Biochemical and Antioxidant Composition of Selected Red Seaweeds from East Coast of Tamilnadu, India.

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Received: July 2, 2014, Accepted: July 29, 2014, Published: July 29, 2014.

ABSTRACT
The Biochemical and antioxidant composition of six red seaweeds: Gelidiella acerosa, Gracilaria crassa, Gracilaria edulis, Gracilaria verrucosa, Hypnea musciformis and Kappaphycus alvarezii has been estimated. The study was correlated with the physiochemical parameters of the collection sites: Pulicat lake, mandapam and Rameshwaram. The study depicted how the water quality parameters of the habitat affect the growth as well as the nutritional composition of the selected seaweeds. The biochemical and antioxidant composition varied according to species as well as the site of collection. H.musciformis with highest carbohydrate value (37.76±0.05 mg/g), G.verrucosa with the highest lipid value (54.30±0.07 mg/g), and G.edulis with highest protein value (4.09±0.03 mg/g), act as a good source of functional food. The permitted levels of antioxidants; Beta carotene, Tocopherols, poyphenols and Selenium also favors Gelidiella acerosa, Gracilaria crassa, Gracilaria edulis, Gracilaria verrucosa, Hypnea musciformis and Kappaphycus alvarezii as a good nutritional source.

Keywords: Red seaweeds, Physio-chemical parameters, Biochemical composition, Antioxidants.

INTRODUCTION
Seaweeds are considered very important because they are an excellent source of single cell protein, hydrocarbons [1], biogas, polysaccharides such as agar-agar, algicnic acid, carrageenin [2], antibiotics [3], colouring pigments [4], important medicines [5].Sea plants are considered as natural sources of long-chain polyunsaturated essential fatty acids from the omega-3 family (LC-PUFAs x3), such as eicosapentaenoic acid, C20:5x3, which may reduce the risk of heart disease, thrombosis and atherosclerosis [6,7]. There is, therefore, interest in the use of edible seaweeds in the development of low-cost, highly nutritive diets for human and animal nutrition[8]. Undaria pinnatifida, a brown algae contains high levels of sulphated polysaccharides (sulphated fucans or fucoidans) that show potential anti-viral activity [9]. The protein content of brown seaweeds is generally small (average: 5-15 % of the dry weight), whereas higher protein activity [9]. The protein content of brown seaweeds is generally small (average: 5-15 % of the dry weight), whereas higher protein contents are recorded in green and red seaweeds (on average 10-30 % of the dry weight). In some Palmaria palmata and Porphyra tenera, proteins can represent up to 35 and 47% of the dry matter, respectively. Typically, algal cultures become depleted in nutrients, as they enter stationary stages of growth, and total lipid and CHO increase while protein declines [10]. Changes in lipid classes also have been observed as a function of growth stage. In general, phospholipids and glycolipids decline and triacylglycerol and free fatty acids increase[11]. This investigation estimates the amount of total protein, total lipid and total carbohydrate and major antioxidants in the selected seaweeds of Rhodophyceae.

MATERIALS AND METHODS

Sampling site
The sea weed samples were collected from Site 1: Pulicat lake (13°33.57°N; 80°10.29°E), Site 2: Rameswaram (9°16.48°N; 79°18.0°E), and Site 3: Munaikkad (9°16.6°N; 79°7.9°E).

Chemicals
All the Chemicals used for the study were purchased from Sigma (St. Louis, USA).

Collection and identification
The collection site was visited during post monsoon period and the specimens were collected by hand picking. The species found attached to rocks are pulled out. Those on shores are collected with hand, those on deeper zones are collected by diving. The species collected are immediately transferred to dark polythene bags by keeping blotting papers in between. pH and temperature is noted in the collection site. Water sample is collected from the site and is fixed immediately for dissolved oxygen analysis. The collected samples are sorted and brought to laboratory for further analysis. The sorted samples are identified by a botanist at University of Madras, Chennai, India. Seaweeds are shade-dried and powdered in a blender. The powdered samples are used for quantification.

