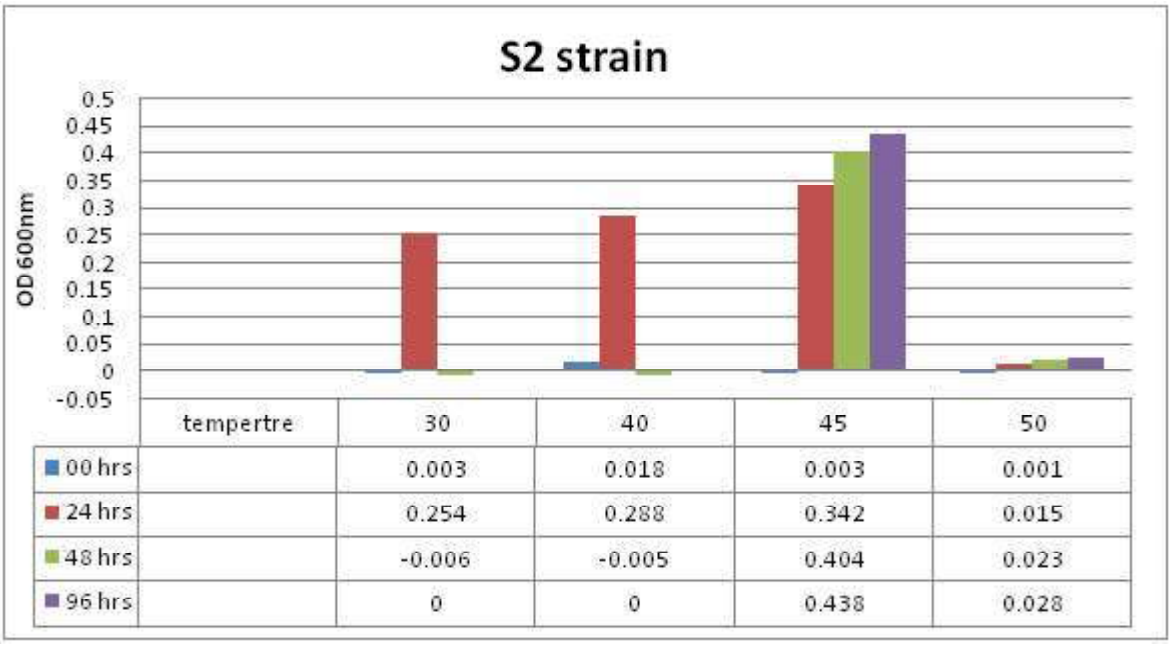



**Graph 1- Shows the abiotic stress tolerance of isolated rhizobium bacteria. The result of different abiotic stress tolerance of rhizobium in *in vitro* condition. Five isolates were showed growth at pH range 4-10 (S1, S2, S3, R1 and R2) among them S1, S2, S3 and R2 isolate showed tolerance to pH at 4 and at pH 8.Bacterium R2 showed best growth at pH 8 after 24 hours.**




| | oo hrs | 24 hrs | 48 hrs | 96 hrs | 120 hrs | 144 hrs |
|---|---|---|---|---|---|---|
| Nacl con | | | | | | |
| 1.50% | 0.012 | 0.308 | 0.327 | 0.375 | -0.102 | 0 |
| 5% | 0.023 | 0.029 | -0.026 | 0 | 0 | 0 |
| 10% | 0.016 | -0.028 | 0 | 0 | 0 | 0 |
| 15% | 0.029 | 0.034 | 0.096 | 0.121 | -0.021 | 0 |
| 20% | 0.011 | -0.226 | 0 | 0 | 0 | 0 |

**Graph 2- The results of salt tolerance ability of five isolate showed tolerance to 1.5-20% concentration of NaCl (S1, S2, S3, R1 and R2) among them R2 bacterium showed growth at 1.5% and 15% NaCl concentration.**




| tempertre | 30 | 40 | 45 | 50 |
|---|---|---|---|---|
| 00 hrs | 0.003 | 0.018 | 0.003 | 0.001 |
| 24 hrs | 0.254 | 0.288 | 0.342 | 0.015 |
| 48 hrs | -0.006 | -0.005 | 0.404 | 0.023 |
| 96 hrs | 0 | 0 | 0.438 | 0.028 |

**Graph 3- The result of temperatures tolerance ability of five isolates showed tolerance to 30$^0$C -50$^0$C (S1, S2, S3, R1 and R2) all isolates showed tolerance to temperature 30-45. Temperature tolerance of all isolates (S1, S2, S3, R1 and R2) at 50$^0$C showed slow growth. S2 bacterium at 45$^0$C showed best growth.**

## DISCUSSION

The result of our study identifies S1, S2, S3, R1 and R2 isolates showed growth in different stress condition such as pH, temperature and salinity. Isolated bacteria showed that they grow in high temperatures (30-50$^{o}$C) some of them grow slowly and some fast. Same as at high pH (4-10 pH) and salinity (1.5%-20% conc.). They tolerate the stress condition. The result of this investigation shows that bacteria can grow at different stress condition Isolates showed the stress tolerant activity if in soil contain high pH, salinity and even high temperature and help in growth of plants. In this study, there was a significant activity of diazotrophs have been seen under the stress of pH NaCl and Temperature even at a very high concentration of NaCl (up to 15%M) pH up to 8 and at a temperature of 45$^{o}$C. Detailed studies are required for understanding the mechanism involved in conferring resistance to all these isolates. The effect of pH and NaCl has been demonstrated in a few studies.[15-16]

## CONCLUSION

In conclusion, the present study reports the isolation of certain endophytes with PGP properties. Certain isolates at high concentrations of NaCl, pH and at high temperature is a new finding of this study. The ability of these bacteria to tolerate this stress will be useful for growing plants at high temperature and acidic soil. The efficiency of these bacteria to colonize inside the roots would be beneficial for plant health as well as in phytoremediation of soil. Further studies are required to study the mechanism of NaCl, pH and at high temperature tolerance in these isolates. The stress-tolerant strains may serve as suitable candidates for developing microbial formulations for the growth of plants in the mining area of Jharkhand and desert-like areas of India that experience this abiotic stress.

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# Transition Metal Oxide-Based Nanoparticles: Role as Catalyst

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**Abstract:** In present time, transition metal oxide based nanoparticle is an important area of scientific research due to its several applications in different fields. Transition metal oxide particle size ranges from 1.0 nm to 100 nm. Due to high demand in catalysis, it has become one of the focused areas in the last 10 to 15 years. The use of this material in catalysis has improved selectivity and productivity academically and industrially. In the last decades, the use transition metal oxide nanoparticle as catalysts for industrial application in the synthesis of important chemical intermediates has increased many folds industrially. In comparison to other properties of catalysts, high selectivity of transition metal oxide based nanoparticles in catalysis is most important. This favours high yields of the desired product. In this paper our study is intended to deal with the application of transition metal oxide nanoparticles as catalyst for oxidations of alcohols, aldehydes, sulfides, olefins, and alkanes toward the synthesis of a variety of organic compounds, such as aldehydes and ketones, carboxylic acids, sulfoxides and epoxides.

**Keywords: Transition metal oxide, catalyst, nanoparticle, selectivity**

## INTRODUCTION

In today's world oxidation chemical reaction is very important in chemical industry and chemistry. The 30% of total reaction carried out in the chemical industry is oxidation process. Therefore, it is clear that oxidation reaction is one of the most important reaction in the production of chemicals.[1,2] Instead of this many product like organic acid, ketones, aldehyde, epoxide and alcohol has been obtained by catalysis.[3] It is required to increase the selectivity and optimization of the catalyst.[4] As a requirement development of new material for catalytic oxidation is needed.

Due to this, development of new catalytic oxidation processes is essential for laboratories and industries. In the last few years, noticeable efforts have been made in the area of nanotechnology[5-7] and nano-science especially at transition metal oxide nanoparticles due to their relatively high chemical activity as well as specificity of interaction. These nano-sized materials in comparison to their bulk equivalents have many different properties such as a large surface-to-volume ratio.[8] Among all the materials on the nanoscale, transition metal oxides are one of the most important.[9] Transition metal oxides show unique characteristics which make them the most versatile class of materials including properties covering all aspects of solid state and materials chemistry.[10] In recent decades oxidation reactions catalyzed by transition metal oxide based nano particle have become as a major research area. The main idea of our review is to discuss the scope and limitations of transition metal oxide nanoparticle as an efficient catalyst for the oxidation of various organic substrates, alcohols, aldehydes, sulfides, olefins, and alkanes toward the synthesis of a variety of organic compounds, such as aldehydes and ketones, carboxylic acids, sulfoxides and epoxides.

### 2.0 Transition metal oxide nanoparticles

#### 2.1 Titanium oxide nanoparticles

$TiO_2$ nano particles are known as a photocatalyst and used in Oxidation reactions. In chemical reaction mostly, $TiO_2$ nanoparticles were used as photo-degradation materials.

**Titanium oxide nanoparticles and Alcohols oxidation.**

Since $TiO_2$ nano particles have photo-degradation capacity, a significant volume of research has been recently carried out in selective oxidation of organic substrates viz. aromatic alkanes alcohols, amines, and cyclohexanes by $TiO_2$ in the presence of $O_2$ under UV-Vis irradiation. A green oxidation method was developed for the oxidation of secondary alcohols to corresponding ketones by Kidwai and coworkers.[11] The catalytic activity of $TiO_2$ nano rods for selective oxidation of benzyl alcohol was compared with $TiO_2$ nano particles. From results it was clear that the $TiO_2$ nano rods were more active due to its high surface-to-volume ratio which promotes the interaction, adsorption and desorption of organic molecules with the surface. The oxidation of various organic compounds over $TiO_2$ catalysts is also possible without light irradiation.

**2.2 Vanadium oxide nanoparticles**

Vanadium oxide nano particles in the oxidation reactions are rare. Vanadium oxide nano particles are supported on the surface of other metal oxides and the nature of support affects the catalytic activity of vanadium nano particles. Oxidation of propene to propene oxide is difficult by vanadium oxide nano particles due to the formation of other products such as ethanal and propanal.

**2.3 Molybdenum oxide nanoparticles**

The transition metal oxides, molybdenum oxides ($MoO_x$) have attracted significant research interest due to their unique structural characteristics. $MoO_x$ has two binary oxides as $MoO_2$ and $MoO_3$. Molybdenum oxides ($MoO_x$) have been utilized in the field of sensors,[12] electrode materials[13] and recording materials.[14] However the catalytic activity of these nano particles has been reported less than other applications. In most cases, molybdenum dioxide, $MoO_2$, has been used as the catalyst in cracking and reforming of hydrocarbon compounds.[15,16]

In another work, the authors developed new tremella-like molybdenum dioxide nano particles, Fe-doped $MoO_2$, for epoxidation of the same olefins.[17] In this study, Fe-doped $MoO_2$ was synthesized by a hydrothermal method according to the reported procedure with slight modification.[18] In the modified synthesis, $Fe_2O_3$ was utilized as the assisting agent instead of hydroquinone. This assisting agent not only acted as a nucleation core for the growth of $MoO_2$ nanoparticles but also regenerated the oxidized ethylene diamine during synthesis. Catalytic performance of as-prepared Fe-doped $MoO_2$ nanoparticles were tested in olefin epoxidation with the aim to investigate the effect of catalyst on selectivity of product.

**2.4 Manganese oxide nanoparticles**

The alcohol oxidation (aerobic oxidation) by manganese oxide nano particles showed significant catalytic activity and selectivity up to 100% .[19] In general, catalytic performance of the nano particles depended on particle size. Nano particles of smaller particle sizes have higher activity in oxidation reactions. In contrast, nano particles were not stable and prone to aggregate formation with decreasing particle size which reduced their stability and catalytic activity.[20] Our research group prepared $MnO_2$ nanoparticle via a simple and novel protocol and used for the oxidation of benzylic alcohols to corresponding aldehydes.[21]

Manganese oxide nano particles are recognized as efficient catalysts in the oxidation of olefins. Epoxides, as products, are found in many important intermediates as well as pharmaceutical materials.[22,23] Results showed that the nano-catalyst has excellent activity toward epoxidation of aromatic but mild activity olefins for epoxidation of non-aromatic olefins. Ability of reuse of the catalyst was also tested which was 86% conversion after six runs.

**2.5 Iron oxide nanoparticles**

In recent years, considerable effort has been devoted to the preparation and application of iron oxide nanoparticles due to their unique properties such as low toxicity, good dispersibility, and easy separation using an external magnetite. Compared to other transition metal oxides as catalysts and from the view point of catalytic application, magnetic recoverability can be a unique advantage which eliminates catalyst separation by centrifugation or filtration after completion of the reaction. The efficiency of these catalysts was studied in selective oxidation of benzyl alcohol as aprobe molecule in the presence of 33% $H_2O_2$ at 75°C. The particle size of as-used iron oxide nano particles had a substantial effect on conversion and selectivity of benzyl alcohol oxidation.

**2.6 Cobalt oxide nanoparticles**

Cobalt oxide nanoparticle have received significant attention due to their applications in catalysis, electrochemical, gas sensing and many other fields.[24-29] The size and morphology of metal oxide nano particle are important to their catalytic activity in oxidation reactions. There is a strong correlation between the above mentioned factors and activity as well as selectivity of these catalysts.

### 2.7 Copper oxide nanoparticles

CuO has recognized as one of the most important transition metal oxides in a broad range of material science.[30] Different method has been used to prepare CuO nanoparticles with various shapes and morphologies such as nanotubes[31], nanorods[32], Different copper salt sources and the preparation method affected shape and morphology of the synthesized CuO particles. On the other hand, unlike copper nitrate, the use copper sulfate and copper chloride as precursors led to CuO NPs with rod-like and octahedral shapes, respectively. Moreover, the above research tested the catalytic activity of these CuO particles with different morphologies in epoxidation of norbornene in the presence of t-butyl hydroperoxide as an oxidant. Because of their uniform and organized shapes, the urchin-like CuO NPs showed excellent catalytic performance with 89.5% conversion and 100% selectivity compared with other CuO particles.

### 2.8 Cerium oxide nanoparticles

Cerium dioxide nano particles with an average size of 15 nm have been used as an environmentally friendly heterogeneous catalyst for the aerobic oxidation of para-xyleneto terephthalic acid in water by Deori and coworkers.[33] The catalytic activity of as-prepared $CeO_2$ nano particles was compared with the commercially available bulk $CeO_2$ materials. The highest activity of $CeO_2$ nano particles could be related to their small crystallite size (15 nm) which provided a very high surface area as well as a large number of pores. The shape and size of $CeO_2$ nanocrystals depended on the reaction time and temperature. On the other hand, upon increasing the reaction time from 15 to 60 min, the average size of the nanocube increased from 15 to 45 nm at 300°C. The experimental results demonstrated that the as-prepared catalyst quantitatively converted the para-xylene to terephthalic acid with absolute selectivity within 20 h at 70°C or within 18 h at 85°C.

It is worth mentioning that the effects of crystal shape and surface property of two types of $CeO_2$ nano particles (Oleic acid-coated $CeO_2$ nano cubes and irregular $CeO_2$ nano particles) on their catalytic activity for selective oxidation of toluene to benzaldehyde were investigated previously.[34] Oleic acid not only acted as a surfactant in the synthesis of $CeO_2$ nanocubes but also increased the conversion of toluene to benzaldehyde in water using its hydrophobic tail which facilitated the contact of toluene with the surface of $CeO_2$ nanocubes.

**Table 1- Summary of Transition Metal Oxide Based Nano Material Catalysts in Oxidation Reactions**

| Transition metal oxide based catalysts | Starting materials | Oxidation conditions | Products | References |
|---|---|---|---|---|
| $TiO_2$ | Secondary alcohols | Solvent: PEG400<br>Oxidant: $H_2O_2$ | Ketones | 11 |
| Fe-doped $MoO_2$ | Olefins | Various Solvents and Oxidants | Epoxides | 17 |
| $MnO_2$ | Benzylic alcohols | Solvent: Acetonitrile<br>Oxidant: $H_2O_2$ | Corresponding aldehydes | 21 |
| $CeO_2$ | para-xylene | Oxidant: air | Terephthalic acid | 33 |
| $MoO_2$ | Olefins | Oxygen donors: tert-butyl hydroperoxide (TBHP | Epoxides | 35 |
| $MnO_2$ | 5-hydroxymethylfurfural | 0.5 MPa $O_2$ | 2,5-diformylfuran | 36 |
| $Fe_2O_3$ –$TiO_2$ | Benzyl alcohol | Oxidant: $H_2O_2$ | Benzaldehyde | 37 |
| $Fe_2O_3$–$ZrO_2$ | Dimethyl sulfide (DMS) | Ozone Atmosphere | Sulfoxide product | 38 |
| V2O5/$SiO_2$ | Propene | UV-irradiation | Propene oxide | 39 |
| V2O5/$Al_2O_3$ | Cyclohexane | Co-catalyst : Pyrazine 2-carboxylic acid | Cyclohexanone | 40 |
| $Fe_3O_4$ | Primary and secondary benzylic and aliphatic alcohols | Oxidant: $H_2O_2$ | Corresponding carbonyl products | 41 |
| $Co_3O_4$ nanocrystals | Cyclohexane | Oxidant: molecular oxygen | Corresponding products | 42 |
| $CeO_2$ nanocubes | para-xylene | Oxidant: air | Terephthalic acid | 43 |
| CuOx/$SiO_2$ | Propylene | Oxidant: air | Propylene oxide | 44 |

## CONCLUSION

In this review paper, we have pointed out how transition metal oxide nanoparticles can be used as catalysts for a wide variety of oxidation reactions such as epoxidation and oxidation of sulfides, alcohols and alkanes.

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Geology

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# Assessment of Paleo - environment conditions of deposition of coals of Raham Block of North Karanpura Coalfield, Chatra District, Jharkhand, India

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**Abstract:** Occurrences of coal seams in the peninsular Gondwana basins of India is more or less confined in the lower Gondwana sequence (Damuda Group) and occur in the Karharbari formation at the base, the Barakar formation at the middle and the Raniganj formation on the top1. Raham block is located on the northern limb of North Karanpura basin where strata dips towards South. The geologic features are in continuity with the adjoining area. Raham block is located in Tandwa sub - division of Chatra district of Jharkhand state. The coal seam present today in Raham Block is a result of deposition millions of years ago. The research paper has been put forward to predict the paleo - environmental conditions that had prevailed in the past. Coal Petrography relates to the study of different microscopic organic constituents of coal to understand the coal type (maceral composition) and coal rank (the maturity of coal). Macerals can be distinguished under the microscope on the basis of their colour, shape, size and texture. The source material, colour or level of reflectivity and nature of formation of the macerals imparts them their distinguishing feature. Research in this field is in progress with future scope to open more opportunities benefitting the society. Authors have also tried to develop another depositional model of Chano - Rikba block on the basis of macerals and mineral matter. Importance was given to mineral matter because in the coals it is directly related to the influx of surface water in the swamps. The plots of petrographic composition of Raham Block coals shows that a major part of coals have been formed under oxic dry mire and sudden flooding condition.

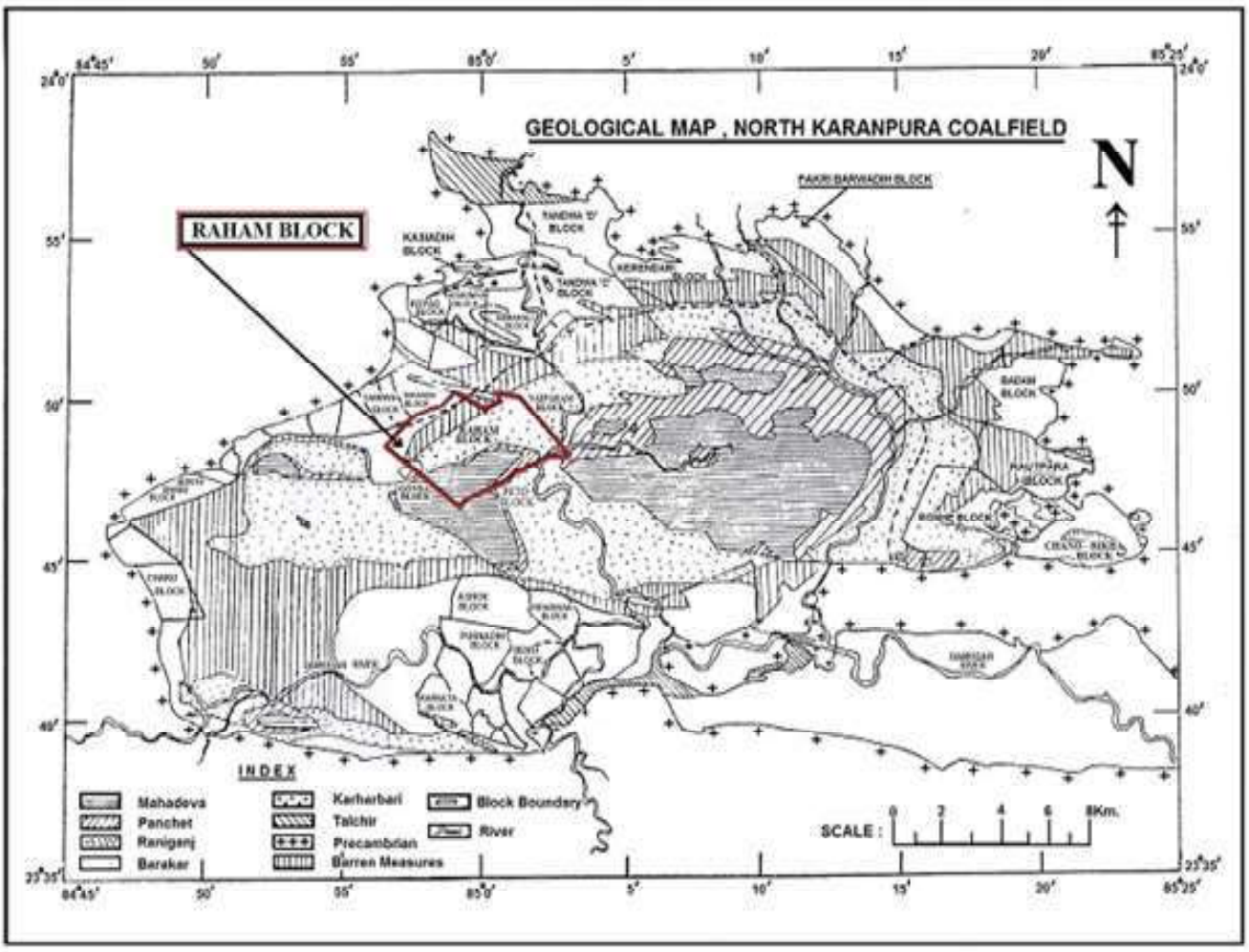
**Keywords: North Karanpura, Raham Block, Coal, Petrographic, Paleo - environment.**

## INTRODUCTION

The petrographic characteristics depends on the conditions operating in the swamps as well as in the source area during the formation viz. Water level, subsidence of swamps, pH level, redox potential is responsible for such type of condition in peat formation of the vegetal matter. If the basin of deposition is shallow and there are high oxidative conditions with prolonged exposure of the peat with the atmosphere, the peat then contains high amount of inertinite macerals. Likewise, if there is a slow rate of water flow with the continuous increase in water table and slow subsidence of basin, then it favours reducing condition with high amount of Vitrinite & Liptinite macerals. The plots of petrographic composition of Raham Block coal helps to predict the paleo-environment conditions.

### Location of Raham Block

Raham block is covered in Survey of India Topo – sheet No. 73 A / 13 (RF 1:50,000) in west and 73 E /1 in east and bounded by Latitudes 23°47'38" N and 23°50'22"N & Longitudes 84°57'38"E and 85°02'02"E. Raham block of North Karanpura coalfield is located in Tandwa sub-division of Chatra district of Jharkhand state. (Map 1)




**Map 1: Location of Raham Block in North Karanpura Coalfield (prepared after GSI, 1987)[1]**

**Geology of Raham Block**

The geologic features are in continuity with the adjoining area of North Karanpura coalfield. Barakar, Barren Measure and Raniganj formations of lower Gondwana series occur in the block in the chronological order of younger above older are exposed on the surface. The Barakar and Barren measure formation occupy major portion of the Raham block. Four faults are interpreted to be present in the Raham block. Raham block is located on the northern limb of the North Karanpura basin where strata dip towards south.

## MATERIALS & METHODS

More than 20 samples were collected by the courtesy of CSIR – Central Institute of Mining and Fuel Research, Ranchi[2]. Coal samples were taken from central part of the block for special test as representation samples and were selected for Petrographic study[3]. The data was acquired by using Petrographic Microscope – LEICA DM 4500P, by the courtesy of Central Mine Planning and Design Institute, Ranchi. The Indian Standard was followed for analysis of coal samples. The data acquired was plotted in the Ternary diagram to predict the paleo – environmental condition of Raham Block.

## RESULTS & DISCUSSION

The results of representative samples from central portion of the block are plotted in the Ternary diagram. The plots reveal the paleo-environment condition that prevailed during formation of coal of Raham Block. (Fig. 1)

**Table 1- Data acquired from Petrographic analysis of selected coal samples**

| Sample Detail | Description | | | | Maceral Composition % | | | |
|---|---|---|---|---|---|---|---|---|
| | Bore Location | Depth (m) | Thick (m) | Seam | Vitrinite | Liptinite | Inertinite | Visible Mineral Matter |
| **P1** | Central Part | 338.07 | 1.88 | IV | 31.8 | 8.2 | 37 | 23.0 |
| **P2** | | | | | 30.8 | 10.4 | 37.2 | 21.6 |
| **P3** | | | | | 30.5 | 10.7 | 37.4 | 21.4 |
| **P4** | | | | | 29.9 | 9.8 | 37.1 | 23.2 |
| **P5** | | 343.2 | 6.49 | III | 22.7 | 11.4 | 30.7 | 35.2 |
| **P6** | | | | | 30.6 | 10.9 | 37.5 | 21.0 |
| **P7** | | | | | 30.1 | 10.4 | 37.7 | 21.8 |
| **P8** | | | | | 28.9 | 9.9 | 36.9 | 24.3 |
| **P9** | | 383.62 | 2.89 | I (T) | 18.6 | 8.5 | 43.2 | 29.7 |
| **P10** | | | | | 30.4 | 10.8 | 37.3 | 21.5 |
| **P11** | | 393.35 | 6.9 | I (M) | 21.8 | 10.6 | 32.8 | 34.8 |
| **P12** | | | | | 29.7 | 10.2 | 37.6 | 22.5 |
| **P13** | | 411.3 | 5.13 | I (B) | 30.9 | 10.9 | 37.6 | 20.6 |
| **P14** | | | | | 30.7 | 8.4 | 37.1 | 23.8 |

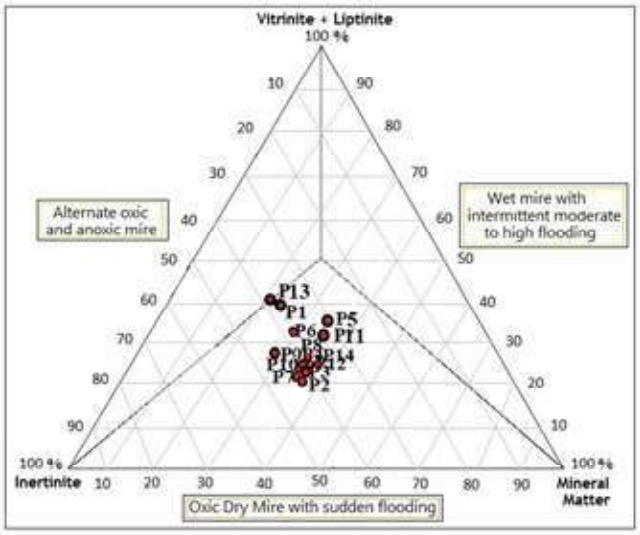



**Fig. 1: Depicting the plots and paleo – environmental condition prevailed in Raham Block**

**Microphotographs of Coal**

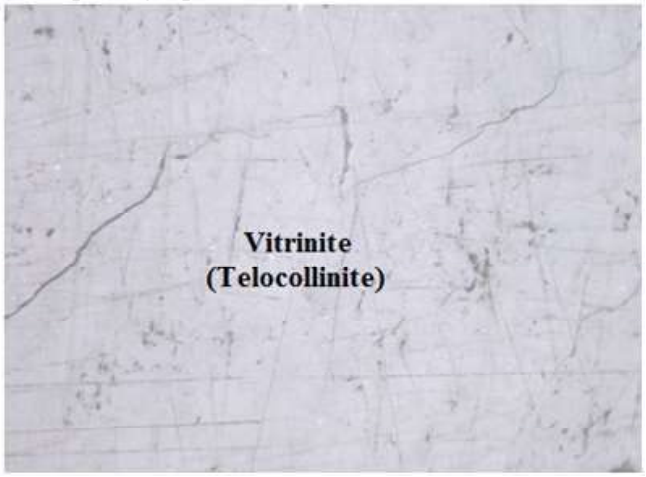



**Plate 1: Showing Maceral Group–Vitrinite, Maceral–Collinite, Sub Maceral – Telocollinite**

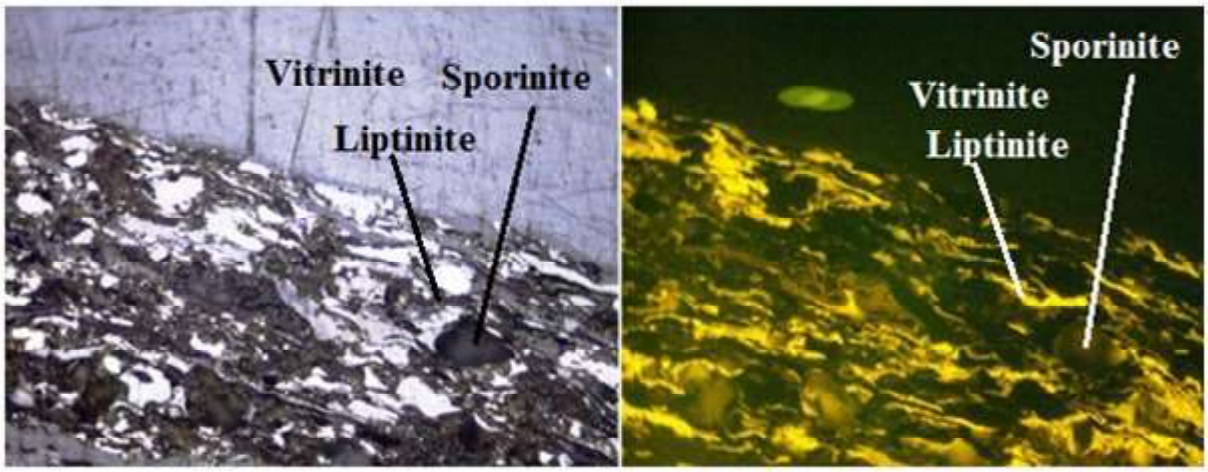



**Plate 2: Showing Maceral Group–Liptinite (Exinite), Sub Maceral – Sporinite**


**Plate 3: Showing Maceral Group – Inertinite (Fusinite)**

The microphotograph (Plate 1, 2 & 3) acquired from the samples shows the presence of Vitrinite, Liptinite and Inertinite. The data incurred have been tabulated above shows that Vitrinite is the most abundant maceral present that makes up the groundmass in which Liptinite and Inertinite are dispersed. The macerals of Liptinite group possess distinct morphology showing dark grey, brown to black under incident white light and yellow to orange under fluorescent light. They are divided as primary Liptinite macerals and are characterized by distinct morphology. They are derived from hydrogen rich constituents of plants such as spores, pollens, cuticles, resin and algae and others. Inertinite shows "Bogen Structure" in highly fragmented structure typical of compressed Fusinite, as seen under incident white light on polished surface, oil immersion, 500 X, from coal sample of Raham Block. The cell structure is well preserved, even the intercellular space is recognizable, cell lumens are generally empty but in some instances they are filled with mineral matter.

Authors have attempted to deduce paleo – environment condition of Raham block on the basis of macerals and mineral matter. Importance was given to mineral matter because in coal it is directly related to the influx of surface water in the swamps. The plots of petrographic composition of Raham coal in the ternary diagram shows that a major part of coals have been formed under oxic dry mire with sudden flooding condition. It is predicted that Raham Block coals originate from forest swamps and the process of vitrinization begins to dominate over fusinization and fusinization begins to over vitrinization. These observations are also corroborated with the finding of Goodarzi[4] and Singh and Singh[5]. This work is also interpreted by a number of workers like Diesel, Misra and Cook, Misra, Chandra & Verma, and Rudra.[6-9]

## CONCLUSION

It is inferred that the paleo-environment condition that prevailed in Raham Block was oxic dry mire with sudden flooding. The variation in maceral assemblage in these coal seams reflects fluctuation in environmental conditions. Thus, the above evidences suggest that the unstable conditions under typical structural set up were responsible for the depositions of these coal seams. These observations are corroborated with findings of Navale[10] and Dutta[11], Casshyap and Tiwari[12], for the formation of Barakar coals in Damodar Valley Coalfields and Jha, Banra and Sinha[13] & Jha and Sanga[14] for North and South Karanpura Coalfield.

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# Geochemical evaluation of ground water of Gharbar panchayat, under Baliapur block, Dhanbad District, Jharkhand

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**Abstract:** The present study was initiated with the aim of hydrogeochemical evaluation of ground water of Gharbar panchayat under Baliapur block of Dhanbad District. For this purpose 15 ground water samples (bore well as well as open wells) were collected after the chemical analysis of all these samples and there statistical analysis it was found that the water of the area is by and large alkaline in nature favouring dissolution of fluoride bearing minerals such as hornblende and biotite. The fluoride concentration ranges from 0.50 to 17.30 mg/L. The anthropogenic activities and the open and unlined drainage system of the area play a major role in nitrate concentration in the study area. The excess of fluoride concentration is causing large scale dental and skeletal fluorosis. The results indicate that the occurrence of very high concentration of fluoride is due to the geochemical composition of the rocks, alkaline condition of water and rock water interaction.

**Keywords: Gharbar, Dhanbad, Fluoride, Dental caries, Dental fluorosis, skeletal fluorosis**

## INTRODUCTION

Water is a renewable, prime and natural resource of the earth. It is a basic human need for activities like domestic, agricultural, industrial, recreational uses. It is a natural asset covering about 75% of the world surface area. Of the total water found on the globe about 97% is in the ocean which is saline in nature and not fit for human uses of the remaining 3%, 2% is found in the form of ice and only 1% is available as fresh water, suitable for human consumption. So far as the fresh water scenario of India is concerned, we are having 2.2% of the global land and about 6% of world's water where as the Indian population is nearly 16% of the world population. This shows that India is becoming a water scarce country. A closer inspection of our potable water availability today gives us a rude shock. The quality of water depends on the physical and chemical constituent present in it due to weathering of rocks through which it passes and rock water interaction in which it is being stored. In addition to the geogenic factor the anthropological activities also controls the quality of water. Hence, hydrogeochemical study of ground water become an essential factor in determining the suitability of groundwater for drinking and other purposes such as agricultural and industrial use.[1] The geological setting, natural slope, climate and type of aquifer material controls the hydrogeochemistry of water[2] about 30% of our urban and more than 90% of our rural population are dependent on surface or ground water resources.[3]

### Study Area

The study area lies in the southern part of Baliapur block of Dhanbad district of Jharkhand. It is bounded by latitudes 23°38'39" to 23°40'13"N and longitudes 86° 32'6" to 86°34'18"E and the river Damodar flows in NEE direction to the south of the area (fig.1).

