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Proximate composition of three abundant species of seaweeds from red sea coast in Massawa, Eritrea

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Abstract:

The present study investigates the preliminary information of proximate composition of the seaweeds collected from the Red Sea coast of Massawa, Eritrea. The proximate composition (moisture, protein, total soluble carbohydrates, lipids, fiber and ash) of three abundant samples; *Enteromorpha clathrata*, *Gracilaria corticata* and *Sargassum linearifolium* were analyzed. It was observed that the moisture content was high, ranging from 85.28% to 90.88%. High content was found in red seaweed *G. corticata* and minimum in brown seaweed *S. linearifolium*. Carbohydrate content of seaweeds ranged from 23.53% to 28.97%. The maximum carbohydrate was recorded in the green seaweed *E. clathrata* and the brown seaweed *S. linearifolium* recorded the minimum value. Quantitative analysis of protein content ranged from 6.93% to 13.64%. High protein was found in the green seaweed *E. clathrata* and low in the brown seaweed *S. linearifolium*. The lipid content varied from 0.20% to 1.42%, high in brown seaweed *S. linearifolium* and lower in red seaweed *G. corticata.* Ash content was observed to range from 51.16% to 26.86%. The maximum ash content was recorded in red seaweed *G. corticata* and the brown seaweed *S. linearifolium* recorded the minimum content. The fiber content ranged from 19.97% to 4.37%; high in brown algae *S. linearifolium* and lower in red algae *G. corticata.* The moisture and ash contents were recorded higher in red seaweed *G. corticata* than *E. clathrata* and *S. linearifolium*. The results of the present work indicates that, the seaweeds from the Red Sea are an alternative nutritional source. Various environmental factors as well as climatic changes affect the seaweed composition; especially minerals present in Red Sea coast are the major parameters for the ash content.

Key Word: Proximate, composition, Seaweeds, *Gracilaria*, *Sargassum*, *Enteromorpha*

Introduction:

Seaweeds are plant like organisms that generally live attached to the rock or hard substrata in the coastal areas. There are about 8,000 species of seaweeds along the world's coast and they may extend 270m deep [Luning, 1990]. Different species of seaweeds especially protein rich seaweeds are used as human food in many different countries all over the world. Therefore, studies on the proximate composition of seaweeds are important to determine their nutritive value [Dawes, 1981].

Seaweeds are also harvested or cultivated for the extraction of alginate, agar and carrageenan; these gelatinous substances are collectively known as hydrocolloids or phycocolloids. Hydrocolloids have attained commercial significance, especially in food production as food additives [Edward, 1987]. Algae are important sources of medicine and fertilizer; therefore seaweeds which are used as fertilizer are suitable in organic agriculture [Lopez-mosquera *et al.*, 2011].

Exploitation of marine resources from the Eritrean coast of Red Sea has started long time ago. The first record of algae from the Red Sea was published by Strand in 1756. However, the first major algal collection was made by Forsskål (1775) during his journey to Egypt and Arabia. [Atewebrhan and Prud 2005]. The first records of algae from Eritrea came from Ehrenberg & Hemprich who visited the Dahlak Archipelago and the western coasts of the Red Sea, Eritrea and described two algal species including the famous *Trichodesmium erythraeum*, whose bloom is said to contribute to the color of the Sea and hence the name. [Atewebrhan, 2004], [Lipkin, 1991], [Papenfuss, 1968].

Seaweeds have been used as food products for thousands of years. These products are part of the cultural diets of Japan, China, Korea and other coastal populations. Japan has the highest per-capita consumption of seaweeds in the world, per capita consumption is 1.6 kg of algae per year [Fleurence, 1999] and the per-capita consumption is to the order of 4-7grams/day [Nisizawa, 2006]. Seaweeds are consumed as salads, soups and vegetables. The most popular Seaweeds include *Laminaria japonica, Undaria Pinnatifida.* Nori seaweed (*Porphyra sp.*) has been found to be especially rich in the B complex of vitamins including vitamins B6 and B12. In addition, seaweeds varieties are rich sources of vitamin C and vitamin-A precursors, such as *β*-carotene [McDermid and Stuercke, 2003], [Takenaka *et al.*, 2001], [Watanabe *et al.*, 2002]. Though the Red Sea is diversified with Seaweeds, almost no information is available about the nutritional value of the seaweeds in Eritrea. So this paper is an attempt to solicit the nutritional importance of the seaweeds.

