Chemical and Mineral Compositions of *Sargassum* spp. from Bo Mao Beach, Chumphon Province, Thailand

Monsuang Yangthong

ABSTRACT

Sargassum spp. or brown seaweeds have been used as food by the people in Pathio district, Chumphon province, south Thailand. This study is the first time that an investigation on the chemical and elemental compositions of *Sargassum* spp. found in the area has been conducted. Three species of *Sargassum*, namely *Sargassum binderi, S. polycystum* and *S. oligocystum* from Bo Mao Beach in Pathio District of Chumphon province were collected from September 2014 to February 2015. Results showed that the chemical compositions such as moisture, ash, crude protein, crude lipid and crude fiber of *S. binderi* were 5.61±0.00, 14.73±0.14, 5.96±0.03, 2.02±0.01 and 13.78±0.99% dry weight, respectively. Whereas, the moisture, ash, crude protein, crude lipid and crude fiber of *S. polycystum* were 5.34±0.01, 14.20±0.13, 6.83±0.05, 2.08±0.02 and 15.44±2.64% dry weight, respectively, and those of *S. oligocystum* were 4.17±0.19, 24.22±0.29, 5.47±0.41, 2.62±0.06 and 12.52±0.49% dry weight, respectively. The amount of Ca, P, K, Mg and Na of these seaweeds were significantly different ($p<0.05$), with *S. binderi* containing 3.23 ± 0.08, 0.07±0.00, 1.55±0.04, 0.99±0.01 and 0.75±0.00 % dry weight, respectively. Whereas *S. polycystum* contained 2.28±0.08, 0.07±0.01, 1.90±0.02, 0.90±0.01 and 1.12±0.00% dry weight, and *S. oligocystum* had 2.17±0.01, 0.06±0.00, 6.30±0.11, 0.85±0.01 and 0.58±0.01% dry weight, respectively. This study indicated that these brown seaweed are rich in beneficial nutrients, with potential for use as food not only for humans but also for animals.

Keywords: *Sargassum*, chemical composition, mineral composition

INTRODUCTION

Seaweeds or macroalgae are aquatic plants that grow in the intertidal as well as the subtidal area up to a certain depth where very little photosynthetic light is available. Unlike terrestrial plants, they have no roots, leaves or vascular systems. They nourish themselves through the process of osmosis. It has been estimated that 50% of the global photosynthesis is contributed from algae (Dhargalkar and Neelam, 2005). Seaweeds are classified into several groups depending on their nutrient, pigment and chemical compositions. Some 400 different species of seaweeds around the world are used by people for food, livestock feed, medicine and as fertilizers. Seaweeds generate billions of dollars each year. In Thailand, approximately 270 species of algae have been found (Lewmanomont *et al*., 1995). *Sargassum* sp. is a brown seaweed which is widely distributed along the coastal areas of both the Gulf of Thailand and the Andaman Sea. Bo Mao Beach in Chumphon province is one of the coastal areas along the Gulf of Thailand. This location is in the south of Thailand where the coastal areas are usually dominated by *Sargassum* spp. The brown seaweed

Program of Fishery Science and Aquatic Resources, Disciplines of Technology Agriculture, King Mongkut's Institute of Technology Ladkrabang Prince of Chumphon Campus, Chumphon Province, Thailand
Corresponding author, e-mail address: ymonsuang@hotmail.co.th
Received 6 March 2017 / Accepted 25 July 2017

is used by coastal inhabitants for food, medicine and as fertilizers. The local people along coastal areas recognize the benefits of utilizing *Sargassum* spp. through knowledge passed on from their ancestors but without information on its nutritional value. The objective of this study was to determine the chemical and mineral compositions of three species of the brown seaweed, namely *Sargassum binderi, S. polycystum* and *S. oligocystum* collected from Bo Mao Beach in Pathio District of Chumphon province.