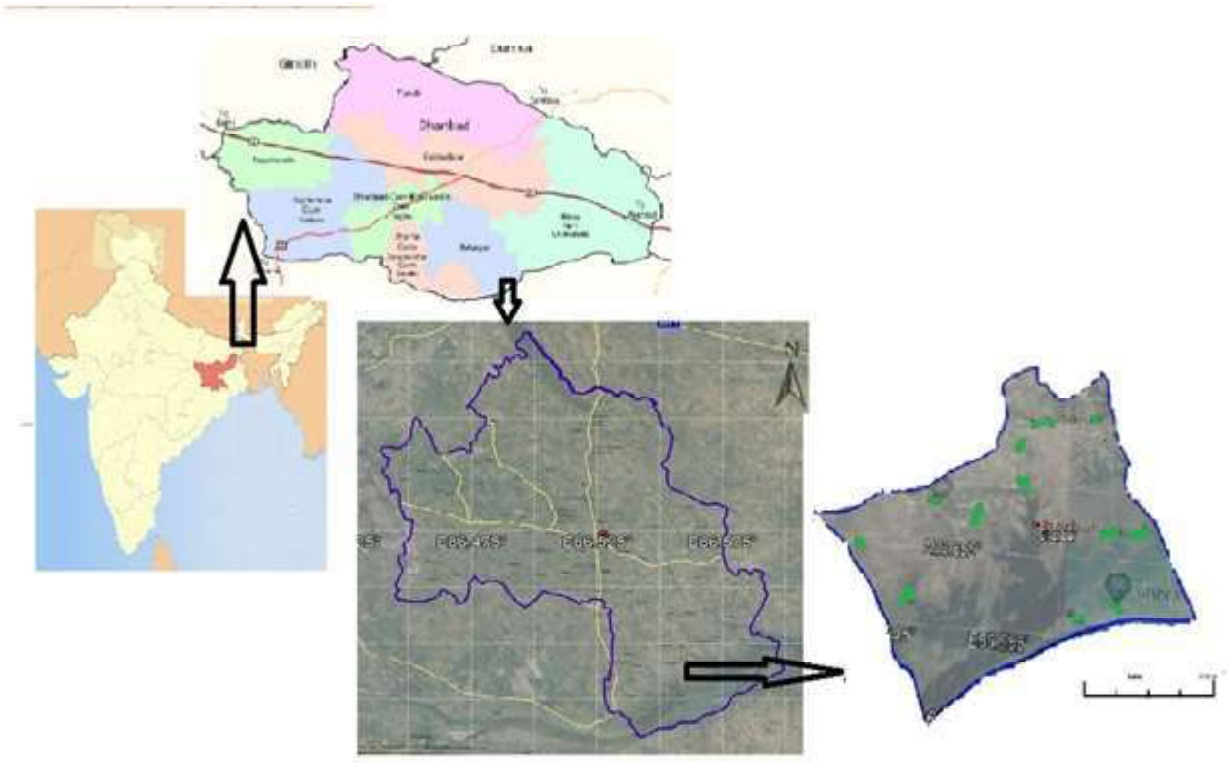

**Fig. 1- Location Map of the study area**

The total area under study is 5.25 km$^2$ having a population of 2171 of which 1134 males and 1037 are female constituting 432 families. It is about 22 km from district head quarter Dhanbad, 12 kilometers from block head quarter Baliapur and 8 km from industrial hub Sindri. The area is surrounded by coal mines, fertilizer plant, cement plant, coal washeries and stone crushers. The drainage pattern in the study area is a part of Damodar basin the general slope of the area is towards East and South East direction. The average annual rainfall in the area is about 1250mm, as reported by Indian Meteorological Department Dhanbad. The study area experiences sub-tropical monsoonal climate characterized by very hot summer from March to May, evenly distributed rainy season from June to September and dry and cool winter from December to February (CGWB 2013).

## GEOLOGY OF THE STUDY AREA

Geologically, the study area is a part of Chotanagpur Granite Gneissic Complex, which is overlain by quaternary alluvium. The Precambrian Granite Gneissic Complex is primarily composed of feldspathic gneiss, amphibolites, hornblende gneiss, and quartzites. The feldspathic gneiss are widely distributed and are found in association with hornblende gneiss, they have been formed by medium to high grade metamorphism of pre existing rocks at some places epidote gneiss are also reported these rocks contain mainly hornblende and biotite minerals which are Fluorine bearing[4] the rocks are highly weathered and fractured. In the area ground water occurs under unconfined conditions in the weathered zone at shallow depths. Under deep seated condition the groundwater occur under confined to semi confined condition but what is significant is that they are unconnected with the top weathered zone.

## MATERIALS & METHODS

First of all the area under investigation was physically surveyed and sampling location sites were selected. The inhabited area was given preference over forest area or area covered under shrubs. Altogether 15 sites were selected for sampling i.e. L1 to L15. The map of the sampling sites of the area is shown below in fig.3. The samples were collected from tube well, open well, and water bodies. The samples were collected from the tube wells after pumping out water for about 10 min to remove stagnant water from the well, The samples were collected in polystyrene bottles ranging in capacity from 0.5 to 1.5 L. The bottles were thoroughly pre-cleaned with water,

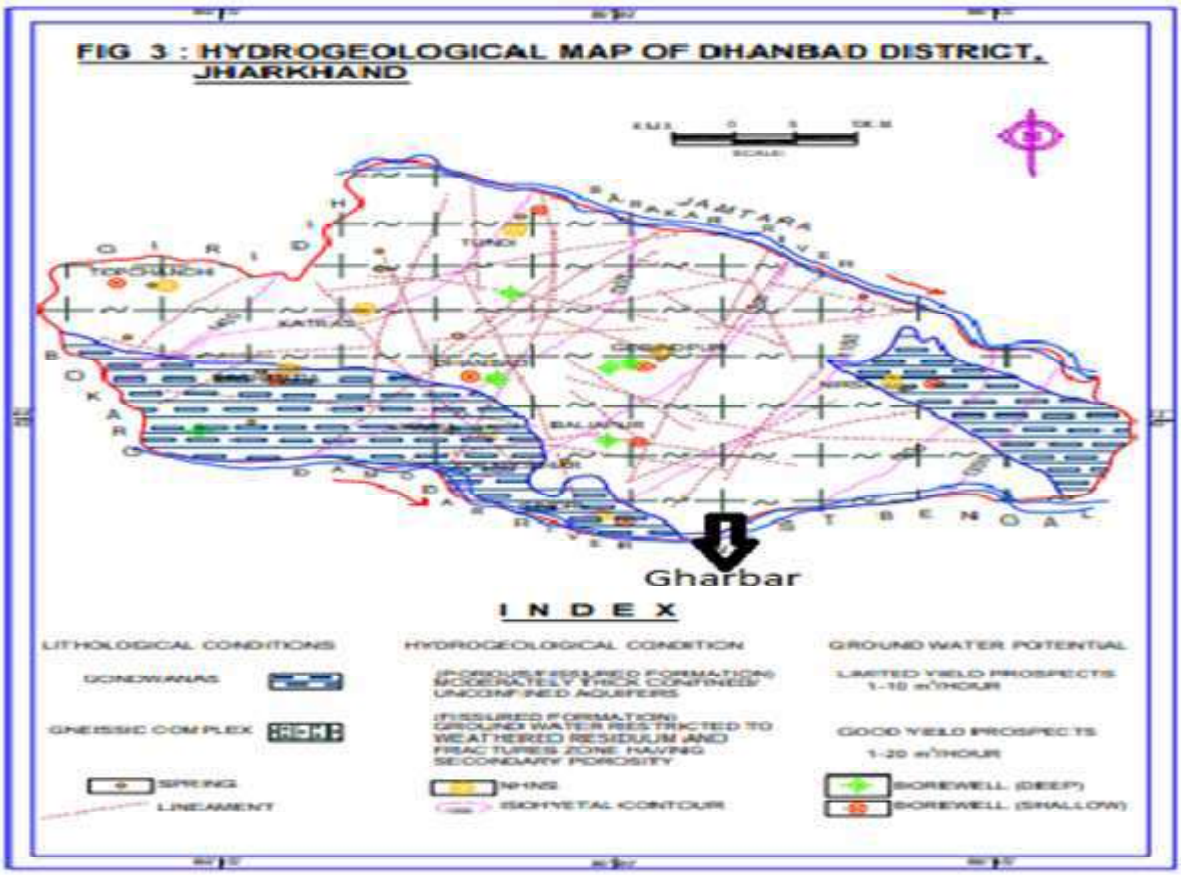


**Fig. 2- Hydrogeological map of the area (CGWB 2013)**

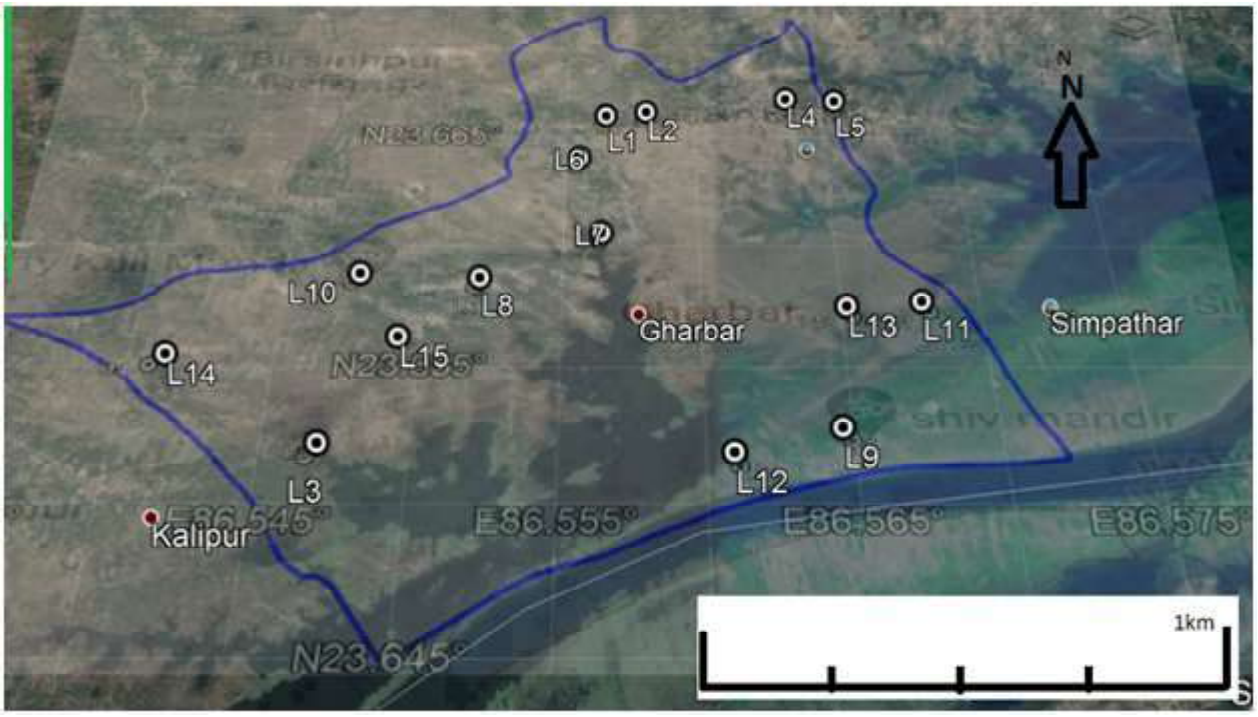


**Fig.3. Sampling locations points in the study area**

dilute nitric acid solution and with distilled water before taking samples. The water analyser S.371, Systronics, was used for determining temperature, odour, colour, pH, TDS and conductivity in the field area and also was analyzed in the laboratory for ion chemistry by following the procedures of standard method as described in APHA, 2017. By titration method Calcium (Ca) and Magnesium (Mg) were determined. Chloride (Cl) was determined by standard $AgNO_3$ titration. Sodium (Na) and Potassium (K) were determined by flame photometry. Sulphate ($SO_4^{2-}$) and nitrate ($NO_3^-$) were determined by UV Spectrophoto meter (UV 3200 lab India) and fluoride ($F^-$) was analyzed by colorimetric method. The fluoride concentration was cross checked on ion chromatograph to ascertain the fluoride concentration in samples.

## RESULTS & DISCUSSION

All the 15 samples of water, collected in May 2021 (Pre monsoon period) were chemically analyzed for. The results chemical analyses of these samples are shown in the table 1.

**Table 1. Physico- chemical parameters of the study area**

| Sample Id | pH | EC | TDS | $Na^+$ | $K^+$ | $Mg^{2+}$ | $Ca^{2+}$ | $F^-$ | $Cl^-$ | $HCO_3^-$ | $SO_4^{2-}$ | $NO_3^-$ | PO42- |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 6.4 | 620 | 970 | 363.3 | 12.9 | 19.6 | 112.6 | 1.58 | 395.3 | 368.2 | 113.6 | 116.4 | 5.7 |
| L2 | 6.5 | 680 | 1070 | 568.7 | 13.3 | 28.7 | 156.6 | 1.18 | 380.4 | 185.2 | 196.9 | 314.1 | 4.1 |
| L3 | 6.8 | 530 | 590 | 202.8 | 13.4 | 8.2 | 24.7 | 0.8 | 61.3 | 380.4 | 33.8 | 56.1 | 1.9 |
| L4 | 6.6 | 630 | 890 | 361.7 | 12.2 | 22.5 | 103 | 1.68 | 325 | 343.8 | 173.9 | 197.3 | 5.6 |
| L5 | 6.8 | 450 | 490 | 154.7 | 13.3 | 8.9 | 50 | 1.08 | 76.5 | 331.6 | 31.1 | 52.4 | 2.1 |
| L6 | 7 | 400 | 430 | 121.6 | 11.5 | 8.5 | 19.5 | 1.28 | 78 | 282.8 | 27.8 | 37.6 | 1.3 |
| L7 | 8.4 | 510 | 460 | 160.2 | 9.7 | 2.3 | 11.2 | 15.5 | 167.3 | 343.8 | 48.4 | 44.7 | 6.2 |
| L8 | 8.3 | 450 | 390 | 336.9 | 28.3 | 1.5 | 24.8 | 17.3 | 39.1 | 87.6 | 19.3 | 29.1 | 1.1 |
| L9 | 6.8 | 600 | 780 | 236.2 | 13 | 16.2 | 44.3 | 0.5 | 90.4 | 478 | 32.4 | 112.2 | 4 |
| L10 | 7.6 | 710 | 680 | 713 | 11.8 | 3.4 | 21.2 | 10.4 | 241.3 | 209.6 | 72.2 | 40.2 | 1 |
| L11 | 6.7 | 610 | 700 | 291.4 | 10.9 | 9.1 | 29.7 | 0.7 | 53.6 | 343.8 | 55 | 72.4 | 3.1 |
| L12 | 6.7 | 470 | 550 | 122.6 | 12.7 | 8.1 | 35.1 | 0.5 | 36.7 | 307.2 | 25.2 | 51.5 | 3.1 |
| L13 | 7.1 | 530 | 650 | 203.2 | 13.5 | 12.3 | 33.8 | 0.6 | 60.4 | 417 | 27.9 | 102.7 | 1.1 |
| L14 | 6.9 | 560 | 670 | 473.6 | 14.9 | 8.4 | 20.8 | 2.28 | 156.4 | 356 | 45.9 | 43.6 | 6.5 |
| L15 | 7.2 | 755 | 850 | 638.7 | 10.6 | 2.9 | 17.9 | 11.8 | 132 | 124.2 | 53 | 32.6 | 3.9 |
| ***Avg.*** | ***7.06*** | ***567*** | ***678*** | ***329.91*** | ***13.47*** | ***10.71*** | ***47.01*** | ***4.48*** | ***152.91*** | ***303.95*** | ***63.76*** | ***86.86*** | ***3.38*** |
| ***Max.*** | ***8.4*** | ***755*** | ***1070*** | ***713*** | ***28.3*** | ***28.7*** | ***156.6*** | ***17.3*** | ***395.3*** | ***478*** | ***196.9*** | ***314.1*** | ***6.5*** |
| ***Min.*** | ***6.4*** | ***400*** | ***390*** | ***121.6*** | ***9.7*** | ***1.5*** | ***11.2*** | ***0.5*** | ***36.7*** | ***87.6*** | ***19.3*** | ***29.1*** | ***1*** |

**Table.2. WHO and Indian Standard 10500 :2012 Standards**

| | Parameters | Drinking water as per IS 10500 :2012 | | Maximum WHO |
|---|---|---|---|---|
| | | Permissible Limit | Maximum limit | Permissible limit |
| 1 | pH | 6.5 to 8.5 | No relaxation | 6.5 to 8 |
| 2 | TDS | 500 | 2000 | 1000 mg/L |
| 3 | Nitrate | 45 | No relaxation | 50 mg/L |
| 4 | Sulphate | 200 | 400 | 400 mg/L |
| 5 | Fluoride | 1 | 1.5 mg/L | 1.5mg/L |
| 6 | Chloride | 250 | 1000 | 1000mg/L |
| 7 | Magnesium | 30 | 100 | 50 mg/L |
| 8 | Calcium | 75 | 200 | 75 mg/L |

**Table 3- The correlation coefficients of all the parameters**

| | pH | EC | TDS | Na+ | K+ | Mg2+ | Ca2+ | F− | Cl− | HCO3- | SO42- | NO3- | PO42- |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 1 | | | | | | | | | | | | |
| EC | -0.22 | 1.00 | | | | | | | | | | | |
| TDS | -0.61 | 0.81 | 1.00 | | | | | | | | | | |
| Na+ | 0.02 | 0.84 | 0.58 | 1.00 | | | | | | | | | |
| K+ | 0.42 | -0.34 | -0.32 | 0.01 | 1.00 | | | | | | | | |
| Mg2+ | -0.71 | 0.29 | 0.77 | 0.08 | -0.18 | 1.00 | | | | | | | |
| Ca2+ | -0.56 | 0.34 | 0.77 | 0.23 | -0.05 | 0.92 | 1.00 | | | | | | |
| F− | **0.91** | 0.08 | **-0.33** | **0.31** | **0.39** | **-0.62** | **-0.38** | 1.00 | | | | | |
| Cl− | -0.29 | 0.58 | 0.77 | 0.54 | -0.22 | 0.67 | 0.80 | -0.06 | 1.00 | | | | |
| HCO3- | -0.42 | -0.20 | 0.04 | -0.55 | -0.43 | 0.28 | -0.01 | **-0.64** | -0.09 | 1.00 | | | |
| SO42- | -0.40 | 0.56 | 0.80 | 0.47 | -0.20 | 0.80 | 0.88 | -0.18 | 0.89 | -0.14 | 1.00 | | |
| NO3- | -0.49 | 0.39 | 0.75 | 0.23 | -0.12 | 0.93 | 0.91 | -0.39 | 0.68 | 0.05 | 0.88 | 1.00 | |
| PO42- | -0.19 | 0.30 | 0.46 | 0.13 | -0.31 | 0.35 | 0.34 | -0.03 | 0.53 | 0.26 | 0.45 | 0.29 | 1.00 |

The hydrogen ion concentration of the samples reveals that it ranges from a minimum of 6.40 to maximum of 8.40 and average pH of the study area is 7.06 which suggest that 33% of the water samples are alkaline in nature where as almost 60% of the water samples are a acidic in nature. pH has strong correlation coefficient with fluoride. The spatial distribution of pH In the study area is shown below in Fig. no. 4

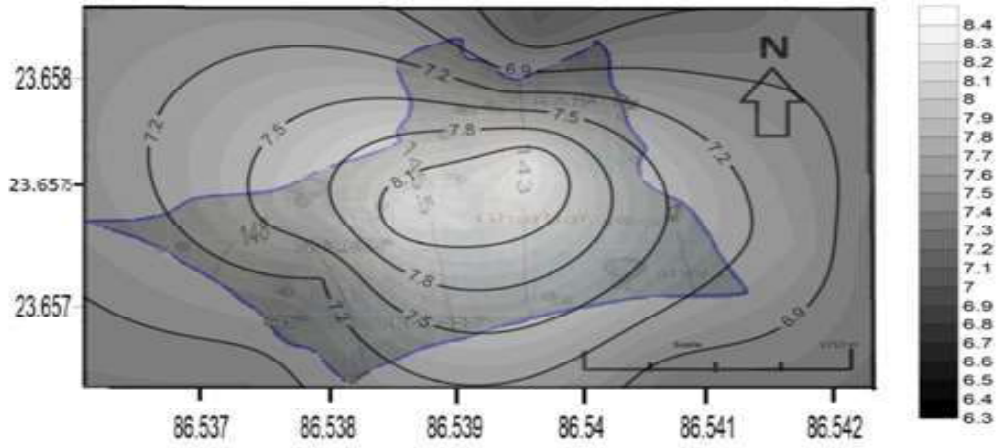


**Fig. 4- pH contour over base map of the study area**

The Electrical conductivity varied from 400 µS/cm to 755 µS /cm with an average value of 567µS/cm it shows positive correlation with Total Dissolved Solids (TDS) and sodium (Na+). The spatial distribution of Electrical conductivity (EC) in the study area is shown below in Fig. no. 5.

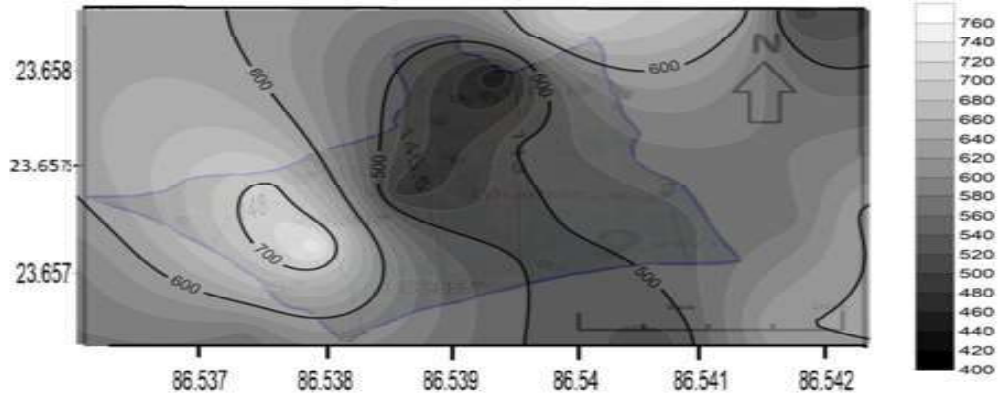


**Fig. 5- Electrical Conductivity contour over base map of the study area**

The Total Dissolved Solid (TDS) value represent the total concentration of substance dissolved in water, the study area TDS value is between minimum 390 to maximum of 1070 mg/L. The spatial distribution of TDS value in the study area is shown below in Fig no. 6

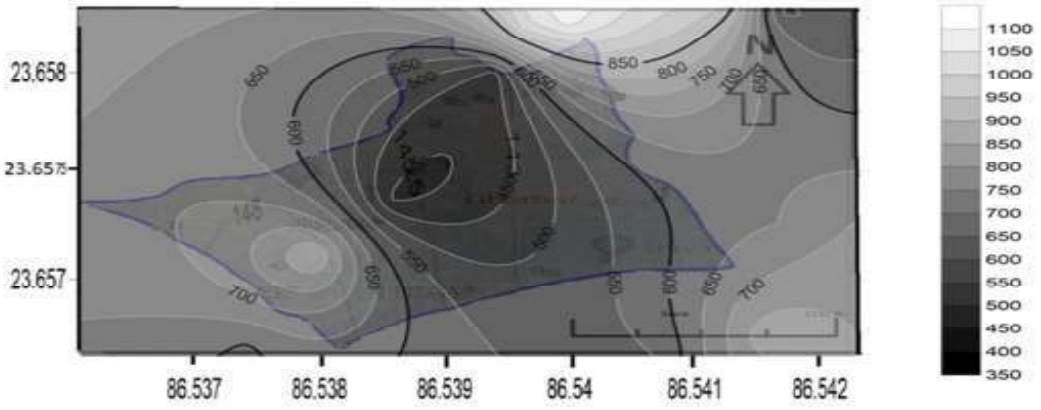


**Fig. 6. TDS value of the study area**

The Sodium ion concentration is found to be as low as 121.60 mg/L to a maximum of 713 mg/L. The average Sodium ion concentration in the study area is 329.91 mg/L, among all the cations Sodium ion is the most dominant cation which is an indicative of dissolution of rocks by weathering processes. The spatial distribution of Sodium in the study area is shown below in Fig no.7

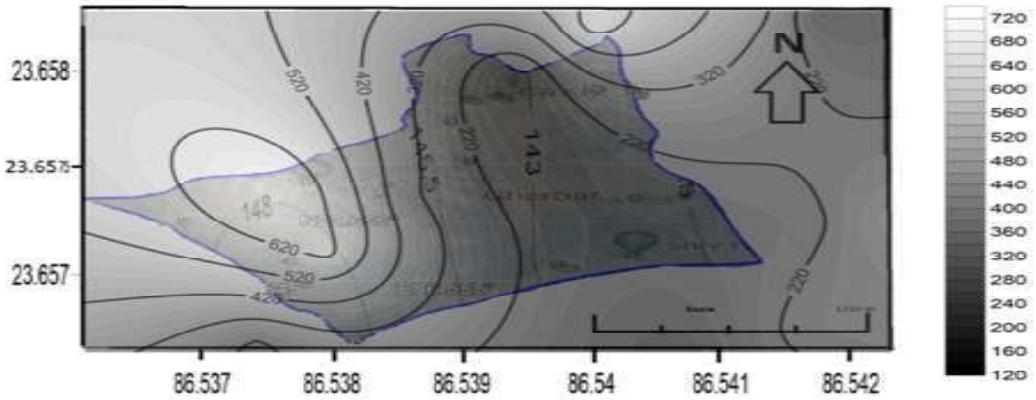


**Fig.7- Sodium (Na+) contour over base map of the area**

The Potassium (K) ion concentration varied from 9.70 to 28.30 mg/L with an average value of 13.4 mg/L. The Magnesium ion concentration varied from 1.50 mg/L to 28.70 mg/L. The spatial distribution of Potassium (K) in the study area is shown in Fig.8.

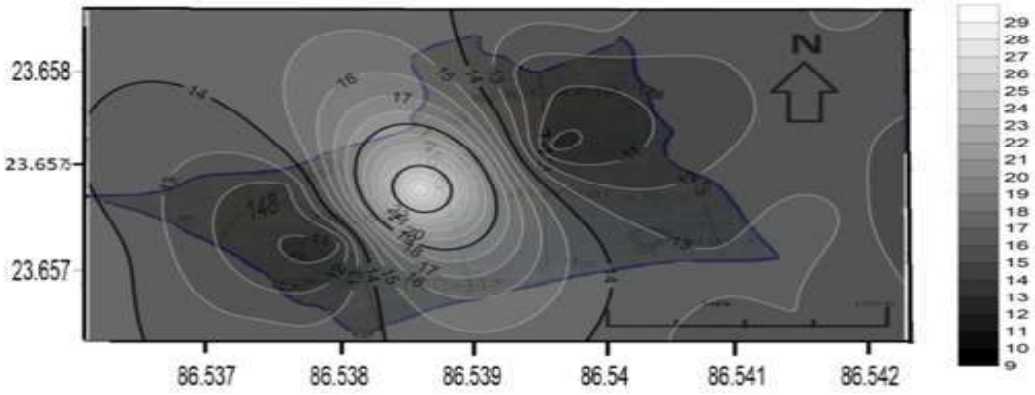


**Fig. 8- Potassium (K+) contour over base map of the area**

The Calcium ion ranges from 11.20 mg/L to a maximum of 156.60 mg/L. Calcium shows a negative correlation coefficient with fluoride. The spatial distribution of Calcium ($Ca^{2+}$) in the study area is shown in Fig.9.

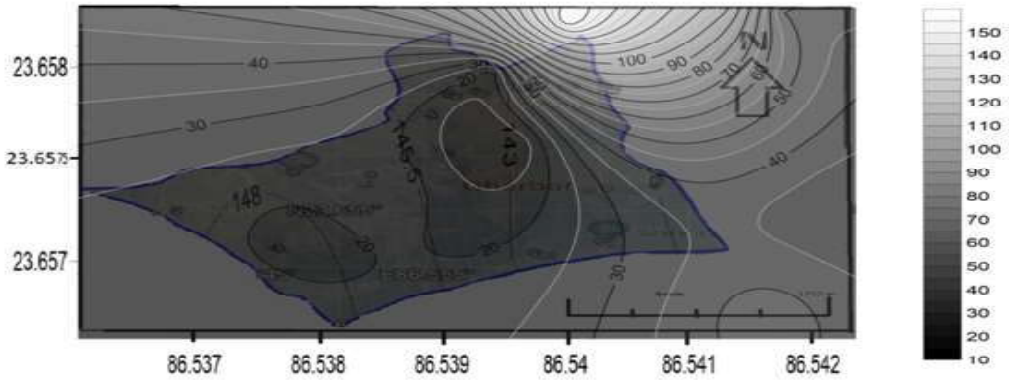


**Fig. 9- Calcium ($Ca^{2+}$) contour over base map of the area**

The magnesium ion concentration ranges between 1.50 to 28.70 mg/L with an average range of 10.71 mg/L. The spatial distribution of Magnesium ion is shown below in Fig. 10

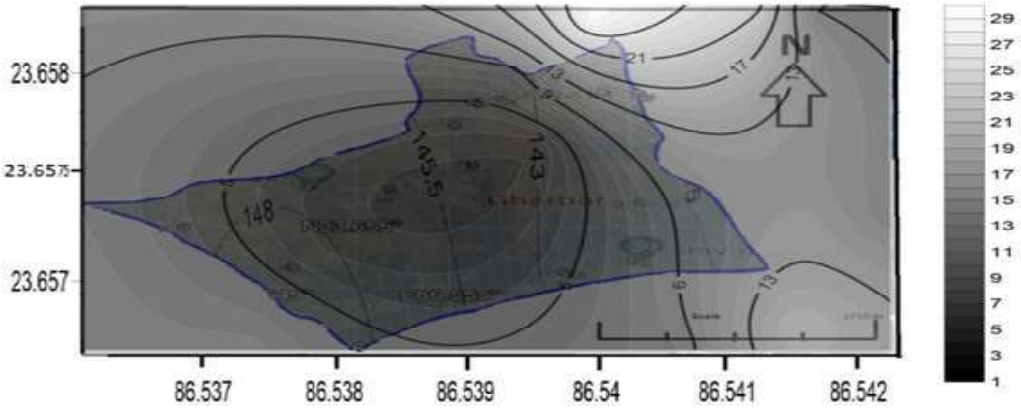


**Fig. 10- Magnesium ($Mg^{2+}$) contour over base map of the area**

The fluoride ion concentration varied between a low of 0.50 mg/L to a maximum of 17.30 mg/L. Of the 15 samples 7 samples are having higher concentration of fluoride. The permissible limit of fluoride concentration in drinking water, as per Indian Standards (IS 10500) is 1.5 mg/L. The water of samples sites L1, L4, L7, L8, L10, L14 and L 15 are not safe, the spatial distribution of fluoride in the study area is shown in Fig.11

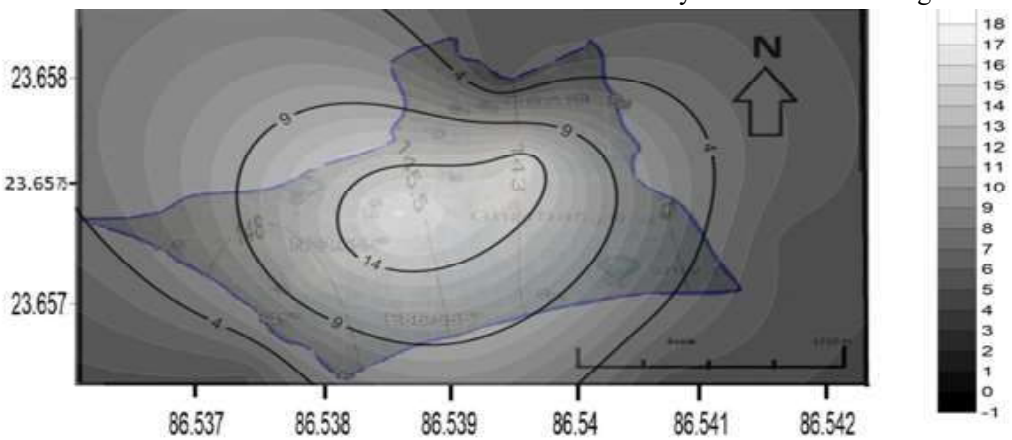


**Fig.11- Fluoride ($F^-$) contour over base map of the area**

The chloride ion concentration in the area varied from a low of 36.70 to a maximum of 395.30 mg/L. The bicarbonate ($HCO^{3-}$) concentration in the study area ranges from a low of 87.6mg/L to a maximum of 478 with an average value of 303.95 mg/L. The Sulphate ($SO_4^{2-}$) ion concentration in the study area ranges from 19.3 to 196.90 mg/ L with an average value of 63.76 mg/L.

## GROUND WATER FACIES

For delineaton of groundwater facies of the area Piper diagram was created using Grapher software for which the cations and anions data was converted into milli-equivalents per litre (meq/l) using the following formula

$$\frac{\text{Concentration (mg/L)} * \text{valence}}{\text{Atomic weight}}$$

after getting value in meq/L then we calculate value in meq/L % for each cations and anions respectively,

$$\frac{\text{cation concentration (meq)}*100\%}{\text{sum of all cation concentrations (meq)}}$$

$$\frac{\text{anion concentration (meq)}*100\%}{\text{Sum of all anion concentrations (meq)}}$$

The data thus obtained was put into Grapher software to plot the piper diagram which is shown in fig.12.

The piper diagram shows that out of 15 water samples collected 11 samples (73.33%) are of sodium bicarbonate type, 3 samples (20%) are of mixed type facies and 1 samples (6.6%) is of sodium chloride type.

## CONCLUSION

The area of present study, Gharbar panchayat is a part of Damodar sub basin which is underlain by Archean gneissic complex. The rocks are mainly composed of hornblende and biotite which in-tern is Fluoride containing minerals. The result of chemical analysis of ground water samples indicates that the ground water of Gharbar panchayt as high pH, high Bicarbonate, high sulphate and high Fluoride among the anions. Among the cations Calcium and Sodium are the dominant cations the concentration of fluoride in the entire area varied from a

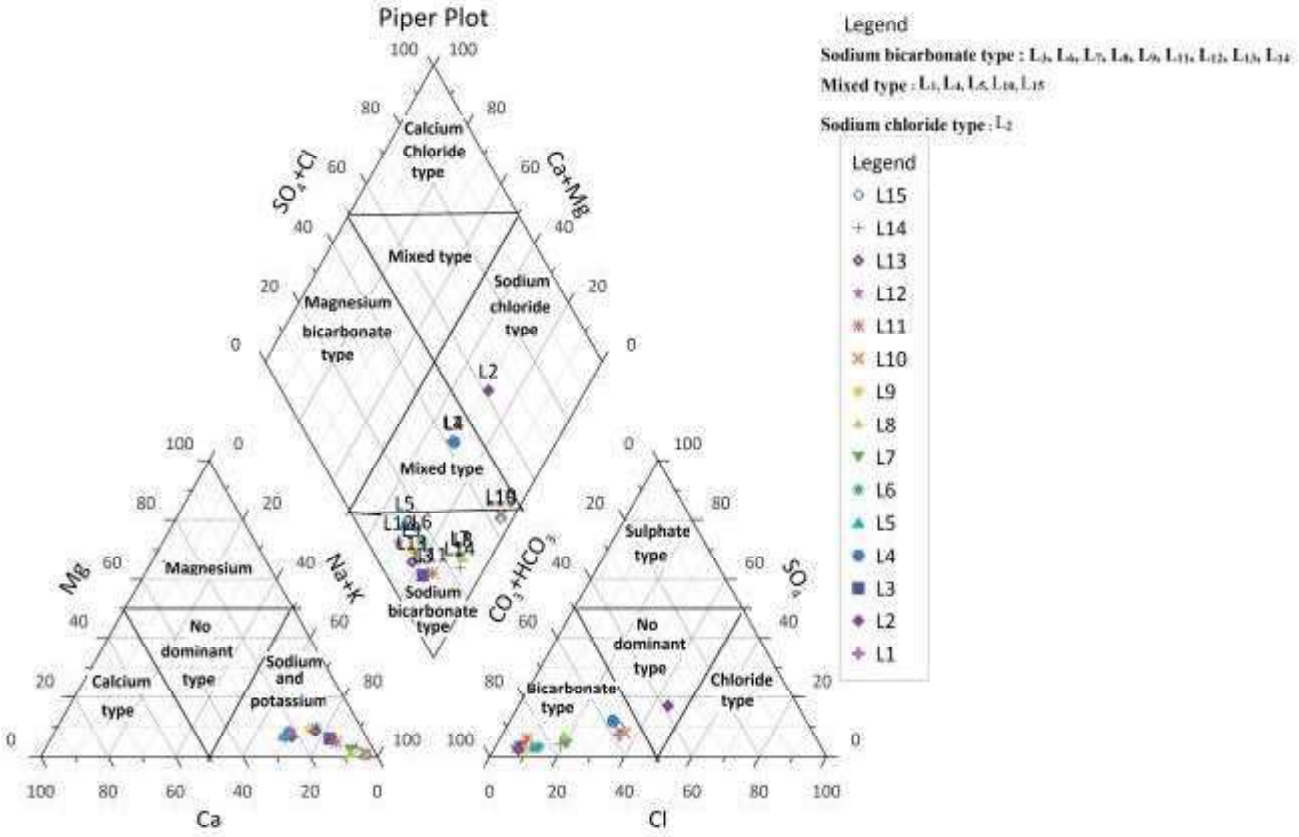


**Fig No. 12: Piper Diagram showing groundwater facies**

low of 0.50 mg/L to a high of 17.30 mg/L. As per the Indian Standard for drinking water (IS 10500-2012) the recommended limit of Fluoride in drinking water should be between 0.6 mg/L and 1.5 mg/L. The water samples of the site L9 and L12 are fluoride deficient which is responsible for Dental caries. The water samples of the site L1, L4, L7, L8, L10, L14 and L15 contains fluoride concentration beyond the permissible limit which is responsible for dental fluorosis, skeletal fluorosis in the people inhabiting in the area of study. The bicarbonate concentration is also beyond permissible limit. The alkaline aquifer condition of the study area is favouring dissolution of hornblende and biotite, the main fluoride bearing minerals in the area. The major problem of dental and skeletal fluorosis is found in the Brahman tola of Gharbar panchayat. All the 84 families of Brahman tola are adversely affected. The main cause of higher fluoride concentration in Brahman tola is likely to be geogenic in nature. The higher concentration of nitrate in the study area is due to sewage water, large scale use of organic manures and the vary location of Gharbar panchayat in Damodar sub basin.

