suggesting that at this temperature (42.7°C) the fish face instantaneous death. It is also evident from Table 1 that the LD_{50} values obtained from the eye fitted curve closely coincide with the values obtained from geometric means suggesting that this method of study would facilitate comparison of thermal tolerance of different species of fish and crustaceans.

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Biochemical Constituents of Seaweeds along the Maharashtra Coast

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Received 28*th April* 1980; *Revised received* 26*th June* 1980

Protein, carbohydrate and organic carbon were estimated in 43 marine algal species from different stations along the Maharashtra coast. These species showed variation in their biochemical contents. Protein varied from 10 to 33%. Chlorophyceae and rhodophyceae members were rich in protein and carbohydrate compared to phaeophyceae. Organic carbon showed maximum average value (33%) in chlorophyceae. C : N ratio varied from 5.2 to 29.8 and showed inverse relationship with protein.

Chemical composition of marine algae like *Ulva* sp. and *Porphyra* sp. has indicated that these species are rich sources of protein, minerals and trace elements[1-4]. Surveys along the west coast of India[5-7] have indicated the non-conventional marine algal resources which can be used as food, feed or fertilizer. Therefore, to find out seaweeds with more nutritive values, efforts have been made to study the major biochemical constituents like carbohydrate, protein and organic carbon in seaweeds collected from the Maharashtra coast.

Marine algae were collected from 11 localities along the Maharashtra coast (Fig.1). The algae were hand picked and washed with seawater followed by freshwater to remove adhering impurities and epiphytes. These were dried in the sun and were again washed with freshwater in the laboratory and then dried in an oven at 80°C to a constant weight. After drying, the seaweeds were powdered in the micro-hammer mill into a fine powder which was used for different analysis. Replicate analysis were carried out for each species.

Nitrogen, carbohydrate and organic carbon were estimated as per methods given earlier[8-10]. Nitrogen was converted to protein using the factor N × 6.25. Using caloric equivalents for protein and carbohydrate, calorific values were calculated[11]. Energy values were also calculated from organic carbon[12]. The number of species analysed at different stations are given in Table 1.

In all 43 species belonging to 25 genera were analysed (Table 2). Protein content of some of the species of *Ulva* was low as compared to the species reported earlier[2]. Dhargalkar[4] reported similar values for *U. reticulata* from Chapora bay, Goa. Chlorophyceae members of Bombay region showed

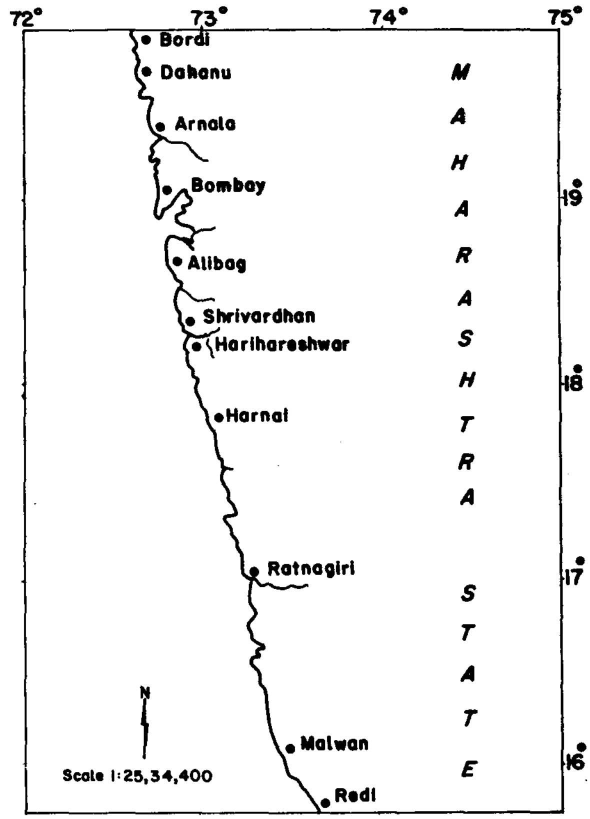

Fig. 1—Stations from where algae were collected

Table 1—Stationwise Analysis of Different Marine Algae

Station	Chlorophyceae	Phaeophyceae	Rhodophyceae
Redi	3	7	2
Malwan	8	9	4
Ratnagiri	6	8	5
Harnai	2	—	—
Shrivardhan	1	—	—
Harihareshwar	5	4	4
Alibag	3	2	3
Bombay	3	—	5
Arnala	3	—	5
Dahanu	2	—	—
Bordi	—	—	1

