UNIT 4 SEAWEEDS BASED PRODUCTS

Structure

4.0 OBJECTIVES

After reading this unit, you will be able to:

- identify various commercially important seaweeds;
- analyse various seaweed products and their properties;
- describe different methods of preparing the products; and
- explain the uses of seaweed based products.

4.1 INTRODUCTION

Seaweeds are marine plants or algae. Generally, they grow in coastal waters, attached to the seabed. Based on the colour of their pigments, algae are grouped into four, namely, green, red, brown and blue green algae. Of these, blue green algae are microscopic and do not come under the so called 'seaweeds' group. You must know that seaweeds are not just 'weeds', but serve as raw materials for making several useful products. Seaweeds have been used for centuries, particularly by the Japanese and the Chinese, as food, fodder and manure. Presently, they are used for extracting various substances that have numerous applications. Several areas of the Atlantic Ocean and the Pacific Ocean are rich sources of seaweeds. The coastal waters of India too, are rich in different species of seaweeds.

There is a good market for the algal products, particularly agar and alginates. In this unit, you will learn few important products from them, their method of preparation and uses.

4.2 COMMERCIALLY IMPORTANT SEAWEEDS

Algae are simple primitive plants compared to those we have on land. Look at the diagram given below (Fig. 4.1). You may only observe certain structures such as holdfast, stipe and blade. The entire plant body is called frond. You should also note that the size of the plants vary greatly from a few centimeters to several meters or even more. And believe it! The seaweed *Macrocystis pyrifera* grows up to a few kilometers in length! Large sized seaweeds are also called 'kelp' (see Fig. 4.2).

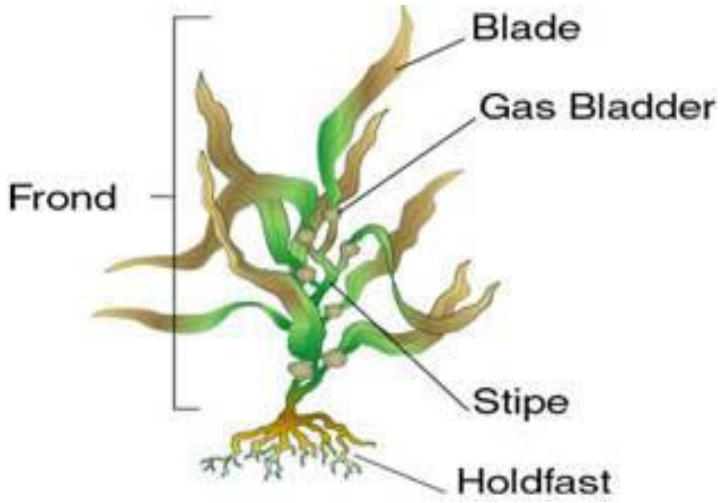

Fig. 4.1: Parts of alga

Fig. 4.2: A kelp 'forest'

There are several species of algae but only some are commercially important. To be commercially useful a seaweed should be rich in components that have applications in various industries - for making food, pharmaceuticals and several other products. Table 4.1 gives a few examples of commercially important seaweeds available in our region.

Table 4.1: Generic Names of Some Economically Important Seaweeds of India

Green Algae Class: *Chlorophyceae*	Red Algae Class: *Rhodophyceae*	Brown Algae Class: *Phaeophyceae*
Enteromorpha	*Geliediella*	*Sargassum*
Ulva	*Gracilaria*	*Turbinaria*
Chaetomorpha	*Hypnea*	*Padina*
Caulerpa	*Gigartina*	*Dictyota*
Codium	*Porphyra*	*Colpomenia*

4.3 HARVESTING AND DRYING

The naturally occurring seaweeds have to be collected by some methods, so that they can be further processed into useful products. Let us learn about these aspects.

4.3.1 Harvesting

Collection of seaweeds from water is termed harvesting. Fishermen have realized the need for a controlled harvesting. It may be done once a year or so from an area. Methods of harvesting include cutting the algae by divers, raking from boats (Fig.4.3) or simply gathering the pieces washed ashore. Many countries including India have also taken up cultivation of seaweeds. Seaweeds have tremendous potential to multiply and increase in quantity. Many institutions coming under the ICAR have perfected the culture technology of seaweeds, using floating rafts. Some private entrepreneurs are cultivating seaweeds in huge quantities along the East Coast by involving fishermen groups. There are many species of seaweeds prevalent along our coasts. However, there is no clear policy in leasing out coastal waters, etc., which can help in the proper utilization and culture of these important resources. A seaweed farm is shown in Fig.4.4.