Water quality analysis
The biomass of seaweed can be correlated with the abiotic factors that prevailed before or during the collection period. Hence, the water quality analysis of the water sample collected from the sample site was carried out. Temperature (°C) was measured using mercury filled Celsius thermometer with an accuracy of 1°C. pH was measured using digital pH meter with glass calomel electrode, pH 0.01 accuracy. Salinity (PSU) was determined by
Mohr-Knudsen argentometric titration method, using standard solution of silver nitrate (Merck) to precipitate halide ions in seawater using potassium chromate (Merck) as an indicator to form silver halides, presence of excess silver ions lead to the formation of red silver chromate (the endpoint of titration). Dissolved oxygen (mg/l) was determined in seawater by Winkler’s method; dissolved oxygen in water reacted with manganese hydroxide in strongly alkaline medium forming manganese (trivalent) hydroxide. When acidified to a pH less than 2.5, the manganese hydroxide dissolved to liberate manganese, which was titrated against a standard thiosulphate (Sodium thiosulphate- Merck) solution using starch as indicator [12].

**Biochemical composition**

The total protein was estimated using the method of [13]. The extraction of lipid was done by the chloroform-methanol mixture [14]. The total carbohydrate was estimated by following the Phenol-sulphuric acid method of [15].

**Antioxidant composition**

The quantitative analysis of antioxidants, beta carotene, tocopherols, polyphenols and selenium was done by the method of [16].

**Statistical analysis**

Test samples were carried out independently in triplicates, data was expressed as the mean ± standard deviation (SD) and the results were processed using Excel 2003 (Microsoft, Redmond, WA, USA).

