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Indian Journal of Geo Marine Sciences
Vol. 49 (01), January 2020, pp. 63-66

Mineral composition of some selected brown seaweeds from Mandapam region of Gulf of Mannar, Tamil Nadu

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Received 2 November 2015; revised 30 August 2016

Mineral content was determined in different brown seaweeds (*Sargassum wightii, Padina tetrastromatica, Chnoospora minima, Hormophysa triquetra, Sargassum myriocystum, Sargassum plagiophyllum* and *Sargassum ilicifolium*), collected from Mandapam region (Gulf of Mannar), Southeast coast of India. The ash content of different seaweeds ranged from 15 % to 20.5 %. The ash values were significantly different among the seaweeds ($P< 0.05$). The selected brown seaweeds contained both macro elements (0.77-564.5 mg/100g; Na, K, Ca, Mg) and trace elements (0.1-4.83 mg/100g; Zn, Mn, Fe, Cu). The present study was carried out in some of the underutilized brown seaweeds and it was concluded that the selected species can be used as feed additives in future.

[**Keywords:** Ash content; ICP-AES; Minerals; Nutrients; Seaweeds]

Introduction

The marine environment in which seaweeds occur, possess great taxonomic diversity and synthesize metabolites with diverse structure with remarkable biological activities[1]. Seaweeds are not only used as food, but whole seaweed mixes have been used in animal and fish feeds[2]. Earlier reports show the biochemical and mineral composition of green, brown and red seaweeds as potential food and feed sources[3,4].

Seaweeds are high in minerals because of their marine habitat, and the variety of the minerals they absorb from the habitat is wide-ranging. The essential minerals and trace elements necessary for human nutrition are present in seaweeds. Brown seaweeds accumulate many elements and are a good source of major, minor and trace elements. Due to this brown seaweed are well known for their efficacy as a dietary supplement or as part of a balanced diet[5].

Mostly, high mineral content (8-40 %) in seaweeds is correlated to factors such as seaweed phylum, geographical location and season. Sometimes it is related to environmental and physiological variations[6]. Now a day, there is an increase in public consciousness regarding the health issues. Thus, the demand for seaweeds as food and biochemical resources is increasing day by day. The numbers of brown seaweed species available for practical use are limited. Since the chemical composition and nutritional assessment is scarce, the present study was undertaken to determine the mineral contents of different species of brown seaweeds from Mandapam region.

Materials and methods

Sample collection

Seven species of macro algae belonging to the Phaeophyta were collected during the period October and November 2011, from Mandapam (Gulf of Mannar) Southeast Coast of India (Lat 8° 35’- 9° 25’ N; Long 78° 08’ - 79° 30’ E). All the algal samples were harvested manually, stored in plastic bags kept in ice box for transportation to the laboratory. They were then methodically cleaned to remove the epiphytes and detritus attached to the fronds. Algal samples were shade dried. The collected samples were *Sargassum wightii*, *Padina tetrastromatica*, *Chnoospora minima*, *Hormophysa triquetra*, *Sargassum myriocystum*, *Sargassum plagiophyllum* and *Sargassum ilicifolium*.

Sample Analysis

To determine the ash content, two grams of dried algal material were taken in a pre-weighed crucible and weighted, placed in a furnace at 500 °C for 4 hr., cooled in desiccators and reweighed. The results are expressed in percentage (%). For mineral analysis the seaweed material was kept in the oven at 110 °C for 12 h, crushed in the grinder and sieved. This powered material was subjected to acid digestion. Mineral analysis (Mg, Fe, Zn, Mn and Cu) was carried out using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES, Perkin = Elmer, Optima 2000) and Na, K and Ca were analyzed by flame photometer. The data is given on dry weight basis as Mean values ± Standard deviation.

Results and Discussion

Figure 1 and Table 1 show the ash and mineral contents for different brown seaweeds, collected from Mandapam, Gulf of Mannar. The ash content of different seaweeds ranged from 15 % to 20.5 %. The ash values were significantly different between the selected seaweeds ($P<0.05$). High amounts of ash ranging between 21.1 to 39.3 % for brown and red edible seaweeds have been reported earlier[7]. In the present study, maximum ash content was observed in *S. wightii* (20.5 %), while minimum in *C. minima* (15 %). The ash content determined in *S. ilicifolium* was lower than the previous reports[8]. Unlike Ruperez[7] in other brown seaweeds the ash content was comparatively lower in the present study.