Fig. 4.3: Harvesting seaweed using rakes

Fig. 4.4: A seaweed farm

4.3.2 Drying

You may consider drying as a preliminary step to processing of seaweeds. The fresh seaweed harvested will definitely contain a good amount of dirt, sand, etc. So, it goes without saying, a thorough washing is a must. The fresh seaweed contains plenty of water- over 80% of its weight. If you dry the material, you cannot only preserve it but also can reduce its bulk. For this, the water content must be reduced well below 20%. Sun drying is the most commonly practiced drying method. A dip treatment of the material in dilute formalin solution may sometimes be given prior to drying. For drying, simply spread the seaweeds on large mats or platforms, or hang them from ropes or poles (Fig.4.5). Avoid spreading directly on the ground as it can lead to heavy contamination with sand, filth, etc. Store the dried material in clean, dry warehouse. They should be packed in sacks for transporting to the processing plant.

Fig. 4.5: Sun drying of seaweeds by hanging

4.4 COMPOSITION AND GENERAL PROPERTIES

Some information about the components present in seaweeds would be helpful in your study. Table 4.2 gives you some idea about the composition of dried seaweeds in general.

Table 4.2: Chemical Composition of Dried Seaweeds

Component	Content (%)
Moisture (water)	7-12
Carbohydrate	30-50
Protein	10-30
Minerals	30-40
Vitamins	(in small amounts)

The composition can vary greatly according to the species, season, region, environment, age, etc. In the fresh seaweed, quantitatively water is the most important component.

Some of the dried seaweeds are rich in proteins and other nitrogen containing compounds of nutritional importance. Numerous minerals have been detected in

seaweeds such as sodium, potassium, calcium, iodine and bromine. Minerals occur as salts of different metals. Vitamins such as B_{12}, C, D and E are present in seaweeds. The total carbohydrate (sugar) content of all seaweeds is high. Majority of the commercially important products are polysaccharides- e.g. agar, algin and carrageenan. Polysaccharides are large molecules that are made up of smaller molecules of sugar or monosaccharide.

? Check Your Progress 1

Note: a) Write your answers within the space provided.
b) Check your answers with those given at the end of the unit.

1) Seaweeds are also called …….. .

2) Three groups of seaweeds based on their colour are ....., ...and …….. .

3) Two purposes of drying seaweeds are …… and …… .

Activity 1

Visit coastal areas or beaches where seaweeds are found. Observe the methods of collecting and drying seaweeds. Check the differences between fresh and dried seaweeds. Collect samples of different varieties of fresh algae. Visit a marine fisheries institute museum or botany laboratory where specimens of various algae are displayed. Study the different parts of the plant. Take the help of a botanist or an algologist at the laboratory who'll explain you the details.

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4.5 SEAWEED PRODUCTS

You have already learnt that seaweeds have been used for food, fodder and manure. You also know by now that various substances are extracted from seaweeds, which have numerous applications. By now, you're ready to deal with the major objectives of this unit which is to study the preparation, characteristics and utilization of various seaweed products.

4.5.1 Agar

A gel forming substance in an alga was accidentally discovered by a Japanese man by name Minoya in the year 1660. This later came to be known as agar or china grass. It's a hydrocolloid extracted from certain red algae. Seaweeds rich in agar are in general called agarophytes. A few examples of agarophytes of Indian waters are *Gelidiella acerosa* and *Gracilaria edulis* (Fig. 4.6). *Gelidium* is a temperate water alga.

Fig. 4.6: An agarophyte- *Gracilaria edulis*

The agar content of dried seaweeds generally varies from 30 to 50% by weight. Agar occurs in the cell walls of seaweeds. It consists of a mixture of mainly two polysacharrides, namely, agarose and agaropectin. Agar is insoluble in cold water, but dissolves upon heating. On cooling, this solution to room temperature, it forms a gel.

(i) Extraction and purification of agar

Dried agarophytes are to be transported to the unit where agar is manufactured. For commercial production, various methods are followed. The important stages in the formation of agar are shown in Fig. 4.7. Dried material must be washed and soaked well in water. Then, we grind the material to a slurry or pulp in order to expose the agar in the cell walls. Now, filter this slurry through a cloth. The agar is insoluble in water at this stage. This along with the seaweed fragments will be retained in the cloth. To this add sufficient quantity of water (e.g. 10 litre per kg). An acid is to be added to reduce the pH to 6. Heat the slurry at a temperature of 90^{o}C for a period 1 or 2 hours with stirring. What happens now? Agar dissolves in the hot water leaving behind rest of the seaweed fragments. The agar goes into solution.

