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Marine algae: An Introduction, Food value and Medicinal uses

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ABSTRACT

The internal and exterior medicinal uses of seaweeds are diverse. Only macrophytic marine algae grown in salt water, whether they are wild or produced, may be properly referred to be seaweeds. There are three botanical categories for seaweeds: green, brown, and red. The photosynthetic pigments, reproductive mode, micro and macro morphologies, and phycopolymers of a given seaweed all play a role in classifying it into one of these categories. The identification of metabolites with biological activity in macroalgae has accelerated in the recent three decades. Despite significant investment in research by both academic and commercial entities, very few items with commercial viability have been found or created. Sulfated polysaccharides as antiviral substances, halogenated furanones from *Delisea pulchra* as antifouling compounds, and kahalalide F from a species of *Bryopsis* as a possible treatment for lung cancer, tumors, and AIDS are some of the substances currently receiving the most attention from pharmaceutical companies for use in drug development or from researchers in the field of medicine-related research. A wide variety of chemicals with recognized biological activity, including macroalgal lectins, fucoidans, kainoids, and aplysiatoxins, are commonly utilized in biomedical research. To the north of the equator, in the Atlantic and Pacific oceans, and in the North and Baltic seas, you'll find the brown seaweed known as *Fucus vesiculosus*. This species often coexists with other seaweeds in kelp preparations. Seaweed has a long history of usage as a herbal medicine, with applications ranging from traditional cosmetics to the treatment of cough, asthma, hemorrhoid, boils, goiters, stomach disorders, and urinary infections. It has also been shown to have anti-cancer, anti-ulcer, and anti-headache effects.

Key words: Marine algae, Food value, Medicinal uses

INTRODUCTION

Large marine algae are what we mean when we talk about seaweed, and they thrive nearly exclusively in the coastal regions of the world's seas. They are beneficial to marine life as a source of shelter and nutrition, to the undersea environment as a whole, and to humans as a source of consumable and industrial raw materials.

Both wild and farmed fresh seaweeds have long been a part of Asian culinary traditions and traditional medicine¹. The bioactive natural compounds found in seaweeds have been cited as a significant source². The bioactivity of several isolated compounds from marine algae has been demonstrated³. Over the last three decades, there has been a dramatic rise in the identification of macroalgal metabolites

with biological activity. However, seaweeds have gained popularity as a source of natural antioxidants in recent years⁴. The process by which seaweeds create carbohydrates from carbon dioxide and water (photosynthesis) identifies them as plants. They have no need for roots or complex conducting tissues since they can get all the nutrients they need from the water around them, making them far simpler than land plants. The holdfasts of giant seaweeds like kelps resemble roots but function simply to anchor the plants to the substrate they grow on. A small percentage of seaweed can thrive when left to float freely in the ocean, but the vast majority of it has to be linked to something to survive⁵.

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There are three distinct classes of seaweed, distinguished by the pigments that give them their signature green, brown, or red hues. Seaweeds can only grow in the relatively shallow regions of the seas, close to the beaches, where there is plenty of sunlight. They range from soft "encrusting corallines" (which resemble pink frosting) that play a crucial role in constructing and cementing coral reefs in the tropics to the massive kelps (particular brown seaweeds) that create forests on temperate (cooler) shores. While certain species of seaweed, especially the bigger reds, may be rather beautiful to see, others can be quite little and unassuming, growing in a low "turf" on the rocks⁶.

About 720 seaweed species have been documented in South African coastlines, out of an estimated 5,000–6,000 total globally. The warm seas of Natal are ideal for the growth of some of them, whereas the chilly waters of the Western Cape are required for the growth of others. South Africa's seaweed flora is distinct because of the abundance of endemic (found only in that location) species.

Macroscopic, multicellular, benthic marine algae are collectively referred to as "seaweed" in common parlance. Some red algae, brown algae, and green algae fall within this category. You may also categorize seaweeds based on what you want to utilize them for (food, medicinal, fertilizer, industry, etc.). Seven, seaweed may be classified as either red algae, green algae, or brown algae, all of which are multicellular algae. The seaweeds are polyphyletic because the three main families do not share a multicellular ancestor. As "seaweed" is a colloquial word without a technical meaning, it is occasionally used to refer to some tuft-forming blue green algae (Cyanobacteria).

