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Research article

Seasonal studies on the carbohydrate content of some marine macroalgae in Gulf of Mannar coastal region, India

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Abstract: Carbohydrates were analysed in 40 species of marine macroalgae belonging to three classes collected at seasonal intervals between April 2018 to March 2019 from the intertidal habitats in Gulf of manner coastal regions. Among the 40 dominant seaweeds 11 species belonged to Chlorophyceae, 13 species to Phaeophyceae and the remaining 16 species to Rhodophyceae. The carbohydrate content of seaweeds varied from 4.50±0.12 to 72.25±3.15 % of DW during the summer season. The percentage of carbohydrate content was maximum in *Gracilaria verrucosa* (72.25±3.15 % of DW) during the summer season and minimum in *Turbinaria ornata* (4.50±0.12 DW) during the summer season. The carbohydrate content of seaweeds varied from 5.50±0.17 to 48.38±3.04 % of DW during the pre-monsoon season. The maximum values were observed in *Gracilaria corticata* var. *corticata* the minimum content was observed in *Padina pavonica*. The carbohydrate content of seaweeds varied from 4.83±0.12 to 58.18±4.56 % of DW during the monsoon season. The maximum value was observed in *Gracilaria corticata* var *corticata* and the minimum was in *Padina pavonica*. The carbohydrate content of seaweeds varied from 7.36±0.16 to 67.25±2.41 % of DW during the post-monsoon season. The maximum value was observed in *Acanthophora spicifera* and the minimum content was observed in *Sargassum ilicifolium*.
Keywords: Marine Algae - Seasonal variation - Carbohydrate - Gulf of Mannar.

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INTRODUCTION

Marine algae are one of the important constituents of the primary producers and contribute substantially to the carbon budget of the coastal ecosystem. Further, they provide habitat and food to a variety of invertebrate species and also play a significant role in nutrient recycling. Marine algae are traditionally used in human and animal nutrition in many countries like China, Japan, and Taiwan. But in India, there use as food is very limited. In recent years studies were carried out on the chemical composition of marine algae and also on the properties of their important biochemical products. As a result, some of the algal species have been reported to be good alternative sources of amino acid, protein, carbohydrates, vitamins and minerals. The biopotential of seaweed liquid fertilizer on *Vigna mungo* (L.) Hepper and *Vigna radiata* (L.) R. Wilczek has also investigated (MarySanthi & ThambiRaj 2015). The chemical composition of marine algae varies with species, habitat, maturity and environmental condition (Ito & Hori 1989). In general marine algae are rich in non-starch polysaccharides, minerals and vitamins (Darcy-Vrillon 1993, Mabeau & Florence 1993, Ruperz & Saura-Calixto 2001). Together with their low lipid content marine algae only provide a very low amount of energy. Consumption of seaweeds can increase the intake of dietary fibre and lower the occurrence of some chronic diseases (Southgate 1990). The nutrient elements present in marine algal and readily absorbed by plants and the translocation (*Sheoran et al.* 1990), alteration of water relation (Barcelo & Poschenrieder 1990, Dawczynski *et al.* 2007). Seasonal changes in growth and biochemical composition of Grateloupia in Kovalam coast, Tamil Nadu studied by Rajasulochana (2013). The chemical composition (Protein, Carbohydrate, Lipid, Fiber, Ash and Nitrogen) of two seaweeds (*Gracilaria* and *Sargassum*) from Northeast Brazil was investigated in order to evaluate their potential nutritive value. Phytochemical estimation and mineral analysis of selected brown

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seaweeds from Mulloor coast, Kerala by HemaVijayan *et al.* (2016). The adhesive properties of some carbohydrates and get forming capability of polysaccharides. Seaweed as a nutrient supplement: preparation of functional foods with *Sargassum wighti* Greville evaluated by Rajakumari *et al.* (2018). Hence, the present investigation was made to study the carbohydrate content in different green, brown and red macroalgae of Gulf of Mannar coastal region, Moreover, the seasonal variation in the carbohydrate content was also estimated and compared during one year to determine the best period for harvesting.

MATERIALS AND METHODS

Collection of samples

Marine Algae samples were collected from intertidal and subtidal regions were devised taking into consideration of the heterogeneous distribution of the marine algal vegetation which are growing attached to the discontinuous and patch substratum. The coastal line (places) between Pamban and Tuticorin was studied for one year during the summer, pre-monsoon, monsoon and post-monsoon for one year from April 2018 to March 2019. The places include pamban, Mandapam, Seeniappa - Dargha, Kilakarai, Eravadi, Valinokkam, Tharuvaikulam and Tuticorin. Samples were collected within the 1.0 m^2 metal quadrat. Each quadrat sample was sorted out into the different species of marine algae and fresh weights of them were recorded. The collected materials were kept in the polythene bags and labelled for further preservation and identification at the later stage in the laboratory. The preservation was done both by the wet and dry preservation method (Agado 1976).

