

# Search for Future Viands

## Algae and Fungi as Food

*Dipanjan Ghosh*

**Algae and fungi have good prospects to be exploited as alternative sources of food. Both these groups of organisms are rich in food value, especially in their protein component. Their large-scale utilization may help to minimize food crises as well as malnutrition around the world.**

For the last few decades, scientists throughout the world have been searching for suitable and nutritional alternatives to conventional food, partly due to the grave food shortage all over the globe due to the ongoing human population explosion. Agricultural yields are increasingly failing to satisfy the need of our daily diet as population increase is geometric whereas crop production increases more or less arithmetically. To meet this challenge, the use of some alternate food source in our diet becomes indispensable. Alternate food literally means some healthy and readily available supplement excluding the conventional staples of our daily diet. So, in respect of diversity and affluence, the selection of algae and mushrooms as an alternate source of food is quite reasonable.

### Seaweeds as Foodstuff

Many Indians may sneer at the thought of having algae as an alternate source of food, but algae are already extensively used as a food source in many countries. These algae are generally marine and are commonly termed as 'seaweeds'. The major users of seaweeds as food are the coastal Japanese, and about 25% of their daily diet consists of seaweeds. Seaweeds are used as food in many forms in several Asian countries, such as Myanmar, China, Thailand, Korea, Malaysia, Philippines and Indonesia, and are also considered a tasteful dish in England and Scotland. Seaweeds are also to be found in the diets of people in Australia, New



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#### Keywords

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About a hundred species of algae are used as food throughout the world, most of them belonging to the classes Chlorophyceae (green algae), Rhodophyceae (red algae) and Phaeophyceae (brown algae).

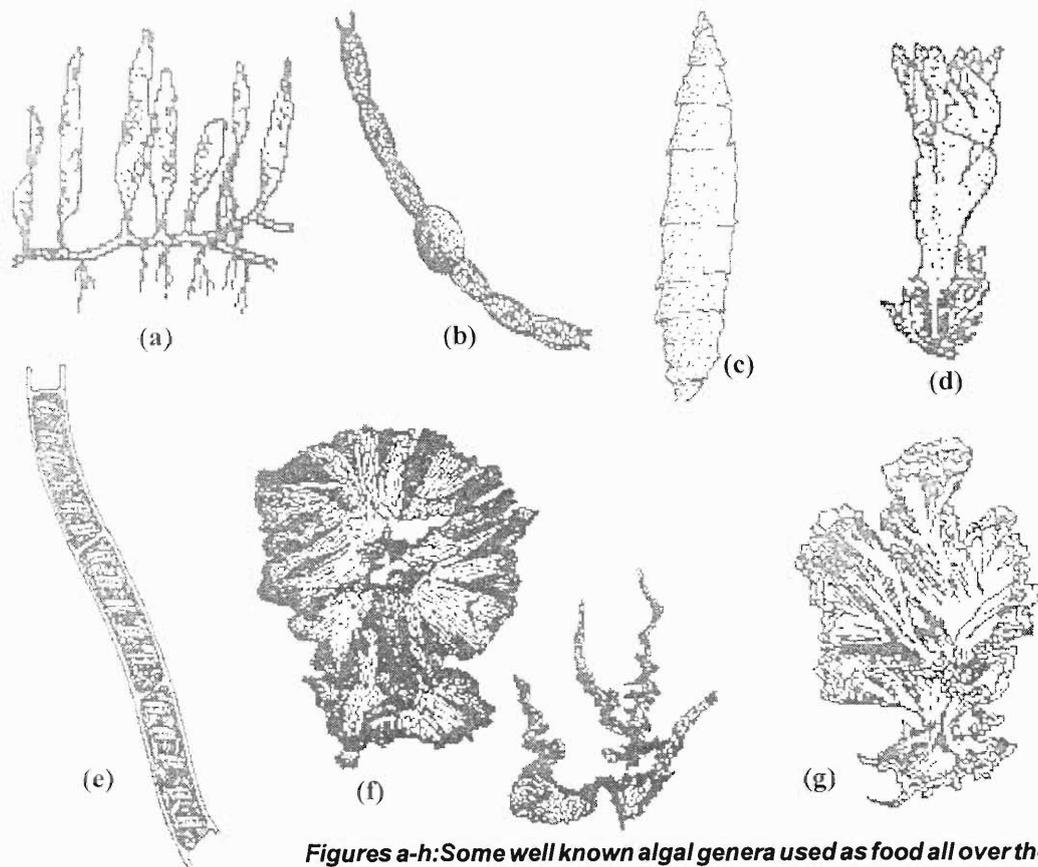
Zealand, France, Chile, Hawaii, Brazil and several other Latin American countries. About a hundred species of algae are used as food throughout the world, most of them belonging to the classes Chlorophyceae (green algae), Rhodophyceae (red algae) and Phaeophyceae (brown algae). Species of the genera *Caulerpa*, *Durvillea*, *Laminaria*, *Monostroma*, *Nereocystis*, *Oedogonium*, *Porphyra*, *Rhodymenia*, *Sargassum*, and *Spirogyra* are particularly commonly used as food in different parts of the world.

