

Seasonal changes of biochemical composition of green algae *Ulva fasciata* Delile, 1813 and *Caulerpa racemosa* Agardh, 1873 from coastal waters of Visakhapatnam, east coast of India

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ABSTRACT

Biochemical constituents such as protein, carbohydrate, lipid and ash in the dry tissue of green algae *Ulva fasciata* and *Caulerpa racemosa* have been reported from coastal waters of Visakhapatnam during February, 2006 - January, 2008. The mean values of protein, carbohydrate, lipid and ash in *U. fasciata* were 25.15%, 60.28%, 9.15% and 5.41% respectively. The mean values of protein, carbohydrate, lipid and ash in *C. racemosa* were 26.52%, 53.02%, 10.88% and 9.58% respectively. The percentage composition of protein, lipid, carbohydrate and ash contents showed variations in their abundance in different seasons. Seasonally highest protein content (27.09%) was noticed in summer, carbohydrate (65.19%) in monsoon, lipid (12.12%) in post-monsoon and ash (12.53%) in summer in *U. fasciata*. The highest protein content (30.88%) was noticed in post-monsoon, carbohydrate (55.78%) in monsoon, lipid (12.91%) in monsoon and ash (15.34%) in summer in *C. racemosa*. The protein content in two seaweed species studied were almost similar, but carbohydrate content noticed in *U. fasciata* little higher than that of carbohydrate content in *C. racemosa*. Tsunami (2004) did not affect the biochemical constituents of *U. fasciata* and *C. racemosa* distributed along the coastal waters of Visakhapatnam.

Key words: *Ulva fasciata*, *Caulerpa racemosa*, Biochemical composition, Visakhapatnam

INTRODUCTION

Seaweeds are marine macro-algae growing abundantly in the shallow waters of seas, estuaries and back waters within the lighted area. Seaweeds are major coastal resources which are valuable to human consumption and environment in many countries [1]. Many protein rich seaweeds are used for human consumption [2, 3]. The seaweeds are scientifically proved to have many of the biological activities [4, 5, 6, 7]. A detailed study on taxonomy of the intertidal macro-algal flora along the coastal waters of Visakhapatnam was given by Umamaheswara Rao and Sreeramulu [8, 9], Narasimha Rao and Umamaheswara Rao [10], Narasimha Rao [11], Umamaheswara Rao [12], Prasanna Lakshmi and Narasimha Rao [13], Satya Rao et al., [14], Yedukondala Rao et al., [15]. But very few studies were made on biochemical composition such as protein, carbohydrate, lipid etc. from seaweeds occurring along the coastal waters of Visakhapatnam [16, 17, 18] and there is no published data on biochemical composition of marine macro-algae after 2004 tsunami along the coastal waters of Visakhapatnam. Considering the paucity of information on the biochemical constituents of marine macro algae after 2004 tsunami effect along the coastal waters of Visakhapatnam, the present study deals with changes of biochemical constituents like protein, carbohydrate, lipid and ash in green algae *Ulva fasciata* and *Caulerpa racemosa* distributed along the coastal waters of Visakhapatnam, east coast of India.

MATERIALS AND METHODS

U. fasciata and *C. racemosa* samples were collected at monthly intervals from coastal waters of Visakhapatnam (Lat 17° 75' N Long 83° 35' E) during February, 2006 - January, 2008. The samples were brushed off their epiphytes and washed 2 or 3 times in ordinary sea water, followed by distilled water. The seaweed samples were shade dried for four days, then made into small pieces and kept in hot air oven for 24 hrs at 50°C. The dried samples were powdered in a mortar and were used for determination of protein, carbohydrate, lipid and ash by using standard methods [19, 20, 21, 22]. The results were expressed as percentage of dry weight.