## MANAGEMENT

In the entire study area the ground water is the only source of drinking water therefore the need of the our is that all the wells ( bore well as well as open well) containing higher fluoride concentration should be marked and the people should be advised not to use water of such wells for their domestic uses. The people of the area should be provided with safe drinking water. The Nalgonda technique, with the use of indigenous active charcoal, can also play an important role in providing safe drinking water in the area.

## ACKNOWLEDGEMENT

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# Volumetric Assessment of (*In situ*) Coal Bed Methane Gas of Raham Block, North Karanpura Coalfield

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**Abstract:** Coal, the fossil fuel, will continue to be dominating in the global energy scenario for many a decades from now. It will be the main source of power generation for the growing population and their increase in energy demand. The conventional method of utilization of coal for power generation has an adverse effect on the environment as compared to all other fossil fuels in basically two ways. Firstly, coal bed methane gas, an important green house gas, is released in the atmosphere in large quantities during mining and transportation of coal. Secondly, carbon dioxide gas and other gases produced during burning of coal. By using the methane gas we can use it as an alternate source of energy thereby helping the globe in reduction of global warming. This research paper gives the technique to find the volumetric assessment of (*in situ*) coal bed methane. It will be beneficial to calculate the volume of coal bed methane (CBM) that can be estimated from any reservoir depending upon basic available data and proximate analysis data of coal. The research paper has taken into account for representative samples from Raham block, North Karanpura Coalfield of Jharkhand, India to estimate the volume of CBM in the block.

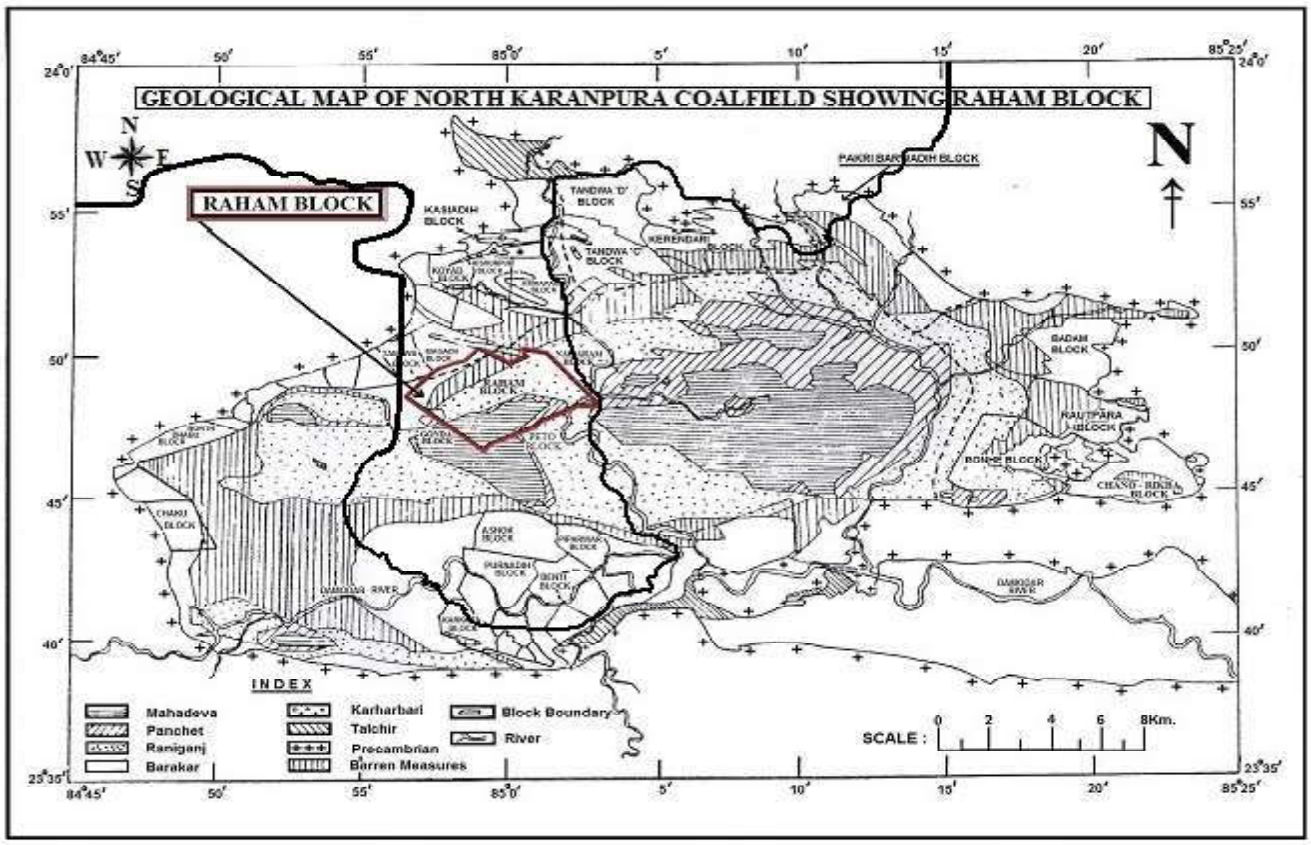
**Keywords: Coal, Proximate Analysis, CBM, Raham, North Karanpura**

## INTRODUCTION

Coal bed methane primarily methane is contained in coal. It is used commercially in gas fired electrical generators, as industrial fuel and also can be used as home heating fuel. CBM is referred as 'unconventional' form of natural gas because it is primarily stored through adsorption to the coal itself rather than in the pore space of the rock, like most of the other 'conventional' gas. The CBM gas is released with a drop of pressure in the coal reservoir. Commercial production of coal bed methane has been reported in the Eastern and Central part Sohagpur, Raniganj, Jharia and Bokaro Coalfields. Research is being carried out in North Karanpura Coalfield where enthusiastic prospect of CBM has been reported. Present paper has dealt with the representative samples taken from three parts i.e. Northern part, Middle part and Southern part of the Raham Block, North Karanpura Coalfield of Jharkhand, India to shows the technique or the formula to estimate the volume of coal bed methane present in the area. It gives the new technique to estimates the volume of coal bed methane; it has been presented by taking basic parameters of coal and the data incurred by chemical analysis i.e. proximate analysis. The data achieved are quite enthusiastic as the result match the data incurred by comparing with empirical formula given by Meissner and Kim. Hence a new formula has been proposed that gives the same result but here author's have used the basic parameter of proximate analysis in incurring CBM volume.

### Location of Raham Block

Raham block is covered in Survey of India Topo - sheet no. 73 A/13 (RF 1:50,000) in west and 73 E/1 in east and bounded by Latitudes 23°47'38" N and 23°50'22" N & Longitudes 84°57'38" E and 85°02'02" E. Raham block of North Karanpura coalfield is located in Tandwa sub-division of Chatra district of Jharkhand state.(Map 1)




**Map 1: Showing study Area "Raham Block" of North Karanpura coalfield (Source: GSI)**

**Geology of Raham Block**

The geologic features are in continuity with the adjoining area of North Karanpura coalfield. Barakar, Barren Measure and Raniganj formations of lower Gondwana series occur in the block in the chronological order of younger above older are exposed on the surface.[1] The Barakar and Barren measure formation occupy major portion of the Raham block. Four faults are interpreted to be present in the Raham block.[2] Raham block is located on the northern limb of the north Karanpura basin where strata dip towards south.

## MATERIALS & METHODS

More than 100 samples were studied for this purpose and selected 21 numbers of samples were taken for assessment of coal bed methane of Raham Block of North Karanpura Coalfield, District – Chatra, Jharkhand, India.[3] The samples were drilled by South West Pinnacle Exploration by the work order of Central Mine Planning and Design Institute, Ranchi and samples were sent to Central Institute of Mining and Fuel Research, Ranchi. The half reserve borehole samples were collected by the courtesy of Central Institute of Mining and Fuel Research, Ranchi and analysis was done by author. Sampling was done as per Indian Standard IS: 436 (Part I)-1976 and Reduction of Gross Samples was done as per Indian Standard IS: 436 (Part I)-1964. Chemical analysis i.e. Proximate analysis was done as per Indian Standard IS: 1350 (Part I)-1984.[4]

Gas content determination techniques generally fall into two categories:

1. Direct methods which actually measure the volume of gas released from coal sample sealed the desorption canister
2. Indirect methods based on empirical correlations, or laboratory derived sorption isotherm gas storage capacity data.

The total gas content by the in direct methods is based on the empirical formula given by Meissner and Kim, which was in general use till date, but now authors have proposed another formula to calculate the volumetric analysis of (*in situ*) Coal Bed methane.[5]

The data incurred from the chemical analysis and the basic parameters were considered and equation was formulated to estimate the gas in place volume of coal bed methane ($CH_4$). GIIP ($CH_4$) Volume in Million Cubic Meter (MCM) is mentioned below as:

Author's Formula for CBM resource estimation:

**Vol. of $CH_4$ = {[100-(M+A+VM)] + (Area/10) [(TxDxGC)/100] - FC (BCM)}*240**

Where,

| | | |
|---|---|---|
| Vol. | = | Volume |
| $CH_4$ | = | Coal bed methane |
| MCM | = | Unit of Volume of methane gas i.e. Million Cubic Meter |
| BCM | = | Unit of Volume of methane gas i.e. Billion Cubic Meter |
| M | = | Moisture % |
| A | = | Ash % |
| VM | = | Volatile Matter % |
| FC | = | Fixed Carbon % |
| Area | = | Area in Square Kilometre |
| T | = | Thickness in Meter |
| D | = | Density in Gram per Cubic Centimetre |
| GC | = | Gas Content in Cubic Centimetre per Gram |

The Author's formula for estimation of volume of CBM would be helpful for resource estimation and exploration of CBM.

## RESULTS & DISCUSSIONS

**Table 1- Shows estimated CBM content by using author's formula:**

| Description | | | | | Proximate Analysis (As Analysis) | | | | Basic Parameters | | | Estimated |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bore Hole No | Depth (m) | Thick (m) | Seam | Sample Detail | M % | A % | VM % | FC % | Area (Sq.Km) | Density (gm/cc) | GC (cc/gm) | CBM (MCM) |
| SPNR11 (North) | 124.44 | 2.32 | IV | A1 | 6.3 | 28.7 | 22.7 | 42.3 | 16.9 | 1.5 | 6 | 80.63016 |
| | 131.79 | 4.09 | III | A2 | 5.8 | 31.7 | 21.8 | 40.7 | 16.9 | 1.5 | 6 | 142.1455 |
| | 163.78 | 1.76 | II (T) | A3 | 5.3 | 43.8 | 19.5 | 31.4 | 16.9 | 1.5 | 6 | 61.16784 |
| | 185.50 | 1.10 | II (B) | A4 | 4.4 | 40.9 | 21.3 | 33.4 | 16.9 | 1.5 | 6 | 38.22984 |
| | 187.20 | 4.24 | I (T) | A5 | 3.8 | 41.4 | 20.6 | 34.2 | 16.9 | 1.5 | 6 | 147.3586 |
| | 193.15 | 2.55 | I (M) | A6 | 3.9 | 41.2 | 20.9 | 34.0 | 16.9 | 1.5 | 6 | 88.6236 |
| | 217.61 | 5.12 | I (B) | A7 | 3.4 | 41.0 | 20.9 | 34.7 | 16.9 | 1.5 | 6 | 177.9425 |
| | 224.93 | 2.02 | I (B) | A8 | 3.1 | 47.0 | 19.2 | 30.7 | 16.9 | 1.5 | 6 | 70.20384 |
| SPNR 8 (Middle) | 338.07 | 1.88 | IV | A9 | 3.9 | 39.1 | 22.8 | 34.2 | 16.9 | 1.5 | 7 | 76.22808 |
| | 343.20 | 6.49 | III | A10 | 3.4 | 35.2 | 23.7 | 37.7 | 16.9 | 1.5 | 7 | 263.1487 |
| | 378.30 | 1.97 | II (T) | A11 | 2.8 | 45.5 | 20.1 | 31.6 | 16.9 | 1.5 | 7 | 79.87728 |
| | 380.27 | 2.20 | II (B) | A12 | 2.6 | 47.9 | 19.8 | 29.7 | 16.9 | 1.5 | 7 | 89.20296 |
| | 383.62 | 2.89 | I (T) | A13 | 2.6 | 43.1 | 21.6 | 32.7 | 16.9 | 1.5 | 7 | 117.1802 |
| | 393.35 | 6.90 | I (M) | A14 | 2.8 | 40.8 | 21.9 | 34.5 | 16.9 | 1.5 | 7 | 279.773 |
| | 411.30 | 5.13 | I (B) | A15 | 2.4 | 38.7 | 19.6 | 39.3 | 16.9 | 1.5 | 7 | 208.0051 |
| SPNR10 (South) | 550.86 | 2.57 | IV (T) | A16 | 2.1 | 40.4 | 7.0 | 50.5 | 16.9 | 1.5 | 8 | 119.0918 |
| | 551.57 | 3.28 | IV (B) | A17 | 2.0 | 42.8 | 7.3 | 47.9 | 16.9 | 1.5 | 8 | 151.9925 |
| | 562.10 | 6.46 | III (T) | A18 | 2.0 | 43.3 | 7.8 | 46.9 | 16.9 | 1.5 | 8 | 299.3513 |
| | 568.56 | 3.13 | III (B) | A19 | 2.5 | 42.1 | 7.4 | 48.0 | 16.9 | 1.5 | 8 | 145.0416 |
| | 571.69 | 0.58 | II (T) | A20 | 2.8 | 54.7 | 8.3 | 34.2 | 16.9 | 1.5 | 8 | 26.87664 |
| | 572.70 | 0.46 | II (M) | A21 | 2.4 | 42.7 | 9.0 | 45.9 | 16.9 | 1.5 | 8 | 21.31608 |
| | 606.35 | 1.28 | II (B) | A22 | 2.8 | 54.6 | 7.6 | 35.0 | 16.9 | 1.5 | 8 | 59.31408 |
| | 612.00 | 1.68 | I (T) | A23 | 2.7 | 55.8 | 7.5 | 34.0 | 16.9 | 1.5 | 8 | 77.84976 |
| | 615.62 | 6.67 | I (T) | A24 | 2.1 | 50.8 | 7.0 | 40.1 | 16.9 | 1.5 | 8 | 309.0826 |
| | 619.19 | 2.91 | I (T) | A25 | 2.0 | 42.5 | 7.2 | 48.3 | 16.9 | 1.5 | 8 | 134.8471 |
| | 638.39 | 7.16 | I (M) | A26 | 2.0 | 47.2 | 7.7 | 43.1 | 16.9 | 1.5 | 8 | 331.7887 |
| | 645.55 | 5.90 | I (M) | A27 | 2.1 | 42.2 | 7.8 | 47.9 | 16.9 | 1.5 | 8 | 273.4013 |
| | 659.50 | 0.71 | I (B) | A28 | 1.3 | 42.9 | 17.7 | 38.1 | 16.9 | 1.5 | 8 | 32.90088 |
| | 660.21 | 15.87 | I (B) | A29 | 1.2 | 41.6 | 18.6 | 38.6 | 16.9 | 1.5 | 8 | 735.4032 |
| | Total Gas In Place volume of coal bed methane estimated in Million Cubic Meter | | | | | | | | | | | **4637.975** |

The data acquired shows proximate analysis values indicating moisture, ash, volatile matter and fixed carbon percentage that ranges from 1.2% to 6.3%, 28.7% to 55.8%, 7.0% to 23.7% and 29.7% to 50.5% respectively.[6] The total coal bed methane (CBM) estimated comes to 4637.975 MCM (Million Cubic Meter).

Coal bed methane (CBM) or coal bed gas is a form of natural gas extracted from coal beds. The term refers to methane adsorbed into the solid matrix of the coal. The total gas content estimated by the indirect methods is based on the empirical formula given by Meissner and Kim. The quantity of gas is determined by Meissner and Kim formula by using the moisture content, volatile matter, volume of gas adsorbed on wet coal, fixed carbon, thickness of coal and temperature. Meissner (1984) observed that the amount of methane gas ($VCH_4$) is related to volatile matter (DAF).

$VCH_4$ = "325.6 × log (V.M/37.8)

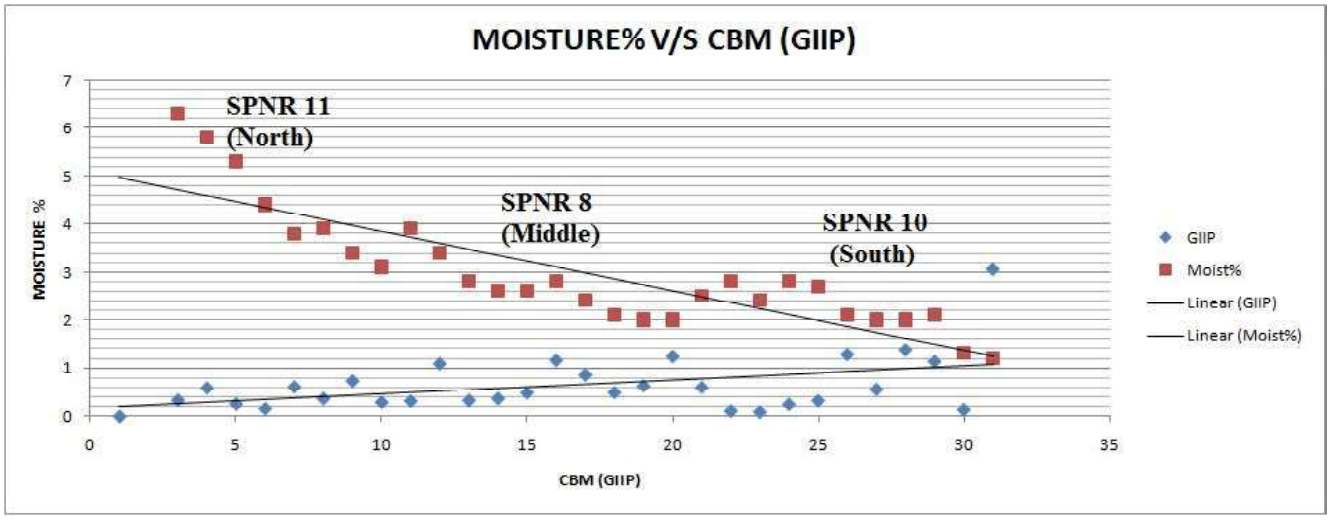
**Table 2- Showing comparative result of Kim & Meissner and Author's data:**

| Description | | | | | Proximate data | Kim & Meissner | Author's |
|---|---|---|---|---|---|---|---|
| Bore Hole No | Depth (m) | Thick (m) | Seam | Sample Detail | VM % | Estimate (MCM) | Estimate (MCM) |
| SPNR11 | 124.44 | 2.32 | IV | A1 | 22.7 | 72.10931092 | 80.63016 |
| (North) | 131.79 | 4.09 | III | A2 | 21.8 | 77.82989571 | 142.1455 |
| | 163.78 | 1.76 | II (T) | A3 | 19.5 | 93.59606057 | 61.16784 |
| | 185.5 | 1.1 | II (B) | A4 | 21.3 | 81.11093115 | 38.22984 |
| | 187.2 | 4.24 | I (T) | A5 | 20.6 | 85.83616307 | 147.3586 |
| | 193.15 | 2.55 | I (M) | A6 | 20.9 | 83.79169927 | 88.6236 |
| | 217.61 | 5.12 | I (B) | A7 | 20.9 | 83.79169927 | 177.9425 |
| | 224.93 | 2.02 | I (B) | A8 | 19.2 | 95.78844996 | 70.20384 |
| SPNR 8 | 338.07 | 1.88 | IV | A9 | 22.8 | 71.48774384 | 76.22808 |
| (Middle) | 343.2 | 6.49 | III | A10 | 23.7 | 66.01326857 | 263.1487 |
| | 378.3 | 1.97 | II (T) | A11 | 20.1 | 89.31069373 | 79.87728 |
| | 380.27 | 2.2 | II (B) | A12 | 19.8 | 91.43714408 | 89.20296 |
| | 383.62 | 2.89 | I (T) | A13 | 21.6 | 79.13318865 | 117.1802 |
| | 393.35 | 6.9 | I (M) | A14 | 21.9 | 77.18272624 | 279.773 |
| | 411.3 | 5.13 | I (B) | A15 | 19.6 | 92.87275319 | 208.0051 |
| | 550.86 | 2.57 | IV (T) | A16 | 7 | 238.4674082 | 119.0918 |
| | 551.57 | 3.28 | IV (B) | A17 | 7.3 | 232.5334068 | 151.9925 |
| | 562.1 | 6.46 | III (T) | A18 | 7.8 | 223.1653274 | 299.3513 |
| | 568.56 | 3.13 | III (B) | A19 | 7.4 | 230.6094821 | 145.0416 |
| | 571.69 | 0.58 | II (T) | A20 | 8.3 | 214.3795031 | 26.87664 |
| | 572.7 | 0.46 | II (M) | A21 | 9 | 202.929969 | 21.31608 |
| | 606.35 | 1.28 | II (B) | A22 | 7.6 | 226.8384244 | 59.31408 |
| SPNR10 | 612 | 1.68 | I (T) | A23 | 7.5 | 228.7113827 | 77.84976 |
| (South) | 615.62 | 6.67 | I (T) | A24 | 7 | 238.4674082 | 309.0826 |
| | 619.19 | 2.91 | I (T) | A25 | 7.2 | 234.4838692 | 134.8471 |
| | 638.39 | 7.16 | I (M) | A26 | 7.7 | 224.9899499 | 331.7887 |
| | 645.55 | 5.9 | I (M) | A27 | 7.8 | 223.1653274 | 273.4013 |
| | 659.5 | 0.71 | I (B) | A28 | 17.7 | 107.2912345 | 32.90088 |
| | 660.21 | 15.87 | I (B) | A29 | 18.6 | 100.2779154 | 735.4032 |
| TOTAL GAS IN PLACE IN Million Cubic Meter (MCM) | | | | | | 4167.602336 | 4637.97474 |
| TOTAL GAS IN PLACE IN Billion Cubic Meter (BCM) | | | | | | 4.17 | 4.64 |

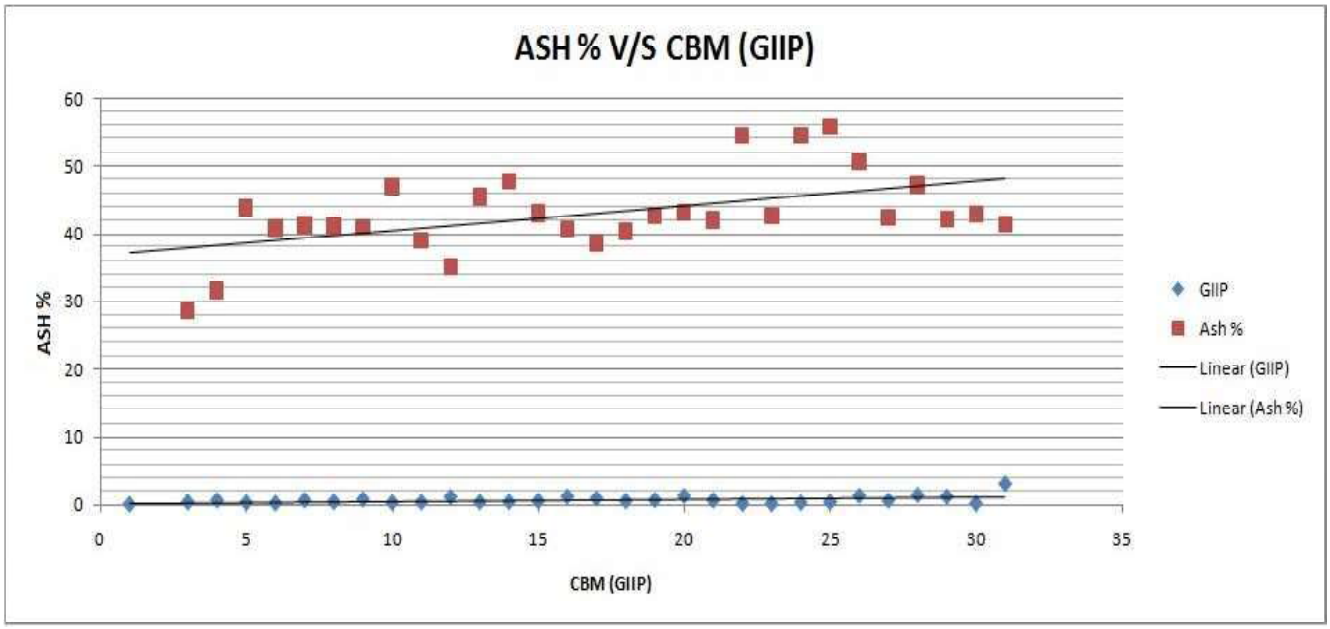
The table above illustrates the relation between proximate analysis data and CBM gas in place with depth. Coal bed methane increases from North to South part of the Raham block.

The graphs depict the trendline of Moisture, Ash, Volatile matter and Fixed Carbon. The trendline of Coal Bed Methane generation is also depicted in the figures. As we move from Northern part of the Raham coal block to Southern part, the Ash, Volatile Matter and Fixed Carbon increase. It indicates that matured and high rank coal can be found in the southern part which is rich in Coal bed Methane.[7] The trendline of Ash and Fixed Carbon trendline increases on moving from North to South, this depicts that due to faulting, much of plant matter along with debris have been deposited. CBM trendline indicates that methane gas is generated more in southern part than northern part.

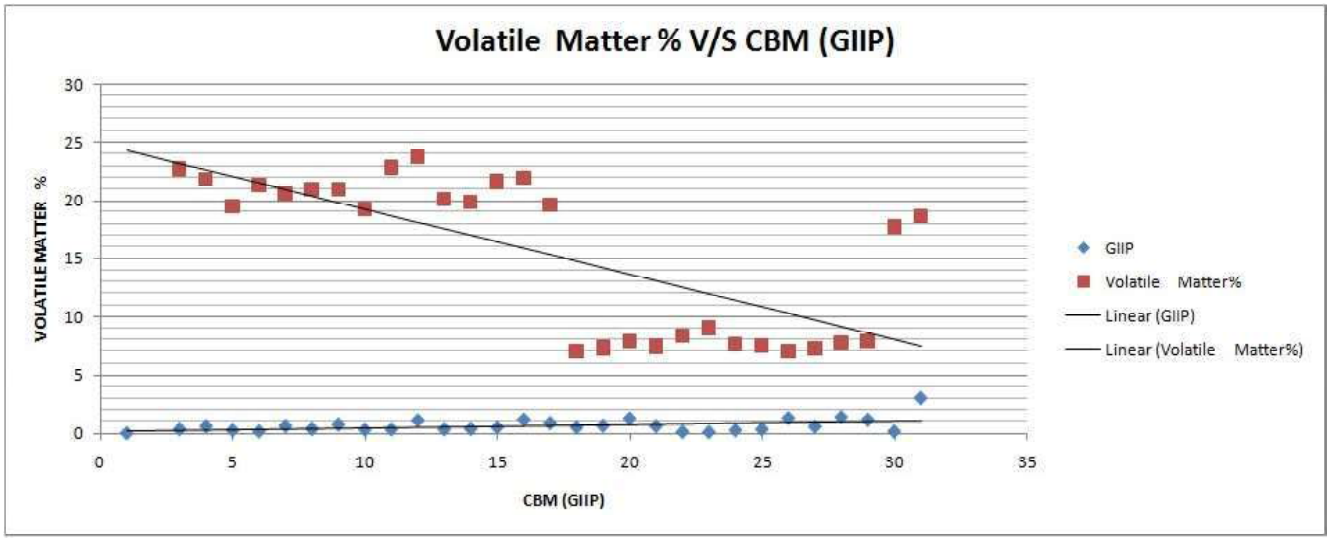
Graphical presentation of CBM gas generated (m3) with respect to proximate data: Moisture decreases with increase with methane gas generation.



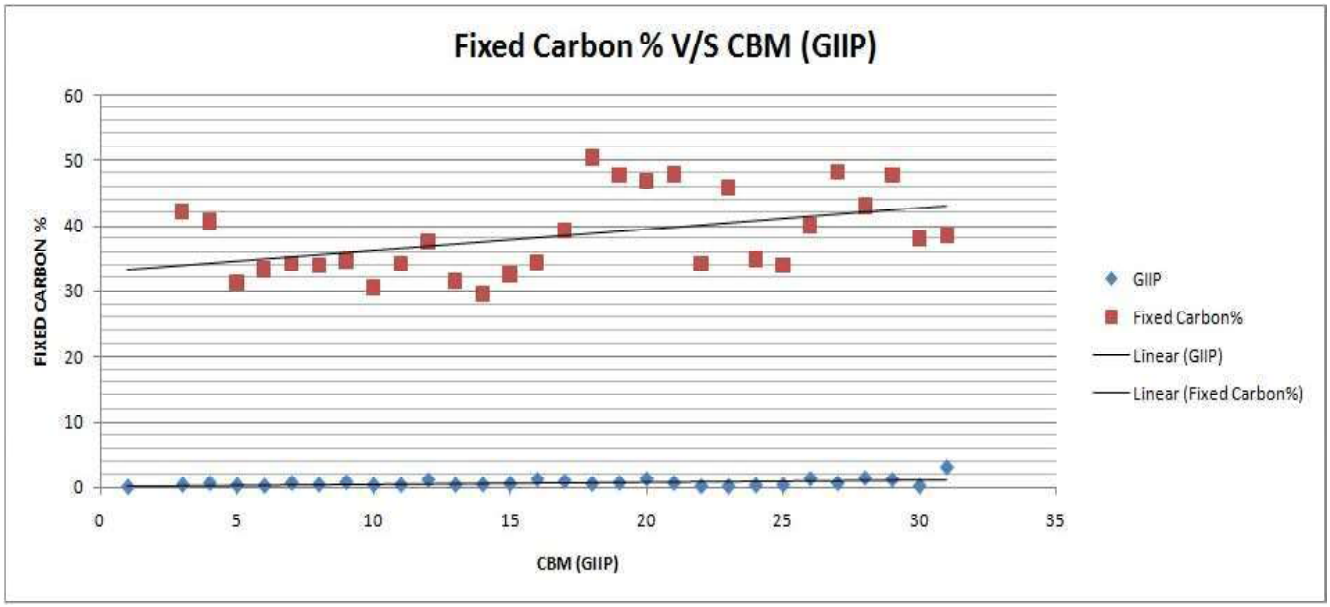

**Graph 1: Shows Moisture decreases with increase with methane gas generation.**




**Graph 2: Shows Ash increases with increase in methane from North to South of the block**




**Graph 3: Shows Volatile Matter decreases with increase of methane gas**




**Graph 4: Shows Fixed carbon increases with increase of methane gas**

Raham block has not felt the thrust of any mining activity since it is still a virgin block. The Author's formula for estimation of volume of CBM can be used with proximate analysis data and basic parameters taking into consideration. So this formula will also be helpful in correlating volume of CBM with the proximate data and basic parameters.

**Inference**

The correlations of chemical analysis data with coal bed methane gas (*in situ*) clearly depict a relation as under:

- **Moisture** decreases with increase in methane gas generation. So Moisture is inversely proportional to coal bed methane (*in situ*).
- **Ash** increases with increase in methane gas generation. So Ash is directly proportional to coal bed methane (*in situ*).
- **Volatile Matter** decreases with increase of methane gas generation. So Volatile Matter is inversely proportional to coal bed methane (*in situ*).

- **Fixed carbon** increases with increase of methane gas generation. So Fixed Carbon is directly proportional to coal bed methane (*in situ*).

## CONCLUSION

The Raham block coal samples have been taken as representative samples for deriving the formula for quantitative measurement of coal bed methane from coal reservoir. The authors have tried to propose the relation between CBM gas generated and their relation between moisture, ash, volatile matter and fixed carbon. The volumetric analysis of coal is determined by two methods i.e. Direct and Indirect method using the empirical formula given by Meissner and Kim; the research paper shows that there is alternate method to determine the volumetric analysis of CBM using the basic chemical analysis parameters. The data incurred by the research work shows a comparative study between the two formulae and found that the proposed formula gives close results. The above data was also used to deduce a relation between the basic chemical analysis parameters and it was found that moisture and volatile matter decreases with increase in coal bed methane gas generation also ash and fixed carbon increase with increase in methane gas generation.[8] This shows that moisture and volatile matter are inversely proportional also ash and fixed carbon are directly proportional to coal bed methane (*in situ*) generated. The research work can be of immense help for CBM industries who can use the author's formula and would be able to correlate the chemical data directly with coal bed methane (*in situ*) generated. The work done by the authors will be a milestone for new researchers and CBM industry.

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# Palynological dating of subsurface sample number WBPS-2 of Pundi area, West Bokaro Coalfield

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**Abstract:** The Present palynological investigation deals with the study of the Lower Gondwana sediments of Borehole no.- WBPS-2 from the Pundi area of West Bokaro Coalfield, Damodar basin, Jharkhand, India. The Coal bearing sediments recovered from the sub-surface samples (borehole WBPS-2) have been characterized with a distinct palynoassemblage which is dominated by the non-striate bisaccate genera represented by Schueringipollenites and sub-dominance of striate bisaccate Striatopodocarpites and Faunipollenites. The recovered Palynoassemblage has been compared with the known biostratigraphic zones of the other basin and suggested its equivalence to the Lower Barakar (Artinskian age).

**Keywords: Palynodating, Barakar Formation, Artinskian, West Bokaro Coalfield**

## INTRODUCTION

The Bokaro coalfield is an important coalfield of Damodar Basin and is divided by Lugu Hill into East and West Bokaro coalfields[1].The West Bokaro Coalfield is located in the districts of Hazaribagh and Ramgarh in Jharkhand. The Pundi area is an open cast mine situated in the western part of West Bokaro coalfields in Ramgarh district.

Throughout the years Playnomorphs have been used to study the Palaeoenvironment, Palaeoclimate, correlation and age determination of the Gondwana sequence. From the previous studies it is proved that spore dispersae is a unique parameter for dating and correlation of strata. Pioneering works on palynology have been done on the Lower Gondwana sediments by Chinna Virkki followed by Birbal Sahni with emphasis on Palaeo-botanical studies of coal in India. Surange worked on palynomorphs of Lower Gondwana sediments[2]. Anand–Prakash[3], Srivastava and Jha[4], Ram-Awatar[5], Murthy[1], and Meena[6] have reported and studied Early Permian palynomorphs of West Bokaro Coalfield.