Estimation of carbohydrate

The carbohydrate was estimated by Phenol - Sulphuric acid method (Dubois *et al.* 1956). A dried sample of 0.5 g, 1 ml distilled water, 1 ml of 5% phenol and 3 ml of concentrated sulphuric acid were added. The mixture was incubated at room temperature for 30 minutes and O.D. was measured in a UV spectrometer at 490 nm. The percentage of carbohydrate present in the sample was calculated using the following formula,

$$\text{Percentage of Carbohydrate} = \frac{\text{Standard Value} \times \text{OD Value}}{\text{Weight of Sample}} \times 100$$

RESULT AND DISCUSSION

Among the 40 dominant marine algae, 11 species belonged to Chlorophyceae, 13 species to Phaeophyceae and the remaining 16 species to Rhodophyceae. The carbohydrate content of seaweeds varied from 4.50±12 to 72.25±3.15 % of DW during the summer season. The percentage of carbohydrate content was maximum in *Gracilaria verrucosa* (Hudson) Papenfuss (72.25±3.15% of DW) during the summer season and minimums in *Turbinaria ornata* (Turner) J. Agardh (4.50±0.12% DW) during the summer season. The carbohydrate content of seaweed varied from 5.50±0.17 to 48.38±3.04 % of DW during the pre-monsoon season. The maximum value was observed in *Gracilaria corticata* (J.Agardh) J.Agardh the minimum content was observed in *Padina pavonica* (L.) Thivy. The carbohydrate content of seaweeds varied from 483±0.12 to 58.18±456 % of DW during monsoon season. The maximum values was observed in *Gracilaria corticata* and the minimum was observed in *Padina pavonica*. The carbohydrate content of seaweed varied from 7.36±0.16 to 67.25±2.41% of DW during post-monsoon season. The maximum and the minimum content and observed in *Sargassum ilicifolium* (Turner) C. Gardh (Table 1). This variation may be due to the stature of plants at the time of collection from each locality. Carbohydrate, protein and lipids are naturally present in almost in all food quantities. Carbohydrate are sugars or polymer of sugars that can be hydrolysed to simple sugar by digestive enzymes and plays a role as an energy supplier for the metabolic process. The dry weight of seaweed comprises 50–60% of carbohydrates (Arasaki & Araski 1983). In the present study, the percentage of carbohydrate content was maximum in *Gracilaria verrucosa* (72.25±3.15% of DW) during the summer season and minimum in *Turbinaria ornata* (4.50±0.12% of DW) during the post-monsoon season which is contradictory to the earlier work done by Rameshkumar *et al.* (2013), in which he observed proximate composition of some selected seaweeds from Palk Bay and Gulf of Mannar, Tamil Nadu in this carbohydrate content was high in *Caulerpa racemosa* (Forsskål) J. Agardh (83.2% of DW) and low in *Chnoospora minima* (Hering) Papenfuss (28.5% of DW). The carbohydrate content was high in red algae might be due to higher phycocolloidal content in their cells walls (Dhargalkar *et al.* 1980). The level of carbohydrate content may vary from season to season and from place to place. Shanmugam & Palpandi (2008) recorded the carbohydrate content in *Ulva reticulata* Forsskål 50.24% of DW, *Gravilaria* sp. 48.4% of DW by Reeta & Kulandaivelu (1999) and *Enteromorpha* sp. 54.71% of DW by Haroon (2000). However, in both the case the carbohydrate content of brown algae were recorded minimum.

