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INDEX

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CROP RESIDUE MANAGEMENT FOR AGRICULTURAL SUSTAINABILITY

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Crop residues are materials left in an agricultural field after the crop harvested. There are two types of crop residues:

1) Field Residues: Field residues are materials left behind in an agricultural field or orchard after harvesting the crop. These residues include stems and culm, leaves and pods.

2) Process Residues: Processing residues are materials that remain after the harvest has been transformed into a usable resource. These residues include shells, seeds, bagasse, molasses and roots.

As per estimates India produced about 500 Mt of crop residues annually including 93.51 million tons (Mt) of wheat, 105.24 Mt of rice, 22.26 Mt of maize, 16.03 Mt of millets, 341.20 Mt of sugarcane, 7.79 Mt of fiber crops, 18.34 Mt of pulses and 30.94 Mt of oilseed crops.

Crop residues are precursors to soil organic matter. Except for carbon, crop residues contain all the mineral nutrients necessary for the crop, but their content varies among crop depending on soil fertility. To avoid depletion of nutrients and organic carbon in the soil, these residues should be returned to the soil and distributed evenly across the field.

Burning of crop residues leads to release of soot particles and smoke causing human and animal health problems. It also leads to emission of greenhouse gases and chemically and radiatively important trace gases such as methane, carbon monoxide, nitrous oxide, oxides of nitrogen and sulphur and other hydrocarbons to the atmosphere. Many pollutants found in large quantities in biomass smoke are known or suspected carcinogens and could be a major cause of concern leading to various air-borne/lung diseases. Heat from burning residues elevates soil temperature causing death of beneficial soil organisms. It is estimated that burning of one tonne of rice straw accounts for loss of 5.5 kg Nitrogen, 2.3 kg phosphorus, 25 kg potassium and 1.2 kg sulphur besides, organic carbon. Therefore, appropriate management of crop residues assumes a great significance.

Crop residue management is the maintenance of soil cover and the protection of the soil from nutrient loss and erosion. In addition, it helps to improve different physical, chemical and biological processes of the soil. The gravity of the situation demands that an appropriate policy should be evolved to promote multiple uses of crop residues in the context of conservation agriculture and to prevent their on-farm burning. To manage the residues in a productive and profitable manner, conservation agriculture offers a good promise. With the adoption of conservation agriculture-based technologies these residues can be used for improving soil health, increasing crop productivity, reducing pollution and enhancing sustainability and resilience of agriculture. The resource conserving technologies involving no or minimum tillage, direct seeding, bed planting and crop diversification with innovations in residues management are the possible alternatives to the conventional energy and input-intensive agriculture.

Uses of Crop Residues

1) Animal feed: the crop residues are traditionally utilized as animal feed as such or by supplementing with some additives. To meet the nutritional requirements of animals, the residues need processing and enriching with urea and molasses, and supplementing with green fodders (leguminous/non-leguminous) and legume straws.

2) Composting: The crop residues have been traditionally used for preparing compost. For this, crop residues are used as animal bedding and are then heaped in dung pits. In the animal shed each kilogram of straw absorbs about 2-3 kg of urine, which enriches it with N. The residues of rice crop from one hectare land, on composting, give about 3 tons of manure as rich in nutrients as farmyard manure (FYM).

3) Substrate for Mushroom: Wheat and rice straw are excellent substrate for the production of *Agaricus bisporus* (white button mushroom) and *Volvariella volvacea* (straw mushroom).

Technologies for Alternate Crop Residue Management

Growing populations will require increased food production in the future, leading to the possibility of rapid generation of crop residues; At the same time, the dependence of developing countries on the Gulf countries for fuel continues to increase. This huge amount of agricultural waste has real potential to generate various sources of bioenergy through biotransformation, which includes thermochemical and biochemical transformation techniques.

A) Biochemical Transformation

Biochemical transformation process involves some specific yeast and bacteria to transform the residue into useful energy.

1) Alcoholic Fermentation: The residues contain fermentable sugars that can be used for bioethanol production via alcoholic fermentation with the help of yeast or bacteria. Comprehensive steps of distillation are followed to produce the crude alcohol, containing 10–15% of ethanol.

2) Anaerobic Digestion: The method of anaerobic digestion is used in biogas synthesis from residue biomass, involving numerous numbers of microorganisms. The biogas contains mainly methane and CO_2, with 20–40% of the energy of the total biomass and a low heating value. Anaerobic digestion has three phases namely hydrolysis, fermentation, and methanogenesis.

Table. 1. Technologies for sustainable crop residue management and their products

Sr. No.	Techniques	Product
1.	Gasification	Syngas
2.	Liquefaction	Bio-oil
3.	Pyrolysis	Bio-oil, Biochar, Syngas
4.	Combustion	Electricity
5.	Anaerobic digestion	Biogas
6.	Alcoholic fermentation	Bio-ethanol
7.	Photobiological hydrogen production	Bio-hydrogen

Sr. No.	Techniques	Product
8.	Transesterification	Biodiesel
9.	Photosynthetic microbial fuel cell	Electricity

3) Photo-Biological Techniques: Photo-biological techniques are mainly used for H2 gas production from microalgal biomass in anaerobic conditions. This technique very often helps in regulating different biological as well as physiological processes in plants. Moreover, it helps in regulating plant growth and development.

B) Thermochemical Transformation

1) Gasification: This technique comprises heating of the biomass at 500–1400 ◦C with 33 bar atmospheric pressure in anaerobic conditions to produce a mixture of combustible gases. In this process, the carbonaceous residues transform into syngas, including hydrogen, carbon monoxide, carbon dioxide, hydrocarbon, and methane, with the existence of gasification agents. This syngas is utilized as an energy carrier of biofuel, hydrogen gas, and biomethane gas.

2) Liquefaction: The process of liquefaction involves bio-oil production like pyrolysis, but the main difference is that liquefaction requires a low temperature and elevated pressure with the presence of hydrogen. Hydrothermal liquefaction (HTL) utilizes sub-critical water at a temperature of 250–374 ◦C with a 40–220 bar operating pressure to produce the bio-oil from the residue biomass.

3) Pyrolysis: thermal decomposition of biomass that takes place at 350–550◦C in anoxic conditions. Pyrolysis transforms the organic residues into a solid, liquid, and gas mixture. In particular, liquid fuel is generated from pyrolysis, while gasification generates combustible fuel gas.

C) Microbial Fuel Cell (MFC) Technique: In combustion, biomass is mixed with O2 at a high temperature to produce CO2, H2O, and heat. The process involves the conversion of chemical energy into heat, light, and radiation energy. The biomass turns into char and volatiles, which react with O2 and generate heat; thereafter, the heat is used to generate stream, which operates the steam turbine to produce electricity. MFC has great potential to generate high-density power in a green and sustainable way.

Benefits of retention of crop residue on soil:

1) Increases soil organic matter.
2) Moisture conservation.
3) Improving soil physical, chemical properties.
4) Improving soil microbial activity.
5) Improving soil fertility and productivity.
6) Decreases soil degradation.
7) Maintenance of soil temperature.
8) Control of weeds.
9) Pollution control.
10) Carbon sequestration.
11) Reduces emission of Green House Gases.

Retention of Crop Residue on soil

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AZOLLA: A SUPER-PLANT FOR PHYTOREMEDIATION

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Abstract
The water crisis is one of the most pressing resource issues of the 21st century in the world. Increasing population, urbanization and industrialization is one of the leading causes of environmental degradation and pollution. Several remediation technologies have evolved to deal with diverse pollutants. Heavy metals are chief contaminants that exert their effect for a prolonged period as compared to other pollutants like pesticides or petroleum by-products. Heavy metals are highly toxic for all biotic components present in the environment. An efficient solution to deal with this current scenario is phytoremediation that utilizes plants for treatment of pollutants. Azolla has appeared as a biological agent for improving agricultural productivity in flooded soils as well as heavy metal cleanup of the aquatic environment.

Introduction
Earth is unique from other planets of solar system because of its abundant water-in rivers, oceans, in glaciers and as fresh water on land. Water is basis of life on earth, without water, life could not exist. The water crisis is one of the most pressing resource issues of the 21st century in the world. Increasing population, urbanization and industrialization is one of the leading causes of environmental degradation and pollution. Several remediation technologies have evolved to deal with diverse pollutants. Heavy metals are chief contaminants that exert their effect for a prolonged period as compared to other pollutants like pesticides or petroleum by-products. Heavy metals are highly toxic for all biotic components present in the environment. The presence of heavy metals in water can affect the environment, aquatic life, and human health thus detoxification is necessary to ensure natural ecosystem services (Sood et al. 2012). The entry of heavy metals into an aquatic ecosystem has been considered a serious threat to the ecosystem, bio-life and can become part of the food chain. The heavy metals have a high specific gravity (five-fold higher than that of water) and can accumulate at the tissue level of aquatic organisms once enter into the body The hazardous metals include cadmium (Cd), lead (Pb), mercury (Hg), chromium (Cr), and arsenic (As) as they are not reported to have any function in physiological activity); while other metals such like copper (Cu), cobalt (Co), iron (Fe), molybdenum (Mo), manganese (Mn), nickel (Ni) and zinc (Zn) are known as essential plant nutrients (Han, 2022). The major industrial sources include effluents of various industries, e.g. paints, pigments, batteries, ceramic glazes, textile industry, etc. An efficient solution to deal with this current scenario is Phytoremediation that utilizes plants for treatment of pollutants. The use of traditional methods that involve chemicals for the recovery of metals from wastewaters has been criticized as they can produce secondary compounds of toxic nature; this limitation reduces the overall benefits of chemical-intensive techniques.

Phytoremediation
It is a method for removal of pollutants from environment by using plant species. It is more economic or eco-friendly method then other chemical and physical methods of waste water

treatment. The ability of plants to grow in highly nutritive water and to utilize these nutrients rapidly makes them attractive for integrating into waste water treatments. They also have high growth rates and can double their mass in 3-4 days.

Techniques of Phytoremediation

Different Phytoremediation as shown in fig.1 processes have evolved to decontaminate the environmental toxicity (Vamerali et al., 2010).

a) **Phytoextraction:** It is a process in which plant uptakes heavy metals from water and stores in their body. This process is achieved by using hyper accumulating plants that are highly resistant to heavy metals.
b) **Phytostabilization**: It is a process in which plants immobile the pollutants like heavy metals and reduce their phytoavailability in the environment.
c) **Phytovolatilization**: It is a volatization process in which plants translocates the pollutants to aerial parts ands valatizes them in air.
d) **Phytotransformation:** In this process plants modify, inactivate, degrade and immobilize the pollutants through their metabolism.
e) **Rhizofiltration:** In this process hyper accumulating plants adsorb or absorb the pollutants from environment.

Among other bio-organisms used for biosorption in the aquatic environment, water ferns such as *Azolla* species are also capable to produce abundant biomass in a relatively smaller period due to their fast-growing nature (Sood et al. 2012). Azolla an aquatic fern that floats on water surface. There are about eight species of *Azolla* worldwide; *Azolla microphylla*, *Azolla caroliniana, Azolla mexicana*, *Azolla, circinata*, *Azolla japonica*, *Azolla nilotica, Azolla pinnata* and *Azolla rubra*. *Azolla* belongs to genus *Azolla*, division *Pteridophyta*, family *Azollaceae* and order *Salviniales* (Nordiah et al., 2012). *Azolla* has been divided into two subgenera (Euazolla, Rhizosperma) and six species. Azolla species have sporocarp that produce spores for reproduction and glochidia has a barbed hair-like appearance that helps in the anchoring. Azolla hosts symbiotic relationships with blue-green algae like anabaena and is responsible for atmospheric nitrogen fixation. It provides a favorable environment for the normal growth and development of algae. In absence of Azolla, blue-green algae are only capable of 2-3 kg nitrogen fixation per hectare. But when it is in the symbiotic relationship it can fix 200 kg per hectare nitrogen. Under flooded conditions, the aquatic fern inoculums can reduce the pH of water up to 2 units and improved urea efficiency. Thus Azolla inoculation was found to be effective in improving lowland rice production by sequestering atmospheric Nitrogen and soil nutrients. Azolla has appeared as a biological agent for improving agricultural productivity in flooded soils as well as heavy metal cleanup of the aquatic environment.

