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# SOCIETY OF BIOLOGICAL SCIENCES AND RURAL DEVELOPMENT

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# A COMPARISON OF OCCURRENCE OF FOSSILS OF TWO WHALE FAMILIES (CETACEA BRISSON, 1762: ODONTOCETI FLOWER, 1867) : KOGIIDAE AND KENTRIODONTIDAE

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**ABSTRACT**

**Kogiidae are a family of small odontocetes ; toothed whales (Cetacea), While on the other hand Kentriodontidae is an extinct family of dolphins and are small to medium sized toothed cetaceans. One reason that Odontocetii are important is that they are highly encephalised; encephalisation next only to humans. As the occurrence of the fossils of two families have not been studied in a comparative way. The present study, therefore, had the objectives of –extracting of data on occurrence of Kogiidae and Kentriodontidae from database www.paleodb.org and comparing the occurrence of different taxa. In family Kogiidae, Thalassociatus species appeared first among the Kogiids and its last fossil also occurred the earliest among the Kogiids. While in In Kentriodontidae, Kentriodon premix was the oldest in terms of first occurrence. Well preserved records of Kogiidae are very rare , while Kentrodontidae has relatively common fossils. Both the extant species of Kogiidae are in sub-family Kogiinae and are covered in CITES.**

Accepted : 15.12.2022

***Keywords :*** *Kogiidae, kentridontidae, fossils, occurrence*

## INTRODUCTION

Kogiidae are a family of small odontocetes ; toothed whales (Cetacea), which are similar and closely related to the present day sperm whale (Physeteridae) (Bianucci and Landini,1999). It is rare to get well preserved fossils of Kogiidae. Some of the rare and almost complete skulls described are that by Barnes (1973,1984) and Muizon (1988), the other being by Bianucci and Landini (1999) . *Kogia breviceps* and *K. simus* are the only two living species of this family (Bianucci and Landini ,1999). While on the other hand Kentriodontidae is an extinct family of dolphins and are small to medium sized toothed cetaceans which possibly also had ancestors of the some living species. *Kentriodon hobetsu* from middle Miocene from Hokkaido , Japan was described as a new species on the basis of partial skull , which significantly extended the geographic range of this genus (Ichishima *et al.,*1994). Kentriodontidae has also been described from Miocene sediments from Italy (Bianucci,1994) . They are relatively common fossils and are quite

useful for intercontinental correlations of marine deposits. Dawson (1996) described the family as almost cosmopolitan in distribution.Kentriodontids are small odontocetes with a well-known fossil record in the Miocene. The Kentriodontidae diversified in the Early Miocene and reached peak diversity by the Middle Miocene . Cladistic analysis of Kenriodontidae has also been carried out (Aguirre Fernandez, 2003).

It is obvious from the foregoing review of literature that the occurrence of the fossils of two families have not been studied in a comparative way. The present study, therefore, had the objectives of–

1. Extracting of data on occurrence of Kogiidae and Kentriodontidae from database www.paleodb.org
2. Comparing the occurrence of different taxa.

**MATERIALS AND METHODS**

The paleo database from www.paleodb.org was used. First, in the analyze section

i) Count taxa was used

ii) Thereafter, generate data summary tables was used; in this option a) items to count was chosen as occurrences, and b) fields to tabulate (rows) was selected as 'continent'. The second field (optional) for columns was left blank.

iii) Thirdly, analysis of taxonomic ranges was used. Taxon name was given and then break taxa into species option was selected. It generated confidence interval taxon list. It was submitted to display confidence interval options, wherein options shown by default were used, as a result of which confidence interval output was obtained. Taxa were ordered by first occurrence.

iv) The following taxa were excluded from the chart because they could not be mapped to the time scale specified : *Thalassocetus antwerpiensis* (in case of kogiidae).

**Table - 1 : Occurence data for family kongiidae fossils**

| Taxa/ occurrence | First occurrence (Ma) | Last occurrence (Ma) | Confidence interval (Ma) | Number of horizons | Transposition test |
|---|---|---|---|---|---|
| *Thalassocetus sp.* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Nanokogia isthmia* | 11.608 | 7.246 | 0 | 2 | 0 |
| *Scaphokogia cochlearis* | 11.608 | 7.246 | 0 | 1 | 1 |
| *Kogia sp.* | 11.608 | 0.012 | 26.671 | 4 | 0 |
| *Praekogia cedrosensis* | 7.246 | 5.332 | 0 | 2 | 0 |
| *Scaphokogia sp.* | 7.246 | 5.332 | 0 | 1 | 1 |
| *Aprixokogia kelloggi* | 5.332 | 3.6 | 0 | 1 | 1 |
| *Kogia prisca* | 5.332 | 3.6 | 0 | 1 | 1 |
| *Kogia breviceps* | 5.332 | 0 | 1.285 | 18 | 0 |
| *Kogia pusilla* | 3.6 | 2.588 | 0 | 1 | 1 |
| *Kogia sima* | 3.6 | 0 | 5.274 | 5 | 0 |

**Table - 2 : Occurence data for family ketriodontiadae fossils**

| Taxa/ occurrence | First occurrence (ma) | Last occurrence (ma) | Confidence interval (ma) | Number of horizons | Transposition test |
|---|---|---|---|---|---|
| *Incacetus broggii* | 23.03 | 20.43 | 0 | 1 | 1 |
| *Kentriodon pernix* | 23.03 | 13.65 | 9.99 | 6 | 0 |
| *Kentriodon sp.* | 23.03 | 11.608 | 3.164 | 16 | 0 |
| *Kampholophos sp.* | 20.43 | 15.97 | 0 | 1 | 1 |
| *Rudicetus squalodontoides* | 20.43 | 15.97 | 0 | 2 | 0 |
| *Delphinodon sp.* | 20.43 | 13.65 | 32.768 | 3 | 0 |
| *Delphinodon dividum* | 20.43 | 11.608 | 12.924 | 5 | 0 |
| *Delphinodon wymanii* | 15.97 | 13.65 | 0 | 2 | 0 |
| *Hadrodelphis calvertense* | 15.97 | 13.65 | 11.213 | 3 | 0 |
| *Hadrodelphis poseidon* | 15.97 | 13.65 | 0 | 2 | 0 |
| *Kentriodon diusinus* | 15.97 | 13.65 | 0 | 1 | 1 |
| *Kentriodon obscurus* | 15.97 | 13.65 | 0 | 1 | 1 |
| *Delphinodon carniolicus* | 15.97 | 11.608 | 0 | 2 | 0 |
| *Kentriodon fuchsii* | 15.97 | 11.608 | 2.521 | 9 | 0 |
| *Liolithax kernensis* | 15.97 | 11.608 | 10.033 | 4 | 0 |
| *Lophocetus pappus* | 15.97 | 11.608 | 21.082 | 3 | 0 |
| *Hadrodelphis sp.* | 15.97 | 3.6 | 59.784 | 3 | 0 |
| *Belonodelphis peruanus* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Heterodelphis croatica* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Heterodelphis leiodontus* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Kampholophos serrulus* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Kentriodon hoepfneri* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Kentriodon schneideri* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Leptodelphis stavropolitanus* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Macrokentriodon morani* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Microphocaena podolica* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Rudicetus sp.* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Sarmatodelphis moldavicus* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Sophianacetus commenticius* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Tagicetus joneti* | 13.65 | 11.608 | 0 | 1 | 1 |
| *Liolithax sp.* | 13.65 | 7.246 | 0 | 2 | 0 |
| *Heterodelphis klinderi* | 11.608 | 7.246 | 0 | 1 | 1 |
| *Lophocetus calvertensis* | 11.608 | 7.246 | 0 | 1 | 1 |
| *Lophocetus repenningi* | 11.608 | 7.246 | 0 | 1 | 1 |
| *Macrokentriodon sp.* | 11.608 | 7.246 | 0 | 2 | 0 |
| *Pithanodelphis sp.* | 7.246 | 5.332 | 0 | 1 | 1 |

## RESULTS AND DISCUSSION

The outcome of the above methods has been depicted in Table 1 (Kogiidae) and Table 2 (Kentriodontidae). In family Kogiidae, *Thalassociatus* species appeared first among the Kogiids and its last fossil also occurred the earliest among the Kogiids (Table 1). In Kentriodontidae , *Kentriodon premix* was the oldest in terms of first occurrence followed by*Rudicetus squalodontoides*, with *Kentriodon diusinus* and *Kentriodon*

*obscurus*occurring at the same time after it and further followed by *Kampholophos serrulus* and *Kentriodon schneideri* at the same time (Table 2). This is based on phylogenetic tree by Predo *et al*. (2018).

Most of the taxa had very good Confidence Interval except *Kogiia* species, where further investigation of fossil specimen may be insightful. The taxa occurrence of Kogiddae in Table 1 is broadly in rhyme with phylogeny tree of (Velez-Juarbe, 2015). However, *Kogia prisca*listed in Table 1 has been considered as *nomen dubium* (Biannсci and Landini, 1999). As per Muizon (1988, 1991) , Kogiidae are divided into two subfamilies on the basis of differential architecture of supracranial basin : the Kogiinae (*Kogia* and *Praekogia*) and Scaphokogiinae (*Scaphokogia*). Both the extant species of Kogiidae are in sub-family Kogiinae and are covered in CITES (www.cites.int). Vale-Juarbe (2015) has drawn phylogenetic trees that include Kogiidae. In this phylogenetic tree also , both the extant species of Kogiidae form a single clade. As per these authors, divergence between extant species of Kogia occurred at around the late Pliocene, later than previously predicted by molecular estimates. Phylogenetically, an old separation (at least in the Lower Miocene) of Kogiidae and Physeteridae is suggested (Bianucci and Landini, 1999).

Ichishima *et al*. (1994) has givena classification of kentriodontidae, which is mainly based on Barnes (1985a). They indicated that Kentriodontines are plausible ancestors to some Delphinidae and mentioned the need of cladistics analysis for Kentriodontidae. All of modern Delphinoid families evolved from middle or late Miocene Kentriodontidae (Barnes,1985 b) . It is widely accepted that living delphinoids (Delphinidae, Phocoenidae and Monodontidae) originated from within Kentriodontidae (Aguirre Fernandez, 2003)

Predo *et al*.(2018) while describing a new Kentriodontidfrom early Miocene of Washington state , *Wimahl chinookensis* (one of the oldest known Kentridontids) has given a phylogenetic tree of kentriodontidae and their review of this family includes only 4 genera; *Wimahl*, *Kampholophos*, *Rudicetus* and *Kentriodon* in this family. They refer to 'Kentriodontids'outsideof this clade as stem Delphinidians. As *Wimahal chinookensis* is one of the oldest known Kentriodontid (Predo *et al* ., 2018) , so as per Table 2 , *Ketriodon permix* would be second most oldest in terms of first and last occurrence.

It may be mentioned that Odontoceti (which includes Kogiidae and Kentriodontidae) are important group , one of the reason being that they are highly encephalised ; the encephalisation being next only to modern human sand larger than all other mammals. Besides, they have behavioural faculties that have been ascribed to humans and to some extent greater apes.(Marino *et al*.,2004) .So, they are important in understanding evolution of brain. However, well-preserved records of Kogiidae are very rare: only two almost complete skulls from late Miocene sediments of Mexico (Barnes, 1973,1984) and Peru (Muizon, 1988) have been described previously. The third one by Bianucci and Landini (1999). The lack of substantiated kogiid records until the Upper Miocene is probably due to the rarity of these cetaceans (Bianucci and Landini,1999). On the other hand, fossils of kentrodontidae are relatively common fossils andquite useful for intercontinental correlations of marine deposits (Ichishima *et al*.,1994).

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# INTERCROPPING OF SUGARCANE AND CAULIFLOWER TO GET HIGHER PROFIT RATE IN GONDA DISTRICT OF U.P., INDIA

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**ABSTRACT**

**Sugarcane is the main crop of the Majha (Diara) land of Gonda district, Uttar Pradesh covering with 60-65 percent of total area. Most of the farmers were growing sugarcane as sole crop and got average yield 665 to 810q/ha with the Rs 1.81 lakhs/ha/year net return, which is not good for farmers of gonad district. Keeping in viewcauliflower intercropping with autumn sugarcane was promoted through transfer of technology by frontline demonstration. Yadva and Verma (1984) support for transfer of technology. In this system G-75 hybrid cauliflower nursery was sown in First week of September in low tunnel polyhouse in pots with coco pits and after twenty five days field prepared and sugarcane crop was sown through improved trench planting method at the row to row distance 90 cm in trench and cauliflower nursery transplanted on raised bed between two rows of sugarcane at the distance of 45x30 cm. The recommended dose of fertilizer was uses as basal doses (Half dose of Urea and Full doses of $P_2O_5$ & $K_2O$) on the bases soil testing. Remaining Urea was used as top dressing in two spilt doses. Cultural practices like weeding irrigation and plant protection activities were done as per needs time to time. Cauliflower crop was harvested in the month march first week and sold in market. At time of harvesting of cauliflower crop all cultural practices like- digging, weeding and irrigation completed in sugarcane crop. In this demonstration cauliflower yield got 225qt/ha and Sugarcane average yield 820 qt/ha. The net return was Rs 364250 /ha and in sole crop was Rs. 171500 which clearly showed that intercropping of Cauliflower with sugarcane increase theincome of farmers in comparison to sole crop of sugarcane.**

***Keywords :*** *Intercropping, sugarcane, cauliflower, yield*

## INTRODUCTION

Sugarcane (*Saccharum officinarum*) family *Gramineae* (Poaceae) is widely grown crop in India. It provides employment to over a million people directly or indirectly besides contributing significantly to the national exchequer. Sugarcane growing countries of the world lay between the latitude 36.7° north and 31.0° south of the equator extends from tropical to subtropical zones. Sugar cane originated in New Guinea where it has been known for thousands of years. Sugar cane plants spread along human migration routes to Asia and the Indian subcontinent. Here it cross-bred with some wild sugar cane relatives to produce the commercial sugar cane we know today.

Cultivation of sugarcane in India dates back to the Vedic period. The earliest mention of sugarcane cultivation is found in Indian writings of the period 1400 to 1000 B.C. It is now widely accepted that India is the original home of Saccharum species.

Saccharum barberi and Polynesian group of islands especially New Guinea is the centre of origin of S. officinarum. It belongs to family Gramineae (Poaceae), class monocotyledons and order glumaceae sub family panicoidae, tribe Andripogoneae and sub tribe saccharininea. The cultivated canes belong to two main groups: (a) thin, hardy north Indian types S.barberi and S.Sinense and (b) thick, juicy noble canes Saccharum officinarum. Highly prized cane is S. officinarum.

Intercropping is the growing of two or more crops simultaneously on the same piece of land such that the period of overlap is long enough to include the vegetative stage (Gomez and Gomez, 1983). Intercropping double cropping and other mixed cropping practices that allow more efficient uses of on farm resources are among the agricultural practices associated with sustainable crop production (NRC, 1983; Tolera, 2003). Intercropping provides year -round ground cover, or at least for a longer period then monocultures, in order to protect the soil from desiccation and erosion. By growing more than one crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility, and minimize soil erosion, which ae the serious drawbacks of mono-cropping (Hoshikawa, 1991).

Sugarcane is the main commercial crop grown by most farmers of the Majha(diara) land of Gonda district of eastern U.P. About 65-70% is covered by this crop. Farmers are growing sugarcane in autumn, spring and late spring seasons just after wheat harvesting. In autumn season, sugarcane is sown in the months of Sept-Oct. Most of the farmers are choosing autumn sugarcane as their sole crop and they are getting 700-820 qt/ha by using improved trench method. But, due to increasing Labour and inputs cost, cost of cultivation has increased resulting in farmers not getting good returns. The size of land holding is also decreasing day by day in India, which is caused by division and subdivision of land holding. The Government of India wants doubling the farmers income until 2022. For that purpose the maximum use of land by intercropping of Vegetable production has a potential of enhancing farmer's income. Keeping this issue in view, the Krishi Vigyan Kendra was conducteddemonstration onCauliflower intercropping with sugarcane in autumn season. (Bakhsh et al., 2004) to increase the farmer's income.

The Uttar Pradesh, Bihar, Punjab, Haryana, Uttarakhand, Madhya Pradesh, Rajasthan, West Bengal, Jharkhand, Assam and other north and north eastern state are came in subtropical belt. Among states Uttar Pradesh is the main cane growing state in the country allocating about 2.2 million ha area (43.7%) for cane cultivation and Maharashtra second cane cultivation state with 19.6% cane area.

Small sugarcane growers need not wait until the harvest of sole crop to obtain financial returns. Intercropping of important short duration crop (Cauliflower) with sugarcane through utilization of the present limited land resources would help to sustain sugarcane cultivation and provide interim return to small and marginal farmers.

In the Eastern Uttar Pradesh sugarcane is normally planted in autumn September-October, this planting of sugarcane in variably yields 20-25%. Cauliflower and cane grow as intercrop because there is higher demand of vegetables in the market for whole year. Since the consumption of vegetable is increasing as faster rate in modern time as these are supplementary item in human diet.Sub-tropical region contributes more than 55% area of the sugarcane, however, cane yield and sugar recovery (%) are lower in comparison with tropical India.

## MATERIALS AND METHODS

To keeping in view of the increasing farmer's income the Krishi Vigyan Kendra, Mankapur, Gonda II had conducted a demonstration on cauliflower intercrop with sugarcane under Frontline demonstration in the year 2019-2020 and 2020 and 2021 two constructive years. Total 10 farmers were selectedin two villages of covering two blocks i.e.,Mankapur and Babahnjot. The

variety CO-238 and G-75 were selected for sowing of sugarcane and cauliflower. Cauliflower (Variety G-75 hybrid) seed treated with 0.3 percentage solution and nursery was raising in germination trayfill with cocopit in the first week of September under low tunnel poly house. Sugarcane was planted through improved trench method in furrows at 90 cm apart keeping three budded sets as 30 cm row length in the third week of September. Ahmed et al., (1997) already promoted double row intercropping.

**The use of fertilizer:**

Sugarcane fertilized N2 180kg/ha, ½ N2 at planting as based dressing + 1/2 in two equal split doses as top dressing after harvesting of cauliflower at proper moisture while intercrop are given one third of total N+ full doses of P2O5 and K2O at their transplanting on second week of October just after sugarcane planting and remaining half N is top dressed after 30 day of transplanting. Cauliflower Nursery transplanted at the distance of 45x30 cm between two rows of sugarcane on raised bed. Alam et al., (2000) supported these cultural practices done as per need time to time. Observations are given below.

**RESULTS AND DISCUSSION**

In table No. 2 data shows that sowing time and method of sugarcane planted were same. Seed requirement of sugarcane with cauliflower inter cropping is 75q/ha and it is also 75q/ha in sole crop but cost of cultivation with intercropping became Rs. 1.65 lakh/ha and Rs 0.98 lakh/ha is in sole crop. Its increase 68.36% in comparison to sole crop. Production of sugarcane is 870qt/ha in intercropping cauliflower yield 232 qt/ha. Sugarcane yield in sole crop was 930qt/ha. Geetha et al. (2015) also worked on yield performance of sugarcane in intercropping.

