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MINERAL COMPOSITION OF MARINE MACROALGAE FROM MANDAPAM COASTAL REGIONS; SOUTHEAST COAST OF INDIA

P. Anantharaman*, G. Karthikaidevi, K. Manivannan, G. Thirumaran and T. Balasubramanian

Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University,
Parangipettai-608502, Tamil Nadu, India

Abstract

The present study focused on the trace metal and mineral composition analysis of various seaweeds such as Chlorophyceae (*Cladophora glomerata, Ulva reticulata, Halimeda macroloba, H.tuna*), Phaeophyceae (*Dictyota dichotoma, Padina pavonica*) Rhodophyceae (*Gracilaria crassa, Gelidiella acerosa, Hypnea musciformis*) collected from Mandapam coastal regions, Southeast coast of India. Among these groups of seaweeds, U. *reticulata* belonging to the Chlorophyceae showed the maximum contents of mineral elements such as chromium, copper, and magnesium. *H.tuna* observed the minimum level of mineral content such as cobalt, iron, magnesium, manganese, nickel, lead and zinc.

Introduction

Seaweeds are traditionally consumed in the orient as part of the daily diet currently, human consumption of green algae (5%), brown algae (66.5%) and red algae (33%) is high in Asia, mainly Japan, China and Korea (Dawes,1998). However demand for seaweed as food has now also extended to North America, South Africa and Europe. (MuHugh, 2003).The different species consumed at present have a great nutritional value as source of proteins, carbohydrates, minerals and vitamins.

In the occident the seaweeds have been utilized mainly as raw material for extraction of phycocolloids as alginates from brown macro algae and agar and carageenan from red macro algae. These colloids are currently used in the pharmaceutical and cosmetic and food industries. (Armisen, 1995). The seaweeds are also known to contain bioactive products that display antibacterial, antiviral and antifungal properties (Trono, 1999). Furthermore they are used for animal nutrition as feed are as fertilizers and soil conditioning agents (Robledo Freile, 1997).

The seaweed shows great variation in nutrient contents which are related to several environmental factors as water temperature, salinity, light and nutrients (Dawes, 1998). Most of the environmental parameters vary according to season and the changes in ecological conditions can stimulate or inhibit the biosynthesis of several nutrients (Lobban *et al.,* 1985).The nutritional properties of seaweeds are poorly known and normally are evaluated from the chemical composition (Mabeau and Fleurence, 1993).

The nutrient composition of seaweed varies and is affected by species, geographic area, and season of the year and temperature of water (Jensen, 1993). About, 25% of all food consumed in Japan consists of seaweed prepared and served in many forms and has become the main source of income for the fisherman there. However, at present this seaweed is only consumed in certain coastal areas especially along the east coast of peninsula Malaysia and in East Malaysia, where it is occasionally eaten as a salad dish.

Seafood including seaweeds is known to be one of the richest sources of minerals. The most common minerals found in seafood are iodine, magnesium, calcium, phosphorus, iron, potassium copper and fluoride (Ensminger *et al.,* 1995). Minerals are very important for the biochemical reaction in the body as a co-factor of enzyme. For examples, Ca, P, and Mg build and maintain bones and teeth, whereas, Na and K help maintain balance of water, acids and bases in fluids outside of cells, an involve in acid-base balance and transfer of nutrients in and out of individual cells, respectively (Ensninger *et al.,* 1995).

Defects in mineral are capable of producing severe impairment of health. For instances, Ca malnutrition causes abnormal bone formation, namely Osteoporosis and anemia caused from Fe deficiency (Reinhold, 1988; Martinez – Navareete *et al.,* 2002). Deficiency in Mg can result in a variety of metabolic abnormalities, such as K depletion and clinical presentations.

Seaweeds are major coastal resources which are valuable to human consumption and environment in many countries. Edible seaweeds were widely consumed, especially in Asian countries as fresh, dried, or ingredients in prepared foods. Compared to land plants, the chemical composition of seaweeds has been poorly investigated and most of the available information only deals with traditional Japanese seaweeds Fujiwara –Arasaki *et al.,* 1984; Nisizawa *et al.,* 1987). The chemical composition of

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* Corresponding Author, *Email*: paraman_cas@yahoo.co.in, Tel.: +914144243223, Fax: +914144243555

seaweeds varies with species, habitat, maturity and environmental conditions (Ito and Hori, 1989). In general, seaweeds are rich in non–starch polysaccharides, minerals and vitamins (Darcy – Virillon, 1993; Mabeau and Fleurence, 1993). As seaweed polysaccharides cannot be entirely digested by human, they are regarded as a new source of dietary fiber and food ingredient. Together with their low lipid content, seaweeds only provide a very low amount of energy. Consumption of seaweeds can increase the intake of dietary fiber and lower the occurrence of some chronic diseases (Southgate, 1990).