MATERIALS AND METHODS

Preparation of seaweed

The brown seaweeds, namely *S. binderi, S. polycystum* and *S. oligocystum*, were collected during low tide from the upper littoral zone of Bo Mao Beach (Latitude 10° 43' N; Longitude 99° 23' E) of Pathio District of Chumphon province during September 2014 to February 2015. The fresh seaweeds were thoroughly washed with seawater to remove adherent sand and the epiphytes, then brought to the laboratory in plastic bags. On their arrival at the laboratory, the seaweed samples were again washed with distilled water and dried at 55°C in hot air oven for 48 hours. All samples were milled by herb grinder model NT 500D (*Nanotech, Thailand*) and kept in air tight plastic bottles at 4°C until needed.

Chemical and mineral compositions

The powdered seaweeds were subsequently used for analysis to determine their chemical and mineral compositions. The chemical composition of seaweeds such as moisture, ash, crude protein, crude lipid and crude fiber were ascertained according to the Association of Official Analytical Chemists (AOAC, 1999). Moisture content was analyzed by hot air oven at 105˚C till the constant weight was recorded. Ash content was determined using a muffle furnace at 600˚C for 3 hours. Crude protein determination was done by Kjeldahl method with a conversion factor of 6.25 to calculate protein content. For crude lipid content using petroleum ether for extraction in Soxhlet extractor, crude fiber was analyzed by digestion in sulphuric acid and potassium hydroxide solutions and the residue calcined. The difference in weight after calcination indicates the quantity of fiber present. The elemental compositions such as Ca, P, K, Mg and Na were subjected to acid digestion and analyzed by atomic absorption spectrophotometer and flame photometer (GBC Scientific Equipment Model Avanta PM S/N 5063) following the procedures described by AOAC (1999).

Statistical analysis

The chemical and mineral composition data of *S. binderi, S. polycystum* and *S. oligocystum* were recorded in triplicate data, with the means and standard deviation (SD) calculated and analyzed using a one-way ANOVA. Differences in mean values were considered significant at $p<0.05$.

RESULTS AND DISCUSSION

Macroalgae are extremely nutritious food. The human consumption of seaweed is common in Asian countries. Seaweeds are considered as low caloric foods containing high levels of minerals and vitamins. *Sargassum* spp. or brown seaweeds are used worldwide for many different purposes. In the present study, the chemical composition of seaweeds such as moisture, ash, crude protein, crude lipid and crude fiber showed significant difference ($p<0.05$) (Table 1). The moisture content of the three *Sargassum* species were relatively lower (4.17-5.61% dry weight) than that of *S. vulgare* (14.66 % dry weight) as reported by Marinho-Soriana *et al*. (2006).

Ash content of macroalgae is much higher than that of terrestrial plants (Sanchez-Machado *et al*. 2004). The ash analysis indicated that minerals were present in seaweed. *Sargassum naozhouense* consisted of 35.18 % ash (Peng *et al*., 2013). An ash content of 26.5-31.7 % dry weight of *Sargassum* spp. was reported by Pérez (1997) whereas Marín *et al*. (2009) reported an

Table 1. Chemical composition of dried brown seaweeds

Seaweeds	Moisture	Ash	(% DW) Protein	Lipid	Fiber
S. binderi	5.61 ± 0.31^{a}	14.73 ± 0.10^{b}	5.96 ± 0.03^{b}	2.02 ± 0.01^{b}	13.78 ± 0.99^{b}
S. polycystum	5.34 ± 0.01^{a}	14.20 ± 0.10^{c}	6.83 ± 0.05^{a}	2.08 ± 0.02^{b}	15.44 ± 0.40^{a}
S. oligocystum	4.17 ± 0.19^{b}	24.22 ± 0.29^{a}	5.47 ± 0.41^{c}	2.62 ± 0.02^{a}	12.52 ± 0.49^{b}

[1]Mean ± standard deviation of three replications
Means within each column not sharing a common superscript are significantly different ($p<0.05$).

ash amount of 33 % dry weight of *Sargassum* spp. from the San Juan de La Costa beach. Moreover, *S. vulgare* had 14.20% ash dry weight (Marinho-Soriana *et al*., 2006). In the present study, the ash amount varied from 14.20-24.22 % dry weight.

