



Nutrient and alginate content of macroalgae *Sargassum* sp. from Kupang Bay waters, East Nusa Tenggara, Indonesia

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Abstract. This study was aimed at knowing the diversity, nutrient content, and alginate content of macroalgae *Sargassum* sp. encountered in Kupang Bay waters. Sample collection was done at the lowest tide in the coastal waters of Paradiso, Kelapa Lima, Pasir Panjang, Bolok, and Tabulolong. The samples were identified and then the nutrient and alginate content was examined. Results found 4 species of *Sargassum* in Kupang Bay waters, *Sargassum crassifolium*, *S. cristaefolium*, *S. polycystum*, and *Sargassum* sp. that hold alginate content of 10-33%, and the widest range was recorded in *Sargassum* sp. The nutrient content consisted of 16.19-19.64% water, 22.56-24.11% ash, 6.44-10.64% protein, 0.94-1.99% fat, and 46.59-50.98% carbohydrate. The four *Sargassum* sp. found in Kupang bay waters are potential to be developed as alginate producers and healthy food source because of their high protein and low fat content.

Key Words: species identification, protein, fat, carbohydrate, alginate.

Introduction. Macroalgae of genus *Sargassum* belong to class Phaeophyceae and possess wide distribution and species variations (Pakidi & Suwoyo 2016). Genus *Sargassum* is dominant among aquatic plants and distributed in all Indonesia waters, such as Sunda strait, Bangka Belitung waters, Karimunjawa, southern coast of Java island, Bali coastal waters, Lombok, Kupang, eastern Kalimantan, southeast Sulawesi, North Sulawesi, Ternate, Ambon, Lampung Bay, and Natuna waters (Kadi 2005). There are approximately 400 species of *Sargassum* in the world and more than 15 species are collected in Indonesia waters (Basmal et al 2013). They are used for various needs due to the presence of alginate compound and nutrients. The alginate compound of *Sargassum* spp. is widely utilized in industries as thickening, suspending, stabilizing, film forming materials, gel, and emulsifying material (Basmal et al 2013). Therefore, *Sargassum* spp. has been benefited as raw material in food industries, pharmacy, cosmetics, fertilizer, textile, paper, and etc. (Pakidi & Suwoyo 2016).

Sargassum spp. also has high nutritional value so that coastal communities take it as food. The nutrient content of *Sargassum* spp. differs with species and locality. Previous studies report that *Sargassum polycystum* from Pahuwato waters contains 3.65% protein, 0.5% fat, 53.66% carbohydrate, 24.51% ash, 17.69% water (Manteu et al 2018), while the nutrient content of *Sargassum* spp. from Saugi island, Pangkep regency contains 7.5% protein, 1.33% fat, 50.7% carbohydrate, and 27% ash (Ardiansyah et al 2018).

Despite holding high alginate, nutrients, and active compounds, the use of *Sargassum* spp. in Indonesia is still very low (Handayani 2006; Raharjo & Prasetyaningsih 2018) including Kupang, so that it has very low market value. Therefore, study on species identification, alginate and nutritional content analysis is needed to be done in order to increase the utilization of *Sargassum* spp. Therefore, this study accomplished species identification and analyzed the alginate and nutrient content.

Material and Method

Collection and identification of *Sargassum spp.* The study was accomplished for 2 months. Samples were collected in May 2016 at the lowest tide by haphazardly searching along the coast. It was done in the coastal waters of Paradiso near the mangrove forest, Kelapa Lima and Pasir Panjang near the residential area, Bolok far from the residential area but close to the Hydroelectric, and Tabulolong far from the residential area (Figure 1). The samples were put into plastic bag, then brought to the Laboratory of Faculty of Fisheries and Marine Science, Nusa Cendana University, Kupang, cleansed and separated with species. The clean samples were wind-dried and ready for the examination of alginate and nutrient content.