Dried alga | Agar solution

Agar gel | Dried agar

Fig. 4.7: Stages in the formation of agar

Transfer the hot slurry to a vessel or tank and allow it to stand undisturbed in hot condition to settle the insoluble. The tank may be provided with heating facility to maintain the temperature high. This is to prevent solidification (gelling) of agar. Transfer the hot solution into a cloth bag and squeeze out the liquid into a vessel. A press as shown in Fig. 4.8 can be used for pressing. For large scale operation, special pressure filters are used. Cool the filtrate (solution) to room temperature. What happens now? The solution becomes a gel. This can be cut (shredded) into strips for drying.

The gel formed contains only 1 or 2% agar, the rest being water. Sun drying is a simple method to dry the gel. But, this is quite time consuming. For commercial production, you can follow the freeze-thaw method. What is freeze-thaw method? In this, the gel strips are kept in a cold room at a temperature of -5 to -10^{o}C for a day. Water in the gel freezes forming ice crystals. When exposed to room temperature, ice melts to form water, a process called thawing. The water separates out from the agar and along with it most of the impurities also escape. In order to get colorless product, bleaching with a solution of calcium hypochlorite is done. The agar will still be having some water. This can be easily removed by drying under sun or in a drier. A suitable drier, called tray drier, is shown in Fig. 4.9. Agar is generally marketed as dried strips or as powder. The product can be packed in suitable containers like plastic bottles, plastic bags, etc.

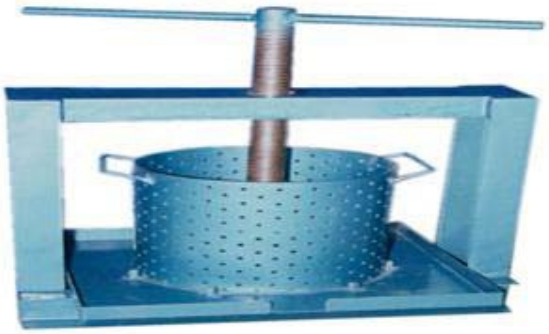

Fig. 4.8: A simple screw press

Fig. 4.9: Tray drier

The Indian Standards Institution (ISI) has laid down specifications for various quality parameters of agar e.g. the maximum limits allowed for moisture, mineral (ash) and sand contents of agar are 20%, 6.5% and 1%, respectively.

(ii) Uses of agar

Agar has several unique properties that make it a very useful substance. It can form gel at concentrations less that 1%. Its gel is probably the strongest amongst the hydrocolloids. It is not attacked by most microorganisms. Now, let's see some of its applications.

a) In microbiology

Probably, the most important use of agar is in the study of microorganisms. In earlier days, it was difficult to grow these organisms on a solid medium. It was a housewife who suggested the possibility of using agar as a gelling agent for culturing (growing) microorganisms. The idea was taken up by the renowned scientist, Robert Koch in the year 1881. This was a turning point in the study of microbes and even today no material has replaced agar. Look at Fig. 4.10. The glass dish (petri plate) contains an agar gel with various nutrients. Over this bacteria are seen growing into visible circles called colonies. Each colony is composed of thousands of bacterial cells. The bacteria utilize the nutrients in the medium, but not the agar.

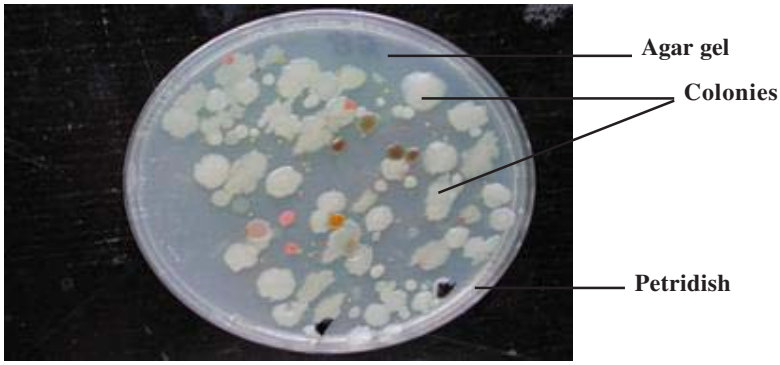

Fig. 4.10: Agar plate with bacterial colonies

b) Other laboratory uses

Agar is used in tissue culturing of plants. You can see in Fig. 4.11 that new plants are developed from cells grown on a nutrient agar medium. This consists of agar gel with various nutrients required for the plant.

Fig. 4.11: Agar medium with tissue cultured plant

Agarose is one of the sugars contained in agar. Agarose is extensively used as a gel in various biochemical and biotechnological studies. Some important applications are in chromatography, electrophoresis and immune-diffusion techniques. These are methods of separating or identifying various biological substances.

c) In food

The name ‘china grass’ is quite familiar to the housewife. You can use it for thickening soups and other liquid foods resulting in a ‘rich’ appearance and feeling. Its gelling property can be applied to jams and marmalades. This way, the concentrated fruit pulp is prevented from flowing. The gelling property is also

made use of in the making of candies, *halwa*, puddings, etc. An example is shown in Fig. 4.12.

