Pakistan J. Sci. Ind. Res., Vol. 31, No. 2, February 1988

SEASONAL CHANGES IN BIOCHEMICAL COMPOSITION OF SEAWEEDS FROM KARACHI COAST

Rashida Qari

Centre of Excellence in Marine Biology, University of Karachi, Karachi-32

(Received September 13, 1987; revised January 24, 1988)

An attempt has been made in this paper to investigate seasonal variation in the biochemical composition of *Caulerpa racemosa, C. scalpelliformis, C. taxifolia, Codium elongatum, Ulva fasciata, Cystoseira spp., Padina pavonica, Sargassum boveanum, Gracilaria corticata* and *Hypnea musciformis*. The results indicate that the total protein, carbohydrate, crude fibre, lipid and ash contents varied seasonally. Calorific values show little variation but *Codium elongatum* (Buleji), *Caulerpa taxifolia* and *Gracilaria corticata* showed high calorific values in January, February and June to August respectively, whereas in *Padina pavonica* (Buleji) and *Ulva fasciata* they were low in January and September respectively. Many species studied had high protein, lipid and ash values in winter months (November - February) and high carbohydrate values in the spring and presummer months (March - June).

Key words: Biochemical composition, Seaweed, Karachi coast.

INTRODUCTION

Caulerpa racemosa, C. scalpelliformis, C. taxifolia, C. elongatum, Ulva fasciata, Cystoseira spp., *Padina pavonica, Sargassum boveanum, Gracilaria corticata* and *Hypnea musciformis* are common species occurring in the coastal region of Karachi, but during the south-west monsoon season (June to October) the coasts are characterized by either the absence or the presence of quantities of seaweeds, viz. *Codium elongatum, Cystoseira* spp. *Sargassum boveanum* and *Caulerpa racemosa*. The occurrence of seaweeds in the Karachi coast has been reported earlier [1,2]. These seaweeds studied contain good quantities of proteins, lipids, carbohydrates and minerals [3,4]. Environmental changes affect to a greater extent the quantity and the quality of the constituents of seaweeds [5,6].

Seasonal variation in the biochemical composition of a number of species has been studied e.g. *Alaria esculenta, Laminaria saccharina, L. hyperborea* and *L. digitata* from the Norweigian coast [7,8], *Eucheuma* spp and *Sargassum pteropleuron* from Florida [9,10], *Padina pavonica* from Egypt [11], and *Hypnea musciformis* from India [12]. Sumitravijayaraghavan *et. al.* [13] have published a paper on seasonal variation in the biochemical composition of six species *Chaetomorpha media, Ulva fasciata, Dictyota dumosa, Padina tetrastromatica, Hypnea musciformis* and *Gracilaria corticata* from Goa coast, India.

According to this author's literatures survey it seems that no previous studies have been carried out on seasonal changes in the biochemical constituents of seaweeds from Karachi coast. With this in view an attempt has been made first time to study the seasonal variation in proteins, lipids, carbohydrates and ash in the above species of seaweeds, so as to exploit them for useful purpose at the most appropriate season i.e., winter (November – February) [1,2].

MATERIAL AND METHODS

Seaweeds from the localities of Buleji and the Manora coast of Karachi were collected at monthly intervals from July 1984 to June 1985. Seaweeds were washed thoroughly with sea water, followed by fresh water and dried in oven at 70° to constant weight. The dried material were homogenised and used for analysis. Moisture, ash and crude fibre content were determined by the standard method [14]. Protein was determined by the micro-kjeldahl method [16]. The percentage of carbohydrates were calculated by substracting the values of moisture, ash, proteins, lipids and crude fibre [17]. The calorific values were determined by converting the biochemical components to calorific value using the standard calorific equivalents: protein, 5.3; lipid, 9.3 and carbohydrate, 4.1 kcal/g [17].

RESULTS AND DISCUSSION

Seasonal variation in the biochemical composition of ten species of seaweeds belonging to eight genra collected from Manora and Buleji are summerized in Table 1. The parameters used are water, moisture, total protein, lipid, crude fibre, carbohydrate, ash and calorific value. The values of each parameter are the mean of three observations expressed as grams percentage dry weight and calorific value as kilo-calories per gram.

