Nutritional composition of *Sargassum* sp. and *Padina* sp.

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Abstract. Macroalgae are primary producers supporting marine ecosystems by providing food and oxygen. Industrially, they are valuable as raw materials or additives in products such as pharmaceuticals, health supplements, cosmetics, food and animal feed. The aim of this research is to know the nutritional composition of two species of macroalgae from Mamburit Island, including proximate, vitamin, and dietary fiber. The content of carbohydrate of *Sargassum* sp. and *Padina* sp. was 73.5 % and 66. 8 %. Moisture, ash, fat and protein content of Sargassum were 8.5 %, 2.6 %, 0.5 % and 4.3 %, and the content of moisture, ash, fat and protein from Padina were 9.7 %, 2.9 %, 0.6 %, and 4.3 %. Vitamin C and dietary fiber content were 1.5 mg/100g and 10.3 % of *Sargassum* sp., 2,5 mg/100g and 15.5 % of *Padina* sp. These findings highlight the potential of these macroalgae as nutrient rich resources.

1 Introduction

Macroalgae is a biological resource that has high economic value, therefore it become an export commodity. Macroalgae has a lot of potential, one of which is as a food ingredient containing fiber, vitamins, minerals, protein and carbohydrates. Various benefits can be obtained from seaweed ranging from the food industry, cosmetics, to medicine. For centuries, seaweed has been used as food, especially by China and as medicine by Japan, and some of it is used as an additional vitamin. [1]. The dietary fiber content of macroalgae has a positive effect on human metabolism, one of them can be used to decrease of the cholesterol level. Seaweed also helps treat stomach ulcers, colitis, constipation, and other digestive disorders [2]. In addition, macroalgae also contain pigments and bioactive substances which can be produced from their secondary metabolites. Based on their pigment content, algae are divided into three groups, namely green algae, red algae and brown algae. In Indonesia, red seaweed has the largest number, that is around 452 types, following by green seaweed with a total of 196 types, and finally brown seaweed with a total of around 134 types [3].

Mamburit Island is a small island with 150 families living on this island. The majority of life on the island depends on marine products. The island is one of 126 islands in Sumenep

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district. Mamburit Island has beautiful views with white sand and coral reefs, this is because the island is surrounded by three uninhabited islands, so it has beautiful nature. Several species of seaweed from the green seaweed, red seaweed and brown seaweed groups are found along the coast of Mamburit Island at a depth of approximately 30-50 cm on the seabed with a brightness level of 100%.

Sargassum sp. and *Padina* sp. are seaweeds from the brown seaweed group that live on rocky substrates and in substantial currents. This seaweed has a high content of phenolic compounds, and has bioactive properties such as antibacterial, antioxidant, antiaging and anticancer. In addition, *Sargassum* sp. is an alginate producer. Alginate is a chemical compound that is used in the food, medicine, cosmetics and textile industries [4]. In the island brown seaweed such as *Sargassum* sp. is still used traditionally as a vegetable and is only sold in dry form at a cheap price of around one thousand to one thousand five hundred rupiah outside the island. The use of Indonesian seaweed has not been carried out optimally, especially its use as raw material for functional food products which can provide health benefits for the community [5]. Meanwhile, *Padina* sp. in Mamburit remains untapped due to a lack of local knowledge on seaweed processing and commercialization. This is a common issue across Indonesian islands, including Aceh [6]. Based on that reason, the aim of this study was to assess the nutritional content of seaweed including proximate, dietary fiber and vitamin C obtained from Mamburit Island. The findings are intended to inform the development of high- value products, promote healthy diets, and enhance the economic prospects of local communities.

2 Methods

2.1 Materials

Seaweed was collected from Mamburit Island, Kangean Islands, Sumenep Regency, Madura, East Java, Indonesia.