In restaurants in many countries, seaweeds are served as palatable dishes under the common names like 'Laber', 'Dulse', 'Sarumen', 'Kombu', 'Mitszu', 'Asakusanori', 'Citron', 'Nori', 'Amanori', etc. 'Kombu' is prepared from the stipes of *Laminaria*, 'Laber' and 'Nori' from *Porphyra*, 'Sarumen' from *Alaria*, and 'Suimeno' and 'Mitszu' from the blending of 2-3 different types of seaweeds. 'Dulse', a salty confection prepared from *Rhodymenia palmata* and 'Citron', prepared from *Nereocystis*, are considered as tasteful dishes in England. *Ulva lactuca* is used for the preparation of salads and soups in Scotland, whereas large quantities of *Durvillea antarctica* and some species of *Ulva* are consumed in Chile. *Monostroma*, *Oedogonium* and *Spirogyra* are now major alternative sources of food in New Zealand. *Caulerpa racemosa* is cultivated in Philippines as a source of food. *Laminaria*, *Porphyra*, *Sargassum*, *Ulva*, etc., are common items of diet in China, Myanmar, Malaysia, Indonesia, Australia and in some European countries. Perhaps the best known and most widely used algal food in Western Europe in recent times is *Chondrus crispus*, commonly known as 'Irish moss' or 'Carragheen'. It is cooked with milk, then seasoned with vanilla or fruits and is made into a 'Blancmange'.

### Food Value

Seaweeds are not just alternate and exotic sources of food, but they also possess great nutritional value. They are rich in proteins, fats, vitamins, and mineral salts. Typically, algae consist of about 25-30% fats of its total dry weight; 10-20% proteins; 2-4% vitamins and 0.2-0.5% mineral salts. Although this proportion





**Figures a-h: Some well known algal genera used as food all over the world.**

- a) *Caulerpa racemosa* – this marine alga covers extensive tracts in the tropical and Mediterranean sea-floors.
- b) *Oedogonium* sp. – a very common green alga occurs in almost all types of fresh water bodies in India.
- c) 'Kelp' (*Laminaria* sp) – the name that originally referred to the ash rich in soda and potash, derived from burning marine plants, is now applied specifically to this large algal group.
- d) *Rhodymenia palmate*, basically an edible red alga, other species are exploited as fodder.
- e) 'Pond silk' (*Spirogyra* sp.) is named after its silky thread-like appearance in the freshwater bodies.
- f) *Porphyra tenera* is with high nutritive value – the protein content is 30-35% on dry weight basis.
- g) 'Sea lettuce' (*Ulva lactuca*) – a marine green alga with crispy thalloid body looks like lettuce.
- h) 'Irish moss' (*Chondrus crispus*) – this purple edible seaweed is very familiar with European delicacy.



Algae are specially rich in vitamins A and E, and often are also rich in vitamin C and D. Mineral elements mainly include sodium, potassium, iodine, chlorine with a trace amount of copper, iron, manganese, zinc, etc. Thus, algae provide many elements essential for a well balanced diet.

varies with different species, depending partly on their habitat, it gives a rough idea about their nutritional value. Algae are specially rich in vitamins A and E, and often are also rich in vitamin C and D. They are also rich in thiamine, niacin, riboflavin, choline, pantothenic acid, pyridoxin, biotin, etc. Mineral elements mainly include sodium, potassium, iodine, chlorine with a trace amount of copper, iron, manganese, zinc, etc. Thus, algae provide many elements essential for a well balanced diet.