Fig. 4.12: China grass pudding

Tuna flake in agar jelly is a canned fish product. Agar gel can also be used as edible casings for meat sausages. Casing is the covering over sausage in the form of a tube. Agar can be used in combination with other gums in order to obtain a more acceptable texture, flavour stability etc. in the food.

d) Pharmaceutical and cosmetic applications

Agar has long been used as a laxative. It slowly disintegrates in our body. This property is applied in the making of capsules and tablets. The drug incorporated with agar is slowly released into our body as desired. Because of its smooth and slippery characteristics, agar can be used as a carrier for topical ointment medicines, in surgical lubricants etc. and also for various cosmetic creams and lotions. Agar gel can be used for casting moulds in dentistry.

e) Industrial uses

Agar finds applications in several areas. Incorporation of agar in detergents can enhance the latter's foaming property. Foam is a dispersion of air bubbles in a film of water. If agar is dissolved in this water, the foam will become more stable. Agar finds application in dye coatings of paper and textile, as an ingredient in shoe polish, in photography, etc.

? Check Your Progress 2

Note: a) Write your answers within the space provided.
b) Check your answers with those given at the end of the unit.

1) Two polysaccharides present in agar are …….. and …….. .

2) In the manufacture of agar, the methods adopted for dehydrating agar gel are …….. and …… .

3) Another name for agar is ……... .

4) What is the role of agar in microbiological studies?

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Activity 2

Purchase a packet of china grass from a supermarket. Examine its appearance, colour and smell. Put some of it into a small vessel. Mix it with water and see whether it dissolves. Next, heat the suspension with stirring. Once it starts to boil remove from flame. What's the change you notice? Then allow it to cool to room temperature. Again observe the change. Try to give reasons for each based on what you've learned.

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4.5.2 Algin

Alginates or algins are salts of alginic acid. The discovery of algin was made by Stanford in the year 1883. Algin occurs in the cell walls of several species of brown algae. Seaweeds rich in algin are called alginophytes. Various species of *Sargassum* (Fig.4.13), *Turbinaria*, *Padina* and *Colpomenia* are the commercially important alginophytes of Indian waters. Some of the important varieties found in temperate waters are *Macrocystis* and *Laminaria*. Alginic acid is also a kind of polysaccharide. Alginic acid and its calcium and magnesium salts are insoluble in water. Other salts like sodium and potassium alginates are soluble. So, how to prepare algin?

Fig. 4.13: An alginophyte- *Sargassum*

(i) Preparation of alginate

You must be aware that when an acid is treated with an alkali, we obtain a salt. So, if we treat alginic acid with an alkali, the corresponding salt, that is, alginate is obtained. The flow chart given below shows you the preparation of one such alginate: sodium alginate.

Wash, soak and grind the dried seaweed
↓
Immerse in hydrochloric acid
↓
Strain (filter) and wash it
↓
Treat with formaldehyde
↓
Strain and wash
↓
Treat with sodium carbonate
↓
Filter
↓
Dry the filterate (Sodium alginate)

Flow chart for preparation of sodium alginate

As in the case of agar let's start with dried seaweeds. Soak the material in water and grind well. Seaweeds naturally contain different alginates but mostly insoluble ones like calcium alginate. So, first we convert them to alginic acid. For this, immerse the material in a solution of 1N (normal) hydrochloric acid. (If you dilute concentrated hydrochloric acid to 10-11 times using water, you get approximately 1N solution). Treat the material at a temperature of 50°C for a period of about 30 minutes. The reaction may be shown as:

Calcium alginate + hydrochloric acid → alginic acid + calcium chloride

Alginic acid is again insoluble in water. So, strain the material through a piece of cloth to collect the ground seaweed (pulp) containing alginic acid. In order to prevent any darkening, you may give a treatment with a dilute solution of formaldehyde. This is to be followed by straining and washing the pulp. Now add sufficient quantity of a 3% solution of sodium carbonate. Allow it to react for a day. The alginic acid will react with the alkali thus:

Alginic acid + sodium carbonate → sodium alginate + carbon dioxide + water

The figure given below (Fig. 4.14) shows the important stages in the making of an alginate from seaweed.

Dried alga

Alginic acid

Alginate solution

Alginate powder

Fig. 4.14: Stages in the formation of sodium alginate

The sodium alginate formed will dissolve in water and thus gets extracted. Pour the slurry into a cloth bag and squeeze using a press (Fig. 4.8). The liquid can then be dried to a powder form. The product obtained may contain impurities. Therefore, you'll have to further treat it to obtain pure alginate. You can prepare other alginates in a similar manner, but by using appropriate chemicals- e.g. potassium hydroxide with alginic acid to form potassium alginate; calcium chloride with alginic acid to form calcium alginate.