2.2 Methodology

2.2.1 Preparation of raw materials

Immediately after collection, the seaweed sample was cleaned and washed with seawater to remove sand, debris, epiphytes and other extraneous matter attached to the thalli and transported to the marine biology laboratory at Trunojoyo Madura University for proximate analysis, dietary fiber and vitamins. In the laboratory, seaweed samples were separated by type and washed again using distilled water to remove dirt and salt attached to the surface of the seaweed thallus, after that dry water with tissue and the samples were ready for analysis. Analysis was carried out using fresh seaweed.

2.2.2 Proximate, dietary fiber and vitamin C analysis

The proximate analysis consisted of moisture, ash, fat, protein, and dietary fibre were carried out according to the procedures of the Association of Official Analytical Chemists (AOAC) [13]. The content of carbohydrate was calculated by subtracting the weights of moisture, ash, fat and protein. Analysis of vitamin C content was carried out by iodometric titration method [29].

3 Result and discussion

3.1 Characteristics of *Sargassum* sp. and *Padina* sp.

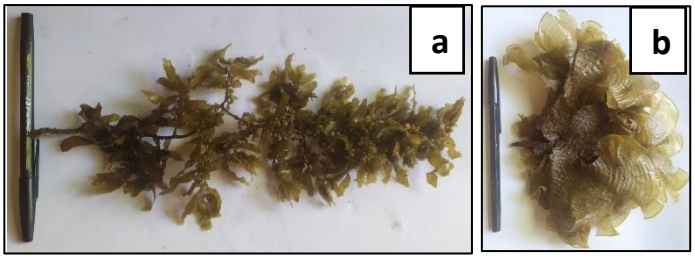

Fig. 1. *Sargassum* sp. (a), *Padina* sp. (b)

Sargassum is a genus of brown algae that is found in many tropical and sub-tropical areas in subtidal and intertidal areas, there are 150 species in tropical areas. [7]. These algae are often said to be similar to land plants which can be found on rocky sand substrates, corals and in flowing waters. Live brown algae attach with holdfasts to dead coral fragments and rocks. Sargassum is brown because it is dominated by the pigment fucoxanthin and has a flattened and oval thallus shape that resembles small leaves with serrated edges and a sleek surface and is attached to a round, branched and rough stem. *Sargassum* has small round air sacs or bladder attached along the thallus, these bladders are a special characteristic of this algae. In Mamburit Island, several species of *Sargassum* and a number of species of green algae, red algae and brown algae were found. *Padina* sp. is also a brown alga. This alga has the morphology of thin sheets like a fan and is arranged in a circle like a flower. Some of the genus *Padina* has thin sheet segments (*lobus*) [8]. It has radial hair lines which serve as a distinction between the genera in *Padina*. Its habitat is in shallow waters with coral and stone substrates. *Padina* lives attached to rocks or coral with holdfasts that resemble fibrous roots. *Sargassum* sp. and *Padina* sp. are a group of brown algae (*Phaeyopecea)* which generally have a brown color because they have the pigment fucoxanthin. The dominant pigment of brown seaweeds is fucoxanthin [9].

3.2 Nutrients Content

3.2.1 The results of proximate analysis

The study of proximate, dietary fiber and vitamin C in this research used two species of macroalgae samples, they are *Sargassum* and *Padina*, which were collected from the waters of Mamburit Island, Madura, Indonesia. For this analysis, the *Sargassum* and *Padina* samples used were still fresh, because on this island a number of residents consume seaweed directly as fresh vegetables or vegetables. Several people on Mamburit Island are interested in learning about the use of seaweed to make products. Seaweed has the potential to be developed as a functional food product because it contains healthy nutrients and bioactive components, which can be used in the food, nutraceutical, supplement and cosmetic sectors. [5,10].

Proximate analysis, which determines moisture, ash, protein, fat and carbohydrate content, serves as a crucial indicator of food quality and provides essential data for subsequent processing. Proximate analysis data is useful in comparing the quality of similar commodities [11]. The quality of seaweed productivity is determined by the proximate and gelatin content [12]. Seaweed contains many nutrients, minerals, vitamins and bioactive substances. The nutritional content of seaweed includes protein, fat, crude fiber, polysaccharides, minerals (K, Ca, P, Fe, I, and Na) and vitamins (A, B1, B2, B6, B12, and C) [6, 14].