Eating patterns of people all over the world have recently undergone marked changes, due to the globalization of markets along with innovation in food technology. The macrobiotic diet, which came to Europe from Japan, contributed to the introduction of sea vegetables in their staple diet. Fresh seaweeds have been used directly as food stuff in the Asian countries for centuries and are considered under–exploited resources (Chapman and Chapman, 1980) About 221 seaweeds are utilized commercially world-wide of which 65% are used for human food (Zemke White-and Ohno, 1999). Most recently seaweeds have been utilized in Japan as raw materials in the manufacture of many seaweed food products, such as jam, cheese, wine, tea, soup and noodles. (Nisizawa *et al.,* 1987) and in Western countries, mainly as a source of polysaccharides (agar, alginates, carageenans) for the food and pharmaceutical industries (Indegrarrd and Ostgarrd, 1991). Seaweeds are a rich source of minerals, especially macro and micronutrients necessary for human nutrition; however, the nutritional properties of seaweeds are usually determined from their biochemical composition alone viz., proteins, carbohydrates, vitamins, amino acids, etc., (Darcy –vrillon, 1993; Mabeau and Fleurence, 1993). The mineral fraction of some seaweed even accounts for up to 40% of dry matter (Ortega- Calvo *et al.,* 1993), however, in some cases the mineral content of the seaweeds is recorded even higher than that of land plants and animals products (Ito and Hori, 1989). Consumption of seaweeds can increase the intake of dietary fiber an lower the occurrence of some chronic diseases (diabetes, obesity, heart diseases, cancers, etc.,) which are associated with low fiber diets of the Western countries (Southgate,1990).

The present study is concentrated on mineral composition of different group of seaweeds from Mandapam coastal regions along Southeast coast of India.

Materials and Methods

Collection of seaweeds

Different groups of seaweeds such as Chlorophyceae (*Cladphora glomerata, Ulva reticulata*, *Halimeda tuna* and *Halimeda macroloba*) Phaeophyceae (*Dictyota dichotoma*, *Padina pavonica*) Rhodophyceae (*Gracilaria crassa, Gelidiella acerosa, Hypnea musciformis*) were collected from mandapam coastal regions, Southeast coast of India (Lat 8º 35'- 9º 25' N; Long 78º 08'- 79º 30' E). The collection was made during low tide from upper littoral zone of the above mentioned locations in January 2008. The seaweeds were handpicked and collected with the help of scalpel then immediately. The collected samples were cleaned with seawater to remove sand and epiphytes. Then the seaweeds immediately transported to the laboratory and cleaned thoroughly using tap water to remove the salt on the surface of the sample. Then it was spread on blotting paper to remove excess amount of water and shade dried at room temperature until constant weight obtained.

Mineral analysis by inductively coupled plasma atomic emission spectroscopy (ICP-AES)

Samples were subjected to acid digestion and analyzed according to the procedure described by Farias *et al., (*2002). Mineralogical analysis was carried out using inductively coupled plasma atomic emission spectroscopy (ICP-AES, Perkin– Elmer, and Optima 2000). All determinations were performed in triplicate and data represented on dry weight basis as mean values (Mean ± standard deviation).

Result

Cadmium attained the highest level from *H. musciformis* (0.055±0.011ppm) and lowest level was obtained from *H.macroloba*, and *C.glomerata* (0.020±0.001ppm) Fig.1. Cobalt content varied from 0.019±0.005ppm to 0.041±0.002ppm; the maximum content was recorded from *D. dichotoma* and a minimum level attained from *H.tuna* Fig-2.

Chromium content was varied from (0.246± 0.010 ppm to 0.882±0.004 ppm; in that the green seaweed *U. reticulata* and the minimum content were recorded at Brown seaweed *D. dichotoma* 0.246±0.010 ppm. Fig-3. Copper attained the highest level from green seaweed *U. reticulata* (1.677±0.018 ppm) and the lowest level was observed at brown seaweed *D. dichotoma* (0.873±0.008ppm) Fig.4.