Total return in Cauliflower intercropping is Rs 5.51 Lakhs/ha and Rs 2.79 Lakhs/ha in sole crop. The total return is 1.97% is excess in comparison to sole crop of sugarcane. The net return is more (Rs 2.72 Lakhs) in comparison to sole crop of sugarcane (Rs 2.79 Lakhs) Ahmed et al., (1997) supported the intercropping system. The benefit cost rate on 2.33 is significant higher in comparison to sole crop (1.84) (Ali and Abedullah, 2002). Data of net return revealed that cauliflower intercropping with spring sugarcane play the significant role toward doubling the income of the farmers. Residual of cauliflower also increased the organic matter in the soil and increased the sustainability of the soil.Priscilla and Singh (2015) also found the same trend in vegetable intercropping with sugarcane in Manipur, India.

**Table - 1 : Details of Cauliflower intercropping with autumn sugarcane.**

| Name of crop | Variety | Row to row distance (cm) | Sowing duration | Plant to plant distance (cm) | Seed rate/ha | Application of fertilizers (Kg/ha) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | N | P | K |
| Sugarcane (Main crop) | CO-0238 | 90 | 3rd week of September | 30 | 75 gm | 180 | 60 | 50 |
| Cauliflower (Intercropping) | G-75 (Hybrid) | 45 | 2nd week of October | 30 | 350 gm | 80 | 40 | 40 |

The same results were also observed by Lithourgidis et al., (2011) during their study. Cauliflowers intercropping with autumn sugarcane also promote and help to the maximum utilization of inputs, soil and water etc.

**CONCLUSION**

On the Object side, it is concluded in the present investigation cauliflower inter cropping with autumn sugar cane data proves that Cauliflower intercropping with autumn sugarcane plantation is

**Table - 2 : Cauliflower intercropping with autumn sugarcane.**

| Sl. No. | Details | Cauliflower intercropping with spring sugarcane | Sole crop of sugarcane |
|---|---|---|---|
| 1 | **Main crop** | **Sugarcane (Co-238 )** | **Sugarcane (Co-238)** |
| 2 | Intercrop | Cauliflower (GS-75)) | - |
| 3 | Sowing time | Sugarcane-3rd week of September<br>Cauliflower-2nd week of October | Sugarcane-3 rd week of September |
| 4 | Seed rate | Sugarcane-75qt/ha<br>Cauliflower-350gm/ha | Sugarcane-75qt/ha |
| 5 | Cost of cultivation | Rs.- 1.55 Lakh/ha | Rs.- 0.95 Lakh/ha |
| 6 | Mill able | | |
| 7 | Production | Sugarcane-770 qt/ha<br>Cauliflower –225 qt/ha | Sugarcane-820 qt/ha |
| 8 | Total Return | Sugarcane-Rs. 250250<br>Cauliflower-Rs. 270000<br>Total= Rs. 520250 | Rs- 266500 |
| 9 | Net return | Rs- 364250 | Rs-171500 |
| 10 | C:B Ratio | 1:2.35 | 1:1.81 |

Note :- Sugarcane @Rs 325/qt, Cauliflower @Rs 1200/qt

profitable (Rs 3.64 Lakhs) in comparison to sole crop of sugarcane cultivation (Rs-1.71Lakhs),the B:C ratio was also Higher (2.35) in intercropping of cauliflower in comparison to the sole crop (1.81) and increase the sustainability of soil. Thus Cauliflower intercropping with autumn sugarcane is recommended for increasing the income of the farmers (Ali and Abedullah, 2002 and Ahmad et al. 2004)autumn plantation of sugar cane should be promoted for increasing income of farmers. With this system inputs and natural resources like soil and water also proper utilized. The input use efficiency also increased. Singh et al. (2015) also worked on vegetables intercropping with autumn planted sugarcane: a step towards doubling farmers' income in Indian sub-tropics. Tripathi , janhavi and Pant, Hemlata, (2012)

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**Intercropping cropping of Cauliflower in Sugarcane at Purechain kunwar village, block Rupaideeh Dist. Gonda**

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# AN ECO-FRIENDLY APPROACH TO BIOREMEDIATION OF PESTICIDE FOR THE ENVIRONMENT

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**ABSTRACT**

**Bioremediation of pesticide is eco- friendly approach which is based on the assumption that various organisms will interact to eliminate waste compounds or pollutants (pesticide) from the environment (biodegrade). Bacteria and fungi are excellent degraders of complex compounds, which they need to fuel their metabolism and growth. The degradation of wastes or contaminants is not the sole aspect of bioremediation. The two methods of *in situ* bioremediation and *ex situ* bioremediation i.e. Bioventing, Biosparging and Bioaugmentation may be sufficient to eliminate the waste or more significant treatments. As a result, applying microbial enzyme directly to the contaminant can occasionally get beyond the constraints associated with biological samples. Enzymes for pesticide breakdown could be developed as a bioremediation technique. Another concern with bioremediation is the cost-benefit ratio, or the cost vs the overall environmental impact. When we wish to employ a live organism or product to remove toxins, it is critical. Understanding the genetics and biochemistry of the target microbe can help to overcome some of these restrictions and to obtain the desired effect in a short period of time. In the development of technology for eliminating toxins from actual locations, bioremediation has a better future than other remediation techniques such as incineration, thermal disposition, land farming, and so on.**

***Keywords :*** *Pesticides, bioremediation, in situ bioremediation, ex situ bioremediation and pollution.*

## INTRODUCTION

Any approach utilized to eradicate the negative impacts of contaminants from the environment is referred to as "bioremediation." Pollutants must be eradicated whenever possible, although this is not always practicable; nonetheless, some species may be able to limit or immobilize them. Organisms, for example, can accumulate contaminants and decrease their presence and impact on the environment, but they do not eradicate them. Such methods, which are now in practice (v.gr. phytoextraction) (Dubchak and Bondar 2019, Tyagi *et. al*., 2011) should be included in the idea of "bioremediation**".** Bioremediators are organisms that are capable of bioremediation. For example pesticides like Algicides target Algae, Bactericides targets Bacteria. Fungicide targets fungi etc.

Microbes are used to breakdown pesticides

*in situ* in bioremediation. An effective bioremediation process necessitates the use of a bacterial strain capable of degrading the biggest pollution to the smallest amount possible. To achieve an acceptable level of pesticide residues or metabolites at a polluted site in a reasonable amount of time, an adequate rate of biodegradation is necessary. The rate of biodegradation in soil is determined by four factors: (i) physiological status of microorganisms, (ii) pesticide or metabolite availability to microorganisms (iii) survival and/or proliferation of pesticide degrading microorganisms at contaminated sites, and (iv) a sustainable population of these microorganisms. Water potential, pH, water potential, Temperature, nutrients, and the amount of pesticide or metabolite in soil could all be limiting factors for pesticide-degrading microorganisms, which have to be investigated further in connection to the overall microbial population and their biochemical activities. Because soil has a unique binding ability for a range of pesticides or metabolites, an understanding of pesticide dynamics in the soil environment is also essential when considering an appropriate bioremediation strategy. Before utilizing any bacterium for pollutant biodegradation, it is also vital to understand the genetics and physiology of pollutant degradation. In the terrestrial ecosystem, pesticide contamination can occur in three places: the saturated zone or ground water and the vadose zone or surface soil. Because surface soils have a significant number of aerobic microorganisms, biodegradation is fast and largely aerobic. However, the quantity of aerobic bacteria diminishes with depth. In the other two zones, namely vadose and ground water, biodegradation is slow. To deal with diverse parts of the terrestrial ecosystem, different bioremediation systems are necessary (Nawaz *et al.,* 2015, Tyagi *et. al*., 2011).

Pollution of the environment, freshwater, and topsoil has evolved from global industrialization. Water quality has worsened as a result of human activity, such as due to mining and ultimate removal of toxic metal effluents from steel mills, battery companies, and electricity generation, posing major environmental concerns. Effluents like petroleum, polythenes, and trace metals harm the environment. Heavy metals are pollutants that exist in nature in the Earth's crust and are difficult to decompose. They exist as ores in rocks and are recovered as minerals. High-level exposures can release heavy metals into the environment. Once in the environment, they remain toxic for much longer (Masindi et al., 2021). Many of these pollutants are mutagenic to both humans along with their surroundings. Absorbing heavy metals accumulates in the brain, liver, and kidney. Other effects on animals include cancer, nervous system damage, stunted growth, and even death (Briffa et al., 2020). Heavy metals in soils reduce food quality and quantity by inhibiting nutrient absorption, plant growth, and physiological metabolic processes. Metal-contaminated soils are being remedied using chemical, biological, and physical methods. However, physicochemical methods produce a lot of waste and pollution, so they are not valued (Rebello et al 2021). Bioremediation is a cost-effective and practical solution for removing environmental contaminants (Tripathi et al 2021).

**Bioremediation technology advancement**

In the field, bioremediation works by either transforming or degrading the contaminant, or by both methods. In this study, the process technologist's goal is to create the best conditions for microorganism growth. Land farming, bioreactors, biologically enhanced soil washing, composting, and solid – phase bioremediation are all examples of bioremediation treatments. *In situ* bioremediation necessitates the manipulation of aqueous constituents as well as bioventing (Adams *et al.,* 2015). Microbes that have been genetically modified are used to improve their degradation capability. The following points should be considered when developing technology: i) contaminant heterogeneity. (ii) Contaminant

concentration and its effect on biodegradative microbes, (iii) contaminant persistence and toxicity, (IV) contaminant behavior in soil, and (v) conditions favorable to biodegradative microbes or microbial populations.

***In situ* bioremediation**

These techniques are generally the most desirable options because they are less expensive and cause less disruption because they provide treatment in place, avoiding excavation and transport of contaminants. The depth of the soil that can be effectively treated limits *in situ* treatment. Effective oxygen diffusion for desirable rates of bioremediation in many soils extends only a few centimetres to about 30cm into the soil, though depths of 60cm and greater have been effectively treated in some cases. The following are the most important land treatments: The most common *in situ* treatment is bioventing, which involves supplying air and nutrients through wells to contaminated soil in order to stimulate the indigenous bacteria. Bioventing used in low air flow rates, which delivers only the quantity of oxygen required for biodegradation while reducing volatilization and the release of contaminants into the atmosphere. It is effective for simple hydrocarbons and can be employed where contamination is found far beneath the surface. *In situ* biodegradation includes circulating aqueous solutions through polluted soils to provide oxygen and nutrients to naturally occurring microorganisms that breakdown organic pollutant. It's suitable for both soil and groundwater. In general, situations such as the infiltration of water-containing nutrients, oxygen, or other electron acceptors for groundwater treatment are included in this method (Chaney *et al.,* 1997). Biosparging is the process of injecting compressed air beneath the water table to raise groundwater oxygen levels and speed up the biological breakdown of contaminants by naturally occurring microorganisms. Biosparging increases the interaction between soil and groundwater by increasing mixing in the saturated zone. Bioaugmentation is a term that refers to the use of the addition of microorganisms, either indigenous or exogenous, to contaminated locations is a common part of bioremediation methodology. The utilization of additional microbial cultures in a landtreatment unit is limited by two factors: 1) Nonindigenous cultures rarely compete well enough with indigenous populations to develop and sustain viable population levels, and 2) most soils with long-term exposure to biodegradable garbage include indigenous microbes that effectively decompose if the land treatment unit is properly-managed (Adams *et al.,* 2015)

***Ex situ* bioremediation**

These methods entail excavating or removing contaminated dirt from the ground. Landfarming is a basic approach that involves excavating polluted soil, spreading it over a prepared bed, and tilling it periodically until pollutants are reduced. The goal is to encourage indigenous biodegradative bacteria and make it easier for them to degrade pollutants aerobically. Composting is a process that includes mixing polluted soil with non-hazardous organic amendments like manure or agricultural waste. The presence of these organic materials encourages the growth of a diverse microbial population and the high temperatures associated with composting (Philp and Atlas 2005). Landfarming and composting are combined in biopiles. Engineered cells are built similarly to aerated composting piles. They are a refined version of landfarming that tend to control physical losses of contaminants via leaching and volatilization. Biopiles include an ideal environment for aerobic and anaerobic bacteria to thrive. Bioreactors are a type of bioreactor. *Ex situ* treatment of contaminated soil and water pumped up from a contaminated plume is done in slurry reactors or aqueous reactors. In reactor bioremediation, polluted solid material (soil, sediment, sludge) or water is processed through a designed containment system. A slurry bioreactor is a containment tank and apparatus used to create a three-phase (solid, liquid,

and gas) mixing condition in contaminated soil and biomass (typically indigenous) to boost the bioremediation rate of soil-bound and water-soluble contaminants as water slurry. Because the enclosed environment is more manageable and hence more controllable and predictable, the pace and amount of biodegradation in a bioreactor system is larger than *in situ* or in solid-phase systems. Despite the benefits of reactor systems, they do have significant drawbacks. Before being placed in a bioreactor, the contaminated soil requires pretreatment (e.g., excavation), or the contaminant can be removed from the soil via soil washing or physical extraction (e.g., vacuum extraction).

**Application of technology at the actual site**

The application of technology at the actual site necessitates of natural bioprocesses at the contaminated site, (ii) detailed and valid data of microbial biodegradation developed in the laboratory, and (iii) monitoring of the onsite biodegradation process. Studies on microbial populations, activities, and soil enzymes will provide a mirror image of the soil's functional status. The majority of bioremediation technologies for the field are intended to remove pollutant after it has been generated or released into the environment Bioaugmentation (the addition of an organism or enzyme to a contaminant), biostimulation (the use of nutrients to stimulate naturally occurring organisms), biofilters (the removal of organic gases by passing air through compost or soil containing microorganisms), bioreacters (the treatment of a contaminant in a large tank containing an organism or enzyme), and bioventing (the treatment of a contaminant in a large tank containing an organism or enzyme) are examples of these technologies (Adams *et al.,* 2015, Tyagi *et. al*., 2011)

**Bioremediation's Limitations**

On the approach to bioremediation technology, there are various challenges. Pollution cleanup by organisms is not a charitable deed. Rather, it is a survival strategy. The majority of bioremediation species work in environments that are conducive to their demands. As a result, some form of environmental modification is required to induce organisms to decay or absorb the pollution at a rate that is tolerable. The organism must often be exposed to low amounts of the contaminant over a long period of time. This causes the organism to develop the metabolic pathways necessary for the pollutant to be digested. It is frequently necessary to provide fertilizer or oxygen to the substance holding the contaminant when utilizing bacteria and fungi. When done *in situ,* this can be harmful to other creatures. When simple chemicals and metals are taken up, the organisms are likely to be exposed to dangerous quantities of these contaminants. Overall, organisms do not often do as well on a pollutant diet as they do on other nutrients available more frequently in their surroundings. When undertaking *in situ* remediation, this is a concern. Cost/benefit ratios, i.e. cost versus overall impact on the environment, are another obvious source of worry. Neither the government nor the private sector is willing to spend significant sums of money to clean up pollution. Bioremediation is often very expensive, labour intensive, and can take many months to attain acceptable levels of cleanup. Air bioremediation, in particular, is inefficient when compared to the volume of dirty air produced by industry. Another issue is that both *ex situ* and *in situ* technologies have the potential to cause environmental disruption in addition to pollution damage. The long-term consequences of importing naturally occurring non-native bioremediation species into a region remain unknown. Under laboratory conditions, bioremediation has been shown to be effective (Rajendran *et al*., 2003; Wasi *et al*., 2011a, b). Bioremediation's popularity is encouraged by the concept that it is more "green" than other remediation procedures. Despite the high risks, companies and individuals are investing in biotechnology futures. As a result, bioremediation companies have a bright future ahead of them, regardless of their long-term efficacy (Fulekar, 2012).

Bioremediation is technology based on the assumption that various organisms will interact to eliminate waste compounds or pollutants (pesticide) from the environment (biodegrade). Bacteria and fungi are excellent degraders of complex compounds, which they need to fuel their metabolism and growth. The degradation of wastes or contaminants is not the sole aspect of bioremediation. However, the method may be sufficient to eliminate the waste or contaminant without degrading in some cases. Bioremediation will function well with some compounds, but it has a number of drawbacks. It is determined by the type of the organisms, the enzyme in question, its concentration and availability, and eventually the microbes' survival. As a result, applying microbial enzyme directly to the contaminant can occasionally get beyond the constraints associated with biological samples. Enzymes for pesticide breakdown could be developed as a bioremediation technique. Another issue with bioremediation is the cost-benefit ratio, or the cost vs the overall environmental impact. When we wish to employ a live organism or product to remove toxins, it is critical. Understanding the genetics and biochemistry of the target microbe can help to overcome some of these restrictions. To obtain the desired effect in a short amount of time, a Super strain can be developed. Multimember microbial consortia can be utilised in the field to accelerate the mineralization of specific pesticides using either elective enrichment or chemostat enrichment. Bioremediation has a brighter future in the development of technologies for removing toxins from actual sites than other remediation procedures such as incineration, thermal disposition, landfarming, and so on (Dua *et al.,* 2002).

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# NUTRITIONAL IMPORTANCE AND PROCESSING ASPECTS OF MIRACLE FOOD (MILLETS)

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**ABSTRACT**

**Millets are a most important food source in arid region including central and western Asia, the Middle East, Africa, North and South America, central and northwest Australia and semi-arid region it includes north and/or south of the deserts (in Africa, Asia and Australia) or inland and at slightly higher elevations (in North America, South America, the Middle East, Africa and Asia). of the world. Millets are good sources of energy. Millet provide us a good source of protein, fatty acids, minerals, vitamins, dietary fiber and polyphenols. They grow in very adverse conditions of climate like low water and high temperatures, no need of fertilizers. They contain all the macronutrients and micronutrients. That's why millets is called Miracle food . Millet contains high amounts of essential amino acids, especially those containing sulfur (methionine and cysteine). Millet processing methods are used to produce a variety of value-added products, and various production methods such as fermentation, germination, peeling, extruding, boiling, puffing, milling, malting, and crushing are used. Processing of millet which can done by milling removes the bran and germ layers that are rich in fibre and phytochemicals & losses in the form of qualitative & qualitative. The millets contains good source of antioxidants, such as phenolic acids and glycated flavonoids. The nutritional significance of millets demands for determination of nutritional characteristics and functional properties of different types of millet crops as well as development of value added products obtained from millets. Processing techniques of millets are involved in making different value added products & in making different techniques are involved such as fermentation, germination, dehulling, extrusion, cooking, puffing, popping, malting, milling, etc. Having a good nutritative value lead in processing which can help the food industry, researchers, and consumers. By adopting suitable processing technique to optimize the nutrient value, increase the bioavailability of nutrients, and help as a nutrition safety concern .**

***Keywords :*** *Millets, processing, nutrients, dietary fiber, Phytochemical*

## INTRODUCTION

MILLETS (Facts )

- Origin: Africa and Asia
- Group of annual grasses arid and semiarid regions
- Small seeded grains
- Gluten free cereals,Non-allergenic, nutri-cereals and superfoods
- Millet is a grain crop commonly known for its small seeds and high nutritional value.Millet

Millet is a generic term for a group of small-seeded annual grasses grown as grains on marginal lands, primarily in temperate, subtropical and tropical arid regions. Common types of millet available in India are Ragi (finger millet), Jowar (sorghum), Sama (small millet), Bajra (pearl millet) and Variga (froso millet).