(ii) Uses of alginates

Alginates are remarkable products that have applications in several fields. Here, again, we make use of their special properties.

a) In foods

Thickening and stabilizing effects can be brought about by soluble alginates (such as sodium and potassium alginates) in soups, sauces, fruit juices, milk shakes, puddings, etc. As it increases the viscosity of soup, various solid food particles will be distributed uniformly without settling down. This property is termed suspension stabilization which is demonstrated in the Fig. 4.15.

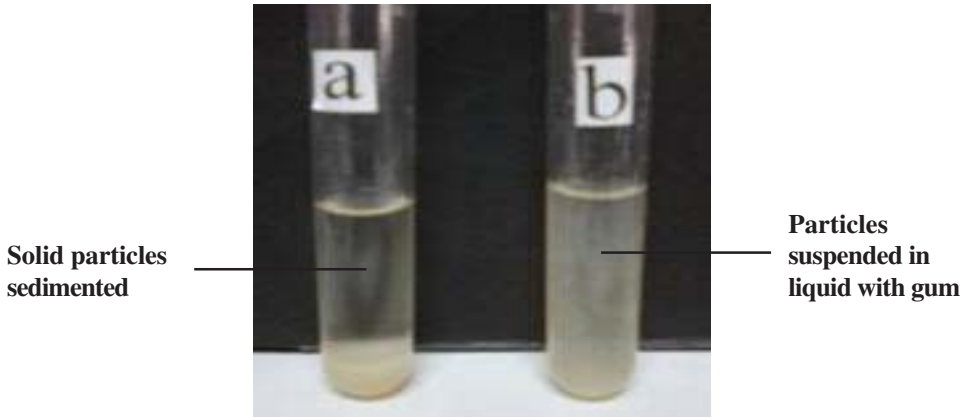

Fig. 4.15: Stabilization of a suspension by gum

Do you feel the presence of ice pieces when you eat ice cream? I'm sure you don't. This is because the alginate (e.g. sodium alginate) dissolved in the ice cream mix slows down the growth of ice crystals during freezing. Thus, numerous but very fine crystals are formed giving a smooth texture.

In order to form edible casings for sausages, edible coatings for meat, fish, chicken, battered products, etc., the food material can be given a coating with calcium alginate. The coating gives protection to the food from moisture loss, oxygen, microorganisms, etc. You can also coat frozen foods such as fish with algin- a process called glazing. This will protect the food material from rancidity problems (on account of oxidation of fat inside), dehydration (loss of moisture), etc.

Alginates such as propylene glycol alginate in beer can produce more stable foam. You may note that in most applications, alginates are used at low concentrations- well below 1%.

b) In pharmaceuticals and cosmetics

Algins are good emulsion stabilizers. What's an emulsion? It's a mixture of two liquids in which one liquid is dispersed as fine droplets in the other e.g. oil in milk. But, it's necessary that the two liquids should not separate out when algin is added in the emulsion, it increases its viscosity thereby reducing the tendency to separate. This effect is demonstrated in Fig. 4.16. This property is applied in the case of many foods and medicines. Ointments containing algin have good emulsion stability. In certain liquid medicines, soluble alginates are used as suspending as well as thickening agents. Alginate solutions are also smooth and slippery. This property is applied in surgical lubricants.

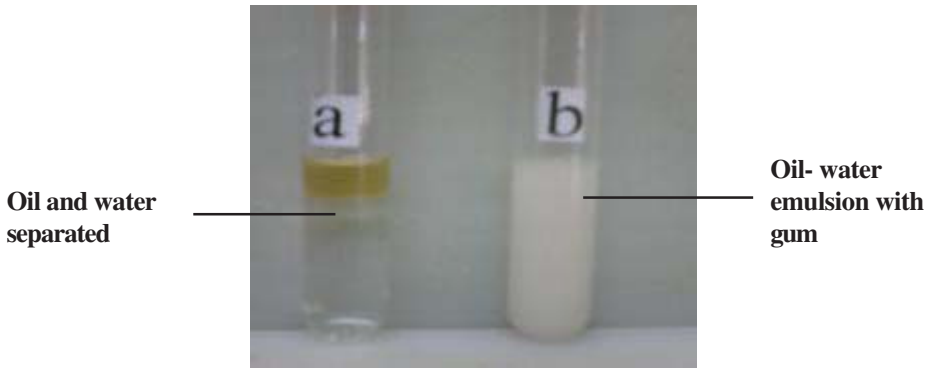

Fig. 4.16: Emulsion stabilization by gum

As in the case of agar, alginates can be used in tablets as a disintegrating agent. Calcium alginate filaments can be used for making high quality absorbable surgical or wound dressings (Fig. 4.17). Algin based dental impression materials are excellent for making dental casts.