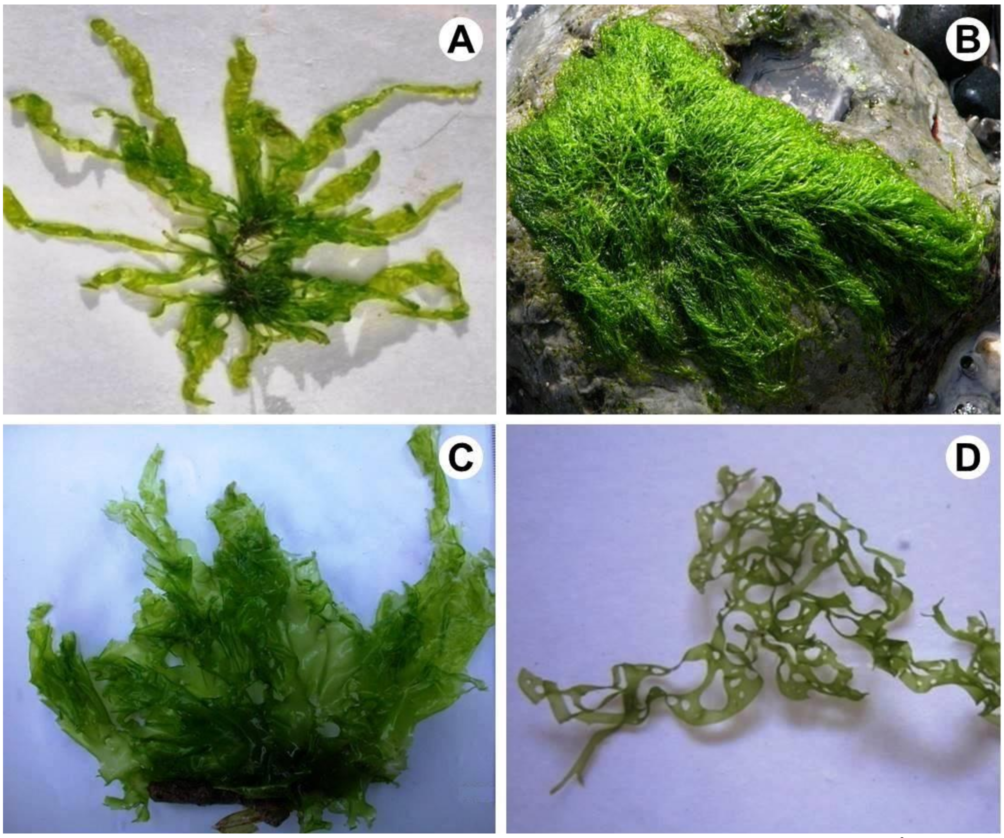

Figure 1. A, *Ulva fasciata* Delile; **B**, *Ulva intestinalis* L.; **C**, *Ulva lactuca* L.; **D**, *Ulva reticulata* Forsskål.

Table 1. Percentage Carbohydrate content of Marine algae studied in Gulf of Mannar region during April 2018 to March 2019 (% of DW).

S.N.	Name of the species	Summer	Pre-Monsoon	Monsoon	Post-Monsoon
Chlorophyceae					
1.	*Caulerpa peltata* J.V.Lamouroux	41.09±1.53	39.16±1.41	45.23±2.06	40.51±1.37
2.	*Caulerpa racemosa* (Forsskål) J.Agardh	11.83±0.03	8.5±0.84	14.25±1.35	9.27±0.47
3.	*Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh	40.27±1.38	28.4±1.97	46.83±2.76	32.76±1.15
4.	*Caulerpa sertularioides* (S.G.Gmelin) M.Howe	-	11.82±1.15	13.74±1.42	25.87±0.71
5.	*Caulerpa taxifolia* (M.Vahl) C.Agardh	20.2±1.40	9.7±0.47	13.46±1.11	-
6.	*Chaetomorpha antennina* (Bory) Kützing	29.46±2.58	-	38.60±1.82	31.58±1.27
7.	*Chaetomorpha crassa* (C. Agardh) Kutzing	33.00±1.16	-	-	29.37±0.97
8.	*Ulva fasciata* Delile	-	13.67±1.03	29.57±0.02	18.45±1.13
9.	*Ulva intestinalis* L.	32.58±1.23	-	43.47±1.17	35.74±1.34
10.	*Ulva lactuca* L.	-	8.50±0.54	18.65± 0.79	13.46±0.38
11.	*Ulva reticulata* Forsskål	10.74±0.61	11.61±0.91	16.82± 1.33	12.79±0.82
Phaeophyceae					
12.	*Dictyota dichotoma* (Hudson) J.V. Lamouroux	7.50±0.43	6.81±0.38	-	-
13.	*Padina boergesenii* Allender & Kraft	35.11±2.31	16.22±0.89	36.47±3.01	-
14.	*Padina pavonica* (L.) Thivy	-	5.50±0.17	4.83±0.12	-
15.	*Sargassum crassifolium* J.Agardh	41.24±0.01	29.38±2.71	45.13±3.46	-
16.	*Sargassum ilicifolium* (Turner) C.Agardh	-	-	-	7.36±0.15
17.	*Sargassum longifolium* (Turner) C.Agard	91.15±0.72	16.8±0.72	21.35±1.67	-
18.	*Sargassum tenerrimum* J. Agardh	43.14±0.04	18.01±1.13	21.79±1.80	-
19.	*Sargassum wightii* Greville	15.98±0.21	25.5±1.37	30.26±1.22	23.78±1.72
20.	*Spatoglossum asperum* J.Agardh	25.48±0.13	19.53±1.07	29.64±2.95	-
21.	*Stoechospermum marginatum* (C.Agardh) Kützing	19.51±0.81	15.8±0.80	9.71±0.89	-
22.	*Turbinaria conoides* (J.Agardh) Kützing	23.54±2.23	14.9±1.08	8.59±0.4	11.54±0.96
23.	*Turbinaria decurrens* Bory	35.40±2.05	17.41±1.35	10.31±0.97	-
24.	*Turbinaria ornata* (Turner) J.Agardh	4.50±0.12	-	-	-

