

Seasonal variation in the elemental composition of *Gracilaria* species of the Gulf of Mannar, Tamil Nadu coast

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ABSTRACT

Seasonal variation of the different cations such as Sodium (Na^+), Potassium (K^+), Magnesium (Mg^{++}), Calcium (Ca^{++}) and Iron (Fe^{++}) was analysed in three species of *Gracilaria* of Gulf of Mannar from August, 1994 to July, 1995. Significant interspecific variation in the elemental composition was observed. *G.crassa* showed higher concentration of Magnesium, Calcium and Iron whereas Sodium and Potassium dominated in *G.edulis*. Accumulation of cation content was high during March in *G.crassa*. In general, a declining cation concentrations was recorded as $\text{K}^+ > \text{Na}^+ > \text{Ca}^{++} > \text{Mg}^{++} > \text{Fe}^{++}$.

Introduction

Gracilaria is an important agarophyte of India used as food, fodder, binder and in pharmaceuticals. The agar production in the country was put around 60 tons per annum available either in strips or in powdered form. Major consumer of agar is in the food industries. Sodium, Potassium, Calcium, Magnesium, Sulfur and Phosphorus are found in relatively higher quantities in algae and utilised directly for the cellular building blocks (De Boer, 1981). The mineral constituents of different species of algae from Saurashtra coast and other part of the west coast of India were investigated (Rao and Indusekhar, 1987 a, b, 1989; Oza *et. al.*, 1983; Fernandez *et. al.*, 1995). Some of the important contributions on the elemental composition of the marine algae appeared from Turkey and White sea (Ilyas and Sukan, 1994; Kapkov and

Trishna, 1990). Very few studies on the elemental compositions of marine algae growing in the vicinity of Mandapam 50 years ago (Pillai, 1955; 1956; 1957) are available. Having so much importance in the food industries, it is very much essential to know the elemental composition of *Gracilaria*.

Materials and Methods

Samples of *G.edulis*, *G.crassa* and *G.corticata* were collected from the natural habitat in the intertidal area of Gulf of Mannar near Thonithurai and Mandapam ($9^{\circ}17'N$ and $70^{\circ}11'E$). *G.corticata* was collected from Pudumadam ($9^{\circ}17'N$ and 79°). The collection was made during the morning low tide. They were transported to the laboratory in plastic packets, brushed off the epiphytes and washed several times in filtered seawater followed by distilled water. The plants were weighed and dried in a preheated oven at $90^{\circ}C$ for 24h. After complete drying, the plants were powdered and sieved. Dried algal powder sample of 250 mg

was taken in 75 ml digestion tube and digested in triple acid mixture (5 ml of nitric acid, 2 ml of perchloric acid and 0.5 ml of sulphuric acid) till the mixture became colourless. They were cooled to room temperature and diluted to 50 ml with deionised water and filtered through Whatman 42 filter paper. Triplicates were taken for each sample for maximum accuracy.

Elemental analysis of Na, K, Mg, Ca and Fe was performed by atomic absorption spectrophotometer using recommended guidelines for wavelength selection and linear working range.

Results

In general, the concentration of cations such as Magnesium, Calcium and Iron were found to be more in *G.crassa* than in *G.edulis* and *G.corticata* whereas that of the Sodium and Potassium content found to be dominated in *G.edulis*.

Magnesium:

Magnesium, being the important constituents of the chlorophyll molecules was found more in *G.crassa* followed by *G.edulis* and *G.corticata*. In *G.crassa*, the Magnesium content ranged between 0.86-1.55%. It showed a gradual increase from the month of September reaching a peak during April and then declined. Further, marginal increase was observed during June. In *G.edulis*, the Magnesium content ranged between 0.88 and 1.21%. It increased gradually up to the month of December and then declined till February. Significant increase was observed during March showing the peak value of Magnesium (1.25%). Further, it declined during April and then increased till June. *G.corticata* showed peaks of Magnesium during January and March. But in general, the Magnesium content showed an increasing trend till March and then declined. During June all the species showed high content of Magnesium (Fig.1).

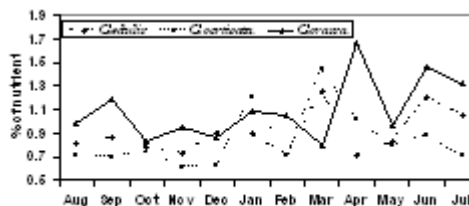


Fig. 1. Magnesium content in different species of Gracilaria

Calcium:

Calcium showed significant variation in the species of *Gracilaria*. *G.crassa* showed very high concentration of Calcium than *G.edulis* and *G.corticata*. The latter ones did not show much variation among them either. After an initial decline from August to December, both the species showed marginal increase till July. From the month of January to June, not much variation was observed. In *G.crassa*, the Calcium concentration increased significantly after December reaching a peak (4.30 %) during March. Further it declined (Fig.2). In *G.edulis*, it increased gradually from 0.64 to 1.59%.

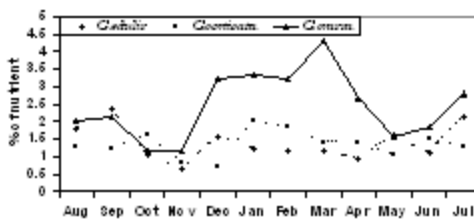


Fig. 2. Calcium content in different species of Gracilaria

Iron :

G.crassa showed high concentration of Iron than *G.edulis* and *G.corticata*. Except a sharp decline during February, Iron content increased till April and then declined during May and June. In *G.edulis*, the Iron content showed an initial decline from August to October, then an increase till January and declined further. During February and April, the Iron content was found to be less than in the other months. *G.corticata* showed least

iron content than the other two species. Not much significant variation was observed from August to July except for a marginal increase during May (Fig.3).

