Global Scientific JOURNALS

GSJ: Volume 10, Issue 2, February 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

THE POTENTIAL OF BROWN SEAWEED AS FOOD

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KeyWords : Brown algae, benefits, food, chemical composition, bioactive compunds

ABSTRACT
The presence of brown seaweed is abundant and widespread in Indonesian waters. There are several potentials of brown algae in human life. Brown algae contain various nutrients and bioactive compounds such as proteins, carbohydrates (Polysaccharides or fibers), lipids, minerals, phlorotannins, fucoxanthin. Brown algae can be processed into various foods such as salads, noodles, soups, snacks, and so on. Some species of edible brown algae include *Ecklonia cava, Hizikia fusiformis, Laminaria japonica, Pelvetia siliquosa, Sargassum fulvellum, Fucus vesiculosus, and Undaria pinnatifida*, *Alaria esculenta, Eisenia bicyclis, Durvillaea antarctic*. Brown algae have been shown to have anti-tumor, antioxidant, anticoagulant, antithrombotic, immunoregulatory, antiviral, and anti-inflammatory effects. This review article aims to describe the potential of brown algae as food and their health benefits.

INTRODUCTION

One of the problems facing the world community today is hunger [1]. The amount of food and food produced in the world is quite a lot [2], but the human population is increasing. Based on data from the worldometer, the world's population currently reaches 7.9 billion [3]. This causes many humans to experience hunger and have an impact on 9.9 percent of the world's population [2]. The total population in Indonesia currently reaches 278,128,438 as of Saturday, February 5, 2022, based on the Worldometer translation of the latest United Nations data. Indonesia is listed as the 4th country with the largest population [3]. Therefore, to meet the world's food needs and especially the food needs in Indonesia, the discovery and production of food ingredients need to be continued.

Macroalgae have been known as a food ingredient in various countries such as in Korea and Japan. Brown algae are the most consumed algae (66.5%) compared to red algae (33%) and

green algae (5%). Brown algae contain various nutrients and bioactive compounds such as proteins, carbohydrates (Polysaccharides or fibers), lipids, minerals, phlorotannins, fucoxanthin [4]. Brown algae are also known to be used as medicinal ingredients. For example, *Sargassum fusiforme*, also known as Yangqicai in Chinese and Hijiki in Japanese can be used to treat dysuria, and edema. Brown algae, *S. fusiforme* also has therapeutic effects such as anticancer, antiangiogenic, and antiviral effects [5].

Macroalgae in Indonesia are quite abundant. Indonesia is one of the countries that exports seaweed to other countries. In Indonesian waters, there are about 28 species of brown algae from six genera namely Dyctyota, Sargassum, Padina, Hormophysa, Turbinaria, and Hydroclathrus [6]. Various researchers have attempted to increase the production of marine algae culture and algae production through tissue culture. Brown algae can be processed into various foods such as salads, noodles, soups, snacks, and so on. However, the utilization of algae, including brown algae as food ingredients, is still below Japan, China and Korea [7]. The purpose of this article is to provide a description of the types of brown algae that can be consumed, their nutritional content, and the variety of types of food that can be processed from brown algae.

EDIBLE BROWN SEAWEED

Brown algae are included in the (Phaeophyceae) which have the main pigment in the form of fucoxanthin. These algae are multicellular macroscopic algae. None of them are unicellular in their vegetative phase. They range in form from small filamentous forms to large, complex seaweeds. Brown algae have cell walls that contain cellulose, alginic acid, and various other polysaccharides. Algae that generally live in marine waters are estimated to consist of 1836 species in ~285 genera [8].