### Indian Perspective

India is a country with several ethnic communities with widely varying dietary habits. However, it is interesting to note that none of them considers algae as a healthy supplement to their conventional food, although a large number of algae have had access into human diets from the ancient times. The earliest records were those of Chinese who mentioned about *Laminaria* and *Gracilaria* in their 'Materia Medica' several thousand years ago. The most diversified dietary use of seaweeds was developed by the Polynesians and reached its maximum in Hawaii where during nineteenth century at least 75 species were separately used as regular food. The phenomenal increase of population in India may result in food shortage in the near future. So, to meet this challenge, suitable substitutes for conventional foods, especially the use of edible algae on a commercial scale, could become a very useful strategy. The large coastline of India also favours mass culture of edible algae. Recently in South India, the popularity of 'Green Laber', a palatable dish prepared from *Spirogyra* and *Oedogonium* gives us a ray of hope of having algae as food supplement on a commercial scale.

### Mushrooms

Mushrooms are the fruiting bodies of one of the most well known groups of organisms called 'Fungi' which typically appear only during moist seasons.

During rainy season, mushrooms grow hither and thither to fulfill their life cycle. Mushrooms are saprophytes and play a role



in the decomposition of organic matter in the biosphere. But most importantly, mushrooms have a high food value and can be used as a substitute for proteinaceous foods in human diet. Mushrooms are members of the highly evolved fungal group, Basidiomycetes. It is the same group of organisms to which rust and smut disease-causing organisms belong. In general, members of this group possess large, macroscopic, coloured, variously-shaped fruiting bodies termed 'basidiocarps'. That is why they are also called macromycetes or macroscopic fungi.

### Mushrooms as Food

Compared to algae, fungi are a more familiar ingredient of human diet. Certain fungi like mushrooms, morels and truffles appear in our diet as food. Mushrooms have been used by man as food since ancient times, but not until the seventeenth century were they cultivated as a crop. The early cultivation of mushrooms took place in France. Soon, many other European countries started to grow them. In the United States they were not grown before the latter part of nineteenth century. Now they are produced commercially in many places all over the world, including India.

At present about two thousand species (belonging to thirty different genera) of mushrooms are either consumed fresh, or dried to make into soups, sauces and other food products, although all mushrooms are not edible (see *Box 1*). Out of the two thousand or so edible species of mushrooms, only eighty have been artificially cultivated around the world.

The edible agarics are popularly known as 'mushrooms' whereas the poisonous ones are the 'toadstools'. Many of the agarics are considered great delicacies e.g., 'meadow mushroom' i.e. *Agaricus bisporus*, and *A. campestris*; *Calocybe indica*, 'inky-cap mushroom' i.e. *Coprinus comatus*; *Lentinus edodes*, *Lepiota morgani*, *Marasmius campanella*; 'oyster mushroom' i.e. *Pleurotus ostreatus*, *P. sajor-caju*; 'termite mushroom' i.e. *Termitomyces sp.*; *Tricholoma personatum*, 'paddy straw mushroom' i.e. *Volvariella volvacea*, etc.

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### Box 1. Poisonous Mushrooms

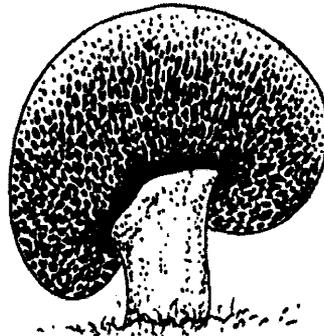
Mushrooms may be poisonous too! Some such fungal genera (about twenty five genera are proven poisonous) are *Amanita* (*A. muscaria*, *A. pantherina*, *A. phalloides*, *A. verna*, *A. virosa*), *Boletus*, *Clitocybe*, *Coprinus*, *Galerina*, *Gyromitra*, *Helvella*, etc. These are widely known as 'death cap', 'destroying angel', 'fly agarics', 'inky-cap', 'false morel' or 'saddle fungi'. Generally they possess some lethal mycotoxins like 'amanitin', 'coprin', 'gyromitrin', 'ibotenic acid', 'muscarine' and 'phallotoxin', etc. After consuming poisonous fungi one may suffer from nausea, diarrhoea, giddiness, convulsion, liver and kidney damage, skin diseases and even death.