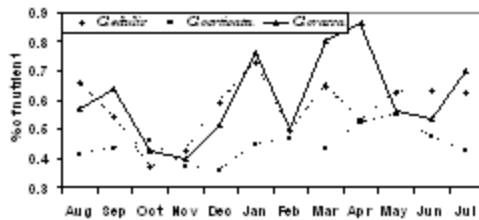


Fig. 3. Iron content in different species of *Gracilaria*

Sodium:

Concentration of Sodium and Potassium was found to be much higher than any other cations. Among the species, *G.crassa* showed less Sodium content than *G.edulis* and *G.corticata*. *G.edulis* showed highest concentration of Sodium followed by *G.corticata*. In *G.edulis* two distinct peaks were observed during January and June coinciding with the peak period of growth (Reeta and Kulandaivelu, 1999). In *G.corticata*, on the other hand showed a peak during January and then declined. Further, not much variation was noticed in the Sodium content of *G.corticata*. In *G.crassa*, a single peak was observed during November and then showed a sharp decline. Further, the Sodium content increased gradually till June (Fig.4).

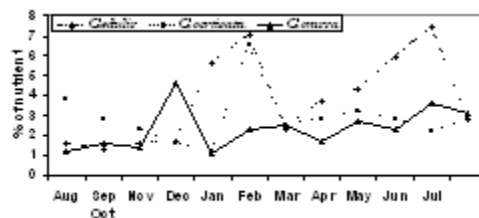


Fig. 4. Sodium content in different species of *Gracilaria*

Potassium:

Concentration of Potassium in all the species of *Gracilaria* did not show any consistent results throughout the year. There were a number of peaks and crests found in different seasons. Potassium content in *G.corticata* after a sharp decline from September to December increased till July. Two peaks were observed during January and April. In *G.crassa*, two peaks were observed during November and April with less concentration of Potassium (Fig.5).

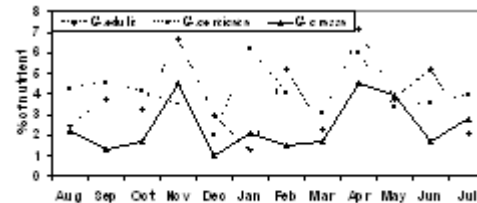


Fig. 5. Potassium content in different species of *Gracilaria*

Statistical Analysis

Analysis of covariance was done for all the species of *Gracilaria* separately based on the variation during different months and also among the nutrient content by Durbin-Watson method. Significant variation was observed in all the parameters in three species of *Gracilaria* (Table.1). In *G.edulis* the variance between the season and the nutrient content was not significant.

Discussion

Bioaccumulation of the elements in seaweeds depends on the habitat proximity to heavily populated or industrial area, surrounding seawater, geographical area, age of the plant and the period of collection. It also depends upon the pH, salinity, dissolved oxygen and the osmotic potential of the system (Styron *et al.*, 1976). Marine algae exhibit high content of ash (De Boer, 1981) mainly due to the presence of Na, K, Ca and Mg cations (Fe and S will be of minor importance).

Table 1. A. Analysis of Variance of *Gracilaria edulis*

| Source | Sum of Squares | df | Meansquare | F-ratio | P |
|----------|----------------|-----|------------|---------|-------|
| Month | 73.115 | 11 | 6.647 | 2.175 | 0.020 |
| Nutrient | 370.766 | 4 | 92.691 | 30.333 | 0.000 |
| Error | 300.462 | 44 | 6.829 | 2.235 | 0.000 |
| Error | 366.697 | 120 | 3.056 | | |

B. Analysis of Variance of *Gracilaria corticata*

| Source | Sum of Squares | df | Meansquare | F-ratio | P |
|----------|----------------|-----|------------|---------|-------|
| Month | 34.353 | 11 | 3.123 | 2.952 | 0.002 |
| Nutrient | 281.232 | 4 | 70.433 | 66.569 | 0.000 |
| Error | 42.995 | 44 | 0.977 | 0.924 | 0.609 |
| Error | 124.850 | 118 | 1.058 | | |

C. Analysis of Variance of *Gracilaria crassa*

| Source | Sum of Squares | df | Meansquare | F-ratio | P |
|----------|----------------|-----|------------|---------|-------|
| Month | 32.501 | 11 | 2.955 | 5.285 | 0.000 |
| Nutrient | 99.085 | 4 | 24.771 | 44.311 | 0.000 |
| Error | 114.420 | 44 | 2.600 | 4.652 | 0.000 |
| Error | 56.463 | 101 | 0.559 | | |

Osmoregulation in marine algae is mainly maintained by Na, K pump operating from seawater and cell sap, and the turgor pressure changes caused by variable ionic composition of vacuoles (Eisler, 1980). The chemical composition of marine macro-algae with respect to major cations and anions is well documented. Contents of Na, K, Mg and Ca were maximum during Oct/Nov in early growth stages of the algae, which is contrary to the present results. Bioaccumulation of Na, K, Mg and Ca was more during March and April. The concentration of Sodium was also found to be high during November and June coinciding with the peak period of growth (Reeta and Kulandaivelu, 1999). Accumulation of Magnesium and Iron was mostly observed during March and April. It may be explained here that the accumulation of the elements *in situ* was more due to reduction in the osmoregulation activities usually affected by the increase in salinity.

Acknowledgement

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