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.

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
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, Seenappa - Dargha, Kilakarai, Eravadi, Valinokkam, Tharuvaikulam and Tuticorin. Samples were collected within the 1.0 m² 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 48.3±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. Carbohydrates 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 & Pulpandi (2008) recorded the carbohydrate content in Ulva reticulata Forsskål 50.24% of DW, Gravelaria sp. 48.4% of DW by Reeta & Kulaivaaidu (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) | 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.  | Dicyota 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.Agardh | 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.  | Stoechospernum marginatum (C.Agardh) | 19.51±0.81 | 15.8±0.80   | 9.71±0.89  | -            |
|      | **Kützing**                |            |             |            |              |
| 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) Børjesen
   26. _Amphiroa fragilissima_ (L.) J.V.Lamouroux
   27. _Centroceras clavatum_ (C.Agardh) Montagne
28. _Gracilaria canaliculata_ Sonder
29. _Gracilaria corticata var. corticata_ (J.Agardh) J.Agardh
30. _Gracilaria corticata var. cylindrica_ Umamaheswara Rao
31. _Gracilaria debilis_ (Forsskål) Børgesen
32. _Gracilaria edulis_ (S.G.Gmelin) P.C.Silva
33. _Gracilaria foliifera_ (Forsskål) Børgesen
34. _Gracilaria megaspora_ (E.Y.Dawson) Papenfuss
35. _Gracilaria verrucosa_ (Hudson) Papenfuss
36. _Hypnea musciformis_ (Wulfen) J.V.Lamouroux
37. _Hypnea pannosa_ J.Agardh
38. _Hypnea valentiae_ (Turner) Montagne
39. _Laurencia papillosa_ (C.Agardh) Greville
40. _Solieria robusta_ (Greville) Kylin

| Species                        | Carbohydrate (%) | Protein (%) | Fatty Acid Iodine Value | Iron (mg/g) | Calcium (mg/g) | Phosphorus (mg/g) |
|--------------------------------|------------------|-------------|-------------------------|------------|----------------|-------------------|
| _Rhodophyceae_                 |                  |             |                         |            |                |                   |
| _Acanthophora spicifera_       |                  |             |                         |            |                |                   |
| _Amphiroa fragilissima_        | 23.83±1.72       | 18.77±1.57  | 29.63±3.05              | 3.47±0.12  | 2.41±0.18      | 2.39±0.12         |
| _Centroceras clavatum_         | 12.78±0.46       |             | 14.92±0.64              | 3.15±0.12  | 3.81±0.12      | 4.01±0.12         |
| _Gracilaria canaliculata_      | 28.02±3.01       | 30.43±2.80  | 31.81±3.25              |            |                |                   |
| _Gracilaria corticata var. corticata_ | 42.05±3.98   | 48.38±3.04  | 58.18±4.56              | 3.41±0.12  |                |                   |
| _Gracilaria corticata var. cylindrica_ | 21.64±1.81    | 34.68±2.33  | 49.4±4.01               |            |                |                   |
| _Gracilaria debilis_           | 33.45±0.30       | 18.14±1.68  | 20.31±1.27              |            |                |                   |
| _Gracilaria edulis_            | 21.11±1.83       | 19.56±1.14  | 43.84±1.35              |            |                |                   |
| _Gracilaria foliifera_         | 32.98±2.44       | 38.10±2.13  | 42.31±3.81              |            |                |                   |
| _Gracilaria megaspora_         | 34.33±2.01       |             |                        |            |                |                   |

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, carrageen and funoran. 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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