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Chemical and Minerals Composition of Dried Seaweed *Eucheuma spinosum* Collected from Indonesia Coastal Sea Regions

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Abstract

This research is aimed to analyze the chemical and mineral composition of dried red seaweed *Eucheuma spinosum* from Nusa Penida, Sumenep, and Takalar. Analysis of the chemical composition was moisture, ash, protein, fat, fiber, and carbohydrate contents. The mineral element was macrominerals (Ca, Cl, K Mg, and Na) and micro minerals (Zn and Cu). The results of the analysis of carbohydrate content of dried *E. spinosum* from Nusa Penida, Sumenep and Takalar was 69.07-69.66% and fiber content 15.12-19.89% dry weight. The protein content of Nusa Penida, Sumenep dan Takalar were 6.04-7.33% dry weight. The ash content of *E.spinosum* from Nusa Penida, Sumenep and Takalar were 23.35-24.66%, fat content 0.012-0.032 % dry weight. The macro minerals from Nusa Penida, Sumenep and Takalar were Ca(0.0455-0.796%), Cl (0.112-0.133%), K(2.881-3.539%), Mg (0.395-0.582%) and Na (0.0455-0.796%) and micro minerals was Zn (4.68-26.37 ppm) and Cu (0.036-0.175 ppm).

Keyword*:* Red seaweed, *Eucheuma spinosum,* chemical composition, macro and micro minerals

INTRODUCTION

Seaweed is one of the plants that are grown and cultivated on the coastal sea. The based pigment content of seaweed is composed of red (Rhodophyta), brown

(Phaeophyta), or green (Chlorophyta). Seaweed has been consumed by humans, especially Asian countries, such as Japan, China, Korea, Vietnam, Indonesia, and Taiwan (Dawes, 1988). Percentage of seaweed consumption as follows: green (5%), brown (62%), and red (33%). The highest consumption rate are in Asia, notably Japan, China, Korea, and also North America, South America, and Europe (McHugh, 2003).

E. spinosum is the raw material for carrageenan, and contains few nutrients, macro and micro minerals necessary for human nutrition. In general, seaweed is low-calorie foods, but rich in vitamins, minerals and fiber content (Ito and Hori 1989). Also, seaweed is used as animal feed ingredients, fertilizers and raw materials for various industrial applications (Mabeau and Fleurence 1993; Fleurence 1999; Rupérez 2002; Kumari et al., 2010.).

Almost 1 ton per year of seaweed have been harvested and extracted into a compound of hydrocolloid (McHugh, 2003). Some studies have been showed that seaweed is a source of protein, fat, vitamins and essential minerals (Mabeau and Fleurence, 1993; Darcy-Vrillon, 1993; Fleurence, 1999; Novaczek, 2001; Ortiz et al., 2006). The demand for marine products as a source of food, fertilizer and medical source continues to increase. *Gelidium, Porphyra, Palmaria, Gracilaria* and *Eucheuma* species of red seaweed edible (McLachlan 1972). *Eucheuma* in Indonesia consists of two species, namely *E. spinosum* and *E. cottonii*. *E. spinosum* has cultivated coastal sea, especially in the provinces of Bali (Nusa Penida), Sumenep (East Java), and South Sulawesi (Takalar).

The chemical composition of red seaweed of the few countries in the world has been documented. Contrary *E. spinosum* of a coastal sea of Indonesia, the content of the chemical composition and nutritional value have not been documented. The chemical composition of nutrients from seaweed was determined by the species and environmental conditions such as habitat, light, water temperature and salinity, may be caused differences in the nutritional composition of seaweed (Burtin, 2003, and Darcy-Vrillon 1993). Seaweed also contains minerals essential such as Ca, Mg, Se, and Fe. The study examined the chemical and mineral composition of tropical species that have been cultivated *E. spinosum* of Nusa Penida, Sumenep, and Takalar.

MATERIALS AND METHODS

Material

The seaweed used in this study was harvested after 45 days of cultivation from the following three different locations Nusa Penida island (Bali province); Sumenep in Madura island (East Java province); and Takalar (South Sulawesi province). The collection of seaweed from the three locations was done during the rainy season in January to February 2011. The harvested seaweed was first cleaned in flowing water to remove dirt and excess of salt and then dried at room temperature of 27-29°C for 24 h until moisture content of the seaweed was around 20%.