Forms of Algae

Cyanobacteria, previously known as the blue-green algae, and green algae (division Chlorophyta), often found in shallow seas and developing as threadlike filaments, erratic sheets, or frond-like tufts, are the simplest of the seaweeds. The brown algae (division Phaeophyta) are the most numerous seaweeds found in both tropical and cold water environments, since their dark color conceals the green of the chlorophyll. They tend to flourish between 50 and 23 meters (15 feet) below. At the highest depths (up to 879 ft/268 m), you'll find the red seaweeds (division Rhodophyta), many of which are delicate and fernlike. Their red colour allows them to absorb the blue and violet light prevalent at such depths.

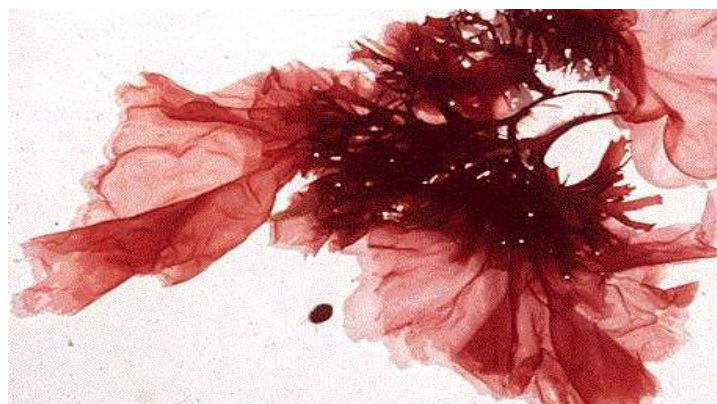


1. Brown Algae - the Phaeophyta

2. The most common form of algae is brown algae.

Phaeophyta, the phylum that contains brown algae, literally means "dusky plants." Brown algae are often found in temperate and polar seas and have a brown or yellow-brown coloration. The "holdfast" is a root-like structure that brown algae use to attach themselves to surfaces. Between 1500 to 2000 species of brown algae have been described so far⁴. *Ascophyllum nodosum* is one species that has attracted its own dedicated body of study due to its high economic value⁵. Brown algae include common seaweeds like kelp, *Fucus*, and *Sargassum*.

3. Red Algae - the Rhodophyta



4. Red algae⁸ are very diverse, with over 6,000 known species. The pigment phycoerythrin gives many types of red algae their vivid color. Due to its ability to absorb blue light, this kind of algae is able to thrive at deeper depths than brown and green algae. The red algae known as coralline are crucial to the development of coral reefs. Dulse (*Palmaria palmata*), Irish moss, and coralline algae are all examples of red algae.

5. Green Algae - the Chlorophyta



There are more than 4,000 species of green algae⁹. Green algae may be found in marine or freshwater habitats, and some even thrive in moist soil. These algae come in 3 forms: unicellular, colonial or multicellular. Examples of green algae: sea lettuce (*Ulva sp.*), which is commonly found in tide pools, *Codium sp.*, one species of which is commonly called "dead man's fingers."

Sea weeds as a food

Up to 36% of seaweed's dry bulk is comprised of the minerals it absorbs from the sea. Micronutrients include iodine, iron,

zinc, copper, selenium, molybdenum, fluoride, manganese, boron, nickel, and cobalt 10, whereas macronutrients include sodium, calcium, magnesium, potassium, chlorine, sulfur, and phosphorus.

Because it contains more iodine than is considered "minimally adequate" in a healthy diet, seaweed is often touted as such. Brown algae have the greatest iodine concentration, with dried kelp containing between 1,500 and 8,000 ppm and dry rockweed (*Fucus*) containing between 500 and 1,000 ppm¹¹. Dried seaweeds, including red and green algae, often have lower concentrations (100–300 ppm), although these levels are still much higher than in terrestrial plants. Small amounts of seaweed may be able to meet the current recommended daily adult intake of 150 micrograms (g). Dried brown algae has anywhere from 500 to 8,000 g of iodine per gram, but green and red algae (like the purple nori used in Japanese cuisine) only have 100 to 300 g per gram¹².

In Japan, many people consume far more than 1 gram of seaweed per day, either as a food source or as a dietary supplement. Researchers have shown that the human body quickly adjusts to increased iodine consumption, with the thyroid gland being the primary tissue responsible for iodine utilization (iodine is a component of thyroid hormones). Many people don't receive enough iodine in their diets because the soil, plants, and animals that make up the bulk of their diets are deficient in iodine. Iodine is added to salt in several countries to make sure people get enough of it. Some emerging nations, however, are still playing catch-up and feeling the impacts of inadequate iodine consumption. The greatest population with a low iodine history is found in China, followed by India.