Table 1. Nutrients content of *Sargassum* and *Padina*.

Nutrients content (Fresh Weight)	**Results**		**References**
	***Sargassum* sp.**	***Padina* sp.**	
Moisture (%)	8.52	9.66	90.56 ± 0.16 [19]
Ash (%)	2.62	2.98	2.11 ± 0.17 [19]
Protein (%)	4.37	4.37	0.3-5.9 [5]
Fat (%)	0.54	0.57	0.40 ± 0.01 [19]
Carbohydrate (%)	73.5	66.87	54.3-73.8 [5]
Dietary fiber (%)	10.37	15.52	
Vitamin C (mg/100 g)	1.58	2.46	

The results of proximate analysis, dietary fiber and vitamin C are presented in table 1. The results showed for moisture, ash, protein, fat and carbohydrate content in *Sargassum* sp. were 8.5%, 2.6%, 4.3%, 0.5% and 73.5% in wet respectively. The content of moisture of *Sargassum* sp. in this study can be said to be low, this can be influenced by several factors, one of which is sample handling during study. The moisture content is an important parameter that can affect the shelf life and quality of food ingredients. Algae contain 80–90 percent water and on a dry weight basis approximately 50 per cent carbohydrates, 1-3 percent lipids and 7-38 percent minerals [15]. Handayani et al (2004). reported that the *Sargassum crassifolium* protein content in their research results was 5.19% wet weight, these results were not much different in this study [16].

3.2.2 Dietary fiber and vitamin C

Carbohydrate levels can affect the dietary fibre content in seaweed, because carbohydrates are the main component of seaweed compared to protein and lipids. In general, their nutritional composition can vary significantly, depending on many factors [17]. Carbohydrate and protein levels were in the range of previous researchers. *Sargassum* sp. seaweed that contains carbohydrates 54.3-73.8%, protein 0.3-5.9% [5]. The variation in algal carbohydrate content may be due to algal species, growth stage, habitat, metabolic preferences, and photosynthetic activity [18]. Different protein levels can be influenced by the type of seaweed, environmental factors and analysis methods.

The moisture, ash, protein, fat and carbohydrate contents of *Padina* sp. were 9.7%, 2.9%, 4.3%, 0.6% and 66.8% respectively in wet basis. Even though the fresh seaweed samples, the water content in this study had a value below 10%. In the results of Santoso et al (2013) research using fresh *Padina Australis* seaweed samples, the water content was 90.56 ± 0.16, ash 2.11 ± 0.17, protein 1.02 ± 0.04, fat 0.40 ± 0.01 and carbohydrates 5.90 ± 0.37 [19]. The highest content proximate of *Padina* sp. was carbohydrates, this was different from other studies where dry-based sample analysis obtained a high ash content. *Padina* is a feed additive with a high ash content (30 – 48%), carbohydrates (25-39%), in dry samples, protein (5-7%) [20]. The nutritional content of seaweed can be influenced by type, habitat and season. The ash content in seaweed is higher in the dry season and the protein content is higher in the rainy season [19]. The fat content in this study had the lowest value for

Sargassum sp. and *Padina* sp. Seaweeds also contain fat and protein in low concentration [21, 22, 23].

In this research, the dietary fiber content of *Sargassum* and *Padina* was observed to be 10.37% and 15.52%. Compared with previous research that the maximum content was observed in brown algae *Sargassum Linearifolium (*19.97%) followed by green algae *Enteremorpha clathrata* (17.17%) and minimum content was observed in red algae *Gracilaria corticata (*4.37%) [24]. The amounts of soluble, insoluble and total dietary fibers of *Padina australis* were 8.4, 5.4 and 13.8 g/100 g fresh weight [19]. Dietary fiber content can be influenced by carbohydrate levels, habitat and season. In general, seaweeds are characterized by their high fiber content [25]. Most of the dietary fiber content of seaweed cannot be digested by the human body, consequently cause seaweed calorie intake to be low. The high fiber content of seaweed cannot be separated from its carbohydrate composition which reaches 33–50% dw [26]. According to Fennema, the type and fiber content of algae varies between groups, as do the environmental conditions in which the algae grows [27].