Table 2—Biochemical Composition and Energy Values of Seaweeds

[All values are expressed on % dry weight basis. Calorific values are expressed in cal/g]

Species	N	Protein	Cal. value	Carbo-hydrate	Cal. value	Organic carbon	Cal. value	C : N
		Chlorophyceae						
Ulva fasciata	2.06	12.88	72.77	47.63	197.66	30.86	4463.72	14.98
U. lactuca	1.73	10.81	67.56	56.17	233.15	32.28	4679.56	18.65
U. reticulata	2.82	17.63	99.61	62.1	257.71	27.4	3937.8	9.71
Enteromorpha intestinalis	3.78	23.62	133.48	53.1	220.35	32.34	4688.68	8.55
E. clathrata	3.14	19.62	110.88	41.9	173.88	26	3725	8.28
E. compressa	4.15	25.94	146.56	50.7	210.4	33.16	4813.32	7.99
Chaetomorpha media	3.25	20.31	114.75	52.8	219.12	34.65	5039.8	10.66
Caulerpa peltata	4	25	141.25	58.75	243.81	34.6	5032.2	8.65
C. sertularioides	2.5	15.62	88.28	46.1	191.32	42.4	6217.8	16.96
C. taxifolia	4.34	27.16	153.45	67.86	281.62	41.4	6065.8	9.54
Cladophora saraceniea	2.31	14.44	81.59	49.75	206.46	32.60	4728.2	14.11
Cladophora sp.	3.73	23.39	131.7	47.6	197.54	—	—	—
Ernodesmis verticillata	3.46	21.62	122.18	32.8	136.12	24.4	3481.8	7.05
Bryopsis hypnoides	4.61	28.81	162.78	56.05	230.6	40.2	5883.4	8.72
Rhizoclonium sp.	2.4	15	84.75	60.4	25.06	37.31	5444.12	15.54
Average		20.12	113.68	52.24	216.8	33.54	4871.08	
		Phaeophyceae						
Padina tetrastromatica	3.01	18.81	106.22	31	128.65	32.29	4681.08	10.72
Dictyota bartayresiana	3.12	19.5	110.17	35.8	148.57	42.78	6275.56	13.71
D. dumosa	4.21	26.31	148.65	34.55	143.38	36.4	5305.8	8.64
D. dichotoma	3.09	19.31	109.1	35.6	147.74	38.6	5643.24	12.49
Dictyopteris australis	4.71	29.44	166.33	32.55	135.08	24.5	3497	5.20
Spatoglossum asperum	3.96	24.76	139.83	35.9	148.99	44.36	6515.72	11.2
Stoechospermum marginatum	3.44	21.5	121.47	42.2	175.13	36.2	5275.04	10.52
Pocockiella variagata	2.05	12.81	72.38	45.8	190.07	37.16	5421.32	18.12
Colpomenia sinuosa	1.6	10	56.5	20.9	86.73	17	2357	10.62
Sargassum ilicifolium	3.04	19	107.35	33.3	138.19	32.4	4697.8	10.66
S. duplicatum	2.82	17.64	43.16	33.3	138.19	36.4	5305.8	12.91
S. plagiophyllum	4.42	27.66	156.28	31.2	129.48	34	4941	7.69
S. weghtii	3.2	20	11.3	46	191.32	31.7	4591.4	9.9
S. tenerrimum	2.56	16	90.4	41.9	173.88	38	5549	14.84
Sargassum sp.	—	—	—	39.2	162.68	38.63	5644.76	—
Sphacelaria furcigera	4.02	25.12	141.96	35.17	145.96	31.66	4585.32	7.88
Average		20.52	115.94	35.89	148.94	34.5	5017	
		Rhodophyceae						
Hypnea musciformis	2.55	15.94	90.06	56.6	234.89	34.6	5032.2	13.56
Hypnea sp.	2.67	16.66	94.13	51.89	214.97	—	—	—
Gracilaria corticata	3.9	24.37	137.71	71.03	294.77	33.9	4925.8	8.69
G. verrucosa	4.22	26.37	149.02	75.3	312.5	38.8	5670.6	9.19
G. foliifera	—	—	—	61.75	256.26	37.8	5518.6	—
Grateloupia filicina	3.73	23.33	131.81	61	253.13	32.8	4758.6	8.79
G. lithophila	—	—	—	36.9	153.13	38	5549	—
Acanthophora specifera	—	—	—	69.4	288.01	34.6	5032.2	—
Chondrococus sp.	3.6	22.5	127.12	63.25	262.48	34.8	5062.6	9.66
Centroceras clavulatum	3.9	24.37	137.72	52.7	218.70	33.16	4813.32	8.5
Caloglossa leprieurii	3.43	21.44	121.14	28.06	116.45	19.8	2782.6	5.77
Chondria sp.	5.28	33	186.45	51.1	212.06	—	—	—
Average		23.1	130.52	56.65	235.09	33.82	4913.64	