Seaweed has one of the highest concentrations of calcium among all plants, however its calcium content is very little compared to that of iodine. Seaweeds have a calcium concentration of roughly 4-7% of dry mass. One gram of dried seaweed contains 7% calcium, or 70 mg, while the recommended daily intake of calcium is about 1,000 mg. Even so, it's more than you'd get from a serving of most dishes that don't include milk.

The amount of protein in different types of seaweed varies. It's just 5-11% of dry matter in brown algae, but 30-40% in certain species of red algae, making it about as abundant as legumes. Still underutilized despite their high protein content (up to 20% of dry mass), green algae are seldom collected. Micro-algae spirulina has gained popularity because to its very high content, which is equal to 70% dry matter.

Several vitamins may be found in seaweed. Carotenoids (provitamin A) are found in abundance in red and brown algae, and these algae are harvested and processed to provide natural mixed carotenes for use in nutritional supplements. Quantities might be anything from 20 to 170 ppm. Red and brown algae are especially famous for their vitamin C concentration, which is 500–3000 ppm. The vitamin B that is so rare in terrestrial plants is among those present.

Both kunbu and haizao sound quite similar in their explanations. These widely utilized seaweeds are described in detail by Yang

Only 1-5% of seaweed's dry weight is fat, yet those lipids have a greater concentration of critical fatty acids than those in terrestrial plants. Compared to other algae, green algae contain a substantially greater concentration of the fatty acids oleic and alpha-linolenic. EPA, an omega-3 fatty acid typically found in mammals, is abundant in red algae. Dry seaweed typically has between 32% and 50% fiber. In green (ulvans) and red algae (agars, carrageenans, and xylans) the soluble fiber fraction accounts for 51-56% of total fibers, whereas in brown algae (*Laminaria*, *Fucus*, and others) it accounts for 67-87% of total fibers. Insoluble fibers have been shown to have a hypoglycemic and cholesterol-lowering impact.

Gelatinous compounds known as hydrocolloids or phycocolloids are extracted from seaweeds during harvesting and cultivation. These substances include alginate, agar, and carrageenan. The use of hydrocolloids as food additives has grown in economic importance. The food business makes use of their physical qualities, such as their ability to gel, retain water, and emulsify. Candies, meat and poultry items, sweets, drinks, and molded meals all contain agar as an ingredient. Carrageenan is utilized as a preservative in a wide variety of food types, including meat and fish products, dairy products, and baked goods.

Seaweeds' healing properties

The salty flavor of seaweeds is a sign that they may help eliminate phlegm buildup, especially when it takes the shape of soft masses like goiter (an enlarged thyroid that is caused by an iodine deficit). Here are the seaweeds described in detail by Oriental Materia Medica¹³.

Kunbu (Laminaria and Ecklonia)

- a) Essence and Flavor: Salty, Cold
- b) Channel Entered: Liver, Stomach, Kidney
- c) Actions: Softens hardness, disperses accumulation, resolves phlegm, cleanses heat
- d) Applications: Scrofula, goiter, tumor, edema, accumulation, testicular pain and swelling

Haizao (Sargassum)

- a) Essence and Flavor: Bitter, Salty, Cold
- b) Channel Entered: Liver, Stomach, Kidney
- c) Actions: Disperses accumulated phlegm, disperses goiter and tumor, delivers water, cleanses heat
- d) Applications: Scrofula, goiter, tumor, edema, testicular pain and swelling

Zicai (Porphyra)

- a) Essence and Flavor: Sweet, Salty, Cold
- b) Channel Entered: Lung
- c) Actions: Resolves phlegm, softens hardness, dispels heat, promotes diuresis
- d) Applications: Goiter, beriberi [leg swelling], edema, urinary infection, sore throat

Yifan: The meridian channels of the liver, lungs, and kidneys are penetrated by the salty and chilly Haizao and Kunbu. Clearing

heat, reshaping phlegm, easing hardness, and dispersing nodules are all abilities shared by both. They help the body eliminate excess fluid by stimulating urine. They are often combined in clinical practice to treat lesions like goiter and scrofula.

Both plants have their own unique properties. Haizao is more effective than other treatments for goiter and scrofula because of its ability to transform phlegm and dissolve nodules. When it comes to treating liver-spleen enlargement, liver cirrhosis, and tumors, Kunbu is superior because of its greater efficacy in decreasing congealed blood and easing hardness.