**RESULTS AND DISCUSSION**

The pH and salinity was found to be changing constantly according to seasonal variations and zonations particularly in site 1, being a brackish water source. The dissolved oxygen variations can also affect the growth of the algae. This may also vary according to the zones. The dissolved oxygen was found to be less as we move to deeper zones. This may be due to reduced sunlight penetration and low photosynthetic rates. The lesser chlorophyll pigments in red algae may also contribute to this aspect (Table 1). Site 1, being polluted area, due to oil discharge, lower rate of dissolved oxygen can be seen even in uppermost layers. In results, alkalinity (as CaCO₃), points out the high amount of calcium in site 1 compared to others. This may be the reason for high amount of Total Dissolved solids in the site. Calcium, sulphates and iron contents (mg/ml) was found to be high in pulicat, owing to high pollution in the site, due to industrial effluents and domestic sewage, as it owes to high heavy metal deposition [17]. This influences the alkalinity too. Phosphates, Fluorides, magnesium and chlorides (mg/ml) showed moderate levels. The above mentioned parameters suggest that the selected seaweed samples can show ambient growth and nutritional excellence in these sites. Owing to the results, it can be concluded that seaweeds of Rhodophyceae have high nutritive values and are ideal for consumption. Literature suggests that the selected six seaweeds have high nutritive values and are edible devoid of irritation, allergy, toxicity etc which makes it disagreeable as food source. It is also relevant to say that they also meet the standards for a balanced functional diet [18]. The comparative study with in the selected seaweeds samples shows that *H.musciiformis* has highest carbohydrate value while *G.verrucosa* showed the highest lipid value, whereas, *G.edulis* showed the highest protein value. However, the results as well as literature say that all the species of Rhodophyceae are highly nutritious. Compared to green and brown seaweeds the protein content for the selected species of red seaweeds are found to be less (average:5-15% dry weight). While Carbohydrates and lipid contents for all the species were found to be high, which make the low amount of protein contents in the sample negotiable. The high carbohydrate levels in cereals like rice, corn flakes etc. provide energy rich food to the body. According to [19], a bowl of white rice have a carbohydrate content of 34.1 (w/w%). While, *H.musciiformis* showed 37.7655 (w/w%) and *G.crassa* with 33.7700 (w/w%) (Fig. 1).Thus, an equivalent amount of seaweed, can prove to be a good supplement to white rice. The protein content of egg yolk for one egg is 3 (w/w%) A gram of *G.edulis* can supplement with 4.090 (w/w%) of protein. The lipid content for average meals containing safflower, Pistachio, coconut or flax and neem have 59.5 (w/w%), 53.7 (w/w%),35 (w/w%) and 40 (w/w%) respectively. The lipid content values of the selected seaweeds ranges from 31.44 (w/w%) to 54.30 (w/w%), which reveals its significance as supplement to these lipid sources.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen (mg/l)</td>
<td>6.1440 ± 0.00100</td>
<td>6.2132 ± 0.0001</td>
<td>5.9807 ± 0.0001</td>
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<td>Salinity (ppt)</td>
<td>16.1444 ± 0.0001</td>
<td>30.0000 ± 0.0001</td>
<td>29.8121 ± 0.0001</td>
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<td>pH</td>
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<td>8.0000 ± 0.0001</td>
<td>8.5000 ± 0.1000</td>
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<td>Alkalinity (as CaCO₃)</td>
<td>0160.00 ± 0.0001</td>
<td>0140.00 ± 0.0001</td>
<td>0120.00 ± 0.0001</td>
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<tr>
<td>Total Hardness (as CaCO₃)</td>
<td>4900.00 ± 0.0001</td>
<td>5000.00 ± 0.0001</td>
<td>5100.00 ± 0.0001</td>
</tr>
<tr>
<td></td>
<td>19,890±0.0001</td>
<td>34,190±0.0001</td>
<td>34,450±0.0001</td>
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</tr>
<tr>
<td>Total Dissolved Solids at 105°C (mg/l)</td>
<td></td>
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<td></td>
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<tr>
<td>Calcium (As Ca) (mg/l)</td>
<td>600.00±0.0001</td>
<td>360.00±0.0001</td>
<td>400.00±0.0001</td>
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<tr>
<td>Magnesium (As Mg) (mg/l)</td>
<td>826.00±0.0001</td>
<td>1000.0±0.0001</td>
<td>1000.0±0.0001</td>
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<tr>
<td>Chlorides (As Cl) (mg/l)</td>
<td>14800±0.0001</td>
<td>13800±0.0001</td>
<td>15600±0.0001</td>
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<td>Sulphates (As SO₄) (mg/ml)</td>
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<td>1400.00±0.0001</td>
<td>1680.00±0.0001</td>
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<tr>
<td>Phosphates (As PO₄) (mg/ml)</td>
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<td>0.0100±0.0001</td>
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<tr>
<td>Iron (As Fe) (mg/ml)</td>
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<td>0.2500±0.0001</td>
<td>0.3000±0.0001</td>
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<tr>
<td>Fluorides (As F) (mg/ml)</td>
<td>0.3000±0.0001</td>
<td>0.4000±0.0001</td>
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</tbody>
</table>

**CONCLUSION**

The selected seaweeds showed average amount of protein, carbohydrate and lipid values. The results show that *H. musciformis* has highest carbohydrate value while *G. verrucosa* showed the highest lipid value, where as *G. edulis* showed the highest protein value. All the seaweeds meets the nutritional needs and are thus edible. Observed the presence of anti oxidants beta carotene, Tocopherols, polyphenols and selenium. Low levels of vitamin C (tocopherols) which are fat soluble, make it advantageous that it can be used as natural anti oxidant. Permitted
antioxidant levels of polyphenols also suggest it as perfect nutritional source.

REFERENCES


Citation: Krishnapriya M V, et al (2014), Biochemical and Antioxidant Composition of Selected Red Seaweeds from East Coast of Tamilnadu, Indi.. J. of Modern Drug Discovery and Drug Delivery Research. V114. DOI: 10.15297/JMDDR.V114.02

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