Fig. 4.17: Calcium alginate dressing material

Algin is a good thickener for liquid shampoos. Cosmetic creams and jellies are made smooth by incorporating algin.

c) In the industry

Algin can be used for surface sizing of paperboard in order to acquire a smooth surface. Its stabilizing property is applied to several items- e.g. rubber latex, paint, polish and insecticides.

Algin is useful for making what is called 'immobilized biocatalysts'. In this, microbial cells or enzymes are entrapped in an alginate gel or bead (Fig. 4.18). Such a system can be used for continuous production of ethanol, citric acid, glycerol, yoghurt, etc.

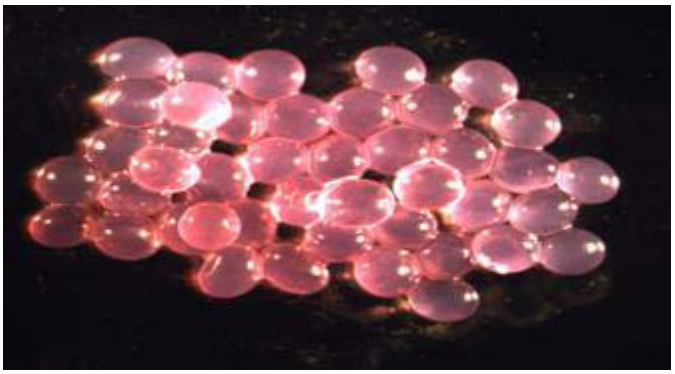

Fig. 4.18: Algin beads

? Check Your Progress 3

Note: a) Write your answers within the space provided.
b) Check your answers with those given at the end of the unit.

1) Alginates are also called …….... These are salts of …….

2) …….. is an alginate soluble in water whereas, …… is one that is insoluble.

3) What's the role of alginate in fruit juice?

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4) Seaweeds rich in algin are generally called ……..

4.5.3 Carrageenan

Carrageenan is yet another seaweed gum that has wide applications. Its name originated from that of an Irish town called Carrageenan where it was first extracted. It's presently being extracted from many species of red algae, e.g. *Chondrus crispus* or Irish moss (Fig. 4.19), *Gigartina stellata* and *Furcellaria*. However, we have only few carrageenophytes in our waters-e.g. *Hypnea*. Until recently, India was importing carrageenan as there was no indigenous production. Now, it is made from cultured seaweeds in Tamil Nadu coastal sea. It is composed of various polysaccharides/fractions and contains good amounts of sulphur. Carrageenan also gives viscous solutions. Most fractions can form gel.

i) Production of carrageenan

We shall only briefly deal with its production since this product is not manufactured in India. But it's a very important industry in several other countries. After washing and soaking the dried alga, it's extracted by treating with a solution of alkali. The mixture is heated at a temperature of 100^{o}C. It's then filtered and the liquid is heated in order to concentrate it. This is further dried to obtain carrageenan powder. Instead of heating the liquid, it may be treated with isopropyl alcohol or ethyl alcohol. By this, we can precipitate out the carrageenan. The material is then dried and pulverized to obtain a powder of carrageenan (Fig. 4.20).

Fig. 4.19: Irish moss

Fig. 4.20: Carrageenan powder

ii) Uses of Carrageenan

There are many uses of carrageean both in food as well as non-food industry. They are as discussed below:

a) In food industry

The majority of applications of carrageenan are in foods. It's used as a gelling agent in puddings, jams, fruit jellies, certain canned fish, etc.

Frozen fish may be given a coating with carrageenan to protect it from fat oxidation and drip loss. Drip is the water that gets separated when a frozen food is thawed. To prevent this, polyphosphates are extensively used for frozen seafoods. But, these are chemicals and so, not desired in foods. Attempts are being made to replace polyphosphates with carrageenan, which is a natural safe substance.

Like agar or alginate, carrageenan has the properties of thickening, stabilizing, binding, etc. For this reason, it's used in milk shakes, concentrated milk, etc. Carrageenan in combination with other gums can be used to obtain a smooth texture for various products such as ice creams, cheese and minced meat products. Cheese has a special problem called 'syneresis.' Sometimes, water comes out of it resulting in a coarse texture. Incorporation of carrageenan helps to prevent syneresis.

The binding property of carrageenan is applied in the making of minced meat products like patties and in the manufacturing of texturized protein food from soybean. The latter is a meat-like product in which carrageenan helps to bind together the fibres (Fig. 4.21).