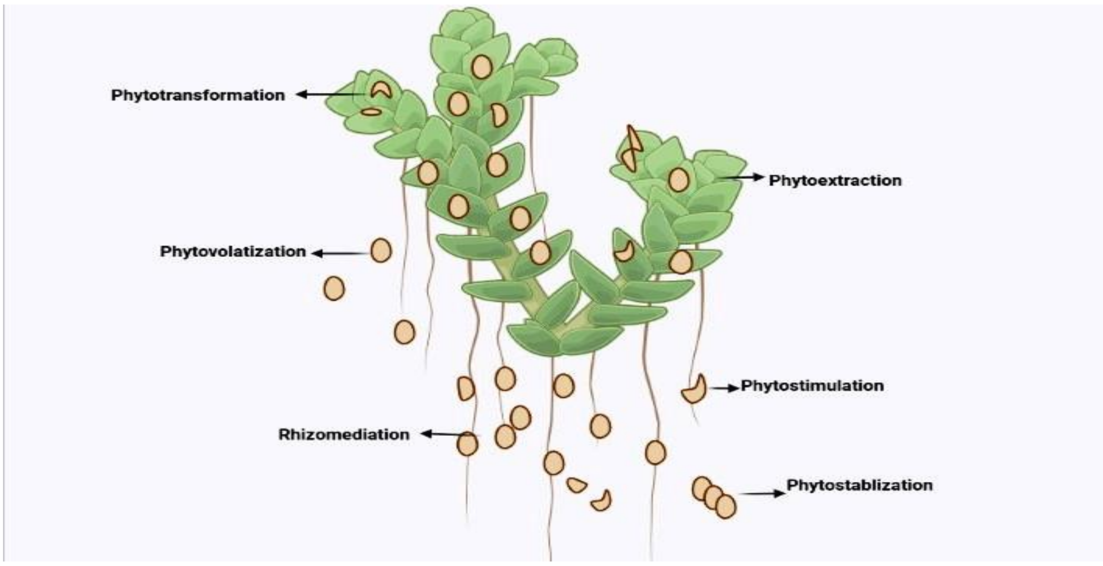

Fig: 1 Shows Different process of Phytoremediation

The *Azolla filiculoides when* growing in metal-laden water can accumulate lead (Pb) up to 1.8% of dry biomass (Valderrama et al. 2013). The Azolla *species* are capable to accumulate as high as 500- to 1000-fold metals as that present in the medium. Among various species, *A. pinnata* possesses a higher accumulation capability to accumulate Cu, Zn, and moderate in terms of Chromium (Cr), Lead (Pb), and Cadmium (Cd). The bio-absorption capability of *A. pinnata* was found in the order of Zn > Cu > Pb > Cr > Cd which can remove a significant portion (65 to 95%) of applied metal elements from wastewater). The synthesis of (PCs) phytochelatins is a mechanism that induces tolerance in plants against heavy metals; the formation of metal-Phyo chelatins complexes may be involved in the tolerance of the living plants (Anandha Varun and Kalpana 2015).

Conclusion

Azolla species are very efficient for uptaking heavy metals and other contaminants from aquatic medium. Azolla inoculums in waste water like sewage waste, Domestic waste, dairy waste and from industries can clean and improve water quality parameter for reuse.

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PREPARATION OF DRIED INDIAN SQUID (*UROTEUTHIS DUVAUCELLI*) AND MAKE READY TO EAT PRODUCTS

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Abstract

Squids are cephalopods which belong to superorder Decapodifomes. The squid is an economically important cephalopod in India contributes nearly 7.3% share of total Indian marine products export. Drying is one of the most common methods for processing and preserving squids. The protein content is higher in dried squid as compared to fresh squid (Remya, 2014). Value addition lays special importance on quality assurance, raise profitability and increases opportunity for earning foreign exchange.

Keywords : Dried squid, Preparation process, Ready to eat products, *Uroteuthis duvauceli,*

Introduction

Squids are cephalopods which belong to superorder Decapodifomes. There are about 80 species recorded from Indian waters but only few are of economically important cephalopods in India.

The squid is an economically important cephalopod in India contributes nearly 7.3% share of total Indian marine products export. The Indian squid (*Uroteuthis duvauceli*) is the dominant species, contributes about 97% catch all over the country, where as other species represents are *Sepioteuthis lessoniana* and *Doryteuthis* sp. (Anusha, 2014). Among total squid landings almost 90% comes from the west coast of India.

Drying involves removal of water content from the Squid body. In Sun drying this process is carried out by exposing target squid directly under the sun. This is usually done in the open air using solar energy to evaporate the water content in the squid. Natural air carried away the evaporated water from squid body. The protein content is higher in dried squid as compared to fresh squid (Remya, 2014). The nutritional benefits and worldwide demand for the squid converted squid fisheries from by-catch to main fishing.

Value addition lays special importance on quality assurance, raise profitability and increases opportunity for earning foreign exchange. So it is important to process squid with value addition.

Procedure

- Fresh squid brought from the fish landing centre.
- It was then washed through fresh water to removed dirt, slime etc.
- After washing Total raw material was weighted.
- removing head, Ink sac and prepare fillet.
- After prepare Fillets, washing material and weighted.
- After weighing fillet was marinated by salt for 24 hours.

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- After salting, fillet were take for the sun drying.
- Collected the dry squid and take a weight and moisture level.
- Then make ready to eat product and Packaging.

Figure:1. Raw Material of squid

Figure :2. Dried Squid

Figure: 3 Ready to eat product of squid

Table :1 Yield and Moisture of the Indian squid. (Moisture massure by moisture meter)

Material of squid	Weight (gm)	Yield(%)	Moisture(%)
Fresh squid	1000 gm	100	81.42
Dried squid	95 gm	9.5	21.55

Conclusion

There is rise in purchasing power of the people, fast life-style, etc. are the main factors responsible for increase in demand for seafood products in India. Squid is among the most widely consumed seafood and a good source of marine protein. Dried squid products possess palatable flavor and are demanded as popular snack foods worldwide. Value addition lays special importance on quality assurance, raise profitability and increases opportunity for earning foreign exchange. So it is important to process squid with value addition.

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HONEY BEES RISK IN ENVIRONMENT AND HOW TO PROTECT THEM

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Cross pollination plays a crucial role in the production of vegetables, fruits and other grains, in which many of the insects including honey bees playing a major role. There are more than 20,000 distinct honey bees species around the world, when they move from one flower to another, pollen grains attach to their legs and are in continuous transport of pollen from one flower to another. Like that the flowers turn into fruits and vegetables. The whole process is declining as the insects population is reducing due to environmental factors. Extreme levels of pollution, indiscriminate urbanization, are having a devastating effect on present food production. Environmental pollution affects not only human health but also food security. The impact will be felt in the short term, but in the long run when there is a shortage of vegetables, fruits, etc., the importance of insects will be realized.

India's scenario

India stood in the 2nd place in the production of fruits and vegetables in the world. At present, scientists are analyzing that the production of fruits and vegetables is gradually declining as the populations of bees and other insects are steadily reducing. Atmospheric pollution is becoming as threat to bees and other insects. Vehicle use is steadily increasing not only in towns and cities but also in rural areas. Scientists came to the conclusion that the effect on pollination would be the reason in reduced production of vegetables and fruits, as in 70% of the crops; cross pollination is done only with insects.

Asian bees, scientifically known as *Apis dorsata,* play a vital role in cross pollination in India. Their hives are also found in large buildings in metropolitan areas. Recent research by scientists has shown that despite the low level of pollution, up to 80% of Asian bees are at risk of extinction. The bees in Bangalore, one of the largest industrial areas in Asia, were collected and examined under a microscope and found to have accumulated on their bodies a number of toxic substances, including arsenic and lead and other dangerous metals. Scientists have found that bees with polluted cells on the body move less than the rest and become weak in approaching the flowers for nectar collection. India is expected to loss of 53 percent of its mango yield and export revenue of about Rs 640 crores if the pollinating insects are decline. According to the findings of Tata Institute of Fundamental Research in Bangalore, bees and other insects' sense of smell deteriorating to the point where they can no longer detect the smell of flowers due to emission of smoke from diesel vehicles.

It is still imperative that the world stays awake and strictly enforces the goals set for the control of pollutant emissions and protects bees. Now-a-days agricultural farm fields have become more and agricultural practices have also changed a lot, focusing on a narrower list of crops and increasing the use of pesticides. Some of the present agricultural practices become the factors which causes to the potentially rapid decline in populations of pollinators, which is likely to impact the production and costs of vitamin-rich crops like fruits and vegetables, leading to increasingly unbalanced diets and health problems, such as malnutrition in the recent times. Many of the honeybee species have distinctive flight patterns and floral preferences, in such a way that their body sizes and behaviors almost perfectly complement the flowers they pollinate. Such honeybee has suffered greatly from colony collapse disorder, in which hives suddenly lose their adult members. In agriculture, the reduction in number of bee species will severely change the human food systems to greater extent. Though many cereal grains are self pollinated or wind-pollinated, fruits and vegetables are much depend on insects like honeybees for pollination. Some fruit crops are rely on honeybees for up to 90 percent of their pollination.

How to protect the honey bees:

1. Ban the most dangerous pesticides in agriculture fields and use proper dosage while spraying.
2. Global warming is believed to be a major obstacle for the survival of insects. Conserve and preserve the wild habitat and encourage the plantations in open areas.
3. Restore ecological agricultural practices which are harmless to the beneficial insects.
4. Develop a bee garden in the house surroundings and in barren lands.
5. Encourage local bee keepers and help them share the knowledge in bee keeping.
6. Set up bee hives in agricultural and horticultural fields having good climatic conditions.
7. Provide water to pollinators by hanging a dripping bottle or placing a small container of water out in the house.
8. To defend bees and other insect pollinators from the extinction to their number, diversity and health, efforts should be made to build a greater diversity of pollinators' habitats in agricultural as well as in urban spaces.
9. Policies in favour of pollinators that promote biological pest control and limit the use of pesticides should be implemented.
10. When cell phones are used they projects electromagnetic waves and it damages bees' ability to return to their colony. So lessen the usage of cell phones.

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FOOD ADDITIVES

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Abstract
With the growing consumption of processed and preserved foods, there is a need to spread awareness among the consumers about different food additives that become an integral part of food after processing. Therefore, in this article a brief update is given about different types of food additives that are commonly used in the food processing.

Introduction
Food additive is defined as substance or mixture of substances that is present or added in a food as a result of any aspect of processing, production, storage, or packing. Food Additives are needed to provide protection against food spoilage during storage, transportation, distribution, or processing. There is the need for the use of food additives to maintain the nutritional quality of food, enhance stability (with reduction in waste), to make food more attractive, and to provide efficient aids in processing, packing and transport. Nowadays, there is a great demand for "instant", "heat and serve", and "ready-to-cook" convenient foods and the "convenience food revolution" would not have been possible without food additives.

<u>Classification of Food Additives</u>
Food additives are classified on the basis of their functional use and are grouped as Food Colours, Preservatives, Antioxidants, Artificial sweeteners, Enzymes, Emulsifiers, Flavours, Stabilizers, Thickening and Gellying agents, Foaming Agents, Humectants, Firming Agent.

i. **<u>Food colouring</u>:** Colourings are added to food to replace colours lost during preparation or to make food look more attractive. Food colours add nothing to the nutritive value of the food. These includes **colours stabilizers, colours fixatives, colour retention**, etc.

ii. **Preservatives:** Preservatives prevent or inhibit spoilage of food due to fungi, bacteria and other microorganisms. These are capable of inhibiting, retarding, or arresting the growth of microorganisms, of any deterioration of food due to microorganisms. **For example: Natural preservatives/ Class I type preservatives:** Salt, Sugar, Spices, Honey

Chemical preservatives / Class II type preservatives:
Sorbic acid, Benzoic acid, Sodium Diacetate etc.

iii. **Antioxidants:** Antioxidants retards oxidation of fats and fat containing substances thereby prolong their wholesomeness, palatability and keeping time. **For example:** Butylated hydroxy-anisole (BHA), Butylated hydroxytoluene (BHT).

iv. **Artificial Sweeteners:** Sweeteners are added to foods for flavouring. Sweeteners other than sugar are added to keep the food energy (calories) low, or because they have beneficial effects regarding diabetes mellitus, tooth decay, or diarrhoea. **For example:** saccharin, sucralose, aspartame, etc.

v. **Emulsifiers:** Emulsifiers are a group of substances used to obtain a stable mixture of liquids that otherwise would not mix or separate quickly. Emulsifiers allow water and oils to remain mixed together in an emulsion, as in mayonnaise, ice cream, and homogenized milk.

vi. **Flavours:** Flavours are additives that give food a particular taste or smell, and may be derived from natural ingredients or created artificially. Flavour enhancers are not flavours but they amplify the flavour of other substances though a synergistic effect.
For example: Aldehydes, esters, ketones (**Natural flavours**)
Amyl acetate, methyl anthranilate (**Synthetic flavours**),
monosodium glutamate (MSG) (**Flavour enhancer**)

vii. **Stabilizers:** Stabilizers, thickeners and gelling agents, like **agar or pectin** (used in jam for example) give foods a firmer texture. While they are not true emulsifiers, they help to stabilize emulsions. They improve texture and inhibit crystallization, stabilize emulsions and foams.

viii. **Antifoaming and foaming agents:** Antifoaming agents reduce or prevent foaming in foods. Foaming agents do the reverse.

ix. **Humectants:** Humectants are moisture retention agents. These prevent foods from drying out. Their function in food includes control of viscosity, reduction of water activity, retention of softness, etc.
For example: glycerol, sorbitol, etc.

x. **Thickeners:** Thickening agents are substances which, when added to the mixture, increase its viscosity without substantially modifying its other properties.
For example: Starch and its derivatives, etc.

xi. **Anticaking agents:** anticaking agents help to prevent particles from adhering to each other and turning into solid chunks during damp weather. Anticaking agents keep powders such as milk powder from caking or sticking.
For example: calcium silicate, etc.

xii. **Bulking agents:** Bulking agents such as starch are additives that increase the bulk of a food without affecting its taste.

xiii. **Fortifying agents:** Vitamins, minerals, and dietary supplements to increase the nutritional value.