Iron was observed the highest level from green alga *H. macroloba* (60.45± 2.021ppm) and the lowest level were observed at *H.tuna* (17.83±0.305 ppm) Fig.5. Magnesium content varied from 32.91±0.509 ppm to 181.5±7.169 ppm); the maximum content was recorded from *U. reticulata* (181.5±7.169 ppm) and the minimum level attained at *H. tuna* (32.91±0.509 ppm) Fig.6.

Manganese content varied from (0.728±0.006 ppm to 4.0305±0.046 ppm) in that the maximum level was obtained (4.305± 0.046 ppm) from *C.glomerata* and the minimum content was recorded at chlorophycean member *H.tuna* (0.728± 0.006 ppm) Fig.7.Nickel attained the highest level from red seaweed *H. musciformis* (0.126±0.008 ppm) and the lowest level was observed at green seaweed *H.tuna* (0.037±0.004 ppm) Fig.8.

Lead content was varied from (0.14± 0.02 ppm; 0.276±0.076 ppm) from chlorophycean member *H.macroloba* and the minimum content was recorded from the chlorophycean member *H.tuna* (0.14± 0.02) ppm) Fig.9 Zinc content was attained the maximum level from chlorophycean member *H.macroloba* (0.737± 0.004 ppm) and the lowest level was observed at from the same chlorophycean member *H.tuna* (0.356± 0.036 ppm) Fig.10.

