Economic Importance of Algae

Algae refers to a wide range of eukaryotic marine and fresh water organisms, all of which engage in the process of photosynthesis. Algae are economically important in a variety of ways. The natural substance can be used as a food source, a fodder, in fish farming, and as a fertilizer. It also plays a key role in alkaline reclaiming, can be used as a soil binding agent, and is used in a variety of commercial products. They are also harmful in many ways.

1. Algae as Food

Algae have been in use as human food for centuries in various parts of the world, e.g., Scotland, Ireland, Norway, Sweden, North and South America, China, and Japan. They are taken in several ways according to the choice and taste of the people. Algae may be taken as a salad, cooked with meat or eaten as vegetable, fried with meat etc.

Some are added for flavour to various dishes, while extract from others is taken as a beverage. Their nutritional value is quite high, as they contain a good amount of proteins, carbohydrates, fats and vitamins, specially A, B, C and E.

Mostly marine species are used and they belong to Chlorophyceae, e.g., Ulva lactuca (Sea lettuce), Enteromorphacompressa, Caulerparacimosa, Phaeophyceae e.g., Laminariasaccharina, Sargassum sp., Durvillea sp., Rhodophyceae e.g., Porphyratenera, P. umbilicalis, P. laciniata, Chondruscrispus (Irish moss), Gracilaria sp. and Cyanophyceae e.g., Nostoc sp.

These are widely used in Japan and south east Asian countries. Some of the important preparations of algae are
Aonori fromMonostroma, Kombu from Laminaria and Asakusa-Nori fromPorphyratenera.Similarly, Laminaria is widely cultivated in Japan and China. It is cultivated more like a crop plant which has resulted in the development of a more stable economic crop. Chlorella is also used extensively.The salient feature of Chlorella is that the cell is rich in protein and vitamin contents (Single cell protein, SCP). It contains all the amino

acids known to be essential for the nutrition of human being as well as animals.

It contains vitamins C, pro-vitamin A, thiamine, riboflavin, pyridoxine, niacine, pantothenic acid, folic acid, inositol and p-amino benzoic acid. The minerals present, in order of contents, are phosphorous, potassium, magnesium, sulphur, iron, calcium, manganese, copper, zinc and cobalt.

2. Algae as Fodder

The sea weeds as fodder have been widely used in Norway, Sweden, Denmark, Scotland, America, China and New-Zealand. In Norway, Rhodymenia palmate has come to be known as **'Sheep's weed'** since sheep are very fond of this particular alga. Laminaria saccharine, Ascophyllum sp., Sargassum sp. and Fucus sp., are equally liked by the cattles.
In many countries factories have been established to process the seaweed into suitable cattle-feed. Eggs, from hens fed on sea weed meal, have an increased iodine content while increased butter-fat content of milk is reported from cattle whose diet is supplemented with sea-weed meal.

3. Algae in Pisciculture

Algae, both floating and attached forms, marine as well as fresh water, provide the primary food for fish and other aquatic animals. In many countries pond culture for fishes has been taken up and they are fed with various forms of algae.

Species of the green algae, the diatoms and some blue-greens are most widely eaten up by the fishes.

It is now known that several vitamins found in fish can ultimately be traced to the phytoplankton's on which they feed. So, directly or indirectly, the algae form the source of food for fishes. At the same time, these algae keep the water habitable for fishes by absorbing the carbon dioxide and enriching water with oxygen by the photosynthetic activity.

4. Algae as Fertilizer

The large brown and red algae are used as organic fertilizers, especially in the coastal areas. The weed is used either directly or as a seaweed meal. A concentrated extract of seaweed is also sold as a liquid fertilizer. However, the greatest utility of the algae, as a friend to the farmers, are members of the classCyanophyceae for their capacity to fix atmospheric nitrogen and thus enriching the soil. In the paddy fields they have been seen to produce an effect almost similar to that of manuring with 30 kg. of ammonium sulphate per acre (Watanabe, 1959).

Aulosira fertilissima, the common blue-green algae of the Indian rice fields is found to add 47-6 lb. of nitrogen fixed /acre/crop (Singh, 1962). At the same time there is a considerable increase in the total organic matter content of the soil. In India, the nitrogen-fixing blue-green algae play an important role in maintaining the fertility of the rice fields.