The calorific values have little variation, but *Codium elongatum, C. taxifolia* and *Gracilaria corticata* show high

Table 1. Seasonal variation in the biochemical constituents (g%) and calorific value (kcal/g) of seaweeds from Karachi coast

S. No.	Name of species	Site	Calorific value	Protein	Carbohydrate	Crude fibre	Lipid	Ash	Moisture	Water
1.	*Caulerpa racemosa*	Buleji	3.84 ± 0.20	11.50 ± 3.20	37.0 ± 7.9	12.20 ± 2.00	8.85 ± 2.30	23.20± 3.80	7.15± 1.50	91.0 ± 5.30
2.	*Caulerpa scal pelliformis.*	Manora	3.57 ± 0.05	13.10 ± 0.60	23.9 ± 1.5	13.30 ± 0.70	4.20 ± 0.41	36.50± 1.10	9.20± 0.36	87.6 ± 0.80
3.	*Caulerpa taxifolia*	"	3.50 ± 0.50	11.90 ± 1.14	17.8 ± 7.8	15.70 ± 2.60	6.70 ± 2.12	39.12± 3.80	8.80± 1.13	86.2 ± 7.20
4.	*Codium elongatum*	"	3.85 ± 0.10	6.34 ± 0.64	43.8 ± 4.7	6.10 ± 1.20	4.83 ± 1.10	32.75 ± 4.46	6.13± 1.70	94.8 ± 1.50
		Buleji	3.82 ± 0.43	6.80 ± 1.60	42.4 ± 8.4	7.00 ± 1.00	4.85 ± 1.35	30.80 ± 4.93	8.10± 1.60	96.0 ± 0.70
5.	*Ulva fasciata*	"	4.10 ± 0.45	8.00 ± 2.20	40.0 ± 3.7	4.25 ± 0.84	10.40 ± 1.60	26.00± 1.10	10.50± 1.20	89.0 ± 2.80
6.	*Cystoseira* spp.	"	3.60 ± 0.23	9.76 ± 1.96	34.0 ± 3.6	10.20 ± 2.50	3.91 ± 1.00	36.30± 3.26	5.72± 1.10	86.6 ± 1.00
		Manora	3.75 ± 0.24	8.86 ± 1.85	28.0 ± 5.0	11.80 ± 1.90	8.30 ± 2.20	36.00± 3.76	7.10± 1.62	90.4 ± 6.00
7.	*Padina pavonica*	"	3.40 ± 0.08	5.46 ± 1.70	40.8 ± 7.5	8.90 ± 0.66	4.60 ± 0.90	28.70± 6.13	11.50± 1.10	87.3 ± 2.70
		Buleji	3.20 ± 0.12	6.67 ± 1.53	33.5 ± 2.5	10.00 ± 2.20	4.40 ± 0.90	33.00± 1.80	12.40b 1.45	90.0 ± 2.86
8.	Sargassum *boveanum*	"	3.54 ± 0.23	7.20 ± 1.40	38.2 ± 8.6	10.70 ± 1.30	5.00 ± 1.60	30.50± 7.40	8.30± 1.90	88.6 ± 4.00
		Manora	3.80 ± 0.13	8.00 ± 1.46	33.7 ± 3.7	9.80 ± 1.30	7.00 ± 1.30	34.50± 3.47	7.00± 1.30	88.2 ± 1.67
9.	*Gracilaria corticata*	"	4.60 ± 0.32	10.60 ± 2.90	28.0 ± 9.5	6.00 ± 0.70	11.50 ± 3.30	36.20 ± 0.73	4.00± 1.40	86.4 ± 11.20
10.	*Hypnea musciformis*	"	3.20 ± 0.10	6.83 ± 1.86	40.5 ± 5.0	8.40 ± 1.71	3.30 ± 1.10	26.70± 3.50	14.30± 1.50	90.6 ± 2.30

