BOTANY (H) 1st SEMESTER

Date : 30.11.2020

CC 1 : PHYCOLOGY

UNIT – 4

Algae

(Part 5)

Roles of algae in environment, agriculture, biotechnology and industry :

Algae are economically important and are used for various purposes. Some of the useful activities are as follows –

1. Algae as food :

Algae are produced by man from ancient times. But due to population bloom in the last decade, the rate of consumption of edible algae has been increased and it will definitely increase much more in near future. The algal species is becoming a popular food to the mankind because of its high nutritive value and yield per unit area than the conventional crops.

Some of the common algae used as food are – *Chlorella, Spirulina, Chondrus, Porphyra, Ulva* etc. Their roles as food are –

(i) *Chlorella* is important for its nutritive value and can be compared with soya beans. It contains 30% of carbohydrate, 30% of protein and 15% lipid. But the digestion of its cell wall is problematic to the human being. It also contains vitamin B.

(ii) *Spirulina* is now popularly used as single cell protein (SCP) due to their high content of protein (50-70%). *Spirulina* contains high amount of vitamin B, essential unsaturated fatty acids and β-carotene.

(iii) From *Chondrus crispus* (Irish moss), a gelatinous carbohydrate is obtained which is used in pudding as a stabilizer and clearing agent in the production of beer. The alga is cooked with milk and with the addition of vanilla it makes a popular dish, the blancmanges.

(iv) *Porphyra* is red algae which is rich in protein (30-35%) and carbohydrate (40-45%). It is a good source of Vitamin B and vitamin C. It is a common food item in Japan (locally called as laver or nori), China (locally known as tsats'ai) and Britain (locally called sloke). *Porphyra* soup is highly priced in Europe.

(v) Algae like *Ulva* and *Codium* is used as salad in Japan.

(vi) *Laminaria saccharina* is rich in carbohydrates (57%) and the commonly used food is called kombu.

2. Algae as fooder :

Algae constitute a source of permanent food for many animals, especially in coastal countries. These include mainly the members of Pheophyceae, Rhodophyceae and some green algae.

(i) *Laminaria, Sargassum, Fucus* etc. are commonly used as fodder in many areas of Japan and U.K.

(ii) Sea weed meals (such as *Rhodymenia palmate*, *Ascophyllum esculenta*) are used to increase the fat content of the milk of cattle in Scotland and Ireland.

(iii) *Macrocystis*, the Pacific-coast kelp is rich in minerals, vitamin A, and vitamin E and is used as fodder to feed cattle and poultry birds in USA.

(iv) The egg lying capacity of the poultry birds also increases by feeding the processed sea weeds like *Fucus, Laminaria, Sargassum* is used as fodder in China.

3. Algae as bio-fertilizer :

Algae are used as bio-fertilizer either directly or indirectly. They belong to different groups like Cyanophyceae, Chlorophyceae, Pheophyceae and Rhodophyceae. They are produced as the source of nitrogen, potassium, calcium. Sea weeds are either allowed to rot in the field or composted with other organic materials. The prepared manures when added in the cultivated land, they not only enrich the soil but also help in soil binding.

(i) Nitrogen source :

About 32 genera and 152 species in blue green algae are capable of fixing nitrogen in either aerobic or anaerobic condition. Species of *Nostoc, Anabaena, Spirulina, Oscillatoria* are capable of fixing nitrogen in the soil. They may be with or without heterocysts. These algae grow well in the rice field and increase the nitrogen content of the soil.

The nitrogen fixing members of Cyanophyceae are classified into following major classes –

a) Unicellular or colonial aerobic nitrogen fixers, e.g., *Gloeocapsa*.
b) Unicellular or colonial aerobic / micro-aerobic nitrogen fixers, e.g., *Dermocarpa*.
c) Heterocystous filamentous aerobic nitrogen fixers, e.g., *Nostoc, Anabaena*.
d) Non-heterocystous filamentous anaerobic nitrogen fixers, e.g., *Oscillatoria*.
e) Non-heterocystous filamentous aerobic nitrogen fixers, e.g., *Trichodesmium*.

(ii) Potassium source :

Sea weeds are rich in potassium but poor in nitrogen and phosphorus than the farm manure. Sea weeds of Phaeophyceae and Rhodophyceae are used as fertilizer. They are used as compost. Sometimes, the weeds are dried and brunt and the ashes are scattered over the cultivated lands. Concentrated liquid extracts of sea weeds are used as liquid fertilizer. In Sri Lanka, Ireland, it is used in potato field. In China, it is used in ground nut field and in Japan in rice fields.