5. Reclamation of alkaline 'usar' land :

In India, vast tracts of land cannot be cultivated for crops because of high alkalinity of the soil, commonly known as **'usar'** soil. The **'usar'** lands would be cultivable, if their pH could be lowered, and organic contents and the water holding capacity of the soil increased. Exactly all these functions are carried out by the blue-green algae.
During the rainy season the blue-green algae, notably species of Nostoc, Scytonema, Anabaena and Aulosira, grow in plenty. According to R. N. Singh (1950), these algae can be of use in the reclamation of the 'usar' lands. The process involves a series of successive growth of the algal crop in a water-logged condition.

(After a year of such reclamation, the pH fell from 9-5 to 7-6, organic contents increased from 36-5% to 59-7%, nitrogen contents from 30% to 38-4%; exchangeable calcium from 20% to 33% and water holding capacity of the soil is also increased by 40%. In such a **'reclaimed'** land, the transplanted paddy crop grew with a yield of 715-907 kg/acre. This method of reclamation is now being practiced widely.)

6. Binding of soil particles :

Algae act as an important binding agent on the surface of the soil. Disturbed or burnt soils are soon covered with a growth of green and blue-green algae thus reducing the danger of erosion.

7. Algae used in space research :

Chlorella is being used in space research. Chlorella has been found very suitable for keeping the air in space vehicles pure on long interplanetary flights. The stale air in which the carbon dioxide has been concentrated is fed into a flood-lit container containing a mixture of water and nutrient chemicals and Chlorella.The alga restores oxygen into the space vehicle by its photosynthesis.

8. Commercial products :

Many forms of marine algae, Phaeophyceae and Rhodophyceae, are highly valuable for certain commercial products, chiefly agar-agar, algin or alginic acid and carrageenin.

i. Agar-Agar (Agar):

Agar-agar is obtained from various members of red algae for e.g., Gelidium, Gracilaria and species of Chondrus, Gigartina etc. It is a non-nitrogenous extract obtained almost in a pure mucilaginous form. The chief constituent of agar is a carbohydrate galactan.The purified agar is sold in the form of flakes, granules or strips which are brittle when dry but become tough and resistant when moist.

The important use of agar is in microbiology and tissue culture (in the preparation of culture media as gelling agent for growing algae, fungi and bacteria in the laboratories).

Other uses are in the cosmetics, paper and silk industries, in dentistry for making impressions and in the preparations of ice-cream, jellies, sweets and baking.

ii. Carrageenin:

This is a metabolic product similar to agar, obtained from Chondruscrispus, Gigartinastellata and Iridaealaminaroides.

The mucilage has several important industrial applications, e.g., in textile industry, in paper making, in the manufacture of straw and felt hats as a stiffening agent; as an ingredient in cosmetics, shoe-polishes, hand lotions, tooth paste etc., as an emulsifying and suspending agent, in the baking, dairy industries and in clarifying liquors.

iii. Algin and Alginates:

Algin is a calcium magnesium salt of alginic acid present in the intercellular substance of the Phaeophyceae. Because of its special colloidal properties alginic acid and its derivatives find considerable use in industry. Its salts are used in the manufacture of variety of goods ranging from ice-cream, salad cream, custard and jams to cosmetics, films, fabrics, ceramics, textiles, polishes and paints.

They are also used as a suspending agent in compounding drugs, lotions and emulsions; in the rubber industry in latex production; as an insulating material and as dental impression powder.

Species of Laminaria, Fucus, Ascophyllum, Macrocystis, Nereocystis, Ecklonia, and Sargassum are the chief sources of commercial algin.

iv. Diatomite :

Fossil forms of diatoms in some regions are found in large deposits which are called **'Diatomaceous earth'**. Silica, the basic constituent of glass and granite rock, is deposited on the cell walls of the diatoms. Because the silica walls are hard and chemically inert, the sediments accumulate in marine and fresh water basins.

Deposits of fossil marine diatoms over 1,200 feet thick are known. Once these were used as an absorbent of nitro-glycerine in the manufacture of dynamite.

Now-a-days, for its hard and chemically inert nature, it is mainly used in insulation, as a filtering agent and as an abrasive, in the industrial filtration processes of sugar refining, brewing and wine making, in the recovery of chemicals and for removing waste mycelium in the production of antibiotics.