calorific values in January, February and June to August respectively. In *Padina pavonica* (Buleji) and *Ulva fasciata* on the other hand, it was low in January and September respectively. Sumitravijayeraghavan *et. al.* [13] observed seasonal variation in the calorific value of Indian seaweeds and found its correlation with the seasonal rhythm in the growth and reproductive cycle. The protein was high in winter season (November – Feb.) in many species. *C. scalpelliformis* has a high protein content in February. From Buleji in December and January. *Sargassum boveanum* from Manora has maximum protein in January and February and from Buleji in November. High protein level in *C. racemosa* was found in December. *Cysteseira* spp. and *Padina pavonica* from Buleji had high protein content in the month of January. In *C. taxifolia, Cystoseira* spp., *P. pavonica*, *Gracilaria corticata* and *Hypnea musciformis* from Manora, protein was maximum in the months of May and June. *Ulva fasciata* was the only species which had high protein in September.

The carbohydrate content was maximum in many species in spring and presummer (March – June). Three species from Manora (*Cystoseira* spp., *Sargassum boveanum* and *Gracilaria corticata*) had high carbohydrates values in March and three (*C. taxifolia, Codium elongatum* and *Hypnea musciformis*) in May whereas species from Buleji (*C. racemosa, Codium elongatum, Ulva fasciata* and *Cystoseira* spp.) had a high carbohydrate value in May and June. The species *C. scalpelliformis, P. pavonica* (Manora and Buleji) and *Sargassum boveanum* (Buleji) had a high carbohydrate level in months of December, January, October and February respectively.

The high peak of lipid content was in winter season (Nov. to February) in eight species, *Cystoseira* spp., from Manora and *C. racemosa, C. elongatum, Cystoseira* spp and *Padina pavonica* from Buleji had maximum carbohydrate content in December and January. *C. scalpelliformis* and *Sargassum boveanum* had maximum lipid content in October, whereas *Gracilaria corticata* and *Ulva fasciata* have a high lipid value in August and *Padina pavonica* from Manora in June. The total inorganic content or ash was maximum in many species also in winter season (November – February). *Codium elongatum* and *Sargassum boveanum* from Manora and *C. racemosa* and *Cystoseira* spp. from Buleji had high ash value in November, whereas *Cystoseira* spp. from Manora and *Codium elongatum* and *Sargassum boveanum* from Buleji have high ash content in December and *Codium elongatum* and *Hypnea musciformis* from Manora in January and February respectively. The other five species have high ash content in September (*C. scalpelliformis, Gracilaria corticata*), July (*Ulva fasciata*)

October (*Padina pavonica*, Buleji) and June to September (*Padina pavonica*, Manora).

It is rather noteworthy that an inverse relationship is found between different parameters in different species: protein vs. carbohydrate (*Caulerpa scalpelliformis, Ulva fasciata, Codium elongatum* from Manora, *Sargassum boveanum* (from Buleji) and *Padina pavonica* from Manora lipid vs. carbohydrate (*Caulerpa taxifolia, Sargassum boveanum, Gracilaria corticata, Hypnea musciformis* from Manora and *Caulerpa racemosa, Cystoseira* spp. from Buleji); ash vs. protein (*Cystoseira* spp. from Buleji) carbohydrate vs. crude fibre (*Cystoseira* spp. from Manora) and protein vs. lipid (*Codium elongatum* from Manora).

The seasonal trend found in ash, protein, lipid, carbohydrate and crude fibre of *Ulva fasciata, Padina pavonica, Sargassum boveanum* and *Gracilaria corticata* in the present study bear much resemblance with the resutls obtained by Prince and Daly [10]. and Murthy and Radia [18], while it is quite different from that of the Goa coast, India [13] and Egypt [11]. The results with regard to *Hypnea musciformis* studied agree well with the results of Dass *et. al.* [12] and Sumitravijayaraghavan *et. al.* [13]. They suggest that environmental conditions affect the biochemical composition of the same species (*Hypnea musciformis*).

