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Seaweeds: A Diet with Nutritional, Medicinal and Industrial Value

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ABSTRACT

Seaweed may belong to one of several groups of multicellular algae: the red algae, green algae and brown algae. As these three groups are not thought to have a common multicellular ancestor, the seaweeds are a paraphyletic group. In addition, some tuft-forming bluegreen algae (Cyanobacteria) are sometimes considered as seaweeds, seaweed is a colloquial term and lacks a formal definition. These can be used human food, cosmetics, fertilizers and for the extraction of industrial gums and chemicals. According to prior reports, it has been proved that so many biologically active compounds are present in seaweeds those we can use them as therapeutic agent, dietary supplements.

Key words: Seaweeds, functional food, bioactive peptides

INTRODUCTION

Seaweeds are floating submerged plants of shallow marine meadow, having salt tolerance, because the osmolarity of cytoplasm is adjusted to match the osmolarity of the seawater, so that desiccation of the plant does not occur.

Seaweeds are large algae (macroalgae) that grown in saltwater or marine environment. They lack true stems, roots and leaves. However, they possess a blade that is leaf like, a stipe that is stem like and a holdfast that resembles a root like terrestrial plant. Seaweeds contain photosynthetic pigments and use sunlight to produce food and oxygen from carbon dioxide and water. The importance of seaweeds for human consumption is well known in many countries such as Malaysia, Indonesia, Korea, Australia, Japan and Singapore where algae are used in the form of salads, soups, jellies and in vinegar dishes. The species used as food includes *Caulerpa* sp., *Codium* sp., *Hydroclathum* sp., *Sargassum* sp., *Porphyra* sp. and *Laurencia* sp. and *Enteromorpha*, *Gracilaria*, *Sargassum*, *Padina*, *Dictyota* are used as a feed for cattle and poultry.

Proteins which are the building blocks of living world also have a hidden capacity of modulating physiology by means of small peptides which are formed either during the processing or during *in vivo* digestion. Small peptides with biological function or physiological effects are called bioactive peptides. These can be obtained from different sources like microorganisms, plants, animals etc., (Smacchi and Gobetti, 2000). Dairy products are important sources of bioactive peptides (Torres-Llanze *et al.*, 2005).

Active peptides are potential modulator of various regulatory processes in the living system. These are immunomodulatory peptides, cytomodulatory peptides, Angiotensin-I-Converting Enzyme (ACE)-inhibitory peptides, opioid peptides, mineral binding peptides.

Research in the field of bioactive peptides has intensified during the last two decades and has been extensively reviewed (Tirelli *et al.*, 1997; Xu, 1998; Meisel and Fitz-Gerald, 2003; Korhonen and Pihlanto, 2003). The potential for bioactive peptides to contribute to a healthier nutrition (e.g., by ingesting them with functional foods) has been widely discussed in the scientific community. Chemical and biological methods have been applied and developed to screen for bioactive peptides that could promote different health effects; however, only some of the postulated health effects have been proven in human studies.

During past 10 years marine organisms have provided a large number of new natural products. Interesting compounds have mainly been derived from microorganisms such as algae, sponges, ascidians, corals and bryozoans. The number of secondary metabolites from marine organisms is smaller, but rapidly increasing (Wanger-Dobler *et al.*, 2002). Many of the marine algae constitute a major part of the diet in Eastern countries which are known for the longevity of life span.

In this research, we are mainly concentrate on marine sources (seaweeds). The reason behind the selection of seaweed is that they can be used as human food, cosmetics, fertilizers and for the extraction of industrial gums and chemicals. According to prior reports, it has been proved that so many biologically active compounds are present in seaweeds those we can use them as therapeutic agent, dietary supplements.

Use of seaweed

As a food: In recent years, there has been a growing interest in so-called functional foods because they can provide physiological benefits additional to nutritional and energetic, as, for instance, antihypertensive, antioxidant or anti-inflammatory (Goldberg, 1996). A functional food can be defined as a food that produces a beneficial effect in one or more physiological functions, increases the welfare and or decreases the risk of suffering a particular disease. Furthermore, new types of products, derived from food, called nutraceuticals have recently been developed. These products, usually employed as food supplements, are marketed as tablets and pills and can provide important health benefits. Frequently, functional foods are obtained from traditional foods enriched with an ingredient able to provide or promote a beneficial action for human health. These are the so-called functional ingredients.

The seaweeds are mainly used as food in the regions of Far East and Australia. The people living on the sea coasts in these countries commonly use fresh seaweeds as food. The most important food species in Japan are Nori (*Porphyra* species), Kombu (*Laminaria* species) and Wakame (*Undaria pinnatifida*). In japan *porphyra tenera* happens to be one of the most important edible algae and a product by the name of Amanori and Asakusa-Nori are made from it.

The use of kelps (kombu in Japan; haidai in China) dates back to at least the 5th century in China. The main species used is *Laminaria japonica* (Laminariales), but 8-11 other species are used also, mainly in Japan.

Plants are dried after harvesting and either cut into strips or powdered. In Japan, kombu is used in the preparation of fish, meat dishes, soups and also as a vegetable with rice. Powdered kombu is employed either in sauces and soups or is added to rice in the same way as curry. Some kinds are used in making an infusion similar to tea.

Nori is a red alga, *Porphyra* sp. (Bangiophyceae). Nori is sold in sheets that may be toasted to give a green colour and then flaked and added to sauces, soups and broths. Sometimes it is just soaked and eaten. Small, dry nori sheets are used to wrap cold rice balls, which make a popular lunch-time snack for Japanese children. The food value of nori lies in its high protein content (25-35% of dry weight), vitamins and mineral salts, especially iodine. Its vitamin C content is about 1.5 times that of oranges and 75% of the protein and carbohydrates are digestible by humans, which is very high for seaweeds.