Seaweeds are well known for their high mineral content. Defects in minerals can generate severe damage to health. Sodium present in stomach walls, joints, and gallbladder, helps to prevent blood clotting, vital for membrane function, nerve impulses and muscle contractions and it is the major cation in body fluids. It plays major role in excretion of carbon dioxide[9]. In the present study, maximum sodium content was obtained in *C. minima* (564.5 mg/100 g dry weight) and minimum content in *S. ilicifolium* (145.6 mg/100 g dry wt).

Potassium is important for membrane function, nerve impulses, and muscle contractions. It is known to be a major cation in cytoplasm; a primary electrolyte

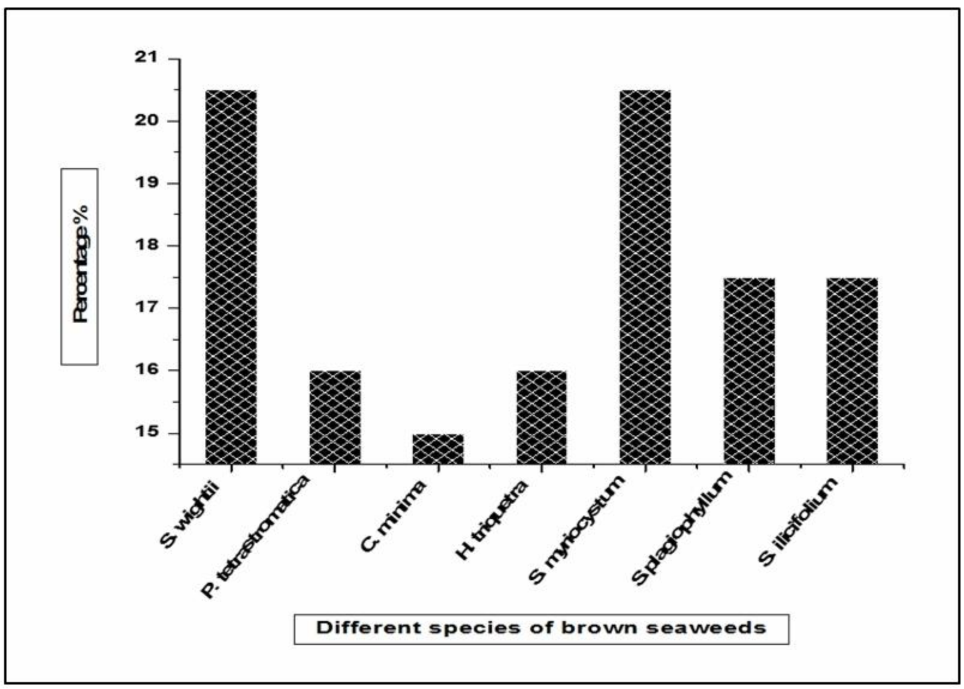

Fig. 1 — The ash content of different brown seaweeds collected from Mandapam

Table 1— Macro and micro elements (mg/100 g dry weight) in different brown seaweeds (mean values ± standard deviation)

Name of seaweeds	Na	K	Ca	Mg	Fe	Mn	Zn	Cu
S. wightii	156.7±0.1	122.9±0.1	2.3±0.2	1.67±0.2	0.85±0.3	0.98±0.3	0.1±0.3	4.83±0.5
P. tetrastromatica	409.3±0.4	311.7±0.3	1.1±0.4	0.97±0.9	2.41±0.2	1.93±0.6	0.2±0.4	0.94±0.3
C. minima	564.5±0.3	309.4±0.1	0.7±0.7	0.97±0.3	2.70±0.3	1.14±0.7	0.1±0.1	3.09±0.2
H. triquetra	298.4±0.1	309.4±0.2	1.1±0.1	0.77±0.1	1.65±0.6	1.73±0.1	0.3±0.3	0.89±0.2
S.myriocystum	345.6±0.1	203.4±0.1	1.9±0.2	0.77±0.5	0.98±0.0	1.14±0.2	0.2±0.4	1.33±0.6
S.plagiophyllum	456.5±0.3	156.5±0.1	1.1±0.0	1.17±0.3	1.40±0.8	0.94±0.7	0.2±0.6	1.45±0.2
S. ilicifolium	145.6±0.0	122.5±0.3	1.5±0.1	0.77±0.0	1.36±0.1	0.84±0.8	0.1±0.3	2.14±0.6