Fig.1 Shows the Cadmium concentration of different seaweeds

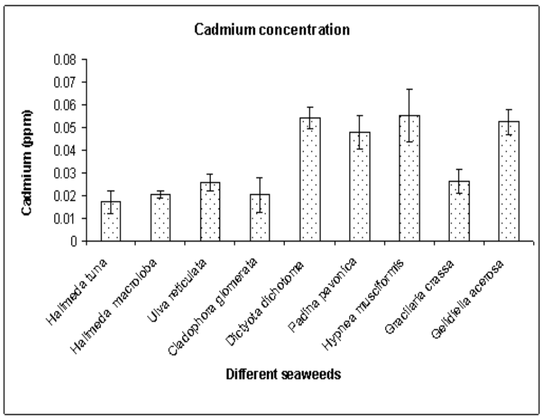


Fig.2 Shows Cobalt concentration of different seaweeds

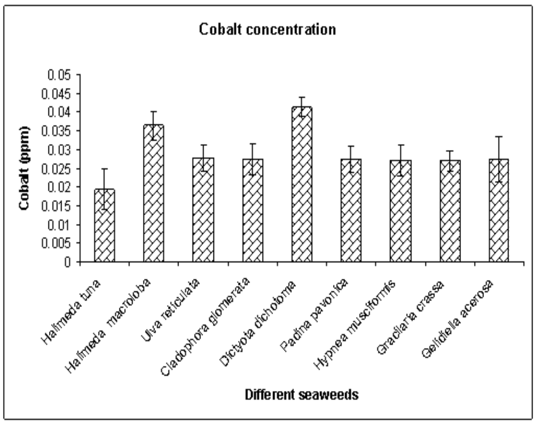


Fig.3 Shows the Chromium concentration of different seaweeds

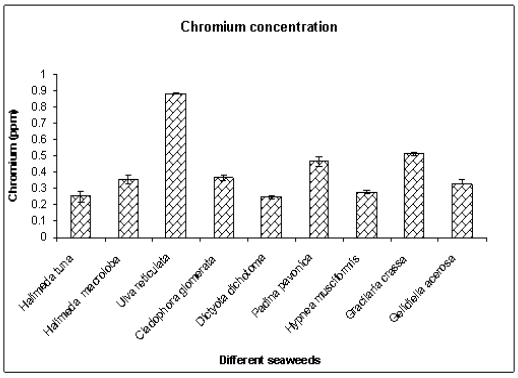


Fig.4 Shows Copper concentration of different seaweeds

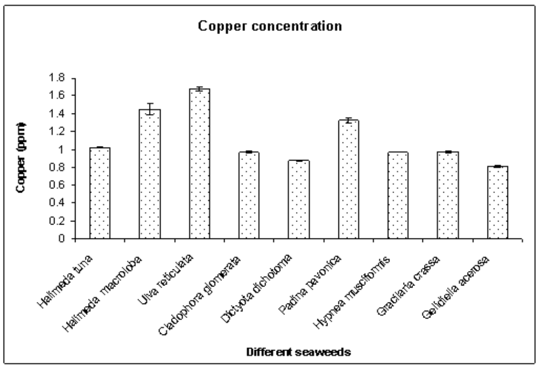


Fig.5 Shows Iron concentration of different seaweeds

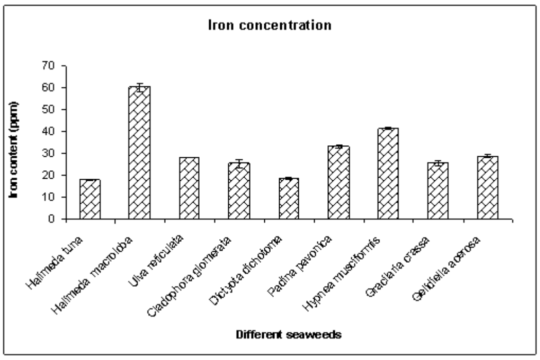


Fig.6 Shows Magnesium concentration of different seaweeds

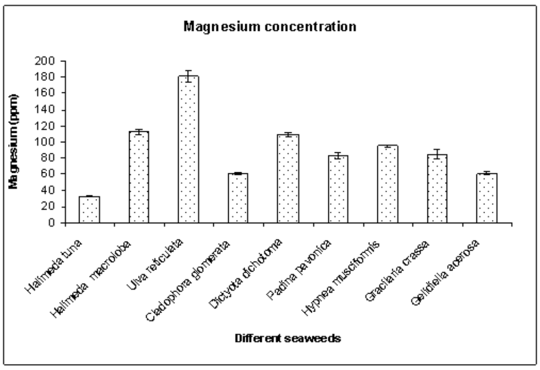


Fig.7 Shows the Manganese concentration of different seaweeds

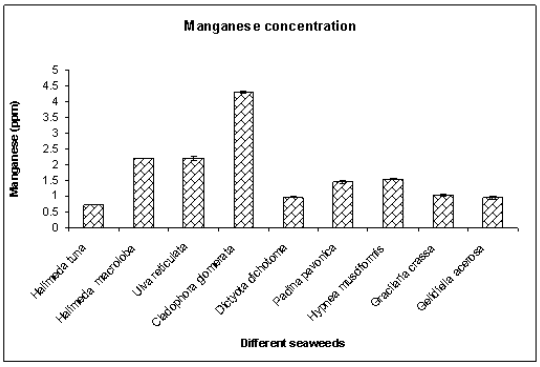


Fig.8 Shows the Nickel concentration of different seaweeds

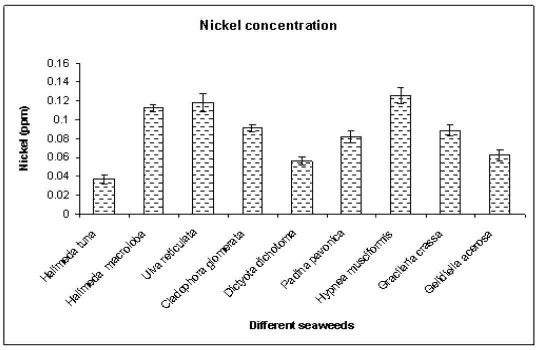


Fig.9 Shows the Lead concentration of different seaweeds

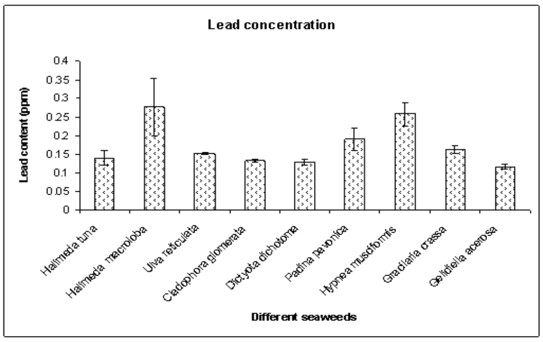
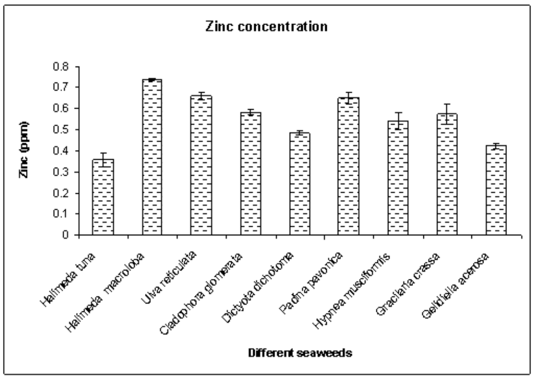


Fig.10 Shows the Zinc concentration of different seaweeds



Discussion

Seaweeds are potentially good sources of proteins, polysaccharides and fibre (Lahaye, 1991; Darcy-Vrillon, 1993). Studies on the biochemical constituents such as protein, carbohydrate and lipid in green and brown marine algae have been carried out from different parts of Indian coast (Sumitra Vijayaragavan et al., 1980; Muthuraman and Ranganathan, 2004; Dave, and Parekh, 1975; Ganesan and Kannan, 1994).