(iii)Calcium source :

The powder of different members of *Lichophyllum* and *Lithothamnion* are used in place of lime. Some species of Chara are also used for similar purpose.

4. Algae as bio-oil :

A number of microalgae have been investigated to produce bio-oil via pyrolysis or thermal liquefaction. Bio-oil yields from microalgae have been reported up to 41% in case of *Spirulina* and about 24%–45% in case of the microalgae *Scenedesmus.* In macrolagal biomass *Laminaria saccharina* accounts for about 63% energy restoration and *Laminaria saccharina* yields 79% oil after hydro-thermal liquefaction. But in case of freshwater macro-algae such as *Oedogonium* and *Cladophora* yields only 26% and 20%, respectively.

5. Algae as bio- diesel :

Microalgal biodiesel is mainly composed of unsaturated fatty acids [33]. The algal biomass from wastewater contains a mixture of various algae and hence different fatty acid profiles can be obtained. *Chlorella vulgaris* and *Chlorella protothecoides* are two main species; containing high oil content has been studied by many workers for the production of biodiesel. Biodiesel can be produced from algae such as *Chlorella* sp., *Euglena* sp., *Spirogyra* sp., *Scenedesmus* sp etc.

6. Algae as bio-ethanol :

Algal biomass is the potential source to produce bio-ethanol. Examples of green algae employed for bioethanol are: *Dunaliella, Chlorella, Chlamydomonas, Arthrospira, Sargassum, Spirulina*, *Gracilaria, Prymnesium parvum, Euglena gracilis* and *Scenedesmus.* The bioethanol from seaweed *Ulva lactua* can be produced by fermentation with yeast.

7. Algae as source of β-carotene :

The unicellular halo tolerant alga, *Dunaliella bardawil* is found to contain high concentration of β-carotene.

8. Algae as a source of phycocolloids :

Phycocolloids are some complex polysaccharides extracted from the walls of some brown and red algae. These are mucilaginous material and hydrophilic in nature. Three principal types of phycocoloids are –

(i) Agar-agar,
(ii) Alginic acid and
(iii)Carrageenan.

(i) Agar-agar :

Agar is composed of two polysaccharides – agarose and agaropectin. It is readily soluble in water. It is commercially obtained from *Gelidium nudifrons, Gracilaria verrucosa*.

USE :

a. It is used as solidifying agent in various culture media because it melts at 85-100°C and become solid at low temperature.
b. It is also used in food pharmaceutical and cosmetics industries.
c. It is used in manufacture of cheese, pudding, creams and jellies.
d. It is also used as laxative, leather and textile industries and to prepare some pills and ointments.
e. Pure agarose is used in gel electrophoresis.

(ii) Carrageenan :

It is a phycocoloid, derived from the cell wall of certain red algae. Example includes *Chondrus crispus* (Irish moss), *Gigartina* sp., *Stellata* sp. It is a complex of D-galactose, 3,6-anhydro D-galactose and mono-esterified sulphuric acid which is almost similar in agar agar.

USE :

a. It is used as stabilizer of emulsion in paints and cosmatics.
b. It is also used as a component of deodorants, tooth pastes, paints, cosmatics etc.
c. Physicians also used carrageenan as a blood coagualant.
d. In alcohol and sugar industry, it is used as a clearing agent.

(iii)Alginic acid :

Alginates are salts of alginic acids, which are found in the cell wall of some brown algae *Laminaria* sp., *Fucus* sp. It is a complex polysaccharide of β-1,4 linked mannuronic acids and α-1,4 linked L-glucorinic acid units. It is also obtained from the cells of some red algae. It is a non-toxic, insoluble in water, viscous but becomes hard when dry.

USE :

a. About half of alginate is used for making ice-creams.
b. In food industry, it is used in the preparation of soap, cream, sauce.
c. In textile industry, it is used in printing pastes and cosmetics.
d. It is used in the production of artificial fibers, plastics and rubbers.

- **Diatomite :**

After the death of diatom cells, the outer covering i.e. the silicified wall (frustules) becomes accumulated at the bottom of the water. This accumulation may be thicker during favorable condition and these deposits are called diatomaceous earth or diatomite. Diatomaceous earth may be white, firm, soft and light.

USE :

a. It is used as filter in different industries (sugar, oil).
b. It is used as insulators of boilers and blast furnaces for its heat resistance ability.
c. It is used as a clearing agent in soap, toothpaste and metal polish industries.