Food Additive Safety

1) Only those food additives shall be endorsed and included in the Standard that, so far are presently available from JECFA/ FSSAI/ BIS/ ISO, and present no appreciable health risk to consumers at the use levels proposed.
2) The food additive is to be used in foods eaten by special groups of consumers (e.g., diabetics, those on special medical diets, sick individuals on formulated liquid diets), account shall be taken of the probable daily intake of the food additive by those consumers.
3) The quantity of an additive added to food is at or below the maximum use level and is the lowest level necessary to achieve the intended technical effect. The maximum use level may be based on the application of the procedures of Annex A, the intake assessment of Codex members or upon a request by the CCFA to JECFA for an independent evaluation of national intake assessments.

Conclusion

Food additives play an important role in food processing. On one hand they provide functional and technological uses to the food processors to produce quality products and on the other hand, food additives must be used judiciously keeping the safety limits in mind.

Food Additives and Limits of their Use

FOOD ADDITIVES	TYPE OF FOODS	MAX. PERMISSIBE LEVEL
Antioxidant: BHA	Rasogulla and vadas	Not exceeding 0.02% (of the total fat content)
	Whole and partially skimmed milk powder.	0.01% (of the finished product)
	Margarine	0.02%
Anticaking agent: Calcium Carbonate	Table salt, onion powder, garlic powder, soup powder	20 gm/Kg
Sweetening agent: Saccharin.	Carbonated non-alcoholic drinks	0.01%
Sequestrant: EDTA	Canned carbonated beverages, salad, dressings, margarine and sources	0.003-0.08 %
Colour	Most foods	0.02%
Flavour: Monosodium glutamate	Meat product, soup powder	0.05%
Sulphur dioxide or salts of sulphurous acid (Potassium) metabisulphite)	Squashes, fruit pulp, crushes, jams. syrups, beer, pickles, beverages etc.	49-3000 ppm

FOOD ADDITIVES	TYPE OF FOODS	MAX. PERMISSIBE LEVEL
Propionic acid and its salts	Bread and bakery	5000 ppm
Benzoic acid and its salts (Sodium Benzoate)	Chutneys, syrups, squashes, jams, RTS beverages, pickles	50-600 ppm
Sorbic acid	Beverages, cakes and icings, cheese, cider, dried fruits, margarine salad, dressings, wine,	200-3000 ppm
Nisin	Cheese	12.5 mg/Kg
Nitrites	Meat products	80 mg/Kg
Nitrates	Meat products	500 ppm

Reference

FSSAI Compendium of Food Safety and Standards Regulations, 2011
FSSAI Appendix A- List of food additives
https://www.sfa.gov.sg/tools-and-resources/food-additives-search
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https://www.fssai.gov.in/upload/uploadfiles/files/Compendium_Food_Additives_Regulations_08_09_2020-compressed.pdf
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FUNCTIONAL FEEDS IN AQUACULTURE

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Abstract
For recently, the fastest growing food producing sector in the world is Aquaculture. In aquaculture, the fish/shrimp diets should be our first priority. The total production of fish farm, their feed cost is about 50-60%. We should try to make feed having all the basic nutrients at low cost. The concept of functional feeds represents the fish and crustaceans diets. For the performance-enhancing in aquaculture by using feed additives that are used a new methodology of feeds called functional feeds. Recent studies, functional feed have the option that help full for requirement of growth and health.A great opportunity in the aquaculture industry to develop functional feeds. Many researches are going on about the functional feeds used in aquaculture to enhance the performance of fishes/crustaceans. For these studies, it also shed light regarding to management and production of aquaculture for farmers and producers for their better economic status. Functional feed is the Sustainable solution of aquaculture industry.

What is functional feed

Functional feeds is defined as the specific ingredients that targetsthe specific functions or products, thus bringing solutions to recurrent problems in animal production cycles rather than only focusing on growth.

In the functional feeds, a range of feed additives can be used to extend beyond the satisfying basic nutritional requirements of the target species to improve growth and feed utilization, but also to support the health and stress resistance of the animals. The nature and characteristics of these feed additives is quite diverse, and their application into diet formulations targets a specific purpose. The most common functional feed additives used in aquaculture diets are Probiotics, Prebiotics, Attractant, Antibiotics, Immuno-stimulants, Vitamins and Nucleotides. Insertion of these components in feeds can increase the feed conversion efficiency and growth as well as having positive effect on immune system of fish/shrimps.

Functional feed is used as dietary ingredients that improve growth, promote health of cultured organisms and improve their immune systems and maintained the nutritional value of feed. Functional feed additives to enhance the digestion and metabolic capability of fish/shrimps. Functional feeds are used to enhancing the nutritional strategies in aquaculturefor specific stresses, environmental situation, requirements as per life stages and pathology, thatoptimize the performance and operational efficiency to become helpful to our farmers.

Whenever, formulate feed the dietary nutrient of fish/shrimp should be:

- Nutritional balanced
- Cost effective
- Economical stable
- Environmentally friendly

Functional feed formulated to nutrient demand. However, protein, carbohydrate and lipid are added to formulation of feed for growth and health. If deficiencies occur in fishes/shrimps such as proteinase, carbohydrolase and lipase causes the major problem in digestion and assimilation. In this, use of probiotics has a solution. A *bacillus subtilis* bacterium was used for probiotics development. Functional Feeds promotes the growth and health of the fish/shrimps, improves their immune systems, and induces physiological benefits beyond traditional feeds used for many years. The prevention of health management through functional feeds, fish/shrimps can divert more energy to tissue growth and reduce the biological energy reserved for fight disease.

Why we use functional feed

Like any other animals, fish/shrimp should be subjected to stress. Stress due to environment (like climate and temperature changes), handling, transportation and disease *etc*. To overcome all these problems, the immune system needs support to secure good growth. So as we used functional feed to strengthen the immune system and maintain the growth of fishes. Functional feed containing well defined and strong effects on physiological functions. The use of these feed must be the part of nutritional strategy for sustainability of aquaculture, higher productivity and enhance the resistance to disease.

- Functional feed for quality control.
- Functional feed having high EPA and DHA levels.
- Contains organic acids (example- formic, sorbic, butyric acids)
- Some exogenous enzymes (example- phytase, xylanase)
- Functional feeds for fish meal replacement.
- Functional feed contains immune-stimulants (example- β-glucan, LPS)
- Functional feed contains pigments (example- carotenoids)
- Chemicals used (example- levamisole)

Advantages

- Functional feeds have better digestibility coefficient.
- Functional Feeds have low FCR hence less feed is utilised.
- Functional Feeds Feeding pond contaminated with low disease causing organism because immune system is improved.
- High Protein Efficiency ratio hence feed conversion into fish meat is good.
- BOD Demand is low in this Pond because there is no need to add more quantity to enhance the growth.
- Functional feeds helps in stress mitigation
- Functional feeds are used for replacement of fish meal, bone meal, and plant meal.
- Functional feeds increases the product quality that increased the shelf-life of flesh.
- For reproduction point of view, it helps in fertilization, embryo development, and larval quality.

Disadvantages

- Need Elaborate Machinery
- Input Cost is higher compare to other

Conclusion

Now days, developing the functional feed markets for the feed additives to promote the growth, health and ensure the aquatic product quality and safety. We need to use environmental friendly and economical viable feed additives especially the anti-stress additives. So, functional feed diets give the positive effects of the performance of the animal ingestion by adding some additional compounds to fulfil their basic nutritional requirement. Functional feed have the solutions to recurrent problems in production. There are the potential benefits of functional feed in aquaculture industry. “Functional feed must be regarded as the future of aquaculture”.

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BIOLOGY OF LOCUST

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Introduction

Locusts are the group of many short horned grasshoppers that belongs to the family *Acrididae* of order *orthoptera*. This species multiply in large number under favourable climatic conditions, form swarms and migrate in millions from country to country or from place to place. Locust differ from grasshoppers with respect to the change in behaviour and physiology, in particular their colour and shape in response to changes in density. This insect is known to have two phases i.e., solitary phase and gregarious phase. When locusts are present at low densities, the individuals are solitarious. And they will become abundant in number under certain circumstances, change their behaviour and habit and become gregarious and stay together in dense group. The transition from the solitarious phase to the gregarious and vice versa is called the transient phase, and the locusts are referred to as transiens. The group of locusts are called swarms and wingless young stages are called hoppers. This non-flying nymphal stage or hopper stage form bands. Since the beginning of civilization, locusts and grasshoppers have been among the most devastating threats to agriculture. Locust is considered as international pest. It is major threat to the well-being of man. Being a polyphagous pest feeds on leaves, shoots, flowers, seeds, stems, and bark. Nearly all crops and non-crop plants are eaten including pearl millet, maize, sorghum, barley, rice, pasture grasses, sugarcane, sugarcane, cotton, fruit trees, date palms, banana plants, vegetables and weeds. Nearly 80,000 adults are present in the one square kilometre of swarm of locust that daily consume food equivalent to 35,000 people. They cause huge devastation to natural and cultivated vegetation. Economic losses due to locust plagues estimated as 30 million tonne/year. There are 10 important locust species are present in the world. In India, only four species of locust are mainly found. They are, Desert locust (*Schistocera gregaria*), Migratory locust (*Locusta migratoria*), Bombay locust (*Nomadacris succincta*), and Tree locust (*Anacridium sp.*). The desert locust is the most important pest species in India as well as in international context. Currently, country is facing a new challenge of battling for food security due to infestation of agricultural fields and grasslands by the voracious 'desert locust' which is threatening the food security and agricultural economy of the country. Understanding the biology and social behaviour of the locust, and implementing sound pest management programs will help us to address and mitigate the problem, and safeguard the crops and harvestable species against economic loss.

Biology of locust

Overall life cycle of locust is completed in 2 to 6 months, with three life stages viz., egg, nymph (hopper) and adult stage. Locusts undergo incomplete metamorphosis. There is no pupal stage and juveniles are similar in appearance to adults.

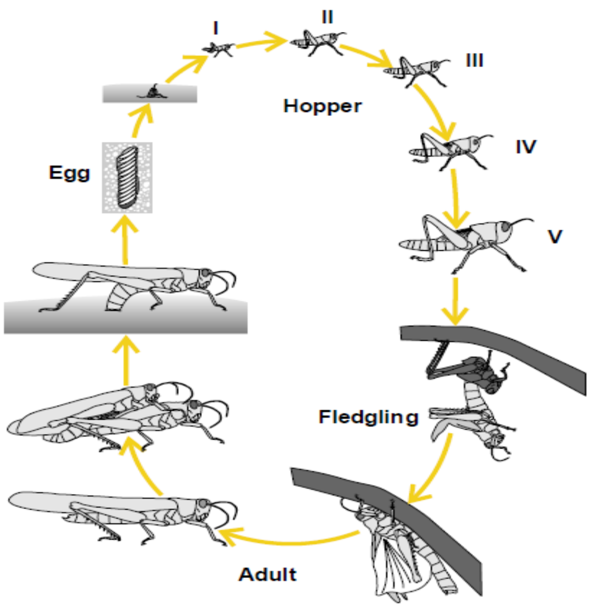
Egg: Mature female lays egg in the moist soil by drilling a hole into the ground at 10cm depth by using its ovipositor present at tip of the abdomen. Female lay eggs in batches called 'pod' at interval of 7-10 days which is sealed with white coloured froth. Froth protects the egg from desiccation, disease and predation. The eggs look like rice grains and arranged like a miniature hand of bananas. Gregarious female lay 2-3 pods having an average of 60-80 eggs. And solitary female lay 3-4 times having 150-200 eggs in average. Pod length is 10-14cm. Egg cycle lasts for 10-65 days.

Hopper: After hatching, wingless nymph emerges from the egg. There are 5 instars in gregarious and 5-6 instars in solitarius population. After completing each instar the locust nymph sheds, or moults its skin (moulting) to continue to grow. On hatching nymph is wingless but with each successive moult the developing wing buds increase in size. In 24-95 days with an average of 36 days the hopper period was complete. In each instar there is a change in growth and characteristic colouration.