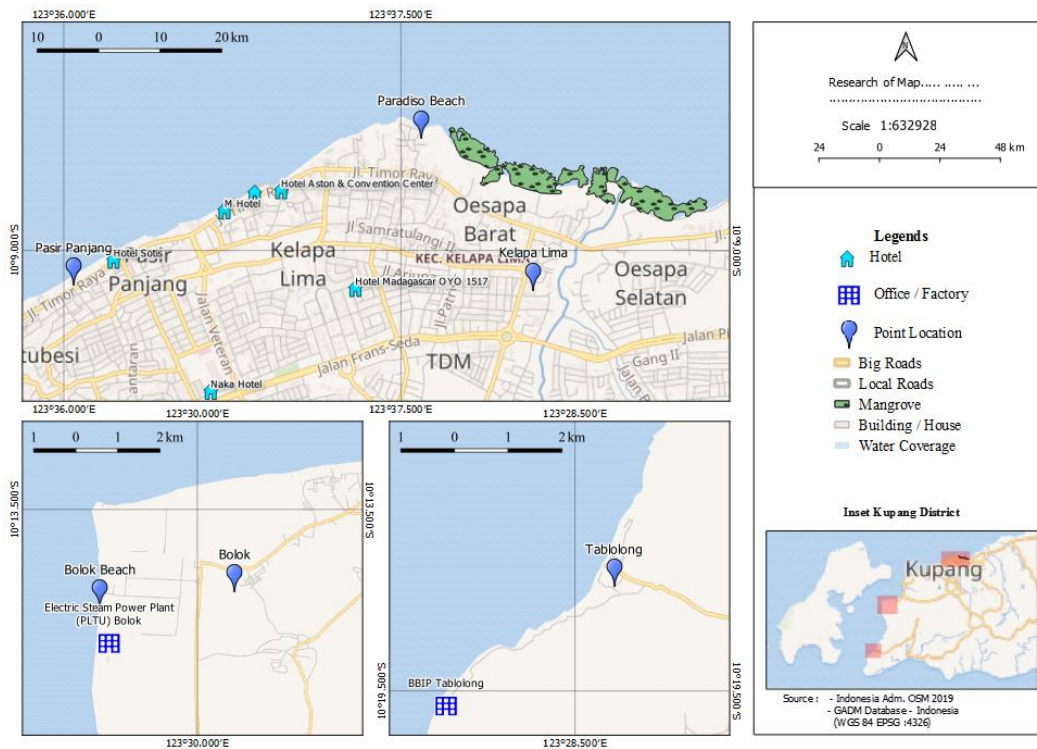


Figure 1. Study site.

Alginate content analysis. Alginate analysis followed the method described by Widyastuti (2009). As much as 3 g of dry macroalga sample were immersed in 15 mL of 1% CaCl_2 solution for 2 hours while stirred using magnetic stirrer, then it was washed in clean water to remove calcium and dissolved salt, then rinsed with 0.33% HCl. The macroalga was washed again in clean water, chopped, and macerated in 4% Na_2CO_3 solution in 1:2 ratio at 40°C for 2 hours while stirred using a magnetic stirrer up to forming homogenous pasta. The pasta was diluted with distilled water as much as 3 times the initial volume while stirred, then filtered through soft cloth. The filtrate was added with 5 mL of 0.33% HCl, left for 6 hours until deposits were formed. The deposit, the alginate rendement, was then filtered through 25 μm -Whatman filter paper and dried in the oven at 60°C .

Nutrient analysis of *Sargassum spp.* Nutrient content analysis followed the standard method of AOAC (2005). Water content was determined using oven method at $105\text{--}110^\circ\text{C}$ for 4 h. Ash content was analyzed based on dry ashing method, in which the material was heated in the furnace at 600°C up to becoming ash. Protein content was examined using Kjeldahl method through oxidation, distillation, and titration. Fat content analysis used Soxhlet method, while carbohydrate content was determined by difference using the following formula: $100\% - (\% \text{ water} - \% \text{ fat} - \% \text{ protein} - \% \text{ ash})$.

Results and Discussion

***Sargassum* spp. in Kupang Bay waters.** Based on the identification guide of Jha et al (2009) and Taylor (1960), seaweeds *Sargassum* found in Kupang Bay waters are shown on Table 1.

Table 1

Sargassum spp found in Kupang Bay waters

No	Genus <i>Sargassum</i>	Locality				
		Tabulolong	Kelapa Lima	Pasir Panjang	Bolok	Paradiso
1	<i>Sargassum cristaefolium</i>	+	+	-	-	+
2	<i>Sargassum</i> sp.	+	-	+	+	-
3	<i>Sargassum polycystum</i>	+	-	+	-	-
4	<i>Sargassum crassifolium</i>	+	-	-	-	-
No. species		4	1	2	1	1
No. substrate		4	2	4	2	1
Substrate types		Mud, dead coral, seagrass, sand	Dead coral, sand	Mud, dead coral, seagrass, sand	Mud, seagrass	Dead coral

Note: + = present; - = absent.