RESULTS AND DISCUSSION

The protein ranges between 17.25 and 32.65% in *U. fasciata*, where as in *C. racemosa* it was ranged between 16.99 and 38.48. Highest concentration of protein was noticed in Sep. 07 in *U. fasciata*, Jan. 08 in *C. racemosa* (Table 1&2). Lowest value reported in Jul. 07 in *U. fasciata* and Aug. 07 in *C. racemosa*. The mean values of protein 25.15±1.4594% and 26.52± 1.3606% were observed in *U. fasciata* and *C. racemosa* respectively (Figure 1: A&B). Seasonally highest protein was observed in summer 07 and lowest in post-monsoon 07-08 in *U. fasciata*, but in *C. racemosa* highest value was noticed in post-monsoon 07-08, lowest value in monsoon 06 (Table 3&4). The protein content in the two seaweed species studied was almost similar. Highest values of protein were also reported in green sea weeds from coastal waters of India [16, 23, 24, 25, 26, 27]. Comparatively lowest values of protein also noticed in *U. fasciata* and *C. racemosa* from other regions [3, 24, 27, 28]. The highest and lowest values of protein corresponded with that nitrates of sea water [29, 30]. The highest value of protein might be attributed to accumulation of more nitrogen in organic wastes brought to the sea by the land run-off during rainy season [5, 31, 32, 33].

Table 1: Percentage composition of protein, carbohydrate, lipid and ash content in the dry tissue of *Ulva fasciata*

Biochemical Constituents	Feb 06	Mar 06	Apr 06	May 06	Jun 06	July 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07
Protein	25.00 ± 1.3109	27.33 ± 0.6629	20.67 ± 1.1461	26.00 ± 1.3040	22.06 ± 2.1158	27.00 ± 1.6224	22.00 ± 1.6343	24.99 ± 1.7359	22.33 ± 1.6120	27.99 ± 1.6737	24.99 ± 1.5410	28.32 ± 1.7685
Carbohydrate	52.00 ± 1.5300	54.99 ± 1.3432	60.00 ± 2.1901	55.33 ± 1.7647	66.00 ± 1.4609	64.33 ± 1.9037	67.33 ± 1.9765	63.66 ± 1.6983	68.50 ± 1.2253	54.33 ± 1.4977	64.33 ± 2.0274	62.66 ± 2.0426
Lipid	6.62 ± 0.1829	7.41 ± 0.5300	7.85 ± 1.2886	6.67 ± 0.4108	6.93 ± 0.7295	4.69 ± 0.8423	9.52 ± 0.4752	10.33 ± 0.5826	9.09 ± 0.1443	14.19 ± 0.1565	9.10 ± 0.9594	6.00 ± 1.1919
Ash	16.38	10.27	11.48	12.00	5.10	3.98	1.15	1.02	0.08	3.49	1.58	3.02

	Feb 07	Mar 07	Apr 07	May 07	Jun 07	July 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Jan 08
Protein	25.67 ± 1.8903	28.33 ± 1.1156	24.95 ± 1.7182	29.39 ± 1.5464	23.87 ± 1.1665	17.25 ± 0.6066	27.67 ± 1.8828	32.65 ± 1.6819	23.64 ± 1.1885	23.87 ± 1.4698	22.84 ± 1.3883	24.42 ± 1.2450
Carbohydrate	61.99 ± 1.4773	63.17 ± 1.4216	65.66 ± 1.4599	57.99 ± 1.9316	60.66 ± 1.7451	65.19 ± 1.2681	60.73 ± 1.3893	53.66 ± 1.8207	55.20 ± 1.6107	52.99 ± 1.2832	59.66 ± 1.4363	56.33 ± 1.7593
Lipid	10.52 ± 1.5556	6.61± 0.5416	7.35 ± 0.5810	7.30 ± 0.4492	10.49 ± 0.5135	9.44 ± 1.1229	9.75 ± 0.4864	11.98 ± 0.6755	11.06 ± 1.1920	14.58 ± 1.3766	10.87 ± 1.1453	11.96 ± 1.3168
Ash	1.82	1.89	2.04	5.32	4.98	8.12	1.85	1.71	10.1	8.65	6.63	7.29