India designates 2018 as the Year of Millet. The United Nations General Assembly passed a resolution declaring 2023 as the International Year of the Flag, as India proposed to the Food and Agriculture Organization (FAO). Millets are highly nutritious ,non glutinious, and non acid forming Foods. Millets have enormous potential to form a core component in agriculture whilst offering nutritional and food security benefits. Millet is a staple food in developing countries. Millet is an excellent source of all essential nutrients such as proteins, carbohydrates, fats, minerals, vitamins and bioactive compounds. Millet is an important human food source, and its production has increased in recent decades to meet the nutritional needs of a growing world population. India, Niger and China are the world's largest producers of millet, accounting for more than 55% of world production. India was the world's largest producer of millet. Millet is a grain mainly used for local consumption. It is rich in dietary fiber, protein, vitamins, potassium, phosphorus, iron, magnesium, and other essential minerals that our body needs. As such, it aids in better digestion and has similar nutritional value to fruits and vegetables. Millet has not only health benefits but also nutritional properties and is used in the treatment of health problems such as diabetes, hyperlipidemia, etc.

Millet is also superior to common grains in terms of nutrient composition and nutritional value for modern lifestyles. They are a rich source of dietary fiber, phytochemicals and micronutrients. India is the world's largest producer of millet. India is the world leader in millet production, accounting for about 15% of global production. In India, Rajasthan is the leading producer of millet. More than 58% of the world's production consists of millet, but few Indians are aware of its health benefits and nutritional value.

Millet: Jowar (millet), Sama (small millet), Ragi (finger millet), Korra (tail millet) and Variga (millet millet). Bajra itself contains a lot of fat, but ragi contains minimal fat. Wheat and rice provide food security, while millet provides many guarantees such as food, health, nutrition, livelihoods, animal feed, etc., making millet an agricultural security product. Millet is used as a food product and is widely available and consumed in rural areas. In rural areas, part of the millet is used for food such as millet and sorghum, and the rest is used as animal feed. Millet plays an important role in traditional diets in many parts of India. Many states in India use different grades of millet. Compared to rice and wheat, all millets are three times more nutritious than rice and wheat. Rice is high in carbohydrates (28%) and low in protein (3%).

It also contains several essential micronutrients such as B vitamins, manganese and iron.

**DIMENSIONS OF MILLETS**


**Nutritional status of millets**

**MILLET AND ITS POTENTIAL**

Millet belongs to a small, rounded annual grass that grows mainly in arid and semi-arid regions. Millet survives on less fertile soils, is drought tolerant, disease tolerant, has a short growing season, and is grown worldwide throughout the year. The word millet dates back to

**Table - 1 : Nutritive value of coarse and fine cereals (Per 100 g).**

| Crop | Protein(g) | Carbohydrate(g) | Fat(g) | Crude fiber(g) | Mineral(g) | Calcium (mg) | Phosphorus (mg) |
|---|---|---|---|---|---|---|---|
| Sorghum | 10.4 | 72.6 | 1.9 | 1.6 | 1.6 | 25 | 222 |
| Pearl millet | 11.6 | 67.5 | 5.0 | 1.2 | 2.3 | 42 | 296 |
| Finger millet | 7.3 | 72.0 | 1.3 | 3.6 | 2.7 | 344 | 283 |
| Proso millet | 12.5 | 70.4 | 1.1 | 2.2 | 1.9 | 14 | 206 |
| Foxtail millet | 12.3 | 60.9 | 4.3 | 8.0 | 3.3 | 31 | 290 |
| Kodo millet | 8.3 | 65.9 | 1.4 | 9.0 | 2.6 | 27 | 188 |
| Little millet | 8.7 | 75.7 | 5.3 | 8.6 | 1.7 | 17 | 220 |
| Barnyard millet | 11.6 | 74.3 | 5.8 | 14.7 | 4.7 | 14 | 121 |

Source: National Institute of Nutrition (NIN), Hyderabad (P Anbukkani et al., 2018).

the beginning of human civilization, and millet is considered the first domesticated grain. Our country, India, is one of the largest producers of pearl millet in the world. Rajasthan is the largest producer of millet. Millet is rich in protein, calcium, dietary fiber and polyphenols, and has unique health benefits, making it an outstanding property.

**Types of Millet**

Millet differs from other millet in appearance, vegetation, type of grain, degree of maturity, and morphological characteristics.

**The main types of millet:**

African millet (Pennisetum glaucum), most commonly consumed by humans.
Foxtail (Setaria italic),
Millet or millet (Panicum miliaceum) and
Pollen millet (Eleusine coracana).
Minor millets are
Barnyard millet (Echinochloa spp.),
Kodo millet (Paspalum scrobiculatum),
Little millet (Panicum sumatrense),
Guineamillet (Brachiaria deflexa),
Browntop millet (Urochloa ramose),
Teff (Eragrostis tef),
Fonio (Digitaria exilis),
Sorghum (Sorghum spp.) and
Job's tears (Coix lacrima-jobi)

**Need to Process Millet**

Millets were good for us because of their calorie and energy content & millets were a good source of fibre & phytochemicals. Processing involves partial separation and/or modification of three major constituents of millets-germ, starch-containing endosperm and protective pericarp. Millets have processed by features
Digestibility
food safety
organoleptic properties
ease of convience
maximize their nutritional value
meeting demand for pre-processed & convenience food

**Structural features of millets**

| **Grain** | **Type** | **Shape** | **Colour** |
|---|---|---|---|
| Sorghum | Caryopsis | Spherical | brown White, yellow, red, |
| Pearl millet | Caryopsis | Ovoid, hexagonal, globose | Grey, white, yellow, brown, purple |
| Foxtail | Utricle | Elliptical | millet Yellow, pale yellow |
| Common millet | Utricle | Globose | Light Purple |
| Finger millet | Utricle | Globose | Yellow, white, red, brown, violet |

**Source : FAO 1995**

**Main Objectives**

Optimal processing of millet to meet the specific requirements for nutrition for human health and improvement of food quality due to its fine grain size and short shelf life (against pest infestation and rancidity). Millet with skin, such as millet, godo, millet, millet, and millet, is difficult to process. Hulling efficiency (percentage of millet to total processed grain) and product quality are below acceptable levels. Shelf life and packaging of processed millet.

**1. Millet - Nutrients**

Millet has high nutritional value and is superior to other grains such as wheat and rice in many components. They are an important source of important nutrients such as niacin, magnesium, phosphorus, manganese, iron and potassium. It is rich in protein, dietary fiber, essential amino acids methionine, lecithin and vitamin E. It is an excellent source of B vitamins, magnesium, antioxidants, manganese, phosphorus and iron. Millet contains 65% carbohydrates, 9% protein, 3% fat, 2-7% crude fiber, vitamins and minerals. Millet is a good source of essential amino acids except for lysine and threonine, but is relatively high in sulfur-containing amino acids such as methionine and cysteine. It is also rich in essential fatty acids such as linoleic, oleic and palmitic acids.

An excellent source of free and bound forms of monogalactosyl, diacylglycerol, digalactosy ldiacylglycerol, phosphatidylethanolamine, phosphatidylserine and phosphatidylcholine. other fatty acids. B. Arachic acid, behenic acid and erucic acid are present in trace amounts. Millet oil can be a good source of linoleic acid and tocopherols.

Millet is a gluten-free, alkaline grain. Vitamins such as niacin, folacin, riboflavin, thiamine and phosphorus are found in millet and play an important role in energy production.

**Table - 2 : Nutritive value of coarse and fine cereals (per 100 g)**

| | Protein (g) | Fiber (g) | Minerals (g) | Iron (mg) | Calcium (mg) |
|---|---|---|---|---|---|
| Sorghum | 10 | 4 | 1.6 | 2.6 | 54 |
| Pearl millet | 10.6 | 1.3 | 2.3 | 16.9 | 38 |
| Finger millet | 7.3 | 3.6 | 2.7 | 3.9 | 344 |
| Foxtail millet | 12. 3 | 8 | 3.3 | 2.8 | 31 |
| Proso millet | 12.5 | 2.2 | 1.9 | 0.8 | 14 |
| Kodo millet | 8.3 | 9 | 2.6 | 0.5 | 27 |
| Little millet | 7.7 | 7.6 | 1.5 | 9.3 | 17 |
| Barnyard millet | 11.2 | 10.1 | 4.4 | 15.2 | 11 |

source :- Source: http://milletindia.org

**II Millet as a healthy diet**

Millet is rich in several beneficial nutrients such as phosphorus, magnesium, copper and manganese. Millet can be used to make bread, beer, cereals and other dishes. Millet is a staple food worldwide. A variety of traditional foods and beverages are made of millet, including roti, bread (fermented or unfermented), cereals, snacks and fast food, baby food, millet liquor, and nutritional millet powder.

**III. Millets and Phytochemicals**

Millets are also rich sources of phytochemicals and micronutrients. Phytochemicals such as phenolics (bound phenolic acid-ferulic acid, free phenolic acid-protocatechuic acid), lignans, β-glucan, inulin, resistant starch, phytates, sterols , tocopherol, dietary fiber and carotenoids are present in millets. The main polyphenols are phenolic acids and tannins, while flavonoids are present in small quantities; they act as antioxidant and play many

roles in the body immune system.

**IV. Millets as Probiotic and Prebiotic**

Probiotics are live microorganisms that, when ingested in sufficient quantities, exhibit health benefits beyond basic nutrition needs.

Probiotics are viable microbial food supplements that improve host health. Prebiotics can be used as an alternative or additional support to probiotics. Prebiotics have great potential to alter the gut microbiome, but these modifications occur at the individual strain and species level and cannot be easily predicted in advance. Probiotics aid existing flora or help repopulate the colon when bacteria levels are reduced by antibiotics, chemotherapy or illness. Probiotics are "live microorganisms" that, when administered in adequate amounts, confer health benefits to the host.

Fermented millet products act as a natural probiotic remedy for diarrhea in young children. Prebiotics are indigestible food components that exert beneficial effects on the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the large intestine. Prebiotic activity that helps increase the population of beneficial bacteria that play an important role in improving digestion. Malting produces important beneficial biochemical changes in millet grains.

**V. Millet as Nutraceutical**

Nutraceuticals are natural bioactive compounds that promote health, prevent disease, or have other medicinal properties. Nutraceuticals provide physiological benefits and help maintain good health. A nutraceutical can be defined as a diet. Supplements that provide bioactive food compounds in concentrated form in a non-food matrix to promote health and prevent disease.

Neutraceuticals are the bioactive compounds found in fortified food, dietary supplements, and herbal products. Millets have nutraceutical properties in the form of antioxidants which prevent deterioration of human health such as lowering blood pressure, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes, decreasing tumor cases etc. The concepts of food consumption are changing from previous to present time. Previous emphasis has been on survival, hunger satisfaction, health maintenance and absence of adverse effects on health and current emphasis is on encouraging the use of nutraceutical foods which promise to promote better health and well being thus helping to reduce the risk of chronic diseases such as obesity, diabetes, CVD and cancer.

**Health Benefits of Millets**

Millets are a powerhouse of nutrients.

Millets have therapeutic benefits such as control of asthma, migraine, blood pressure, diabetic heart disease, atherosclerosis and heart attack.

- Millet have a protective effect against insulin resistance, heart disease, diabetes, ischemic stroke, obesity, breast cancer, childhood asthma and premature death. Because of these benefits millets, millets can be used in functional foods and as neutraceuticals
- Millets have many nutraceutical properties that are helpful to prevent many health problems such as lowering blood pressure, risk of heart disease, prevention of cancer and cardiovascular diseases, decreasing tumour cases etc.

Other health benefits are increasing the time span of gastric emptying, provides roughage to gastro intestine . Millet is an alkaline forming food. Alkaline based diet is often recommended to achieve optimal health, meaning when it combines with digestive enzymes. The soothing alkaline nature of millet helps to maintain a healthy pH balance in the body, crucial to prevent illnesses.

- Millets are anti acidic
- Millets are gluten free
- Millets detoxify body
- Niacin (vitamin B3) in millet can help lower cholesterol
- Prevents breast cancer
- Helps to prevent type 2 diabetes
- Effective in reducing blood pressure
- Helps to protect against heart diseases
- Aids in treating respiratory conditions such as

asthma

- Helps to optimize kidney, liver and immune system health
- Reduces risk of gastrointestinal conditions like gastric ulcers or colon cancer
- Eliminates problems like constipation, excess gas, bloating and cramping
- Millet acts as a prebiotic feeding microflora in your inner ecosystem

## CONCLUSION

Millets are staple food source that is not only providing major nutrients like protein, carbohydrate, fat etc.

As well as providing adequate amounts of vitamins and minerals. In developing countries, various health problems such as malnutrition, obesity, diabetes, cardiovascular disease, skin disease, cancer, and celiac disease are the most prominent. This is mainly due to underutilized crops for food and people's ignorance and ignorance. Millets are readily available and inexpensive.

Millets contain many major and minor nutrients like carbohydrate, good protein, fat, dietary fibre, vitamins and minerals as well as antioxidant and phytochemicals. The importance of this study undertakes to concern and developing specific agenda for these crops which must be recognized as an important food and introduce the millets as a nutritious food, fulfillment of the nutritional need of global population and to find ways to consume the millets nutritionally, effectively and to reduce the problems of malnutrition and other health problems. This study focused to reducing some anti-nutrients which diminish the acceptability, digestibility and bioavailability of nutrients and improve the nutrients of millets for nourishing the health. Household food processing strategies are used for improving the nutritional quality to promote millet utilization for future prospective.

This study emphasized on nutraceutical properties of millets and the application of millets as alternative cereals potentially healthy to elaborate therapeutic food products like protein and energy rich diet, diet for diabetes, gluten free diet, CVD, etc. This study showed that millet is used as a "food medicine". Millet is a source of antioxidants such as phenolic acids and glycated flavonoids. Millet products are also characterized as potential prebiotics and may increase the viability of probiotics with potential health benefits.

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# BASELINE DATA ON BIRD DIVERSITY IN PRAYAGRAJ AND ADJOINING AREAS OF UTTAR PRADESH, INDIA: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

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**ABSTRACT**

**This paper provides a comprehensive overview of the avian fauna in Prayagraj, Uttar Pradesh, India, drawing on both primary and secondary data sources. A total of 93 bird species were recorded, belonging to 74 genera, 43 families, and 18 orders. Maximum species were from the Columbidae family, and the maximum birds were recorded from the Sam Higginbottom Institute of Agriculture, Technology, and Sciences (SHI). Out of 93 recorded species, 87 fall under the Least Concern (LC) category of IUCN Red List, four are Near Threatened (NT), and one is Vulnerable (VU). Lesser Adjutant *Leptoptilos javanicus* is the only species in the Vulnerable category among the recorded species. Additionally, the authors report that 91 out of 93 species are protected under the Indian Wildlife (Protection) Act of 1972. Specifically, seven species have been placed under Schedule I, which provides the highest degree of protection under the law. This paper highlights the importance of conservation efforts for the avian fauna in Prayagraj and the significance of laws such as the Indian Wildlife (Protection) Act in achieving this goal.**

***Keywords :*** *Avian fauna; prayagraj; wildlife protection; endangered species; indian wildlife protection act*

## INTRODUCTION

Prayagraj (25°27′N 81°51′E), formerly known as Allahabad, is one of the largest cities in India, situated in the northern state of Uttar Pradesh. It is an important cultural, historical, and administrative center of the region. The city is located at the confluence of the Ganga, Yamuna, and Saraswati rivers, which makes it a significant pilgrimage site for Hindus. The confluence point, known as the Sangam, is considered to be one of the holiest places in India.

Prayagraj has a humid subtropical climate, with hot and dry summers from April to June, followed by warm and humid summers from July to September, and winters from December to February. The city experiences dense fog during the winter season, which can disrupt transportation and cause respiratory problems for residents.

The unique location and climate of Prayagraj support a diverse range of bird species, especially water-dependent species. Although the city does not have any designated Important Bird Areas (IBAs), as per Islam and Rahmani (2004), the Sangam and Ganga ghat attract a significant number

of migratory birds during the winter season. According to the "Fauna of Uttar Pradesh" report published in 2015, the state supports over 500 bird species, while Prayagraj is home to over 300 (ebird.org/india) bird species out of the 1253 species found in India (Praveen et. al., 2023).

The Ganga-Jamuna Doab, of which Prayagraj is a part, is a region that lies between the Ganga and Yamuna rivers and is responsible for the city's unique flora and fauna. The doab is a fertile region that supports agriculture, and the city is known for its production of crops like wheat, rice, and sugarcane.

In addition to its natural resources, Prayagraj is also home to a number of historical and cultural landmarks. The city has a rich heritage of literature, art, and music and is famous for the Kumbh Mela, a Hindu festival that attracts millions of pilgrims from around the world. The festival is held every 12 years in Prayagraj, and during this time, the city becomes a hub of spiritual and cultural activity.

**Study Area:**

The current study was carried out in Allahabad and adjoining area during the GSDP training programme. The main focus of the study was to train the GSDP students in identifying birds and preparation of familywise checklist with a parallel aim to document the species diversity of the region. During this study we have covered areas such as Botanical Survey of India campus, Allahabad University, Triveni Sangam, Yamuna Ghat, Allahabad Fort, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Minto Park and Company Garden.

## MATERIALS AND METHODS

Throughout our trip, we walked over 50 kilometers while conducting surveys from morning till evening, occasionally even during mid-day. Some areas were located far away, requiring additional travel time to reach them. We used 8 X 42 and 8 X 50 binoculars to observe birds, and we made an effort to photograph all of the species that we encountered. To ensure maximum area coverage and encounter as many species as possible, we visited a new locality every day.

We used the Focal Animal Sampling method, as described by Altmann (1974), to record bird species. This method involves selecting a particular individual or group of individuals and observing their behavior over a specified period of time. By focusing on a particular bird species, we were able to gather detailed information about their behavior and ecology. Our fieldwork allowed us to observe and document a diverse range of bird species in their natural habitats. Through our efforts, we hope to contribute to a better understanding of the ecology and conservation of these fascinating creatures.

## RESULTS AND DISCUSSION

The paper provides an updated and comprehensive overview of the avian fauna in Prayagraj, drawing on both primary and secondary data sources. The authors relied on the findings of recent field trips to Allahabad, as well as specimens housed in the National Zoological Collections. Distribution records from Birds of India (Majumder et. al., 2022), and ebird data were also incorporated to supplement the authors' findings. Moreover, the authors examined previous records of species found in earlier literature, which were not present in the National Zoological Collections or not encountered during the authors' field visits. This multi-faceted approach allowed the authors to present a thorough and well-rounded view of the various species that inhabit Prayagraj, Uttar Pradesh.