Fig. 4.21: Texturized soy protein

b) Non food uses

The properties we discussed above for foods are also useful for various other products. Addition of carrageenan to tooth paste provides better texture and shape retention. Carrageenan gel can be formed into capsules for drugs (Fig. 4.22). Carrageenan stabilizes medicines that are in the form of emulsions or suspensions. The same properties are applied to pesticides, water based paints, etc. The binding property of carrageenan is adopted in pet foods and fish feed also.

Fig. 4.22: Carrageenan capsules

4.6 OTHER SEAWEED PRODUCTS

Several products other than the ones we've discussed so far can be prepared from seaweeds. These include a few other gums also.

a) Laminaran

This is a gum obtained from several species of *Laminaria*. These are brown algae growing in temperate climate. It is produced only in small amounts in some countries. Laminaran is a white, odourless and tasteless powder. In the medical field, laminaran is used as surgical dusting powder, cancer inhibiting agent, etc.

b) Fucoidan

Fucoidan occurs in most of the brown algae. It is extracted from certain species of *Fucus, Laminaria, Ascophylum and Macrocystis.* Fucoidan may have applications in the medical field, as blood anti-coagulant, antiviral agent, antioxidant, cancer inhibiting agent, etc. Studies related to them are in progress.

c) Seaweed as food

We've seen that almost all seaweed gums have several applications in foods. In addition, several species of seaweeds can be directly used as food. In many countries of the Far East, especially Japan and China, seaweeds are extensively consumed as salads, curries, soups or as vegetable dishes. Fig. 4.23 gives you some idea of the various dishes from seaweeds. *Nori* is a dried film of edible seaweeds like *Porphyra*.

Rice- seaweed dish

Nori

Fig. 4.23: Foods prepared from edible seaweeds

In India, seaweeds are rarely consumed- may be in certain coastal areas. However, several species available in our waters are edible. Important amongst them are *Ulva* (Fig. 4.24)*, Enteromorpha, Gracilaria, Codium* and *Chaetomorpha.*

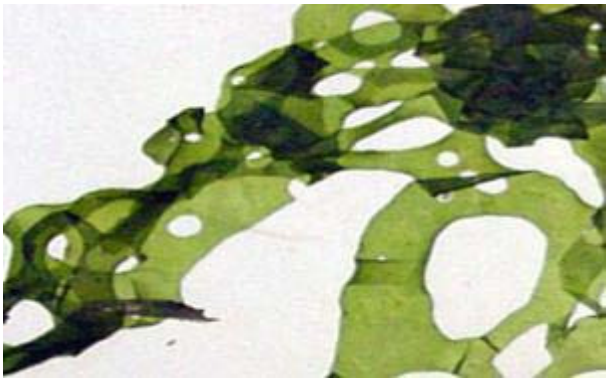

Fig. 4.24: An edible seaweed- *Ulva reticulata*

From Table 4.2, you can understand that seaweeds are rich in proteins and minerals. They are also rich in certain vitamins, especially vitamin C. Seaweeds are rich sources of iodine too. After drying and pulverizing, they can be incorporated into various food items, so that their nutritional value is increased. It's also possible to extract out the proteins from seaweeds. Some research work in this line has been attempted in India also. Technologies have been developed for incorporation of seaweeds into foods. If we can popularize such foods it'll be a great relief to the food shortage problem existing in many developing countries.

d) Seaweed meal

Since seaweeds contain good amounts of proteins and minerals they could be incorporated into animal feeds also. The edible seaweeds mentioned earlier and several other species could be used for making seaweed meal. Dried and pulverized seaweed is mixed with other ingredients of the animal feed in a certain ratio.

Several feeding studies have shown that seaweed meal is as good as any other feed supplement.

e) Seaweed manure

As farm manure seaweeds are extensively used worldwide. Seaweeds are rich in minerals and trace elements and can readily be absorbed by plants. The organic components of the algae (proteins, carbohydrates, etc.) are good sources of carbon and nitrogen. Seaweeds are excellent for making compost manure. *Hypnea, Ulva, Arachis, Enteromorpha, Spatoglossum* and *Sargassum* are examples of seaweeds used in India as farm manure. Seaweed manures in general are found to be superior to many other conventional farmyard manures. Such observations were made based on the growth of plants and yield of crops. Extracts of certain marine algae are found to promote seed germination and growth of seedlings. Foliar sprays have also been developed for spraying on leaves for increased leaf size.

f) Mannitol

This is a sugar alcohol present in the cell sap of most brown algae. This occurs to the extent of 2 to 10% of the dried seaweed. This may be extracted as crystals. Mannitol may be helpful in the treatment of diseases of brain and kidney. It can be used as a sweetener in foods in the place of table sugar (sucrose), thus benefiting the diabetic patients. Several mouth fresheners are available in the market in the form of tablets, chewing gums, etc. Many of them contain mannitol as it develops a cool and fresh feeling.

g) Potential uses

Attempts are being made to produce several other products from seaweeds. Seaweeds can be fermented to produce methane gas, ethyl alcohol, various esters and acids.