Character of different instar of hopper:

I instar: Newly hatched are white in colour but turns to black colour in 1-2 hour.
II instar: Head is larger in size and pale colour pattern is conspicuous.
III instar: Two pairs of wing buds project each side of thorax.
IV instar: colour is conspicuously is black and yellow.
V instar: Colour is bright yellow with black pattern.

Adult: The fifth instar moult into adult stage. This is called as ‘fledging’, when the locust develops fully formed flying wings. The young adult is called ‘fledgling’ or ‘immature adult’ which means they are sexually immature. The period of sexual maturity varies with climatic condition. It takes 3 weeks to mature under suitable condition, but during dry or cool condition it make take 8 months to mature. During this stage adults fly for thousands of kilometres in search of favourable condition for breeding. Usually, males become sexually mature before females. The young immature female is pink in colour but older ones is dark red or brown in colour. The matured adults are bright yellow in colour. The oviposition commences in two days of copulation. The total life span of adult is 2.5 to 5 months. Adults migrate in swarms and disperse into millions of areas at speed of 12-17 kmph.



Conclusion

India in the past has encountered several plagues of locust, upsurge, and incursion. Due to their ability to form swarms and hopper bands, locust is causing heavy devastation to natural and cultivated vegetation. They can flare up at any time and inflict huge loss to crops, ultimately leads to economic loss of the country. So understanding the biology of this pest helps to implement the management practices against particular stages of the pest.

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NUTRITIONAL VALUE OF DRIED AND SMOKED FISH

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Introduction

Fish preservation is a cheapest methods as a form of dried and smoke. Drying, salting and smoking is an ancient method for the preservation of fish in India. Fish is the cheapest sources of animal protein and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body. Fish represent an essential component of global food basket to improve the nutrition, health and well-being of people. Dries and smoked fish having a good source of essential micro and macro nutrients. In India about 17% of the total catch is being used for the production of dry fishes (Jeya Shakila *et al*., 2003).

Fish as a health food

All around 179 million tons of fish are harvested from the oceans, lakes, and rivers consistently (Handbook of fisheries Statistics., 2020). Eicosapentaenoic acid and docosahexaenoic acid, long-chain omega-3 unsaturated fats, are found in fish. Docosahexaenoic acid is a component of our cerebral framework, making it particularly important for optimal cerebrum and neurodevelopment in children. Fish consumption provides numerous health benefits. The use of fish, particularly oily fish, reduces the risk of coronary heart disease death, according to solid evidence. Fish is perishable material, and it degrades faster than other foods. To maintain its freshness and nutritious qualities, several postharvest management procedures, processing, preservation, packing, storage, and transportation systems are necessary. Fish drying is used to extend the time that fish can be used after being caught.

Dried Fish

Fish drying is a age old practices, and some of the traditional methods are being employed today. Drying is the procedure where the moisture content in the fish is decreased to suitable required qualities under controlled clean conditions. Heat and mass transfer are two things of primary significance during drying. Simple sun drying is a generally practiced traditional strategy for fish preservation. Consumers are particularly concerned about the quality of dry goods at the moment.

Blowfly infestation, rotting, and physicochemical contaminants are all contributing to the loss of this species. Individuals consider dry fish to be a healthy diet since it is a totally natural product that contains the omega-3 and antioxidant characteristics of fresh fish. When compared to animal flesh, which includes double the calorie and significantly less protein, 100 grammes of dried fish contains roughly 80% protein and 300 calories.

Method of fish drying

Generally two terms are now being commonly used in drying of fis Viz. “Sun drying” and “Dehydration”. These two methods of preserving fish are almost similar but with little difference.

In sun drying this process is carried out by exposing target fish directly under the sun. this is usually done in the open air using solar energy to evaporate the water content un the fish and naturally air carried away the evaporated water from fish body.

Tab 1. Some dried fish products

Name of fish	Dry fish products
Tilapia nilotius	Bulti
Lebeo niloticus	Dabs
Cirrhinus reba	Lashim
Puntius sarana	Sidra
Mackere	Pedah
Shell fish	Gulbi

Smoked fish

Smoking is one of the oldest methods of fish preservation developed in prehistoric period. In recent times smoking is used as a method of preservation with the incorporation of smoke flavour and development of colour. In under developed countries this method is used as a means of preservation only, while in developed countries this method is used to impart smoke flavour to the product since in these countries there are other sophisticated means of preservation of fish. Smoking is a method of preservation effected by the combination of drying, deposition of naturally produced chemicals resulting from thermal breakdown of wood and salting.


Fig 1. Sun dried fish


Fig 2. Smoked fish

Different types of smoking

1. **Hot smoking:** In this type, the temperature should be maintained above 30^oC and the normal range is 70-80^{o}c. In hot smoking fish is completely cooked and consumer can take it without further cooking.
2. **Cold smoking:** In cold smoking temperature should be maintained below 30^oC. Here meat will not be cooked and it is used to impart flavour in the meat. So it has to be cooked before consumption. This method is followed in temperate countries as temperature in these countries is very low.
3. **Combined method of hot and cold smoking:** Here fish is first smoked below 30^oC for few hours and finally it is hot smoked.

4. **Liquid smoking:** Liquid smoking extract is prepared by dry distillation of wood and then it is concentrated to a particular degree and later it is used in proper dilution. Dilute smoke is concentrated, fishes are dipped into it for required time and then it is dried.
5. **Electrostatic smoking:** Here smoked particles are charged into an electrical field (usually positively charged) and at the same time fishes are negatively charged. The positively charged smoke particles are attached by the fish. It is a rapid process.

Types of wood used for smoking

Smoke is prepared by "Smouldering fibre" ie. Burning without flame. The source of producing smoke is the wood. All types of wood are not suitable for smoking purpose. Depending on types of wood odour and taste differs. For smoking hard wood is suitable and we should not use soft wood. Types of wood used for smoking are mentioned below.

- Coconut shell and husk
- Sag wood dust
- Sag wood ships (leaves)
- Mango wood
- Paddy husk etc.

Some smoked fish products

1. **Bhunji machhali:** It is a traditional smoked-dried fish product in Chhattisgarh. Puntius spp, Mystus spp. and Parluciosoma danioconius are frequently used for production of Bhunji machhli.
2. **Sukshi machhli:** It is also a popular traditional sun dried fish product of Chhattisgarh. For the preparation of sukshi machli some local fishes are used such as *Puntius ticto* & *Puntius sophore, Mystus tengara, Parluciosoma danioconius, Anabas testudineus, Mastacembelus armatus, Lepidocephalichthys guntea, Heteropneustes fossilllis, Channa striatus, Salmostoma bacailai, and Ambylopharyngodon mola.*

Source of Omega-3

Like fresh fish, smoked fish is a great source of omega-3 fatty acid. Omega-3 fats are known for providing a number of health benefits including improved blood clotting and vessel constriction, reduced tissue inflammation, relief from rheumatoid arthritis, and reduced depression and mental decline in aging individuals. Oily smoked fish like mackerel, sardines, cod, and salmon are particularly rich in omega-3 fats.

Low-Calorie Protein

One of the main nutritional benefits of smoked fish is that it is a lean source of protein. Smoked fish is high in protein and healthy fats while being low in carbohydrates – it also provides some vitamins and minerals like selenium, potassium, B vitamins, zinc, and iodine. A four-ounce serving of smoked fish generally has about 20 grams of protein, or more.

Conclusion

Dried fish products and smoked fish have been part of the world menu for a long time. For the preparation of sukshi machhli and bhunji machhli, the sun light and paddy straw were used as the main sources of fuel. The fish are left to organically infuse with smoke overnight. Smoke is manufactured in the mechanical way by using smoke condensates, which are produced by the industrial process of turning smoke into steam. The omega-3 fatty acids in these fish are good for brain, heart and immune system. These healthy fats have the added benefit of absorbing the flavor of smoke very well, resulting in a tastier food compared to leaner fish.

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ROLES OF BIRDS IN AGRICULTURAL SYSTEMS: THE POSITIVE OR THE NEGATIVE

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Birds are economically important as both biological control agents and pests in agriculture, but the presence of birds in agro ecosystem is often regarded as an economically significant threat to crops. However, the net effects of birds in agro ecosystems are neutral i.e. the more they harm, the more they benefit. Consumption of insect pests by birds is beneficial to farmers and plays an important role in IPM and reduces overall health, economic and environmental risks. There are 10,700 species of birds and many birds have at least a partially insectivorous diet, and insects are an important source of protein. The world's insectivorous birds can consume 400 - 500 million metric tons of prey per year. While some birds primarily rely on plant diets, such as seeds, fruits, and nectar, others feed as carnivorous on animal prey, or as omnivorous on a mixed diet of plant / animal matter.

Figure 1. Insectivorous birds in rice ecosystems

Birds as bio-control agents

Insectivorous birds (Table 1, Fig. 1) can fit well in biological control of insects. For example, the first known successful importation of a bird occurred in 1762 when the mynah bird (*Acridotheres tristis*) was introduced from India to Mauritius to control the red locust (*Nomadocris septemfasciata*). Other early introductions of birds include the importation of the English or house sparrows (*Passer domesticus* L.) and the European starling (*Sturnus vulgaris* L.) from Europe to the eastern United States. The sparrow was introduced in 1851 to control tree pests in eastern U.S. cities; the starling was introduced in 1872. Many times, theses birds played considerable role in local suppression of insects in local outbreaks, but that large outbreaks were beyond the capacity of birds to control. Birds can also influence insect population indirectly by altering the micro environment of their prey thus making them more susceptible to weather, parasitism and possibly disease and by also spreading insect viruses. Most insectivorous birds are facultative feeders utilizing a multitude available prey species opportunistically.

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Table 1. Important families of insectivorous birds

S. No.	Family	Food preference
1	Alaudidae	Mainly seeds, some insects
2	Anatidae	Chiefly vegetarian, but ducklings feed on insects
3	Apodidae	Insects
4	Certhiidae	Exclusively insectivorous
5	Cuculidae	Chiefly insectivorous (hairy caterpillars)
6	Falconidae	Insects, mice and small birds
7	Fringillidae	Some mainly insectivorous
8	Gaviidae	Mostly fish, also some insects and other invertebrates
9	Tetraonidae	Browsers, buds, foliage, berries, some insects
10	Phasianidae	Chiefly vegetarian, grain and weed seeds; some insects
11	Gruidae	Omnivorous; insects and small vertebrates, grain, fruits
12	Hirundinidae	Exclusively insectivorous
13	Icteridae	Omnivorous, predominantly insectivorous
14	Laniidae	Small mammals, birds and large insects
15	Laridae	Omnivorous; insects in fields
16	Mimidae	Mainly insectivores
17	Paridae	Mainly insectivorous
18	Parulidae	Mainly insectivorous
19	Picidae	Mainly insectivorous
20	Sittidae	Mainly insectivorous
21	Sylviidae	Almost entirely insectivorous
22	Trochilidae	Insects, arachnids and nectar form flowers
23	Troglodytidae	Insectivorous, some spider
24	Turdidae	Mainly insectivorous or other invertebrates
25	Tyrannidae	Exclusively insectivorous
26	Vireonidae	Exclusively insectivorous

Birds as dispersal agents of insect pathogens

Birds help in the spread of entomopathogens by eating infected insects. It is found that bird droppings collected from trees are infective. Birds can affect parasitized insects a) by direct consumption of adult b) indirectly by preferentially selecting (or avoiding) parasitized prey as food and c) altering prey habitat to make it more susceptible to parasitism. Most avian predators eat parasitized insects. However, the relative frequency of parasites in the stomach contents of birds is usually low in comparison to the frequency of other prey or to the density with which parasites occur in the field.

Conclusion

Estimation of the effectiveness of birds in insect control is a complex task. It would be highly derivable and mutually beneficial for entomologists and ornithologists to cooperate and investigate insect-bird problem jointly. Insectivorous birds play an important role in the population dynamics of many insects, especially at low to moderate population levels. Birds can act as direct mortality agents or can affect their prey indirectly through influencing insect parasites and predators of the prey or by altering the micro-environment of the prey. The major role of birds is in the retardation or prevention of insect outbreaks and in suppression of insect pest population before they reach outbreak levels.

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SCOPE AND PROSPECTS OF PRAWN FARMING IN INDIA

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Abstract
The production of freshwater prawns in India, which includes both farmed and wild capture of *Macrobrachium rosenbergii* and *Macrobrachium malcolmsonii* has continuously grown. Growth retardation and diseases in ponds due to poor seed quality and inbreed broodstock over several generations; pond water quality issues and increased production costs due to feed, labour, and mandatory certification requirements are thought to be some of the factors contributing to production declines. While the majority of the output is produced in Andhra Pradesh, single crop paddy–prawn production practices in Kerala, low-lying fields have aided in the gradual transition to a sustainable, organic model of rice and prawn farming that is acceptable for other Indian states.