and alkalizer. It attracts oxygen to tissues and helps to eliminate toxins from the body[7]. The present study shows high amount of potassium in *P. tetrastromatica* (311.7 mg/100 g dry wt) whereas low amount of potassium was recorded in *T. decurrens* (98.4 mg/ 100 g dry wt).

The importance of calcium in human beings is well known. It is essential for the formation of bones and teeth, clotting of blood, and controls the functions of nerves and muscles. It plays an important role as a cofactor for extra cellular enzyme and proteins. Maximum content of calcium was found in *S. wightii* (2.3 mg/100 g dry wt) whereas minimum content was recorded in *C. minima* (0.7 mg/100 mg dry wt).

Magnesium acts as a cofactor in many enzyme-linked biochemical reactions in different physiological processes. It plays prominent role in ATP-dependent metabolic reactions, vital for brain and liver function and calm nerves. It helps cell growth, increase tissue elasticity and performs neuromuscular functions[10,11]. Here in the selected brown seaweeds, high level of magnesium was observed in *S. wightii*, (1.6 mg/100g dry wt) whereas 0.7 mg/100 g dry wt was observed in *H. triquetra*, *S. myriocystum*, *S. ilicifolium* and *T. decurrens*.

The maximum iron content was recorded in *C. minima* (2.71 mg/100 g dry wt) whereas minimum iron content was noted in *T. decurrens* (0.61 mg/100 g dry wt). Similarly, manganese content varied from 0.84 mg/100 g dry wt (*S. ilicifolium*) to 2.45 mg/100 g dry wt (*T. decurrens*).

In the present study, zinc varied from 0.1 mg/100 mg dry wt (*S. wightii*, *C. minima* and *S. ilicifolium*) to 0.33 mg/100 g dry wt (*H. triquetra*). Similarly, the copper ranged from 0.89 (*H. triquetra*) to 4.83 mg/100 g dry wt of seaweed (*S. wightii*).

Minerals for example iron and copper are present in seaweeds at higher levels than in terrestrial sources such as meats and spinach. Brown seaweeds accumulate many elements and are good source of magnesium, copper, iron, and iodine as well as other rarer elements. It is complicated to compare the values obtained for algal mineral composition with the available data in the literature because, mineral variations might be due to, oceanic residence time, seasonal, environmental, physiological factors, type of processing and sometimes due to the method of mineralization used[7,12].

Mineral content in seaweeds was higher than the values reported for edible terrestrial plants. The macro elemental composition expressed for direct comparison as Na+ K+ Ca+ Mg in mg/100 g dry wt was lower in the present study than the values reported for edible terrestrial plants and marine seaweeds[7,13-16]. The trace element content (Fe+ Zn+ Mn+ Cu) in the present study was in the range of 2.92 to 7.03 mg/100g. *C. maxima* showed higher trace element contents than *Laminaria*[7].

The Na/K ratios were in the range of 0.96 to 2.91 in all the seaweeds studied. But, the Na/K ratios in olives and sausages were 43.63 and 4.89, respectively. From nutrition point of view, it is significant since the consumption of NaCl and diets with a high Na/K ratio is linked to the incidence of hypertension[14].

Copper and zinc content were below the values, and Zn content (0.1 to 0.3 mg/100 g) in marine algae was also below the maximum amount allowed in macroalgae for human consumption in Japan and France (1.5-10 mg/100g), respectively[13]. So, it is suggested that the algal products would enhance the regular intake of some trace elements for adults.