The carbohydrate content varied between 52.00 and 68.50% in *U. fasciata*, between 43.02 and 67.33 in *C. racemosa*. The highest value observed in Oct. 06 in *U. fasciata*, Aug. 06 in *C. racemosa*. Lowest value noticed in Feb. 06 in *U. fasciata*, Oct. 07 in *C. racemosa* (Table 1&2). The mean value of carbohydrate noticed was 60.28± 1.6359% in *U. fasciata* where as in *C. racemosa* it was 53.02± 1.7601% (Figure 1: A&B). Seasonally highest value was observed in monsoon 06 and monsoon 07 in *U. fasciata* and *C. racemosa* respectively, but lowest value noticed in summer 06 in *U. fasciata*, post-monsoon 06-07 in *C. racemosa* (Table 3&4). The carbohydrate content noticed in *U. fasciata* little higher than the *C. racemosa* in the present study. The higher contents of carbohydrate also noticed in green sea weeds from Indian waters [3, 5, 16, 17, 18, 23, 25, 27]. Carbohydrate contributes relatively largest proportion of the biochemical composition of sea weeds [34, 35]. Comparatively lowest contents of carbohydrate

were also reported in *U. fasciata* and *C. racemosa* [23, 24, 28]. These variations might be attributed to the changes in hydrographic and ecological conditions and reproductive pattern of algae [16].

Table 2: Percentage composition of protein, carbohydrate, lipid and ash content in the dry tissue of *Caulerpa racemosa*

Biochemical Constituents	Feb 06	Mar 06	Apr 06	May 06	Jun 06	July 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07
Protein	25.42 ± 1.7741	26.00 ± 1.1464	20.24 ± 1.4521	20.74 ± 1.2268	20.74 ± 1.2268	19.66 ± 0.6149	17.73 ± 0.7810	29.00 ± 1.5662	26.33 ± 2.6736	19.72 ± 0.9318	27.65 ± 1.7798	31.99 ± 2.1956
Carbohydrate	54.32 ± 2.7786	53.99 ± 2.1913	49.34 ± 2.6168	45.68 ± 2.0303	45.68 ± 2.0303	55.66 ± 1.6648	67.33 ± 1.6044	45.99 ± 2.6248	49.66 ± 2.1532	53.65 ± 1.8187	49.99 ± 1.6332	48.32 ± 2.0912
Lipid	5.40 ± 1.0035	6.97 ± 0.1249	10.68 ± 1.9269	14.28 ± 2.0809	14.28 ± 2.0809	8.28 ± 1.1912	9.74 ± 0.3471	12.25 ± 0.7887	12.53 ± 1.1916	12.83 ± 1.6092	10.98 ± 0.9552	4.31 ± 0.1334
Ash	14.86	13.73	19.74	19.30	19.30	16.40	5.20	12.76	11.48	13.80	15.38	15.38