In Palynological dating, pollen grains produced by seed plants (angiosperms and gymnosperms) and spores (pteridophytes) are studied. The pollen is the most vital part of the flowering plants with a special structure and function. The hard outer coat of pollen grains called the exine, embodies morphological characteristics that serve to identify the plant it belongs to, thus becoming useful in the studies of plant taxonomy and several other applied aspects of pollen studies. The present investigation is focused on the palynological dating of the sediments of subsurface samples of borehole WBPS-2 from the Pundi area of West Bokaro Coalfield in Ramgarh district, Jharkhand. The investigation is focused on Quantitative and qualitative analysis of the palynomorphs from samples from different depths of Borehole no. WBPS-2. Comparisons with other Lower Permian palynoassem blages of Gondwana basins of Peninsular India have also been done for age distinction.

**Geology:**

The Pundi Open Cast Mine is a part of Kuju area of Central Coalfields Limited (C.C.L) Ranchi. The location of Borehole no. WBPS-2 is Latitude 23$^0$49'52"N and Longitude 85$^0$32'56"E. The Pundi area has Archean basement rocks overlained by an unconformity followed by formations of Karharbari, Barakar, Barren Measures, Raniganj and Panchet ranging from Permo-Carboniferous to Jurassic and Post- Jurassic. The geology of the West Bokaro coalfield has been shown on Fig. 1 and the stratigraphy of the Pundi area is shown in Table 1. The location of the borehole is shown on Fig. 2.

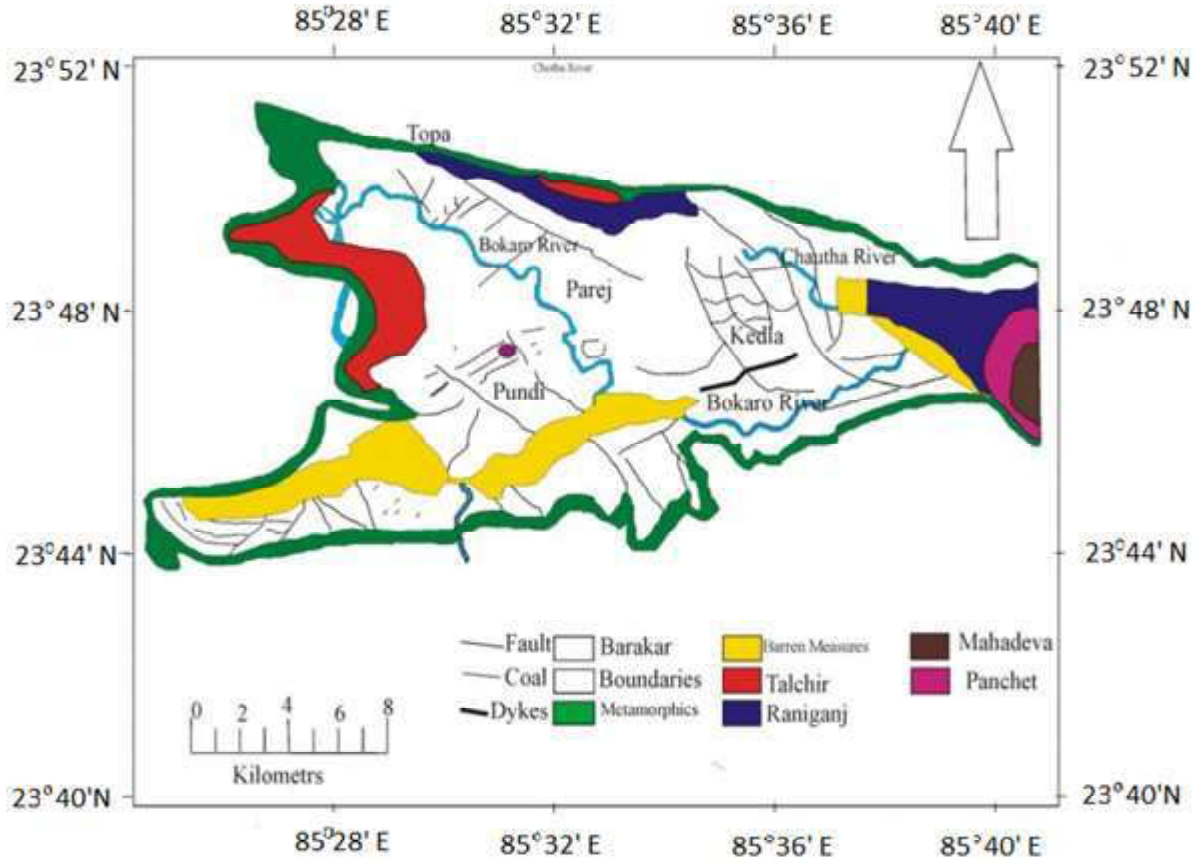


**Fig. 1: Map showing the Geology of the West Bokaro Coalfield (Raja Rao, 1987,modified by Lakra[9])**

**Table 1: Stratigrahic Sequence of Pundi area (Prepared by Author[9]).**

| Age | Formation | Description |
|---|---|---|
| Jurassic and Post Jurassic | Panchet | Micaceous fine grained sandstone intercalated with shale |
| Upper Permian | Raniganj | Sandstone, Grey shale with thin coal seam |
| Middle Permian | Barren Measures | Grey micaceous and carbonaceous shale inter-bedded with thin furrugineous sandstone |
| Lower Permian | Barakar Formation | Medium to course grained sandstone, pebbly Barakar Formation the Lower portion with shale, sandy shale |
| Permo-Carboniferous | Karharbari Formation | Mainly arkosic sandstone, coal seams |
| Unconformity | | |

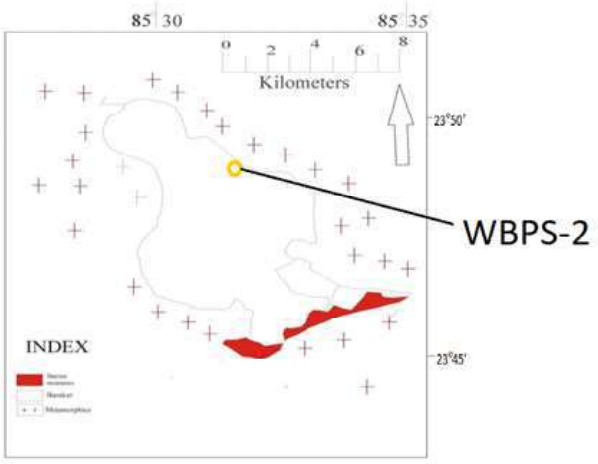


**Fig.2: Map showing location of Borehole WBPS-2 in Pundi area (C.C.L, 2006, modified by Lakra[9])**

## MATERIALS & METHOD

The present work comprises of Quantitative study of miospore genera of borehole no. WBPS-2. The maceration technique used for the present palynological study is based on (Bharadwaj and Salujha[7], Jha and Mahto[8] and Lakra *et al.* [9]).

10-15 grams of sample material was taken in a maceration jar and was washed thoroughly with water to remove the impurities. It was then treated with 200 cc of commercial Nitric acid and was placed in fume chamber for oxidation, with the material being stirred occasionally. The coal sample usually takes 3-5 days for oxidation while carbonaceous shale takes 2-3 days for complete oxidation. After oxidation the sample was washed with clean water to remove acid and was taken in a porcelain dish. It was then treated with 10% Potassium hydroxide solution and was heated upto simmering point with constant stirring and then was removed to cool and settle down. Then the alkali was drained off and sample was washed thoroughly with clean water.

The material was first then sieved through 150 and then through 400 meshes size. After sieving the material was washed several times and transferred into a jar. To concentrate the sporiferous matter the material was taken in a watch glass and placed in a glass sheet to give gentle rotation. The rotation causes the sporiferous material to float which was then transferred in a specimen tube through fine pipette. The process was repeated to get the sporiferous matter. The specimen tube with concentration of sporiferous matter was centrifuged to remove water and then glycerine jelly was added. Following this the sample was stored for investigation.

After obtaining the macerate, the slide was prepared in glycerine jelly using square, zero number cover slips and was sealed with paraffin wax. Detailed morphographic and micrographic studies were done of various miospore and the specimens were microphotographed. Detailed morphographic characters were recorded for generic and specific description.

**Miospores Distributions:**

**1.** Borehole No. WBPS2, Depth 360.64 m, Sample No. A22:- Dominance of non-straiate bisaccate Schueringipollenites (47%), Ibisporites (1%), and sub dominance of Faunipollenites (10%), Straitopodocarpites (10%), Indotriradites (10%), Microfoveolatispora (10%), Chordasporites (4%), Callumispora (2%), Parasaccite (2%), Potoniesporites (1%), Horriditriletes (1%), Platysaccus (1%), Striasulcites (1%), Lunatisporites (1%), Osmundacidites (1%) (Table .1).

**2.** Borehole No. WBPS2, Depth 360.65 m, Sample No. A23:- Dominance of non-striate bisaccate Schueringipollenites (36%), Ibisporites (4%) and Sub dominance of Striate bisaccate Faunipollenites (9%), Straitopodocarpites (9%), along with the presence of Microbaculispora (11%), Indotriradites (10%), Microfoveolatispora (6%), Lunatisporites (3%), Osmundacidites (2%), Horriditriletes (1%), Lacinitriletes (1%), Densipollenites (1%), Crescentipollenites (1%), Stroterosporites (1%) (Table.1)

**3.** Borehole No. WBPS2, Depth 372.77 m, Sample No. A24:- Dominance of non-striate bisaccate Schueringipollenites (20%), Ibisporites (7%) and Sub dominance of Striate bisaccate Straitopodocarpites(15%), Faunipollenites (8%), along with the presence of Parasaccite (15%), Crescentipollenites (6%), Stroterosporites (6%), Chordasporites (5%), Striamonosaccites(4%), Potoniesporites (2%), Lophotriletes (2%), Platysaccus (2%), Microfoveolatispora (1%), Microbaculispora (1%), Horriditriletes (1%), Lacinitriletes (1%), Caheniasaccites (1%), Plicatipollenites (1%), Densipollenites (1%) and Lunatisporites (1%) (Table.1).

**4.** Borehole No. WBPS2, Depth 388.63 m, Sample No. A25:- Dominance of non-striate bisaccate Schueringipollenites (30%), Ibisporites (1%), and sub dominance of striate bisaccate Faunipollenites (19%),

Straitopodocarpites (15%), along with the presence of Parasaccites (10%), Chordasporites (9%), Microbaculispora (4%), Caheniasaccite (3%), Indotriradites (2%), Crecentipollenites (2%), Brevitriletes (1%), Horriditriletes (1%), Platysaccus (1%), Stroterosporites (1%), Osmundacidites (1%)

**Table. 2. Shows the miospore distribution of Borehole No. WBPS2.**

| Borehole no. WBPS-2 | | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| **Depth (m)** | 360.64 | 360.65 | 372.77 | 388.63 |
| **Thickness** | 5.74 | 5.74 | 0.6 | 0.86 |
| **Miospores/ Samples no.** | A22 | A23 | A24 | A25 |
| **Scheuringipollenites** | 47 (47%) | 36 (36%) | 20 (20%) | 30 (30%) |
| **Faunipollenites** | 10 (10%) | 9 (9%) | 8 (8%) | 19 (19%) |
| **Straitopodocarpites** | 10 (10%) | 9 (9%) | 15 (15%) | 15 (15%) |
| **Crescentipollenites** | 0 | 1 (1%) | 6 (6%) | 2 (2%) |
| **Callumispora** | 2 (2%) | 0 | 0 | 0 |
| **Caheniasaccites** | 0 | 0 | 1(1%) | 3(3%) |
| **Parasaccites** | 2 (2%) | 5 (5%) | 15 (15%) | 10 (10%) |
| **Plicatipollenites** | 0 | 0 | 1(1%) | 0 |
| **Lophotrilete** | 0 | 0 | 2(2%) | 0 |
| **Striomonosaccaites** | 0 | 0 | 4(4%) | 0 |
| **Osmundacidites** | 1 (1%) | 2 (2%) | 0 | 1 (1%) |
| **Potoniesporites** | 1 (1%) | 0 | 2 | 0 |
| **Microfoveolatispora** | 5 (5%) | 6 (6%) | 1 (1%) | 0 |
| **Microbaculispora** | 3 (3%) | 11 (11%) | 1 (1%) | 4 (4%) |
| **Lunatisporites** | 1 (1%) | 3 (3%) | 1 (1%) | 0 |
| **Ibisporites** | 1 (1%) | 4 (4%) | 7 (7%) | 1 (1%) |
| **Brevitrilete** | 0 | 0 | 0 | 1(1%) |
| **Platysaccus** | 1 (1%) | 0 | 2 (2%) | 1 (1%) |
| **Lacinitriletes** | 0 | 1(1%) | 1 (1%) | 0 |
| **Horriditriletes** | 1 (1%) | 1 (1%) | 1 (1%) | 1 (1%) |
| **Indotriradites** | 10 (10%) | 10 (10%) | 0 | 2 (2%) |
| **Striasulcites** | 1 (1%) | 0 | 0 | 0 |
| **Densipollenites** | 0 | 1(1%) | 1(1%) | 0 |
| **Chordasporites** | 4 (4%) | 0 | 5 (5%) | 9 (9%) |
| **Stroterosporites** | 0 | 1 (1%) | 6 (6%) | 1 (1%) |
| | 100 | 100 | 100 | 100 |

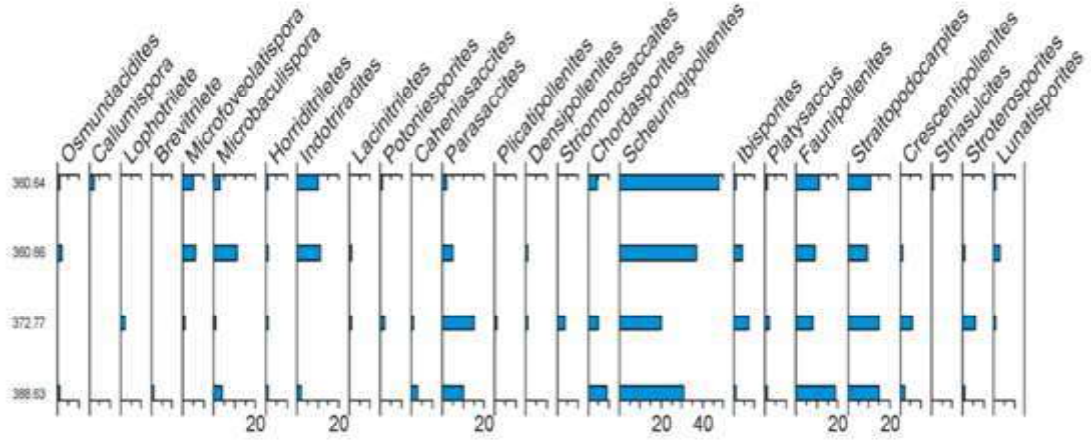


**Fig. 3- Histogram showing Frequency distribution of various miospores of Borehole No. WBPS-2.**

## RESULT

The Quantitative and qualitative palynological analysis of sediments has revealed a distinct palynoassemblage in borehole WBPS-2. Palynologically the borehole WBPS-2 yielded 25 spore-pollen species. The various recorded taxa of this palynoassemblage have been shown in the Fig. 3.

## DISCUSSION

The Palynoassemblage is characterized by the abundance of the non-striate bisaccate Scheuringipollenites (20-47%) and sub-dominance of striate bisaccates, i.e. Faunipollenites (8-19%).The Palynoassemblage is equivalent to the Scheuringipollenites barakarensis zone (Zone III- A) of the Damodar basin in having the predominance of Scheuringipollenites and sub-dominance of striate bisaccates[10]. The Palynoassemblage also correlates well with Zone- 3 of the Umaria Coalfield[3], Zone-3 of the Johilla Coalfield[3] , Assemblage- B of the Pathakhera Coalfield[11], Assemblage- B of the Wardha Coalfield[12] , Assemblage-II of the Talcher Coalfield[13], Palynozone-2 of the Ib River Coalfield[6] , Palynoassemblage-I of the Pali sediments of the Sohagpur Coalfield[5] and Palynozone-2 of the Tatapani- Ramkola Coalfield[14]. Present palynoassemblage also shows its equivalence with various areas of the Godavari Valley Coalfield Palynoassemblage-III of the Mamakannnu area[15], Palynoassemblage-D of the Gundala area[16], Palynozone-3 of the Mailaram area[17] and Palynozone-I of the North Karanpura Coalfield[18].

## CONCLUSION

On the basis of the palynological attributes, a distinct palynoassemblage has been identified in the present investigation. The Indian Lower Barakar palynoflora is characterized by the predominance of non-striate bisaccates along with fairly good percentage of striate bisaccates while striate bisaccates attain dominance in the Upper Barakar and remain dominant up to the Raniganj palynoflora (Late Permian) . The dominance of non- striate bisaccate (Scheuringipollenites) and sub-dominance of striate bisaccates (Faunipollenites) in this investigation of Palynoassemblage (388.63-360.64m) of WBPS2 proposes the Lower Barakar palynoflora. Hence, it is inferred that Palynoassemblage was preserved during the Artinskian age.

## ACKNOWLEDGEMENT

The authors are grateful to the Officer incharge, Dr. MotiLal Banra, CIMFR Ranchi for providing samples. Authors are grateful to the Director, Birbal Sahni Institute Of Palaeosciences, Lucknow, India for granting permission for palynological study. One of the author, Lakra, C is grateful to the National Fellowship for Higher Education (NFHE) for providing the scholarship to pursue Ph.D. degree. Authors are also grateful to Prof. Bijay Singh, the Head of Department of Geology, Ranchi University for encouragement.

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# A comparative study of water pollution in North Koel River basin of pre and post monsoon months in Palamu and Latehar districts

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**Abstract:** Water is an important and widely distributed resource on earth. It fulfills the various necessities of human civilization, improves climate and landscape quality, supports flora and fauna, and is recycled through the hydrological cycle. Surface Water has become an essential resource over the past few decades due to the increased usage for drinking, irrigation, industrial and other uses. Water is the basic necessity for a living being and detritions in the quality of water led to many harmful impacts. It is important to regulate the water quality to maintain the balance in all the variation of lives. In the present study, the water samples were collected during the pre-monsoon and post-monsoon periods of 2021 from selected locations of the study area in Palamu and Latehar districts and a comparative study was done for the same.It is one of the rapidly growing areas in the state of Jharkhand. In the present study, an attempt has been made to analyze the quality of surface water of the selected sites in Pre- and Post-monsoon phases. The physiochemical parameters like pH, Total Hardness, Electrical conductivity, Chloride, Total Alkalinity, Sulphate, Fluoride, Phosphate, and Nitrate were studied and analyzed. The level of pollution that occurred may be due to the anthropogenic activities and urbanization.

**Keywords: Total Suspended Solids, Water Quality, Anthropogenic activities and Urbanization.**

## INTRODUCTION

Water is an important and widely distributed resource on earth. It fulfills the various necessities of human civilization, improves climate and landscape quality, supports flora and fauna, and is recycled through the hydrological cycle. Surface Water has become an essential resource over the past few decades due to the increased usage for drinking, irrigation, industrial and other uses. Water is the basic necessity for a living being and detritions in the quality of water led to many harmful impacts. It is important to regulate the water quality to maintain the balance in all the variation of lives. Water can be acquired from different sources among which are the streams, lakes, waterways, downpour, spring and wells. It is colourless, tasteless, odourless and considered as a universal solvent.[1]

The physio-chemical water parameters like pH, turbidity, conductivity, alkalinity, total dissolved solid (TDS), hardness concentration of chloride, fluoride, sulphate, nitrate etc. should be in limited values.[2] The Quality of water is affected, when these parameters exceed the permissible limit. So WHO has published the maximum and minimum values for each parameter within that limit the water quality is considered suitable for drinking, agriculture and other uses. Besides this, one major factor that affects the concentration of ions in water is the monsoon period, so it is very important to study and compare the physio-chemical parameters before and after rainfall.[3]

**Geographical Area**

Geographically, the study area is located on western side of the state of Jharkhand covering parts of Latehar and Palamu districts. The area can be approached by road and railways both with a considerable walk to the river side. The study area in the North Koel river basin starts from Kechki to Rehla which passes through Chianki, Sua, Kauria, Medininagar, Kajri, Rajhara and Pandwa areas of both the districts. The nearest railway station is Kechki in Chianki, Daltonganj and Garhwa Road. Roads are close to the river banks.

**Location**

The area falls within the latitudes 23° 45' N to 37° 30' N and longitudes 83°50' E to 84°23'E covering Latehar and Barwadih blocks of Latehar district and sadar block of Daltonganj and Rehla area of Palamu district. The area is covered in Toposheet No.F45A/2, F45A/1, G45S/4 and G44X/16 of Survey of India of India in the scale of 1:50000.


**Location Map of the Study Area**


**Map of North Koel River**

## MATERIALS & METHODS

Around 50 samples were collected and total 9 of them were submitted for the detailed study referred in this paper.

The method applied for inferring the conclusion was IS: 2296:1982 for detection of heavy metals and analysed for grade of pollution, which was used to acquire the desired results. The selected samples were manually collected for the duration of pre-monsoon & post- monsoon covering a wide distance of more than 30km from upstream to downstream. The samples were collected and preserved in tuscon bottles at the site and were brought for its analysis in the laboratory of Yugantar Bharti, Namkum, Ranchi unit of Analytical & Environment Engineering.

**Table 1- Climatic conditions:- Monthly rainfall data (in mm) of Daltonganj and adjoining areas of Year 2020 till July 2021 is as under**

| MONTHS | YEAR (2020) | YEAR (2021) |
|---|---|---|
| January | 36.5 | 5.2 |
| February | 48.2 | 0.1 |
| March | 120.9 | 1.0 |
| April | 5.4 | 1.8 |
| May | 37.4 | 184.8 |
| June | 324.9 | 353.2 |
| July | 309.1 | 200.7 |
| August | 265.5 | - |
| September | 142.7 | - |
| October | 76.7 | - |
| November | 18.7 | - |
| December | 0.1 | - |

**Courtesy-** Indian Meteorological Department, (Govt. of India) Meteorological Centre, Birsa Munda Airport, Ranchi.

**Sample Collection Points: Samples were collected twice (Pre Monsoon: 07.01.2021, Post Monsoon: 28.07.2021) from the same points WS1-WS9**

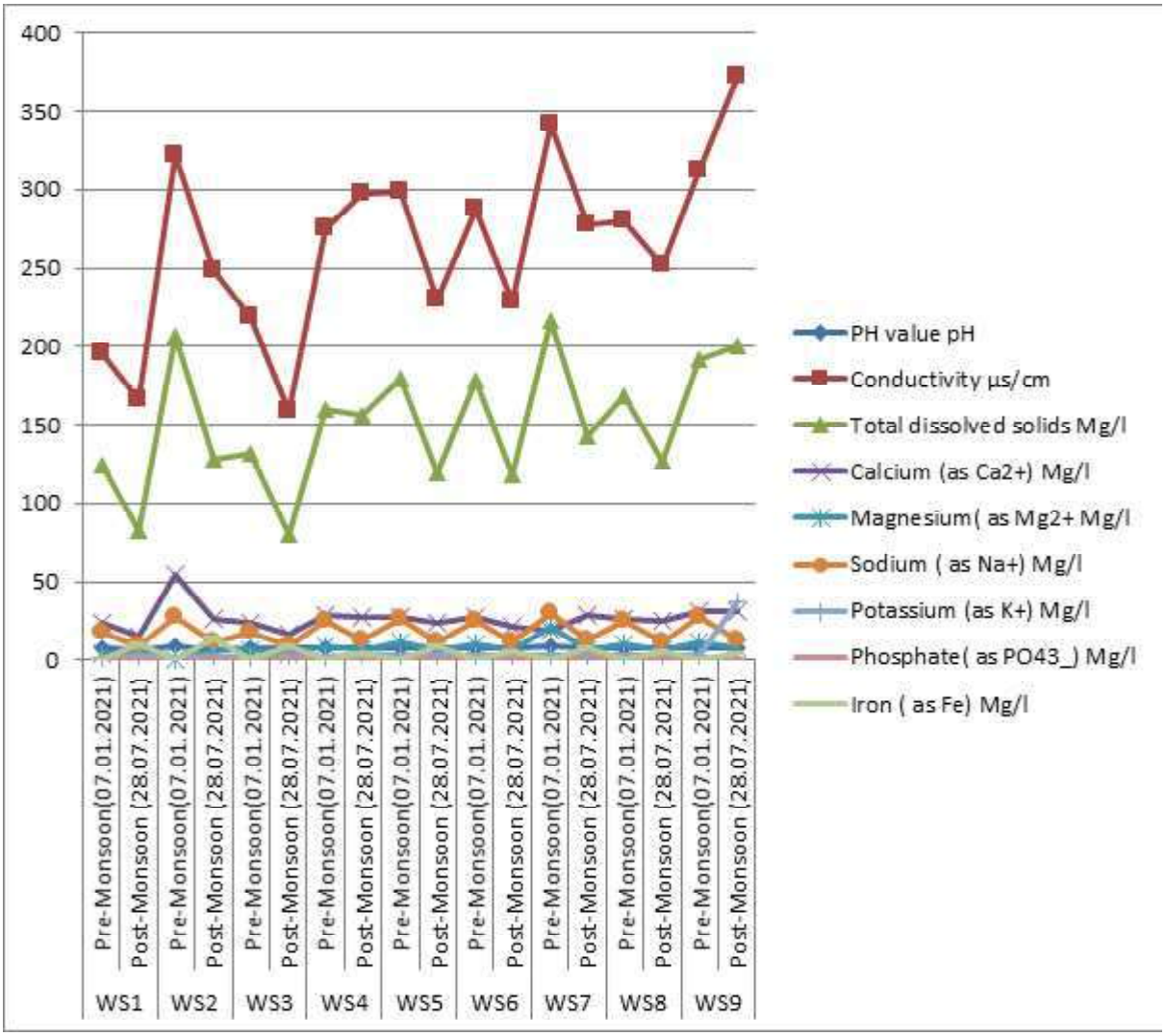
**WS-1)** (North Koel near Kechki)
**WS-2** (Auranga river near Kechki)
**WS-3** (Confluence of North Koel + Auranga river)
**WS-4** (Pampukal Belwatikar)
**WS-5** (Bisfutta Daltongunj)
**WS-6** (North Koel at Singra)
**WS-7** (River Amanat at Singra)
**WS-8** (Confluence of North Koel + Amanat river at singra)
**WS-9** (North Koel river at Rajhara)

**Table 2- Water Samples Analysis**

| Parameters | Samples → | WS1 | | WS2 | | WS3 | | WS4 | | WS5 | | WS6 | | WS7 | | WS8 | | WS9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M | Pre-M | Post M |
| PH value | pH | 7.77 | 6.65 | 8.65 | 7.05 | 8.3 | 7.15 | 8.04 | 7.43 | 7.82 | 7.54 | 8.25 | 7.45 | 8.44 | 7.53 | 8.28 | 7.62 | 8.21 | 7.29 |
| Conductivity | µs/cm | 195 | 165.6 | 322 | 248 | 219 | 159.2 | 275 | 297 | 298 | 230 | 288 | 228 | 342 | 278 | 280 | 252 | 312 | 372 |
| Total dissolved solids | Mg/l | 124 | 82 | 206 | 128 | 132 | 80 | 160 | 156 | 180 | 120 | 178 | 118 | 216 | 143 | 168 | 127 | 192 | 200 |
| Calcium (as $Ca^{2+}$) | Mg/l | 24 | 15.2 | 54.4 | 25.6 | 23.2 | 16 | 28.8 | 28 | 27.2 | 23.2 | 27.2 | 21.6 | 19.2 | 28.8 | 25.6 | 24.8 | 31.2 | 31.2 |
| Magnesium (as Mg2+) | Mg/l | 4.37 | 4.76 | 0.48 | 6.36 | 6.8 | 4.36 | 8.74 | 6.92 | 11.7 | 6.04 | 10.2 | 5.96 | 21.38 | 6.52 | 10.2 | 6.28 | 11.7 | 7.24 |
| Sodium (as Na+) | Mg/l | 17 | 9.04 | 27 | 11.76 | 18 | 9.08 | 25 | 12.64 | 26 | 11.56 | 25 | 11.76 | 30 | 12.08 | 25.3 | 11.6 | 28 | 12.32 |
| Potassium (as K+) | Mg/l | 2 | 2.64 | 2 | 2.64 | 2 | 2.28 | 2 | 4.12 | 3 | 3.12 | 3 | 3.2 | 3 | 3.08 | 3 | 2.76 | 3 | 37.48 |
| Phosphate (as $PO_4^{3-}$) | Mg/l | 0.04 | 0.37 | ND (DL 0.003) | 0.31 | 0.01 | 0.4 | 0.03 | 0.36 | 0.01 | 0.38 | 0.01 | 0.34 | 0.04 | 0.24 | 0.01 | 0.24 | 0.05 | 0.17 |
| Iron (as Fe) | Mg/l | ND (DL 0.1) | 10.36 | ND (DL 0.1) | 13.29 | ND (DL 0.1) | 8.76 | ND (DL 0.1) | 4.41 | ND (DL 0.1) | 8.56 | ND (DL 0.1) | 5.49 | ND (DL0.1) | 7.73 | ND (DL 0.1) | 5.28 | ND (DL 0.1) | 3.81 |

## Results

## Pre-Monsoon and Post Monsoon Variation




### DISCUSSION

The pH value, Conductivity, Total dissolved solids, Calcium, Magnesium, Sodium, Potassium, Phosphate and Iron parameters in specific unit as shown in the analysis chart was considered for comparative study of water sample during Pre and Post monsoon season of 2021.

As expected with increase of volume of water there is a decrease in all the parameters except a few. The enrichment of Potassium from 2.0 to 2.64 indicates that even with increase of volume of water it has enriched. This indicates the discharge of Potassium rich ion has increased. Same is the case with Phosphate. The remarkable feature is the detection of Iron as 10.36 Mg/l but it was not detected in Pre- monsoon season.

In sample no. WS-2, same is the case. Potassium from 2.0 to 2.64, Phosphate from 0.003 to 0.31 and detection of Iron as 13.2 Mg/l is the important feature. In sample no. WS-3, WS-4, WS-5, WS-6, WS-7 is same is the case. However, in sample no. WS-8 at the confluence of North koel and Amanat river at singra, there is a decrease in Potassium. This indicates the less discharge of Potassium rich ion into the river.

In sample no. WS-9 there is a drastic increase of Potassium from 3.0 to 37.48 along with slight increase of

Phosphate and detection of Iron as 3.81 Mg/l is another important feature. The cause of increase of Potassium at Rajhara may be due to discharge of Potassium ions either from domestic source or colliery sources, which will be studied in forthcoming time to know the exact cause of pollution. In sample no. WS-4 at the entry of Medininagar city, the Conductivity has increased from 275.0 to 297.0 µs/cm. But immediately, after the end of city the analysis of water sample WS-5 indicates the lowering of Conductivity from 298.0 to 230.0 µs/cm.

## CONCLUSION

The above discussion clearly indicates the richness of Potassium, Phosphate and Iron in water causing pollution from Kechki to Singra village. This is causing the life of aquatic species in the the river particularly the fishes. As enquired from the villagers they have found dead fishes in the bank of Amanat river the cause of which has to be ascertain from the zoologist. The study clearly reveals that the pollution of water is taking place with above mentioned ions even during Post-monsoon.

The study carried out partially in 2020 and then again in 2021 because of the Corona pandemic also indicated the same features. Hence, it is finally concluded that the future study will clear the cause of pollution and then remedial measure will be suggested.The parameters that are high should be reduced in a proper treatment method so that this water can be used both for agricultural and drinking purpose.

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**Geology**

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# Delineation of Gem Mineral Deposits using GIS technique in Koderma District, Jharkhand

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**Abstract:** Koderma district is well known for its production of mica. Mica deposits are found in association with the pegmatite veins. The pegmatite veins are also known for the occurrence of gem minerals/ gemstones. Gemstones which are of mineral origin are found mainly in metamorphic terrain. The Koderma district which is primarily enclosed by high grade metamorphic rocks is the study area. This study addresses field investigations and the potential capabilities of geographical information system (GIS) to point out the potential zones of gem mineral deposit.

**Keywords: Gem minerals, BMB, Koderma, Geographical Information system (GIS)**

## INTRODUCTION

Koderma was once the mica capital of India. It forms the part of Bihar Mica belt (BMB), famous for its world class ruby mica. The mica deposits were in association with pegmatite veins. Pegmatite is basically igneous rock[1] which is mostly of granitic composition. It can be differentiated from other igneous rocks either by exceeding coarse and crystal size variation in systematic order or by an ample amount of crystals with skeletal, graphic or other strong directional growth habits or by prominent spatial zonation of mineral assemblages, including monomineralic zones. Pegmatite are also the source of fine and valuable coloured gemstones which may include varieties of beryl, tourmaline, topaz, spodumene and spessartine etc.[2]. More than 50 less familiar gemstones also occur in pegmatites[3]. GIS helps in many aspects of the mineral exploration which may include data collection management, analysis, and reporting. Field geologists can now capture field data electronically, using Global Positioning System (GPS) receivers. All the collected data sets can be worked upon, be integrated, scrutinized and analysed using the GIS techniques. Thus, this research work focuses on mapping of the potential zones of gem mineral deposits in association with different pegmatite vein using GIS techniques in Koderma district.

## STUDY AREA

Koderma District forms an integral part of famous Bihar Mica Belt (BMB). It spreads over an area of about 1500 sq.km. and was carved out of Hazaribagh in April 1994. It lies in northern fringe of Jharkhand state and is bounded by the longitude 85°26'01" and 85°54'16" E and latitude 24°15'46" and 24°40'18" N. Area is included in degree sheet 72H and survey of India toposheet (1:50,000 scale) no. 72H/6, 7, 9, 10, 11, 13, 14, 15, 16. Most part of the district is occupied by Koderma plateau. This area has a slope which differentiate it from the Hazaribagh plateau which lies in the south. The Koderma district is a part Chhotanagpur Plateau. The area exhibits undulating topography comprising hill, hillocks, mounds, and plains. Valleys fills with low to moderate frequency of lineaments, Pedi plains are major geomorphological units of the districts. Average elevation of the area ranges from 300 to

500 meters above mean sea level. Northern part of the district comes under the Koderma Reserve Forest. The highest peak is in Debour Ghati (677 m.) which marks the state boundary of Jharkhand and Bihar. The district is mainly drained by Barakar, Sakri river and their tributaries.

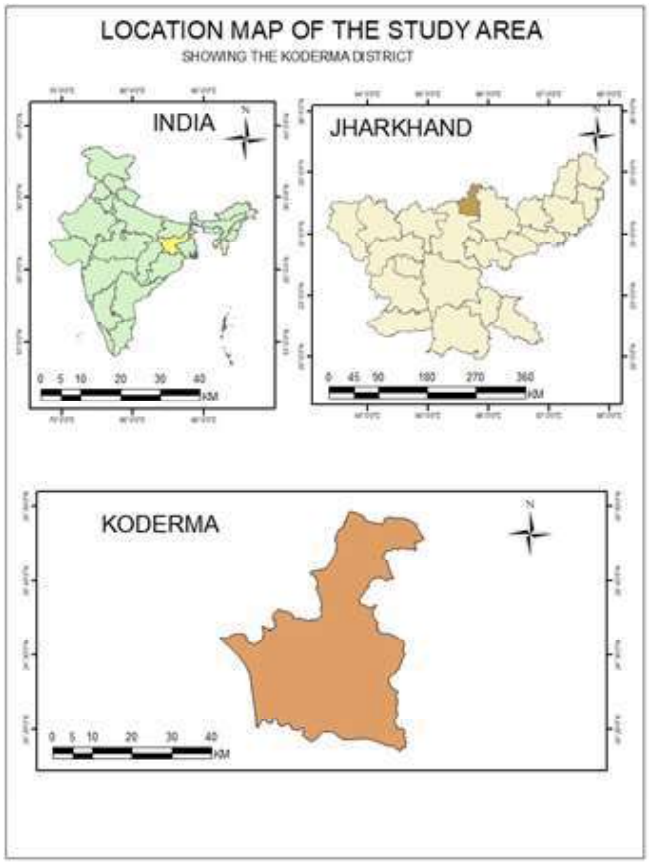


**Figure 1: Location Map of the Study Area**

## GEOLOGICAL SETTING

The part of Koderma district is widely known as a segment of Bihar Mica Belt (BMB). BMB is eastern India is a belt of metasediments approx.150 Km long and 20Km wide which runs from WSW to ENE through Nawada, Gaya, Hazaribagh, Koderma, Giridih and Munger districts of Bihar and Jharkhand (4). It forms an integral part of Chhotanagpur Granitic Gneiss complex (CGGC). It is situated north of the Hazaribagh plateau at the northern extremity of the CGGC and is separated from the gneiss terrain by the peneplained Barakar River Valley[5]. The BMB has geological setting distant from the extensive migmatitic granite gneiss belts of the CGGC[6]. It is characterised by large phaccolithic, often domical, plutons emplaced into relatively more open-folded schistose formations, "superacrustals", metamorphosed to upper amphibolites to lower granulite facies conditions. According to Mahadevan and Maithani[7], the principal geological formation in the Bihar Mica Belt are represented by a series of metasedimentary rocks. The dominant rocks type is the fibrolite-muscovite-biotite schists which is interbedded with small bands of hornblende schist, calc-silicate granulite and gneiss, micaceous quartzite, and conglomerate with several granitic bodies intrusive into schists. The pegmatites found in BMB are mostly emplaced into mica-schist and micaceous quartzite and rarely into hornblende-schist, metamorphosed under conditions of almandine- amphibolite facies.