Parveen et. al., (2022) reported that India is home to 1351 naturally occurring bird species under 26 orders, 114 families and 493 genera. According to the "Fauna of Uttar Pradesh" report published in 2015, the state supports over 500 bird species, while Prayagraj is home to over 300 (ebird.org/india) bird species out of the 1253 species found in India (Praveen et. al., 2023). During this survey a total of 93 bird species were recorded belonging to 74 genera, 43 families and 18 orders. Maximum species

were from Columbidae family. Maximum birds were recorded from Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHI) (fig. 1). As per IUCN Threat category, out of 93 recorded species, 87 falls under the Least Concern (LC) category of IUCN Red list, 4 are Near Threatened (NT) and one is Vulnerable (VU). The four Near Threatened species are Black-headed Ibis *Threskiornis melanocephalus,* River Lapwing *Vanellus duvaucelii,* Oriental Darter *Anhinga melanogaster* and Alexandrine Parakeet *Psittacula eupatria*. Lesser Adjutant *Leptoptilos javanicus* is the only species in Vulnerable category among the recorded species. While taking into consideration the status of Indian Wildlife Protection act, 91 out of 93 species are protected under the law

The Indian Wild Life (Protection) Act, 1972 is divided into six schedules, each providing varying degrees of protection to different plant and animal species. Schedule I and Part II of Schedule II offer the highest level of protection, with the most severe penalties prescribed for any infringements of these schedules. Species listed in Schedule III and Schedule IV are also protected, but the penalties for violations are less severe than those for Schedule I and Part II of Schedule II. Schedule V lists animals that are classified as vermin and may be hunted freely. However, the hunting of animals listed under Schedule V is subject to regulation by the authorities, and fines may be imposed for any violations of the rules. In conclusion, the Wild Life (Protection) Act of 1972 is a crucial piece of legislation that has helped to conserve and protect India's natural resources. Its six schedules provide a framework for the protection of a wide range of plant and animal species, and its enforcement ensures that the law is upheld and any violations are punished.

Regarding the Prayagraj, it is noteworthy that a total of 91 species have been reported from this region. Among these species, it has been reported that they are classified under three different schedules of the Indian Wildlife (Protection) Act, 1972. Specifically, 7 species have been placed under Schedule I, which provides the highest degree of protection under the law. These species are considered to be highly endangered and threatened, and any violations of this schedule result in the most severe penalties. Indian Peafowl Pavo cristatus, Lesser Adjutant *Leptoptilos javanicus*, Crested Serpent Eagle *Spilornis cheela*, Western Marsh Harrier *Circus aeruginosus*, Shikra *Accipiter badius*, Small Minivet *Pericrocotus cinnamomeus* and Rufous-fronted Prinia *Prinia buchanani* are Schedule I species that receives highest degree of protection. Aprt from this, 84 are listed under Schedule II of the act which provide relatively less protection than Schedule I. However, these species are still considered to be important and in need of conservation efforts. Any violations of this schedule are punishable by less severe penalties than those for Schedule I.

The findings of this study have important implications for the conservation and management of bird species in Prayagraj, Uttar Pradesh. With 91 species of birds being reported in the region, it is evident that there is a significant diversity of avian fauna in the area. It is encouraging that the vast majority of species recorded are classified under the Least Concern category of the IUCN Red List, indicating that they are not at immediate risk of extinction. However, the presence of four Near Threatened species and one Vulnerable species highlights the need for conservation efforts to protect these species and their habitats. The identification of Schedule I species in the region underscores the importance of stringent conservation measures to prevent further decline in their populations. It is crucial that the government and conservation organizations take proactive steps to protect these species by enforcing the Wildlife (Protection) Act of 1972, implementing habitat restoration programs, and promoting awareness among local communities. The findings of this study provide a basis for the development of targeted conservation strategies to protect the avian fauna of

Prayagraj and ensure their long-term survival.

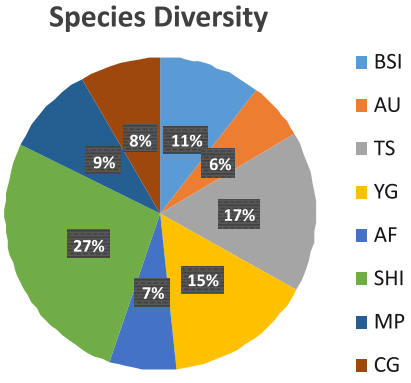


**Fig. - 1 : Pie-chart showing area wise bird sightings.**

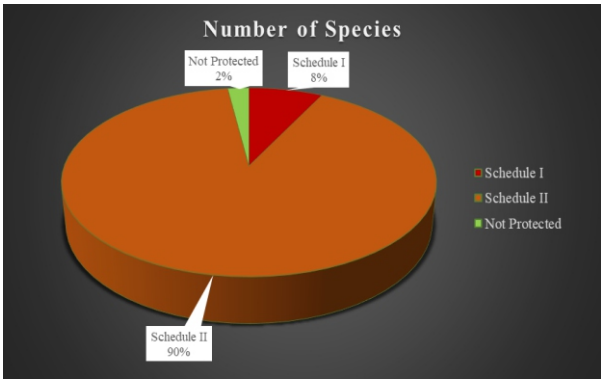


**Fig. - 2 : Pie-chart showing number of species protected under different Schedules of Indian Wildlife Protection Act, 1972.**

**Table - 1 : List of Species observed from Prayagraj, Uttar Pradesh.**

| Sl No | Order | Family | Species | Authority | IUCN Category | WPA Schedule |
|---|---|---|---|---|---|---|
| 1 | Anseriformes | Accipitridae | Ruddy Shelduck *Tadorna ferruginea* | (Pallas, 1764) | Least Concern | Schedule-II |
| 2 | Anseriformes | Accipitridae | Indian Spot-billed Duck *Anas poecilorhyncha* | Forster, JR, 1781 | Least Concern | Schedule-II |
| 3 | Galliformes | Accipitridae | Indian Peafowl *Pavo cristatus* | Linnaeus, 1758 | Least Concern | Schedule-I |
| 4 | Galliformes | Accipitridae | Black Francolin *Francolinus francolinus* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 5 | Galliformes | Accipitridae | Grey Francolin *Ortygornis pondicerianus* | (Gmelin, JF, 1789) | Least Concern | Schedule-II |
| 6 | Columbiformes | Alaudidae | Rock Pigeon *Columba livia* | Gmelin, JF, 1789 | Least Concern | Not protected |
| 7 | Columbiformes | Alcedinidae | Oriental Turtle Dove *Streptopelia orientalis* | (Latham, 1790) | Least Concern | Schedule-II |
| 8 | Columbiformes | Alcedinidae | Eurasian Collared Dove *Streptopelia decaocto* | (Frivaldszky, 1838) | Least Concern | Schedule-II |
| 9 | Columbiformes | Alcedinidae | Spotted Dove *Spilopelia chinensis* | (Scopoli, 1786) | Least Concern | Schedule-II |
| 10 | Columbiformes | Alcedinidae | Asian Emerald Dove *Chalcophaps indica* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 11 | Columbiformes | Anatidae | Yellow-footed Green Pigeon *Treron phoenicopterus* | (Latham, 1790) | Least Concern | Schedule-II |
| 12 | Pterocliformes | Anatidae | Chestnut-bellied Sandgrouse *Pterocles exustus* | Temminck, 1825 | Least Concern | Schedule-II |
| 13 | Cuculiformes | Anhingidae | Greater Coucal *Centropus sinensis* | (Stephens, 1815) | Least Concern | Schedule-II |
| 14 | Cuculiformes | Apodidae | Sirkeer Malkoha *Taccocua leschenaultii* | Lesson, 1830 | Least Concern | Schedule-II |
| 15 | Cuculiformes | Ardeidae | Pied Cuckoo *Clamator jacobinus* | (Boddaert, 1783) | Least Concern | Schedule-II |
| 16 | Cuculiformes | Ardeidae | Asian Koel *Eudynamys scolopaceus* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 17 | Caprimulgiformes | Ardeidae | Large-tailed Nightjar *Caprimulgus macrurus* | Horsfield, 1821 | Least Concern | Schedule-II |
| 18 | Caprimulgiformes | Ardeidae | Indian Nightjar *Caprimulgus asiaticus* | Latham, 1790 | Least Concern | Schedule-II |
| 19 | Caprimulgiformes | Bucerotidae | Asian Palm Swift *Cypsiurus balasiensis* | (Gray, JE, 1829) | Least Concern | Schedule-II |
| 20 | Gruiformes | Campephagidae | Eurasian Coot *Fulica atra* | Linnaeus, 1758 | Least Concern | Schedule-II |
| 21 | Gruiformes | Campephagidae | Grey-headed Swamphen *Porphyrio poliocephalus* | (Latham, 1801) | Not Recognised | Schedule-II |
| 22 | Gruiformes | Campephagidae | White-breasted Waterhen *Amaurornis phoenicurus* | (Pennant, 1769) | Least Concern | Schedule-II |
| 23 | Gruiformes | Caprimulgidae | Ruddy-breasted Crake *Zapornia fusca* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 24 | Charadriiformes | Caprimulgidae | River Lapwing *Vanellus duvaucelii* | (Lesson, 1826) | Near Threatened | Schedule-II |
| 25 | Charadriiformes | Charadriidae | Red-wattled Lapwing *Vanellus indicus* | (Boddaert, 1783) | Least Concern | Schedule-II |
| 26 | Charadriiformes | Charadriidae | Bronze-winged Jacana *Metopidius indicus* | (Latham, 1790) | Least Concern | Schedule-II |
| 27 | Charadriiformes | Ciconiidae | Common Sandpiper *Actitis hypoleucos* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 28 | Ciconiiformes | Ciconiidae | Asian Openbill *Anastomus oscitans* | (Boddaert, 1783) | Least Concern | Schedule-II |
| 29 | Ciconiiformes | Cisticolidae | Lesser Adjutant *Leptoptilos javanicus* | (Horsfield, 1821) | Vulnerable | Schedule-I |
| 30 | Suliformes | Cisticolidae | Oriental Darter *Anhinga melanogaster* | Pennant, 1769 | Near Threatened | Schedule-II |
| 31 | Suliformes | Cisticolidae | Little Cormorant *Microcarbo niger* | (Vieillot, 1817) | Least Concern | Schedule-II |
| 32 | Pelecaniformes | Columbidae | Little Egret *Egretta garzetta* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 33 | Pelecaniformes | Columbidae | Cattle Egret *Bubulcus ibis* | (Linnaeus, 1758) | Least Concern | Schedule-II |

| Sl No | Order | Family | Species | Authority | IUCN Category | WPA Schedule |
|---|---|---|---|---|---|---|
| 34 | Pelecaniformes | Columbidae | Indian Pond Heron *Ardeola grayii* | (Sykes, 1832) | Least Concern | Schedule-II |
| 35 | Pelecaniformes | Columbidae | Black-crowned Night Heron *Nycticorax nycticorax* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 36 | Pelecaniformes | Columbidae | Glossy Ibis *Plegadis falcinellus* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 37 | Pelecaniformes | Columbidae | Black-headed Ibis *Threskiornis melanocephalus* | (Latham, 1790) | Near Threatened | Schedule-II |
| 38 | Accipitriformes | Coraciidae | Black-winged Kite *Elanus caeruleus* | (Desfontaines, 1789) | Least Concern | Schedule-II |
| 39 | Accipitriformes | Corvidae | Crested Serpent Eagle *Spilornis cheela* | (Latham, 1790) | Least Concern | Schedule-I |
| 40 | Accipitriformes | Corvidae | Western Marsh Harrier *Circus aeruginosus* | (Linnaeus, 1758) | Least Concern | Schedule-I |
| 41 | Accipitriformes | Corvidae | Shikra *Accipiter badius* | (Gmelin, JF, 1788) | Least Concern | Schedule-I |
| 42 | Accipitriformes | Cuculidae | Black Kite *Milvus migrans* | (Boddaert, 1783) | Least Concern | Schedule-II |
| 43 | Strigiformes | Cuculidae | Spotted Owlet *Athene brama* | (Temminck, 1821) | Least Concern | Schedule-II |
| 44 | Bucerotiformes | Cuculidae | Indian Grey Hornbill *Ocyceros birostris* | (Scopoli, 1786) | Least Concern | Schedule-II |
| 45 | Coraciiformes | Cuculidae | Common Kingfisher *Alcedo atthis* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 46 | Coraciiformes | Dicruridae | Stork-billed Kingfisher *Pelargopsis capensis* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 47 | Coraciiformes | Dicruridae | White-throated Kingfisher *Halcyon smyrnensis* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 48 | Coraciiformes | Estrildidae | Pied Kingfisher *Ceryle rudis* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 49 | Coraciiformes | Hirundinidae | Green Bee-eater *Merops orientalis* | Latham, 1801 | Least Concern | Schedule-II |
| 50 | Coraciiformes | Jacanidae | Blue-cheeked Bee-eater *Merops persicus* | Pallas, 1773 | Least Concern | Schedule-II |
| 51 | Coraciiformes | Leiothrichidae | Blue-tailed Bee-eater *Merops philippinus* | Linnaeus, 1767 | Least Concern | Schedule-II |
| 52 | Coraciiformes | Megalaimidae | Chestnut-headed Bee-eater *Merops leschenaulti* | Vieillot, 1817 | Least Concern | Schedule-II |
| 53 | Coraciiformes | Meropidae | Indian Roller *Coracias benghalensis* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 54 | Piciformes | Meropidae | Coppersmith Barbet *Psilopogon haemacephalus* | (Müller, PLS, 1776) | Least Concern | Schedule-II |
| 55 | Piciformes | Meropidae | Eurasian Wryneck *Jynx torquilla* | Linnaeus, 1758 | Least Concern | Schedule-II |
| 56 | Piciformes | Meropidae | Brown-capped Pygmy Woodpecker *Yungipicus nanus* | (Vigors, 1832) | Least Concern | Schedule-II |
| 57 | Psittaciformes | Motacillidae | Alexandrine Parakeet *Psittacula eupatria* | (Linnaeus, 1766) | Near Threatened | Schedule-II |
| 58 | Psittaciformes | Motacillidae | Rose-ringed Parakeet *Psittacula krameri* | (Scopoli, 1769) | Least Concern | Schedule-II |
| 59 | Psittaciformes | Motacillidae | Plum-headed Parakeet *Psittacula cyanocephala* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 60 | Passeriformes | Motacillidae | Indian Pitta *Pitta brachyura* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 61 | Passeriformes | Muscicapidae | Small Minivet *Pericrocotus cinnamomeus* | (Linnaeus, 1766) | Least Concern | Schedule-I |
| 62 | Passeriformes | Nectariniidae | Long-tailed Minivet *Pericrocotus ethologus* | Bangs and Phillips, 1914 | Least Concern | Schedule-II |
| 63 | Passeriformes | Oriolidae | Large Cuckooshrike *Coracina macei* | (Lesson, 1831) | Least Concern | Schedule-II |
| 64 | Passeriformes | Oriolidae | Indian Golden Oriole *Oriolus kundoo* | Sykes, 1832 | Least Concern | Schedule-II |
| 65 | Passeriformes | Passeridae | Black-hooded Oriole *Oriolus xanthornus* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 66 | Passeriformes | Phalacrocoracidae | Black Drongo *Dicrurus macrocercus* | Vieillot, 1817 | Least Concern | Schedule-II |
| 67 | Passeriformes | Phasianidae | White-bellied Drongo *Dicrurus caerulescens* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 68 | Passeriformes | Phasianidae | Rufous Treepie *Dendrocitta vagabunda* | (Latham, 1790) | Least Concern | Schedule-II |
| 69 | Passeriformes | Phasianidae | House Crow *Corvus splendens* | Vieillot, 1817 | Least Concern | Not protected |
| 70 | Passeriformes | Picidae | Large-billed Crow *Corvus macrorhynchos* | Wagler, 1827 | Least Concern | Schedule-II |
| 71 | Passeriformes | Picidae | Grey-headed Canary-flycatcher *Culicicapa ceylonensis* | (Swainson, 1820) | Least Concern | Schedule-II |
| 72 | Passeriformes | Pittidae | Ashy-crowned Sparrow Lark *Eremopterix griseus* | (Scopoli, 1786) | Least Concern | Schedule-II |
| 73 | Passeriformes | Ploceidae | Common Tailorbird *Orthotomus sutorius* | (Pennant, 1769) | Least Concern | Schedule-II |
| 74 | Passeriformes | Psittaculidae | Rufous-fronted Prinia *Prinia buchanani* | Blyth, 1844 | Least Concern | Schedule-I |
| 75 | Passeriformes | Psittaculidae | Ashy Prinia *Prinia socialis* | Sykes, 1832 | Least Concern | Schedule-II |
| 76 | Passeriformes | Psittaculidae | Wire-tailed Swallow *Hirundo smithii* | Leach, 1818 | Least Concern | Schedule-II |
| 77 | Passeriformes | Pteroclidae | Red-vented Bulbul *Pycnonotus cafer* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 78 | Passeriformes | Pycnonotidae | Red-whiskered Bulbul *Pycnonotus jocosus* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 79 | Passeriformes | Pycnonotidae | Jungle Babbler *Argya striata* | (Dumont, 1823) | Least Concern | Schedule-II |
| 80 | Passeriformes | Rallidae | Brahminy Starling *Sturnia pagodarum* | (Gmelin, JF, 1789) | Least Concern | Schedule-II |
| 81 | Passeriformes | Rallidae | Chestnut-tailed Starling *Sturnia malabarica* | (Gmelin, JF, 1789) | Least Concern | Schedule-II |
| 82 | Passeriformes | Rallidae | Common Myna *Acridotheres tristis* | (Linnaeus, 1766) | Least Concern | Schedule-II |

| Sl No | Order | Family | Species | Authority | IUCN Category | WPA Schedule |
|---|---|---|---|---|---|---|
| 83 | Passeriformes | Rallidae | Bank Myna *Acridotheres ginginianus* | (Latham, 1790) | Least Concern | Schedule-II |
| 84 | Passeriformes | Scolopacidae | Jungle Myna *Acridotheres fuscus* | (Wagler, 1827) | Least Concern | Schedule-II |
| 85 | Passeriformes | Stenostiridae | Oriental Magpie Robin *Copsychus saularis* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 86 | Passeriformes | Strigidae | Purple Sunbird *Cinnyris asiaticus* | (Latham, 1790) | Least Concern | Schedule-II |
| 87 | Passeriformes | Sturnidae | Baya Weaver *Ploceus philippinus* | (Linnaeus, 1766) | Least Concern | Schedule-II |
| 88 | Passeriformes | Sturnidae | Scaly-breasted Munia *Lonchura punctulata* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 89 | Passeriformes | Sturnidae | House Sparrow *Passer domesticus* | (Linnaeus, 1758) | Least Concern | Schedule-II |
| 90 | Passeriformes | Sturnidae | Grey Wagtail *Motacilla cinerea* | Tunstall, 1771 | Least Concern | Schedule-II |
| 91 | Passeriformes | Sturnidae | Western Yellow Wagtail *Motacilla flava* | Linnaeus, 1758 | Least Concern | Schedule-II |
| 92 | Passeriformes | Threskiornithidae | White Wagtail *Motacilla alba* | Linnaeus, 1758 | Least Concern | Schedule-II |
| 93 | Passeriformes | Threskiornithidae | Paddyfield Pipit *Anthus rufulus* | Vieillot, 1818 | Least Concern | Schedule-II |

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# EXPLORING CONSTRAINTS FACED BY FARMERS IN THE ADOPTION OF MUSHROOM PRODUCTION TECHNOLOGY

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**ABSTRACT**

**The adoption of mushroom production technology in rural areas is crucial for improving the livelihoods of farmers. However, there are several constraints that hinder the adoption of this technology. This study aims to explore the constraints faced by farmers in the adoption of mushroom production technology in District Nalanda, Bihar. The study found that the major constraints faced by mushroom growers were heavy domestic workload, which was reported by 80.80% of the respondents. This was followed by distance problem, as the Krishi Vigyan Kendra (KVK) was far from the village was reported by 75.8% of the respondents, less freedom of movement (69.2%) and little time available to spend away from home (58.3%).**

***Keywords :*** *Explore, freedom of movement, livelihoods, production technology*

## INTRODUCTION

The study was conducted in Nalanda region of Bihar. The KVK of Harnaut Nalanda Bihar was selected for the study. This KVK was operated by Rajendra Agricultural University Pusa, Bihar. In the Impact of training program on knowledge and Adaptation Level for Mushroom, the study was conducted to assess the functioning and effectiveness of selected KVKs in Nalanda Region of Nalanda Bihar. The finding of the study was focused on the KVK in Nalanda Region of Bihar under different system such as Rajendra Agricultural University. It wi highlights the problem as well as the necessary steps required to ameliorate funds which had invested on the Mushroom training programme by the central and state government, but very little systematic and planned attempt had been made to evaluate their effectiveness. For this purpose, training centre had set up all over the country stated earlier, when training programmes of greater magnitude had undertaken, it called for the scientific research with reference to each aspect of the training programme. The evaluation of performance of KVKs regarding training programme and other extension activities was essential to improve the content, quality and methodology. The scheme of KVKs was operating since a long time. The time to assess the performance was made systematically. The study had combined quantitative and qualitative approaches to enable an insight working of KVKs and the reactions of the KVKs functionaries and beneficiaries.