The range of values (5-13g%) obtained for proteins in the present study appear to be lower than the values reported earlier by Hussain *et. al.* [11] and close to the values recorded by Dass *et. al.* [12]. For the lipid content the present values (3-11g%) agree with the values recorded by Hussain [11]. Ash values (23-39%) recorded here appears to be close to the values reported earlier by Sumitravijayaraghavan *et. al.* and Parekh *et. al.* [13,19] but are higher than those given by Hussain [11]. The range of values (17-43%) obtained for carbohydrates in the present study, is somewhat similar to the range recorded by Sumitravijayaraghavan *et. al.* [13]. Dass *et. al.* [12] and Hussain *et. al.* [11].

From the observations made by this author, it may be concluded that high ash content is associated with minerals in the sea. The percentage of carbohydrates and lipids in the seaweeds are stimulated by light. In a few species of seaweeds, protein and calorific values were higher which may be due to the fact that the plants collected for biochemical analysis might have reproductive or fertile tissues having higher energy values. Miller [5] and Himmelman and Carefoot [6] are of this view.

From the results of the present study it could safely be concluded that at the Manora and Buleji coasts of Karachi the species studied are abundantly available (*C. scalpelliformis*, 2.2g. dry weight per m^2. *C. taxifolia*, 3.1 g d.w./m^2; *C. racemosa*, 6 g d.w./m^2; *Codium elongatum* 21 g d.w./m^2; *Ulva fasciata* 29.5 g d.w./m^2; *Cystoseria* spp. 10.7 g.d.w./m^2; *Padina pavonica* 2 gd.w/m^2; *Sargassum boveanum* 12 g d.w./m^2; Gracilaris corticata 1.5 g d.w./m^2; *Hypnea musciformis* 1.1 g d.w./m^2) in winter season, November to February [1,2], having good quantity of proteins, lipids, carbohydrates and minerals. The harvest of winter may be utilized on commercial scale as a feed supplement to poultary nation and cattle feeds and they can also be utilized for extraction of commercial phycocolloids, such as agar agar, alginate and carragheen.

REFERENCES

1. R. Qari and R. Qasim, Proc. Int. Conf. Marine Sci. of the Arabian Sea (in press).
2. R. Qari and R. Qasim, Proc. Nat. Sem. Fisheries Policy and Planning (in press).
3. R. Qasim, Karachi Univ. J. Sci. **8**, 135 (1983).
4. R. Qasim Karachi Univ. J. Sci. **9**, 105 (1981).
5. J.D.A. Miller, *Physiology and Biochemistry*, Academic Press, New York (1962).
6. J.H. Himmelman and T.H. Carefoot, J. Exp. Mar. Biol. Ecol., **18**, 139 (1975).
7. A. Haug and A. Jenson, Norw. Inst. of Seaweed Res. Rep. **4**, (1954).
8. A. Jenson, A. Haug., Norw. Inst. Seaweed Res. Rep., **14** (1956).
9. C. J. Dawes, J. M. Lawerence, D. P. Chaney and A.C. Mathieson, Bull. Mar. Sci, **24**, 286 (1974).
10. J.S. Prince and E.L. Daly, Phycologia, **20**, 232 (1981).
11. M.M. Hussain, A. Abdel Aziz and H.M. Saleem, Pakistan J. Sci. Ind. Res. **20**, 4 (1977).
12. S.B. Dass, S.Y. Kamat, L. Fernandes and C.V.G. Reddy, Indian J. Mar. Sci., **9**, 134 (1980).
13. Sumitra – Vinayaraghavan, M.D. Rajagopal and M.V.M. Wafer, Indian J. Mar. Sci., **9**, 61 (1980).
14. A.O.A.C. Assoc. Off. Agri. Chemi. Washington. D.C. (1960).
15. B.P. Hawk, L.B. Oser and H.W. Summerson, *Practical Physiological Chemistry*, Mc.Graw Hill Book Co., London (1954).
16. J. Folch, M. Leess and G.H. Sloane – Slanley, JBC, **226**, 497 (1957).
17. P.J. Dare and D.S. Edwards, J. Exp. Mar. Biol. Ecol. **18**, 89 (1975).
18. M.S. Murthy and P. Radia, Bot. Mar. **21**, 417 (1978).
19. R.G. Parekh, L.V. Maru and M.J. Dave, Bot. Mar. **20**, 359 (1977).