The Koderma district is underlain by the rocks of wide variety of geological formation ranging in age from archaean to recent, the main being archaean Proterozoic, permo-carboniferous and recent. Phyllite, mica schist, granite gneiss and intrusive granites are the main geological formation of the district. periodic and isolated occurrence of pegmatite veins, quartz, quartzite, dolerite is also found. The general geological map of the district is shown below in figure 2.

## METHEDOLOGY

The methodology mainly comprises of literature survey, filed investigations and GIS analysis. Field investigations have been carried out based on available geological and topographical maps of the area. During field survey, the primary data about the area and the mining activities were collected through local villagers and government officials. Further, the primary occurrence of the gem minerals associated with the mica pegmatites were plotted known from literature and field survey. All these field, topographical, geomorphological, geological, mineralogical, and remote sensing data were analysed. Finally, these data were integrated using GIS to obtain a gem mineral potential map of the Koderma district.

## RESULT AND DISCUSSION

Earlier Bhola (1968)[8] has stated about the BMB that besides quartz, microcline, albite and mica, the pegmatite of Bihar Mica Belt carry topaz, tourmaline, garnet, apatite, monazite and other phosphates, cassiterite, uraninite, beryl, columbite, tantalite, lithium minerals, rare earth minerals etc. Being the part of BMB, it is very much possible for the pegmatites of Koderma district to have occurrence of

gem minerals. According to field survey and secondary data analysis the authors have resulted few locations as potential zone for gem mineral deposit which have been shown in the given figure 3.

**BANDARCHUA** (longitude 84°34'30" E and latitude 24°34'15" N SOI toposheet no.72H/10) - a hill situated between the 8th and 9th milestone in the Koderma-Rajauli section of the Ranchi-Patna road in the Koderma Reserve Forest. The pegmatite forms an elliptical hill elongated in the strike direction of north-south. The bandarchua pegmatite is an asymmetrically zoned pegmatite that has been classified into 5 units by Mahadevan and Maithani[7]. The units are- (i) massive quartz body, (ii) muscovite-quartz pegmatite, (iii) muscovite- plagioclase- quartz pegmatite, (iv) muscovite- plagioclase- perthite- quartz pegmatite and (v) perthite- quartz pegmatite. In the units the observed gem minerals are variety of quartz, tourmaline, beryl, garnet.

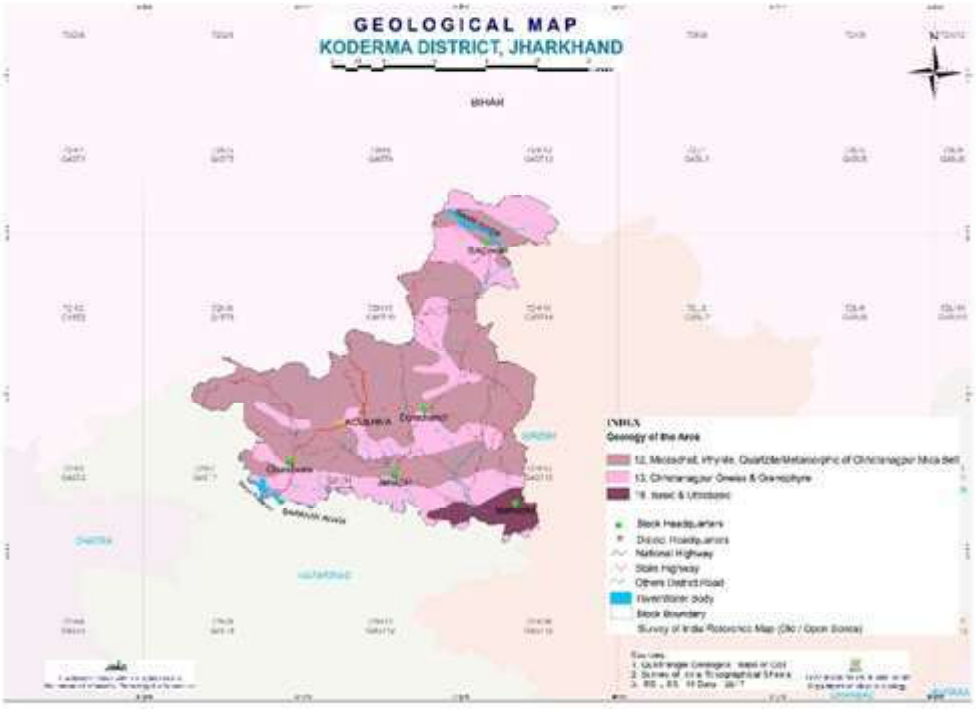


**Figure 2: Geological Map of Koderma District**

**LOKAI-INDERWA** (longitude 85°37'43" E and latitude 24°28'53" N and SOI toposheet no.72H/11) - this area is located 4-5 km away from Koderma town on Koderma-Domchanch road. The pegmatite intruding the schistose rocks of this area occur as lens, veins, and stringers, possess pinch and swell structures at places. It consists of various important minerals such as feldspar, quartz, garnet, beryl etc. the gem minerals identified in the area are feldspar varieties – k-feldspar, Na- to Ca-feldspar, bytownite, blue variety of moonstone, beryl, garnet and quartz.

**RUPANDI-DOMCHANCH (**longitude 85°42'30" E and 24°30'15" N and SOI toposheet no.72H/10)- the area Rupandi is almost 11km away from Koderma town Koderma-Giridih Highway via Domchanch. The area can be reached by jeepable road from Domchanch. The pegmatite has a general east-west strike and is vertical body. It has centrally place quartz body surrounded by zone of muscovite- plagioclase-perthite-quartz pegmatite[7]. The gem minerals observed associated with the pegmatite are tourmaline, garnet, gem variety of quartz.

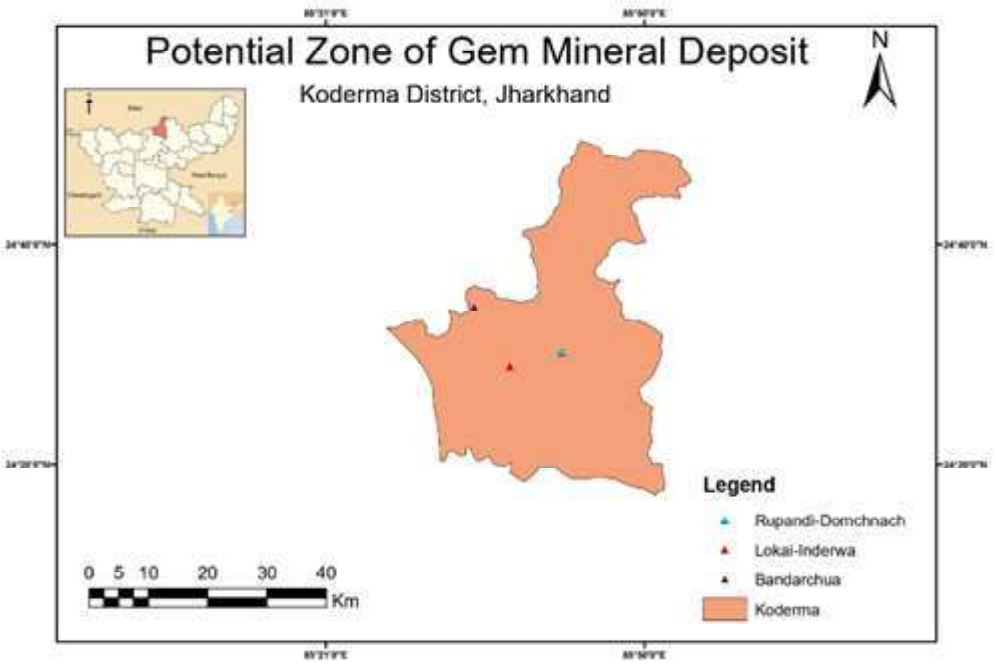


**Figure 3: Gem Mineral Potential Map**

## CONCLUSION

The minerals of gem varieties are localised within the pegmatites of the study area. The pegmatites have undergone weathering and other structural disturbances which have degraded the quality of gemstones near the surface, but deeper strata may bear good varieties of gem minerals. The study area has got a great potential for gem minerals and with this regard further research and investigation is very much required.

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# Evolutionary trend analysis of Carbon Dioxide Emission from solid fuels and its future prediction in India

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**Abstract:** Based on carbon dioxide emission data from solid fuels in India for the period 1960-2014, a model has been developed by using non linear least square method and regression analysis method. Efficacy of the model is tested by some statistical tools like R squared and adjusted R squared analysis. Utilizing the proposed model, future prediction has been done by using Instantaneous Rate of Change (IROC) analysis that can help us to understand the evolutionary trend of emissions of the gas.

**Keywords: Carbon dioxide, Least Square method, R squared analysis, Instantaneous rate of change (IROC), Green House Gases.**

## INTRODUCTION

Climate is the most powerful determinant of ecosystem, global vegetation pattern, forestation, industrialization etc. The climatic change because of global warming is a burning problem not only in India but also throughout the world. Unrestricted emission of different green house gases (GHG) are responsible for this deadly situation. Carbon dioxide ($CO_2$) is one of the leading green house gases.[1]

Uncontrolled emission of carbon dioxide ($CO_2$) increases the global temperature and as a result of this polar ice sheets and glaciers are melting rapidly and the sea level is rising gradually. As a result of this, we often observe its impacts of very extra weather events like tsunami, typhoons, droughts, heat wave etc. Fossil fuel combustion and ongoing energy consumption is leading to rapid increase of $CO_2$ emission. 72.4% of the total GHG are $CO_2$. India is the fourth largest emitter of the gas in the world. Copper and Aluminium are two major manufacturing industries that produces large amount of $CO_2$. There are so many sectors of sources of the gas namely, liquid fuel and gaseous fuel consumption etc. We intend to focus on the source of $CO_2$ emission through solid fuel (mainly coal) consumption here[2]. Carbon dioxide emissions from solid fuel consumption refer mainly the emissions through use of coal as an energy source.

Few researchers worked on $CO_2$ emission in Indian states. Ghoshal and Bhattacharyya (2008)[3] estimated the state wise $CO_2$ emissions in India from 1980 to 2008. Jin *et al.* (2010)[4] proposed a nonlinear dynamic system model by using nonlinear least square method and regression analysis[5] method in Yangte Delta to analyse evolutionary emission trend on carbon emission. Basak and Nandi (2014)[6] developed a third degree polynomial model to characterize the pattern of $CO_2$ emission in some eastern states like West Bengal, Bihar and Assam and in some northern states like Uttar Pradesh and Delhi. Besides that the authors (2014)[7] also analyzed the emission pattern of the gas in the states of Punjab, Maharastra and Madhya

Pradesh. Mondal *et al.* (2019)[8] studied the $CO_2$ emission utilizing the mathematical model for the states of West Bengal, Orissa and Assam.

In this study, our objective is to develop a polynomial model (Searle, S.R., 1971)[9] based on the historical data of about 54 years and analyse the evolutionary emission trend of $CO_2$ from solid fuel consumption. We also aim to prediction of the gas in near future using the proposed model. This article is organized as follows: the brief discussion of material and method is given in Section 2 and result and conclusion part presented in Section 3. Conclusions are outlined in Section 4.

## DATA & METHODOLOGY

### Method of Least Square

The data of $CO_2$ emission due to solid fuel consumption for 54 years (1960-2014) is utilized for developing the proposed model. We formulated a third degree polynomial model for the evolutionary trend analysis of $CO_2$ emission in India (Jin *et al.*, 2010)[4]. For generating the model of $CO_2$ emission, we went through the works of Tokos and Xu (2009)[10] and Basak and Nandi (2014)[11]. Authors suggested a third degree polynomial model for the characterization of emission behaviour of $CO_2$, for example

(1) $Y = a + bx + cx^2 + dx^3$

where Y is the emission of carbon dioxide in kiloton (kt) and x is representing time in years.

With the help of the given data points ($x_i$, $y_i$); (i=1, 2,.., n) the error associated as

(2) $$F(a,b,c,d) = \sum_{i=1}^{n} (y_i - a - bx_i - cx_i^2 - dx_i^3)^2$$

is a function of four variables a, b, c and d.

For minimization of error and to estimate corresponding a, b, c and d, we use multivariate calculus namely,

$\frac{\partial F}{\partial a} = \frac{\partial F}{\partial b} = \frac{\partial F}{\partial c} = \frac{\partial F}{\partial d} = 0$ and this leads to the normal equations,

$$\begin{aligned} \sum y_i &= na + b\sum x_i + c\sum x_i^2 + d\sum x_i^3 \\ \sum x_i y_i &= a\sum x_i + b\sum x_i^2 + c\sum x_i^3 + d\sum x_i^4 \\ \sum x_i^2 y_i &= a\sum x_i^2 + b\sum x_i^3 + c\sum x_i^4 + d\sum x_i^5 \\ \sum x_i^3 y_i &= a\sum x_i^3 + b\sum x_i^4 + c\sum x_i^5 + d\sum x_i^6 \end{aligned} \quad (3)$$

For given set of points ($x_i$, $y_i$); (i=1, 2,…, n), the equations (3) are solved for a, b, c, d to estimate values of a, b, c, d namely, $a^{\#}, b^{\#}, c^{\#} and\ d^{\#}$. It has been found that in all the cases, the value of the second order derivatives evolves to be positive at the points a, b, c, d ensuring minimization of F.

The third degree fitted polynomial of $CO_2$ emission is now estimated as

(4) $$Y = a^{\#} + b^{\#}x + c^{\#}x^2 + d^{\#}x^3$$

### Instantaneous Rate of Change of emission

Instantaneous Rate of Change (IROC) is a useful parameter utilized to predict future emission of the gas. For the computation of rate of change of the gas, the derivative of equation (5) is presented as

(5) $$\frac{dY}{dx} = b^{\#} + c^{\#}x + d^{\#}x^2$$

The equation (5) is utilized for prediction of $CO_2$ at any particular value of x (time).

### Quality of estimates

We shall use equation (5) for obtaining the estimation of the $CO_2$ emission for short and medium terms of time. It remains to examine the goodness of fit for this estimation. The matter depends on the quality of the developed analytical models using the raw data. The quality of the proposed analytical models is verified with the statistical criteria, namely the coefficient of determination (R squared), adjusted coefficient of determination (adjusted R squared) and IROC.

### Coefficient of determination

The coefficient of determination ($R^2$) is defined as the proportion of the total response variation that is explained by the model. It provides an overall measure of how well the model fits. The general definition of $R^2$ is defined as

$$R^2 = 1 - \frac{SS_{err}}{SS_{tot}}$$

where,

$$SS_{tot} = \sum_i (y_i - \bar{y})^2 \ , SS_{reg} = \sum_i (f_i - \bar{y})^2 \ , SS_{err} = \sum_i (y_i - f_i)^2$$

Here, $SS_{tot}$ = Total sum of square (proportional to the sample variance)

$SS_{reg}$ = the regression sum of squares or the explained sum of square and

$SS_{err}$ = the sum of squares of residuals, also called the residual sum of square. $y_i$ and $f_i$ are observed and estimated values of $CO_2$ emission.

**Adjusted Coefficient of Determination**

The Adjusted Coefficient of Determination (Adj $R^2$) is defined as

$$R^2 = 1 - (1 - R^2)\frac{n-1}{n-p-1} = R^2 - (1 - R^2)\frac{p}{n-p-1}$$

where p is the total number of regressors in the model (not counting the constant term) and n is the sample size. It is, however, another advanced measure how good the model fit the observed dataset.

**Data source**

Carbon Dioxide Information Analysis Centre, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.

## MAIN RESULTS AND DISCUSSIONS

General equation of the proposed model is $y(x) = a + bx + cx^2 + dx^3$, a third degree polynomial in x. The approximate value of $a = -9.34881 \times 10^{10}$, $b = 1.42301 \times 10^{10}, c = -72203.1, d = 12.2124$.

Therefore the particular equation is

$y(x) = -9.34881 \times 10^{10} + 1.42301 \times 10^{8}x - 72203.1x^2 + 12.2124x^3$

The solutions of this equation are approximate values. The comparative study between real emission data and approximate emission data is done and it is presented in Fig. 1 below. Where the approximate values are closely related to the real values.

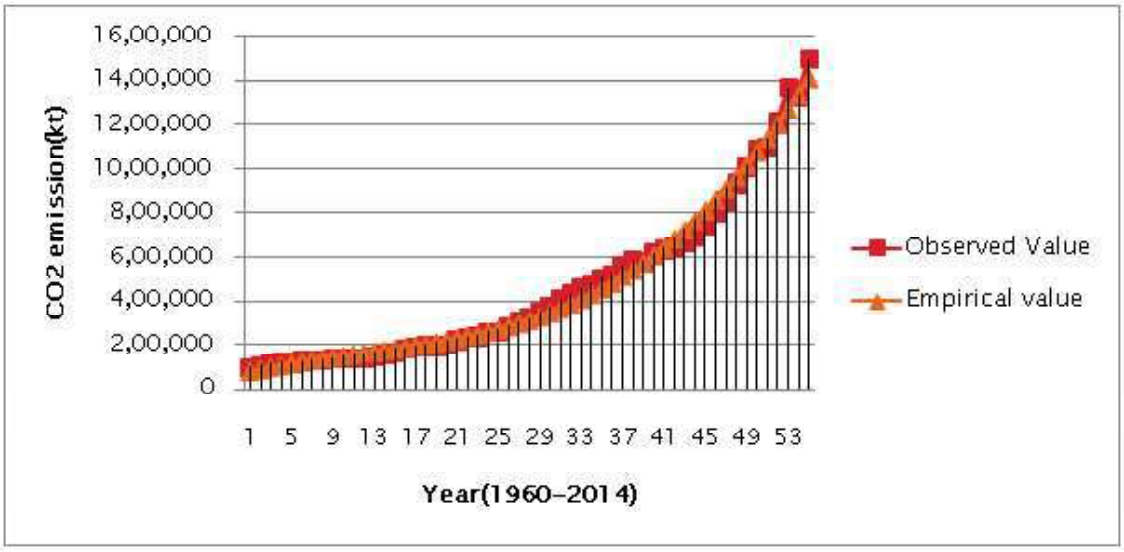


**Fig. 1: Comparative diagram of real emission and approximate emission data value.**

The model for the $CO_2$ emission for solid fuel is modelled as

(6) $Y(x) = -9.34881 \times 10^{10} + 1.42301 \times 10^{8}x - 72203.1x^2 + 12.2124x^3$

A graphical display of the actual data and model data is given by Fig. 5

Estimated data & Dotted line represents real data

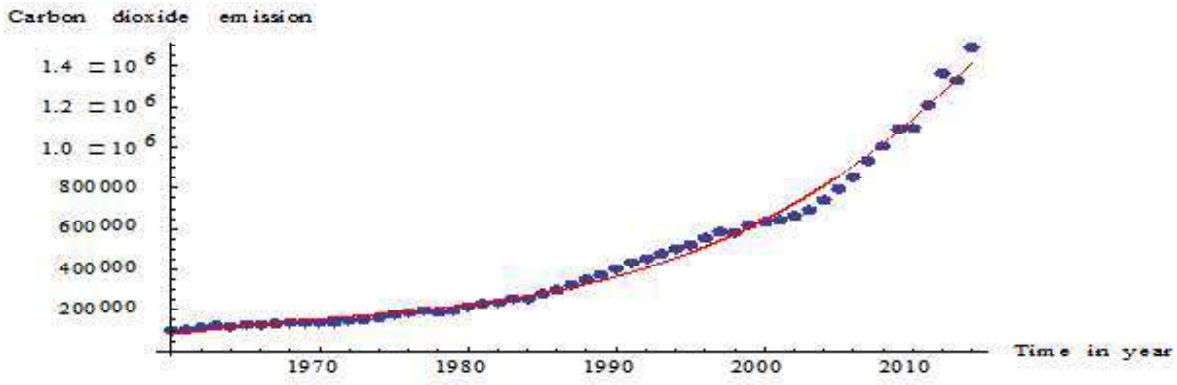


**Fig. 2: Graphical presentation of the model**

Above model may be used to get estimation of $CO_2$ emission for the emission data of solid fuel for short or medium terms of time. The R square and R square (adjusted) are also computed and the result indicates that a good model have been identified. The statistical criteria are displaced in Table 1.

**Determination of R squared and Adjusted R squared:**

The value of coefficient of determination i.e. R squared value and adjusted R squared value is evaluated by statistical analysis. The numeric value is very closer to 1 which suggests that the model suitably presents the reality. The result is shown in Table 1.

**Table 1: Numeric value of R squared, adjusted R squared, SSE and RMSE**

| R Square | R Square adjusted | SSE | RMSE |
|---|---|---|---|
| 0.9913 | 0.9908 | 6.482e+10 | 3.565e+04 |

The numeric value of the R squared and adjusted R squared is presented in the above Table 1. This value indicates good quality of the proposed model. The value of Sum of Squared Errors (SSE) and Root Mean Square Error (RMSE) assure us that the model may be used for prediction of $CO_2$ emission. It endorses that a good model is identified.

**Instantaneous Rate of Change (IROC) computation**

To get the instantaneous rate of change the differentiation of equation (6) is to be computed and the result follows. The IROC of $CO_2$ emission for solid fuel consumption can be derived by the differential equation.

(7) $$\frac{dY}{dx}(x) = 1.42301 \times 10^8 - 59432.2x - 14.9408x^2$$

The expression (7) can expressed visually as

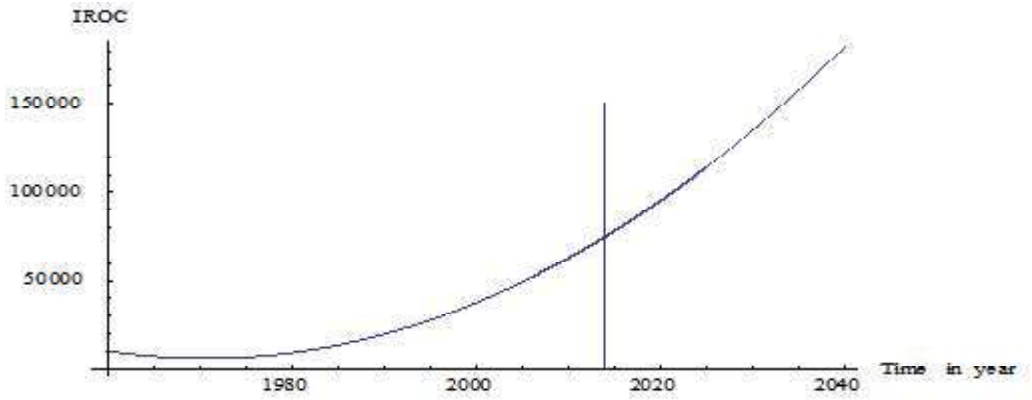


**Figure 3: IROC of the emission data.**

Considering the proposed model, the future emission of $CO_2$ is evaluated and shows a rapid increasing rate of change at the end of the curve. Decreasing curve of IROC indicates that controlled emission of the gas. Whereas increasing curve indicates the fact that the emission is unrestricted. Fig. 3 represents that the use of solid fuel consumption rate is increasing at an exponential growth and therefore the necessary precautions is to be taken in advance. Total $CO_2$ emission and instantaneous rate of change data is given in Table 2.

**Table 2: IROC and prediction of $CO_2$ emission in future**

| Year | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| IROC in future | 94969.0 | 113926.0 | 134715.0 | 157335.0 | 181788.0 |
| Emission of carbon dioxide (kt) | 1920680 | 2442150 | 3062990 | 3792350 | 4639400 |

Here both the numeric value of IROC and $CO_2$ emission data in future is positive and it assigns increasing emission. IROC value in 2020, 2025, 2035 and 2040 are 94969.0, 113926.0, 134715.0, 157335.0 and 181788.0 kiloton respectively. Whereas at the same time total amount of $CO_2$ emissions from solid fuels consumption as per proposed model are 1920680, 2442150, 3062990, 3792350 and 4639400 kilotons respectively.

## CONCLUSION AND POLICY IMPLICATIONS

The results of this study indicate that $CO_2$ emissions are correlated with climate change. Uncontrolled emission of the gas increases global temperature. The results of this study are based on time data from 1960 to 2014. $CO_2$ emissions from solid fuels consumption have a statistically significant effect on increasing global temperature.

The value of $R^2$ and adjusted $R^2$ are 0.9913 and 0.9908. The numerical values indicate that proposed model is fitted fairly well. Therefore the evolutionary emission trend of $CO_2$ emissions from solid fuel consumption may be analyzed statistically using our study. Future prediction of emission of $CO_2$ can be evaluated from our proposed model. This paper will be helpful for the future researchers for finding emission of $CO_2$ and other GHGs from other sources like liquid fuel and gaseous fuel consumption in India and abroad.

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# Mathematical and Statistical analysis of Carbon dioxide emissions trend from different sources in India

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**Abstract:** This paper attempts to analyse statistically the emissions trend of carbon dioxide from different sources like gaseous fuel and liquid fuel consumption. A model is proposed to characterize the emission pattern depending on the historical data of 54 years for the time period 1960 to 2014. Nonlinear dynamic model is developed by using regression analysis method and nonlinear method of least square. The goodness of the model is tested statistically using the tools like coefficient of determination, adjusted coefficient of determination, SSE, RMSE etc. We also used wavelet transform to decompose the emission curve. Multi Resolution Analysis has been applied for the better understanding of the signals. The result is statistically significant and interesting.

**Keywords: Carbon dioxide, Least Square method, Coefficient of determination, Regression sum of square, RMSE**

## INTRODUCTION

Global warming has reached at an alarming stage throughout the world. As a result we see the abrupt change of climate and weather. It is not a local issue now, it is a global phenomenon[1] and the scientists along with the environmentalists are seriously worried about the evil effects of the unnatural change of weather. Green house gases (namely carbon dioxide ($CO_2$), methane ($CH_4$), sulphur dioxide ($SO_2$), carbon monoxide (CO), water vapour ($H_2O$) etc.) play an important role in global warming which affect negative impact on human health[2]. Carbon dioxide is the leading one. Due to rapid growth of industrialization, pollution and deforestation the atmospheric concentration of $CO_2$ is increasing[3] day by day which helps for trapping heat[4] near earth surface. In this regard India is one of the leading countries in the world.

A follow-up study issued by the Intergovernmental Panel for Climate Change (IPCC) in April 2007 cautioned that global warming may cause widespread food and water shortages, as well as devastating consequences on biodiversity. Sea level could rise[5] between 7 and 23 inches (18 to 59 centimeters) by century's end, the IPCC's February 2007 report projects. Rises of just 4 inches (10 centimeters) could flood many South Seas islands and swamp large parts of Southeast Asia. This unnatural and unpredictable diversity of climate change[6] due to global warming are caused for human induced emission. Uncontrolled use of fossil fuels (like liquid and gaseous fuel consumption) and abuses of natural resources generates huge amount of $CO_2$ which gives result the high rise of temperature of the Earth surface.[7-9] GHG emissions can only be reduced by reducing the use of fossil fuels, stopping deforestation, simplifying agricultural practises, and reducing consumption. This is not an easy job for nations to do; their reliance on fossil fuels for energy and forest products for diverse raw materials is substantial. Reduced usage of fossil fuels may have a negative impact on industry and transportation.

Our objective, in this study, is to develop a model for characterizing the emission behaviour of $CO_2$ from different sources (from the gaseous and liquid fuel consumption) so that immediate preventive measures can be taken to protect the alarming stage. Besides, this we intend to have decomposition of the signals for getting an insight about the influencing factors of $CO_2$ emission by multi resolution analysis (MRA) through wavelet decomposition

The software we used here for developing the model is MATHEMATICA and MATLAB. Several research work accomplished on $CO_2$ emission[8,10,11] in India. Basak and Nandi (2014)[10] have done analytical study on $CO_2$ emission from different attributes in West Bengal. Authors also studied the emission in different states of India[12].

## MATERIALS & METHODS

### Method of Least Square

The data of $CO_2$ emission from gaseous and liquid fuel consumption of time interval (1980-2000) is utilized to develop the model. The work of Jin *et al.*, (2010)[13] and the works of Tokos and Xu (2009)[14] and Basak and Nandi (2014)[10] is studied well. Authors suggested a third degree polynomial model for emission of $CO_2$, for example

$$y = f(x) = \alpha + \beta x + \gamma x^2 + \delta x^3 \quad (1.1)$$

where $y$ is emission of carbon dioxide in kiloton of carbon and x represents time in years.

With the help of the given data $\{(x_1,y_1),(x_2,y_2),\ldots\ldots\ldots(x_n,y_n)\}$ we may define the error associated by

$$v(\alpha,\beta,\gamma,\delta) = \sum_{i=1}^{n}(y_i - \alpha - \beta x_i - \gamma x_i^2 - \delta x_i^3)^2 \quad (1.2)$$

is a function of four variables $\alpha$, $\beta$, $\gamma$ and $\delta$ For minimizing the error and to estimate corresponding $\alpha, \beta, \gamma$ and $\delta$. multivariate calculus is used to have

$$\frac{\partial v}{\partial \alpha} = 0, \quad \frac{\partial v}{\partial \beta} = 0, \quad \frac{\partial v}{\partial \gamma} = 0, \quad \frac{\partial v}{\partial \delta} = 0$$

Now corresponding normal equations are:

$$\begin{aligned}
\sum y_i &= n\alpha + \beta\sum x_i + \gamma\sum x_i^2 + \delta\sum x_i^3 \\
\sum y_i x_i &= \alpha\sum x_i + \beta\sum x_i^2 + \gamma\sum x_i^3 + \delta\sum x_i^4 \\
\sum x_i^2 y_i &= \alpha\sum x_i^2 + \beta\sum x_i^3 + \gamma\sum x_i^4 + \delta\sum x_i^5 \\
\sum x_i^3 y_i &= \alpha\sum x_i^3 + \beta\sum x_i^4 + \gamma\sum x_i^5 + \delta\sum x_i^6
\end{aligned} \quad (1.3)$$

For given set of points $(x_i, y_i)$; (i=1, 2,…,n), the equations can be solved for $\alpha, \beta, \gamma$ and $\delta$ to find estimated $\alpha^{\#}, \beta^{\#}, \gamma^{\#} and\ \delta^{\#}$ It has been found that in all the cases, the value of the 2nd order derivatives evolves to be positive at the points $\alpha, \beta, \gamma$ and $\delta$. These satisfy the minimization criteria of $v$.

The third degree fitted polynomial of $CO_2$ emission is now estimated as

$$y = f(x) = \alpha^{\#} + \beta^{\#}x + \gamma^{\#}x^2 + \delta^{\#}x^3 \quad (1.4)$$

### Instantaneous Rate of Change of emission

Instantaneous Rate of Change (IROC) is a useful parameter that may be utilized to predict future emission of gas. For computing rate of change of the gas, the derivative of equation (1.4) is presented as

$$\frac{dy(x)}{dx} = \beta^{\#} + \gamma^{\#}x + \delta^{\#}x^2 \quad (1.5)$$

The equation (1.5) at a particular time is utilized for prediction of $CO_2$.

### Wavelet Transform

Wavelet may be treated as a complement to classical Fourier decomposition method. Wavelet transform, a mathematical technique, is utilized here to decompose the emission curve into multiple lower resolutions level. Using this tool we shall try to understand the $CO_2$ emission patterns more intuitively so that the hidden factors may be identified. Multi Resolution Analysis (MRA) done by applying wavelet transform.

### Quality of estimation

The quality of the developed analytical models using the raw data be examined by the following statistical tools. The quality of the proposed analytical models is verified with the statistical criteria, namely the coefficient of determination, adjusted coefficient of determination and residual analysis.

### Coefficient of determination or R square

The coefficient of determination ($R^2$) is defined as the proportion of the total response variation that is explained by the model. It provides an overall measure of how well the model fits. The general definition of $R^2$ is defined as

$$R^2 = 1 - \frac{SS_{err}}{SS_{tot}}$$

Where,

$$SS_{tot} = \sum_i (y_i - \bar{y})^2 \ , \quad SS_{reg} = \sum_i (f_i - \bar{y})^2 \ , SS_{err} = \sum_i (y_i - f_i)^2$$

Here, $SS_{tot}$ = Total sum of square (proportional to the sample variance)

$SS_{reg}$= the regression sum of squares or the explained sum of square and

$SS_{err}$ = the sum of squares of residuals, also called the residual sum of square. and are observed and estimated values of $CO_2$ emission.

**Adjusted Coefficient of Determination**

The Adjusted Coefficient of Determination (adjusted $R^2$) is defined as

$$\bar{R}^2 = 1 - (1 - R^2)\frac{n-1}{n-p-1}$$

$$= R^2 - (1 - R^2)\frac{p}{n-p-1}$$

where p is the total number of regressors in the model except constant term and n is the sample size. Adjusted R squared is another advanced tool to measure goodness of fit of the model.

## RESULTS & OBSERVATION

**Gaseous fuel**

**Polynomial model**

The third degree polynomial model to represent the $CO_2$ emission data of 54 years from gaseous fuel consumption is

$$y = f(x) = p_1x^3 + p_2x^2 + p_3x + p_4 \qquad (2.1)$$

where x is normalized by mean 1987 and standard deviation 16.02

Coefficients (with 95% confidence bounds):

$p_1$ = 1002 (-1254, 3258),

$p_2$ = 1.245e+04 (1.049e+04, 1.441e+04),

$p_3$ = 2.582e+04 (2.147e+04, 3.017e+04) and

$p_4$ = 1.423e+04 (1.165e+04, 1.681e+04)

The graphical visualization of observed values and empirical values is shown in Fig. 1. Here from the graphical presentation we observed that the use of gaseous fuel is increasing gradually and slowly. Sometimes it upward and sometimes it downward but monotonic.

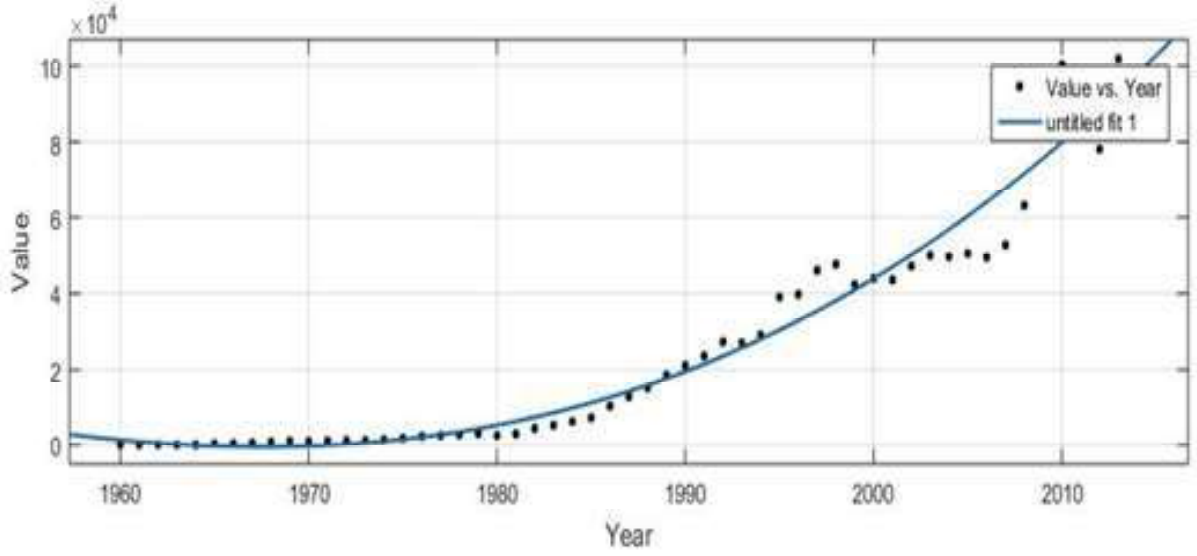


**Fig. 1: Graphical presentation of the model for gaseous fuel.**

Where x axis represents Time and y axis represents $CO_2$ emission from gaseous fuel consumption.