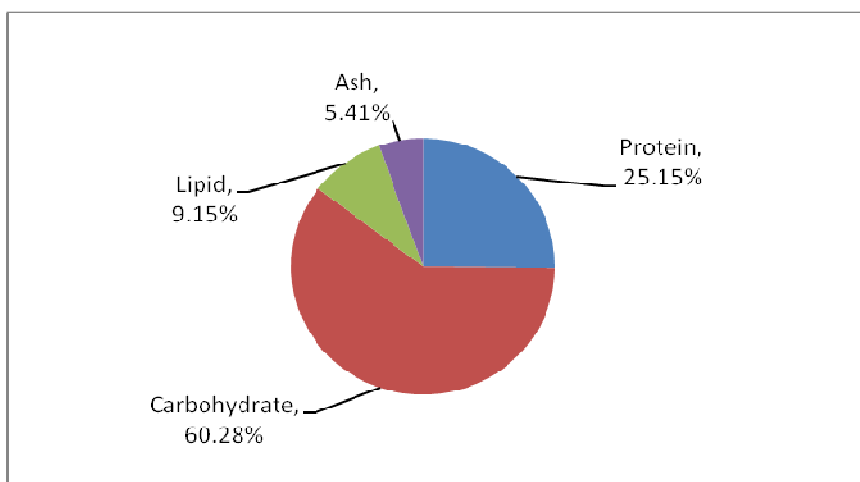
	Feb 07	Mar 07	Apr 07	May 07	Jun 07	July 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Jan 08
Protein	31.90 ± 0.6794	33.33 ± 1.4165	25.66 ± 1.6799	31.33 ± 1.4650	33.29 ± 0.9702	24.20 ± 1.5536	16.99 ± 0.7581	31.33 ± 1.1243	37.04 ± 1.7934	21.35 ± 1.4394	26.66 ± 1.2038	38.48 ± 1.2067
Carbohydrate	55.88 ± 1.5981	52.51 ± 1.4881	52.77 ± 0.8956	45.35 ± 1.8910	47.72 ± 1.2871	57.73 ± 1.3860	64.41 ± 1.5348	53.25 ± 1.7004	43.02 ± 1.6679	63.81 ± 0.7722	56.66 ± 1.3707	49.17 ± 1.1544
Lipid	9.47 ± 1.6391	12.84 ± 1.2373	9.93 ± 1.6823	9.48 ± 1.2975	14.03 ± 1.4368	10.54 ± 1.1367	14.07 ± 1.0945	12.98 ± 1.2341	16.50 ± 0.5662	12.30 ± 0.6526	13.29 ± 1.4065	7.87 ± 1.3776
Ash	2.75	1.32	11.64	13.84	4.96	7.53	4.53	2.44	3.44	2.54	3.39	4.48

The lipid content ranged from 4.69 to 14.58% in *U. fasciata*, where as in *C. racemosa* it was ranged from 4.31 to 16.50%. The highest values noticed in Nov. 07 in *U. fasciata*, but it was Oct. 07 in *C. racemosa* (Table 1&2). The mean value of lipid noticed was 9.15 ± 0.7687 in *U. fasciata*, 10.88 ± 1.1446 in *C. racemosa* (figure 1: A&B). Seasonally highest value observed in post-monsoon 07-08 in *U. fasciata*, monsoon 07 and post monsoon 07-08 in *C. racemosa*. Lowest value noticed in summer 06 in both species (Table 3&4). The lipid content in the two species studied was almost similar. Lipids were present in lower concentrations than carbohydrates and proteins, since sea weeds usually accumulate smaller quantities of fatty acids and lipids [16], but higher content of lipids in green algae might be due to their occurrence together with chlorophyll in chloroplast [16]. The highest value of lipids has also been reported in green algae [16, 17, 23, 24, 27]. Relatively lower values were also noticed in *U. fasciata* and *C. racemosa* [3, 24, 25, 26, 27]. The difference could have been attributed to factors such as climate and geography of development of sea weeds, hydrographic and ecological conditions of the sea water.

The ash content ranged between 0.08 and 16.38% in *U. fasciata*, where as in *C. racemosa* it was ranged between 1.32 and 19.74%. The highest value noticed in Feb. 06 in *U. fasciata*, Apr. 06 in *C. racemosa*. Lowest value noticed in Oct. 06 in *U. fasciata*, Mar. 07 in *C. racemosa* (Table 1&2). The mean values of ash observed were 5.41 ± 1.2206 and 9.58 ± 1.1133 in *U. fasciata* and *C. racemosa* respectively (Figure 1: A&B). Seasonally highest value noticed in summer 06 in both species, lowest value observed in post-monsoon 06-07 in *U. fasciata*, post-monsoon 07-08 in *C. racemosa* (Table 3&4). Ash content noticed in the *C. racemosa* higher than the ash content in *U. fasciata* in the present study. Highest values of ash content were also noticed in green algae [25]. These variations might be due to nutrients in the sea water, land run-off during rainy season and other ecological conditions of the environment.

