

Seaweed Composition and its Diverse Applications

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ABSTRACT

Seaweeds are rich in bioactive compounds like amino acids, omega-3 fatty acids, vitamins, and antioxidants, which offer various health benefits, including antioxidant, anticancer, antidiabetic, antimicrobial, and anti-inflammatory effects. Their well-balanced nutritional profile makes them a promising source of functional ingredients for food products and nutraceuticals, promoting health, preventing diseases, and supporting therapeutic interventions. As such, seaweeds are emerging as an important resource for the development of health-promoting foods and supplements.

INTRODUCTION

Seaweed, or macroalgae, includes thousands of species of macroscopic marine algae, categorized into three families such as (Chlorophyceae- includes green algae), (Phaeophyceae- includes brown algae), and (Rhodophyceae- includes red algae). In Asian countries, brown algae make

up 66.5% of consumption, followed by red algae at 33% and green algae at 5%. There are about 12,000 documented seaweed species, with over 7,000 being red algae. Brown seaweed species such as kelps and Fucus, are common, as well as red algae species like dulse and Irish moss. Seaweed production

reached 35.8 million tonnes globally, with 97% from cultivation. Seaweeds are used in food, chemicals, textiles, agriculture, and pharmaceuticals, providing dietary fibre, vitamins, essential minerals, antioxidants, and antimicrobial properties. This article explores the nutritional value of seaweeds, including their proteins, amino acids, minerals, lipids, vitamins, fibre, antioxidants, and antimicrobial properties, along with their potential culinary and therapeutic applications, including pharmaceutical uses.

Biochemical Composition:

Protein and amino acids: Seaweeds are a valuable source of protein, with red and green varieties containing higher protein levels (10-30% on dry matter basis) compared to brown algae (5-15%). Red algae like Nori and Dulse have protein contents ranging from 35-47%. These proteins resemble with plant proteins, which contains all the amino acids (essential) necessary for various metabolic functions. Amino acids like glutamic acid, alanine, and glycine are the primary components contributing to seaweed aroma and taste. Additionally, light-harvesting pigments in seaweed, such as phycoerythrin and phycocyanin, possess antioxidant properties that may help prevent oxidative stress-related conditions like neurodegenerative diseases, cancer, and gastric ulcers.

Minerals: The seaweeds are significant source for minerals due to their potential in order to soak up inorganic molecules from the surrounding environment. They contain minerals that make up 7-38% of their dry matter, including iodine, potassium, iron, copper, manganese, magnesium, zinc, and calcium. The highest copper content has been noted in the green algae namely *Ulva reticulata*, while the maximum level of manganese was found in the red algae *Porphyra tenera* (Santoso et al., 2006).

Vitamins: The seaweeds are a significant birthplace for both type of vitamins i.e. lipid soluble and water soluble. The concentration of vitamin C in some brown and green seaweeds ranges from 500-3000 mg/kg of dry matter. Thiamine and riboflavin, two water-soluble B vitamins, are commonly found in most red and brown seaweeds, with comparable levels of both vitamins. For example, the red seaweed *Porphyra umbilicalis* contains 3.4 mg/100 g of dry matter of riboflavin (MacArtain and Gill, 2007). In *Undaria pinnatifida*, which is a brown seaweed, riboflavin levels varied, with one sample containing 1.35 mg/100 g, while another had a greater level of concentration 11.7 mg/100 g on basis of dry matter. Seaweeds are also rich in vitamin E and carotenoids (fat-soluble), which are known to be the vitamin A provitamins. A potent antioxidant (Vitamin E) was known for its ability to protect lipid membranes from peroxidation.

Lipids: Seaweed contains less concentration of lipids, varies from 1-5% on dry matter basis. Therefore, the primary lipids specially, polyunsaturated omega-3 (ω -3) and omega-6 (ω -6) fatty acids, which are known to successfully lower the risk of cardiovascular, diabetes, and osteoporosis, (Maeda et al., 2008). The seaweeds mainly brown and red are particularly rich in PUFA content (20 Carbon), including two omega fatty acids namely ω -3, and ω -6. The example of ω -3 is EPA (eicosapentaenoic acid- C 20:5) and AA, (arachidonic acid -C 20:4).

Dietary fibre: The seaweed poly carbohydrates are a diverse group of molecules which serve various biological roles. From a nutritional perspective, seaweed polysaccharides are significant as they act as dietary fibre (DF). These polysaccharides are classified into two categories: structural and storage, based on their chemical composition and functions. In green seaweed, starch is the

primary storage polysaccharide, while in red seaweed, floridean starch is the main storage polysaccharide. In brown seaweed, laminarin is the major storage polysaccharide, with a chemical structure consisting of (1,3)- β -D-glucan with β -(1,6) branching.

Bio-active Compounds:

- ✓ **Antioxidant compounds:** Phenolic compound, ferric compounds, flavonoids, phlorotannin and fucoxanthin.
- ✓ **Phytochemicals:** phenolic compounds, Steroids, saponins, alkaloids, flavonoids and anthraquinones which are procured from brown seaweed/algae.
- ✓ **Antibacterial and antifungal compounds:** Seafood contains many antibacterial and antifungal compounds, including peptides, macrolides, alkaloids, and terpenoids. These compounds can be used to treat bacterial and fungal infections, and may also be used in agriculture and food.