**Table 1: Numerical values of R square, adj R square, SSE and RMSE.**

| R squared value | Adjusted R squared value | SSE | RMSE |
|---|---|---|---|
| **0.9586** | **0.9561** | **2.061e+09** | **6357** |

**Multi Resolution Analyses (MRA)**

MRA of the emission curve is presented in Fig. 2. Here the signals or the images being decomposed in multi level resolution or scale from which an intuitive idea of emission trend may be obtained. Using discrete wavelet transform (DWT) the MRA is performed with Daubechis Wavelet (db3) by the help of the software MATLAB.

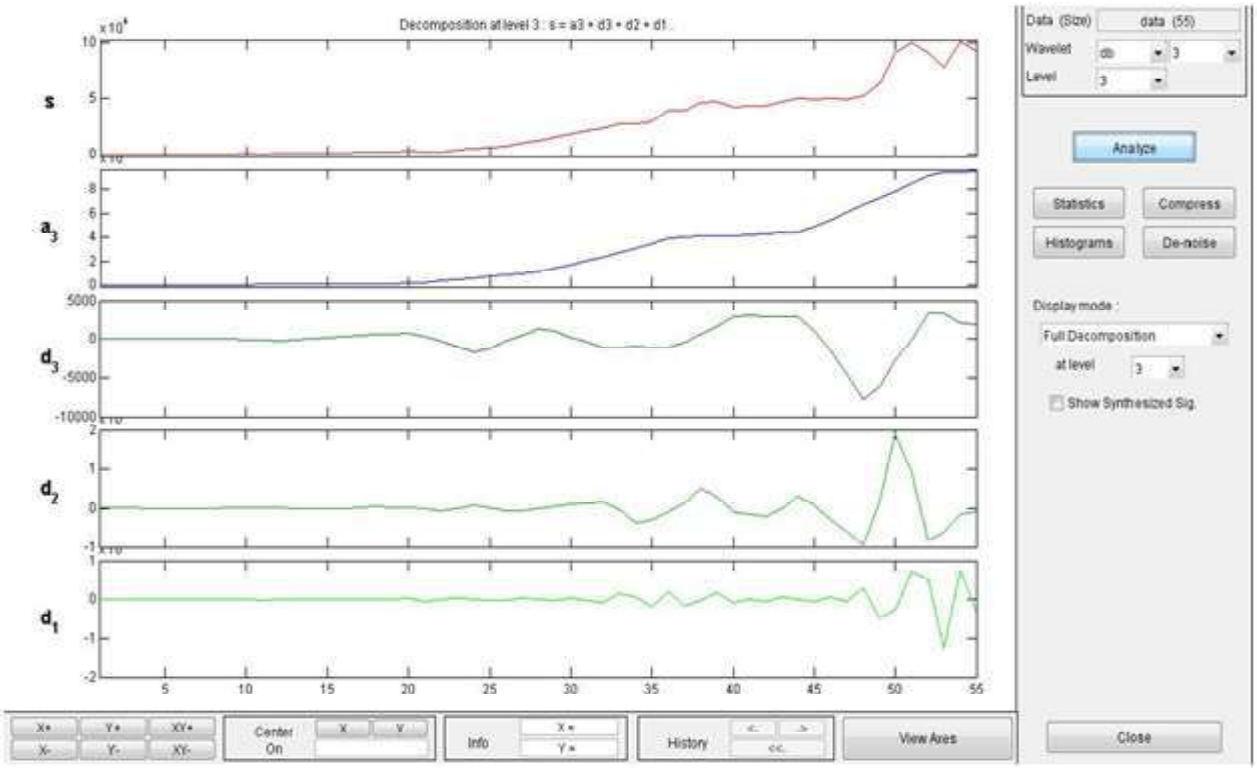


**Fig. 2: MRA for gaseous fuel consumption.**

**Liquid fuel**

**Polynomial model**

The third degree polynomial model to represent the $CO_2$ emission data of 54 years from liquid fuel consumption is

$$y = f(x) = p_1x^3 + p_2x^2 + p_3x + p_4 \qquad (2.2)$$

where x is normalized by mean 1987 and standard deviation 16.02

Coefficients (with 95% confidence bounds):

$p_1$ = 3682 (-2085, 9449)

$p_2$ = 4.206e+04 (3.705e+04, 4.707e+04)

$p_3$ = 1.273e+05 (1.162e+05, 1.384e+05)

$p_4$ = 1.361e+05 (1.295e+05, 1.427e+05)

Now, the observed value ($CO_2$ emission) and empirical value is presented in the following Fig. 3. From the graph it is seen that the emission in increasing rapidly from 1960 to 2000 and then gradually decreasing from 2001 to 2008 and again the increasing trend observed from the year of 2009.

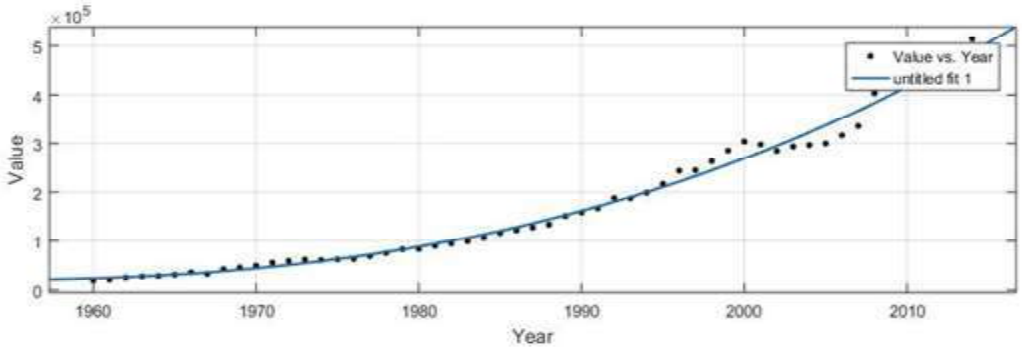


**Fig. 3: Graphical presentation of the model for liquid fuel.**

Where x axis represents Time and y axis represents $CO_2$ emission from liquid fuel consumption

**Table 2: Numerical values of R square, adj R square, SSE and RMSE.**

| R squared value | Adjusted R squared value | SSE | RMSE |
|---|---|---|---|
| **0.9872** | **0.9865** | **1.347e+10** | **1.625e+04** |

**Multi Resolution Analyses (MRA)**

MRA of the emission curve is shown below where the signals or the images been decomposed in more than one resolution or scale. It helps for better understanding the emission pattern.

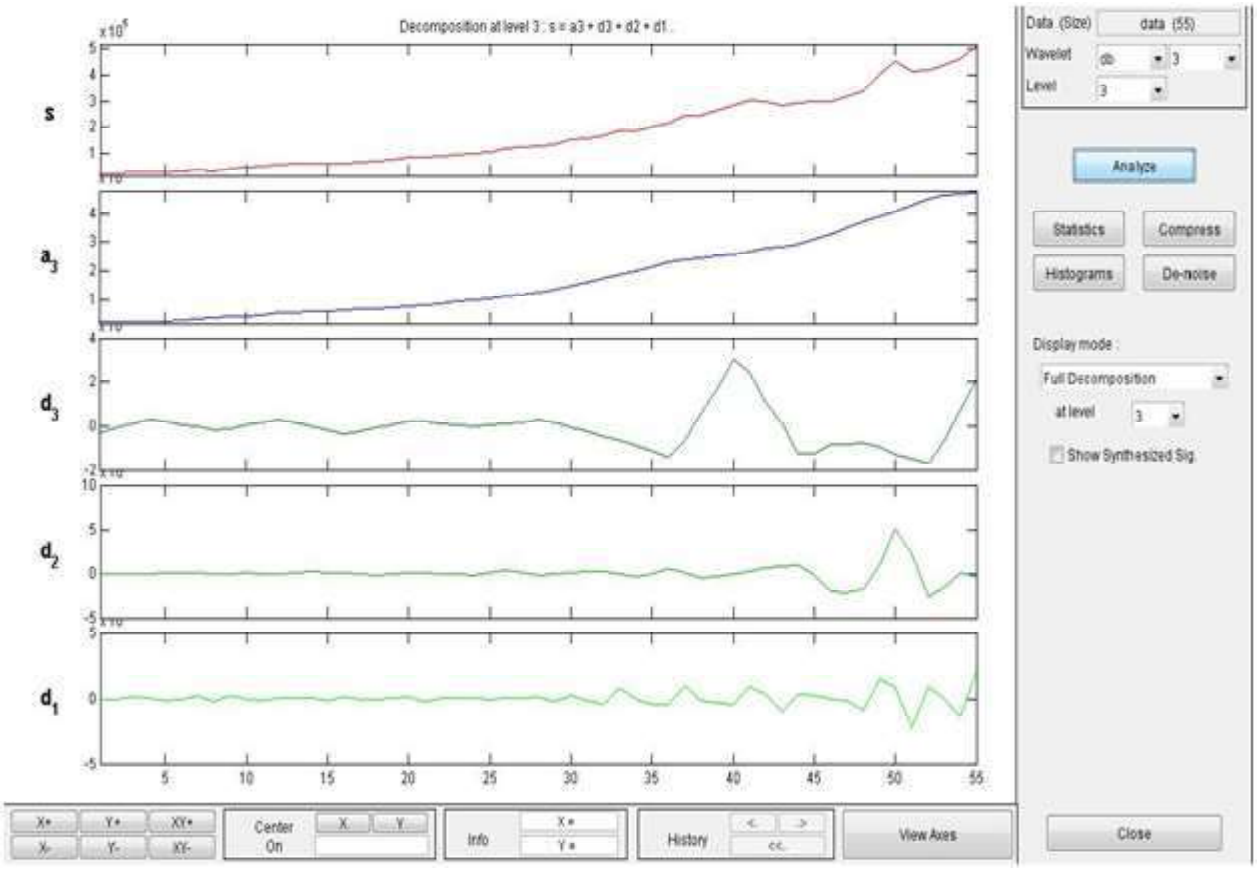


**Fig. 2: MRA for liquid fuel consumption.**

Certain up and down are seen in the MRA. Here the analysis is done by using Daubechies Wavelet (db3).

## SUMMARY & CONCLUSION

The analytical expressions for emission have been tested with the statistical procedures $R^2$ and $R^2$ adjusted to identify the efficacy of our mathematical expression and each of them attests the good quality of the proposed systems. The pattern of growth is not uniform it is widely area and time dependent and the proposed model is found to be fitted well with the $CO_2$ emission data (both in gaseous and liquid fuel consumption) in the considered time span. To decompose the image or signal the useful mathematical tools wavelet transform and MRA has been utilized which presents a clear picture of the emission curve that help us to find the ups and downs of the representing curve. From the diagram of Multi Resolution Analysis, we observed a sudden increase or decrease in the production of green house gases in a certain time period. It may happen due to several hidden factors and that factors are to be find out. Further research is needed in this regards.

Present study shows that the dependency on gaseous and liquid fuel consumption is increasing day by day and

as result of this uncontrolled use of the fuels the production of $CO_2$ is increasing in an exponential growth. This leads the planet to a fatal and alarming situation.

Proposed model can be used for understanding the emission trend and future prediction of the other GHGs emission in India and other countries in the world. Future prediction of emission of $CO_2$ may be evaluated from our proposed model. This article may be helpful for the future researchers for finding the nature of emission of different anthropogenic gases produced due to the burning fossil fuels.

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**Physics**

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# Result of cavity-field statistics on atomic entanglement in intensity dependent two-photon process

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**Abstract:** In this paper the development of entanglement for a pair of two-level Rydberg atoms passing one after another into an ideal cavity filled with a single mode radiation field has been studied. The atoms interact with the cavity field via intensity dependent two-photon transitions. The initial joint state of the two successive atoms entering the cavity is unentangled. Interactions mediated by the single mode cavity field give rise to the final two-atom mixed entangled type state. The widely known measure relevant for the mixed states, viz. the entanglement of formation has been used to quantify the entanglement. The entanglement of formation of the joint two-atom state as a function of the Rabi angle has been calculated for the Fock state field, coherent field and thermal field respectively inside the cavity. The change in the magnitude of atomic entanglement with cavity photon number and detuning has been discussed.

**Keywords: Jaynes-Cummings Model (JCM), Intensity Dependent Coupling, Photon Statistics, Fock state, Coherent state, Thermal state**

## INTRODUCTION

In the recent years Quantum entanglement has been widely studied due to its potential applications in many quantum information protocols like teleportation, key distribution, logic operations and quantum communications.[1-3] Cavity Quantum Electro Dynamic (QED) techniques have been recognized as a promising candidate for the physical realization of quantum information processing[4,5]. In cavity QED, single atomic transitions and single cavity mode can be isolated and coupled coherently and preparation of entangled states is achievable[6-9]. Usually the atom is sent through the cavity and interacts resonantly with one of the cavity modes. In most of the cases the dynamics is well described by the analytically solvable Jaynes-Cummings Model (JCM)[10]. The JCM model via intensity-dependent coupling is a theoretical model proposed by Buck and Sukumar[11,12] to describe the dependence of the interaction between light and atoms on the intensity of light.

Here, we study the evolution of entanglement between two two-level atoms that pass one after the other mediated by various cavity fields via intensity dependent two-photon degenerate process. As the atoms do not interact directly with one another, the characteristics of the radiation field encountered may produce remarkable effect on the nature of atomic entanglement.

We study the effect of different field statistics on the magnitude of two-atom entanglement and compare the results with non-degenerate process obtained in Ref. 13 and also with two-photon degenerate process in Ref. 14.

## DESCRIPTION OF THE MODEL

We consider a single mode lossless cavity through which two two-level Rydberg atoms pass one after another. The atom interacts via intensity dependent two-photon process. Due to interaction of the first atom with the cavity

field, cavity field statistics gets changed. Since the cavity is lossless, the changes remain inside the cavity until the second atom arrives in the cavity. The second atom thus interacts with the field that was changed due to interaction with the first atom. In this process the two atoms get entangled[6-9, 12,13] although they do not interact directly with one another or with the cavity field at the same time. The Hamiltonian for the model for such a system under the rotating wave approximation is written as

$$\hat{H} = \hbar\frac{\omega_0}{2}\hat{\sigma}_3 + \hbar\omega\hat{a}^\dagger\hat{a} + \hbar g(\hat{\sigma}_+\hat{a}^2 + \hat{\sigma}_-\hat{a}^{\dagger^2}) \qquad (1)$$

where $\omega_o$ is the transition frequency and g is the atom-field coupling constant, $\hat{\sigma}_3$ is the inversion operator and $\hat{\sigma}_+, \hat{\sigma}_-$ are the Pauli raising and lowering operators respectively. $\hat{a}^\dagger$ and $\hat{a}$ are the creation and annihilation operators respectively. The $\hat{\sigma}$ 's and â 's obey the following commutation relations.

$$[\hat{\sigma}_3, \hat{\sigma}_\pm] = \pm 2\hat{\sigma}_\pm, \qquad [\hat{\sigma}_+, \hat{\sigma}_-] = \hat{\sigma}_3, \qquad [\hat{a}, \hat{a}^\dagger] = 1$$

For the Single-mode Two photon process with intensity dependent coupling the Hamiltonian is obtained from Eq. (1) as

$$\hat{H} = \frac{\hbar\omega_o\hat{\sigma}_3}{2} + \hbar\omega\hat{a}^\dagger\,\hat{a} + \hbar g(\hat{Q}_+ + \hat{Q}_-) \qquad (2)$$

where $\hat{Q}_+ = \hat{\sigma}_+\hat{a}^2\sqrt{\hat{a}^\dagger\hat{a}}\,, \hat{Q}_- = \hat{\sigma}_-\sqrt{\hat{a}^\dagger\hat{a}}\,\hat{a}^{\dagger^2}$ (3)

Initially both the atoms are in their upper states so that the initial condition for the system when the first atom enters the cavity is

$$|\psi(t=0)\rangle = \sum_{n=0}^{\infty} C_n |a_1, n\rangle \qquad (4)$$

where $|n\rangle$ designates the cavity photon number states with an initial distribution $P_n = |C_n|^2$. $|a_1\rangle$ represents the upper state of the first atom. At resonance $2\omega \approx \omega_0$ and the time evolution of the atom-field system wave function can be written as[15]

$$|\psi(t)\rangle = e^{-i\hat{H}t}|\psi(t=0)\rangle \qquad (5)$$

$|\psi(t)\rangle$ can be obtained by expanding $e^{-iHt}$ and operating each term of the expansion on the initial state.

At resonance $2\omega \approx \omega_0$ all the terms can be summed up giving $|\psi_1(t)\rangle$ in a simple form.

$$|\psi_1(t)\rangle = \cos gt\sqrt{(n+1)}(n+2)|a_1, n\rangle - i\sin gt\sqrt{(n+1)}(n+2)|b_1, n+2\rangle \qquad (6)$$

where 't' is the duration of the atom-field interaction. The initial condition for the second atom can be written as $|\psi_2(t=0)\rangle = |a_2\rangle|\psi_1(\tau)\rangle$ and therefore

$$|\psi_2(t=0)\rangle = \cos gt\sqrt{(n+1)}(n+2)|a_1, a_2, n\rangle - i\sin gt\sqrt{(n+1)}(n+2)|b_1, a_2, n+2\rangle \qquad (7)$$

The state vector representing the two atoms and the cavity for $t > 2\tau$ is given by

$$|\psi(t)\rangle_{A-A-F} = \alpha|a_2, a_1, n\rangle + \beta|a_2, b_1, n+2\rangle + \gamma|b_2, a_1, n+2\rangle + \delta|b_2, b_1, n+4\rangle \qquad (8)$$

where $a_2$ and $b_2$ are the upper and lower states respectively of the second atom and it has been assumed that the second atom interacts with the cavity field for the same time t. Here,

$$\begin{aligned}
\alpha &= \cos^2 gt\sqrt{(n+1)}(n+2) \\
\beta &= [\cos gt\sqrt{(n+3)}(n+4)][-i\sin gt\sqrt{(n+1)}(n+2)] \\
\gamma &= [\cos gt\sqrt{(n+1)}(n+2)]\,[-i\,\sin gt\sqrt{(n+1)}(n+2)] \\
\delta &= [-i\sin gt\sqrt{(n+1)}(n+2)]\,[-i\sin gt\sqrt{(n+3)}(n+4)]
\end{aligned} \qquad (9)$$

At resonance $2\omega \approx \omega_0$, the operators become time independent in Heisenberg picture and the following properties has been used to obtain Eq.(6) and Eq. (8).

$$\begin{aligned}
\hat{Q}_-|a, n\rangle &= \sqrt{(n+1)}(n+2)|b, n+2\rangle \\
\hat{Q}_+\hat{Q}_-|a, n\rangle &= (n+1)(n+2)^2|a, n\rangle \\
Q_+|a, n\rangle &= 0 \qquad \text{etc.}
\end{aligned} \qquad (10)$$

Here a and b are again the atomic upper and lower levels respectively.

**Atom-atom Entanglement and Effect of Field Statistics**

The density operator of the two atoms and the cavity field is given by

$$\rho_{A-A-F} = |\psi(t)\rangle\langle\psi(t)| \qquad (11)$$

where $|\psi(t)\rangle$ is given by Eq. (8). The atom-atom density operator is given by

$$\rho_{A-A} = Tr_F\rho_{A-A-F} \qquad (12)$$

Since the joint state of two atoms emanating from the cavity is not a pure state, the entanglement of the two-atom system can be quantified by the concurrence as proposed by Wootters[16, 17]. This has been widely used to study bipartite entanglement.

The concurrence of the system is given by

$$C(\rho) = \max\ \{0, \sqrt{\lambda_1} - \sqrt{\lambda_2} - \sqrt{\lambda_3} - \sqrt{\lambda_4}\ \} \qquad (13)$$

where $\lambda$ are the four eigen values of the non-Hermitian matrix

$$R = \rho(\sigma_y \otimes \sigma_y)\rho^*(\sigma_y \otimes \sigma_y) \qquad (14)$$

arranged in a decreasing order, $\rho$ is the $(4\times 4)$ density matrix of the two atom system. Entanglement can be quantified by another function also, called the entanglement of formation $E_f(\rho)$, monotone of C. It can be defined as

$$E_f(\rho) = h\left[\frac{1+\sqrt{1-C^2(\rho)}}{2}\right] \qquad (15)$$

where $h(x) = -x\log_2 x - (1-x)\log_2(1-x)$

State is entangled (inseparable) whenever C>0. Maximum possible entanglement is given by C=1, while on the contrary, C=0 implies separability.

Based on previous studies[6-9], it is expected that the cavity field statistics can have considerable influence on the atom-atom entanglement. In what follows, we study the influence of the cavity field obeying various statistics.

**Cavity Field in a Fock state**

We trace over the field variables in order to obtain the reduced mixed density state of two atoms as

$$\rho_{A-A} = \alpha^2|a_2a_1\rangle\langle a_2a_1| + \beta^2|a_2b_1\rangle\langle a_2b_1| + \beta\gamma^*|a_2b_1\rangle\langle b_2a_1| + \gamma\beta^*|b_2a_1\rangle\langle a_2b_1| + \gamma\gamma^*|b_2a_1\rangle\langle b_2a_1| + \delta\delta^*|b_2b_1\rangle\langle b_2b_1| \qquad (16)$$

In the above, the non-vanishing terms only has been displayed. When the cavity field is in a number state $|n\rangle$, the four eigen values of R in Eq.(14) is given by

$$\lambda_1 = 0$$
$$\lambda_2 = \lambda_3 = |\alpha|^2|\delta|^2$$
$$\lambda_4 = 4|\beta|^2|\gamma|^2 \qquad (17)$$

where $\alpha, \beta, \gamma, \delta$ values are given by Eq.(9). Hence the concurrence of the two atom bipartite system is given by

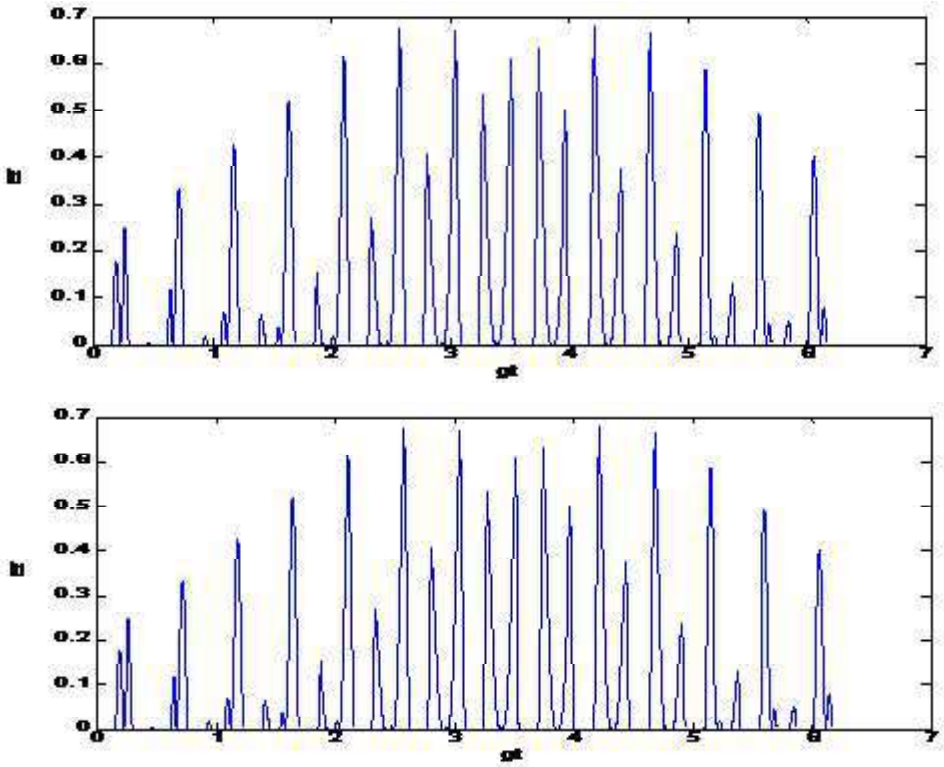
$$C = \max[0, \sin 2gt(n+1)^{1/2}(n+2)\sin gt\{(n+3)^{1/2}(n+4) - (n+1)^{1/2}(n+2)\}] \qquad (18)$$

For a vaccum state, n=0 it reduces to

$$C = \max[0, \sin 4gt \sin 2(2\sqrt{3}-1)gt] \qquad (19)$$

Hence the vacuum field can induce atom-atom entanglement whenever $\sin(4gt)$ and $\sin\{2(2\sqrt{3}-1)gt\}$ have the same sign. In Figure 1, we plot the entanglement of formation which is a monotone of concurrence for (a) n=0 (b) n=2 (c) n=5.

We find that there is a notable entanglement induced by the vacuum field. This is due to the fact that the first atom in excited state interacts with the vacuum cavity field and in this process disturbs the field. So the cavity field no longer remains in the vacuum state when the second atom enters. This makes the atoms entangled.



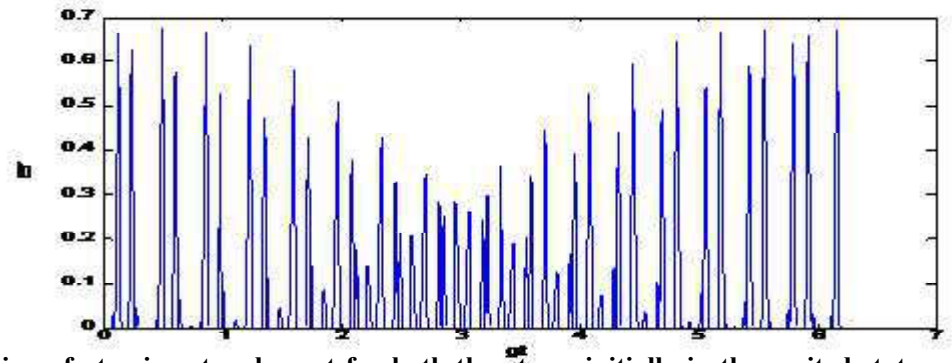



**Fig. 1. Evolution of atomic entanglement for both the atoms initially in the excited state and the field in a number state for (a) n=0 (b) n=2 (c) n=5**

For non-zero n, the argument of the sin functions increase with increase in n. This makes the concurrence non-zero more frequently. We find that with increase in the number of photons the entanglement of formation $E_f$ increases. A comparison of the values of $E_f$ for n=0, n=2 or n=5 with the corresponding values obtained in Fig.1. (a)-(c) for the degenerate Two photon Jaynes Cummings model[14] reveals that the entanglement of formation $E_f$ is greater in the two-photon process with intensity dependent coupling. The intensity dependent coupling thus increases the entanglement in degenerate two-photon process for initial vacuum state.

**Cavity field in a coherent state**

For the cavity field in initial coherent state, we can write the complete wave function for the model in the following way

$$|\psi(t)\rangle = \sum_{n=0}^{\infty} C_n[\alpha|a_2, a_1, n\rangle + \beta|a_2, b_1, n+2\rangle + \gamma|b_2, a_1, n+2\rangle + \delta|b_2, b_1, n+4\rangle] \quad (20)$$

where,

$$|C_n(\alpha)|^2 = P_n(\bar{n}) = |\langle n|\alpha\rangle|^2 = \exp(-\bar{n})\frac{\bar{n}^n}{n!} \quad (21)$$

$P_n(\bar{n})$ represents the coherent field probability distribution functions for photon numbers in the Poisson statistics. The coherent states $|\alpha\rangle$ are given by

$$|\alpha\rangle = \exp(-\tfrac{1}{2}|\alpha|^2)\sum_{n=0}^{\infty}\frac{\alpha^n}{\sqrt{n!}}|n\rangle \quad (22)$$

We trace over the field variables to get the reduced density state of the two atoms system

$$\rho(t)_{A-A} = \sum_{n=0}^{\infty}\langle n|[|\psi(t)_{A-A-F}\rangle\langle\psi(t)_{A-A-F}|]|n\rangle \quad (23)$$

Making use of the above expression we obtain the matrix elements of $\rho_{A-A}$ as:

$$\rho_{11} = \sum_{n=0}^{\infty}|C_n|^2 \cos^4 g\,t\sqrt{(n+1)}(n+2) \quad (24a)$$

$$\rho_{12} = \sum_{n=0}^{\infty} C_{n+2}\,(\cos^2 g\,t\sqrt{(n+3)}(n+4))C_n^{\,*} \quad (24b)$$

$$(i\sin g\,t\sqrt{(n+1)}(n+2))(\cos g\,t\sqrt{(n+3)}(n+4))$$

$$\rho_{13} = \sum_{n=0}^{\infty} C_{n+2}\,(\cos^2 g\,t\sqrt{(n+3)}(n+4))C_n^{\,*} \quad (24c)$$

$$(i\sin g\,t\sqrt{(n+1)}(n+2))(\cos g\,t\sqrt{(n+1)}(n+2))$$

$$\rho_{14} = \sum_{n=0}^{\infty} C_{n+4}\,(\cos^2 g\,t\sqrt{(n+5)}(n+6))C_n^{\,*}$$

$$\left(i\sin g\,t\sqrt{(n+1)}(n+2)\right)\left(i\sin g\,t\sqrt{(n+3)}(n+4)\right) \quad (24d)$$

$$\rho_{21} = -\rho_{12} \quad (24e)$$

$$\rho_{22} = \sum_{n_1=0}^{\infty} |C_n|^2 \left(cos^2\, g\, t\sqrt{(n+3)}(n+4)\right)\left(sin^2\, g\, t\sqrt{(n+1)}(n+2)\right) \quad (24f)$$

$$\rho_{23} = \sum_{n=0}^{\infty} |C_n|^2 \,(-i\, sin\, g\, t\sqrt{(n+1)}(n+2)\, cos\, g\, t\sqrt{(n+3)}(n+4))$$

$$\left(i\, sin\, g\, t\sqrt{(n+1)}(n+2)\right)\left(cos\, g\, t\sqrt{(n+1)}(n+2)\right) \quad (24g)$$

$$\rho_{24} = \sum_{n=0}^{\infty} C_{n+2}(-i\, sin\, g\, t\sqrt{(n+3)}(n+4)\,(cos\, g\, t\sqrt{(n+5)}(n+6))$$

$$C_n{}^{*}(i\, sin\, g\, t\sqrt{(n+1)}(n+2))(i\, sin\, g\, t\sqrt{(n+3)}(n+4)) \quad (24h)$$

$$\rho_{31} = -\rho_{13} \quad (24i)$$

$$\rho_{32} = \rho_{23} \quad (24j)$$

$$\rho_{33} = \sum_{n=0}^{\infty} |C_n|^2 \left(cos^2\, g\, t\sqrt{(n+1)}(n+2)\right)\left(sin^2\, g\, t\sqrt{(n+1)}(n+2)\right) \quad (24k)$$

$$\rho_{34} = \sum_{n=0}^{\infty} C_{n+2}\,(-i\, sin\, g\, t\sqrt{(n+3)}(n+4))(cos\, g\, t\sqrt{(n+3)}(n+4))C\overset{*}{n}$$

$$(i\, sin\, g\, t\sqrt{(n+1)}(n+2))(i\, sin\, g\, t\sqrt{(n+3)}(n+4)) \quad (24l)$$

$$\rho_{41} = \rho_{14} \quad (24m)$$

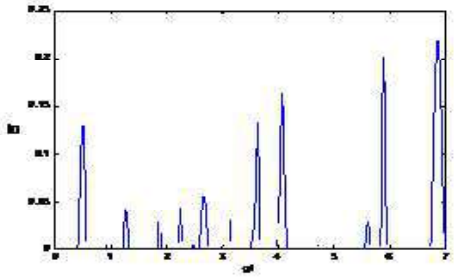
$$\rho_{42} = -\rho_{24} \quad (24n)$$

$$\rho_{43} = -\rho_{34} \quad (24o)$$

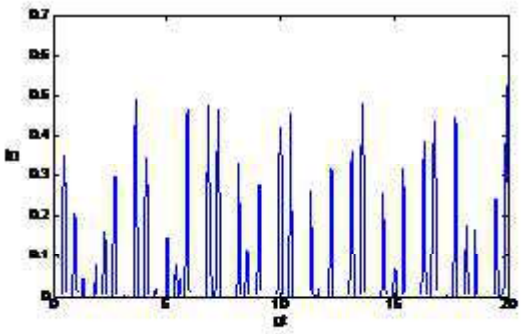
$$\rho_{44} = \sum_{n=0}^{\infty} |C_n|^2 \,(sin^2\, g\, t\sqrt{(n+1)}(n+2))(sin^2\, g\, t\sqrt{(n+3)}(n+4)) \quad (24p)$$

$E_f(\rho)$ in Eq.(15) is evaluated numerically in order to study the atom-atom entanglement. We compute the entanglement of formation $E_f$ for low photon numbers. In Fig.2 (a)-(d), we plot $E_f(\rho)$ versus the Rabi angle gt for different low values of photon numbers.

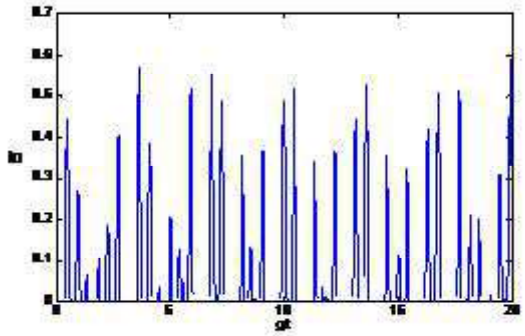
In Figure 2. (a)–(d) we find that the peak value of entanglement of formation $E_f$ increase with decrease in the cavity photon numbers $\overline{n} = |\alpha|^2$. We obtain sharp narrow peaks for small values of $\overline{n}$. The Poisson distribution peaks at $\overline{n}$ and becomes broader with increase in $\overline{n}$. The Poisson distribution, however,



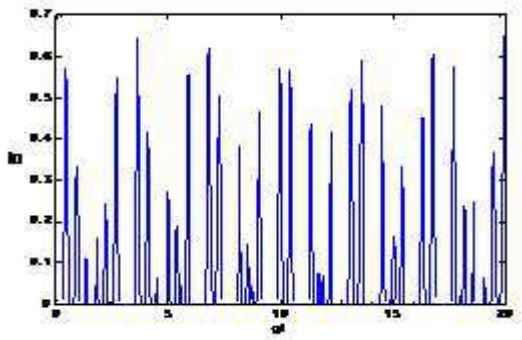
(*a*) $\langle n \rangle = 0.5$



(*b*) $\langle n \rangle = 0.1$



(*c*) $\langle n \rangle = 0.05$



(*d*) $\langle n \rangle = 0.01$

**Figure 2. Evolution of atomic entanglement for both atoms initially in the excited state and field in the single-mode coherent state with various photon numbers: (a)** $\langle n \rangle = 0.5$ **, (b)** $\langle n \rangle = 0.1$ **(c)** $\langle n \rangle = 0.05$ **, (d)** $\langle n \rangle = 0.01$

becomes narrower as $\overline{n}$ decreases. We also observe that peaks of entanglement of formation $E_f$ shift to right as the average photon number increases as expected for a coherent field.