Introduction

Inland open water have a significant place in the national economy by providing livelihood, food and nutritional safety and ecological services to the India growing population. Indian freshwater resources comprise of 45,000 kilometer of rivers, 3.51 million ha of reservoirs, 0.354 million ha of floodplain wetlands and 0.72 million ha of upland lakes. As per CIFRI (2019) annual report, about 1.24 million inland fishers depends on these resources for employment and a livelihood. Freshwater prawns are an essential component of aquatic ecosystems such as lakes, rivers, swamps, irrigation canals, ponds, and estuarine zones and several of species play a significant part in the export market due to its higher demand and market value (Abowei *et. al.,* 2006). As per the report of MPEDA (2020), nine Indian states produced 9540 mt of scampi from 12704 ha culture area with 0.80 mt/ha/year annual production (West Bengal, Odisha and Andhra Pradesh are the top three producers).

Holthuis (1980) reported the seven genera across the globe under Palaemonid family. *Macrobrachium* is a genus with over 100 species globaly and 40 species were reported from India (Jayachandran and Joseph, 1992). *Macrobrachium* genus of freshwater prawns has distributed across the tropics and subtropics of the world with about 28 varieties found in India alone. *Macrobrachium rosenbergii*, *Macrobrachium malcolmsonii*, and *Macrobrachium gangeticum* are the three larger varieties from Indian waters (Ling, 1969). According to Jayachandran and Joseph (1992), from a fisheries point of view, 15 species are significantly important. One of most widely dispersed species in India is *M. rosenbergii* which is the most significant commercial species found of Indian rivers and estuaries recorded as of the Tapti River on the west coast, as well as the backwaters of Kerala and connected regions of rivers pouring into the Bay of Bengal on the east coast from Tamil Nadu to West Bengal.

Systems for prawn cultivation

Pond culture

Macrobrachium rosenbergii can be grown in freshwater or brackish water up to a salinity of 10 gL^{-1}, while a salinity of 5 g L^{-1} results in enhanced production, individual size, and stock survival was good. To build raised earthen ponds in Andhra Pradesh, large sections of paddy and sugarcane fields were excavated. These ponds may be entirely emptied and dried and they are fed by groundwater from deep (50–70 m) bore wells in the Nellore district, or irrigation canal water diverted for aquaculture in the West and East Godavari districts.

In India, the majority of prawn farmers run own small farms of less than 4 hectares. There are also large (above 8 ha) and middle (4–8 ha) farmers holding. In India, there are no intensive freshwater prawn farming systems. Low saline (10 gL^{-1}) coastal locations, particularly abandoned shrimp farms, were frequently employed for freshwater prawn farming in Nellore and West Godavari districts, where periodical occurrence of white spot syndrome viral illness in tiger shrimp *P. monodon* was widespread.

Inland, irrigated agriculture-saline ponds that are affected by underground water salinity and otherwise unusable (about 30 million ha in states like Karnataka, Maharashtra, Punjab and Haryana) were successfully tested for freshwater prawn polyculture with carps by diluting the salinity from 30 to 7 gL^{-1} using irrigation canal water. In Rajasthan, effective polyculture trials of growing *M. rosenbergii* with the fish *Mugil cephalus* in an earthen pond with salinity varying from 8 to 11 gL^{-1} obtained from an open well were carried out.

Rotational cultivation of rice, fish and prawns

During the flooding season in Kerala, extensive low-lying paddy fields ranging from 40 to 400 ha are used for stocking prawn juveniles as a rotating crop to rice (one crop rice – one crop fish/prawn), as well as smaller farm ponds. Paddy cum prawn integrated cultivation systems have long been proven to be sustainable in India, notably in central Kerala low-lying wetlands. The riparian region, which is inundated by three river systems, is extremely fertile and productive. In Kerala, a form of rice–fish rotational farming was discovered to optimise rice productivity and revenue without disturbing the ecology, encouraging farmers to continue planting rice and they are still cultivating fish and prawns in the flooded fields, which allows them to avoid the rising expense of cultivation and the fluctuating price of rice, which has lowered their rice farming revenue.

Reservoir-based cultured prawn fisheries

In several northern Indian states, stocking freshwater fish and prawn in reservoirs and harvesting them significantly contribute to inland fisheries production. The medium and large reservoirs in Kerala are thought to have the ability to produce 250 and 100 kg ha^{-1} $year^{-1}$ of fish and prawn, respectively. The excellent growth of *M. rosenbergii* stocked in the Malampuzha irrigation reservoir without extra feeding demonstrates the potential of freshwater prawn farming in such reservoirs. The average output in the aforementioned reservoir, which was just 2.23 kg ha^{-1} $year^{-1}$ during the preceding 10 years, was enhanced by the stocking of *M. rosenbergii*.

Culture practices of freshwater prawn in India

Freshwater prawn farming in India, notably in Andhra Pradesh, is dominated by monoculture. Small numbers of Indian major carp *Catla catla* (100–150 fingerlings per ha) are also raised with prawns to help prevent excessive algae blooms in ponds. In addition to catla, rohu (*Labeo rohita*), and silver carp, grass carp (*Ctenopharyngodon idella*) is a significant component in the prawn polyculture – rice fields of Kerala with strong macroalgal growth in the field.

Nursery rearing

In Andhra Pradesh, earthen nursery ponds ranging from 0.1 to 0.4 hectares are commonly used to raise PL to juveniles. Smaller ponds of 0.01 ha are utilised only in the West Godavari area to feed the juveniles of *M. rosenbergii* and *P. monodon* necessary for grow-out ponds, forming a parallel supply chain to hatcheries. For prawn juveniles, nursery care for two months might result in a 400–500% increase in value. At a stocking density of 250 000 ha^{-1}, survival rates in nurseries range from 70% to 80% after 45–60 days. In the nursery ponds, folded coconut leaves are used as hideouts, as they are thought to boost survival rates.


Fig 1. Prawn Faming in India

Practices of "grow-out" farming

In Andhra Pradesh, grow-out ponds are earthen ponds of a consistent size and form, often ranging from 0.4 to 1.0 hectares. Stocking densities ranging from 20 000 to 25 000 PL ha^{-1} are monitored in mixed culture throughout an 8–10 month rearing period. A moderate density of 20 000 PL ha^{-1} is followed with additional feeding in the rotational cropping method of prawn in rice fields in Kerala; however, it may still be lower up to 5000 PL ha^{-1} if supplemental feeding is not done. Farm yields range between 500 and 1500 kg per hectare $^{-1}$.

Feeds and feeding practices

In some of the large farms of 100–400 ha, giant freshwater prawns are produced completely on abundant natural feeds as a rotating crop with paddy. Pellet feeds are utilised in the nursery (which is located within the grow-out field) for 30–45 days before the juveniles are released to the entire area. In the grow-out field, grass carp, catla, and rohu fingerlings, as well as prawn juveniles, are directly stocked. The prawn/fish crop also makes rice production easier by reducing or eliminating the labour expense of weeding and leveling during field preparation, as well as reducing insect infestations.

Diseases

Within a few years of its revival, freshwater prawn farming, especially in Andhra Pradesh, had experienced significant losses due to a number of illnesses. The first big epidemics of White Tail Disease (WTD), affecting mostly PL and juvenile. Branchiostegal blister illness was also related to rostrum and appendage abnormalities, as well as a swollen, crispy branchiostegite area with little white spots. The BBD-affected adult prawns had no viral pathogen or parasite and the disorder was thought to be caused by degradation in water quality. They concluded that ADS is a disorder caused by poor water quality since no viral or bacterial infection could be identified from ADS-affected prawns. *M. rosenbergii* nodavirus (MrNV) and extra small virus (XSV), two WTD causal viruses, have been isolated, purified, and described. However, unlike in the case of marine shrimp farming, an organised disease diagnosis and surveillance system has yet to be established in freshwater prawn farming in India, owing to the fact that diagnostic laboratories still focus on marine shrimps and rapid detection kits for freshwater prawn diseases have not become popular.

Challenges to prawn farming

Indiscriminate conversion of agricultural fields

Wherever practicable, the bulk of paddy and sugarcane farming lands were converted to ponds for freshwater prawn farming, such as beside roads or in remote places. Regardless of the availability of appropriate water supplies, coconut plantations were demolished to create ponds for prawn cultivation. The massive expansion of farmland resulted in an excessive consumption of groundwater, and bore wells had gone deeper in many locations, depleting subsurface aquifers. The Nellore district of Andhra Pradesh gets very little rain, which is mainly restricted to the monsoon season in the northeast. Despite decreasing farming lands in Nellore, freshwater prawn farming, notably in the West Godavari district of Andhra Pradesh, has been developing, employing irrigation canal water. However, the issues in those areas were linked to the development of toxic algal blooms (particularly blue green algae), which had hampered the country's shrimp and prawn exports.

Brood-stock management

Except in Kerala, Orissa, and other states in India, broodstock for *M. rosenbergii* hatchery production is primarily supplied from culture ponds. When wild-sourced, naturally produced broodstock is accessible Domesticated populations of prawns used as broodstock in commercial farms across the world have shown a drop in output owing to inbreeding depression. Poor hatchery larval survival rates up to PL stage, poor survival and growth of juveniles in nursery ponds as well as grow-out ponds, premature development of blue claw males, early female maturity, higher percentage of runts and susceptibility to diseases, among other things, all contributed to a decline in offspring quality.

Conclusion

In India, the promise and challenges of freshwater prawn farming are focused in the state of Andhra Pradesh. There are various more states that are rapidly developing their prawn farming industries. Despite the fact that prawn production in Andhra Pradesh has been extremely poor until recently. The farms in the West Godavari area that were irrigated by rivers or irrigation canals and had less disease outbreaks did better by using several new methods such as all-male culture. Freshwater prawn and paddy rotational cropping in Kerala, as well as organic farming successfully tried in Kerala and Andhra Pradesh, have shown to be cost-effective and disease-free methods.

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SOILLESS FARMING- FUTURE OF PRECISION FARMING

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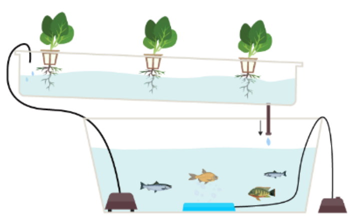
With the advent of civilization, agriculture faces great challenges; especially the decrease in the per capita availability of land. Due to rapid urbanization and industrialization, the arable land will further decrease as well as fertile soils are rapidly disappearing due to climate change and intensive agriculture. the presence of pathogenic organisms and nematodes, inadequate soil reaction, soil compaction, ill drainage, degradation is some serious soil limitation for plant growth. In addition, conventional farming is somewhat difficult because it involves a large space and a lot of input consumption.

Soilless farming alternatives to traditional farming can offer a more sustainable system for growing enough food to feed the world's population. Soilless farming addresses many of the concerns we now have about today's farming. In soilless cultivation, the plants are raised without soil. Improved space and water conservation methods for food production in soilless farming. All factors involved in crop nutrition like solution composition, solution temperature, water supply, dissolved oxygen concentration, pH and the electrical conductivity of the nutrient solution are precisely managed as well as farmer can optimizes the temperature, humidity, airflow, and light within the growing environment of crop therefore crops are protected from the potentially negative impacts of the various factors. This is why soilless farming is the future of precision farming.

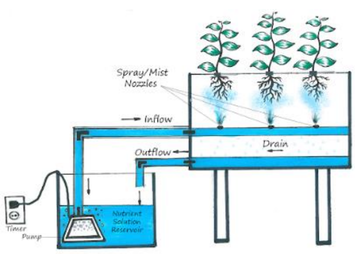
Different types of soilless systems:

1) Hydroponics: This system works by allowing tight control of environmental conditions, such as temperature and pH balance, and maximized exposure to nutrients and water. Hydroponics works on a very simple principle: providing plants with exactly what they need when they need it. Various components of this system are growing media, air stones, air pumps, mesh pots.

2) Aquaponics: Aquaponics is raising fish and plants in the same water source. The fish actually provide the fertilizer for the plants and the plant roots filter the water for the fish. Nitrifying bacteria converts the fish waste into nitrites, and eventually nitrates, which is plant food. Aquaponic systems come in many different sizes, from small indoor units to large commercial units.

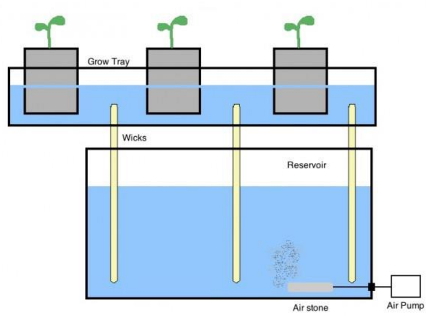


3) Aeroponics: Aeroponic systems suspend plants in the air and expose bare roots to a nutrient-packed mist. These systems are very precise with nutrient delivery and water usage, it takes 95% less water to grow aeroponically than in an irrigated field. The water and nutrients are stored in a tank and then pumped into a

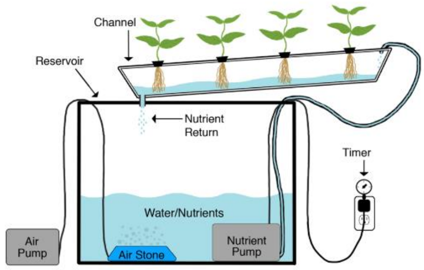


nozzle that atomizes the solution and distributes it as a fine mist. In aeroponics plant roots available ample of oxygen.