? Check Your Progress 4

Note: a) Write your answers within the space provided.
b) Check your answers with those given at the end of the unit.

1) The gum present in Irish moss is …… .

2) What's the role of carrageenan in fruit jam?

.....

.....

.....

3) Seaweed gums of minor importance are …….. and …… .

4) What's the purpose of adding carrageenan to minced meat products?

.....

.....

4.7 LET US SUM UP

Several commercially important species of seaweeds grow in the coastal waters of India. Seaweeds can be eaten raw. They are to be harvested and sun dried for storage as raw material. Seaweeds contain water, carbohydrates, protein, minerals and vitamins. The important products from seaweeds are gums or hydrocolloids. They are large molecules called in general as polysaccharides. The gum can dissolve in water to form viscous solution. The gums have varied uses because of these properties. Agar is an important hydrocolloid obtained from certain species of red algae. Agar has important applications in microbiology, food preparation, industry, etc. Algin is present in many brown algae. Algins also have wide applications in food, pharmaceutical and other industries. Other gums include carrageenan, laminaran, fucoidan, etc. But these are not produced in India. Carrageenan has several applications especially in food making. In addition to gum preparation, many of the seaweeds can be used as food itself. Several seaweed dishes are popular in many Far East countries. Seaweeds can also be used for making animal feed, manure and many other applications.

4.8 GLOSSARY

Agar : Gum obtained from certain species of red algae, chiefly consisting of agarose and agaropectin.

Alga : Aquatic water plant (algae- plural).

Algin : Salt of alginic acid obtained from several species of brown algae.

Anticoagulant : A substance that prevents coagulation- e.g. it stops blood from clotting.

Antiviral : Having activity against virus or viral infection.

Antioxidant : Substance capable of slowing/ preventing oxidation of other substances.

Alginate : Algin.

Binding Agent : Substance having adhesive property.

Bleaching : Treating a material to obtain a lighter colour.

Carrageenan : A gum containing sulphate obtained from certain species of red algae.

China Grass : Agar.

Dehydration : Removal of water from a material.

Emulsion : Intimate mixture of two immiscible liquids in which one is distributed as fine droplets in the other liquid.

Entrapped : Trapped inside a material- e.g. enzyme molecules held inside an alginate gel.

Enzyme : Biological materials that catalyze (increase the rate of) chemical reactions.

Foliar Spray : Liquid spray for feeding plants with certain nutrients through leaves.

Gel : A network of a solid (e.g. gum) in which liquid molecules (e.g. water) are entrapped.

Gum : Polysaccharides obtained from seaweeds showing colloidal properties when dissolved in water.

Hydrocolloid : Gum.

Kelp : Very large seaweeds.

Polysaccharide : Large molecules of sugars (carbohydrates) formed of several small molecules joined as a chain (polymer) e.g. starch- a polymer of glucose.

Pharmaceuticals : Products of medicinal use.

Precipitate : Insoluble substance or solid formed in a solution as a result of some chemical reaction.

Slurry : A thick suspension of solids in a liquid.

Suspension : Particles distributed in a liquid.

Thickening : Increasing viscosity of a liquid.

Viscosity : Resistance of a liquid to flow.

4.9 SUGGESTED FURTHER READING

Anonymous. 1987. *Seaweed Research and Utilization in India*. CMFRI Bulletin 41, Central Marine Fisheries Research Institute, Cochin. pp. 1- 116.

Mathew, P.T. 2002. *Seaweeds and their Industrial Uses*. In: Textbook of Fish Processing Technology, Gopakumar, K. (Ed.). Indian Council of Agricultural Research, New Delhi, pp. 303- 330.

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Mchugh, D.J. 1987. (Ed.). *Production and Utilization of Products from Commercial Seaweeds.* FAO Fisheries Technical Papers- T288, pp. 1- 94.

Whistler, R.L. and Bemiller, J.N. 1973. *Industrial Gums*, Academic Press, New York, pp. 1- 807.

4.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Marine algae.

2) Green algae, brown algae and red algae.

3) For preservation (storage) and for reducing weight.

Check Your Progress 2

1) Agarose and agaropectin.

2) Freeze- thaw method, drying under sun or in drier.

3) China grass.

4) Used as a gelling agent for growing microorganisms.

Check Your Progress 3

1) Algins; alginic acid.

2) Sodium alginate; calcium alginate.

3) As thickening agent.

4) Alginophytes.

Check Your Progress 4

1) Carrageenan.

2) As solidifying (gelling) agent.

3) Laminaran and fucoidan.

4) To function as a binder of meat and other components.