Table 1 shows that there are 4 species of *Sargassum* found in Kupang Bay waters. All these species were recorded in Tabulolong coast, 2 species in Pasir Panjang, and only 1 species each in Kelapa Lima, Paradise and Bolok coast. This evidence is supported with the high number of substrate types present in Tabulolong and Pasir Panjang, 4 substrate types each. It is in agreement with Kadi (2007) that the occurrence and the diversity of genera are usually highly dependent on the habitat and the substrate complexity.

Although number of substrate types in Tabulolong coast was the same as Pasir Panjang, number of species found was different. It could result from human activities near the locality. The sampling site in Tabulolong coast is far from the residential area and human activities, but Pasir Panjang coast is close to the residential area. The diversity of macroalgae is influenced by habitat availability as well. Pasir Panjang coast is very close to human residences so that the environmental pressure on the microalgal diversity occurs in the area. It is in agreement with Langoy et al (2011) that human activities tend to affect the macroalgal diversity.

Sargassum cristaeifolium and *Sargassum* sp. were found in 3 locations (Table 1). This condition reflects that both species could adapt to these environmental conditions and their spores have enough dispersion ability. Atmadja (1999) claimed that the occurrence of macroalgal species in certain area is determined by the characteristics of the environment and the macroalgae themselves. The suitability between both factors will determine the macroalgal growth including attachability at early growth stage.

Number of *Sargassum* species recorded in Kupang Bay waters was higher than that found in several other places in Indonesia. In Kotania Bay waters, west Seram, only 2 species occur, *Sargassum crispivalium* and *S. duplicatum*, respectively (Arfah & Patty 2014), 2 species in Anambas group of islands, *S. echinocarpum* and *S. polycystum*, respectively (Kadi 2009), and 2 species in Hari island, southeast Sulawesi, *S. crassifolium* and *S. filipendula*, respectively (Ira et al 2018). Only in Untung Island, Java, four species were found, *S. binder*, *S. asperifolium*, *S. ilicifolium*, and *S. polycystum* (Marianingsih et al 2013).

Compared with number of *Sargassum* species in other countries, Kupang Bay waters have higher number of *Sargassum* species than those of Konkan coastal waters,

Maharastra, with only 3 species, *S. cinerum*, *S. tenerrimum*, and *S. wightii* (Ambhore & Whankatte 2016), but fewer than those in Blue lagoon waters, Malaysia, with 6 species, *S. polycystum*, *S. siliquosum*, *S. cristaefolium*, *S. ilicifolium*, *S. asperifolium*, and *S. oligocystum* (Asmidah et al 2017).

Alginate content of *Sargassum* spp. Table 2 shows that alginate content of *Sargassum* spp. from Kupang Bay waters varies even though they belong to the same genus. The highest alginate content was found in *Sargassum* sp., up to 33.33% and the lowest in *S. crasifolium*, only 10%.

Table 2

Alginate content of genus *Sargassum* found in Kupang Bay waters

No	Genus <i>Sargassum</i>	Alginate content (%)
1	<i>S. crassifolium</i>	10
2	<i>Sargassum</i> sp.	33.33
3	<i>S. cristaefolium</i>	13.33
4	<i>S. polycystum</i>	23.33

It means that alginate content of brown macroalga differs with species. The same finding is also reported by Raharjo & Prasetyaningsih (2018) that the alginate content in *Sargassum* varies with species, thallus size, and age.

Besides species difference, the alginate content is affected by the habitat where they live as well. It could be indicated with the difference in alginate content recorded in *S. polycystum* taken from different localities, 23.33% for the species collected from Kupang Bay waters, 32.70% from Sepanjang coastal waters, and 30.35% from Drini coast, Gunung Kidul regency (Rahardjo & Prasetyaningsih 2018). Similarly, *S. crassifolium* from Kupang Bay hold only 10% alginate, different from that in Awur Bay, Jepara 37.91% (Handayani 2004). Different alginate content obtained in the macroalgae could also result from different extraction method used. Kasim et al (2017) found that different Na₂CO₃ concentration and extraction temperature influence the quality of alginate content produced. Alginate extraction done at the same temperature (60°C) with different concentration of Na₂CO₃ solvent yielded different alginate content, 35.17% in 2% solvent, 18.74% in 4% solvent, 12.73% in 6% solvent, respectively. Similarly, with the same Na₂CO₃ concentration (2%) but extracted at different temperature could also yield different alginate content, 29.14% at 50°C, 35.17% at 60°C, and 27% at 70°C (Kasim et al 2017).

