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

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ABSTRACT

The Biochemical and antioxidant composition of six red seaweeds: *Gelidiella acerosa, Gracilaria crassa, Gracilaria edulis, Gracilaria verrucosa, Hypnea musciformis* and *Kappaphycus alvarezzi* 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 alvarezzi* 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, alginic 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 antiviral 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 1ºC. 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 $CaCo_3$), 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 seaweed samples shows that *H.musciformis* 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.musciformis* 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 1. Physio-chemical parameters of water collected from the habitat of seaweeds

Parameters	**Site 1**	**Site 2**	**Site 3**
Dissolved oxygen(mg/l)	6.14400±0.00100	6.2132±0.0001	5.9807±0.0001
Salinity(ppt)	16.1444±0.0001	30.0000±0.0001	29.8121±0.0001
pH	8.1000±0.1000	8.0000±0.0001	8.5000±0.1000
Alkalinity(As $Caco_3$) (mg/ml)	0160.00±0.0001	0140.00±0.0001	0120.00±0.0001
Total Hardness(As $CaCo_3$)(mg/l)	4900.00±0.0001	5000.00±0.0001	5100.00±0.0001

Total Dissolved Solids at 105°C(mg/l)	19,890±0.0001	34,190±0.0001	34,450±0.0001
Calcium(As ca)(mg/l)	600.00±0.0001	360.00±0.0001	400.00±0.0001
Magnesium(As Mg)(mg/l)	826.00±0.0001	1000.0±0.0001	1000.00±±0.0001
Chlorides(As Cl)(mg/l)	14800±0.0001	13800±0.0001	15600±0.0001
Sulphates(As SO_4) (mg/ml)	3200.00±0.0001	1400.00±0.0001	1680.00±0.0001
Phosphates(As PO_4) (mg/ml)	0.0100±0.0001	0.0100±0.0001	0.0100±0.0001
Iron(As Fe) (mg/ml)	1.5000±0.0001	0.2500±0.0001	0.3000±0.0001
Fluorides(As F) (mg/ml)	0.3000±0.0001	0.4000±0.0001	0.4000±0.0001

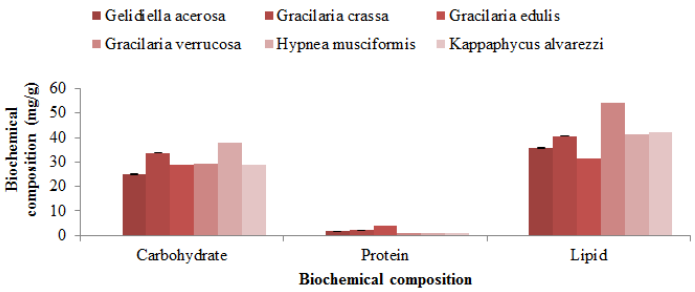

Fig. 1. Biochemical composition of selected seaweeds

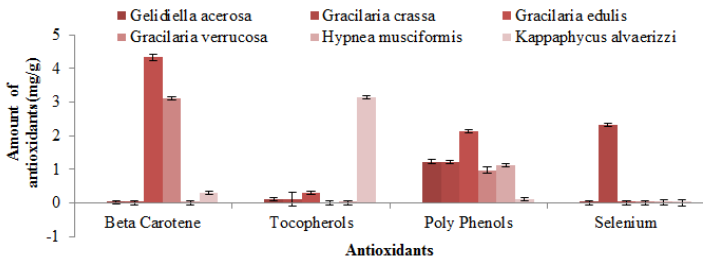

Fig. 2. Antioxidant composition of selected red seaweeds

Seaweeds act as natural antioxidants, thus, reducing the free radicals released by the body as a result of metabolic activities. These free radicals can go and bind to the antioxidants and reduces the cellular degradation and other harmful effects like cardiovascular diseases, stroke, cancer and aging [20].The results (Fig. 2) shows that the antioxidants like Tocopherols, Beta carotene, poly phenols and selenium are found in good amounts which are found in fresh fruits and vegetables. The *G.edulis* show high amount of beta carotene, which shows that it can act as a highly efficient anti oxidants. Higher the value of antioxidants, higher is its efficiency to act as natural antioxidant. Beta carotene helps in cell reproduction. It also stimulates immunity and is needed for production of some hormones, vision, bone growth skin and hair colour. Its daily requirement to act as antioxidant are 3 mg/day.The intake of red seaweed can act as a rescue for aging. Vitamin C (Tocopherols) are water insoluble and thus effects the body adversely leading to hypercholestemia. The permitted value is 20-50 mg a day. The reduced values for Tocopherols for all the six species make the results more relevant. Within the six species ,for Tocopherols , exept *kappaphycus* all the species showed low values. The permissible limit for polyphenol intake is 1-2 g/day. The poly phenol composition more than 100 mg a day results in aging, while 1-2g a day reduces cellular oxidation and aging. The poly phenol composition for all the six species of selection, falls out with in this range. Selenium is an essential constituent of a number of enzymes some of which have antioxidant function (50 mcg/day for adults). Selenoproteins show great activity as natural antioxidants. The poly unsaturated fatty acids of the slenoproteins preserves the elasticity of the tissue. [21].Selenium was observed in traces in all the species but found to give around 2 mg/g in case of *G. Crassa.* The selenium values also suggest it is a good anti-oxidant in all the six species. Thus, the present study is relevant owing to the ability of Rhodophyceae to act as natural anti-oxidants.

CONCLUSION

The selected seaweeds showed average amount of protein, carbohydrate and lipid values. The results shows 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 edibible. 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.

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