11. Medicinal use:
Alaria was once used for strengthening the stomach and restoring the appetite after sickness. Alginates are used for their haemostatic nature; fucoidin and sodium lamanarin sulphate are used as **'blood anticoagulant'**. Digenia simplex, a Rhodophycean alga, provides an antihelmnitic drug. Agar-agar, for its absorptive and lubricating action, is used medicinally in the prevention of constipation.
The antibacterial product **chlorellin**, obtained from Chlorella acts as antibiotic. The antibacterial effects are more pronounced against coliforms and other related intestinal bacteria.Extracts of Cladophora, Lyngbya and certain other algae kill strains of Pseudomonas and Mycobacterium and exhibit antiviral activity.

13. Sewage Disposal:
Sewage consists of water borne domestic and industrial waste which is rich in dissolved or suspended organic and inorganic constituents but very poor in oxygen. Species of Chlamydomonas, Scenedesmus, Chlorella and Euglena are used in sewage treatment plants for providing through photosynthesis the oxygen necessary for rapid decomposition of the sewage by bacteria.

Bacteria break down the sewage component of complex organic compounds into such simple inorganic compounds as ammonia, carbon dioxide etc. and water with the needed amount of oxygen. Oxygen required may be supplied artificially which is quite expensive or through the agency of the photosynthetic algae which grow in sewage disposal ponds.

The most common algal species present in the sewage oxidation ponds are Chlamydomonas, Scenedesmus, Chlorella, Euglena, Eudorina and Pandorina.

Tests have shown that the algae recovered from sewage ponds can be used as animal food and in certain regions it may be a valuable source of fodder.

16. Other Products:
From members of Phaeophyceae, two important products mannitol and fucoidin are obtained. Mannitol is used in food and medicinal products, inks and plastics etc. and fucoidin is used as a mucilage and in medicines.

The burnt **'ash'** of larger Brown algae, specially the **Kelp** belonging to Laminariales, has been used for the extraction of minerals iodine and bromine. It is also used as a source of soda in the manufacture of soaps, glassware and alum.

Negative Importance

1. Toxicity and parasitism:

Gymnodinium veneficum, Prymnesium parvum and species of Microcystis cause mortality in fish and in domestic animals that drink water infested with these algae.Some species such as Gonyaaulax produce endotoxins which accumulate in the digestive glands of shellfishes feeding on them. If such shellfishes are consumed by other animals including humans, paralysis and even death may result.

Bloom forming blue green algae such as Microcystis aeruginosa, and Anabaena flos-aquae have been found to cause animal poisoning in temperate countries.

If some of the toxic planktonic algae happen to be ingested, they may cause various disease syndromes. For example, some Anabaena and Microcystis species cause gastric trouble; Gymnodinium brevis produces respiratory disorders, and Lyngbya and Chlorella are responsible for certain skin infections.

Species of parasitic green algae Cephleuros cause 'red rust of tea' and cause heavy economic losses by seriously affecting the yield of tea.

The excessive growth of certain algae such as Microcystis aeruginosa in a body of water often results in severe depletion of oxygen in the habitat. This leds to mass mortality of fish due to suffocation. Sometimes, high temperature and bright sunlight result in massive disintegration of algal blooms which releases

their noxious compounds into the medium. Choking of the mouth or gills of fish by these algae is also partly responsible for their death.

2. Fouling of marine vessels :

Some sea weeds may grow on the metal hulls and woodwork of ships and boats producing a corroding and destructing effect. Thick growth of weeds sometimes results in considerable increase in friction between hull and water thereby accentuating wear and tear and shortening the life of the vessel.

3. Importance in municipal water supplies :

The problems associated directly or indirectly with algal growths in water reservoirs and water supplies are:

i. loss of recreational and fishing values of pools, ponds and lakes due to excessive growth of Microcystis, Spirogyra, Cladophora and Pithophora

ii. impartingabnormal tastes and odours by the metabolic or decomposition products of organisms such as Symura, Synedra, Anabaena, Microcystis and Dinobryon.

iii. Clogging of water filters by Oscillatoria, Spirogyra and certain diatoms.

iv. Colouration of raw and finished waters due to the presence of planktonic algae such as Chlorella, Chlamydomonas, Euglena and Oscillatoria

v. Production of toxic substances

vi. Corrosion of concrete and metallic walls of pipes and boilers by carbonic, oxalic and silicic acids excreted by certain algae, e.g., Anacystis and Chaetophora

vii. Changes in pH, CO_2, bicarbonate and oxygen contents of water.

However, they serve useful purpose by maintaining of aerobic conditions by checking putrefaction of organic substances and reduction of total hardness of water by consuming bicarbonates and insoluble carbonates.

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