Materials and Methods

Collection of sample

A preliminary survey was made and three most abundant seaweed samples were identified and collected during the low tide from the Hirgigo and Gurgusum beach areas. The selected samples are *Gracillaria corticata* (Rhodophyta), *Sargassum linearifolium* (Phaeophytae) and *Enteromorpha clathrata* (Chlorophyta). The collected samples were kept in polyethylene bags with sea water, tied and transported to the laboratory in Massawa College of Marine Science and Technology. The taxonomic identifications were done with the help of Marine biology department of the college and Research department of Ministry of Marine resources by following the identification key of Ateweberhan and Prud (2005), Lipkin & Silva (2002).

The samples were thoroughly washed with fresh water to remove epiphytes and dirt particles, followed by oven drying at 70°C to obtain a constant weight and pulverized in a blender (approximately size of 2mm). These were kept in air tight plastic container and stored at room temperature until further analysis.

Methods:

The major biochemical constituent like Total protein, total soluble carbohydrates, lipids and fibers can be identified by following the various protocols.

Moisture content in seaweeds was determined by conventional hot air oven drying method [AOAC, 1990]. Total protein content of sea weeds were estimated by Kjaldhal method [Nielsen, 2003],an indirect method of estimation of total nitrogen using J.P Spectra semi micro Kjaldhal instruments (serial no. 0550460) made in Italy, Total crude protein was estimated by multiplying the total Nitrogen value with the factor of 6.25.The lipid content was estimated using Chloroform-Methanol mixture, solvent extraction method described by Folche's method. [Folch *et al.*, 1956], the crude fiber was estimated by Hennenberg- Stohmann method [AOAC, 1990], the soluble carbohydrate was estimated by difference method [Nielsen, 2003] and the ash content of seaweeds were estimated by using Muffle furnace model: (model: carbolipe euro pherm) at 550^{0}C [Nielsen, 2003]. Finally the results were analyzed by using a simple excel work sheets.

Results and Discussion:

Moisture content

Moisture contents of seaweeds was considered to be high as they dwell in water ecosystem, they contain high range of moisture. The quantitative analysis of moisture content ranged from 85.28% to 90.57%. Higher water content was found in red seaweed *G. corticata* (90.57%) followed by *E. clathrata* (87.22%) and lower in brown seaweed *S. linearifolium* (85.57%) (fig: 1).

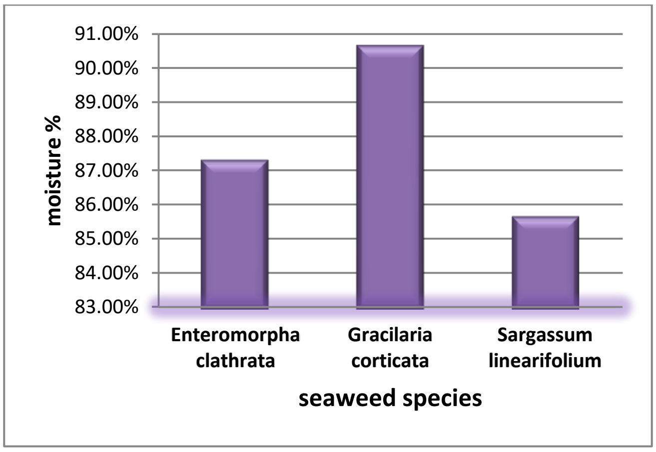

Fig: 1 Moisture content

Carbohydrate content

Carbohydrate content of seaweeds ranged from 23.53% to 28.97%. Higher content of carbohydrate was found in green seaweed *E. clathrata* (28.97%), followed by Brown seaweed *S. linearifolium* (27.82%) and lower in red seaweed *G. corticata* (23.53%) (Fig:-2). Similarly Manivannan (2008) has reported the 24.15% of carbohydrates in *E.clathrata*. Chakraborthy and Santra (2008) recorded higher carbohydrate in the green seaweeds *Ulva lactuca* (35.27%) and *E. intestinalis* (30.58%). Both biotic and abiotic factors form the micro and macro environment of the organism and the strong or less perceivable variations in the environmental parameters influence such distinct differential amount of carbohydrates. In present study, the Chlorophycean members showed high carbohydrate content than Rhodophycean and Phaeophycean members. The reason might be that, the Chlorophycean species grow in very shallow water and high exposure to the sunlight makes them to synthesize more carbohydrates by photosynthesis. In contrast to these results Dhargalkar (1980) from the Maharashtra coast recorded higher value of carbohydrate content in Rhodophycean members than in Phaeophycean and Chlorophycean members [Dhargalkar *et al.*, 1980], The maximum content of carbohydrate in the red seaweed might be due to higher phycocolloids content in their cell walls and green seaweeds might convert the soluble carbohydrates in to insoluble carbohydrates like fiber and other polysaccharides to store in the cells.

