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Nutritive Properties of the Chorophyceae Seaweeds Available at Gulf of Kutch, Gujarat, India

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ABSTRACT

Nutritive properties (Protein, Lipid, Carbohydrate, Free amino acid, vitamin-C and calorific value on dry weight basis) were estimated in 18 species of chlorophyceae group of seaweeds collected from the Gulf of Kutch, Gujarat during the post monsoon season in the year 2015. Higher concentration of protein was recorded in Entromorpha compressa (15.5 ± 0.8 mg g^{-1} DW). While lipid content were higher in Caulerpa racemosa (1.83 ± 0.4) and carbohydrate contents were estimated higher in Entromorpha compressa (54.6 ± 0.7 mg g^{-1} DW). The highest total amino acid and vitamin-C content were observe in Entromorpha compressa with 15.73 ± 0.47 mg g^{-1} DW and 3.23 ± 0.23 mg g^{-1} DW showed the lowest as well as highest values for vitamin-C concentration. Among all the species studied, Caulerpa taxifolia and Caulerpa racemosa showed higher calorific value (95.60 Kcal/100 g).

Key words: *Chorophyceae, Nutritive properties, Calorific value, Vitamin-C, Gulf of Kutch*

INTRODUCTION

Seaweeds refer to any large marine benthic algae that are multicellular, macrothallic, and thus differentiated from most algae that are of microscopic size. These plants form an important renewable resource in the marine environment and have been a part of human civilization from time immemorial. Reports on the uses of seaweeds have been cited as early as 2500 years ago in Chinese literature[16].

Seaweeds have been used since ancient times as food, fodder and fertilizer and as sources of medicinal drugs. Today, seaweeds are used as the raw material for industrial production of agar, carrageenan and alginates, but they continue to be widely consumed as food in Asian countries[7]. They are nutritionally valuable as fresh or dried vegetables, or as ingredients in a wide variety of prepared foods[11]. In particular, certain edible seaweeds contain significant quantities of lipid, protein, vitamins and minerals[8,13,18]. These seaweeds are of nutritional interest as they contain low calorie food, but rich in vitamins, minerals and dietary fibers[3]. In addition to that, seaweeds are also potentially good sources of proteins, polysaccharides and fibers[4]. The lipids which are present in seaweed are in very small quantity.

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MATERIALS AND METHODS

18 species of Chlorophyceae group of seaweeds collected from the Gulf of Kutch, Gujarat (Fig.1) during the post-monsoon season in 2015. All the species were identified by referring the taxonomic keys of Umamaheswara Rao[17]. The seaweed materials were transported to the laboratory using insulated ice-box. All the species were shade dried and powdered using grinding mill. The powdered samples were stored in polythene bags in refrigerator for analysis.

The nutritive properties in terms of protein, lipid, carbohydrate and vitamin-C of the seaweeds were estimated using standard methods. The protein content was estimated with Folin-ciocalteu reagent using bovine albumin as the standard[5]. The lipid content was estimated gravimetrically[2] by extracting lipid using chloroform-methanol mixture. The carbohydrate content was estimated by phenol-sulphuric acid method[1] and the values were calculated referring to the glucose standard curve. Vitamin-C content was estimated following Roe and Keuther[12] method. While the calorific values were calculated by the following formula using caloric equivalents of proximate compounds estimated.

Cal (Kcal/100g)= 4 x Protein(%) + 9 x Lipid(%) + 4 x Carbohydrate(%)

Fig. 1: Map showing the seaweed collection site

RESULTS

Altogether 18 species of class Chlorophyceae were recorded from two station of Gulf of Kutch, i.e. Okha and Beyt Dwarka (Table-1). The results obtained for the concentration of protein, lipid, carbohydrate and vitamin-C in the Chlorophyceae are given in Table-2 and Figs. 1 to 3. In general, the concentration of protein, carbohydrate, lipid and vitamin-C in all the species, ranged from 6.0 ± 0.21 to 15.53 ± 1.47; 54.63 ± 2.17 to 23.07 ± 0.42; 1.83 ± 0.41 to 0.5 ± 0.1 and 3.23 ± 0.98 to 0.42 ± 0.07.