The range of alginate content obtained from *Sargassum* spp. of Kupang Bay waters was not quite different from the alginate content of brown macroalgae collected in Gunung kidul, Yogyakarta, the highest is 30.5% and the lowest is 16.93% (Musholaeni & Rusdiana 2011), but higher than that from *Sargassum* spp. of Lombok waters ranging from 4 to 18% (Widyastuti 2009).

Nutrient content of *Sargassum* spp. The nutrient content of *Sargassum* spp. collected from Kupang Bay waters is given in Table 2. *Sargassum* spp. contains 46.59-50.98% carbohydrate, 0.94-1.99% fat, 6.44-10.64% protein, 22.56-24.76% ash, and 16.19-19.64% water.

Table 2

Nutrient content in *Sargassum* spp. found in Kupang Bay waters

Macroalgae	Water content (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
<i>S. crassifolium</i>	19.64	24.11	8.06	1.61	46.59
<i>S. cristaefolium</i>	17.60	24.00	9.13	0.94	48.34
<i>S. polycystum</i>	16.19	24.76	6.44	1.63	50.98
<i>Sargassum</i> sp.	17.29	22.56	10.64	1.99	47.52

The water content of *Sargassum* spp. collected in this study ranged from 16.19 to 19.64%, not so different from that in *Sargassum polycystum* from Pahuwato waters, 17.69% (Manteu et al 2018). This finding is higher than that in *Sargassum* sp. collected from west Aceh coastal waters, 10.54% (Gazali et al 2018) and in *S. hystrix* from Sepanjang coastal waters, Gunung Kidul, Yogyakarta, 13.43% (Lailatussifa et al 2017).

Sargassum sp. collected from west Aceh coastal waters contains 52.74% ash (Gazali et al 2018), while *S. polycystum* from Pahuwato waters holds 24.51% ash (Manteu et al 2018). Ardiansyah et al (2018) reported that *Sargassum* spp. from Saugi Island, Pangkep Regency, had 27% ash. The ash content of *Sargassum* sp. in those 3 localities mentioned above is higher than that in *Sargassum* spp collected in Kupang Bay waters, 22.56-24.76%.

Macroalgae possess high protein and carbohydrate content (especially fiber) (Pattara et al 2011; Kasimala et al 2015) and low fat (Suparmi & Sahri 2009). This information is supported with the nutrient content of *Sargassum* spp. from Kupang Bay waters, 46.59-50.98% carbohydrate, 6.44-10.64% protein, and 0.94-1.99% fat. Similar condition occurs also in *S. polycystum* from Pahuwato waters that contains high protein, 3.65%, low fat, 0.5%, and high carbohydrate, 53.66% (Manteu et al 2018). *Sargassum* spp. from Saugi Island, Pangkep Regency, contains 7.5% protein, 1.33% fat, and 50.7% carbohydrate (Ardiansyah et al 2018). Furthermore, the nutrient content in *Sargassum* sp. from west Aceh coastal waters is high in protein, 2.53%, low in fat, 0.79%, high in carbohydrate, 23.77%, respectively (Gazali et al 2018), while *S. hystrix* from Sepanjang coastal water, Gunung Kidul, Yogyakarta, contains high protein, 6.54%, low fat, 0.05 %, and high fiber, 31.53% (Lailatussifa et al 2017). Nutrient composition of the macroalgae with high protein and carbohydrate (particularly fiber), low fat, and high ash content reflects that *Sargassum* is potential to be developed as good food for human health. According to Da Costa et al (2018), seaweed is rich in nutritional and non-nutritional substances beneficial for human health.

Conclusions. Morphological identification of *Sargassum* found 4 species in Kupang Bay waters, *S. crassifolium*, *S. cristaefolium*, *S. polycystum*, and *Sargassum* sp. The alginate content of *Sargassum* species collected from Kupang Bay waters ranged from 10 to 33% and the highest range was recorded in *Sargassum* sp. The nutrient content of *Sargassum* sp ranged from 16.19 to 19.64% water, 22.56 to 24.76% ash, 6.44 to 10.64% protein, 0.94 to 1.99% fat, and 46.59 to 50.98% carbohydrate. These species have potential to be developed as alginate producer and healthy food source for diet since they contain high protein and low fat.

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Received: 16 October 2019. Accepted: 24 November 2019. Published online: 08 December 2019.

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How to cite this article:

Salosso Y., 2019 Nutrient and alginate content of macroalgae *Sargassum* sp. from Kupang Bay waters, East Nusa Tenggara, Indonesia. *AACL Bioflux* 12(6):2130-2136.