Mushroom production technology has the potential to provide sustainable livelihood opportunities to small farmers in rural areas.

However, the adoption of this technology is often hindered by various constraints. In order to promote the adoption of mushroom production technology, it is important to understand the constraints faced by farmers in its adoption. This study aims to explore the constraints faced by farmers in the adoption of mushroom production technology in District Nalanda, Bihar. District Nalanda is one of the major agricultural districts of Bihar, where mushroom cultivation is gaining popularity as an alternative source of income for small farmers. The Krishi Vigyan Kendra (KVK) and other government agencies have been promoting mushroom production technology in this district through training programs and other extension services. Despite these efforts, the adoption of mushroom production technology is still low among farmers.

## MATERIALS AND METHODS

The selected farmers were interviewed using a structured schedule to collect data on the constraints they faced in the adoption of mushroom production technology. The schedule was developed based on a review of relevant literature and expert opinion. The data collected through the schedule was analyzed using descriptive statistics such as frequency distribution and percentage analysis.

## RESULTS AND DISCUSSION

### Farming Experience:

It is observed from Table 1 that the majority of the respondents i.e. 56.7 per cent were belonged to below 10 years of farming experience followed by 29.2 per cent of the respondents were between 10-25 years of farming experience and 14.2 per cent of the respondents were above 25 years of farming experience.

**Table - 1 : Farming experience wise distribution of respondents.**

| S.N. | Farming Experience | Frequency | Percentage |
|---|---|---|---|
| 1. | Below 10 years | 68 | 56.7 |
| 2. | Between 10-25 years | 35 | 29.2 |
| 3. | Above 25 years | 17 | 14.2 |
| | **Total** | **120** | **100.00** |

Thus, it is concluded that the high level of farming experience of respondents belonged to above 10 years of farming experience. The findings of the present study were in accordance with the findings of Thoke and Gunjal (2010).

### Farm Holding:

It was observed from Table 2 that the majority of the respondents 53.3 per cent were belonged to small farmer group followed by 36.3 per cent of the respondents were belonged to marginal farmer group whereas, 10.0 per cent were belonged to large farmer group.

**Table - 2 : Size of land holding wise distribution of the respondents.**

| S.N. | Farm Holding | Frequency | Percentage |
|---|---|---|---|
| 1. | Small farmer | 64 | 53.3 |
| 2. | Marginal farmer | 44 | 36.3 |
| 3. | Large farmer | 12 | 10.0 |
| | **Total** | **120** | **100.00** |

Thus, it was concluded that the maximum number of respondents were belonged to small farmer group. The findings of the present study were in accordance with the findings of Patil (2008).

### Annual income wise distribution of the respondents

It was cleared from Table 3 that, majority 68.3 per cent of the respondents were in the medium annual income category, 16.7 per cent of the respondents were from high annual income category and 15 per cent of the respondents were from low income category.

**Table - 3 : Annual income wise distribution of the respondents.**

| S.N. | Annual Income | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( Below Rs 40000) | 18 | 15.0 |
| 2. | Medium (Between Rs. 40000-Rs. 80000) | 82 | 68.3 |
| 3. | High (Above Rs 80000) | 20 | 16.7 |
| | **Total** | **120** | **100.00** |

It was inferred from the present study that the majority of respondents had medium annual income category. The findings of the present study were in accordance with the findings of Anchule (2000).

**Social Participation:**

The data presented in Table 4 revealed that majority of the respondents of 65.8 per cent belonged to medium social participation category followed by 20.8 per cent of the respondents belonged to low social participation category and 13.3 per cent of the respondents were under high social participation category.

**Table - 4 : Distribution of respondents according to their social participation**

| S.N. | Social Participation | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( below 6) | 25 | 20.8 |
| 2. | Medium ( Between 6-9) | 79 | 65.8 |
| 3. | High ( Above 9) | 16 | 13.3 |
| | **Total** | **120** | **100.00** |

Thus, it was concluded that the maximum respondents were belonging to medium social participation category. The findings of the present study were in accordance with the findings of Biswas *et al.* (2008).

**Participation in Extension activities:**

The data presented in Table 5 revealed that majority of the respondents of 62.5 per cent belonged to medium category followed by 21.7 per cent of the respondents belonged to high category and 15.8 per cent of the respondents were under low category.

**Table - 5 : Participation in extension activitie wise distribution of the respondents**

| S.N. | Participation in Extension | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( below 6) | 19 | 15.8 |
| 2 | Medium ( Between 6-9) | 75 | 62.5 |
| 3. | High ( Above 9) | 26 | 21.7 |
| | **Total** | **120** | **100.00** |

Thus, it was concluded that the maximum respondents were belonging to medium category. The findings of the present study were in accordance with the findings of Biswas *et al.* (2008).

**Mass Media Participation:**

The data presented in Table 6 revealed that majority of the respondents of 42.5 per cent belonged to medium category followed by 39.2 per cent of the respondents belonged to high category and 18.3 per cent of the respondents were under low category.

**Table - 6 : Distribution of respondents according to their participation in Mass Media**

| S.N. | Mass Media Participation | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( below 6) | 22 | 18.3 |
| 2. | Medium ( Between 6-9) | 51 | 42.5 |
| 3. | High ( Above 9) | 47 | 39.2 |
| | **Total** | **120** | **100.00** |

Thus, it was concluded that the maximum respondents were from medium category. The findings of the present study were in accordance with the findings of Biswas *et al.* (2008).

**Constraints faced by farmers:**

Farmers are expected to spend more time with their family members and have domestic work load. In rural areas farmers have little time to spend away from home. Problem in this study has been operationalized as the difficulties faced by the respondent in attending training programme about mushroom cultivation and adoption of mushroom cultivation .Findings related to this aspect of the study have been presented in table 7.

The Table 7 clarified the problems in attending the training programme. The most significant constraint reported was the heavy domestic workload with 80.8% of farmers citing this as a major issue. Other important constraints included the distance problem, as the KVK (Krishi Vigyan Kendra) was far from the village (75.8%), and the lack of freedom of movement for farmers (69.2%). Additionally, farmers reported that they faced challenges related to their ability to spend time away from home (58.3%), a lack of proper facilities

**Table - 7 : Problems in attending training programmes .**

| S.No | Constraints | Frequency | Percentage |
|---|---|---|---|
| **1.** | Heavy domestic workload. | **97** | **80.8** |
| **2.** | Less freedom of movement to Farmers. | **83** | **69.2** |
| **3.** | Little time available to spend on home. | **70** | **58.3** |
| **4.** | Distance problem (KVK is far away from the village) | **91** | **75.8** |
| **5.** | Lack of monetary incentives. | **53** | **44.2** |
| **6.** | Lack of practical experience on mushroom cultivation | **63** | **52.5** |
| **7.** | Problem in long stay at KVK. | **77** | **64.2** |
| **8.** | Lack of interest among farmers. | **62** | **51.6** |
| **9.** | Can't properly understand the technique of mushroom cultivation. | **58** | **48.3** |
| **11.** | Lack of knowledge about mushroom cultivation. | **54** | **45.0** |
| **12.** | Lack of proper Facilities at KVK. | **64** | **53.3** |
| **13.** | Lack of planned workshop for mushroom cultivation | **58** | **48.3** |
| **14.** | Don't have support of their family. | **32** | **26.6** |

at the KVK (53.3%), and a lack of practical experience with mushroom cultivation (52.5%). Lack of interest among farmers (51.6%) and the lack of planned workshops for mushroom cultivation (48.3%) were also cited as barriers to adoption. Further analysis revealed that a lack of understanding of the techniques involved in mushroom cultivation (48.3%), a lack of knowledge about mushroom cultivation (45.0%), and a lack of monetary incentives (44.2%) were additional constraints. Finally, some farmers reported that they did not receive support from their family (26.6%) in their efforts to adopt mushroom cultivation.

**Suggestions to overcome the constraints faced by mushroom growers in cultivation of mushroom:**

Suggestions confronted by mushroom growers in respect of improving their position for further development may be considered as feedback to overcome the constraints. Suggestions were presented in Table 8.

As per the frequency level of the suggestion expressed by the mushroom growers was; there should proper knowledge about mushroom cultivation (rank 1st) followed by proper marketing of the product (rank 2nd), cooperation with mushroom growers (rank 3rd). Continuous

**Table - 8 : Suggestions expressed by rural women regarding participation in agricultural activities**

| S.No | Suggestion | Frequency | Percentage | Rank |
|---|---|---|---|---|
| **1.** | There should be family support and guidance. | 56 | 46.6 | 7 |
| **2.** | There should be cooperation between family members | 61 | 50.8 | 5 |
| **3.** | Proper knowledge about mushroom cultivation | 80 | 66.6 | 1 |
| **4.** | Proper marketing of the product | 77 | 64.2 | 2 |
| **5.** | Continuous participation in mushroom cultivation training | 62 | 51.6 | 4 |
| **6.** | Proper works training should be given | 56 | 46.6 | 8 |
| **7.** | There should be proper inspiration about mushroom cultivation | 60 | 50.0 | 6 |
| **8.** | Cooperation with mushroom growers | 74 | 61.6 | 3 |

participation in mushroom cultivation training(rank 4rth).,There should be cooperation between family members(rank 5th) ,There should be proper inspiration about mushroom cultivation(rank 6th). ,There should be family support and guidance(rank 7nth) and Proper works training should be given(rank 8rth), Pant, Hemlata and Pandey G., (2011), Pant, Hemlata and Pandey, G., (2011), Pant, Hemlata and Pandey, G., (2011), Pant, Hemlata and Pandey, G. (2014).

## CONCLUSION

In conclusion, the study highlights the various constraints that farmers face in adopting mushroom production technology in Nalanda, Bihar. Heavy domestic workload, less freedom of movement, and little time available to spend away from home were some of the major constraints faced by mushroom growers. The distance problem as KVK was far from the village, lack of monetary incentives, and lack of practical experience on mushroom cultivation were also significant factors. The long stay in KVK, lack of interest among farmers, and inability to understand the technique of mushroom cultivation were found to increase the difficulties in training programs and of mushroom cultivation. Moreover, the lack of knowledge about mushroom cultivation, lack of proper facilities at KVK, lack of planned workshop for mushroom cultivation and no support from family were also found to affect the adoption of mushroom cultivation. It is important to address these constraints and provide farmers with the necessary resources and support to encourage the adoption of mushroom production technology.

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# IMPACT OF DIFFERENT PHOSPHATE SUBSTRATES AND THEIR CONCENTRATION VARIATION OVER PHOSPHATE UPTAKE IN THE CYANOBACTERIUM AULOSIRA FERTILISSIMA

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**ABSTRACT**

**The importance of the research's subject matter "Impact of different Phosphate substrates and their concentration variation over Phosphate uptake in the cyanobacterium Aulosira fertilissima" remains in the fact that all the $N_2$-fixing cyanobacteria demonstrated high potential for phosphate acquisition and its accumulation in the form of poly P granules which in turn may be used for phosphate harvesting from fertiliser effluents and eutrophic aquatic ecosystems. The P-uptake behaviour pattern was examined and observed in the test organism in the presence of several P (Inorganic-$K_2HPO_4$, $Na_2HPO_4$, and Organic-pNPP) substrates at 30 to 150 minutes of incubation. The data shows that the rate of P uptake is nearly 3.7 times higher in inorganic P (rate of K uptake is 265% more than Na which is 203%) when compared to organic P, even though the latter can serve as an alternative source of P in the absence of inorganic P. However, in both (inorganic & organic) cases within 30 minutes nearly 50 to 70% of substrate has been taken. Under varied $K_2HPO_4$ supplementation concentrations (1, 5, and 10 mg $l^{-1}$) in BG-11 growth media, the ability of test organisms to uptake phosphorus was also characterised. Incubation begins with a highly rapid rate of absorption, with 35, 43, and 70% of external P entering cells after 30 minutes, but only 1, 5, and 10% doing so within the following 30 minutes.The work's significance still rests on the fact that P is one of the fundamental constraints on cyanobacterial dominance in natural ecosystems. Throughout the course of the experiment, it became abundantly evident that P has a significant influence on the metabolism of the test organism (*Aulosira fertilissima*). This organism has been discovered to be a powerful biofertilizer with effective P metabolic processes and the capacity to alter its surrounding ecology.**

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**Keywords :** *Aulosira fertilissima, cyanobacteria, various p-substrates, paddy-fields, p-uptake.*

## INTRODUCTION

Phosphate is essential for development and metabolic activity in all types of life, including cyanobacteria, and is engaged in a number of geochemical processes that are critical in mats. Phosphorus typically only makes up 0.6% of the dry mass of cyanobacteria cells, however they can occasionally store phosphate as polyphosphate (Stal, 2000).

Orthophosphate ($H_3PO_4$), the most prevalent form of inorganic phosphorus, is absorbed by cyanobacteria. Elemental concentrations of $Ca^{2+}$,

$Mg^{2+}$, $Fe^{2+}$, $Fe^{3+}$, and $Al^{3+}$ affect how soluble orthophosphate is. Orthophosphate solubility in seawater is primarily regulated by $Ca^{2+}$, which at an appropriate pH (7.4–8.1) generates the very insoluble hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$; solubility product (1.53X110–112) (Ehrlich, 1996). Additionally, phosphate can also form an insoluble precipitate with the ferric ion ($FePO_4.2H_2O$) strengite; solubility product 1.35X10-18 (Stal, 2000).

Microbial activity may allow phosphate to be released from these insoluble minerals. In a distinct genomic island, numerous genes were shown to frequently be present in low-P sites while absent in high-P areas (Martiny et al. 2009). In conclusion, this research shows that Prochlorococcus' genome and oceanic environmental circumstances are related.

Two diazotrophic cyanobacteria, *Westiellopsis prolifica* and *Anabaena variabilis*, were tested for their capacity to solubilize Mussorie rock phosphate (MRP) and extracellularly insoluble tricalcium phosphate (TCP). The two strains responded differently to the phosphorus employed in the insoluble forms. According to Yandigeri et al. (2011), TCP (20 mg $P\ l^{-1}$) was the greatest source of insoluble P as opposed to MRP or $K_2HPO_4$ and A. variabilis, one of the two cyanobacteria, performed best in terms of P-solublization and nitrogen fixation.

In phosphorus-limited settings, cellular phosphorous concentrations decrease when the growth rate is reduced, but the potential for phosphorus intake increases. Due to the substantial formation of polyphosphate reserves caused by a pulse of phosphorus delivered to cells with low phosphorus levels (the polyphosphate "overplus" phenomenon), cellular phosphorus levels can exceed those that occur under steady state maximum growth rates (Allen, 1984; Riegman & Mur, 1984). While using a variety of organic phosphates as a substrate, *Calothrix brevissima* and its thermo-tolerant mutant's phosphomonoesterase activity showed a slight fluctuation in temperature and pH optima, indicating the reliance of temperature and pH optima on the substrate. However, cyanobacterial strains cultivated at their respective temperature and pH maxima differentiated spores less frequently along with early spore commencement. Even though it wasn't apparent until 30°C, the growth of the thermo-tolerant strain (tr) isolated throughout the experiment peaked at 50°C. A sort of thermo-tolerant strain that has been isolated has a lot of potential for use as a biofertilizer in rice farming, particularly in tropical regions (Pandey & Tiwari, 2004).

The uptake rates of phosphate and ATP were less tightly connected in heterotrophic bacteria and *Prochlorococcus* than in *Synechococcus*, and phosphate seemed to be preferred over ATP in all three groups. In comparison to other microbial groupings, *Synechococcus* absorbed both substances at substantially higher rates. In the Sargasso Sea, cyanobacteria compete successfully with other organisms for phosphate and ATP (Michelou et al. 2011).

In order to grow more when they reach the surface, filamentous cyanobacteria can obtain phosphate in deeper strata. They did exist there, albeit in very small numbers. Only 0.3–10% of the biomass in the surface layer at 30 m deep was made up of cyanobacteria. Therefore, compared to other sources, this contribution to bloom development could not be as significant (Nausch et al. 2011).

In microbial cells, inorganic polyphosphate (polyP) plays a significant role in increasing cell resistance to unfavorable environmental conditions and in regulating different biochemical processes. polyP is a polyfunctional compound. The most important of its functions are the following: phosphate and energy reservation, cat-ion sequestration and storage, membrane channel formation, participation in phosphate transport, involvement in cell envelope formation and function, gene activity control, regulation of enzyme activities, and a vital role in stress response

and stationary-phase adaptation. The functions of polyP have changed greatly during the evolution of living organisms. In prokaryotes, the most important functions are as an energy source and a phosphate reserve. In eukaryotic microorganisms, the regulatory functions predominate. Therefore, a great difference is observed between prokaryotes and eukaryotes in their polyP-metabolizing enzymes (Kulaev & Kulakovskay, 2000).

Phosphorus potentially limits the growth and productivity of the unicellular cyanobacterium Synechococcus in many oligotrophic oceans. Both dissolved inorganic phosphorus (DIP) and dissolved organic phosphorus (DOP) could be important P sources in these regimes (Fu et.al.,2006).