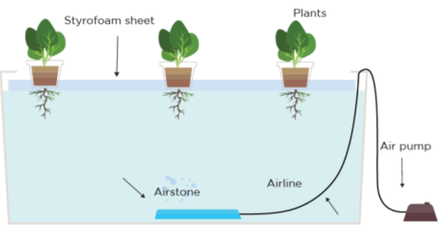
4) Wicking System: This is one of the simplest and least expensive hydroponic growing methods another great starting point for beginners because of its low maintenance. The nutrient solution is delivered into the culture medium from the reservoir with a wick and then to the roots via the plant's capillary action. It is recommended to use a medium such as perlite or vermiculite. The disadvantage of the system is Wick System is not the most efficient when it comes to nutrient use.



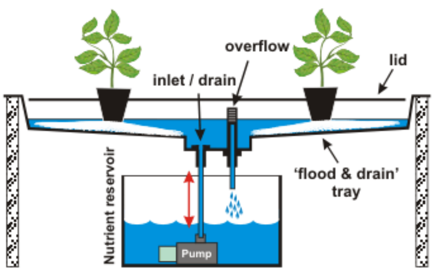
5) Nutrient Film Technique (NFT): This versatile technique uses channels for running a very shallow stream of water to the roots. It can be done on a timer or with a continuous flow. It is a recirculating hydroponic system. Unlike deep water hydroponics, the roots of plants in an NFT system are not submerged in water. Instead, current only flows through the tips of its roots.



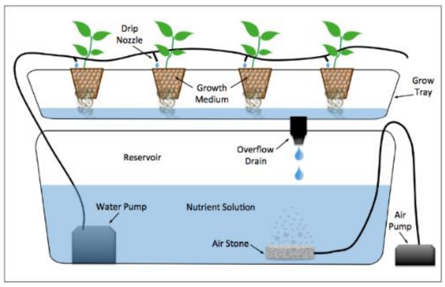
6) Deep Water Culture (DWC): Deep Water Culture is the floating plants on recirculating water. In this system plant roots are suspended in about 6 to 18 inches of a well-oxygenated nutrient solution until harvest. It's perfect for leafy greens and small herbs because they don't require a lot of root support. DWC systems often contain a large volume of water.



7) EBB and Flow System: This is flooding and draining system. Plants are grown in small plastic bucket with clay granules or other growing media that flood and drain. Other way, the grow tray is temporarily flooded with solution every few hours, submerging the roots before returning to the storage tank. Because of the root support and the oxygen levels they can provide.



8) Drip System: Drip systems are another simple and common technique whereby a pump on a timer delivers a slow supply of solution to the base of each individual plant. Drip system work well with coir, peat or rockwool medium because they are capable to retain more water.



Advantages of soilless farming systems:

1) maximum crop yield per unit area and per unit time: Optimized nutrition plan means more faster growth of plants which resulted in more crop growth cycles per year, more performance, more yield.

2) Very high water and nutrient use efficiency: By closing the loop and recycling water back into the system, hydroponics typically uses at least 90% less water than conventional farming.

3) Controlled Environment Agriculture (CEA): CEA is method of modern farming that optimize the growing condition of crops which is required for the precision agriculture. farmers using greenhouses or indoor vertical farms of soilless systems can create optimal growing conditions 365 days a year, anywhere in the world. In soilless farming systems, crops are grown protected from the potentially negative impacts of the various biotic and abiotic factors.

4) Use significantly less land: With soilless farming systems, the yield per square foot greatly increases. This is important in order to grow enough food for growing populations without needing to expand farmland into wetlands, forests, or other important natural ecosystems.

5) Very less use of pesticides and chemicals: In soilless farming there is less or no need for potentially toxic pesticides and chemicals because the crops are protected. Being grown in controlled condition reduces the risk of a plant's exposure to pests and diseases. Controlled environment agriculture uses integrated pest management to prevent or treat any pest problems.

6) Provide nutritional food: Soilless farming provides consumers with a food option that is thought to contain higher nutritional value. Additionally, provide the personal and environmental health. farming in a controlled environment also greatly improves a farm's ability to predict harvest time, grow high-quality food, and maintain high food safety standards.

7) Location: The farm can be significantly closer to the consumer, decreasing the carbon footprint of food delivery and increasing the freshness of the product. Soilless farming is not depending on soil fertility therefore production can be done anywhere.

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FRUIT CRACKING, ITS CAUSES AND MANAGEMENT

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Introduction

Fruits, along with vegetables, are considered protective foods because of their high content of vitamins and minerals, which are necessary to protect our bodies from many diseases and disorders. Fruit cracking is a phrase that has been given to a variety of physical problems in fruit that manifest as cuticle or skin cracks. Varietal characteristics, orchard soil management as well as climate (light, temperature) and micronutrients, may all contribute to fruit cracking. Litchi, sweet cherry, pomegranate, gooseberry water apple and other citrus fruits contain it. Fruit cracking losses vary from 50 to 85 percent on average. All cracked fruits lose their fresh market value and may only be utilised for processing (particularly fruit juice) if they are not fungus-affected.

Causes of fruit cracking

There are many reasons which cause cracking of fruit.

Temperature: It has a significant impact on the fruit cracking ratio. Cracking is more likely in dry and semi-arid zones when temperatures are higher and humidity or rainfall is low. There was a linear rise in cracking with increasing temperature in general.

Rainfall: When there is a lot of rain, the fruit skin absorbs a lot of water, which generates high osmotic pressure, which leads to cracking. Furthermore, a protracted dry period makes the fruit skin stiff and turgid, and then a quick rain produces additional cell imbibition, resulting in internal pressure fractures.

Over maturity: It leads fruit cracking due to more osmotic pressure.

Fruit size: Large fruits, as well as kidney-shaped fruits, are thought to be more susceptible to shattering. Because kidney and heart-shaped cultivars have a larger stem cavity, rain drops can linger there for longer, allowing for more water absorption through the skin, making them more vulnerable to fruit cracking**.**

Micronutrient deficiency: Cracking in cherry, pomegranate, and litchi is caused by boron and calcium insufficiency. Boron is found in the cell wall, calcium is found in the cell membrane, and potassium maintains cell osmotic pressure, therefore these micronutrients keep the cells turgid, and a lack of these micronutrients causes the fruits to fracture.

Sometimes cracking occur due to many insect or pest attack. Sunburn causes the formation of microscopic black water-shaped spots in litchi, which eventually take on the shape of elevated patches. These parts of the fruit develop longitudinal fractures and begin to ooze from the breaks.

Example of fruit cracking and its management

Litchi: Litchi cracking is one of the most major difficulties that contribute to the decline of litchi output. Litchi fruit skin cracking is a major issue that is exacerbated by high temperatures, low humidity, and poor soil moisture. The skin becomes hard and inelastic (sun-burned) as a consequence of insufficient moisture. It may also crack if subjected to high internal pressure as a result of rapid aril development after watering.

Management: Calcium in liquid formulations at 2 m/l and Gibberellins at 20 ppm decreased cellulose activity and thereby reduced cracking. Cracking is reduced by spraying 2,4-D and NAA at quantities of 20 ppm or 20 mg/litre. At the period of fruit development, consistent moisture and suitable humidity are required. Cracking resistant cultivars such as Swarn Roopa (created in Ranchi, Jharkhand) were suggested for cultivation. Litchi cultivars with thin skin and few tubercles per unit area, as well as a rounded to flat form, are less likely to break.

Pomegranate: Pomegranate fruit cracking is a serious issue. Fruit cracking has also been linked to calcium and boron deficits. Extreme temperature differences between day and night may induce cracking in growing fruits. When soils become too dry during fruit ripening, followed by excessive irrigation or showers, cracking may develop. Fruit cracking can also be caused by a significant delay in picking completely matured fruits or a severe insect or disease infestation.

Management: Fruit cracking can be reduced by cultivating tolerant resistant varieties such as Sur-Anar, Francis, Shirvan, and Krasnyl, selecting proper planting material, controlling and systemic irrigation during fruiting season, regulating bahar, and using pinolene (5%) as a vapour guard, GA3 (15ppm), and boron (0.2%) sprays.

Cherry: The most prevalent cause of cracking is that caused by external factors, which may be seen when cherries break in the rain. Because the fruit has a high osmotic potential, rainwater is absorbed through the cuticle. The sugar content of the fruit causes the high osmotic potential. In order to equalise the potential, water travels over the membrane. The cherry subsequently expands to the point where the skin can no longer hold it together, and the fruit rips open**.** According to Oregon study, minimal splitting happened at 40^0, but the splitting potential increased by 50% at 77^0compared to 59^0.

Management: Spraying CaCl2 at 300g to 350g per 100 litre water at weekly intervals before harvest was said to prevent fruit cracking in Bing and Lambert. However, scientists found no link between the shape of fruit skin and its breaking susceptibility. Spraying CaCl2 on the apples boosted the calcium content but had no effect on cracking, according to the researchers. Spraying GA3 (2000 ppm) on Hedelfingen and Ekero cultivars three weeks before harvest decreased the amount of fruit cracking induced by heavy rain after a drought.

Citrus: Citrus fruit breaking has been linked to an abrupt shift in meteorological conditions. Drought-induced cracking developed after rainfall. Drought causes the rind of the fruit to become hard and less elastic, while rain causes the tissue inside the fruit to expand. Cracks appear when the peel does not grow as quickly as the pulp. Lemons are more prone to fruit breaking than other citrus fruits.

Management: Early harvesting and crop thinning to increase ring thickness have been proposed as possible solutions. During the summer, it can be reduced by providing timely and regular watering. Fruit cracking in lemons can be reduced by foliar spraying of CaCl2 (0.5%) during the half-grown stage of fruit development without affecting fruit size, yield, or quality.

Some other fruits cracking

Fruit cracking in wax apples (*Syzygium samarangense*) can be caused by a variety of factors. The biggest issue with wax apple manufacturing is cracking, which lowers customer choice. The goal of this research is to figure out what causes wax apple fruit to break. During fruit development, a rise in total soluble sugars and total titratable acid causes a reduction in tissue osmotic potential. Water absorption in response to an osmotic potential reduction can cause cells to expand, elevating turgor pressure and triggering cell and tissue rupture. When polygalacturonase activity increases, the cell walls weaken. The combination of these elements causes fruit cracking.

When it comes to bael, Fruit splitting is another issue, particularly in cultivars with flat fruits. Just before ripening, the fruit splits the most. Harvest the fruits in January-February and ripen under artificial conditions to avoid fruit splitting. Otherwise, spray the trees three times a year with potassium sulphate (4 percent), in August, November, and February.

Conclusion

Fruit cracking is another huge loss in agriculture produce. Most of the cracked fruits are infected by fungus, so there is no use moreover due to lack of processing industry sometimes cracked fruits cannot use in processing sector also. So more research should be needed for preventing cracking and also maintain quality of fruits.

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THE FISHERIES INSTITUTION AND DEVELOPMENT OF FISHERIES EDUCATION IN INDIA

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The population of India is increasing and it is expected to be 1.6 billion by 2050. The need for increased food production is a significant challenge for the increasing trends of the Indian population. Fisheries is a rising food producing sector with differed resources and potential, in this sector more than 28.06 million people are engaged at the primary level and along the value chain (Handbook of fisheries statistics, 2020). The changes in the fisheries sector from traditional to advance production technology bring it at business scale have increase in fish production from 7.5 lakh tons in 1950-51 to 14.16 lakh tons during 2019-20 (Handbook of fisheries statistics, 2020). The export earnings from this sector are Rs. 46,589 crores in 2018-19 (NFDB, 2018-19). The fisheries sector contributed around 1.24% to the Gross Value Added (NGVA) and 7.28% to the agricultural GVA (2018-19) (Handbook of fisheries statistics, 2020).

The fisheries professionals have employment opportunities in fisheries departments of the central and state Governments, fisheries research institutes, academic/ universities, private fisheries corporations and federations, banking sector, private industries, fish and shrimp farms, technical consultant/ executive and self-employment. The fisheries graduates require a superior establishing in administration and more practical experience in commercial fisheries operations (Shetty, 1988). There is scope for producing more professional fisheries graduates if Central and every State department endorse fisheries degrees for fisheries positions. The analysts revealed that scope for producing more professional fisheries graduates with appropriate training, education and expertise levels which is necessary to empower or uplift the fisheries sector (Ayyappan and Biradar, 2000). The necessity of fisheries graduates requirement for 10,457 against a supply of 4,570 by 2020 (Munil, 2010) while according to Biradar (2018) the annual outturn required from professional fisheries colleges/institutions ought to be around 2,820 B.F.Sc., 450 M.F.Sc. and 220 Ph.D. by 2022.