Vitamin C of *Sargassum* sp. and *Padina* sp. in this study obtained results of 1.58 mg/100g and 2.46 mg/100g. The vitamin C content of *Padina* sp. had a higher value than *Sargassum* sp. Vitamin C is a water-soluble vitamin and can function against the infections in cells. In addition, Vitamin C is also a high source of antioxidants, so vitamin C has an important role in improving the health of the human body. Vitamin C or ascorbic acid is a powerful antioxidant molecule in macroalgae [28].

4 Conclusion

Carbohydrate content was the predominant component in both *Sargassum* sp. and *Padina* sp., while fat levels were minimal. Dietary fiber content was 10.37% for *Sargassum* sp. and 15.52% for *Padina* sp., with corresponding vitamin C levels of 1.58 mg/100g and 2.46 mg/100g respectively.

References

1. S.K. Kim. Handbook of marine microalgae: biotechnology and applied phycology. (John Wiley & Sons, Ltd., 2012)
2. J.T. Anggadiredja, A. Zatnika, H. Purwanto, S. Istini. Rumput Laut. (Penerbit Swadaya, Jakarta, 2006)
3. F.G. Winarno. Teknologi Pengolahan Rumput Laut. (Pustaka Sinar Harapan, Jakarta, 1996)
4. I. M. Setyoaji, M. Subehi, Susanty, A. R. Nugrahani. Pembuatan Natrium Alginat Dari Alga Coklat (Phaeophyta) Dan Pengaruh Penambahannya Pada Sifat Antibakterial Sabun Minyak Dedak Padi (Rice Bran Oil). Jurnal Rekayasa dan Manajemen Agroindustri. **7**, 370-379 (2019)
5. Erniati, F.R. Zakaria, E. Prangdimurti, D.R. Adawiyah. Potensi rumput laut: kajian komponen bioaktif dan pemanfaatannya sebagai pangan fungsional. Acta Aquatica. **3**, 12-17 (2016)
6. M. Gazali, Nurjanah, P. Zamani, Neviaty. Eksplorasi senyawa bioaktif alga cokelat sargassum sp. Agardh sebagai antioksidan dari pesisir barat aceh. JPHPI. **21** (2018)
7. S. Agus. Antioxidant Activities of Species Seaweed from Sumba Island. Jurnal Sains dan Teknologi Indonesia. **9**, 34-38 (2007)