Phosphorus availability is one of the key factors implicated in controlling cyanobacterial growth (Armstrong, 1999).Phosphorous (P) starved cells of the cyanobacterium *Anabaena oryzae* showed higher phosphate uptake rates than P-sufficient cells. The P-uptake obeyed saturation kinetics. The Km value for Pdeficient cells was lower (54.34 μM) than P-sufficient cells (82.64 μM) while Vmax was higher in Pdeficient and lower in P-sufficient cells (Singh et.al.2007).

In the Baltic Sea, surplus phosphorus after the spring bloom or phosphorus intake from deeper levels, such as by upwelling, are nutritional sources for the growth of filamentous cyanobacteria (Nausch et al. 2011).

In Prochlorococcus uptake of PO4 depends on the high-affinity P uptake system composed of a periplasmic-binding protein, PstS, and associated membrane-bound ABC transporter, PstCAB (Scanlan et al., 2009). Expression of these four genes is coordinately regulated (Martiny et al., 2006). When Pi is depleted, cells attempt to scavenge P from organic sources by upregulating phoA to produce alkaline phosphatase (APase), which can cleave P from organic compounds such as b-glycerophosphate or glucose-6- phosphate (Krumhardt et al., 2013).

Cyanobacterial blooms are generally explained by nutrient uptake kinetic constants that may confer competitive capabilities, like high nutrient-uptake rate, affinity, and storage capacity. However, cyanobacteria are capable of flexible physiological responses to environmental nutrient fluctuations through adaptation of their phosphate uptake properties. Growth optimization is possible if the physiological reaction time of cyanobacteria (tR) matches the duration of nutrient availability (Aubriot & Bonilla, 2012).

*Synechocystis* cells can survive under Pi-limiting conditions following initial growth in BG-11 medium. The uptake of Pi in *Synechocystis* 6803 is accomplished mainly by Pst1 despite its lower affinity for Pi than that of Pst2. The expression of Pst2 might be useful when cells encounter low Pi environments. Pi uptake is stimulated by alkaline pH as well as by ionic solute such as NaCl whereas it is inhibited by non-ionic solute (sorbitol) generating osmotic stress (Burut-Archanai et.al., 2011).

All living things require phosphorus, a vital mineral nutrient, for a variety of processes, including the production of DNA, RNA, and nucleotides like ATP, as well as the functional control of proteins through phosphorylation. Although it is typically present in natural surroundings at nanomolar levels, inorganic phosphate (Pi), the only form of phosphorus that can be utilised directly by organisms, is frequently limited (Hudson et al., 2000).

The fact that there were no significant differences in Pi uptake at pH 7 and 10 suggested that the Pi uptake system in *Synechocystis* 6803 can recognize both $H_2PO_4^-$ and $HPO_4^{2-}$. The ability of *Synechocystis* 6803 to bind two different Pi species is advantageous to its survival especially under fluctuating external pH and low Pi availability (Lindsay, 1979).

The increased Pi uptake activity by NaCl is ascribed to an ionic rather than an osmotic effect since an osmotic stress of the same strength achieved with a non-ionic sorbitol caused a reduction in Pi uptake. It is possible that the presence of $Na^+$ might facilitate

the uptake of Pi, as in *E. coli* where it is transported as neutral metal phosphate (van Veen et.al.,1994). The driving force for the uptake of Pi in Synechocystis 6803 is likely to be ATP generated by ion gradient or ion gradient itself. Indeed, the effect of the inhibitors tested on this uptake support this hypothesis. The fact that Pi uptake is Na+-stimulated and that the uptake is favorable at alkaline pH can support this contention (van Veen et.al.,1994).

Florida Bay, a shallow, seagrass-dominated bay in southern Florida, USA, absorbs a lot of nutrients and has recently seen microalgal blooms and seagrass losses. Although the effects of organic nutrients, specifically dissolved organic nitrogen (DON) and organic phosphorus (DOP), on microbial processes in the bay are unknown, inorganic nutrient inputs have been widely studied. There are significant management repercussions from the discovery that DON and DOP may contribute differently to the growth of cyanobacteria and other microorganisms in Florida Bay (Glibert, 2004).

## MATERIALS AND METHODS

The diazotrophic heterocystous cyanobacterium *Aulosira fertilissima* Ghose was used as experimental materials and it was obtained from paddy fields in epiphytic form.. The present study was conducted in rice-grown areas associated with Lucknow zone which phytographically belongs to Indo-Gangetic Plain. The strain was raised in cultures using standard microbiological culture techniques (Norris & Ribbons, 1968). The culture media, modified Chu-10 (Safferman & Morris, 1964) and BG-11 (Rippka et.al. 1979) were used for routine transfer and maintenance of cyanobacterial cultures. The pH of the medium was adjusted to 7.6 by HEPES (0.2 M) buffer.

Assay of Phosphate Uptake:

The P-acquisition in the $N_2$-fixing strains was determined on the basis of depletion of phosphate from the medium. The exponential phase culture cells were harvested through centrifugation (10000 x g: 10 min.) washed with sterilized diluted culture (BG-11) medium and homogenized with glass beads. The cyanobacteria cells in the form of homogeneous suspension were inoculated in P-deficient BG-11 medium with 1, 5, and 10 mg P l-1 substrate ($K_2HPO_4$) concentrations. The level of phosphate in the medium was determined at 30 min to 150 min. of incubation. The rate of P-acquisition per unit of protein cell biomass was determined in the medium. The P-uptake in other P substrates like $Na_2HPO_4$ and pNPP was detected at 10 mg P $l^{-1}$ concentration in a similar experiment described as above.

Cells grown in BG-11 medium for 3 days were washed twice by centrifugation and resuspension in Pi-limiting BG-11 medium. The washed cells were subsequently grown in either BG-11 or Pi-limiting BG-11 medium for 24 h before being washed twice by centrifugation and resuspension in Pi-free buffer to an optical density at 730 nm of 0.3. The uptake experiment was initiated by the addition of $K_2HPO_4$ solution at room temperature. At different time intervals, aliquots were withdrawn, filtered through a 0.45 μm membrane filter and the remaining Pi in the filtrate was determined by the colorimetric method (Katewa & Katyare, 2003). The statistical analysis of the data were performed using analysis of variance (ANOVA) as described by Underwood (1997).

## RESULTS AND DISCUSSTION

The *Aulosira fertilissima* is a dominant cyanobacteria of rice field appeared throughout the crop season where it can be used as a potent biofertilizer. The A. fertilissima was incubated under different growth conditions in terms of P supplementation in separate experimental set up.

Influence of different P-Substrates& their variable levels (concentration) over Phosphate uptake:

Cyanobacteria are frequently prominent members of undesirable blooms in natural waters, in which phosphate availability is a common limiting factor. The phosphorus contents of acid soluble pools, lipid, ribonucleic acid, and insoluble polyphosphate were

lowered in organisms in proportion to the reduction in growth rate under phosphate-limited but not in nitrate-limited continuous culture. Phosphorus in these cell fractions was lost proportionately during progressive phosphate starvation of batch cultures.

In the previous experiments, a differential response of diazotrophic cyanobacterial strain *Aulosira fertilissima* in terms of growth was observed in relation to the different P and N- sources. The growth in the presence of phosphate depends upon the cyanobacterial capacity to utilize the phosphate. The utilization occurs in a two-step process, uptake of the nutrient and its further metabolism. The potential of *A. fertilissima* to take up phosphorus by phosphate starved cells under different P substrates was investigated during present course of work.

**A. Phosphate uptake behavior under different P-substrates:**

It is widely accepted that phosphorus is the main nutrient that controls the development of natural populations of cyanobacteria since, depending on its concentration; it can act as a growth limiting factor or, on the other hand, promote blooms in which $N_2$ fixing cyanobacteria prevent the population from becoming N- deficient.

Orthophosphate is believed to be the form of phosphorus commonly taken up by autotrophs. Under normal phosphate supply, its uptake by cyanobacteria is an apparent hyperbolic function of the external phosphate concentration but generally phosphate uptake is modified under conditions of P deficiency. Although the cyanobacteria potential to use organic sources of P cannot be generalized, the utilization of phosphate monoesters has been shown on different occasions. The ability is due to the fact that the cyanobacteria contain extracellular phosphatases that release the orthophosphate. Cell-bound alkaline phosphatases are typical of phytoplankton and seem to respond to P-deficiency since they are adaptative enzymes depending on phosphate concentration.

Keeping in view of the above the P-uptake was investigated in test organisms in presence of different P-substrates ($K_2HPO_4$, $Na_2HPO_4$, and pNPP) and the result has been presented in the Figure 1. Cyanobacterial strains starved for phosphate for 72 h were harvested, washed and incubated in different P-substrates supplemented BG-11 growth medium and P-uptake was determined at 30 min to 150 min of incubation.

It is quite evident from the findings obtained (Fig. 1) that inorganic P is an essential requirement of an organism in comparison to organic P, however the latter can serve as a provisional source in absence of available orthophosphate. P uptake rate is nearly 3.7 times higher in inorganic P (K is preferred 265% more over Na 203% as nutrient) when compared to organic P; however in both cases within 30 minutes nearly 50 to 70 % of substrate has been taken by the organism.

**B. Substrate concentration dependent Phosphate uptake pattern:**

Keeping in view of the above the P-uptake was further investigated and characterized by taking $K_2HPO_4$ as substrate and varying its concentration in test organism and the result has been presented in the Figure 2. Cyanobacterial strains starved for phosphate for 72 h were harvested, washed and incubated in different concentration supplemented BG-11 growth medium.

P-uptake was determined at 30 min to 150 min of incubation under 1, 5 and 10 mg $l^{-1}$ and the result reveals that the P-uptake phenomenon determined in test organism is a concentration dependent mechanism. The rate of uptake is very fast within 30 minutes and 35, 43, and 70% of external P (1mg, 5mg, and 10mg P $l^{-1}$, respectively) has been transported intracellular, however this rate gradually slowed down.

Cyanobacterial blooms caused by eutrophication in Lake Taihu have led to ecological threats to freshwater ecosystems (Peng et. al., 2020). A pilot scale experiment was implemented to investigate the relationship between cyanobacteria and other aquatic plants and animals in simulated eutrophic ecosystems under different phosphorus

(P) regimes. The results of this study showed that cyanobacteria had two characteristics favorable for bloom formation in eutrophic ecosystems. One is the nutrient absorption. The presence of alkaline phosphatase was beneficial for algal cells in nutrition absorption under low P concentration. The other is the release of microcystin.

Many photosynthetic microorganisms, including cyanobacteria, evolved in nutrient-poor environments or environments with varying nutrient concentrations. As a result, they acquired a broad array of acclimations to scarce and/or fluctuating nutrient availability, including the capability for luxury uptake. Although this phenomenon has been known for quite a long time (Ketchum, 1939), many aspects of LPU remain largely unknown to date.

Phosphorus (P) is an important nutrient central to storing and the exchange of energy and information in the cell (Dyhrman, 2016). At the same time, the availability of P in many habitats dwelled by cyanobacteria is scarce and/or fluctuating. Cyanobacteria developed a broad array of acclimations to cope with P shortage. One of the most widespread is the capability of taking up P in large excess of the current metabolic demand, termed "luxury P uptake" (LPU) (Ketchum, 1939). The ability of the P-deprived culture to accumulate excessive amounts of inorganic polyphosphate (PolyP) after refeeding with $P_i$ is known as "hyper-compensation" or "phosphate overplus" (Kulaev, 2004).

To cope with fluctuating phosphorus (P) availability, cyanobacteria developed diverse acclimations, including luxury P uptake (LPU)—taking up P in excess of the current metabolic demand (Solovchenko et. al., 2020). LPU is underexplored, despite its importance for nutrient-driven rearrangements in aquatic ecosystems. Solovchenko et. al. (2020) studied the LPU after the refeeding of P-deprived cyanobacterium *Nostoc* sp. PCC 7118 with inorganic phosphate ($P_i$), including the kinetics of $P_i$ uptake, turnover of polyphosphate, cell ultrastructure, and gene expression. The P-deprived cells deployed acclimations to P shortage (reduction of photosynthetic apparatus and mobilization of cell P reserves). The P-starved cells capable of LPU exhibited a biphasic kinetic of the $P_i$ uptake and polyphosphate formation. The first (fast) phase (1–2 h after $P_i$ refeeding) occurred independently of light and temperature. It was accompanied by a transient accumulation of polyphosphate, still upregulated genes encoding high-affinity $P_i$ transporters, and an ATP-dependent polyphosphate kinase. During the

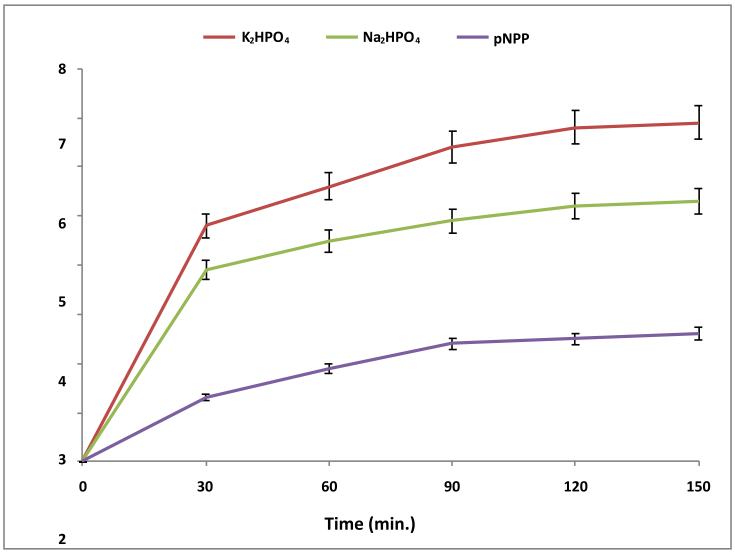


**Figure - 1 : Phosphate uptake behavior of *Aulosira fertilissima* under different P- substrates.**

Anova: Single Factor

SUMMARY

| Groups | Count | Sum | Average | Variance |
|---|---|---|---|---|
| Column 1 | 6 | 12 | 2 | 1.572 |
| Column 2 | 6 | 17.9 | 2.983333333 | 3.045666667 |
| Column 3 | 6 | 30.5 | 5.083333333 | 6.833666667 |

ANOVA

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 29.76777778 | 2 | 14.88388889 | 3.899254817 | 0.0432898 | 3.682320344 |
| Within Groups | 57.25666667 | 15 | 3.817111111 | | | |
| Total | 87.02444444 | 17 | | | | |

- The group comparison test (one way ANOVA) for three different samples i.e., 1mg $Pl^{-1}$ , 5 mg $Pl^{-1}$ and 10 mg $Pl^{-1}$ supplemented growth conditions for *Aulosira fertilissima* cells were performed for determining the possibility of variation among the group sample means is greater than expected by chance or not i.e., the null hypothesis is beingtested.
- The F test is performed by taking the ratios of among MS and withinMS.
- $F_{critical/Expected} = 3.682320344$ and
- $F_{observed} = 3.899254817$ at alpha ($\alpha$) =0.05 and df=2, 15.
- Here, the calculated F-value (3.89) is larger than $F_{critical}$ (3.68) for $\alpha$=0.05.
- Thus, the test is significant at $\alpha$ =5% →Not all mean samples are the same; the substrate concentration acts as an influential factor for cyanobacterial growth and phosphate uptakebehavior.
- Since $F_{observed} > F_{Expected}$ so null hypothesis is rejected.
- It can be concluded that there is significant inequality among the three test samples (i.e., one or more sample is significantly different from the othersamples).

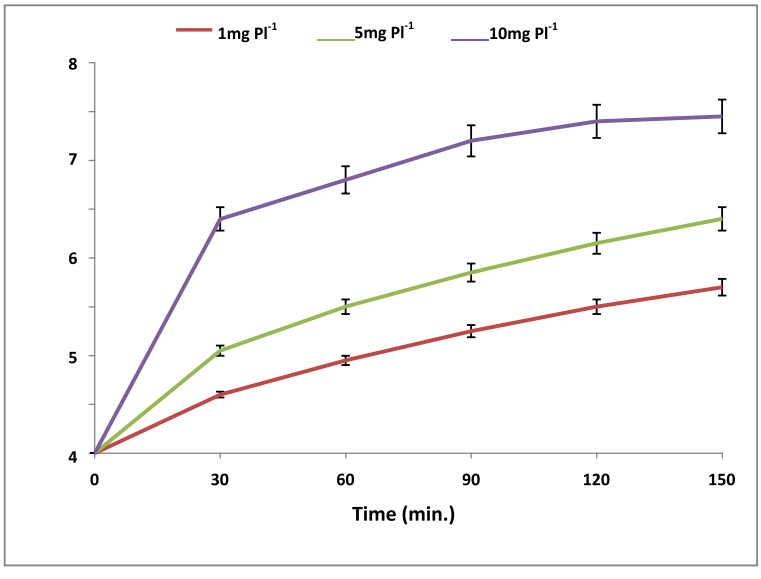


**Figure - 2 : Substrate concentration dependent Phosphate uptake behavior of *Aulosirafertilissima.***

Anova: Single Factor

SUMMARY

| Groups | Count | Sum | Average | Variance |
|---|---|---|---|---|
| Column 1 | 6 | 12 | 2 | 1.572 |
| Column 2 | 6 | 17.9 | 2.983333333 | 3.045666667 |
| Column 3 | 6 | 30.5 | 5.083333333 | 6.833666667 |

ANOVA

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
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- Thus, the test is significant at α =5% →Not all mean samples are the same; the substrate concentration acts as an influential factor for cyanobacterial growth and phosphate uptakebehavior.
- Since $F_{observed} > F_{Expected}$so null hypothesis is rejected.
- It can be concluded that there is significant inequality among the three test samples (i.e., one or more sample is significantly different from the othersamples).

second (slow) phase, recovery from P starvation was accompanied by the downregulation of these genes. The study revealed no specific acclimation to ample P conditions in *Nostoc* sp. PCC 7118.

## CONCLUSION

Agrochemical companies and farmers are interested in cyanobacteria because of their abilities as biostimulants and biofertilizers. Crop production may use cyanobacterial biostimulants and biofertilizers to promote agricultural sustainability. Hence, cyanobacteria are employed in agriculture in different applications, such as amendment, foliar application, and seed priming. These may be used as a substitute for synthetic fertilisers, crop protection agents, and plant growth regulators, or in combination with them to produce a variety of benefits, including improved roots, higher crop yields and quality, and tolerance to salt and drought. This study is aimed at reporting the uptake potential of *Aulosira fertilissima* under different inorganic and organic P-substrates and under different concentrations of inorganic P-substrate ($K_2HPO_4$). Cyanobacteria showed better acquisition potential under inorganic P-substrates in comparison to organic P- substrates. Hence, it can be said that the organic P-substrates would be used as an alternated source of P in the case of inorganic P deficiency.