Proteins are essential nutrients for the human body and have crucial functions in all biological processes. Protein content of macroalgae differs according to species. The protein content in the present study was in the range of 5.47-5.96 % dry weight. In comparison, Pérez (1997) reported that *Sargassum* spp. collected during summer from La Paz Bay had a protein content ranging from 3.5 to 4.7 % dry weight.

In another study by Marín *et al*. (2009), *Sargassum* spp. collected from San Juan de La Costa beach, in La Paz Bay had a protein content of 7.7 % dry weight. Moreover, Murugaiyan *et al*. (2012) found that the protein value of *S. wightii* was 16.59±0.86%, whereas *S. longifolium* had high protein content at 18.65±1.21 % dry weight (Narasimman and Murugaiyan, 2012), and *S. vulgare* had 15.76 % dry weight (Marinho-Soriana *et al*., 2006). Generally, the protein level of brown algae is between 3 and 15% dry weight (Fleurence, 1999). Moreover the protein content of seaweeds also depends on the season. Higher protein levels were observed during the end of the winter and spring, while lower amounts were recorded during the summer (Fleurence, 1999).

Normally, the seaweeds have low lipid contents and are not considered to be sources of lipid. In this study, the lipid contents in the three samples ranged from 2.02 to 2.62 % dry weight. While Pérez (1997) reported that *Sargassum* spp. collected in the summer had crude lipid of 0.1-0.4 % dry weight, samples from La Paz Bay had lipid content of 0.45% dry weight (Marín *et al*., 2009). In addition, lipid content was about 1.5 % dry weight of *S. wightii* and 8.2±1.57% dry weight of *S. longifolium* (Narasimman and Murugaiyan, 2012). Accordingly, the lipid amount of *Sargassum* sp. differed according to species. *Sargassum* spp. are low-calorie foods and have many health benefits.

Fiber is found in plants and seaweeds. The algal polysaccharides behave like soluble or insoluble fibers and are not digested (Fleurence, 1999). Fiber is important for keeping the digestive tract working smoothly. The crude fiber content of seaweeds in the present study showed a higher value than those from earlier studies reported by Pérez (1997), Marinho-Soriana *et al*. (2006) and Marín *et al*. (2009). Therefore, this study revealed that the chemical composition of marine seaweeds varies according to seasons, geographic distribution, environmental factors, and species.

In the present study, different minerals (calcium, phosphorus, potassium, magnesium, and sodium) were determined in *S. binderi, S. polycystum* and *S. oligocystum* (Table 2). Each species contained significant amounts of essential minerals. Calcium, phosphorus and magnesium were the most abundant in *S. binderi*, while sodium was the most abundant in *S. polycystum*, and potassium was the most abundant in *S. oligocystum*. In this study, magnesium contents were relatively similar to *S. longifolium* which was collected during August in the Gulf of Mannar region, India (1,575.47±16.45 µg/ml) as reported by Murugaiyan

Table 2. Elemental composition of dried brown seaweeds

Seaweeds	(mg•100g^{-1})				
	Ca	P	K	Mg	Na
S. binderi	3.23 ± 0.06^{a}	0.07 ± 0.00^{a}	1.55 ± 0.03^{c}	0.99 ± 0.01^{a}	0.75 ± 0.01^{b}
S. polycystum	2.28 ± 0.06^{b}	0.06 ± 0.01^{b}	1.90 ± 0.02^{b}	0.90 ± 0.01^{b}	1.12 ± 0.00^{a}
S. oligocystum	2.17 ± 0.01^{c}	0.06 ± 0.00^{b}	6.30 ± 0.11^{a}	0.85 ± 0.01^{c}	0.58 ± 0.01^{c}

[1]Mean ± standard deviation of three replications
Means within each column not sharing a common superscript are significantly different ($p<0.05$).

and Narasimman (2012). Magnesium is one of the major elements in the plants and it is mainly involved in chlorophyll synthesis (Murugaiyan and Narasimman, 2012). Seaweeds are considered to be a good source of minerals. The mineral contents of marine algae are higher than those of terrestrial vegetables and so they could be used as a source of mineral supplements for humans and animals (Ruperez, 2002; Tabarsa *et al*., 2012). The present investigation revealed that *S. binderi, S. polycystum* and *S. oligocystum* could be used as dietary supplements due to their low lipid content and high levels of minerals.