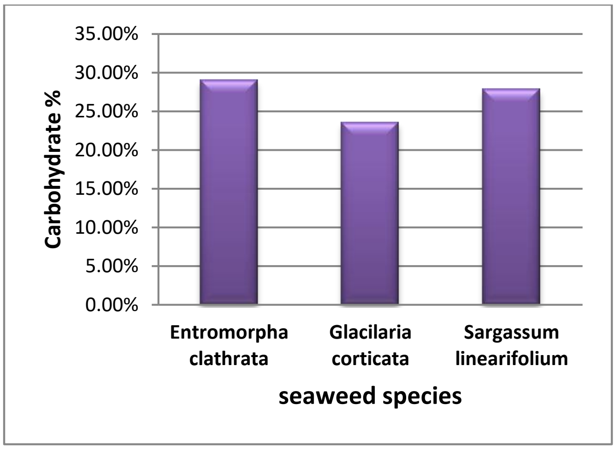

Fig: 2 Carbohydrate content

Protein content

Quantitative analysis of protein content ranged from 6.93% to 13.64%. Higher protein content was found in the green seaweed *E. clathrata* (13.64%) followed by red seaweed *G. corticata* (12.18%) and lower in the brown seaweed *S. linearifolium* (6.93%) (Fig: 3). The protein content of *E. clathrata* is similar to reports of Manivannan. [Manivanna *et al*, 2008]. Burtin reported that the protein concentration of brown macro algae was low, 5-11% of dry weight [Burtin, 2003]. Protein content varied among different genera and also in different species of the same genus [Dhargalkar *et al*., 1980]. This change may be of spatial or temporal in nature. However, it is largely attributed to the surrounding water quality as reported by Dave and Parekh. The variations in the protein contents in macro algae can be according to station, depth and environment [Dave and Parekh, 1975].

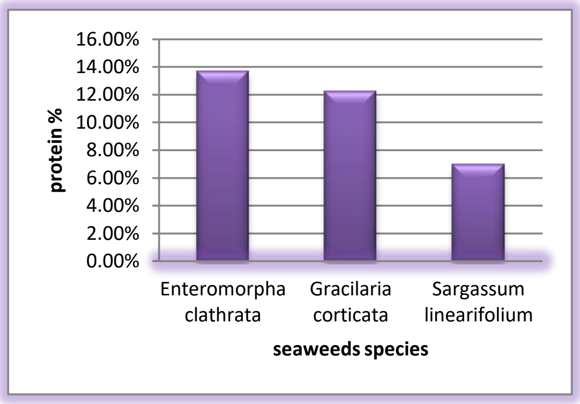

Fig: 3 Protein content

Lipid content

The lipid content of the seaweeds was generally low, in this study the range varied from 1.42% to 0.2%. The maximum content of lipid was recorded in brown seaweed *S. linearifolium* (1.42%), followed by green seaweed *E. clathrata* (0.80%) and minimum content in red seaweed *G. corticata* (0.20%) (Fig: 4). In contrast to these results Manivannan reported that the high lipid content in green seaweed *E. clathrata* (4.6%); followed by red seaweed *Gracilaria folifera* (3.23%), then brown seaweeds *Codium tomentosum* (2.53%), *Colpomenia sinuosa* (2.33%) and S*argassum wightii* (2.33%). The minimum lipid concentration was recorded from *Enteromorpha intestinalis* (1.33%) followed by *Padina gymnospora* (1.40%), *Sargassum tenerrium* (1.46%) and *Uvla lactuca* (1.60%) [Manivannan *et al*., 2008].