The major cell wall components of brown algae are cellulose, fucoidan and alginates. The variations in the mineral composition of seaweeds may be due to the presence these polysaccharides in their cell walls[17-19]. Subsequently, their carboxyl and sulphated active groups are negatively charged functional ones, which play important role in absorption. Other aspects such as water temperature, pH and salinity may also affect metal accumulation[11,20,21]. Furthermore, the seaweeds are able to selectively absorb minerals from the surrounding seawater and accumulate them in their thalli[22,23]. Even, the concentrations of some metals in seaweeds depend on sampling seasonality[24] and the age of the fronds, which become more permeable over time[25]. The mineral content in the present study was similar to earlier reports[7,26] but slightly lower than other reported for brown seaweeds[27].

Conclusion

Seaweeds are commercially used as a food or feed additives. In the present study, mineral composition of some of the underutilized brown seaweeds was taken up for analysis. It is concluded that the selected species can be used as feed additives in future. Additional studies are needed on the nutritional and toxicological characteristics of seaweeds for human and animal consumption, respectively.

Acknowledgement

This study was financed by the University Grants Commission under Major Project F. No. 40-392/2011

(SR). The authors wish to thank Prof. Dr. K. Kathiresan for his helpful suggestions on the manuscript.

References

1 Batista Gonzalez, A. E., Charles, M. B., Mancini-Filho, J. and Vidal Novoa, A., Seaweeds as sources of antioxidant phytomedicines, *Rev. Cubana. De. Plantas. Medicinales.*, 14(2009) 1–18.

2 McHugh, D. J, *A guide to the seaweed industry*, (FAO Fisheries Technical Paper No. 441, Rome) 2003, pp. 105.

3 Rohani, K., Rajabi, I., Rameshi, H., Behzadi, S., Dehghani, R., Tamadoni, S., Hossaini, M. R., Study on distribution and biomass estimation of seaweeds in Hormozgan coastal waters and some of Persian Gulf Islands, *Iranian. Sci. Fish. J.*, 15(2007) 59–68.

4 Gomez-Ordonez, E. G., Escrig, A. J. and Ruperez, P., Dietary fibre and physicochemical properties of several edible seaweeds from the north western Spanish coast, *Food. Res. Int.*, 43(2010) 2289-2294.

5 Teas J. Dietary brown seaweeds and human health effects. Section 9. Advances in applied phycology utilisation. In: Critchley AT, Ohno M, Largo DB. eds. World Seaweed Resources. Amsterdam, ETI Bioinformatics; 2006.

6 Mabeau, S., and Fleurence, J., Seaweed in food products: biochemical and nutritional Aspects, *Trends. Food. Sci. Tech.*, 4(1993) 103–107.

7 Ruperez, R., Mineral content of edible marine seaweeds, *Food. Chem.*, 79(2002) 23–26.

8 Rohani, K., Abdulalian, E., and Ng, W.K., Evaluation of the proximate, fatty acid and mineral composition of representative green, brown and red seaweeds from the Persian Gulf of Iran as potential food and feed resources, *J. Food. Sci. Technol*., 49(2012) 774-80.

9 Rao, P.V.S., Mantri, V.A., Ganesan, K., Mineral composition of edible seaweed *Porphyra vietnamensis*, *Food. Chem.*, 102(2007) 215–218.

10 McDermid, K. J., and Stuercke, B., Nutritional Composition of Edible Hawaiian Seaweeds, *J. Appl. Phycol.*, 15(2003) 513–524.

11 Struck, B.D., Pelzer, R., Ostapczuk, P., Emons, H., Mohl, C., Statistical evaluation of ecosystem properties influencing the uptake of As, Cd, Co, Cu, Hg, Mn, Ni, Pb and Zn in seaweed (*Fucus vesiculosus*) and common mussel (*Mytilus edulis*), *Sci. Total. Environ.*, 207(1997) 29–42.

12 Honya, M., Kinoshita, T., Ishikawa, M., Mori, H., and Nisizawa, K., Monthly determination of alginate, M/G ratio, mannitol and minerals in cultivated *Laminaria japonica*, *Nippon. Suisan. Gakk.*, 59(1993) 295–299.