Proximate analysis

The proximate chemical composition (protein, crude lipid, fiber, ash and moisture content) of *E. spinosum* from Nusa Penida, Sumenep, and Takalar was determined according to the method (AOAC, 2005). Protein content was analyzed by the Kjeldahl method, which involved protein digestion and distillation. The percentage crude protein was calculated from the % Nitrogen. The conversion factor of 6.25 has been used to convert total nitrogen content into crude protein (978.040 AOAC 2005).

Moisture content was analyzed by oven method. (AOAC 934.01 2006). Fiber was analyzed by gravimetric (AOAC 2005). The difference method used to calculate carbohydrate content. A fat was determined using Soxhlet extraction for 4 hr starting with ethanol, (AOAC 2005 963.15).

Mineral analysis

The determination of mineral elements (calcium, chloride, potassium, magnesium, sodium, zinc, copper), samples were digested by dry ashing and dissolved in 1 M HCl (985.35.50.1.14 AOAC 2005).

The concentration of the elements in *E. spinosum* were determined using atomic absorption spectrophotometer 6300 equipped with a single hollow cathode lamp (Shimadzu Co, Kyoto, Japan) for each element and an air-acetylene burner. The concentration of the elements was determined from calibration curves of the standard elements.

Statistical Analysis

Data were analyzed using SPSS version 16 (SPSS, Chicago, IL), and were treated statistically by one-way analysis of variance (ANOVA). The composition of chemical *E. spinosum* collected from Nusa Penida, Sumenep, and Takalar was compared using one-way ANOVA.

RESULT AND DISCUSSION

Proximate composition

Proximate composition of *E. spinosum* from Nusa Penida, Sumenep, and Takalar have shown in Table 1. The moisture contents of seaweed *E. spinosum* from Nusa Penida, Sumenep, and Takalar were 19.55±0.49, 19.92±2.15, and 21.27±0.52% dry weight (dw), respectively. The main components of *E. spinosum* are carbohydrate from 69.07-69.66% dw while the fiber content 15.12- 9.89% dw. The chemical composition of *E. spinosum* (Nusa Penida, Sumenep, and Takalar), moisture, ash, fat and protein content were not significant ($p < 0.05$). Duncan test showed fiber content *E. spinosum* from Nusa Penida significantly different from Sumenep and Takalar ($p < 0.05$).

Table 1. Chemical composition and fiber content *E. spinosum* from Nusa Penida, Sumenep and Takalar

Composition (%)	Nusa Penida	Sumenep	Takalar
	dw*	dw*	dw*
Moisture	19.55 ± 0.49	19.92 ± 2.15	21.27 ± 0.52
Ash	24.26 ± 0.20	23.34±0.25	23.66±0.06
Protein	6.04 ± 0.79	7.30±0.01	7.33±0.33
Fat	0.012 ± 0.0	0.032±0.03	0.032±0.01
Crude Fiber	15.12 ± 1.08[a]	19.89±1.39[b]	18.56 ±0.32[b]
Carbohydrate*	69.66 ±1.86	69.64 ±3.08	69.07 ±1.22

**by difference, dw=dry weight. Letters indicate statistical significance (P < 0.05) for each location*

The protein content of *E. spinosum* was Nusa Penida (6.04% dry weight), Sumenep (7.30% dry weight), and Takalar (7:33% dry weight). *E.spinosum* has lower protein content than other red seaweed. Fleurence (1999), reported the protein content of red and green seaweed from 10-40% dry weight. Protein content *E.spinosum* are lower than some other red seaweed such as *Gracilaria cervicornis* (22.96% dw, *Hypnea japonica* (19.00%), *Hypnea musciformis* (18.64% dw) and *Porphyra tenera* (34.20% dw) and *E. cottonii* (9.76% dw). It was higher than *Gracilaria cornea* (5.47% dw), and *Gracilaria changgi* (6.90% dw). The fat content of *E.spinosum* was lower than *Gracilaria cervicornis* (0.43% dw), *Gelidium pristoides* (0.90% dw*),* and *Porphyra tenera* (0.70%) dw).