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# ASSESSING THE CHALLENGES HINDERING FARM WOMEN'S EFFECTIVE USE OF MASS MEDIA FOR EMPOWERMENT AND RURAL DEVELOPMENT

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**ABSTRACT**

**This study aimed to assess the challenges hindering farm women's effective use of mass media for empowerment and rural development. Through a comprehensive analysis of constraints, including lifestyle factors and mass media utilization barriers, a range of challenges were identified. These challenges encompassed farm women's busy schedules with household work, unreliable electricity due to load shedding, poor economic conditions, limited time for utilizing mass media, inadequate educational opportunities, lack of confidence resulting from societal pressures and customs, and insufficient knowledge and communication facilities. The findings highlight the need for concerted efforts to overcome these constraints and promote the empowerment of farm women, as well as induce a positive change in their attitudes toward social issues. Strategies to address these challenges include providing training and educational opportunities, improving infrastructure, promoting confidence and empowerment, tailoring content and delivery, and fostering collaboration and partnerships among various stakeholders. By addressing these constraints and implementing the recommended strategies, it is possible to create an environment that supports farm women in effectively utilizing mass media for their empowerment and rural development. This, in turn, can contribute to significant social transformations and enhance the overall well-being of farm communities.**

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***Keywords :*** *Unreliable electricity, load shedding, empowerment, opportunities .*

## INTRODUCTION

The mass media is the vehicle that carry messages to a large audience. It is very pervasive in modern life but normally people do not even notice its influence. In liberal democracy, the role of the media can be summarised as a medium of information, entertainment and a medium to educate the people. It is widely accepted in liberal democracy that when the media help to put information at the disposition of the people, they will be able to formally or informally control the state. The mass media is essential for democracy. By keeping people on top of current issues, the media enables people to participate intelligently in public policy discussion and decision- making. In a democracy the principal role of the media is to act as a check on the state and fearlessly expose abuses of official authorities. This watchdog role is said to

override in importance all other functions of the media and dictate the form in which the media system should be organized. The media is also the vehicles by which people debate the issues and try to persuade each other is different points of view. Even when it provides us entertainment, the mass media is capable of portraying and shaping values that enrich our dialogue on social issues and public policy (Baishakhi Nag, 2011).

The mass media has long been welcomed as the watchdog of society and this tradition bestows upon them the social responsibility to mirror and guide the process of social change. But in contemporary India, mass media under various pressures has become the commercial channels only and failed to reflect the social problems or aspirations of the entire population, especially the problems faced by women in particular. So, the portrayal of women in Indian media is films, television programmes, visual advertisements or newspaper and magazine is becoming an area of great concern to the people having interest in social research and studies. There is an on-going trend

## MATERIALS AND METHODS

The present study has been carried out in the Jaunpur district of Uttar Pradesh. Out of 75 district in Uttar Pradesh, Jaunpur district was selected purposively. There are 21 blocks in Jaunpur district. Out of which one block namely Sondhi was selected purposively based on the assumption that the Tilak Dhari Post Graduate College, Jaunpur is well connected center for education and transfer of latest agricultural technology. Hence, this block was selected.

The study was conducted in Sondhi block of Jaunpur district (Uttar Pradesh) during 2021-22. Main purpose of the study is to assess the impact of mass media on life style of farm women. From the selected block, five villages were selected for the present investigation through random sampling method. Thus five villages were selected for the study purpose. The selection of these villages is based on the assumption that these were having impact of mass media on lifestyle of farm women. From each selected village 24 respondents were randomly selected. Thus the total sample size constituted to 120 respondents. A structured questionnaire was developed to gather quantitative data on the challenges faced by farm women in utilizing mass media. The questionnaire will include closed-ended questions to measure the frequency and severity of challenges.

## RESULTS AND DISCUSSION

### Social participation:

Social participation of farm women exposes them to various spheres of life as it leads to their empowerment. It is important parameter in social empowerment. The social participation of women respondents had been studied in the present investigation.

It was observed from the table 1 that majority of women respondents 78.3 per cent had occasional social participation, 15.8 per cent women respondents had never and 5.8 per cent women respondents had regular social participation.

**Table - 1 : Distribution of the respondents according to their social participation:**

| S. N. | Category | Frequency | Percentage |
|---|---|---|---|
| **1.** | Regularly | 7 | 5.8 |
| **2.** | Occasionally | 94 | 78.3 |
| **3.** | Never | 19 | 15.8 |
| | **Total** | **120** | **100.0** |

It is concluded that majority of respondents were found in the occasional category of social participation.

The same findings were reported by Lohare (2017). That 78.3 per cent respondents has participated in social organization in occasional category.

### Attitude towards mass media:

It was observed from the table 2 that majority of women respondents 71.7 per cent agreed

with attitude towards mass media, 18.3 per cent women respondents undecided and 10.00 per cent women respondents had strongly agreed with mass media.

**Table - 2 : Distribution of the respondents according to their Attitude towards mass media:**

| S. N. | Category | Frequency | Percentage |
|---|---|---|---|
| **1.** | Strong Agree | 12 | 10.0 |
| **2.** | Agree | 86 | 71.7 |
| **3.** | Undecided | 22 | 18.3 |
| | **Total** | **120** | **100.0** |

These findings were in conformity with the findings of Rambabu *et. al.* (2000). They have reported similar observations where in most of the farm women members were 71.7 per cent agree with attitude towards mass media.

**Availability of mass media:**

It was observed from the table 3 that majority of women respondents (75 per cent) have availed mass media with difficulty. 13.3 per cent easily available to mass media and 11.6 per cent not available to mass media.

**Table - 3 : Distribution of The Respondents according to their availability of mass media:**

| S. N. | Category | Frequency | Percentage |
|---|---|---|---|
| **1.** | Easily available | 16 | 13.3 |
| **2.** | Available with difficulty | 90 | 75.0 |
| **3.** | Not available | 14 | 11.6 |
| | **Total** | **120** | **100.0** |

Due to exposure and viewing to various sources of information women's get influenced to do something new to increase their socio-economic status. From this point of view the media availability has been considered for the present study.

**Challenges hindering farm women's in effective use of mass media for empowerment and rural development**

**Table - 4 : Constraints in effective use of mass media.**

| Constraints | Percentage | Rank |
|---|---|---|
| Too busy in household work | 59.33% | I |
| Improper electricity due to load shedding | 58.00% | II |
| Poor economic condition | 55.33% | III |
| Lack of time for utilizing mass media | 50.67% | IV |
| Inadequate educational opportunities | 42.67% | V |
| Farm women feel inhibited due to lack of confidence, family pressure, and customs etc. | 39.33% | VI |
| Lack of knowledge | 34.67% | VII |
| Poor communication facilities | 30.67% | VIII |

The constraints analysis revealed from table-4 that the life style and mass media utilization constraints i.e., too busy in household work ranked as the highest concern, with a percentage of 59.33%. Improper electricity due to load shedding was the second-highest constraint, with a percentage of 58.00%. Poor economic condition ranked third, with a percentage of 55.33%. Lack of time for utilizing mass media accounted for 50.67% of the constraints. Inadequate educational opportunities were reported by 42.67% of the participants, while farm women feeling inhibited due to lack of confidence, family pressure, and customs accounted for 39.33%. Lack of knowledge and poor communication facilities were constraints reported by 34.67% and 30.67% of farm women, respectively. These data highlight the multifaceted challenges that farm women face in effectively utilizing mass media for their empowerment and rural development. Addressing these constraints it is crucial to enable farm women to overcome barriers and fully leverage the potential of mass media for their benefit. It could be concluded that the analysis of these constraints emphasizes to have concerted efforts to overcome these so as to increase the empowerment of farm women and to change their attitude towards the social issues.

**CONCLUSION**

In conclusion, the assessment of challenges hindering farm women's effective use of mass media for empowerment and rural development revealed that a majority of the respondents had low social participation, while a significant proportion

exhibited a positive attitude towards mass media. Television, radio, and newspapers were readily available, but other print media options were lacking. The analysis highlighted constraints related to lifestyle and mass media utilization, such as busy household work, unreliable electricity, poor economic conditions, lack of time, limited educational opportunities, lack of confidence, family pressure, customs, inadequate knowledge, and poor communication facilities. Overcoming these constraints requires concerted efforts to increase farm women's empowerment and transform their attitudes towards social issues. By addressing these challenges, we can enhance their access to and effective use of mass media, fastering their empowerment and contributing to rural development.

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# IMPACT OF KVK TRAINING PROGRAM ON KNOWLEDGE AND ADOPTION OF MUSHROOM PRODUCTION TECHNOLOGY

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**ABSTRACT**

**This study aimed to assess the impact of KVK (Krishi Vigyan Kendra) training programs on the knowledge and adoption of mushroom production technology among farmers in District Nalanda, Bihar. A total of 120 respondents were surveyed with most of them being young, male, unmarried and belonging to the OBC category. The majority of respondents had a graduate education and were engaged in primary occupations and the most common family type was joint. The study found that most respondents had a medium level of knowledge and adoption of mushroom production technology. However after attending KVK training programs there was a significant improvement in the level of knowledge and adoption of mushroom production technology among the respondents. The study concludes that KVK training programs have a positive impact on farmers' knowledge and adoption of mushroom production technology which can lead to increased productivity and income in the agricultural sector.**

***Keywords :*** *Adoption, productivity, technology .*

## INTRODUCTION

Indian economy is based on the growth of agriculture. After 1964-65 the tremendous production is observed in our country. In present time the production is stagnant in major food crops. There is a need to strengthen extension system which plays a key role in modernising country so that production can be extended. Training is one of the important component of extension system. The directorate of Extension and the Ministry of Agriculture funding to all types of training. The KrishiVigyan Kendra ( KVKs ) are functioning as per the mandates to transfer the latest agriculture technology to the farmers' field through organising short and long-term training courses for farmers, farm-women, rural youth and extension workers, laying down the demonstration in the farmers' field with their participation. Dr. Mohan singh Mehta committee recommended the establishment of a network of KrishiVigyan Kendra ( KVKs ) in the country.

Mushroom growing is one agricultural activity in which farmers can play a vital role without sacrificing their household responsibilities. Krishi Vigyan Kendra, Nalanda is imparting trainings in mushroom cultivation to the farmers,

farm women and rural youth. During 2018-19 to 2020-21, five such vocational training programmes valuate the outcome of these training programmes, a study was conducted to assess the socio - economic profile of the trainee, gain in knowledge and adoption status of the enterprise in mushroom farming among the rural farmers of the Nalanda District were organized regarding mushroom farming in which 120 farmers participated. In order to evaluate the outcome of these training programmes, a study was conducted to assess the socio- economic profile of the trainee, gain in knowledge and adoption status of the enterprise in mushroom farming among the rural farmers of the Nalanda District.

The Oyster mushroom (Pleurotus sp.) belonging to class Basidiomycetes and family Agaricaceae is popularly known as Dhingri in India and grows naturally in the temperate and tropical forests. It also grows on decaying organic matter and produces protein rich food. The best growing season is September/October to March/April. It requires a short growth time in comparison to other edible mushrooms. The economic importance of the mushroom lies primarily in its use a food for human consumption. It is rich in vitamin C and B complex and the protein content varies between 1.6 to 2.5 per cent. Farmers were mainly focused on button mushroom than Dhingri. Mushroom cultivation can directly improve livelihoods through economic, nutritional and medicinal contributions. Mushroom is a popular food due to their special flavour, nutritive value and medicinal properties. Mushrooms are a good source of vitamin B, C and D, including niacin, riboflavin, thiamine, and various minerals including potassium, phosphorus, calcium, magnesium, iron and copper. Mushroom is considered to be a nutritious food, rich in protein, low in fat and carbohydrates. However, mushroom growing can help in a long way in the efficient utilization of agricultural and industrial waste. It can also play a significant role to alleviate poverty and generate employment opportunity for educated unemployed youth. Mushroom farming is increasingly becoming attractive to small farmers because the farmers in rural areas are convinced about the profit of mushroom farming within short time. This can enhance their empowerment to gain other farming skills; greater initial independence and also self-respect. The vocational trainings were given by the Krishi Vigyan Kendra for the farmers, farm-women and unemployed youth to increase the income and make them self- dependent entrepreneur in future. So, the present study was undertaken to find out the knowledge and adoption level of farm women in mushroom cultivation techniques. Mushroom farming is taken up as vocational training programme, as it is considered to provide security to rural poor by providing additional income, thus alleviating the poverty in rural areas and confronting educated unemployment in urban and semi urban areas. It is a subsidiary low cost occupation grown as an indoor crop, by utilizing vertical space and obtaining more productivity per unit area.

Mushrooms are a fleshy fungi having a stem, cap, gills underneath the cap .They can be edible ,wild and toxic too. They provide carbohydrates, but are low in fats and fibers.

## MATERIALS AND METHODS

The research methodology for this study involved selecting a sample of farmers who were involved in mushroom cultivation in Nalanda, Bihar. The population for the study consisted of 470 farmers and an updated list of these farmers was prepared by the researcher with the help of the mushroom cultivation center and the KVK. From the population of 470 farmers, a sample of 120 farmers was selected using a random sampling method. In case some of the sampled farmers were not available or did not agree to participate, a reserve list of 10 farmers was prepared to use as a replacement. The data collection was done from the selected farmers to assess their level of knowledge and adoption of mushroom production technology. The questionnaire was designed to collect

information on demographic characteristics, level of knowledge, and adoption of mushroom production technology, as well as the impact of KVK training programs on their knowledge and adoption. The collected data were analyzed using descriptive statistics, such as frequency, percentage, mean, and standard deviation. The study used statistical software to analyze the data and draw conclusions based on the findings.

## RESULTS AND DISCUSSION

**Age:**

The data of Table 1 show that out of 120 respondents, the majority ( 56.7 per cent ) of them were from young age group, 29.2 per cent belong to middle age group, whereas only 14.2 per cent belonged to old age group.

**Table - 1 : Age wise distribution of the respondents:**

| S.N. | Age ( Years) | Frequency | Percentage |
|---|---|---|---|
| 1. | Young ( below 37) | 68 | 56.7 |
| 2. | Middle ( 37-50 years) | 35 | 29.2 |
| 3. | Old ( above 50) | 17 | 14.2 |
| | **Total** | **120** | **100.00** |

From the above findings, it is concluded that majority of the respondents were from young age group, having experienced ups and downs in the life for a considerable period. The findings of the present study were in accordance with the findings of Kaur and Gill (2001).

**Education:**

The data of Table 2 reveal that out of 120 respondents, the maximum (31.7 per cent) of them were Graduate, 30.00 per cent belonged to Intermediate, 18.3 per cent belonged to Secondary education, 13.3 per cent were Illiterate and 6.7 per cent belonged to Primary education.

**Table - 2 : Education wise distribution of the respondents**

| S. N. | Education | Frequency | Percentage |
|---|---|---|---|
| **1.** | Illiterate | 16 | 13.3 |
| **2.** | Primary | 8 | 6.7 |
| **3.** | Secondary | 22 | 18.3 |
| **4.** | Intermediate | 36 | 30.0 |
| **5.** | Graduate | 38 | 31.7 |
| | **Total** | **120** | **100.00** |

Highest number of the respondents were graduate i.e 31.7 per cent. The findings of the present study were in accordance with the findings of Noor *et al*. (2015).

**Gender :**

The observations with regard to Gender of the respondents are shown in Table 3

**Table - 3 : Gender wise distribution of the respondents**

| S.N. | Gender | Frequency | Percentage |
|---|---|---|---|
| **1.** | Male | 62 | 51.7 |
| **2.** | Female | 58 | 48.3 |
| | **Total** | **120** | **100.00** |

The data presented in Table 3 revealed that out of 120 respondents the majority (51.7 per cent) was Male and 48.3 per cent of the respondents were Female. Therefore, Most of the respondents were Male.

**Marital Status :**

The observations with regard to marital status of the respondents are shown in Table 4 .

**Table - 4 : Marital status wise distribution of the respondents**

| S.N. | Marital status | Frequency | Percentage |
|---|---|---|---|
| **1.** | Married | 46 | 38.3 |
| **2.** | Unmarried | 62 | 51.7 |
| **3.** | Widow | 12 | 10.0 |
| | **Total** | **120** | **100.00** |

The data presented in Table 4 reveal that out of 120 respondents the majority (51.7 per cent) were unmarried , 38.3 per cent of the respondents were married and in widow category there were 10.0 per cent. Since, most of the respondents were Unmarried.

**Caste Category:**

It is the social status or position of the respondents which is acquired by heredity. It was categorized into four categories as per Govt. of India norm. The distribution of the respondents according to their categories has been presented in table 5.

**Table - 5 : Distribution of Respondents According to Their Caste Category**

| S.N. | Category | Frequency | Percentage |
|---|---|---|---|
| **1.** | General | 19 | 15.8 |
| **2.** | Other Backward class (OBC) | 80 | 66.7 |
| **3.** | Schedule Caste (SC) | 21 | 17.5 |
| **4.** | Schedule Tribes(ST) | 0 | 0 |
| | **Total** | **120** | **100.00** |

A glance on the Table 5 revealed that maximum (66.7 per cent) number of respondents belonged to the Other Backward Caste followed by Schedule caste 17.5 per cent and General caste 15.8 per cent. No Schedule Tribe participates in the training. This table reported that maximum respondents had Other Backward Caste category. The findings of the present study were in accordance with the findings of Prakash (2000).

**Nature of Family:**

It was measured based on the information obtained from the respondents whether they are living with more than a pair or with single pair of couples and unmarried children.

This variable was categorized in two categories: joint family and nuclear family.

**Table - 6 : Distribution of Respondents According to Their Family Type**

| S.N. | Nature of Family | Frequency | Percentage |
|---|---|---|---|
| **1.** | Joint | 67 | 55.8 |
| **2.** | Nuclear | 53 | 44.2 |
| | **Total** | **120** | **100.00** |

The data presented in Table 6 reveal that majority (55.8 per cent) of respondents were from joint family followed by 44.2 per cent respondents from nuclear family. Therefore, it may be concluded that still people in Bihar have faith in joint family. The findings of the present study were in accordance with the findings of Singh *et al.* (2016).

This trend is still prevalent in many parts of the country. The findings of the present study were in accordance with the findings of Singh et al. **(2016).**They having also reported that 60 per cent of farmers were from joint family.

**Agricultural Occupation:**

The data presented in Table 7 revealed that 67.5 per cent of the respondents were engaged in agriculture as their main occupation for their livelihood, followed by 26.7 per cent of them were engaged in Secondary occupation, 5.8 per cent of them were engaged in Tertiary occupation.

**Table - 7 : Distribution of Respondents According to their Occupation**

| S.N. | Occupation | Frequency | Percentage |
|---|---|---|---|
| **1.** | Primary | 81 | 67.5 |
| **2.** | Secondary | 32 | 26.7 |
| **3.** | Tertiary | 7 | 5.8 |
| | **Total** | **120** | **100.00** |

**Knowledge Level of the respondents:**

The data presented in Table 8 revealed that majority of the respondents of 63.3 per cent belonged to medium level of knowledge of

mushroom growing followed by 21.7 per cent of the respondents belonged to high level of knowledge and 15 per cent of the respondents were under low level of knowledge.

**Table - 8 : Distribution of respondents according to their Knowledge level**

| S.N. | Knowledge Level | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( below 18) | 18 | 15.0 |
| 2. | Medium ( Between 18-28) | 76 | 63.3 |
| 3. | High ( Above 28) | 26 | 21.7 |
| | **Total** | **120** | **100.00** |

Thus, it was concluded that the maximum respondents were belonging to medium level of knowledge.