As a source of vitamins, seaweeds are the richest source of vitamins. The vitamins A, B and E are found abundantly in sea weeds. The vitamin B essentially required for the development of human body is found in great abundance in almost all phaeophyceae.

As a source of agar: The best agar is manufactured from *Gelidium* of Rhodophyceae, which is also called vegetative agar; Japan produces the largest quantity of agar. It produces 95% of the world production. Agar is also obtained from several other marine algae, the yield of agar, setting temperature and gel strength of the product from ten species belonging to *Gelidium*, *Sarconema*, *Hypnea* and *Gracilaria* were obtained by Thivy (1957). Japan is the chief agar producing country and it exports agar to most of the countries of the world.

The agar is used in several ways. It is employed in the preparation of ice cream, jellies, desserts etc., in sizing the textiles and clearing many liquids. It is also used in preparing shaving creams, cosmetics and shoe polishes. The agar has constantly been used in biological laboratories for media preparation.

In India, agar resources, as annual yield of dry sea weeds of Chilka lake have been estimated to be about 4.06-5.08 metric tons, of Cape Comorin. Thivy (1957) about one metric ton and of the Pamban area as estimated by Thivy (1957) about seven metric tons. Other large quantities are in *Kathiawar peninsula* end estuaries, the resources of the Andamans are believed to be considerable.

Used as fertilizers: Due to the presence of potassium chloride (KCl) in seaweeds, they are used as fertilizers in many countries, such as: Japan, France, United States, England and South India.

Seaweeds are used in different parts of the world as fertilizer for various land crops. In India, freshly collected and cast ashore seaweeds are used as manure for coconut plantation either directly or in the form of compost in coastal areas of Tamilnadu and Kerala. Seaweed manure has been found superior to farm yard manure.

Medicinal use: Seaweeds have a salty taste that is an indication that the material can disperse phlegm accumulation, particularly as it forms soft masses, include goiter, the thyroid swelling that indicates severe iodine deficiency. Following are the descriptions of the seaweeds from Oriental Materia Medica (Hsu *et al.*, 1986):

Kombu (*Laminaria* and *Ecklonia*)

- **Essence and flavor:** Salty, cold
- **Channel entered:** Liver, stomach, kidney
- **Actions:** Softens hardness, disperses accumulation, resolves phlegm, cleanses heat
- **Applications:** Scrofula, goiter, tumor, edema, accumulation, testicular pain and swelling

Haizao (*Sargassum*)

- **Essence and flavor:** Bitter, salty, cold
- **Channel entered:** Liver, stomach, kidney
- **Actions:** Disperses accumulated phlegm, disperses goiter and tumor, delivers water, cleanses heat
- **Applications:** Scrofula, goiter, tumor, edema, testicular pain and swelling

Zicai (*Porphyra*)

- **Essence and flavor:** Sweet, salty, cold
- **Channel entered:** Lung
- **Actions:** Resolves phlegm, softens hardness, dispels heat, promotes diuresis
- **Applications:** Goiter, beriberi (leg swelling), edema, urinary infection, sore throat

As marine algae have good nutrient analysis so they can easily be used as dietary supplement. Seaweed is alkaline from nature, meaning very low on acids and what we call digestible sugars. The liquid extract holds enough sugar but not in a digestible form/shape.

Before starting the fermentation citric acid is use to lower the pH to about 4.5-5.0 and some sugar or honey should be added. pH 7 is neutral, below 7 is acid like and above 7 is alkaline, grapes are around 4.5. Citric acid is usually used to lower the pH because it will disappear during Fermentation. Acids are not required by the yeast but play other roles. This can be produced from the fermentation of cane molasses (Manoj *et al.*, 2010). They contribute to taste, enhance the flavors, but above all their ability to stop, or atleast retard the growth of potentially harmful microorganisms. To produce a good quality wine citric acid should be use to lower the pH (Make it more acid like) and add some sugar, honey or raisins.

Some enzymes like amylase, brandy kinase, cellulase, lipase, pancreatin, papain, protease, ptyalin, serum, glutamicpyruvic, transaminase are found in sea vegetation are use in the binding withdrawl and removal of numerous toxic chemicals and residues, which have accumulated in our bodies. Without enzymes the body would never utilize the food we ingest. Lipase can also be produced from bacterial fermentation (Madhusudan *et al.*, 2010).

Seaweed draws an extraordinary wealth of mineral elements from the sea that can account for up to 36% of its dry mass. The mineral macronutrients include sodium, calcium, magnesium, potassium, chlorine, sulfur and phosphorus; the micronutrients include iodine, iron, zinc, copper, selenium, molybdenum, fluoride, manganese, boron, nickel and cobalt.

Seaweed has such a large proportion of iodine compared to dietary minimum requirements, that it is primarily known as a source of this nutrient. The highest iodine content is found in brown algae, with dry kelp ranging from 1500-8000 ppm (parts per million) and dry rockweed (*Fucus*) from 500-1000 ppm. In most instances, red and green algae have lower contents, about 100-300 ppm in dried seaweeds, but remain high in comparison to any land plants. Daily adult requirements, currently recommended at 150 $\mu\text{g day}^{-1}$, could be covered by very small quantities of seaweed. Just 1 g of dried brown algae provides from 500-8,000 μg of iodine and even the green and red alga (such as the purple nori that is used in Japanese cuisine) provides 100-300 μg in 1 g.

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