8. P. J. L. Geraldino, L. M. Liao, and S. M. Boo. Morphological Study of the Marine Algal Genus Padina (Dictyotales, Phaeophyceae). Southern Philippines: 3 Species New to Philippines. Algae. **20**, 99-112 (2005)
9. D. D. Hong, H. M. Hien, P. N. Son. Seaweeds from Vietnam used for functional food, medicine and biofertilizer. J Appl Phycol. **19**, 817–826 (2007). https://doi.org/10.1007/s10811-007-9228-x
10. C. S. Pakidi, S. S. Hidayat. Potensi dan pemanfaatan bahan aktif alga coklat sargassum sp. Octopus Jurnal Perikanan. **5**, 488-498 (2016)
11. S. Musa, G. Sanger, H. A. Dien. Komposisi kimia, senyawa bioaktif dan angka lempeng total pada rumput laut Gracilaria edulis. Media Teknologi Hasil Perikanan. **5**, 184-189 (2017)
12. E. Yudiati, A. Ridho, A. A. Nugroho, S. Sedjati, L. Maslukah. Analisis kandungan agar, pigmen dan proksimat rumput laut *Gracilaria* sp. pada reservior dan biofilter tambak udang litopenaeus vannamei. Buletin Oseanografi Marina. **9**, 133-140 (2020)
13. (AOAC) Association of Official Anlytical Chemis. Official Methods of Analytical of Chemist. Arlington*:* The Associantion of Official Analytical Chemist, Inc. (2005)
14. M. S. Cardoso, O.R. Pereira, A.M.L. Seca, D.C.G.A. Pinto, A. M. S. Silva. Seaweeds as preventive agents for cardiovascular diseases: from nutrients to functional foods. Marine Drugs. (13), 6838-6865 (2015)
15. K. Vijay et al. Proximate and mineral composition of brown seaweed from Gulf of Mannar. International Journal of Fisheries and Aquatic Studies. **5**, 106-112 (2017)
16. T. Handayani, Sutarno, D. W. Ahmad. Analisis Komposisi Nutrisi Rumput Laut *Sargassum crassifolium*. Jurnal Biofarmasi. **2**, 45-52 (2004)
17. A. Lopez-Santamarina, J. M. Miranda, A. C. Mondragon, A. Lamas, A. Cardelle-Cobas, C. M. Franco, et al. Potential use of marine seaweeds as prebiotics: a review. Molecules. **25**, 1004 (2020) doi: 10.3390/molecules25041004
18. H. M. Mwalugha, J.G. Wakibia, G. M. Kenji, M. A. Mwasaru. Chemical composition of common seaweeds from the Kenya coast. J. Food Res. **4**, 28–38 (2015) doi: 10.5539/jfr.v4n6p28
19. Santoso et al. 2013. Chemical Composition And Antioxidant Activity Of Tropical Brown Algae *Padina Australis* From Pramuka Island, District Of Seribu Island, Indonesia**.** Jurnal Ilmu dan Teknologi Kelautan Tropis. **5**, 287-297 (2013)
20. G. Subramanian, A. Nagaraj, P. Gunavathi, S. Jamuna, V. Banumathi, V. Jayanthi, et al. Biochemical Composition of *Padina pavonica* (L.) a Brown Alga from Mandapam Coastal Regions; Southeast Coast of India. International Journal of Advanced Research, **2**, 21–24 (2015)
21. K. H. Wong, and C.K. Cheung. Nutritional evaluation of some subtropical red and green seaweeds. Part I – proximate composition, amino acid profiles and some physico-chemical properties. Food Chemistry. **71**, 475-482 (2000)
22. D. I. Sánchez-Machado, J. López-Cervantes, J. López-Hernández, and P. Pasiero-Losada. Fatty acid, total lipid, protein and ash contents of processed edible seaweeds. Food Chemistry. **85**, 439-444 (2004)
23. C. Denis, M. Morancais, M. Li, E. Deniaud, P. Gaudin, G. Wielgosz-Collin, G. Barnathan, P. Jaouen, and J. Fluerence. Study of the chemical composition of edible red macroalga *Grateloupia turuturu* from Brittany (France). Food Chemistry. **119**, 913-917 (2010)

24. Kasimala et al. Proximate composition of three abundant species of seaweeds from red sea coast in Massawa, Eritrea. J. Algal Biomass Utln. **8**, 44-49 (2017)
25. V. Venugopal. Marine polysaccharides: Food applications. Boca Ratón, FL: CRC Press (2011).
26. P. Rupérez, F. Saura-Calixto. Dietary fibre and physicochemical properties of edible Rspanish seaweed. Eur. Food Res. Technol. **212**, 349-354 (2001)
27. Fennema OR. Priciples of Food Sciences. Marcel Dekker, lnc. New York. pp 792 (1976)
28. S. Lordan, R.P. Ross, C. Stanton. Marine bioactives as functional food ingredients: potential to reduce the incidence of chronic diseases. Mar Drugs. **9**, 1056-1100 (2011).
29. C. Sudarmadji. Analisa bahan makanan dan pertanian. (Penerbit Liberty, Yogyakarta. 1989)