On comparison of Fig. 2(a)- Fig. 2.(b)with Fig.3(a)-Fig.3(b) in the Two-photon Jaynes-Cumming Model without intensity dependence[14], plotted for initial coherent field with (a) $\langle n \rangle = 0.5$ and (b) $\langle n \rangle = 0.1$ we observe that the peak value of entanglement is almost equal in both the cases. But in the intensity dependent two-photon process we find that the concurrence takes maximum values more frequently.

Comparing Fig. 2(c)-Fig.(d) with Fig.3(c)-Fig.3(d) in for the Two-photon Jaynes-Cumming Model without intensity dependence[14], plotted for initial coherent field with (a) $\langle n \rangle = 0.05$ and (b) $\langle n \rangle = 0.01$, we find that the peak value of $E_f$ is larger in the present case with intensity dependence and it becomes maximum at smaller and regular intervals of time .

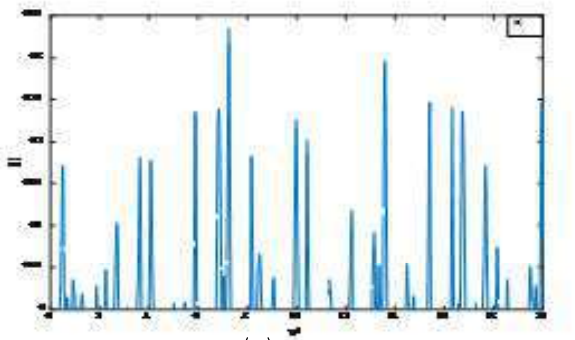
**Cavity field in a Two mode thermal state**

The field at thermal equilibrium obeying Bose-Einstein statistics has an average photon number at temperature T$^0$ K given by $\langle n \rangle = (e^{\frac{\hbar\omega}{kT}} - 1)^{-1}$. The thermal field probability distribution function is given by

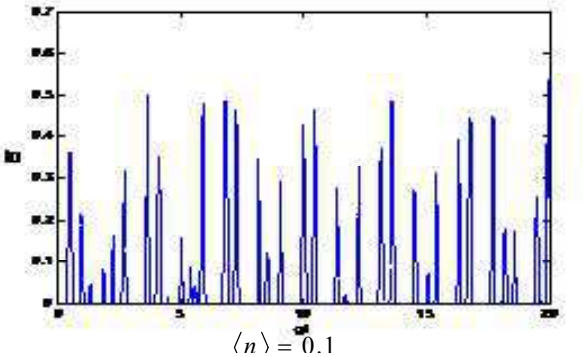
$$P_n = \frac{\langle n \rangle^n}{(1+\langle n \rangle)^{n+1}} \qquad (25)$$

On summing over all n, the joint two-atom cavity state is obtained. We compute the entanglement as done in the previous section. In Fig. 3. we plot $E_f$ versus gt for $\langle n \rangle = 0.5, 0.1, 0.05, 0.01$ . Here also we find that the magnitude of atomic entanglement increases with decrease in the cavity photon number. Comparing Fig. 3(a)-Fig. 3(d) with Fig. 4. (a)-(d) of for single mode two-photon process[14] we find that find that the peak value of $E_f$ is higher in case of intensity dependence.

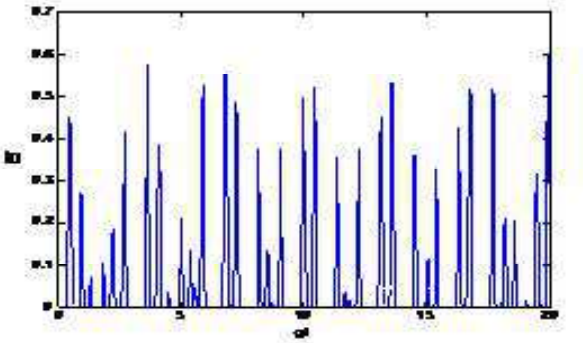
If we compare the peak values of entanglement with two-mode Jaynes Cummings models with intensity dependent coupling[13] keeping same values of initial photon numbers, we find that peak values of Ef is higher in the present degenerate case with intensity dependent coupling both for initial coherent field as well as thermal field.



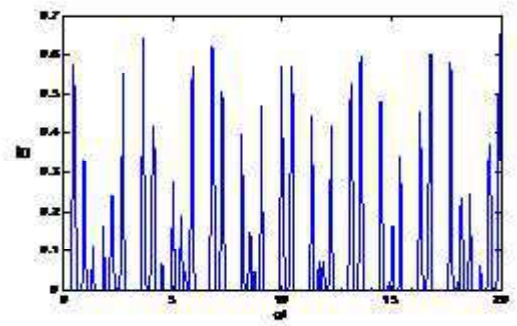
$\langle n \rangle = 0.5$



$\langle n \rangle = 0.1$



$\langle n \rangle = 0.05$



$\langle n \rangle = 0.001$

**Fig. 3. Time evolution of atomic entanglement in two-photon intensity dependent single-mode thermal fields with various photon numbers: (a)** $\langle n \rangle = 0.5$ **, (b)** $\langle n \rangle = 0.1$ **, (c)** $\langle n \rangle = 0.05$ **, (d)** $\langle n \rangle = 0.01$ **.**

## CONCLUSION

It is observed that for low cavity photon number case, the entanglement between the two atoms increases with decrease in average photon numbers both for initial coherent as well as and thermal field. The evolution of $E_f$ for a single-mode two-photon coherent field and thermal field are similar. Quantum effects that are noticeable, mostly when photon number is low helps to increase the peak value of $E_f$ .

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Zoology

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# Extraction of cellulase producing bacteria from the gut of fresh water fish, *Labeo rohita*

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**Abstract:** Microorganisms like bacteria, yeast and fungi are widely used in several food preparations, due to their ability to produce different extracellular enzymes. They have been used for improving taste, texture and offer a huge economic benefit to industries. In the present investigation an effort has been made to isolate the cellulase producing bacteria from the intestinal portion of fresh water fish, *Labeo rohita*. Isolation was done on NA media. The purification of bacteria was done by Streak plate technique. After performing the Gram staining, bacteria was identified as Gram-positive *Bacillus* sp. Cellulase is an enzyme that has the ability to hydrolyze cellulose into free glucose by breaking β-1,4-glycosidic bond. The cellulase producing property of bacteria in vitro was confirmed by the emergence of clear zone around the bacterial growth on CMC media. Cellulase enzyme is widely used in industries for textile wet processing, biostoning of denim fabric, paper and pulp industries and food industries. It is largely used in juice industries where cellulase-mediated extraction of juice is done. Thus, the isolated bacteria have economic importance and can be exploited for the production of cellulase enzyme in a cost-efficient manner.

**Keywords: Cellulase, CMC media, NA media, *Labeo rohita, Bacillus.***

## INTRODUCTION

The digestive tract of fish is colonized by a vast number of heterotrophic bacteria such as obligate and facultative anaerobes.[1] Gut microbes are known to play a crucial role in maintaining gut integrity, strengthening immunity and disease resistance.[2]

Muthukumar & Kandeepan (2015)[3] reported that due to the reason of direct contact with environment, fish receives bacteria in its digestive tract from the external aquatic environment along with food and water. The rich nutrient availability inside the gut acts as a favourable culture environment for microbes.

The microflora of the gastrointestinal tract represents a very pivotal and diversified enzymatic potential. Some fish species fulfil their need of intestinal enzymes from the microflora inhabiting the gut.[4]

*Labeo rohita* is a freshwater herbivore fish basically feeding upon plant and plant products. The major components of plants are starch and cellulose. Thus, a number of bacteria having the ability to degrade these components dwell in the digestive tract of fish.

Apart from producing exogenous enzymes it has also been reported that gut microbiota helps in converting the nutrients into energy and can produce vitamins. Gut bacteria prevent the microbial colonization of pathogens by competitive exclusion and by production of bacteriocins.[5]

The present study aims at the extraction of cellulase producing bacteria from the gastrointestinal tract of *Labeo rohita.*

## MATERIALS & METHODS

### Collection of fish

Disease free *Labeo rohita* were collected from the Fish Farmers Training Centre, Shalimar, Dhurwa, Ranchi, Jharkhand, India. This Centre was started in the year 2010 as the first state level fisheries training centre. The fishes were brought to the laboratory for further investigation.

**Collection of bacteria**

Fish was starved for 24 hours in order to clean its alimentary canal.[6] The fish was weighed and its length was measured. Body surface of fish was washed thoroughly with alcohol. Then the fish was dissected and its gut was removed carefully, inside the laminar airflow chamber.[7]

**Isolation and enumeration of bacteria**

The removed fish gut was washed three times with distilled water. 1g of gut was weighed and homogenized in 9 ml of distilled water and then centrifuged.[3,6] After the centrifugation 1 ml of cell free supernatant (CFS) was serially diluted up to the $6^{th}$ dilution. 1ml of content from the $6^{th}$ dilution was inoculated on the surface of nutrient agar media plate using spread plate technique.[8] Plates were then incubated for 48 hours at 37°C. A random individual bacterial colony was picked and purified by streak plate technique.[9,10]

**Identification and characterization of bacteria**

The bacteria isolated from the gut were carefully identified morphologically according to Bergey's manual of determinative bacteriology.[11] Identification was followed by Gram staining.

**Screening of cellulase production**

Firstly, the CMC (carboxy methyl cellulose) media was prepared with CMC, $NaNO_3$, KCl, $MgSO_4$, yeast extract, glucose and agar. Plates were prepared and isolated bacteria were inoculated. It was then incubated at 37°C for 48 hours. After the incubation, the plates were flooded by 1% Congo red solution and left for few minutes. Then the plates were washed with one mole (1M) of sodium chloride (NaCl) solution for about 6 to 7 times and finally the result was observed.

**Evaluation of effect of temperature on the bacterial growth**

Temperature plays an important role on the bacterial growth and metabolism. In the present investigation a loop full of isolated bacteria was inoculated in 50 ml of nutrient broth and divided equally in five test tubes so that each tube contains 10ml of broth which were incubated at temperatures of 25°C, 35°C, 40°C, 50°C and 60°C for 24 hours.[7] Then each sample was serially diluted up to $6^{th}$ dilution. 1ml of sample from each temperature was plated over the nutrient agar and incubated for 48 hours at 37°C. The bacterial colonies were then counted and colony forming unit (CFU) per ml of sample was calculated.

## RESULTS

Morphological analysis of isolated bacteria revealed that colonies were quite large, circular, with smooth edge and having cream colour with a little raised elevation [Fig.1].The bacteria was Gram positive and identified as *Bacillus species.*

Cellulose is a rigid biomolecule made up of long chain of β-glucose. Production of cellulase enzyme was tested on CMC media and a positive test result was found. As a result, clear zone around the bacteria was observed confirming the production of cellulase enzyme [Fig.2].

Effect of different temperatures was also evaluated on the growth of isolated bacteria. Different temperatures were selected ranging from 25°C to 60°C. After incubation of bacteria at different temperatures, a maximum bacterial growth in the form of colonies CFU/ml was found at the temperature of 40°C. Furthermore, deviation from the 40°C showed a declination in bacterial growth [Fig 3].

**Fig. 1- Growth of bacterial colonies**

**Fig. 2- Qualitative analysis of cellulase enzyme production using CMC Media. Plate shows clear zone around bacterial growth**

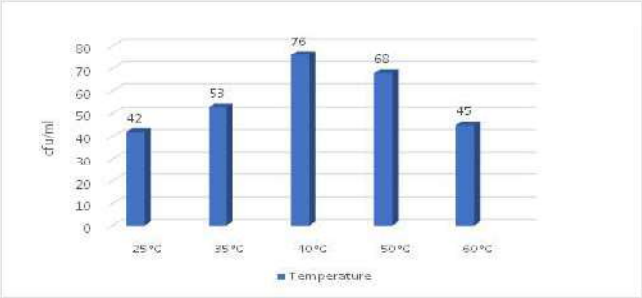


**Fig. 3- Effect of temperature on bacterial growth**

## DISCUSSION

Microbes of the outer environment play a significant role in the formation of the microflora of the gastrointestinal tract of fishes.[12] Compared to the water, ecosystem of gut is far rich in nutrients, thus more favourable for the growth of the majority of bacteria.[13] However, Molinari *et al.* (2003)[14] opined that not all bacteria that enter in the digestive tract with food and water establish themselves there.

The microbial population of the gut represents a very important and diversified enzymatic potential. The enzymatic mass present in the digestive tract interferes, in many ways, in the metabolism of food content as suggested by Ganguly & Prasad (2012)[13]

A number of studies have revealed that the beneficial gut bacteria are mainly related to the *Bacillus* sp. like *Bacillus subtilis, Bacillus licheniformis, Bacillus cereus.*[15] This shows resemblance with the present results in which the identified bacteria was Gram positive *Bacillus* species. Ghosh *et al.* (2002)[16] has also reported the isolation of three bacterial species under genus *Bacillus* from the digestive tract of Indian major carp rohu and identified them as *Bacillus pumilus, Bacillus cereus, Bacillus circulans.*

The keen observation of Ghosh *et al.* (2002)[16] and Bairagi *et al.* (2002)[17] divulge that fish shelters enzyme secreting bacteria in their digestive tract. Cellulose digestion has been observed not only in fish but also in other animals like cattle and termites which is attributed to the production of bacterial cellulase. This is because their diet contains plant and its products in which cellulose is the major biomolecule. Production of cellulase enzyme in these animals by gut bacteria helps to a great extent in cellulose digestion.[17-19]

With the resemblance to the result of Ray *et al.* (2012)[19], the present investigation revealed the cellulase producing capacity of isolated gut bacteria in vitro. A clear zone was observed around the bacterial growth due to the hydrolysis of β-1,4-glycosidic bond.[20] Congo red does not stain the area with degraded cellulose, which confirms the cellulase producing capacity of isolated bacteria. On the other hand, Kirchman *et al.* (2005)[21] opined that the temperature plays a remarkable role in the growth and metabolism of bacteria. Membré *et al.* (2005)[22] added that effect of temperature can vary from species to species of bacteria. On examining the effect of temperature, it was found that the 40°C was the optimum temperature for growth of bacteria and deviation from that temperature shows declination in bacterial growth. This result is similar to that of Balaji *et al.* (2012)[7].

So far the industrial use is concerned, cellulase enzyme is extensively used in textile wet processing, biostoning of denim fabric and biopolishing of textile fibres.[23] It is also used in paper and pulp industries.[24] Cellulase is widely used in juice industries. Cellulase mediated extraction of juice gives high yield, lessens the heat damage and takes less processing time.[25] Keeping in mind the economic importance of cellulase, the isolated bacteria can be exploited for the mass production of enzyme cellulase that can be utilised for various industrial purposes.

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# Physicochemical characterization of chitosan extracted from *Macrobrachium dayanum* shells

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**Abstract:** In this study, chitosan was extracted from freshwater prawn *Macrobrachium dayanum* shells. In order to determine physicochemical characteristics of the extracted chitosan, the yield, water and fat binding capacities, FTIR studies and degree of deacetylation were measured. The result of study indicates that yield obtained for extracted chitosan was 11.62±1.07% from shells. The water and fat binding capacity were 670±1.15% and 596±1.15% respectively. The FTIR spectrum of extracted chitosan contains seven major peaks at the range of 898, 1033, 1419, 1554, 1651, 2881 and 3263 $cm^{-1}$ which confirms the structure of the chitosan when compared to the standard chitosan. The degree of deacetylation of the extracted chitosan was calculated as 79.32±9.07%.

**Keywords: Chitosan, *Macrobrachium dayanum*, physicochemical characteristics.**

## INTRODUCTION

Chitosan is one of the important derivatives of chitin after deacetylation. It is made by treating shells of crustaceans like prawns and crabs with the alkaline solution, sodium hydroxide. Structurally, chitosan is a straight chain copolymer of D-glucosamine and N-acetyl-D-glucosamine.

This polymer is biodegradable, biocompatible and could assist in the reduction of pollutants in residual waters by chelating with heavy metallic ions, by adsorption of industrial dyes and pesticides, [1-4] such as several natural adsorbents, like clay in tubular membrane[5]. This polymer has a wide range of applications in the medical field, cosmetics, in the food industry and especially in the waste water treatment[6-7].

The aim of the present study was to determine physicochemical characterization of the chitosan extracted from *Macrobrachium dayanum* shells with chemical methods. In the determination of physicochemical characterization of the chitosan the yield, water binding capacity, fat binding capacity, degree of deacetylation by FTIR studies were measured.

## MATERIALS & METHODS

**Collection of prawn raw materials:-**

The freshwater prawns, *Macrobrachium dayanum* were collected from local market of Ranchi, Jharkhand. The specimens were washed repeatedly in freshwater to remove all the dirt and sand. They were then taken to the laboratory to separate the shells from muscles. The shells were thoroughly washed, dried in hot air oven at 60°C and ground to obtain shell powder.

**Extraction of chitosan:-** Isolation of chitosan from prawn shell involves three steps[8,9] demineralization, deproteinization and deacetylation.

**1) Demineralization:** 20g of sample powder was demineralized with 300ml of 2N HCl for 24 hours with constant stirring and then filtered. The filterate was again washed with distilled water and filtered till the liquid

showed neutral pH. The filterate was dried in overnight in hot air oven and weighed.

**2) Deproteinization:** The demineralized shells were deproteined with 300ml of 1N NaOH at 80°C for 24 hours with constant stirring. The NaOH was exchanged regularly and the sample was washed with distilled water every time before adding fresh NaOH. The deproteinized shells were filtered and washed until NaOH was washed off completely , then dried and weight was noted.

**3) Deacetylation:** The deproteinized sample was deacetylated with 250ml of 40% NaOH, treated for 6 hours at 110°C constant stirring. The sample was filtered and washed as before.

**Purification of chitosan[10]:**

a) Removal of insolubles with filtration: 1mg/ml chitosan in acetic acid 1% v/v solution was prepared by a magnetic stirrer until a homogenous solution is obtained. The insolubles were removed by filtration through Whatman filter paper 22µm.

b) Reprecipitation of chitosan with 1NaOH: Chitosan was precipitation from filtered chitosan solution by titration with 1NaOH until pH value of 8.5. The chitosan obtained will be washed several times with distilled water by centrifugation at 8000-10000 rpm for 10 minutes. The chitosan was dried and weighed.

**Characterization of chitosan:**

**I.** Yield:

The chitosan yield was calculated by comparing the weight measurements of the raw material to the chitosan obtained after treatment.

**II.** Water Binding Capacity (WBC):

WBC of chitosan will be measured using a modified method of Wand and Kinsell (1976)[11]. WBC will initially carried out by weighing a centrifuge tube containing 0.5 g of sample and adding 10ml of water, mixing on a vortex mixer for 1 min to disperse the sample. The sample contents were left at ambient temperature for 30 min with intermittent shaking for 5s every 10 min and centrifuged (at 3,500 rpm (6,000 xg) for 25 min. The supernatant will be decanted and the tube will be weighed again. WBC was calculated as follows:

**WBC(%)= [water bound (g)/initial sample weight(g)] x 100**

**III.** Fat Binding Capacity (FBC):

FBC of chitosan will be measured using a modified method of Wang and Kinsella (1976)[11]. FBC was initially carried out by weighing a centrifuge tube containing 0.5 g of sample, adding 10ml of olive oil will be added mixed with a vortex mixer for 1min. The contents will be left at ambient temperature for 30 min with shaking for 5 seconds every 10 min and centrifuges for 25 min. After the supernatant will be decanted, the tube will be weighed again. FBC was calculated as follows:

**FBC (%)=[fat bound(g)/initial sample weight (g)]x100**

**IV.** Fourier Transform Infrared spectroscopy[12] (FTIR):

In order the structural changed incurred in the chitosan sample after chemical treatment with sodium nitrite or acetic anhydride, the FTIR spectra of the chitosan sample were acquired before and after treatment using a Fourier Transform Infrared Spectrophotometer. The lyophilized powders were analyzed using Kbr method. 2mg of chitosan powder was mixed with 198 g of Kbr, and pressed into a pellet under a pressure of 13 tons for 10 min. The FTIR spectra will be measured in Kbr pellets in the transmission mode in the range 400-4000/cm. FTIR experiment was conducted in CIF, BIT, Mesra, Ranchi.

**V.** Degree of Deacetylation[13] :

IR technique will be used for determining the DD. Degree of deacetylation was calculated by graph obtained from FTIR-Spectroscopy following the formula of Brugnerotto, J. *et al.* (2001)[13]:

Degree of deacetylation (DDA %) = 100 – Degree of acetylation

$$DA\ \% = 31.92 \times A_{\frac{1320}{1420}} - 12.20$$

Where, $A_{1320}$ and $A_{1420}$ represented the absorbance at 1320 and 1420 $cm^{-1}$ respectively

## RESULTS

The present study to investigate various physico chemical characterization of chitosan extracted from *Macrobrachium dayanum* shells. The results of yield, water and fat binding capacity, FTIR studies and degree of deacetylation of chitosan extracted from *Macrobrachium dayanum* were analysed (Table 1).

**Table 1:- Physicochemical characteristics of extracted chitosan**

| Parameters | Extracted chitosan |
|---|---|
| Yield (%) | 11.62±1.07 |
| Water Binding Capacity (WBC%) | 670±1.15 |
| Fat Binding Capacity (FBC%) | 596±1.15 |
| Degree of Deacetylation (%) | 79.32±9.07 |

(mean ±standard deviation of triplicate determinations.)

The table 1 shows the yield, Water Binding Capacity, Fat Binding Capacity, and Degree of Deacetylation was being about 11.62±1.07%, 670±1.15%, 596±1.15% and 79.32±9.07% respectively.

FTIR spectroscopy showed following graph of transmission/cm wave number of the chitosan extracted from shells of which Degree of Deacetylation was calculated.

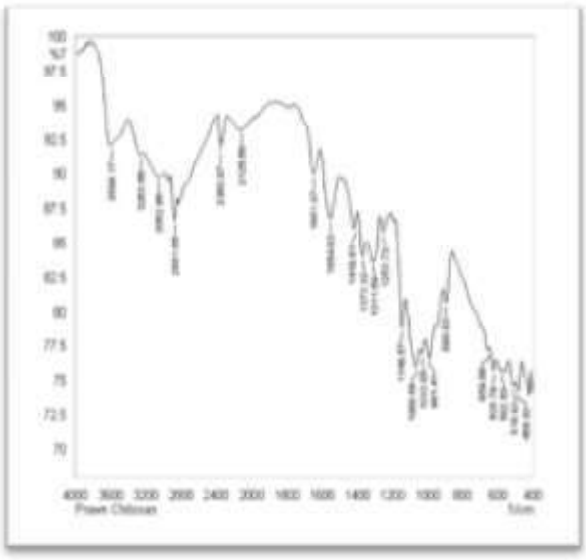

**Fig.1:- FT-IR spectra showing % transmission /cm of chitosan from *M.dayanum* shell.**

**Table 2:- Wavelength of the main bands obtained chitosan extracted from shells of *M.dayanum*.**

| Sl. No. | Vibration modes | Standard chitosan ($cm^{-1}$) | Chitosan from *M.dayanum* ($cm^{-1}$) |
|---|---|---|---|
| 1. | NH out of plane bending | 752 | - |
| 2. | Ring stretching | 896 | 898 |
| 3. | CO stretching | 1026 | 1033 |
| 4. | $CH_2$ bending and $CH_3$ deformation | 1418 | 1419 |
| 5. | Amide II band | 1563 | 1554 |
| 6. | Amide I band | 1661 | 1651 |
| 7. | CH stretching | 2878 | 2881 |
| 8. | Symmetric $CH_3$ stretching & asymmetric $CH_2$ stretching | 2930 | - |
| 9. | NH stretching | 3268 | 3263 |

The FT-IR spectrum of chitosan in the present study was obtained and effective peaks were compared with that of standard chitosan.(Table.2) The FTIR spectrum of standard chitosan contains nine major peaks at the range of 752, 896, 1026, 1418, 1563, 1661, 2878, 2930, 2930 and 3268 $cm^{-1}$. Whereas, in the present study , absorbance bands were observed at 898, 1033, 1419, 1554, 1651, 2881, and 3263 $cm^{-1}$. 7 out of 9 bands were very similar to that of standard chitosan.

## DISCUSSION

The yield of chitosan was being about 11.62±1.07%. Similar to the present study, chitosan yield of 14.6% was reported from carapax of *Penaeus monodon*[14] and 17.5% from *Metapenaeus stebbingi* shells[15]. The chitosan yield reported in the mantis shrimp *Harpiosquilla melanoura*[16] from 4.45% to 8.3% in different size groups which is less than the yield of present specimen.

In the present study, the Water Binding Capacity was 670±1.15%. Similar result has been reported by Marjan Nouri *et al.* (2016)[17] and Gokilavani S. *et al.* (2014)[18]. The Fat Binding Capacity, 596±1.15% of extracted chitosan in the present study was compatible to those reported by Aygul Kucukgulmez *et al.* (2011)[15] and Gokilavani S. *et al.* (2014)[18].

Degree of Deacetylation of the compound is 79.32±9.07% found in the present study was slightly similar to that 73.64-88.60% reported by Marjan Nouri *et al.* (2016)[17] and lower than that 92.19±2.56% reported by Aygul Kucukgulmez *et al.* (2011)[15].

Fourier transform infrared spectroscopy (FT-IR) was used to determine the structure of chitosan. According to this spectrum, effective peaks of extracted chitosan were compared with that of standard chitosan. The FTIR spectrum of standard chitosan contains nine peaks at the range of 752,896, 1026, 1418, 1563, 1661, 2878, 2930 and 3263 $cm^{-1}$. In standard chitosan major absorption band were observed 1220 and 1020 $cm^{-1}$ which represents the free amino group (-$NH_2$) at $C_2$ position of glucosamine, a major group present in chitosan. The chitosan sample of *M. dayanum* showed the adsorption bands for free amino groups between 1033.85 to 1253.73$cm^{-1}$ in shell whereas chitosan extracted from shell of shrimp, *Penaeus monodon*[14] showed the bands from 1026.33 to 1259.94 $cm^{-1}$. Further the peak at 1374 $cm^{-1}$ represents the -C-O stretching of primary alcoholic group (-$CH_2$-OH) in

standard chitosan, whereas the corresponding band was 1373.32 $cm^{-1}$ in the case of *M.dayanum* similar with the absorbance band of *Penaeus monodon*[14] chitosan. In the standard chitosan the absorbance bands of 3268, 2930.2878, 1661, 1563, 1418, 1026, 896, 752 $cm^{-1}$ indicates NH stretching, symmetric $CH_3$ stretching and asymmetric $CH_2$ stretching, CH stretching, Amide I band, Amide II band, $CH_2$ bending and $CH_3$ deformation, CO stretching, Ring stretching, NH out of plane bending respectively. In the present study absorbance bands were observed at 3263, 2881, 1651, 1554, 1419, 1033, 898 $cm^{-1}$ indicating NH stretching, CH stretching, Amide I band, Amide II band $CH_2$ bending and $CH_3$ deformation, CO stretching, and Ring stretching respectively (Fig 1) which confirms the structure of chitosan.

## CONCLUSION

This study investigated the physiochemical characteristics of chitosan extracted from the shells of *M.dayanum* results of FTIR studies were compared with standard chitosan. Based on the results it is suggested that there is good potential for the production of chitosan from crustacean shell and can be suitable for pharmaceutical applications.

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# Studies on the species diversity of Coreidae (Heteroptera) from Ranchi, Jharkhand

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**Abstract:** Members of family Coreidae are commonly known as leaf footed bugs and squash bugs due to leaf like expansions on their hind leg. A total of 105 individuals of 6 species of family Coreidae of Hemiptera were collected from four selected sites of Ranchi during the survey period. On the basis of number of identified insect species *Riptortus fuscus* Fabricius 1798 was the most dominant species reoresented by 26 individuals, followed by *Leptocorisa acuta* by 20 individuals, *Physomerus grossipes* Fabricius 18 individuals, *Leptocoris angur* Fabricius 15 individuals, *Notobitus dorsalis*, Westwood 14 individuals and lastly the species *Homocerus biguttatus* Westwood 12 individuals. The Shannon-Weiner diversity index ($\overline{H}$) was 1.06. It indicates poor species diversity.

**Keywords: Hemiptera, Coreidae, Biodiversity, Shannon-Weiner, *Riptortus fuscus***

## INTRODUCTION

Biodiversity is the term used to describe all the variety of life on earth or in a specifically mentioned particular area. It includes all the ecosystems and living organism in that region. It also includes diversity within species, between species, and of ecosystems. The Class Insecta is the largest and the most diverse class of phylum Arthropoda constituting more than 80% of the total animal species known. It includes about one million known species.[1]

The Order Hemiptera is one of the largest Order of Class Insecta, Heteroptera includes about 50,000 species of insects belonging to 73 families[1], many of them have still not been described. It includes a diverse assemblage of insects that have become adapted to different type of habitats. Some are aquatic and some are semiaquatic.

Members of family Coreidae are commonly known as leaf footed bugs and squash bugs due to leaf like expansions on their hind leg. These bugs feed on the shoots, buds, fruits and unripe seeds of many plants through the world. Coreidae includes some of the largest members of Heteroptera from 7-45 mm.[2] In some species the hind femora are thickened and adorned with large spine.[3] Thorasic scent glands produce strong smelling defensive chemicals. The general morphological features of Coreidae are oval shaped body, antennae composed of four segments, numerously veined forewing membrane, a metathoracic stink gland and enlarged hind tibia. Many species are covered with spines and tubercles. There are more than 1800 species recorded under family Coreidae in the world. Barcellos A, *et al.* (2008)[4] worked on abundance and species richness of Coreoidea from, Southern Brazil. Prabhaker (2015)[5] listed the biogeographical distribution of species of the superfamily Coreoidea : Hemiptera in India. Basu and Mitra (1977, 1977, 1978, 2003, 2004)[6-10] recorded different species of Coreoidea from Arunachal Pradesh, West Bengal, Sikkim, and Manipur. Chandra (2008)[11] listed Faunal diversity of Hemiptera from Jabalpur District, MP. Mitchell (2001)[3] reported Coreidae Hemipterans of Economic importance.

The present study was undertaken with the purpose to record the biodiversity of the family Coreidae (Hemiptera) in and around Ranchi to find the extent of species composition changes in different habitats.

## MATERIALS & METHODS

Survey sites were chosen based on accessibility and location within an eco region. Four different types of habitats were selected on the basis of ecological factors, flora, type of soil, surrounding environment and anthropogenic activities, to get an insight of the best possible insect diversity. Study was conducted during the period from 2017-2019.

**a) Study Sites** : Four sites were taken for collection and study –

1. Ranchi University Campus, Morahabadi, Ranchi
2. Agricultural fields around Ranchi City
3. Community Gardens
4. Residential area

**b) Collection Methods**

Insects were collected throughout the year. Each study area was visited twice every month (7 a.m. to 9 a.m. and 5 p.m.to 7 p.m.) on the same day. All the collected adult specimens were pinned and provided with proper locality and collection data.The specimens were identified at ZSI, Kolkata.

Quantitative estimation of species and individuals in different area was made using data from survey. Species diversity ($\overline{H}$) was computed based on Shannon –Wiener diversity index formula (1948):

$\overline{H}$= Pi ln pi

Here, pi = ni/N

ni= Number of individuals of a species

N = Total number of individuals of all species

ln = natural logarithm (to base)

$\overline{H}$ = Diversity index

The maximum possible diversity consisting X categories ( no. of species here) was calculated by using the formula

$\overline{H}$ max =ln. X

Evenness (J) was calculated by

J' = $\overline{H}$/ $\overline{H}$max

## RESULT & DISCUSSION

Species richness is the simplest diversity measure to count the number of species in an area.

Species diversity, on the other hand takes into account the relative abundance of a species and not just its occurrence. The first index used in the present study is Shannon-Wiener diversity index.

A total of 105 individuals of 6 species of family Coreidae of Hemiptera were collected from four selected sites of Ranchi during the survey period. Among the six species site I-21 individuals site II-29 individuals, site III-36 individuals and site IV-19 individuals were collected. On the basis of number of identified insect species *Riptortus fuscus* Fabricius 1798 was the most dominant species reoresented by 26 individuals, followed by *Leptocorisa acuta* by 20 individuals, *Physomerus grossipes* Fabricius 18 individuals, *Leptocoris angur* Fabricius 15 individuals, *Notobitus dorsalis*, Westwood 14 individuals and lastly the species *Homocerus biguttatus* Westwood 12 individuals. (Table 1 & Fig.1)

**Table 1-Total species collected from four selected sites of Ranchi**

| S.No | Name of Species of Coreidae family | site I | site II | site III | site IV | Total |
|---|---|---|---|---|---|---|
| 1 | *Notobitus dorsalis* Westwood | 3 | 0 | 6 | 5 | 14 |
| 2 | *Leptocoris angur* Fabricius | 6 | 0 | 0 | 9 | 15 |
| 3 | *Physomerus grossipes* Fabricius | 8 | 10 | 0 | 0 | 18 |
| 4 | *Leptocorisa acuta* Thunb | 4 | 8 | 3 | 5 | 20 |
| 5 | *Riptortus fuscus* Fabricius | 0 | 9 | 17 | 0 | 26 |
| 6 | *Homocerus biguttatus* Westwood | 0 | 2 | 10 | 0 | 12 |
| | **Total** | **21** | **29** | **36** | **19** | **105** |

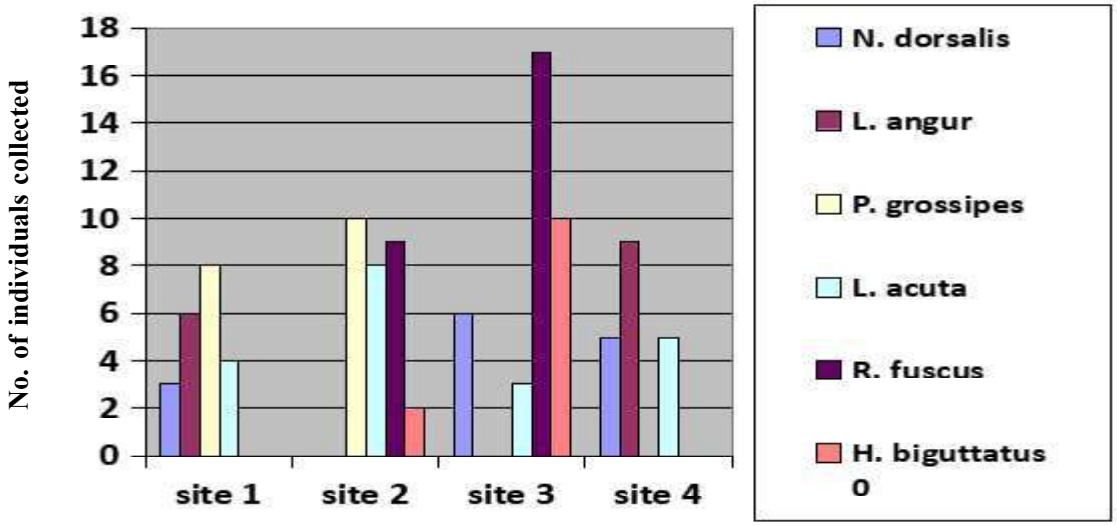


**Fig. 1- Distribution of species in different sites**

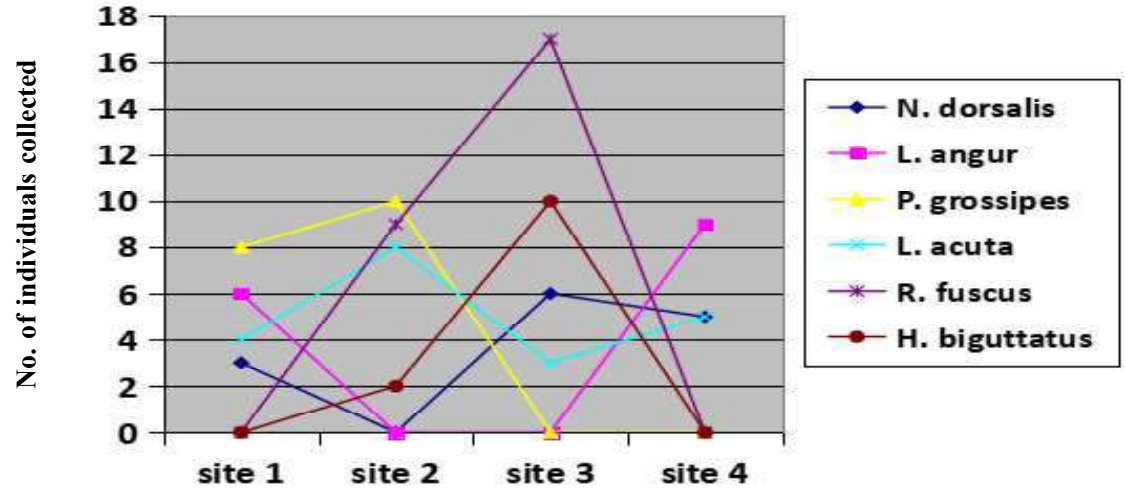


**Fig. 2- No. of species of Coriedae family in different sites**

**Table 2- Site-wise distribution of species**

| S.No | Name of Species of Coreidae family | site I | site II | site III | site IV | Total |
|---|---|---|---|---|---|---|
| 1 | *Notobitus dorsalis* ,Westwood | + | - | + | + | 14 |
| 2 | *Leptocoris angur* Fabricius | + | - | - | + | 15 |
| 3 | *Physomerus grossipes* Fabricius | + | + | - | - | 18 |
| 4 | *Leptocorisa acuta* Thunb | + | + | + | + | 20 |
| 5 | *Riptortus fuscus* Fabricius | - | + | + | - | 26 |
| 6 | *Homocerus biguttatus* Westwood | - | + | + | - | 12 |
| Total no.of individuals | | | | | | 105 |

**Table 3- Shannon-Weiner diversity index**

| S.No | Name of Species of Coreidae family | No. of individuals | R.A.ni/ 100 | pi= ni/N | log pi (ln) | $\overline{H}$ = pi. log pi |
|---|---|---|---|---|---|---|
| 1 | *Notobitus dorsalis*, Westwood | 14 | 0.14 | 0.13 | -2.04022 | -0.2652 |
| 2 | *Leptocoris angur* Fabricius | 15 | 0.15 | 0.14 | -1.96611 | -0.27524 |
| 3 | *Physomerus grossipes* Fabricius | 18 | 0.18 | 0.17 | -0.76955 | -0.13073 |
| 4 | *Leptocorisa acuta* Thunb | 20 | 0.20 | 0.19 | -0.72124 | -0.13699 |
| 5 | *Riptortus fuscus* Fabricius | 26 | 0.26 | 0.24 | -0.61978 | -0.14856 |
| 6 | *Homocerus biguttatus* Westwood | 12 | 0.12 | 0.11 | -0.95860 | -0.10538 |
| $H = -\sum_{i=1}^{s} \frac{pi}{npi} = -(1.06210)$ | | | | | H = 1.0621 | |

Table 3 indicates the Shannon-Weiner index as 1.0538. It clearly represents poor species diversity. The anthropogenic interventions may be considered as important factor for the result.