It is often difficult to differentiate edible mushrooms from poisonous mushrooms. However, one may take the following precautions:

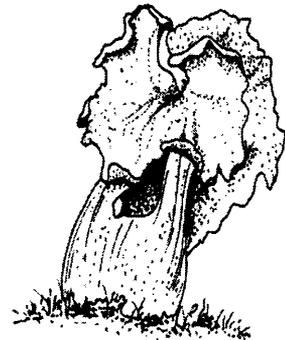
- 1) Mushrooms collected from hither and thither should not be taken as food.
- 2) Poisonous mushrooms are generally odorous and colourful.
- 3) Metallic silver articles turn black in contact with the poisonous mushrooms.
- 4) Snails feed on mushrooms. But they do not eat poisonous mushrooms even by mistake. So one can examine that the mushroom is poisonous or edible with the help of snails.



*Amanita verna*



*Boletus satanus*



*Helvella esculenta*

*Boletus edulis*, *B. mirabilis* and their close relative *Suillus cavipes* are also good edible species.

'Sponge mushroom' (*Morchella*) is rather well known as a delicious edible fungus under the name 'morel'. However, no one has yet succeeded in cultivating species of this ascomycetous fungus. It usually occurs under trees or in open grassland areas naturally. Some well-known species of *Morchella* are *M. conica*, *M. esculenta*, *M. rotunda*, etc. and these are found mainly in the

forests of Jammu and Kashmir, Punjab, Uttaranchal and Uttar Pradesh.

Species of another ascomycetous genus *Tuber* is commonly known as 'truffles'. This dark brown fungus looks like roots of the yam plant. Besides just being edible, these fungi have already earned fame of special importance for their delicacy of flavour. Their fruiting bodies emit a powerful odour during maturity. The subterranean fruiting bodies are gathered usually with the assistance of trained dogs or pigs in France, Spain and Italy. A common Indian species is *T. melanosporum*

Fruiting bodies of 'puff-ball' fungus *Lycoperdon* (*L. alveolatum*, *L. elongatum*, *L. microspermum*, etc.), 'giant puff-ball fungus' *Calvatia* (*Calvatia cyathiformis*, *C. gigantea*) and 'jelly fungus' *Auricularia auricula-judae* are also edible when young. The young maize cob tumours formed as a result of localized infection induced by the fungus *Ustilago maydis* are fried to make popular side dish.

Most of the clavarias are tender and may be used as food. In fact several of them have been reported as edible, such as *Clavaria vermicularis*, *Clavariadelphus pistillaris*, *C. truncatus*, *Ramaria aurea*, *R. botrytis*, *R. flava*, *R. rufescens*, etc. In India also, *Ramaria apiculata* and a species of *Sparassis* (cauliflower fungi) grow profusely at the base of conifers during rainy season. These large-sized clavarias are widely used as food in Western Himalayas.

### Food Value

The food value of any edible substance depends on its protein, carbohydrate, and fat content or even on the minerals, vitamins and trace elements it provides. In general mushrooms contain a higher amount of mineral elements than any other conventional vegetables. Phosphorus and potassium are the main constituents. Copper and iron are also present in appreciable amounts, besides sodium, calcium, magnesium and some trace elements.

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Mushrooms are especially rich in proteins containing most essential amino acids. They are excellent sources of vitamins like A, D, K, C, and B-complex group, such as thiamine, riboflavin, niacin, pantothenic acid, biotin and folic acid. The vitamins are well retained even when cooked. Carbohydrates present in mushroom are of low calorific value. Also, mushrooms are almost free of fatty acid and cholesterol. As a result, mushrooms make an ideal protein-rich food for heart patients, diabetics and obese persons.

### Indian Perspective

Mushrooms are relished all over the world. In India, the prospect of mushroom cultivation was pointed out by a famous mycologist S R Bose in 1921 but it was K M Thomas and his associates who first attempted to grow mushrooms in 1940s. Nowadays, mushrooms are a familiar ingredient of many Indian recipes.

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### Suggested Reading

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#### Please Note

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The number 2 has been inadvertently omitted twice; both before 'du' in the penultimate equality and before the integral sign on the last line.

**This is important because the whole idea was doubling the integral.**