Some species of edible brown algae include *Ecklonia cava*, *Hizikia fusiformis*, *Laminaria japonica*, *Pelvetia siliquosa*, *Sargassum fulvellum*, *Fucus vesiculosus*, and *Undaria pinnatifida* [9], *Alaria esculenta*, *Eisenia bicyclis*, *Durvillaea antarctica* [10]. Brown algae, *E. cava* is popular as a food ingredient, fertilizer, as an ingredient in folk medicine, and animal feedstock in Korea and Japan. Many companies have extracted *E. cava* to be used as a food supplement. Brown algae, *H. fusiformis* can be called hijiki in Japan and tot in Korea. Hijiki has been widely consumed in East-Asian countries. *Laminaria japonica* which contains lots of laminarin is commonly known as

kombu in Japan or Dasima in Korea. *Pelvetia siliquosa* is a source of alginic acid and is usually used in seasoned sea greens as religious services in Korea. Undaria pinnatifida is known as wakame in Japan and miyeok in Korea. This algae has been widely consumed in the form of wakame soup [9]. *Sargassum* sp. is quite well known in Indonesia as edible algae. This algae has been processed into chips. *Durvillaea antarctica*, also known as (Chamisso), is found in New Zealand. *Alaria esculenta* is commonly referred to as Atlantic kelp which can live in cold sites with good water exchange as a winter crop and can grow up to 3 meters. *Alaria esculenta* can be interpreted as edible wings [11]. *Eisenia bicyclis* commonly called arame or sea oak comes from the temperate Pacific Ocean waters centered near Japan. Some countries have cultivated it such as Korea [12].

Brown Seaweeds in Your Cooking and Baking

Various foods can be processed from edible brown seaweed. *Undaria pinnatifida* can be processed into soup, salad, miso. Hijiki can be processed into salads, fried foods, bibimbap, and so on. *Laminaria japonica* is put into a soup to be used to improve a woman's health recovery after giving birth. In addition, Laminaria can also be processed into sauces, added to rice, beverages, sashimi, Kombucha (seaweed tea). *Pelvetia siliquosa* can also be made into soups and salads. Sargassum can be processed into chips, crackers, salads, soups, or a mixture of various side dishes [9]. *Fucus vesiculosus* can be used as food additives, flavorings, food supplements. *Durvillaea antarctica* can be processed into salads, stews. *Eisenia bicyclis* can be used as garnishes, salads, pickles. Meanwhile, *Alaria esculenta* can be processed into salads [10].

The nutritional content of some brown algae can be seen in the following table:

Table 1. Proximate Analysis of Edible Brown Algae (% DW)

Brown Algae	Protein	Lipid	Carbohydrate	Fiber	Ash	Water	Reference
Sargassum sp.	8,42	4,54	53,28	NT	33,74	28,20	13
Laminaria japonica	7.40	1.37	54.50	28.91	28.33	8.4	14
Hizikia fusiformis	12.94	1.76	61.85	NT	19.18	NT	15
Ecklonia cava	14.9	0.5	NT	NT	12.1	NT	16
Fucus vesiculosus	12.99	3.75	NT	NT	20.71	NT	17

Health Benefits of Brown Seaweeds

As explained above, brown algae contain many nutrients and bioactive compounds that can act as medicinal ingredients. Fucoidan contained in brown algae has been shown to have anti-tumor, antioxidant, anticoagulant, antithrombotic, immunoregulatory, antiviral and anti-inflammatory effects. The biological activity is thought to be due to the molecular weight and the presence of sulfate groups. For example as an antiviral, The sulfated polysaccharide inhibits virus attachment to host cells by interacting with the positively charged domain of viral envelope glycoproteins involved in virus attachment [18]. Besides fucoidan, brown algae also contain laminarin which also has biological activities, such as antitumor, antioxidant, anti-inflammatory, and prebiotic properties [19]. Not only that, but alginate is also a secondary metabolite that is widely contained in brown algae that can play a role in wound healing. In addition to the things above, brown algae still have many benefits for human health. Some of the advantages in health if consumed regularly are as follows:

1. Nourishing the thyroid gland & brain
2. Balancing hormones
3. Improving metabolism & facilitating weight loss
4. Removing radioactivity, heavy metals & environmental toxins from the body
5. Naturally inhibiting cancer cell growth
6. Soothing the skin and the digestive tract
7. supporting bone & joint health [20]

Conclusion

Macroalgae in Indonesia are quite abundant. Indonesia is one of the countries that exports seaweed to other countries. In Indonesian waters, there are about 28 species of brown algae from six genera namely Dyctyota, Sargassum, Padina, Hormophysa, Turbinaria, and Hydroclath-rus. Brown algae has several benefits for human life. Some of the benefits of brown algae are that it can be consumed, processed into food, and used in the pharmaceutical and nutracutical fields.

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