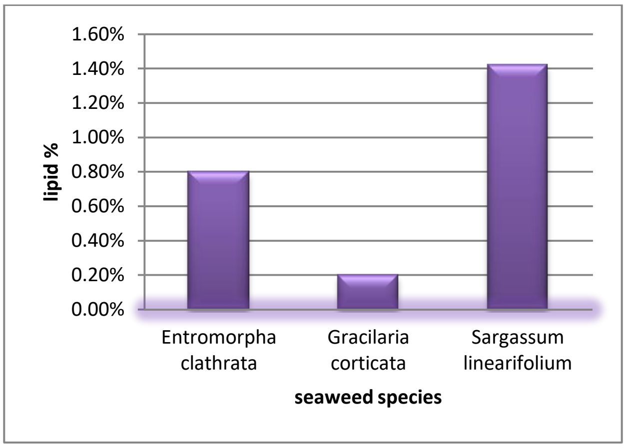

Fig: 4 Lipid content

Ash content

The ash content was observed to be high and is probably due to the presence of salt in fronds. In this study the range varied from 26.86% to 51.16%. The maximum content of ash was recorded in red seaweed *G. corticata (*51.16%) followed by green seaweeds (39.42%) and minimum content in brown seaweed *S. linearifolium (*26.86%) (Fig: 5). Similarly Rajeswary and Sivasurbramaniam (1984) reported 49% of ash in *Gracilaria crossa*, 31% in *Sargassum tenerrium* and 29% in *Ulva lactuca*, obtained from Mandaitivu, indicates species specificity. Robert has reported the maximum ash content in *Hypnea musciformis* 31% followed by *Enteromorpha intestinalis* 25.6% and minimum in *Sargassum filipendula* 21.5% collected from Gulf of Mexico [Robert, 1984].Marine seaweeds absorb minerals in their ionic form from seawater, but they shall depend upon a number of factors including concentration in the waters, growth stage of the algae and competition between the ions for uptake by the algae [Nisizawa, 2006], [Sanderson & Di Benedetto, 1998].The seaweeds from Massawa coast of Red sea has recorded comparatively high amount of minerals. The reason might be due to high salinity of the red sea, results in the accumulation of the high quantity of minerals.

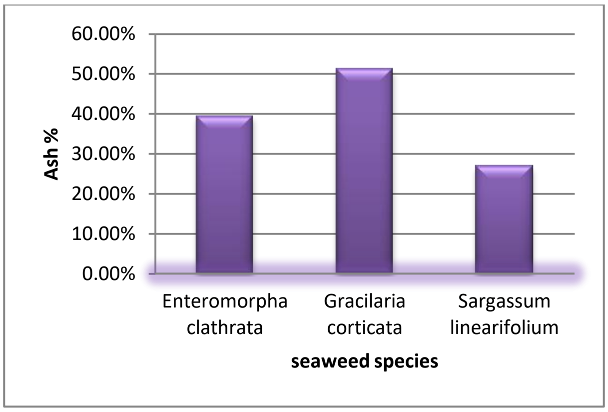

Fig: 5 Ash content

Fiber content

In this study, crude fiber quantitatively ranged from 19.97% to 4.37%. The maximum content was observed in brown algae *S. Linearifolium (*19.97%) followed by green algae *E. clathrata* (17.17%) and minimum content was observed in red algae *G. corticata (*4.37%). (Fig:-6). These results are competitively low with the available literatures. But the similarity is the family Pheophyacean has high amount of fiber, followed by Chloroheacae and Rhodophyta. The variation in biochemical composition in seaweeds; depend on the season and the area of production [Connan *et al*., 2004], [Khan *et al*., 2007], [Zubia *et al*., 2008].

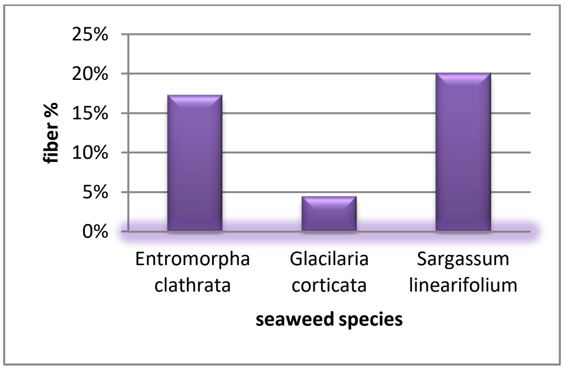

Fig: 6 Fiber content

Conclusion

The seaweeds are a potential healthy food supplement for human diets and may be of use to the food industry as a source of ingredients with high nutritional value, and its commercial value can be enhanced by improving the quality and expanding the range of seaweed-based products. Biochemical composition may change with varying environmental fluctuations; a range of physical, chemical and climatological factors and the natural fluctuation in the species composition. So the effects could only be understood by interactions among different environmental factors; on the other hand, the dominant algal groups probably have some influence in the observed changes in biochemical composition of seaweed.

The present study all the seaweeds have high amount of ash due to high salinity of the Red Sea, and further study has to be conducted to determine the essential minerals. The green seaweed has shown the high amount of fiber indicates the hot environmental conditions increase the possibilities for photosynthesis. The fluctuations in the biochemical composition of these selected seaweeds compared with other countries might be due to the environmental conditions of the Red Sea around Massawa, the Eritrean coast contributing the growth; physical, chemical, nutritional composition of Seaweed species. However the chemical composition became higher in its contents and it illustrates that seaweeds in Massawa Eritrea coast are nutritionally beneficial.

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