comparably high value of protein which might be due to the effect of organic waste in the waters. In pheophyceae, *Dictyopteris australis*, *Colpomenia sinuosa* and *Sargassum* sp. showed higher values of protein as compared to the values reported earlier[2].

Rhodophyceae members showed higher protein values than the chlorophyceae and phaeophyceae members (Table 2). *Gracilaria* sp. showed high protein content than the values reported by Rao and Tipnis[2] from Gujarat coast while *Grateloupia filicina* showed low protein values (23.3%) than the values reported by Lewis[6] for *G. lithophila* from Bombay coast. protein content of *Caloglossa leprieurii* was higher than the values reported for the same species from mangrove swamp of Goa[13].

Protein content varied among the different genera and also different species of same genus (Table 2). Protein content in the same species, but collected from different localities and in different seasons, showed fluctuating values, as reported earlier[14].

Maximum carbohydrate (28-75.3%) was recorded in rhodophyceae. In the present investigation, some of the chlorophyceae members like *Ulva* sp., *Bryopsis* sp. showed high carbohydrate content which might be because of high phycocolloid content present.

Calorific values calculated from organic carbon were higher than those calculated from protein and carbohydrate (Table 2). Calorific values in chlorophyceae were comparatively lower than other 2 groups (Table 2). In some of the species calorific values were higher which may be due to the fact that plants collected for biochemical analysis might have reproductive or fertile tissue having higher energy values[15]. C : N ratio showed inverse relationship with protein and organic carbon values (Table 2).

Taking into consideration the ever growing demand of proteinaceous food for human consumption and for other purposes, it is essential to locate the non-conventional resources with nutritional value. In this context, the biochemical studies of the marine algae found along the Maharashtra coast indicate that at least some species could probably be utilized as an additional source of protein. These selected marine algal species, if proved fit for consumption, could be cultivated on large scale.

The authors thank Drs. S Z Qasim and T S S Rao for correcting the manuscript. Thanks are also due to Shri V V Agadi for his help. One of the authors (TGJ) is thankful to CSIR for awarding the fellowship.

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Chemical Composition of Leaves of *Avicennia officinalis* Linn. & *A. marina* var. *acutissima* Stapf & Moldenke

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Received 21 *April* 1980; *revised received* 21 *May* 1980

A. marina, found on the seaward fringe of the vegetation, has more Na and Cl content in the leaves. It maintains the level of K, which helps in increasing salt tolerance. *A. marina* also has P and carbohydrate levels high. *A. marina*, a pioneer species in the mangrove zonation, is more tolerant to salinity compared to *A. officinalis*. *A. marina* shows more chlorophylls and carbohydrates indicating that in spite of more salts in metabolic environment it is better adapted and is therefore found towards more saline environment.

Avicennia officinalis and *A. marina* var. *acutissima* which belong to salt excreting type of mangroves are found at Bhatya creek, south of Ratnagiri city (17°0′ N and 73°3′ E). The vegetation starts with *A. marina* while *A. officinalis* is found towards the interior of mangrove stand. It will be of interest to investigate physiology of *A. marina* under strongly saline environment to understand its occurrence as pioneer species and to compare it with *A. officinalis* found in the same stand.

Green mature leaves of *A. officinalis* and *A. marina* along with the supporting soil and water samples were collected from Bhatya creek during October at high tide. The leaves, collected from 3-4 plants, were randomly selected for analyses. Three replicates were used for each analysis. The organic constituents were estimated from fresh material and oven dried (60°C) material was used for mineral constituents. Na, K and