Figure 1: Percentage composition of protein, carbohydrate, lipid and ash (mean value) in the two species of seaweeds

A. *Ulva fasciata*



B. *Caulerpa racemosa*

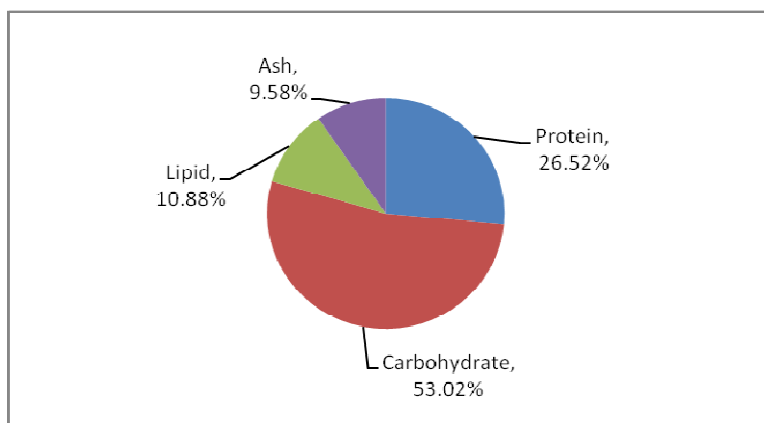


Table 3: Seasonal variations of protein, carbohydrate, lipid and ash content (mean-percentage) in the dry tissue of *Ulva fasciata*

Year	Seasons	Protein	Carbohydrate	Lipid	Ash
2006	Summer	24.75 ±1.1060	55.58 ±1.7070	7.14 ±0.6031	12.53 ± 1.3327
2006	Monsoon	24.01 ±1.7771	65.19 ±1.7599	7.87 ±0.6574	2.79 ± 1.0069
2006-2007	Post - monsoon	25.91 ±1.6488	62.45 ±1.7232	9.46 ±0.6130	2.18 ± 0.7700
2007	Summer	27.09 ±1.5676	62.20 ±1.5726	7.95 ±0.7818	2.77 ±0.8520
2007	Monsoon	25.36 ±1.3344	60.06 ±1.5580	10.42 ±0.6995	4.17 ±1.5191
2007-2008	Post - monsoon	23.69 ±1.3229	56.02 ±1.5223	12.12 ±1.2576	8.17 ±0.7692

Table 4: Seasonal variations of protein, carbohydrate, lipid and ash content (mean-percentage) in the dry tissue of *Caulerpa racemosa*

Year	Seasons	Protein	Carbohydrate	Lipid	Ash
2006	Summer	23.01 ±1.3987	53.58 ±2.4691	8.07 ±1.1039	15.34 ±1.5130
2006	Monsoon	21.78 ±1.0472	53.67 ±1.9811	11.25 ±1.1012	13.41 ±3.0479
2006-2007	Post - monsoon	26.42 ±1.8952	50.40 ±1.9241	10.17 ±0.9723	13.01 ±0.9677
2007	Summer	30.56 ±1.3102	51.63 ±1.4682	10.43 ±1.4640	7.39 ±3.1363
2007	Monsoon	26.45 ±1.1015	55.78 ±1.4770	12.91 ±1.2255	4.87 ±1.0449
2007-2008	Post - monsoon	30.88 ±1.4108	53.17 ±1.2413	12.49 ±1.0007	3.46 ±0.3970

CONCLUSION

The results of the present study concluded that the proteins in two seaweed species studied were almost similar, but carbohydrate content noticed in *U. fasciata* was little higher than that of carbohydrate content in *C. racemosa*. The results of the present study also concluded that the green algae *U. fasciata* and *C. racemosa* are potential health food in human diets and may be used to the food industry as source of nutritive ingredient, because these two sea weeds contains high content of polysaccharides and proteins. Tsunami (2004) did not affect the biochemical constituents of *U. fasciata* and *C. racemosa* distributed along the coastal waters of Visakhapatnam.

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