Haizao Yuhu Tang, also known as the Sargassum Decoction for the Jade Flask 14, is one of the most well-known seaweed-based recipes. Included among the 12 components of this recipe are the algae Sargassum, Ecklonia, and Laminaria. It was prescribed for a case of goiter so severe that the patient's neck resembled a big flask. These seaweeds are traditionally used to treat ovarian cysts, breast lumps, lymph node swellings, lipomas, and simple obesity, but they have recently been included into formulae for the treatment of other soft swellings as well.

Wound dressings and dental impression trays both benefit from alginates' versatile properties. Agar is widely used as a culture medium in the field of microbiology. Iodine, found in seaweed, is important for healthy thyroid function and for avoiding goiter. However, consuming too much seaweed may lead to dangerously high amounts of iodine. It has been hypothesized that some types of seaweed may treat a wide variety of illnesses, from worm infections to cancer. Some weight loss aids include seaweed extract. Similar to gastric banding, other seaweed tablets inflate in the stomach to make you feel full.

Airway Management

For centuries, people have turned to red algae rich in carrageenan for relief from respiratory problems including chronic sinusitis and persistent pneumonia. In the past, asthma was not identified as a distinct disease.

Seaweed Hormones Melatonin

Many types of seaweed contain up to a thousand times more melatonin than terrestrial plants like feverfew or St. John's Wort. This might help to explain why eating seaweeds can be so relaxing. The melatonin concentration of seaweed collected at night is much higher than that of the same species obtained during the day. Melatonin 15 extracted from seaweed has medicinal potential.

Marine Sources of Thyroid Hormones

Thyroid hormones can only be obtained from brown seaweeds, which are the only plant-based sources. Some of the consequences of consuming brown seaweeds may be explained by the presence of organically-bound iodine in these foods, which acts as thyroid hormones.

Di-iodothyronine

Brown seaweeds belonging to the genus *Fucus* have been used to treat thyroid disorders. Di-Iodothyronine (DIT) is the thyroid hormone found in *Fucus*, and it has little activity as a thyroid hormone in mammals. T₄, or thyroxine, is made by combining two molecules of diiodothyronine (DIT) in a sophisticated

esterification mechanism. The prefabricated T₄ components provided by the organically bound iodine in *Fucus* may improve T₄ synthesis. Studies linking DIT from *Fucus* to the thyroid or circulating T₄ are lacking, in my opinion.

Fucus powder, 3–5 grams per day, has therapeutic benefits that are similar to

Goiters diminish, weight is lost, symptoms of non-autoimmune hypothyroidism disappear, energy levels rise, mood stabilizes, and eczema disappears as a result of treatment with thyroxine. This is particularly true for mothers who have been pregnant and nursed for a while and are now experiencing postpartum physiological depression.

Several brown seaweeds, including *Laminaria* sp. and *Sargassum* sp., have been reported to have thyroxine and tri-iodothyronine as their primary organically bound iodine compounds. Laminarian iodine might consist of up to 10% MIT, DIT, T₃, or T₄. Surprisingly, there is even more of this compound in the less commercially accessible *Sargassum* (less commercially available; it is a fast increasing invader of all temperate coastlines; this may be excellent news for thyroid patients).

In both Japan and the United States, kombu is a popular seaweed. Regular use of kombu may have the following physiological effects: improvement in coronary artery disease, improved liver function, increased metabolic rate, accelerated meal transit time, decreased LDL cholesterol, and increased HDL cholesterol. The potential to cure hypothyroidism without the need of synthetic thyroxines or animal-thyroid medications¹⁶ suggests that the thyroid hormones in kombu and *Sargassum* might be used as a dietary supplement.

Seaweeds Are a Vital Source of Fat and Vitamins

The B vitamin family, including B₁₂, is particularly abundant in seaweeds. They also contain high levels of Omega-3 fatty acids (1-3%). Particularly high in vitamin A and C, nori also contains 3 percent omega-3 fatty acids. The Japanese recommend a high-nori diet for males at risk for developing male pattern baldness.

Different Applications

Fertilizer might be made from other types of seaweed. The feasibility of using seaweed as a feedstock for bioethanol is presently being researched. Toothpaste, makeup, and even paint all use seaweed as a component. Like carrageenan, alginates have a wide variety of industrial applications. They may be found in things like adhesives, dyes, gels, and explosives, as well as in paper sizing, textile printing, hydro-mulching, and drilling¹⁷.

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