CONCLUSION

The brown seaweeds (*S. binderi, S. polycystum* and *S. oligocystum*) are good healthy food which are rich in minerals, but low in fat and calories. They could potentially be used as food for fresh consumption and raw material to supplement the nutritive value in human diets and animal feed.

ACKNOWLEDGEMENTS

This research was supported by King Mongkut's Institute of Technology Ladkrabang Prince of Chumphon Campus. I am grateful to Khanjanapaj Lewmanomont and Jantana Sangkaew for assistance in the identification of seaweed species. I would also like to thank Mr. Mark Major for the English editing task.

LITERATURE CITED

AOAC, (Association of Official Analytical Chemists). 1999. **Official Methods of Analysis.** Washington, DC.

Dhargalkar, V.K. and P.Neelam. 2005. Seaweed: Promising plant of the millennium. **Science Culture.** 71: 60-66.

Fleurence, J. 1999. Seaweed proteins: biochemical, nutritional aspects and potential uses. **Trends in food science and technology.** 10: 25-28.

Lewmanomont, K., L. Wongrat, and C. Supanwanid. 1995. **Algae in Thailand.** The Report of the Office of Environmental Policy and Planning, 334 pp. Bangkok, Thailand.

Marín, A., M. Casas-Valdez, S. Carrillo, H. Hernández, A. Monroy, L. Sanginés, and F. Pérez-Gil. 2009. The marine algae *Sargassum* spp. (Sargassaceae) as feed for sheep in tropical and subtropical regions", **Revista de. Biologia Tropical.** 57(4): 1271-1281.

Marinho-Soriana, E., P.C. Fonseca, M.A.A Carneiro, and W.S.C. Moreira. 2006. Seasonal variation in the chemical composition of two tropical seaweeds. **Bioresource Technology.** 97: 2402-2406.

Murugaiyan, K and S. Narasimman. 2012. Elemental composition of *Sargassum longifolium* and *Turbinaria conoides* from Pamban Coast, Tamilnadu. **International Journal of Research in Biological Sciences.** 1(1): 1-3.

Murugaiyan, K., S. Narasimman, and P. Anatharaman. 2012. Proximate composition of ma-rine macro algae from Seeniappa Dharka, Gulf of Mannar region, Tamil Nadu. **International Journal of Research in Marine Sciences.** 1(1): 1-3.

Narasimman, S and K. Murugaiyan. 2012. Proximate composition of certain selected marine macro-algae form Mandapam coastal region (Gulf of Mannar), southeast coast of Tamil Nadu. **International Journal of Pharmaceutical and Biological Archives.** 3(4): 918-921.

Peng, Y., E. Xie, K. Zheng, M. Fredimoses, X. Yang, X. Zhou, Y. Wang, B. Yang, X. Lin, J. Liu and Y. Liu. 2013. Nutritional and Chemical Composition and Antiviral Activity of Cultivated Seaweed *Sargassum naozhouense* Tseng et Lu. **Marine Drugs.** 11: 20-32.

Pérez, R.C. 1997. **Composición química de *Sargassum* spp. colectado en la Bahía de La Paz, B.C.S., y la factibilidad de su aprovechamiento en forma directa o comofuente de alginato.** Tesis de Maestría. Centro Interdisciplinario de Ciencias Marinas. I.P.N., 76 p. La Paz, Baja California Sur, México

Sanchez-Machado, D.I., J. Lopez-Cervantes, J. Lopez-Hernandez and P. Paseiro-Losada. 2004. Fatty acids, total lipid, protein and ash contents of processed edible seaweeds. **Food Chem.** 85(3): 439-444.

Tabarsa, M., M. Rezaei, Z. Ramezanpour and J. Robert Waaland. 2012. Chemical compositions of the marine algae *Gracilaria salicornia* (Rhodophyta) and *Ulva lactuca* (Chlorophyta) as a potential food source. **Journal of the Science of Food and Agriculture.** 92: 2500-2506.

Ruperez, P. 2002. Mineral content of edible marine seaweeds. **Food Chemistry.** 79: 23-26.