13 Indegaard M and Minsaas J, Seaweed resources in Europe: uses and potential, *Animal and human nutrition*, edited by M. D. Guiry, & G. Blunden, (Chichester: John Wiley & Sons Ltd) 1991, pp. 21–64.

14 Ortega-Calvo, J. J., Mazuelos, C., Hermosın, B., and Saiz-Jimenez, C., Chemical composition of *Spirulina* and eucaryotic algae food products marketed in Spain, *J. Appl. Phycol.*, 5(1993) 425–435.

15 Hernandez-Carmona, G., Carrillo-Dominguez, S., Arvizu-Higuera, D.L., Rodriguez-Montesinos, Y.E., Murillo-Alvarez, J.I., Munoz-Ochoa, M., and Castillo-Dominguez, R.M., Monthly variation in the chemical composition of *Eisenia arborea* J.E. Areschoug, *J. Appl. Phycol.*, 21(2009) 607-616.

16 Larrea-Marin. M.T., Pomares-Alfonso, M.S., Gomez-Juaristi, M.F., Sanche-Muniz, J., and De la Rocha, S.R., Validation of an ICP-OES method for macro and trace element determination in *Laminaria* and *Porphyra* seaweeds from four different countries, *J. Food. Comp. Anal*., 23(8) (2010) 814-820.

17 Davis, T.A., Volesky, B., Mucci, A., A review of the biochemistry of heavy metal biosorption by brown algae, *Water. Res.*, 37(2003) 4311–4330.

18 Burtin, P., Nutritional value of seaweeds, *Elect. J. Environ. Agri. Food. Chem.*, 2(2003) 498–503.

19 Bocanegra, A., Bastida, S., Benedı, J., Rodenas, S., Sanchez-Muniz, F.J., Characteristics and nutritional and cardiovascular-Health Properties of Seaweeds. *J. Med. Food*., 12(2009) 36–258.

20 Lodeiro, P., Cordero, B., Barriada, J.L., Herrero, R., Sastre de Vicente, M.E., Biosorption of cadmium by biomass of brown marine macroalgae, *Biores. Technol.*, 96(2005) 1796–1803.

21 Marinho-Soriano, E., Fonseca, P.C., Carneiro, M.A.A., Moreira, W.S.C., Seasonal variation in the chemical composition of two tropical seaweeds, *Biores. Technol.*, 97(2006) 2402–2406.

22 Sanchez Rodrıguez, I., Huerta-Dıaz, M.A., Choumiline, E., Holguın-Quinones, O.J., Zertuche-Gonzalez, A., Elemental concentrations in different species of seaweeds from Loreto Bay, Baja California Sur, Mexico: implications for the geochemical control of metals in algal tissue, *Environ. Pollut.*, 114(2001) 145–160.

23 Azmat, R., Hayat, A., Khanum, T., Talat, R., Uddin, F., The inhabitation of bean plant metabolism by Cd metal and Atrazine III: effects of seaweed *Codium Iyengaria* on metal, herbicide toxicity and rhizosphere of the soil, *Biotechnol.*, 5(2006) 85–89.

24 Vasconcelos, M.T., and Leal, F.C., Seasonal variability in the Kinetics of Cu, Pb, Cd and Hg accumulation by macroalgae, *Mar. Chem.*, 74(2001) 65–85.

25 Farıas, S., Perez Arisnabarreta, S., Vodopivez, C., Smichowski, P., Levels of essential and potentially toxic trace metals in Antarctic macroalgae, *Spectrochimica Acta* 57 (2002) 2133–2140.

26 Matanjun, P., Mohamed, S., Mustapha, N.M., Muhammad, K., Nutrient content of tropical edible seaweeds, *Eucheuma cottonii*, *Caulerpa lentillifera* and *Sargassum polycystum*, *J. Appl. Phycol.*, 21(2009) 75–80.

27 Renaud, S.M., Luong-Van, J.T., Seasonal variation in the chemical composition of tropical Australian marine macroalgae, *J. Appl. Phycol.*, 18(2006) 381–387.