The fisheries education in India was started very late in compared to veterinary and agricultural education. The professional fisheries education in India began at the Fisheries College at Mangalore in 1969 under the University of Agricultural Sciences, Bengaluru and presently, more than thirty professional fisheries colleges in India which constitute of State Agricultural Universities (63), Central Agricultural University (3) and deemed-to-be university ICAR- Central Institute of Fisheries Education, Mumbai in India and intake capacity of these institutes are 915 for UG, 349 for PG while 132 for Ph.D. (Table 1). The ability of the fisheries sector could be utilized and developed through high-quality advanced fisheries education by different colleges and institutes, these are described as bellow:

Central Institute of Fisheries Education (CIFE), Mumbai

Central Institute of Fisheries Education (CIFE) is a leading Fisheries Institute having a distinguished heritage and has nurtured many illustrious scholars and leaders over the years. In over 50 years of existence, CIFE has emerged as a center of excellence for higher education in fisheries and allied disciplines. The Institute was established on 6th June 1961, under the Ministry of Agriculture, Govt. of India with assistance from FAO/UNDP. It came under the administrative control of Indian Council of Agricultural Research (ICAR) on 16th April 1979 and subsequently, the scope and mandate have been widened to include education, research and extension.

Recognizing the pivotal role played by CIFE in human resources development in fisheries, the institute was conferred the status of Deemed-to-be-University on 29th March 1989. Encouraged by the new status, the University grew by leaps and bounds. Building professional capabilities and competencies of more than 4000 State fisheries extension and development personnel since 1961, the emphasis has always been on quality education. Now CIFE is a knowledge powerhouse and a brand name in fisheries higher education.

National Fisheries Development Board (NFDB)

Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India established National Fisheries Development Board (NFDB) to enhance fish production and productivity in the country and to coordinate fishery development in an integrated and holistic manner. About holistic development of the fisheries sector through enhancement of fish production and productivity; to supplement nutritious protein for the growing population; to accelerate the overall economy of the country, besides improving health, economy, exports, employment and tourism in the country is the mission of this organization. (NFDB : ANNUAL REPORT 2019-20).

Central Institute of fisheries nautical & engineering training (CIFNET)

The Government of India, in 1959 constituted a committee on "Fisheries Education", for assessing the manpower requirement and to suggest measures for providing trained manpower for boosting the fishery developmental activities. CIFNET, the erstwhile Central Institute of Fisheries Operatives (CIFO), was thus established in 1963 at Kochi on the recommendation of above committee to meet the trained manpower needs of ocean going fishing vessels and that of fishing industry. to cope up with the additional requirements due to expansion of fishing fleet/industry of the country, Subsequently a unit of CIFNET was established in Chennai in 1968 and another unit at Vizag in 1981 Since then, CIFNET is serving the nation by creating trained manpower needed for manning the fishing vessels. To impart quality training in order to upgrade skills, prevent obsolescence, develop healthy constructive

attitude with focus on competitiveness to meet the challenges of the fishing and the mercantile marine fields is the main vision of CIFNET. CIFNET has been conducting various regular and short term courses since inception. A total of 21,734 candidates have been trained. A capacity building training on Monofilament long line and Tuna Handling onboard have been conducted by CIFNET A total of 335 fishermen have been trained, under Blue Revolution Scheme.

National Institute of Fisheries Post Harvest Technology and Training (NIFPHATT), Cochin

The National Institute of Fisheries Post Harvest Technology and Training NIFPHATT, erstwhile Integrated Fisheries Project, which is devoted to all-round development of Post-Harvest Technologies. NIFPHATT envisages the best post-harvest fish utilization and consumption with the least post-harvest losses and delivery of the best quality fish and fish products. Adaptive research to suit the ever increasing and fast changing consumer needs by developing new processes, products and packaging on pilot scale helps in post-harvest technology up gradation. Dissemination of the upgraded technology is achieved through consultancy, training, popularization of products and consumer response surveys.

Fishery survey of India (FSI), Mumbai

The primary responsibility of this institute is marine fisheries resources survey, assessment and monitoring in the Indian Exclusive Economic Zone (EEZ) and adjoining seas for promoting sustainable exploitation and Management of the fish stocks. With passing time, the FSI had passed through the administrative Control of multiple ministries of Govt. of India viz., Ministry of Food and Agriculture, Ministry of Agriculture (Department of Agriculture and Cooperation), Ministry of Food Processing Industries, Ministry of Agriculture (Department of Animal Husbandry and Dairying), Ministry of Agriculture and Farmers' Welfare (Department of Animal Husbandry, Dairying and Fisheries). Presently the institute is in the administrative control of Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying since 2019 with a survey fleet of 11 deep sea vessels operating from Seven operational Bases viz., Mumbai, Mormugao, Cochin, Porbandar on the west coast and Chennai, Visakhapatnam and Port Blair on the east coast in order to accomplish the mandate of the Institute.

Central Institute of Coastal Engineering for Fishery (CICEF)

Government of India established Pre-Investment Survey of Fishing Harbors (PISFH), now known as Central Institute of Coastal Engineering for Fishery (CICEF), is a premier institution of the in January 1968 with its jurisdiction covering the entire Indian coastline for conducting economic investigations, engineering and preparing the Techno-Economic Feasibility Reports (TEFRs) for the fishery harbor (FH) projects., when the maritime States/UTs in the

country lacked the experience and expertise required in conducting the required investigations and surveys (http://cicef.gov.in).

Central Marine Fisheries Research Institute (CMFRI), Cochin

Government of India established ICAR-Central Marine Fisheries Research Institute on February 3rd 1947 under the Ministry of Agriculture and Farmers Welfare and later it joined the ICAR family in 1967. The Institute has emerged as a leading tropical marine fisheries research institute in the world, over 65 years. The CMFRI devoted its research attention towards the estimation of marine fisheries landings and effort, taxonomy of marine organisms and the bio-economic characteristics of the exploited stocks of finfish

and shellfish. This research effort contributed significantly to India's marine fisheries development from a predominantly artisanal, sustenance fishery till the early sixties to that of a complex, multi-gear, multispecies fisheries development and refinement of a unique method for estimation of fishery catch and effort from the over 8000 km coastline called the "Stratified Multistage Random Sampling Method" is the One of the major achievements of CMFRI. With this methodology the Institute is maintaining the National Marine Fisheries Data Center (NMFDC) with over 9 million catch and effort data records from all maritime states of India of more than 1000 fished species. Capture fisheries production alone would not be able to cater to the needs of our growing population and it became very clear that there was need to supplement capture fisheries with production from coastal mariculture and sea farming. So, a major part of the research effort was diverted towards sea farming and coastal mariculture and this effort paid rich dividends in the form of viable farm and hatchery technologies for shrimp, edible oyster, mussel, clam and seaweeds and marine pearls. Besides, human resources in mariculture were successfully developed through the Postgraduate Programme in Mariculture, offering MFSc and Ph.D. courses (https://www.cmfri.org.in).

Central Institute of Brackishwater Aquaculture (CIBA), Chennai

The Central Institute of Brackishwater Aquaculture (CIBA) established Indian Council of Agricultural Research (ICAR), New Delhi, under the Ministry of Agriculture, Government of India on 01-04-1987. The Central Institute of Brackishwater Aquaculture serves as the nodal agency for the development of brackishwater aquaculture in the country. The Headquarters of the Institute is located at Chennai with an experimental field station at Muttukadu (MES), about 30 km south of Chennai. A second experimental farming facility, which

spreads around 64 acres in the Muttukadu backwaters, located at Kovalam has been added recently (22.05.2021) as expansion of the farming infrastructure. The Institute has two Research Centers, at Kakdwip in West Bengal in the east coast and at Navsari in Gujarat on the west coast of India. These centers' main objectives are to cater to the needs of aquaculture development with a regional perspective along the east and west coast of India. CIBA envisages its role as one of the world's foremost scientific research institute in brackishwater aquaculture through the pursuit of excellence in research and innovation that contribute modernization and development of sustainable brackish water aquaculture in the country. (http://www.ciba.res.in)

Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar

A premier research Institute on freshwater aquaculture in the country is Central Institute of Freshwater Aquaculture (CIFA) under the aegeis of the Indian Council of Agricultural Research (ICAR), New Delhi. The present Institute has had its beginnings in the Pond Culture Division of Central Inland Fisheries Research Institute (CIFRI) established at Cuttack, Orissa in 1949 with a view to face challenges in the field of fish culture in ponds, tanks and other small aquatic body. CIFRI,

in a major effort to give emphasis to freshwater aquaculture research, initiated steps to establish the Freshwater Aquaculture Research and Training Center (FARTC) over 147 ha campus at Kausalyaganga, Bhubaneswar, and Orissa. CIFRI became an independent Institute during 1987 as Central Institute of Freshwater Aquaculture (CIFA). CIFA is also the Lead Center on 'Carp Farming in India' under Network of Aquaculture Centers in Asia-Pacific (NACA) operative under Food and Agriculture Organization of United Nation (FAO). Excellence in research for developing sustainable and diversified freshwater aquaculture practices for enhanced productivity, quality, water use efficiency and farm income is the mission of CIFA. Making Indian freshwater aquaculture globally competitive through eco-friendly and economically viable fish production systems for livelihood and nutritional security is the vision of CIFA. (http://cifa.nic.in)

Central Institute of Fisheries Technology (CIFT), Cochin

The ICAR-Central Institute of Fisheries Technology started functioning at Kochi on 29th April, 1957 under the Department of Agriculture of the then Ministry of Food and Agriculture. The administrative control of the Institute was brought under the Indian Council of Agricultural Research on 01 October, 1967. To facilitate sustainable harvesting and total utilization of fishery resources through innovations in harvest and post-harvest technologies is vision of this institute. The Institute is the only national center in the country where research in all disciplines relating to fishing and fish

processing is undertaken. Research Centers function at Visakhapatnam (Andhra Pradesh), Veraval (Gujarat) and Mumbai (Maharashtra). Ensure responsible harvesting of fishery resources through eco-friendly, energy efficient and economical means; ensure total utilization of the harvested fish through appropriate processing, value addition, packaging and waste utilization; ensure food safety and nutritional security to the consumer and minimize carbon and water footprint per unit volume; and to ensure equitable benefits to the stakeholders, across the value chain is the mission of this institute.

Central Inland Fisheries Research Institute, Barrackpore

ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI) is a premier research institute which work with inland Fisheries including reservoir and wetland ecology and fisheries, riverine and estuarine fisheries, ecosystem and fish health, aquatic Environmental management ,climate resilient inland fisheries, resource Assessment modeling and fisheries socioeconomics. At present, the Institute has 86 scientists, 50 technical staff, 36 administrative and 44 supporting personnel Posted at Head Quarters Barrackpore and Regional Centers/Stations.

Sustainable fisheries from Inland open waters for Environmental integrity; Livelihood and Nutritional security is the vision of CIFRI. Knowledge based management of Enhanced fishery, conservation of Biodiversity, integrity of ecological Services and to derive social benefits from inland open waters is the mission of this institute.

National Beuro of Fish Genetics and Research (NBFGR), Lucknow

Indian Council of Agricultural Research of Government of India established National Bureau of Fish Genetic Resources is a dedicated research center in 1983 located at Lucknow, Uttar Pradesh to undertake research related to the conservation of fish germ plasma resources of the country.

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Table 1. The state wise outcome distribution of fisheries professional in India.

Sl. No.	State	U.G.	P.G.	Ph.D.
1.	Andhra Pradesh	30	08	-
2.	Assam	20	05	-
3.	Bihar	40	10	05
4.	Chhattisgarh	37	-	-
5.	Gujarat	54	18	04
6.	Jammu and Kashmir	18	01	01
7.	Jharkhand	30	-	-
8.	Karnataka	42	20	18
9.	Kerala	50	14	05
10.	Madhya Pradesh	30	-	-
11.	Maharashtra	115	109	48
12.	Manipur	41	30	06
13.	Odisha	48	08	04
14.	Punjab	22	05	02
15.	Rajasthan	45	10	-
16.	Tamil Nadu	125	67	18
17.	Telangana	25	-	-
18.	Uttar Pradesh	71	-	-
19.	Uttrakhand	20	08	07
20.	West Bengal	32	30	08
21.	Haryana	20	6	06
	Total :	**915**	**349**	**132**

Source

https://amscau.icar.gov.in/GreenBook.pdf
https://www.apnaahangout.com/government-fisheries-science-colleges-seats-india
AIEEA Online counseling brochure for admission to ICAR's AIEEA (UG)-2021, (PG) 2021 and AICE-JRF/SRF (Ph.D.)-2021.