**Adoption Level of the respondents:**

The data presented in Table 9 revealed that majority of the respondents of 53.3 per cent belonged to medium level of adoption followed by 24.2 per cent of the respondents who belonged to low level of Adoption and 22.5 per cent of the respondents who were under high level of Adoption.

Thus, it was concluded that the maximum respondents were belonging to medium level of Adoption.

**Table - 9 : Distribution of respondents according to their level of adoption**

| S.N. | Adoption Level | Frequency | Percentage |
|---|---|---|---|
| 1. | Low ( below 18) | 29 | 24.2 |
| 2. | Medium ( Between 18-28) | 64 | 53.3 |
| 3. | High ( Above 28) | 27 | 22.5 |
| | **Total** | **120** | **100.00** |

## CONCLUSION

It was concluded that the majority of farmers involved in mushroom cultivation in District Nalanda, Bihar, were young, male, unmarried, and belonged to the OBC category. Most of them had a graduate education, were engaged in primary occupations and had joint family types. The study found that the majority of respondents had a medium level of knowledge (63.3%) and adoption (53.3%) of mushroom production technology. This indicates that there is a need for increased awareness and training programs to improve farmers' knowledge and adoption of new technologies in mushroom cultivation.

The findings of the study suggest that KVK training programs have a positive impact on improving the knowledge and adoption of mushroom production technology among farmers. Therefore, there is a need for continued and expanded KVK training programs to enhance the productivity and income of farmers in the agricultural sector, Pant, Hemlata (2010-11).

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# EFFECCT OF DIFFERENT VARIABLES ON PHYSICO-CHEMICAL STUDY OF TULSI ENRICHED MANGO (MANGIFERA INDICA L.) ICE-CREAM

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**ABSTRACT**

**An experiment was conducted to improve physico-chemical properties of ofTulsi enriched mango Ice-cream. Ice cream with, 2, to 18 % Mango pulp, 0.5 Tulsi extract was prepared. Mango flavor ice cream (without Mango pulp) was kept as control treatment. Ice cream samples were analyzed for physico-chemical parameter such as overrun, protien, fat, meltdown, moisture, pH. The highest score were awarded to the ice cream with 10% mango pulp, 0.5% tulsi extract and 12% sugar followed by ice cream with 18 mango pulp, 0.5% Tulsi extract and 12% sugar. The ice cream samples without mango pulp were liked least. Overrun, protien, fat, meltdown, moisture, pH was affected significantly at 10% mango pulp, 0.5% Tulsi Extract and 12% sugar.**

***Keywords :*** *Ice cream, mango (mangifera indica), pulp physico-chemical analysis, tulsi extract*

## INTRODUCTION

Ice cream is a frozen dairy product obtained from cow or buffalo milk or a combination thereof from cream and other milk product, with or without addition of cane sugar, egg, fruits juice, preserved fruits, nuts, chocolate, edible flavours and permitted food colours. It may contain added emulsifiers and stabilizers not exceeding 0.5 per cent by weight and should contain minimum of 3.5 per cent protein, 10.00 percent fat, 36.00 percent total solids'. (FSSAI 2017)

Ice cream is a liquid mixture that turns into a paste after simultaneously shaking and cooling although the definition of ice cream varies from country to country due to differing regulations and traditions of composition(Fiol.*et al*, 2016).

Ice cream is a nutritionally enriched frozen dairy product consumed by all groups of age, particularly children, during summer (Sharif *et al.,* 2005). In the ice cream mix that will become ice cream are so many elements of different nature as sugars, fats, dairy, stabilizer, water, among others. And they all have to be correctly blended and emulsified together so there is nothing left behind that may reduce the quality of the final product. Making this possible considering the characteristics and behaviors of each ingredient and the relationships between them is what is known as the balancing exercise. We can make it stable and spreadable at negative temperature from −11 to −18 °C (standard ice cream serving temperatures) (Corvitto, 2011).

Ice-cream is palatable, nutrition, healthful and relatively inexpensive food. One serving good average composition of vanilla ice-cream (1\6 qt) supplies approximately 200 calories, 3.9 g protein, 0.31g calcium, 0.104 g phosphorus , 0.14 g iron, 548 IU vitamin A, 0.038 mg thiamine and 0.236 mg riboflavin. (Arbuckle and Shumaker, 1956)

Indian ice cream industry is one of the fastest growing segments of the dairy or food processing industry. India has a low per capita ice cream consumption of 400 ml as compared with per capital consumption of ice cream of 22 L in the United States and 3 L in China. With the improving cold chain infrastructure in the country coupled with increasing disposable income and the changing lifestyle, the sector has great potential for growth (Anonymous 2018 b).

The ice cream industry in India generated revenue of about USD 1.5 billion in 2016 and is projected to generate revenue of approximately USD 3.4 billion by 2021. Lately, frozen desserts which are made out of vegetable oils have been eating into the market share of ice cream. Key players offering frozen desserts in India are Kwality Walls, Vadilal, and Cream Bell. (Anonymous 2018 b). The annual growth rate of Ice cream is 10-15 per cent. (Singh *et al*, 2003)

Ice cream is highly palatable and nutritious food. One serving of a good Ice cream at average composition (100 g) supplies approximately 200 calories, 4 g protein, 0.13 g calcium, 0.105 g of phosphorous, 0.1 mg iron, 490 IU Vit A, 0.38 mg thiamine and 0.24 mg riboflavin (Bhandari, 2001).

In addition to nutritional importance ice cream can be used as a functional food. The increased awareness of the consumer regarding health and nutrition related issues as well as the role of several food regulator bodies to promote the production and consumption of minimally processed, healthier and more nutritious food products, appear to be steering a transformation within the food industry (Fogliano and Vitaglione, 2005). Dairy products, such as ice creams and yogurts, are considered nutritious foods and present a great potential to incorporate bio- actives (Aboulfazli et al., 2016). Many research support that ice cream is a good source of different essential nutrients. In related to health, ice cream is used as probiotics carrier and also for other disease prevention.

Tulsi or basil (Ocimum sanctum.) has been utilized in Ayurveda, a Hindu form of medicine, for thousands of years for its various medicinal effects. The Charaka Samhita, an ancient Ayurvedic text mentions it. Tulsi or basil is an adaptogen, which means it helps you adapt to stress by harmonizing numerous processes in our body. It is regarded as a kind of "elixir of life" in Ayurveda, with a powerful aroma and astringent taste, and is thought to prolong lifespan. Tulsior basil is pungent and bitter in taste pungent in the post digestive effect and hashot potency. It alleviates kapha and vatadoshas, but slightly aggravates the pitta dosha. It possesses light and dry attributes.

On the contrary the seeds are oily and slimyin attributes and have a cold potency. Tulsi or basil is a stimulant, aromatic herb and effectively reduces the fever. Tulsi or basil also contains antioxidants like beta-carotene that help in preventing cell damage. Tulsi or the holy basil is famous throughout the globe for its healing andother medicinal properties. Its leaves are helpful in sharpening memory and incuring fever and common cold. They also act as an anti-stress agent and also help in purifying blood. This, inturn, helps in reducing the risk of heart attacks and also lowers the cholesterol level. The leaves of the basil are also effective in reducing mouth ulcer and other infections of the mouth. Tulsi belongs to division-Magnoliophyta, genus Ocimum, species-Sanctum, class Magnoliopsida, order Lamiales and family Lamiaceae. In Hindi and Gujarati, tulsi is known as "Tulsi, in Sanskrit language it is known as 'Tulasi' and in Marathi, it is called as "Tulas' while in English, tulsi is known as "Holy basil" or "Sacred basil". (Krishna *et al*., 2014)

Tulsi or basil (Ocimum sanctum L.) family-Lamiaceae is a fragrant plant that has long been used to treat headaches, coughing, diarrhoea, constipation, warts, worms, and kidney issues. It has a long history as a culinary herb, with its leaves lending a distinct flavour to a wide range of recipes. It also contains insecticidal, nematicidal, fungistatic, and antibacterial biologically active components, as well as aroma compounds and essential oils. Extracts of the tulsi or basil are widely used to treat a variety of ailments, including the common cold, inflammation, malaria, heart disease, headaches, stomach problems, kidney stones, cardiac problems, and more. Tulsi, Indian basil, is also useful for air cleaning. The tulsi plant is an excellent repellent for flies Mosquitoes and other insects. Also,extremely useful in the fight against malaria. (David, 2015)

In sweet basil, the fat content and calorific value is low while high amount of minerals and vitamin A are present. In 2.5 g of basil leaves (five fresh leaves), there are 96.6 IU vitamin A, 3.85 mg calcium, less than 1 calorie, 11.55 mg potassium, and smaller proportions of vitamin C and other vitamins, protein, fibre and minerals. The GRAS (generally recognized as safe) list of the US Department of Agriculture includes sweet basil leaf to be used in the range of 2–680 ppm and 0.01–50 ppm for the essential oil. The use of exceedingly large quantities of oil is suggested to have a health risk due to the occurrence of carcinogenic compounds. The GRAS-suggested amount of basil essential oil is very minute, and internal use of a large amount of this oil should be avoided (Hanif*et al*., 2011; Hosseini-Parvar*et al.,* 2015).

Mango (*Mangiferaindica L.)* belongs to family Anacardiaceae, genus Mangifera and species indica. It is one of the important tropical fruits and ranks 5th in total production of major fruit crops in the world, after musa, citrus, grapes and apples (Mukherjee, 1997). It is valued for its excellent flavor, attractive fragrance, delicious taste and nutritional benefits. Therefore, it is referred to as the 'King of fruits', in Asia. More than a thousand varieties of mango are grown in the world. However, sensory properties and biochemical constituents vary depending on the mango variety. India produces about 50% of the total world mango fruit production. It was reported that during the 2012-2013, India produced about 16.2 million metric tonnes of mangoes (NHB, 2013). Mango cultivation in the world was reported to be around 3.7 mn ha (Jahurul*et al.,* 2015) and its cultivation in India was estimated to be approximately 2.46 mn ha, which is the highest among the mango growing countries (Sekhar, 2013). Although the production of mango is initially limited to Asian countries, currently its production has spread to different parts of the world such as South and Central America, Africa, Australia, and some parts of Europe especially Spain (Mukeherjee, 1997).

Mango (MangiferaIndica L.) is one of the favoured fruits in the tropical and subtropical regions. It is often called 'King of Fruits'. Ithas an excellent flavour, attractive fragrance, delicious taste and high nutritional value that have made it one of the best fruits (Pal, 1998). India accounts almost half of the world production.It is receiving increased attention because of its potential antioxidant activity. It is a rich source of Vitamin A and C. It contains on an average 54 μg of Vitamin A and 36.4 mg Vitamin C per 100 g ofedible portion. It also contains minerals like calcium, iron and phosphorous.Carotenoids are compounds of great dietary importance not only as precursors of vitamin A, but also as molecules that take part in cell protection and consumer attraction due to the visual colour they provide to food **(Jadhav*et al.,*** 2009).

## MATERIALS AND METHODS

Raw materials including milk, fresh cream, skim milk powder, sugar, Mango Flavour, and fresh Mango were purchased from local market of Jaunpur Uttar Pradesh.

**Table - 1 : Basic steps involved in the ice-cream manufacture as**

| Sr. No | Process steps | Processing conditions |
|---|---|---|
| 1. | Selection of the ingredients | Raw material processed and packed under set norms should be of acceptable quality and from approved suppliers. |
| 2. | Weighing of the ingredients. | - |
| 3. | Mixing of the ingredients | Sequence of addition depends on type of ingredients used. |
| 4. | Pasteurization of the mix. | By one of three methods: a) B atch or long hold at 68.3°C(155°F)/30 min b) High temperature short time 79.4°C (175°F)/25 s) c) Ultra high temperature at 150°C (300°F) for a fraction of a second. |
| 5. | Homogenization of the mix. | At 70-75°C by two stages. (I stage 2500 psi and II stage 500 psi) |
| 6. | Cooling of the mix | To 4°C (40°F) or below |
| 7. | Ageing of the mix | At 2-4°C/2-24 h |
| 8. | Freezing and aeration | At a high shear / 20 -30 s extrusion temperature -5 to -6°C. |
| 9. | Packaging | In case of low temperature continuous freezer -9°C or below. At t he extrusion temperature or after hardening in the blast tunnel. |
| 10. | Hardening of the ice-cream | At -25 to -30°C |
| 11. | Storage of the ice-cream | At-12.2 to -23°C (10 to -10°F) |

**Source: -** Khanna (2004) suggested the steps for a typical manufacturing process of ice-cream as under Investigation.

Different treatments used in this Investigation

$T_0$ = Ice-cream mix as per standard

$T_1$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 2% Mango pulp

$T_2$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 4% Mango pulp

$T_3$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 6% Mango pulp

$T_4$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 8% Mango pulp

$T_5$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 10% Mango pulp

$T_6$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 12% Mango pulp

$T_7$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 14% Mango pulp

$T_7$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 16% Mango pulp

$T_9$ = Ice-cream mix as per standard + Acceptable level of 0.5% Tulsi extract + 18% Mango pulp

For ice cream preparation, all the ingredients were weighed using weighing balance according to the formulation. All the dry ingredients as well as liquid ingredients were manually mixed thoroughly by stirring until a uniform mixture resulted. The ice cream mix was pasteurized at 72 °C for 30 minutes as described by Marshall and Arbuckl (1996) to destroy pathogenic organisms. After pasteurization, the mix was homogenized in electric homogenizer as described by Berger and White (1976). The fat globules were reduced in size by homogenization in order to obtain a uniform dispersion of the fat. After homogenization, mango pulp, Tulsi extract was incorporated according to treatment.

The mix was cooled down to 4 °C immediately in a deep freezer and stored at 4 °C for ageing. Ageing also increased the viscosity of the mix. After ageing, the mix was frozen at –5 °C in the freezing chamber of electrically operated batch type ice cream machine. When the desired consistency had been attained, the product was filled into disposable paper cups. The cups were immediately transferred to the hardening unit maintained at –250C to –300C and the ice cream were kept for 24 hours. These cups were then transferred to deep freezer at –20 °C.The data obtained in the research on different aspects were tabulated and analysed statically using the methods of One-way analysis of variance (ANOVA).

**Procedure of Methodology-**

Receiving of Milk

↓

Filtration

(10% Fat,12% SNF, 12% Sugar, 0.5% (Stabilizer and Emulsifier), 2-18% mango pulp and 0.5%-Tulsi Extract)

↓

Pre heating (at 60°C)

↓

Homogenization the mix (2500 psi)

↓

Formulation of Ice-cream mix (making of mix)

↓

Pasteurization (63°C for 30 min)

↓

Cooling (5°C)

↓

Addition of Tulsi and mango pulp (as per treatments)

↓

Ageing (overnight at 4 to 5°C)

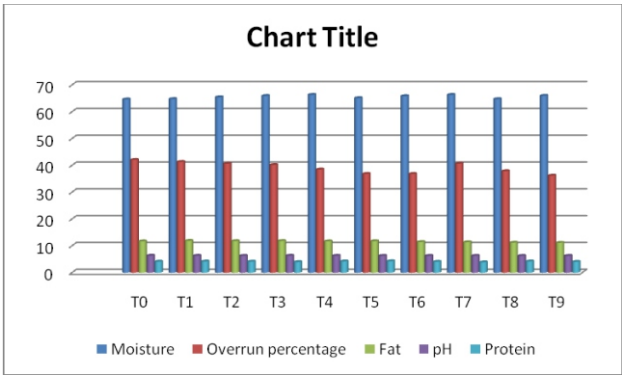
↓

Freezing (-4 to -5°C)

↓

Packaging

Hardening and storage (-23 to -29°C)




## RESULTS AND DISCUSSION

Results of chemical analysis are shown in Table 2. On the basis of physico chemical parameter such as pH, moisture, fat, protein and Overrun percentage the ice cream with 0.5% Tulsi Extract + 10% mango pulp has shown significant as compared to other treatment. Significant decrease in pH and significant increase in acidity is due to presence of ascorbic acid in mangos. The results of this study are supported by the findings of(Akhilesh et al 2018)

**Table - 2 : Physico-chemical properties of mango pulp enriched ice cream**

| Treatment | Moisture | Overrun percentage | Fat | pH | Protein |
|---|---|---|---|---|---|
| **T0** | 64.63 | 42.08 | 11.70 | 6.35 | 4.13 |
| **T1** | 64.78 | 41.32 | 11.88 | 6.32 | 4.18 |
| **T2** | 65.45 | 40.63 | 11.78 | 6.29 | 4.13 |
| **T3** | 65.94 | 40.20 | 11.82 | 6.33 | 3.98 |
| **T4** | 66.33 | 38.49 | 11.70 | 6.31 | 4.23 |
| **T5** | 65.13 | 36.85 | 11.74 | 6.29 | 4.26 |
| **T6** | 65.87 | 36.85 | 11.44 | 6.28 | 4.08 |
| **T7** | 66.35 | 40.65 | 11.37 | 6.30 | 3.90 |
| **T8** | 64.75 | 37.87 | 11.19 | 6.28 | 4.20 |
| **T9** | 65.99 | 36.20 | 11.14 | 6.28 | 4.06 |

Table 2 Shows that the Moisture score was the highest in treatment $T_7$(66.35%) than the lowest score was recorded in treatment $T_0$ (64.63%). The Protein score of prepared Ice cream was highest in treatment $T_5$ (4.26%) and the lowest in treatment $T_3$ (3.98%). The maximum and minimum score for Fat was recorded in treatment $T_1$ (11.88%) the lowest in treatment $T_9$ (11.14%). The pH score was highest in treatment $T_0$ (6.35) and the lowest value recorded in treatment in $T_6$ (6.28),$T_8$ (6.28)and $T_9$ (6.28). The Overrun percentage was highest in treatment $T_1$ (42.08%) and the lowest value recorded in treatment in $T_6$(36.85%) and $T_7$(36.85%). It is clear from table 1 that the score obtained by treatment T1 for sensory parameters as color& appearance, flavor, body & texture, melting properties and overall acceptability was (8.73, 8.37, 8.75, 8.11, 8.41 respectively) highest whereas the score obtained by Control sample (T0) for color& appearance flavor, body & texture,melting properties and overall acceptability was (7.81, 7.66, 7.9, 7.16, 6.69 respectively) very near to the treatment T1. It is revealed from the above result that the difference in the value obtained by treatment T1 was Non - Significant ($p<0.05$) to the value obtained by T0 (Control) treatment.The results of this study are supported by the findings of Gwiszczynska and Kaluziak (1971).

## CONCLUSION

A new variety of ice creams particularly rich in chewy eating sensation and pleasant flavor can be manufactured by utilizing frozen strawberry fruit.

Appearance, taste and mouthfeel characteristics of the ice cream improved upon the addition of the fruit. Further research is recommended to establish theconditions for processing of strawberry fruit in different forms and levels of addition in ice cream without compromising the quality of the product. On the basis of above findings it can be concluded that the superior quality of Tulsiextratenriched Mango Ice Cream can be prepared by addition of 10% of mango pulp, 0.5% tulsi Extract and 10% of sugar as the overall acceptance for treatment combination T1 was highest in all physico-chemical treatment.

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