Reeta Jayasankar, (1993) reported the seasonal variation in chemical constituents of *S. wightii* with reference to alginic acid content. Amino acids in free and combined state have been quantitatively estimated in three species of green algae viz., *Halimeda tuna*, *Spongomorpha indica* and *Udotea indica* collected from Okha Port, biochemical investigations on economically important species have been carried out (Centingul, and Guner, 1996; Centingul, Aysel and Kurumulu, 1996).

The vitamin and mineral contents of edible seaweeds make them nutritionally valuable. red algae of Gujarat coast were analyzed for protein content by Dave *et al*. (1987). Much work has been done on algal fatty acids both micro algae as well as on the fatty acid composition of seaweeds.

Seaweeds are known as an excellent source of vitamins and minerals, especially sodium and iodine, due to their high polysaccharide content which could dietary fiber Muthuraman and Ranganathan (2004) selected six species of marine macro algae viz., *Caulerpa scalpelliformis, Cladophora vagabunda, Enteromorpha compressa, Halimeda macroloba, Ulva fasciata* and *Chaetomorpha antennina* to investigate protein, amino acids, total sugars and lipid contents. Mineral content are shown to vary according to species, wave exposure, seasonal, annual, environmental and physiological factors and the type of processing and method of mineralization (Honya *et al.,* 1993; Fleurence, and Le Coeur, 1993; Mabeau, and Fleurence, 1993; Yamamoto *et al.,* 1979; Yoshie, 1994).

Manivannan et al., (2009) reported the mineral composition of different group seaweeds such as Chlorophyceae (*Ulva lactuca, Enteromorpha intestinalis*) Phaeophyceae (*Turbinaria ornata, Padina gymnospora*) and Rhodophyceae (*Hypnae valentiae, Gracilaria folifera*) from Mandapam coastal regions, and they found that *P. gymnospora* showed the maximum content of mineral composition such as copper, chromium, iron, lead, sulphur and calcium content and potassium than other seaweeds. *H. valentiae* observed the minimum level of mineral content such as cadmium, iron, magnesium and calcium. In the present study also *U.reticuata* showed maximum content of mineral composion chromium, copper and magnesium and the lowest level of mineral content were present in *H.tuna* cobalt, copper, magnesium, manganese, lead and zinc.

Karthikai Devi et al., (2009) observed the element concentration of various seaweeds such as Chlorophyceae (*Codium tomentosum, Enteromorpha clathrata, Enteromorpha compressa*) Phaeophyceae (*Turbinaria conoides, Colpomenia sinuosa, Sargassum tenerimum, Sargassum wightii*) and Rhodophyceae (*Acanthophora spicifera*) from Gulf of Mannar marine biosphere reserve; Southeast coast of India. The *S. wightii* showed the highest level of element composition such as chromium, copper, manganese, nickel, lead and zinc content than other seaweeds. *A. spicifera* recorded the lowest level of element content such as chromium, copper, lead and zinc.

In contrasts with the earlier investigations, our present study only concentrated on mineral composition and trace metal concentration accordance with species level. Based on the results; minerals are influenced with the varying species level. Further more studies are necessary to evaluate the nutritional value of different seaweed for food ingredients.

Seaweeds are known to contain an excellent source of vitamins and minerals, especially sodium and iodine, due to their high polysaccharide content which could also imply a high level of soluble and insoluble dietary fiber and marked changes in the chemical constituents were found to occur with change of seasons, environmental conditions as well as in the various phases of plants growth and fruiting cycle. Thus results of the present study concluded that seaweeds are a potential health food in human diets and may be used to the food industry as a source of ingredients with high nutritional value. Seaweeds also can be provided as a dietary alternative due to its nutritional value and its commercial value can be enhanced by improving the quality and expanding the range of seaweed – based products.

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