The ash content of *E. spinosum* from Nusa Penida, Sumenep and Takalar were: 23.66%, weight, 23.34%, and 24.26% dw, respectively. The ash content *E.spinosum* of three coastal sea regions (Nusa Penida, Sumenep, and Takalar) were the highest compared to the species of red seaweed *H.pannosa* (18.65%) and *H. musciformis* (21.57% dw) (Siddique et al . 2013). Its similar to the research of Fleurence Mabeau (1993) reported a red seaweed ash content 8-40% dw. Several studies showed that it found the ash content of seaweed depend on the species, geographical origin and methods of demineralization (Nisizawa, 1987; Sanchez-Machado, 2004. Its compared to other species are similar to other red seaweed, *H. japonica* (22.10%), *H. chlorides* (22.80%), *G. changgi* (22.70% dw) (Norziah and Ching, 2000; Wong and Cheung, 2000).

The carbohydrate content of *E. spinosum* from Nusa Penida, Sumenep, and was almost identical. Seaweed contained another polysaccharide that was composed of laminarin (β-1.3-glucan) from brown seaweed and flour floridea. Amylopectin-glucan was established in red seaweed. Polysaccharides (agar, carrageenan, ulvan, and fucoidan) cannot be digested in the human intestine and is referred to as dietary fiber (Lahaye et al. 1991). Fibers composed of soluble fiber and insoluble in water has a physiology.

The fiber contents of *E. spinosum* from Nusa Penida, Sumenep, and Takalar were 12.18, 14.61, and 15.92%, respectively. Seaweeds of the same species but a different growth shows the difference of the total fiber content. The chemical composition of dried seaweed showed that the growth in influential on the chemical composition of the seaweed was mainly ash and carbohydrates. Environmental factors will affect the survival of living things such as water temperature and salinity.

In general, tropical sea surface temperatures have not much variation annually. The Takalar (South Sulawesi) coastal sea region is unique because there is a meeting of two water masses, causing a higher nutrient content, in contrast to Sumenep and Nusa Penida. In addition, temperature and salinity, current velocity can affect the supply of nutrients that seaweeds can absorb nutrients, clean the dirt and the exchange of CO_2 and O_2.

Micro and macro mineral composition

Table 2 showed mineral composition**.** The content of macro minerals such as Ca, Cl, K, Mg, and Na and micro minerals Zn and Cu are respectively 0.397-3.539% and 0.0036-26.l37 ppm. *E.spinosum* from Nusa Penida, Sumenep and Takalar has the highest mineral content of potassium ranging from 2.88-3.54% and the lowest Na (0.066-0.074%). While the mineral content of Ca was (0.455-0.796), Mg (0.395-0.582) and Cl (0.112-0.133%). Mineral macro highest potassium in dried seaweed *E.spinosum* from Nusa Penida than Sumenep, and Takalar. While the highest Zn micro minerals from Takalar (26.37 ppm). Nusa Penida (21, 335 ppm) and lowest Sumenep (4.66 ppm). The content Cu relatively was very low, Nusa Penida (0.036), Sumenep (0.175) and Takalar (0.232 ppm)

The content Zn of *E.spinosum* with red seaweed types *Acanthophora spicifera* was equally low (Karthikai Devi et al. 2009). The content of macro minerals (Na, K, Ca, and Mg) *E.spinosum* were lower than other red seaweed. Seaweed contains some macro-minerals (12.01 to 15.53%) and trace elements (7.53-71.53 mg.100 g-1) (Matanjum et al. 2009).

Table 2. Mineral composition of dried *E.spinosum*

Karagenan	Macro Mineral makro (%)					Micro Mineral (ppm)	
	Ca	Cl	K	Mg	Na	Zn	Cu
Nusa Penida	0.455±0.002	0.133± 0.021	3.539±0.001	0.395± 0.001	0.074±0.000	21.335±0.346	0.036±0.026
Sumenep	0.676±0.000	0.125± 0.022	2.973±0.004	0.408±0.004	0.066±0.000	4.68±0.000	0.175±0.067
Takalar	0.796±0.001	0.112± 0.012	2.881±0.019	0.582± 0.000	0.067± 0.068	26.37±0.127	0.232±0.006

CONCLUSION

The chemical compositions (moisture, ash, protein, fat, and carbohydrate) of E. spinosum from Nusa Penida, Sumenep, and Takalar were not significantly different, while fiber content was significantly different. The content carbohydrates and fiber were the highest. The macro mineral content was the highest potassium, followed by calcium, magnesium and the lowest was sodium, while the micro minerals except for the highest Zn from Sumenep were lower and the Cu content relatively was the lowest.

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