## CONCLUSION

Author concludes the effect of topography habitat loss, loss of host plants as major factors that leads to the species diversity decline in the Ranchi district.

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# The Science of Open Educational Resources (OERs): A Democratic Aspect of Education

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**Abstract:** The objective of this article is to showcase the importance of open education resources (OERs) in online mode of teaching and learning system. These resources are digital form of the information like word doc, pdf, ppt, audio podcasts and video forms. The methodology adopted to gather information was based on the browsing data. This paper fulfil gap related to summarized information about the status of OERs around the world. The right to study is based on the equality and therefore, OERs provide resources to every part of the society without and discrimination.

**Keywords: Open educational resources, Digita data, PDF, PPT, DOC, OERs.**

## INTRODUCTION

Amber Gilewaski quoted about the OERs that it is a social justice issue and this is about the democratization of education. The revolution in the field of information technology (IT) and telecommunication has shrinks the world in a Global Digital Village (GDV) and distances has been shortening by digital pathways. Beyond any boundaries, the digital neighbourhood is growing day-to-day. By registering a domain on the world web site, we become a Global Digital Citizen (GDC). The date that we share in public domain for educational purposes is called Open Educational Resources (OERs). The William and Flora Hewlett Foundation[1] defines it as OERs. OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge. This Foundation also said that Open Education through the web in particular provide an extraordinary opportunity for everyone to share, use and reuse knowledge. UNESCO[2] defines it as teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. The World Open Educational Resources Congress that held on 22nd June, 2012 and adopted 2012 Paris OER Declaration. UNESCO believes that open educational resources (OERs) have huge potential for widening access to education and improving its quality and cost-effectiveness for every citizen of the world.

The preparation of the paper is based on the online collection of data and reading the authentic materials about the open educational resources (OERs).

The Open Source Initiative (OSI) was founded by Eric Raymond and Bruce Perens (1998)[6]. It allows anyone to redistribute, modify and copy the OERs. In same year, 1998, David Wiley founded Open Content Project (OCP)[7] through which user can get online materials for modification, use and redistribution with certain restrictions. The Open Access Initiatives (OAI)[8] freely and openly available OERs with no unnecessary restrictions.

Rate of literacy is variable throughout the countries. Dr. A.P.J. Abul Kalam, ISRO Scientist and Former President of India always said in his lectures that most critical illness of a society is 'poverty' and only solution of this illness is 'education'. The literacy rate of countries need a huge investment of both money and man power. This is very tuff for the poor countries. According to the UNESCO Institute for Statistics (UIS) (2015) estimates based on students ages 15 and over who can write and read[12]. According to this survey, the Global Literacy Rate (GLR) was found 86.3%.

**Table1: Literacy percentage in different regions at global level[12]**

| Region | % of literacy |
|---|---|
| Developed Countries | 99.2% (2013) |
| Underdeveloped regions | |
| a. Oceania | 71.3% |
| b. South and West Asia | 70.2% |
| c. Sub-Saharan Africa | 64.0% |

The data in Table 1 clearly indicates the discrepancy at literacy level at different parts of the world. Over 75% of total population resides in underdeveloped regions of the world. It is very hard and time taking process for a government to achieve the set goals as hundred percent literacy within limited resources. So, massive online courses emerged as a breeze for them to adopt this system with internet facilities to the last student of the society.

For the full utilization of online educational resources (OERs), the most important tool is information and communication technology. It includes high-speed internet facilities and basic instruments from a laptop to a smart phone. Internet Statistics 2019 says that there are 4.1 billion internet users in the world as at December 2018.[13] Asia is having most internet users and developing countries are fasting involving in the digital mission. It is also being observed that the policy of the government is also focusing on digital initiative mission. In India, the ambitious mission of the Prime Minister Mr. Narendra Modi is 'Digital India Mission' and for this he created separate department in the ministry.

**Table 2: Top 5 countries with highest number of internet users till May, 2019**

| # | Country or Region | Population, 2019 Est. | Population 2000 Est. | Internet Users 31 Mar 2019 | Internet Users 31 Dec 2000 | Internet Growth 2000 - 2019 |
|---|---|---|---|---|---|---|
| 1 | China | 1,420,062,022 | 1,283,198,970 | 829,000,000 | 22,500,000 | 3,584 % |
| 2 | India | 1,368,737,513 | 1,053,050,912 | 560,000,000 | 5,000,000 | 11,100 % |
| 3 | United States | 329,093,110 | 281,982,778 | 292,892,868 | 95,354,000 | 207 % |
| 4 | Brazil | 212,392,717 | 175,287,587 | 149,057,635 | 5,000,000 | 2,881 % |
| 5 | Indonesia | 269,536,482 | 211,540,429 | 143,260,000 | 2,000,000 | 7,063 % |

(Courtesy- https://www.internetworldstats.com/top20.htm)

In the Table 2, the top five countries with highest number of internet users till May, 2019 indicates that among them only USA is a well-developed country, while other four are fast growing nations. China and India are growing with their Gross Domestic Product (GDP) and they are increasing the share of education and technology in their budgets.

## METHODOLOGY

This study is a comparative analysis of different research and review articles published online during the year 2000 to year 2019. The two major quarries were searched on Google browser, YouTube and Scribd to extract the desired data and related online contents. Acknowledging the problem of OER diversity, this research provides a comparative analysis that evaluates the right to use of the OERs by the countrymen of different countries.

This methodology included the following steps.

**Step 1.** Selection of queries about the growth and development of OER at global level.

**Step 2.** Selection of authentic online platforms to conduct the comparative analysis.

**Step 3.** Development of discussion based on the data extracted online.

**Step 4.** Based on the data retrieved by the search engine, the presentation, comparison, and analysis of the results was made to terminate into a conclusion.

## RESULTS & DISCUSSION

### Open Educational Resources (OERs)

Open Educational Resources (OERs) are defined as any type of educational materials is available in the public domain with an open license.

### (a) Licensing and Flexibility of OERs

How a user can evaluate if something is an OER? It can be possible by checking the copyright statuses of the resources whether these are in public domain or not, having Creative Commons (CC) license and having free software license or not. Any one of them can be considered as the OER.[3] It is characterized by following features (Table-3)

**Table 3: Features of open educational resources**

| Feature | Comment |
|---|---|
| Reuse | The OERs can be used once and again by a person or a group. |
| Remix | The new changes can be made and outdated information can be omitted. |
| Revise | To make desirable changes in the content of OERs. |
| Retain | To make copies of the matter for future use. |
| Redistribution | To share copies of the OERs with your global family. |
| Renewable | To renew the format of the OERs. |
| Recreate | To make more creative way of the presentation of the matter. |

### (b) Diversity of OERs

Diversity of open educational resources (OERs) is one of most important features that add quality of education at global level. These resources are either in the public domain or under a license. It can be in Text format, PDF, JPG, Audio, Videos etc. Open educational resources are reaching and learning materials that can be spread globally through the fast internet services. They expand the access of learning through quick circulation. It is cost effective and showcasing of new and fresh innovation. Learning contents[10] are:

(a) Videos (b) Audio clips
(c) Images (d) Test and Quizzes
(e) Instructional games (f) Class lecture notes
(g) Assignments (h) Lesson plans
(i) e_textbook (j) e_reports (k) e_news materials

### (c) Authentication of OERs

The United Nations Educational, Scientific and Cultural Organization (UNESCO) and Commonwealth of Learning (CoL) made a Survey on Governments' Open Educational Resources (OERs) Policies (2012)[4] concluded that OERs is now a global initiative and several countries are involved in the creating the contents. Several projects are launched by the government and local non-governmental organizations (NGOs) to allowing online access to digitized academic materials. Licensing of OERs is one of the most important challenges. To solve this problem the Creative Commons framework is developed. COL and UNESCO prepared a 'Basic Guide to OER' for countries, institutions and regional educational bodies. Creative Commons[9]

### (d) Repositories of OERs (ROER)

ROER offers the content type, format and subject to be going online[11]. The quality and utility based scrutiny of the topics are always a challenging part of the ROER. Current ROERs include more drivers that promote the reuse of OERs, mainly through open licenses and social networks, than features facilitating the retrieval and use of OERs according to educational needs, such as learning goals[11]. The ROERs are more focused on pedagogy and bottom-up approaches for the usefulness of ROER and the reuse of OERs. A continuous assessment system may help to add additional features based on users' interaction, kind of information shared, social tagging procedures, etc. The targeted preparation of OER is important for more accurate use and reuses. The authentication of the source of materials, produced by students or educators is important for the readers' point.

### Opportunities and Challenges of OERs

On the basis of survey made by various government and non-government agencies at global level a common rationale for open educational resources can be summarized as opportunities:

1. The educators may develop innovative teaching methods and resource extraction.
2. The university or institute can increase its visibility at not only national but international level.
3. The educators may gain a global recognition.

4. The educators may increase the reach of his/her OERs for the students and colleagues.
5. The institutions and educators can gain scores during their appraisal.
6. The academic collaboration with reputed organization.
7. Financial savings for the user bodies.
8. Improvisation in the quality of teaching materials.
9. Quick upgradation of materials.
10. Opportunity for the IT sector to provide placement.

It is considered that the growth of OER based education system is growing day-by-day. In India, the Ministry of Human Resource Development (MHRD), Govt. of India is enhancing its massive open online courses through SWAYAM portal. In the UGC regulations, it is quoted that universities has to deal with their education system at least twenty percent through the SWAYAM portal. Academicians and IT institutions are called for the better performances. It creates a number of challenges for the educators and institutions like:

1. Legal challenges
2. Pedagogical challenges
3. Strategic challenges
4. Financial challenges
5. Linguistic challenges
6. Cultural challenges
7. IT-dependent challenges

The above said challenges can be a barrier in the growth and expansion of OERs. Most users are not aware with the Intellectual Property Rights (IPRs) therefore, the unauthorized use or production of OERs can be a legal issue for both user and producers. The web OERs require a well developed IT infrastructure which may be an expansive affair for individual. Not only is the speed of internet essential rather a good configuration of output machines is also important. Higher Education Institutes have to adopt the OERs as emerging pedagogical approaches. Language barrier is one of the big challenges, as most of OERs in English language. It is important to develop the OERs in regional languages to increase it reach. The smooth running of OER based education needs a strong regulatory body as found in India and that is University Grant Commission (UGC), National University of Educational Planning and Administration (NUEPA) etc.

## CONCLUSION

The new education policies of the government are embedding the need of massive open online courses for the students in regional languages too. This is penetrating the barrier of flow of information. The last student of the society is also getting equal opportunity of grab the information that can change the quality of its life. Still, more researches are required at government and non-government levels to exact portrait the effectiveness of OERs on the society.

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# The effect of ethnyl estradiol on serum testosterone level of male juvenile *Clarias batrachus*.

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**Abstract:** The effect of oral administration of different doses of ethnyl estradiol was studied on the serum testosterone level of male juvenile catfish (*Clarias batrachus)*. Fishes weighing 150-200 g were obtained from breeders and kept in aquaria under normal aquatic conditions in the laboratory at a temperature of 23±5°C. The fishes were divided into four groups. Three diets with increasing levels of ethynl estradiol i.e; 10 µg, 55µg and 75 µg $kg^{-1}$ feed were provided to the fishes daily, supplemented through premarin (oral contraceptive pill) and constituted the experimental groups. Control group fishes were not fed with ethnyl estradiol (0 µg $kg^{-1}$). After treatment for 20 consecutive days blood was collected from fishes of all groups. Serum testosterone was assayed by Fully Automated Immunoassay. Results indicated significant reductions in the blood testosterone levels in fishes treated with ethnyl estradiol as compared to the control group fishes. A dose dependent effect of ethnyl estradiol was observed. The results showed the serum testosterone values to be 2.5µg/ml (control group), 1.65 µg/ml (10 µg ethnyl estradiol $Kg^{-1}$ feed), 0.4 µg/ml (55 µg ethnyl estradiol $Kg^{-1}$ feed) and 0.1µg/ml (75 µg ethnyl estradiol $Kg^{-1}$feed). The present results showed an inhibitory effect of ethnyl estradiol on the testis of the fish and suggest that exogenous estrogen administration may interfere with development and testicular function in this catfish.

**Keywords: ethnyl estradiol, catfish, estrogen, testosterone.**

## INTRODUCTION

Aquatic animals have a high threat of anthropogenic chemicals because their habitat is the end recipient of anthropogenic pollutants.[1] Many of these pollutants enter the water bodies from sources like agriculture, household waste, sewage treatment plants, industries etc. Some anthropogenic pollutants are considered as endocrine disrupting chemicals.[2] These endocrine disrupting chemicals affect the reproduction as well as development of aquatic animals.[3-6] The human birth control pill (oral contraceptive) contains synthetic ethnyl estradiol ($EE_2$). Estrogens are potent endocrine disrupters and this impacts the endocrine system of fishes. Aquatic animals especially fish population are highly threatened due to this endocrine disrupting chemical because there are more estrogen receptors in fish than in human.[7] Evidence indicate that exogenous administration of ethnyl estradiol can reverse the sexual morphology of fishes.[8] The male Indian catfish, *Clarias batrachus* has a fast growth rate and it attains sexual maturity at the age of one year. Therefore, the aim of the present study was to observe the effect of ethnyl estradiol on the serum testosterone level of the juvenile *Clarias batrachus*.

## MATERIALS & METHODS

The experiment was performed according to the guidelines accepted by the "Local Animal Ethical Committee" for investigation on animals. The study was performed on the juvenile males of the catfish, *Clarias batrachus.* Male fishes weighing 150-200 g were collected during the spawning period (June) from local breeders and then brought to the laboratory. The fishes were kept in glass aquaria under normal aquatic conditions at a temperature of 23±5°C and acclimatized for three days.

**Experimental diet and selection of Dose**

The fish diet with increasing dose of ethnyl estradiol supplemented through premarin (oral contraceptive pill), were provided daily to the fishes of different groups. Determination of $LD_{50}$ for Ethnyl Estradiol was performed as per standard methods opted by earlier workers.[9-11] $LD_{50}$ of ethnyl estradiol was found to be 55 µg $kg^{-1}$ feed.

**Experimental Design**

The fishes were divided into four different groups of twelve animals each. They were maintained in separate glass aquaria. Control group fishes were fed normal fish diet. Experimental groups were fed with diets containing 10µg, 55µg, 75µg of ethnyl etradiol per kg feed supplemented through premarin.

**Analysis**

After treatment for twenty consecutive days the blood was collected from caudal vein of fishes belonging to the different groups. Serum testosterone was assayed by "Fully Automated Immunoassay".[12] Data was analyzed by Student's 't' test and analysis of variance, ANOVA.[13]

## RESULTS

Results are presented in Table-1 and Figure1. A dose dependent inhibitory effect of ethnyl estradiol was observed on the serum testosterone level of the fish. Results indicated significant ($p<0.001$) reductions in the serum testosterone levels in fishes treated with ethnyl estradiol as compared to the control group fishes. ANOVA indicated a significant variation in serum testosterone level with respect to ethnyl estradiol dose ($F = 27.61$, $p < 0.001$).

**Table 1- Serum testosterone levels (ng/ml) in male juvenile *Clarias batrachus* after treatment with different doses (µg $kg^{-1}$ feed) of ethnyl estradiol for twenty consecutive days.**

| Dose of Ethnyl Estradiol | Serum testosterone |
|---|---|
| Control | 2.50 ± 0.06 |
| 10 µg | 1.65 ± 0.02[a] |
| 55 µg | 0.40 ± 0.02[a] |
| 75 µg | 0.10 ± 0.01[a] |

**Significance of difference from control: a, $p < 0.001$. Ethnyl estradiol was dissolved in fresh water and supplied for 20 days during the spawning period (June). Data are presented as Mean ± Standard Error for 12 fishes.**

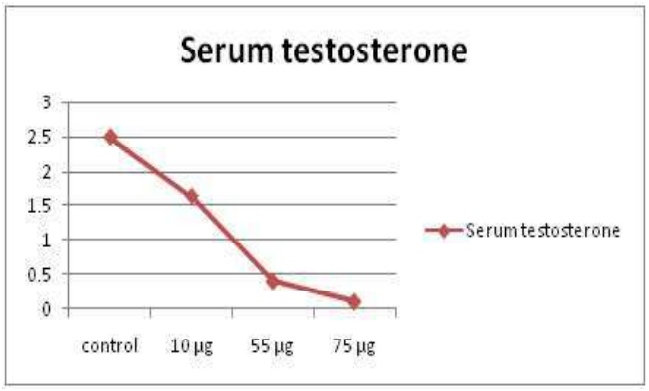


**Figure 1- Data indicated significant ($p<0.001$) reductions in the serum testosterone levels in fishes treated with ethnyl estradiol through premarin after twenty consecutive days of treatment. X- axis indicates the dose of ethnyl estradiol (µg/$kg^{-1}$ feed) and Y- axis indicates the level of serum testosterone (ng/ml).**

## DISCUSSION

The present results clearly showed an inhibitory effect of ethnyl estradiol on serum testosterone level of the male juvenile *Clarias batrachus*. A dose dependent effect of ethnyl estradiol was evident. Exposure of fishes to a high dose of 75 µg $kg^{-1}$ feed of ethnyl estradiol resulted in lowering the serum testosterone level significantly (0.10 ± 0.01ng/ml) as compared to that of control fishes (2.50 ± 0.06 ng/ml). This reduction in serum testosterone level after ethnyl estradiol exposure suggests an effect on the testicular organization of the juvenile fish. It may be possible that ethnyl estradiol has an antagonistic effect on the growth of the fish testes leading to reduced testosterone secretion, higher doses of ethnyl estradiol being more potent in producing such an effect.

The oral contraceptives for women have ethnyl estradiol as a major ingredient which is released through urine and excrement. Sometimes the unused pill containing ethnyl estradiol may be poured into the drain and in this way it reaches the water bodies and ultimately the fishes. This ethnyl estradiol can interfere with hormones in the body of the fish leading to the developmental disorder. Ethnyl estradiol has been reported to be an effective feminizing hormone. It may cause malfunction of gonads leading to feminization or sterilization.[14] Ethnyl estradiol exposure to male fathead minnow (*Pimephales promelas*) showed delayed spermatogenesis with malfunctions of the

seminiferous tubules.[15] Exposure to estrogen causes disrupted gonadal development and presence of intersex i.e., both male and female tissues in the same fish.[16-18] There are reports of arrest in development of testis and the presence of ova-testis having primary stage oocyte after ethnyl estradiol exposure. Intersex male fish show low sperm production and hence a reduced fertilization success.[16] In fish this gender-bending effect has been identified but it has not been attributed to the birth control pills. These results are in agreement with those of our present study with *Clarias batrachus* which exhibited a negative impact of ethnyl estradiol on its testes as evidenced by decrease in serum testosterone levels.

Surveys by the United State Fish and Wildlife Service and also by the United State Geological Survey showed the presence of female egg cells growing in the testes of male fishes. This condition was refered to as intersex. Horiuchi *et al.* (2005)[19] reported the presence of alkyl-phenols, an endocrine disrupting chemical having estrogenic activity in the coast of Japan and also in rivers and sea water sediments from Tokyo Bay. The report by the United State Geological Survey (USGS) shows that ethnyl estradiol, of birth control pills, that reaches water bodies may affect the fertility of fish upto three generations.[20]

Studies on the effects of ethnyl estradiol on male fish fertility have been carried out mostly on those belonging to temperate zones. The present results are new in the case of an air breathing catfish native to India. The study confirms the detrimental effect of ethnyl estradiol on the male sex hormone production in this fish. It can be suggested that exposure to this endocrine disruptor (ethnyl estradiol) may result in inhibition of spermatogenesis leading to feminization or sterilization of the juvenile male *Clarias batrachus*.

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# An inventory of moth fauna (Lepidoptera: Heteroceran) belonging to the family Sphingidae of Ranchi, Jharkhand

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**Abstract:** The present work has investigated the biodiversity and ecology of moths in some areas of the Ranchi district of Jharkhand from the year 2016 to 2019. During this project, the effect of climatic factors like temperature, rain, wind speed, sunlight, and relative humidity was taken as a parameter to correlate with the species richness of the study area. The light trap was applied to collect moths. Total 4210 moths belonging to seventeen species of the family that is Sphingidae was collected. They were *Acherontia lachesis* (Fabricius); *Acherontia styx* (Westwood); *Deilephila nerii* (Linn.); *Deilephila lineate* (Fabricius); *Diacrisia oblique* (Walker); *Agrius convolvuli* (Linn.); *Meganoton analis* (Felder & Felder); *Psilogramma menephron* (Cramer); *Acherontia atropos* (Linn.); *Thamnoecha uniformis* (Butler); *Dolbina inexacta* (Walker); *Ambulyx sericeipennis* (Butler); *Ambulyx placida* (Moore); *Theretra oldenlandiae* (Fabricius); *Ambulyx liturata* (Butler); *Theretra clotho* (Drury) and *Theretra alecto* (Linn.). A sum of 1898, 1433 and 1279 individuals from three collection sites Harmu, Bariyatu, and Morhabadi respectively.

**Keywords: Biodiversity, Ranch, Lepidoptera, Species Dominance, Sphingidae**

## INTRODUCTION

Order Lepidoptera of class Insecta of animal kingdom comprises of both butterflies and moths and make it second-largest order.[1-4] Butterflies are diurnal and moths are nocturnal. Moths are a major partner of this order.[5] They are a major insect pest in agroforestry and horticulture area. They are an important component of the terrestrial ecosystem because of their role as food resources for birds[6] and some mammals[7]. They also act as a pollinator[8,9] and recycle many nutrients[10]. Their larva actively feeds on the different parts of the host plant and affects the economy. The abundance, species richness in response to vegetation and climatic factors were established by Holloway (1980, 1984, & 1985)[11-13]. The present project was conducted at the three sites viz. Harmu, Morhabadi, and Bariyatu of Ranchi, Jharkhand from the year 2016 to the first trimester of 2019. The objective of this article to collect and identify the moths diversity of family Sphingidae of the order Lepidoptera[14-19]. It also compared the spatial distribution of the moths at three localities of Ranchi year wise. The inventory of moth fauna is a catalogue of the diversity of Sphinx at the collection area.

## METHODOLOGY

**Study area:** The author collected moths (Lepidoptera: Heteroceran) from the three areas of Morhabadi, Bariyatu, and Harmu of Ranchi district. The hundred square meters of transacts were scheduled at each sample site.

**Collection and sampling:** To sample moths author used light traps with LED (9W) and CFL (23W) bulb lights, powered by 12-V batteries. Moths are photophilic and fall through a funnel into a collection box. The light traps were

properly kept on for four to five hours from 5 pm-10 pm during the sampling period [summer (April-May), monsoon (June-July), and post Monsoon (August-September)]. Moths were killed using ethyl acetate in a killing jar. The collected samples were processed for pinning, setting, and preserving in air-tight wooden boxes. Each site was sampled eight to nine times,

**Identifications:** It was done with the help of available literature and also by comparing with the reference collection available at Zoological Survey of India, Slides of moths of the University of California. The classification used mainly follows Hampson (1892, 1894, 1895, and 1896)[20-23] and subsequent changes in the families based on Kristensen (1999)[24]

## RESULTS & DISCUSSION

On the three sites of Ranchi, the random sample seasonal collection recorded four thousand two hundred ten moths of seventeen species (Table 4).

At Harmu site (Table 1), total one thousand four hundred thirty-three moths of family Sphingidae were collected and counted. They were identified and found fifteen species where *Deilephila lineate* (Fabricius)was most abundantly found. It is a polyphagous moth that feed on flowers of different plants.[25] *Theretra oldenlandiae* (Fabricius) was found in least number. It is also a polyphagous pest. It is commonly found in lowland habitat.[20] At Bariatu site (Table 2), *Deilephila lineate* (Fabricius) was dominantly found in the year 2016-19. In 2018, its availability was reported highest. Due to polyphagous nature, its survival is more favoured in the habitat.[25] *Ambulyx liturata* (Butler) was reported in lowest number during the collection period. During 2018, it could not be found at the habitat. It is a hawk moth.

At the Morhabadi site (Table 3), *Deilephila nerii* (Linn.) was reported in highest availability in the habitat during the entire collection period and it was four hundred nineteen. It was dominant in the population collected during the 2016 and 2018, while *Deilephila lineate* (Fabricius) was abundantly found in the year 2018. *Ambulyx liturata* (Butler) was reported in lowest number during the collection period. In the year 2017, it could not be reported.

**Table 1: Collection table of moths belonging to family Sphingidae from Harmu Site of Ranchi**

| Code | Name | 2016 | 2017 | 2018 | 2019 | Total |
|---|---|---|---|---|---|---|
| SPH01 | *Acherontia lachesis* (Fabricius) | 39 | 57 | 34 | 10 | 140 |
| SPH02 | *Acherontia styx* (Westwood) | 40 | 35 | 38 | 5 | 118 |
| SPH03 | *Deilephila nerii* (Linn.) | 47 | 42 | 40 | 6 | 135 |
| SPH04 | *Deilephila lineate* (Fabricius) | 55 | 46 | 50 | 6 | 157 |
| SPH05 | *Diacrisia oblique* (Walker) | 55 | 0 | 51 | 8 | 114 |
| **SPH06** | ***Agrius convolvuli* (Linnaeus)** | **57** | **63** | **50** | **6** | **176** |
| SPH07 | *Meganoton analis* (Felder & Felder) | 52 | 48 | 41 | 7 | 148 |
| SPH08 | *Psilogramma menephron* (Cramer) | 53 | 52 | 33 | 8 | 146 |
| **SPH09** | ***Acherontia atrophos* (Linn.)** | **0** | **0** | **0** | **0** | **0** |
| SPH10 | *Thamnoecha uniformis* (Butler) | 0 | 0 | 43 | 4 | 47 |
| **SPH11** | ***Dolbina inexacta* (Walker)** | **0** | **0** | **0** | **0** | **0** |
| SPH12 | *Ambulyx sericeipennis* (Butler) | 0 | 38 | 31 | 3 | 72 |
| **SPH13** | ***Ambulyx placida* (Moore)** | **0** | **0** | **0** | **0** | **0** |
| SPH14 | *Theretra oldenlandiae* (Fabricius) | 0 | 37 | 21 | 3 | 61 |
| **SPH15** | ***Ambulyx liturata* (Butler)** | **0** | **0** | **0** | **0** | **0** |
| SPH16 | *Theretra clotho* (Drury) | 44 | 0 | 28 | 4 | 76 |
| SPH17 | *Theretra alecto* (Linnaeus) | 38 | 48 | 19 | 3 | 108 |
| | TOTAL | 480 | 466 | 479 | 73 | 1498 |

**Table 2: Collection table of moths belonging to family Sphingidae from Bariatu Site of Ranchi**

| Code | Name | 2016 | 2018 | 2018 | 2019 | Total |
|---|---|---|---|---|---|---|
| SPH01 | *Acherontia lachesis* (Fabricius) | 27 | 41 | 34 | 7 | 109 |
| SPH02 | *Acherontia styx* (Westwood) | 33 | 41 | 39 | 3 | 116 |
| SPH03 | *Deilephila nerii* (Linn.) | 36 | 31 | 38 | 2 | 107 |
| **SPH04** | ***Deilephila lineate* (Fabricius)** | **37** | **47** | **52** | **6** | **142** |
| SPH05 | *Diacrisia oblique* (Walker) | 30 | 30 | 25 | 3 | 88 |
| SPH06 | *Agrius convolvuli* (Linnaeus) | 34 | 29 | 35 | 8 | 106 |
| SPH07 | *Meganoton analis* (Felder & Felder) | 26 | 41 | 39 | 4 | 110 |
| SPH08 | *Psilogramma menephron* (Cramer) | 24 | 30 | 34 | 5 | 93 |
| SPH09 | *Acherontia atrophos* (Linn.) | 20 | 27 | 28 | 4 | 79 |
| SPH10 | *Thamnoecha uniformis* (Butler) | 25 | 27 | 27 | 3 | 82 |
| SPH11 | *Dolbina inexacta* (Walker) | 15 | 12 | 22 | 3 | 52 |
| SPH12 | *Ambulyx sericeipennis* (Butler) | 26 | 26 | 33 | 2 | 87 |
| SPH13 | *Ambulyx placida* (Moore) | 0 | 0 | 25 | 5 | 30 |
| SPH14 | *Theretra oldenlandiae* (Fabricius) | 17 | 39 | 13 | 3 | 72 |
| **SPH15** | ***Ambulyx liturata* (Butler)** | **0** | **0** | **20** | **3** | **23** |
| SPH16 | *Theretra clotho* (Drury) | 21 | 20 | 18 | 3 | 62 |
| SPH17 | *Theretra alecto* (Linnaeus) | 17 | 29 | 19 | 10 | 75 |
| | **TOTAL** | **388** | **470** | **501** | **74** | **1433** |

**Table 3: Collection table of moths belonging to family Sphingidae from Morhabadi Site of Ranchi**

| Code | Name | 2016 | 2018 | 2018 | 2019 | Total |
|---|---|---|---|---|---|---|
| SPH01 | *Acherontia lachesis* (Fabricius) | 26 | 39 | 38 | 6 | 109 |
| SPH02 | *Acherontia styx* (Westwood) | 28 | 35 | 25 | 2 | 90 |
| SPH03 | *Deilephila nerii* (Linn.) | 41 | 21 | 42 | 2 | 106 |
| **SPH04** | ***Deilephila lineate* (Linn.)** | **39** | **42** | **35** | **4** | **120** |
| SPH05 | *Diacrisia oblique* (Walker) | 18 | 22 | 35 | 3 | 78 |
| SPH06 | *Agrius convolvuli* (Linnaeus) | 5 | 24 | 28 | 5 | 62 |
| SPH07 | *Meganoton analis* (Felder & Felder) | 21 | 29 | 25 | 3 | 78 |
| SPH08 | *Psilogramma menephron* (Cramer) | 23 | 29 | 37 | 3 | 92 |
| SPH09 | *Acherontia atrophos* (Linn.) | 26 | 22 | 20 | 3 | 71 |
| SPH10 | *Thamnoecha uniformis* (Butler) | 14 | 24 | 23 | 2 | 63 |
| SPH11 | *Dolbina inexacta* (Walker) | 14 | 18 | 12 | 4 | 48 |
| SPH12 | *Ambulyx sericeipennis* (Butler) | 33 | 19 | 20 | 2 | 74 |
| SPH13 | *Ambulyx placida* (Moore) | 21 | 0 | 22 | 3 | 46 |
| SPH14 | *Theretra oldenlandiae* (Fabricius) | 21 | 32 | 19 | 2 | 74 |
| **SPH15** | ***Ambulyx liturata* (Butler)** | **19** | **0** | **16** | **4** | **39** |
| SPH16 | *Theretra clotho* (Drury) | 12 | 19 | 28 | 5 | 64 |
| SPH17 | *Theretra alecto* (Linnaeus) | 17 | 19 | 23 | 6 | 65 |
| | TOTAL | 378 | 394 | 448 | 59 | 1279 |

**Table 4: Overall collection table of moths belonging to family Sphingidae at different sites in Ranchi during the year 2016-19.**

| Code | Name | Harmu | Bariatu | Morhabdi | Total |
|---|---|---|---|---|---|
| SPH01 | *Acherontia lachesis* (Fabricius) | 140 | 109 | 109 | 358 |
| SPH02 | *Acherontia styx* (Westwood) | 118 | 116 | 90 | 324 |
| SPH03 | *Deilephila nerii* (Linn.) | 135 | 107 | 106 | 348 |
| **SPH04** | ***Deilephila lineate* (Fabricius)** | **157** | **142** | **120** | **419** |
| SPH05 | *Diacrisia oblique* (Walker) | 114 | 88 | 78 | 280 |
| SPH06 | *Agrius convolvuli* (Linnaeus) | 176 | 106 | 62 | 344 |
| SPH07 | *Meganoton analis* (Felder & Felder) | 148 | 110 | 78 | 336 |
| SPH08 | *Psilogramma menephron* (Cramer) | 146 | 93 | 92 | 331 |
| SPH09 | *Acherontia atrophos* (Linn.) | 0 | 79 | 71 | 150 |
| SPH10 | *Thamnoecha uniformis* (Butler) | 47 | 82 | 63 | 192 |
| SPH11 | *Dolbina inexacta* (Walker) | 0 | 52 | 48 | 100 |
| SPH12 | *Ambulyx sericeipennis* (Butler) | 72 | 87 | 74 | 233 |
| SPH13 | *Ambulyx placida* (Moore) | 0 | 30 | 46 | 76 |
| SPH14 | *Theretra oldenlandiae* (Fabricius) | 61 | 72 | 74 | 207 |
| **SPH15** | ***Ambulyx liturata* (Butler)** | **0** | **23** | **39** | **62** |
| SPH16 | *Theretra clotho* (Drury) | 76 | 62 | 64 | 202 |
| SPH17 | *Theretra alecto* (Linnaeus) | 108 | 75 | 65 | 248 |
| | TOTAL | 1498 | 1433 | 1279 | 4210 |

## CONCLUSION

During this collection work, one significant this was found and that was the dominance of polyphagous species of family Sphingidae. The host plants and ecological factors are suggested to be optimum for their survival. On the basis of the records of collected data, author concludes that the diversity of moths of family Sphingidae is satisfactory in the area. Dominance of *Deilephila lineate* (Fabricius) in all around the habitat signified its optimum. Few things are suggested for the new workers and that is a question to them-What are the actual impact of anthropogenic innervations on the diversity of moths?

## CONFLICT OF INTEREST

Author certifies no conflict of interest related to this article.

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