Edible Seaweeds

- ✓ Seaweed species named Nori, commonly known as purple laver, which is deep purplish-red coloured (fresh) and when dried it turns into dark green. The red algae *Porphyra* and its dried sheets are commonly utilized for making soups or wraps for sushi or onigiri.
- ✓ Agar-agar, extracted from red seaweed, is widely used as a substitute for gelatin.
- ✓ Seagrasses (*Caulerpa lentillifera* and *Caulerpa racemosa*) and Gusô (*Eucheuma* spp.) are traditionally consumed in the cuisines of Southeast Asia, Oceania, and warmer regions of East Asia. These products are typically consumed raw either as a snack or in a salad by mixing with vinegar.

- ✓ Wakame seaweed is also called sea mustard, which is in dark green color frequently used in making miso soup. This seaweed has a sweetish flavor, a silky texture, and is an excellent source for fatty acids like omega-3.
- ✓ Kombu seaweed is a variety of kelp, which is one among the popularly consumed seaweeds in East Asian countries. It is cooked in water with flakes of skipjack tuna (bonito), and is the key component in dashi dish, which is a common Japanese soup stock.
- ✓ Dulse seaweed is attached to rocks and is in reddish color and grows mainly in the wintry regions like Pacific Oceans and northern Atlantic. These seaweeds are used for making soups, baked products like chips, and as a seasoning material for meats.
- ✓ A brown color seaweed namely Hijiki which turned into black color when it is dried, resembling small, thin twigs. The seaweed is harvested from the rocky shore of countries like Korea, Japan and China. It is further boiled and dried after collection. Hijiki is commonly used for stir-fried products or serves with fish as such.
- ✓ Irish moss is a purple color red seaweed which is native to shorelines of the countries like Europe and Atlantic U.S. It resembles miniature trees with branching stems and is used in desserts like tapioca and ice cream for its carrageenan polysaccharides, which act as thickening agents.
- ✓ The seaweed namely Sea lettuce belongs to genus *Ulva*, is a blue-green algae which is edible and primarily isolated from the coastlines. It is popularly known as green nori. Different types of edible seaweeds are represented in figure 1.

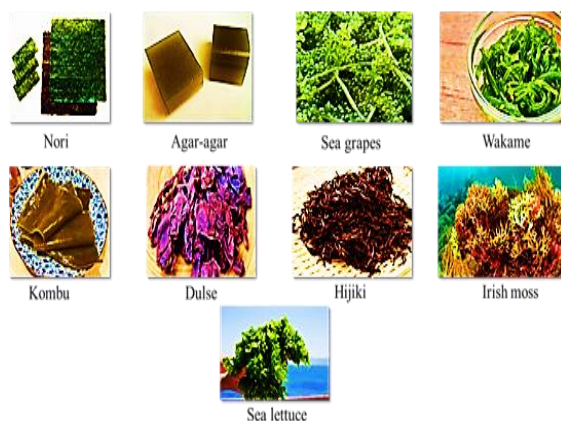


Figure 1. Different types of edible seaweeds

Nutritive value of Seaweeds

The nutritive value of seaweeds has a greater concentration of essential fatty acids, like (EPA) Eicosapentaenoic acid and (DHA) Docosahexaenoic acid. when compared to terrestrial plants, They, are rich source of iodine and tyrosine, which support thyroid function. Seaweeds may also serve as a potential vegan source of Vitamin B12. Additionally, they contain high levels of polysaccharides which can be used as prebiotic functional ingredients applicable for animal and human health. As a nutraceutical product, many edible seaweeds are applicable in various field of health benefits, including antiallergic, anti-inflammatory, antitumor, antimutagenic, antioxidant, antidiabetic, antihypertensive, and neuroprotective properties. Feeding cows, the seaweed *Asparagopsis taxiformis* has been shown to reduce methane emissions. Seaweeds are also extremely rich in iron (Fe) and calcium (Ca), with significant amounts of magnesium (Mg), potassium (K), vitamins, and iodine. Furthermore, seaweeds are known for their cleansing and antiviral properties. They help cleanse the blood, stimulate kidney and liver functions, eliminate toxins, and reduce the absorption of heavy metals.

Applications of seaweeds

- ✓ **Seaweed as Human Food:** Nori (*Porphyra* species), *Palmaria palmata* (dulse, dillisk),

Kombu species (*Saccharina* and *Laminaria*), and Wakame species (*Undaria pinnatifida*) are some of the most well-known edible seaweeds.

- ✓ **Seaweed as Cosmetics:** The Algo-therapy involves the use of seaweeds or its extracts for health care and beauty treatments. Seaweed and its extracts are widely recognized by cosmeticians and beauticians for their skin benefits.
- ✓ **Seaweed as Fertilizer:** Spreading seaweed fronds on light soil in lazy beds can provide nutrients, promote growth, and potentially offer antifungal properties.
- ✓ **Seaweed as Industrial Gum:** Seaweed used as industrial gums, are also called 'seaweed hydrocolloids,' and are classified into three categories: Agars, Alginates (alginic acid), and Carrageenan.
- ✓ **Seaweed as Medicine:** Kombu, Sargassum, and Nori, which is utilized for treating goiter, edema, scrofula, tumors, accumulation, and testicular pain, swelling, beriberi (swelling of leg), urinary infections, and sore throat.
- ✓ **Seaweed as a Culture medium:** Agar, extracted from the cell walls of certain red algae, has been widely used in bacteriological research since 1900 (Christopher Lobban in *The Biology of Seaweeds*). It is commonly used to culture bacteria on petri dishes or in test tubes for scientific study.

CONCLUSION

The Seaweeds are the rich source of vitamins, minerals, fatty acids mainly PUFA, and bioactive molecules, making them a valuable source of healthy food. They can help address protein, carbohydrate, and mineral deficiencies in human nutrition when consumed regularly. Additionally, seaweeds possess active



constituents that contribute to various pharmacological benefits, offering potential in both food and medicinal applications.

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