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ENERGY PLANTATION

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Introduction

The term "energy plantation" is comparatively a new one, however, it's concept has been quite frequently used since a couple of decades. India is one of the world's 2nd largest populated country. Most of the population (75%) residing in rural area which totally depends upon forest to meet out their energy requirement. The demand for fuelwood in India is increasing day by day. India‟s current firewood consumption is more than 133 million tonnes; most of it is being used in cooking. To cook 1 kg of food 1.2 kg of firewood is required. It clearly indicates that India should produce more wood than food if it is to be cooked before it is consumed. The electricity can also be generated by dried wood. According to estimate 400 million tonnes of cattle dung equivalent to about 60 million tonnes of fuelwood are burnt annually in our country. If this much quantity of cattle dung is incorporated into the soil then it could increase soil productivity. Similarly fuelwood is the most significant reason for tree cutting. To save forests from degradation, fuel wood tree growing should become part of agriculture through agroforestry in blocks in order to meet out their demands of fuelwood improve the microclimate by means of saving trees in natural forests. An energy plantation is one that is grown purely for plant material for their fuel than for fibre content.

The woody plants have been used since ancient times to generate fire for domestic and industrial purpose. In recent years, to meet the ever growing demand of energy, plantation of energy plants is been encouraged. We are all aware that trees are cut in many of the forest belts of India like Gangetic plains, Siwalik region and foot-hills of Himalayas. In terms of fuel wood production, India is the biggest, but the per capita fuel wood production is very low. In India, people of hill area hardly get fire-wood plants and they have to go to interior of forest to collect wood-falls. Also introduction of technologies developed for plains is not achievable in these areas. For example, they cannot be motivated to use solar cooker, because of being solely traditional and religious. Even gobar gas plant cannot be useful in hills, due to low temperatures. Therefore, renewable source of energy is highly desirable for survival of population in hills and for reducing the pressure on forests. And thus, energy plantation has got great support in our country. For obtaining good amount of biomass, afforestation and forest management government has started many plans like social forestry, silviculture and agro-horticulture practices in waste and barren lands. These programmes include growing of drought resistant, salt resistant, pollutant resistant and high density energy plantations (HDEP) in waste and barren. The technique used in high density energy plantations, HDEP is the practice of planting trees at close spacing. Here, the trees grow rapidly due to struggle for survival. It provides fast and high returns with many opportunities of permanent income and employment.

Energy plantations refers to the process of growing some plants that can be used as green fuels. These plants are used for burning to produce heat, biogas, biodiesel and bio petrol. They may be herbaceous or woody plants. Most of the herbaceous plants used for this purpose are grasses that belong to the family of Poaceae. These are selected species of trees and shrubs which are harvestable in a comparably shorter time. These plantations help provide wood either for domestic or industrial purposes. The energy plantations provide almost inexhaustible renewable sources of energy which are local and independent of unreliable and finite sources of fuel.

Types of Energy Plantations

The energy plantations are classified into three types. They are:

1. Solid biomass - Solid biomass is burnt to generate energy. They are used to produce heat and electricity (Fuel wood).
2. Gas biomass - Gas biomass is produced by anaerobic digestion (Methane).
3. Liquid biomass - Liquid biomass is produced by the process of extraction (Biodiesel, Bio-petrol).

Advantages of energy plantations

- Emit little or no sulphur and less nitrogen dioxide than fossil fuel
- Helps in rehabilitation of degraded lands
- Provide rural employment
- Alive and active growing forest and other plant biomass absorb the green house gas in quantities broadly equivalent to amount emitted when plant material decay or burned. They are thus called as “Carbon neutral” fuel sources
- Growing energy crops creates a “carbon sink” which includes storing carbon underground through the tree root system
- Lower energy cost per unit area as lower inputs are require as compared to agriculture crops
- Energy plantations are thought to remove the entire nutrient from soil. However, by use of thermo chemical process of biomass conversion it is feasible to recover all nutrients as ash which can be returned to the plantation sites
- Dependable & renewable source of energy along with afforestation of marginal lands
- Used as Aesthetic value, Windbreak and Shelterbelts
- Fodder
- Handling & disposal of by products is safe
- Energy plantations are both ecologically as well as sociologically much sounder investments
- Good amount of heat content of wood
- Non-polluting
- Ash from burnt wood is a valuable fertiliser
- Raising plantations in erosion-prone lands helps to reduce soil erosion

The following must be considered while selecting plant species for energy plantations:

- The species should be local which would help for better climatic and soil adaptation.
- Species should show rapid growth and high coppicing ability.
- The species should also produce additional products like fruits, seeds, fodder and green manure apart from fuel wood.

- The species must have hard wood.
- The species must have low requirement of water and fertilizer.
- The species must have ability to increase the soil quality.
- The species also should have high calorific value of wood.
- Tree species should be fast growing with high photosynthetic efficiency which results into high yields.
- Tree species should have high pollarding capacity.
- Tree species selected to energy plantation should be conical or cylindrical in shape.
- Tree species should have wood of high wood density, dry weight and burns without sparks or toxic smoke.
- Tree species should be able to tolerate incidences of insects, pests and diseases.
- Tree species should have ability in them to reduce transpiration loss in arid areas.
- Tree species should have ability to fix nitrogen, if possible, that can improve soil fertility without having much competition with main crop for soil moisture and sunlight.
- Tree species should be multiple in nature.

Plate 1: *Eucalyplus* Wood Lot

Plate 2: *Casuarina equisetifolia* wood lot

Plate 3: *Acacia leucophloea* wood lot

Plate 4: *Emblica offcinalis* wood lot

Plate 5: *Pongamia pinnata* wood lot

Plate 6: *Zizyphus mauritiana* wood lot

Table 1: A few species used in energy plantations with their respective calorific value and specific gravity

Sr. No.	Species	Sp. gravity	Calorific value (K cal/kg)
1.	*Acacia auriculiformis*	0.60-0.78	4800-4900
2.	*Acacia catechu*	1.00	5142-5244
3.	*Acacia dealbata*	0.70-0.85	3500-4000
4.	*Acacia leucophloea*	0.78	4899-4886
5.	*Albizia procera*	0.68	4870-4865
6.	*Anogeissus pendula*	0.94	4900
7.	*Azadirachta indica*	0.75	-
8.	*Casuarina equisetifolia*	0.80-1.2	4950
9.	*Diospyros melanoxylon*	0.79-0.87	4957-5030
10.	*Emblica offcinalis*	0.70-0.80	5200
11.	*Eucalyptus grandis*	0.40-0.70	4900
12.	*Grevillea robusta*	0.57	4904-4914
13.	*Holoptelia integrifolia*	0.63	5228
14.	*Leucaena leucocephala*	0.55-0.70	4200-4600
15.	*Morus alba*	0.63	4371-4773
16.	*Pongamia pinnata*	0.75	4600
17.	*Prosopis juliflora*	0.70	4800
18.	*Pterygota alata*	0.25-0.62	5160
19.	*Sesbania grandiflora*	0.55	4407
20.	*Tamarindus indica*	0.91-1.28	4909-4969
21.	*Tamarix aphylla*	0.60-0.75	4835
22.	*Terminalia arjuna*	0.74-0.82	5030-5128
23.	*Terminalia chebula*	0.77	3967
24.	*Xylia xylocarpa*	0.92	4975-5044
25.	*Zizyphus mauritiana*	0.93	4900

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MICROALGAE AND THEIR IMPORTANCE IN AQUACULTURE

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Abstract
Algae are a diverse group of (mainly) photosynthetic creatures that form a complex, polyphyletic assemblage. Microalgae are microscopic photosynthetic organisms that live in both freshwater and saltwater habitats. Microalgae cultivation is often considered to be the most profitable biotechnology business. It's a waste-free, environmentally friendly, energy- and resource-saving procedure. Microalgae feeds are currently employed mostly for larvae and juvenile shell and finfish culture, as well as growing the zooplankton. The use of microalgae in aquaculture is another emerging business.
Keywords : Fish, Microalgae, Sustainable, Aquaculture

Introduction

Algae creatures encompass a wide range of micro-and macro-organisms from all around the tree of life, including both eukaryotic and prokaryotic members, making algae the most genetically diverse group of organisms in the world (McFadden, 2001). Micro-algae are microscopic photosynthetic organisms that live in both freshwater and saltwater habitats. In aquaculture, micro-algae are utilized as food and live feed for bivalve molluscs, juvenile stages of abalone, crabs, as well as some fish species, and zooplankton in aquaculture food chains. Microalgae can be used to produce a wide range of metabolites for health, food and feed additives, cosmetics, and energy generation, including proteins, lipids, carbohydrates, carotenoids as well as vitamins. Spirulina, Chlorella, Dunaliella salina, and Aphanizomenon flos-aquae are among the microalgae.

Mass culture of Microalgae

Microalgae biomass is generated in engineered facilities whose basic design and architecture are determined by the microalgae of interest's growth requirements as well as the type and value of the final product. The photobioreactor and the open pond are two primary production methods. Two major production techniques are the photobioreactor and the open pond. Photobioreactors are lit fermentors of varying sophistication that are closed to the environment to prevent chemical or biological contamination, comprising parasitism, predation, and the necessity to control competition from undesirable microalgae ('weeds') when the desired species is otherwise uncompetitive. Only commodities with great value such as reagent grade phycobilins or isotopically-labeled research combinations are generated in closed systems.

Harvesting of microalgae

Micro-algae can be harvested by various procedures including such as Sedimentation, Flocculation, Flotation, Centrifugation, Filtration, or a combination of any of these. Despite the significance of harvesting to the financial and energy equilibrium viability of micro-algal biofuel, however, there is no universal harvesting technique for microalgae (Mata *et al*. 2010; Shen *et al*. 2009).

Microalgae as animal feed

Microalgae as an animal feed are a more recent development. A vast number of nutritional and toxicological studies have shown that algal biomass can be used as a good feed supplement or replacement for conventional protein sources including soybean meal, fish meal as well as rice bran. Poultry is the domestic animal of choice because incorporating algae into poultry rations offers the best chance for commercial usage in animal feed. The use of microalgae in aquaculture is another emerging business. Around 30% of current global algal production is sold for animal feed applications, according to estimates (Becker, 2007).

Use as an aquaculture feed

Microalgae feeds are currently employed mostly for larvae and juvenile shell and finfish culture, as well as growing the zooplankton needed for nourishing juvenile animals (Chen, 2003). Chlorella, Tetraselmis, Isochrysis, Pavlova, Phaeodactylum, Chaetoceros, Nannochloropsis, Skeletonema, and Thalassiosira are the most commonly employed species in fish cultivation. Spirulina and, to a lesser extent, Chlorella are utilized for a variety of animals in this area, including cats, dogs, aquarium fish, decorative birds, horses, poultry, cows as well as breeding bulls (Spolaore *et al*. 2006). Chaetoceros, Thalassiosira, Tetraselmis, Isochrysis, and Nannochloropsis are some of the most popular microalgae genera for larval feeding. These organisms are supplied to the cultivated larval creature directly or indirectly. Artemia, rotifers, and daphnia are used as indirect sources of algae, which are then fed to the target larval organisms. Several companies make aquaculture feeds with Chlorella, Spirulina, or a combination of the two. Microalgae species Hypneacervicornis and Cryptonemia crenulata, which are particularly high in protein, have been studied in shrimp diets (da Silva *et al*. 2008). Microalgae including Dunaliella salina, Haematococcus pluvialis, and Spirulina are utilized in the culture of prawns, salmonid fish, and ornamental fish as a source of natural colors. Hundreds of microalgae species have been tried as food over the last four decades, but only about twenty have become widely used in aquaculture.

Importance of microalgae

The benefits of feeding microalgae to aquaculture species include enhanced growth, improved health, and improved flavor since the seafood would have a taste similar to wild-caught fish and shrimp, improving the value of aquaculture products in food markets. Microalgae also have a lot of promise for use in sustainable aquaculture since they are phototrophic, which means they can make protein and lipids straight from sunlight. The usage of microalgae will allow the aquaculture industry to employ more readily available and stable feed, allowing it to continue to grow and fulfill current and future demands (Guedes *et al*. 2015). Owing to the wonderful performance of microalgae in carbon dioxide fixation and wastewater remediation, pollution affected by aquaculture can be alleviated. In addition, since microalgae feed has useful consequences on the health of aquatic animals, the abuse of antibiotics or medicines could be restricted in microalgae-assisted aquaculture.

Conclusion

Microalgae cultivation is often considered to be the most profitable biotechnology business. It's a waste-free, environmentally friendly, energy- and resource-saving procedure. Microalgae also have a lot of promise for use in sustainable aquaculture. The benefits of feeding microalgae to aquaculture species include enhanced growth, improved health, and improved flavor. Micro-algae can be used as a good feed supplement or replacement for conventional protein sources.

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