Rhodophyceae					
25.	*Acanthophora spicifera* (M.Vahl) Børgesen	-	-	56.75±2.08	67.25±2.41
26.	*Amphiroa fragilissima* (L.) J.V.Lamouroux	23.83±1.72	18.77±1.57	29.63±3.05	23.78±2.81
27.	*Centroceras clavulatum* (C.Agardh) Montagne	12.78±0.46	-	14.92±0.64	14.23±0.72
28.	*Gracilaria canaliculata* Sonder	28.02±3.01	30.43±2.80	31.81±3.25	-
29.	*Gracilaria corticata* var. *corticata* (J.Agardh) J.Agardh	42.05±3.98	48.38±3.04	58.18±4.56	51.76±3.41
30.	*Gracilaria corticata* var. *cylindrica* Umamaheswara Rao	21.64±1.81	34.68±2.33	49.4±4.01	-
31.	*Gracilaria debilis* (Forsskål) Børgesen	33.45±0.30	18.14±1.68	20.31±1.27	-
32.	*Gracilaria edulis* (S.G.Gmelin) P.C.Silva	21.11±1.83	19.56±1.14	43.84±1.35	36.68±1.94
33.	*Gracilaria foliifera* (Forsskål) Børgesen	32.98±2.44	38.10±2.13	42.31±3.81	-
34.	*Gracilaria megaspora* (E.Y.Dawson) Papenfuss	34.33±2.01	-	-	-
35.	*Graciliaria verrucosa* (Hudson) Papenfuss	72.25±3.15	-	52.75±3.48	66.15±2.39
36.	*Hypnea musciformis* (Wulfen) J.V.Lamouroux	-	-	55.29±2.11	48.73±2.71
37.	*Hypnea pannosa* J.Agardh	-	21.46±1.27	42.15±3.47	37.45±2.27
38.	*Hypnea valentiae* (Turner) Montagne	-	-	18.22±1.18	16.73±0.96
39.	*Laurencia papillosa* (C.Agardh) Greville	24.85±2.61	13.89±0.71	19.57±1.12	-
40.	*Solieria robusta* (Greville) Kylin	36.00±0.02	-	-	23.08±1.04

Note: "-" indicates unavailability of the species.

SUMMARY & CONCLUSION

Biochemical content such as Carbohydrate analysed from the dominant marine algae collected from the study area during summer, pre-monsoon, Monsoon, Post-Monsoon season from April 2018 to March 2019. The seaweed sample collected from the different station of the same seasons were grouped for the biochemical analysis. 106 species were collected from all the 8 stations in the Gulf of Mannar region of which 40 species of seaweeds were predominantly found in all the stations. Chlorophyceae (11 species), Phaeophyceae (13 species) and Rhodophyceae (16 species) were found prevalently in all seasons which is chosen for biochemical analysis. Percentage of Carbohydrate content observed maximum in *Gracilaria verrucosa* (72.25±3.15) summer season and minimum in *Turbinaria ornata* (4.50±0.12% of DW) during summer season (Table 1). The higher carbohydrate content might be due to the phycocolloid content of the cell wall, nutrient accumulation and higher light intensity.

Seaweed polysaccharides are differentiated into reserve polysaccharide, such as laminarin and floridean starch & structural polysaccharide. The major components of seaweed are carbohydrate in nature and thus the use of seaweed in food and industry is due to its carbohydrate content and especially to such polysaccharides as agar, algin, carrageem and funorin. Hence further research on different varieties of seaweeds can be resourceful for tapping various nutritional benefits, keeping into view, the recent tremendous increase in research on marine algae, this study is to be continued for evaluation of certain other potential nutritional parameters like lipid, protein content and their respective fatty acid iodine value, iron, calcium and phosphorus content, pigment content, anti-nutritional factors like phytic acid and Trypsin inhibitors etc.

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