Table 1: List of seaweed collected from two different collection sites of Gulf of Kutch

No.	Name of Species	Station	
		Okha	Beyt Dwarka
1	*Boodlea composita* (Harvey) Brand	++	+
2	*Bryopsis plumosa* (Hudson) C. Agardh	-	++
3	*Caulerpa racemosa* (Forsskål) J. Agardh	+++	+
4	*Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh	+++	+
5	*Caulerpa sertularioides* (S. Gmelin) Howe f. brevipes	+++	++
6	*Caulerpa taxifolia* (Vahl) C. Agardh	+	++
7	*Caulerpa veravalensis* Thivy & Chauhan	++	+
8	*Chaetomorpha crassa* (C. Agardh) Kützing	-	+
9	*Cladophora glomerata* (Linnaeus) Kützing	+	-
10	*Codium dwarkense* Børgesen	-	+++
11	*Codium elongatum*	+	-
12	*Enteromorpha compressa*	++	-
13	*Enteromorpha prolifera*	-	+
14	*Halimeda tuna* (Ellis & Solander) Lamouroux	++	+
15	*Udotea indica* A. & E. Gepp.	+++	+
16	*Ulva fasciata* Delile	+++	+
17	*Ulva lactuca* Linnaeus	+++	+
18	*Ulva reticulate*	+++	+

+ = Present, ++ average abundant, +++ abundant; - = Absent

Table 2: Nutrient composition of seaweed collected from Okha and Beyt Dwarka (mg/g DW)

No.	Name of Species	Protein	Lipid	Carbohydrate	Free Amino acid	Vit-C	Calorific value
1	*Boodlea composita*	8.48 ± 0.86	1.55 ± 0.41	26.25 ± 1.56	11.15 ± 0.65	1.25 ± 0.52	31.17 ± 1.14
2	*Bryopsis plumosa*	9.65 ± 0.57	1.23 ± 0.21	23.12 ± 1.69	12.19 ± 0.74	1.11 ± 0.24	69.25 ± 3.48
3	*Caulerpa racemosa*	12.3 ± 1.22	1.12 ± 0.11	24.23 ± 2.13	14.13 ± 1.08	0.99 ± 0.33	92.97 ± 5.97
4	*Caulerpa scalpelliformis*	14.83 ± 0.44	1.83 ± 0.4	24.6 ± 2.1	11.9 ± 0.96	1.02 ± 0.21	92.97 ± 7.66
5	*Caulerpa sertularioides*	14.77 ± 1.01	1.67 ± 0.25	28.13 ± 0.85	11.17 ± 1.2	1.27 ± 0.17	18.09 ± 1.21
6	*Caulerpa taxifolia*	11.27 ± 0.21	1.37 ± 0.38	23.97 ± 0.81	10.87 ± 0.98	0.92 ± 0.09	1.19 ± 0.87
7	*Caulerpa veravalensis*	14.9 ± 1.00	1.73 ± 0.35	26.17 ± 0.42	10.77 ± 0.88	1.06 ± 0.24	69.05 ± 2.47
8	*Chaetomorpha crassa*	7.87 ± 1.18	1.47 ± 0.25	29.47 ± 1.42	11.93 ± 1.11	1.08 ± 0.19	17.93 ± 1.24
9	*Cladophora glomerata*	9.55 ± 1.14	0.65 ± 0.21	27.65 ± 2.15	9.88 ± 0.69	1.27 ± 0.11	8.21 ± 0.88
10	*Codium dwarkense*	7.73 ± 0.42	0.57 ± 0.15	43.15 ±1 .35	10.93 ± 1.21	1.97 ± 0.21	23.13 ± 1.27
11	*Codium elongatum*	6.00 ± 0.26	1.6 ± 0.26	42.47 ± 0.59	8.6 ± 0.87	1.57 ± 0.24	2.49 ± 0.22
12	*Enteromorpha compressa*	15.5 ± 0.79	0.83 ± 0.32	54.63 ± 1.35	15.73 ± 1.23	3.23 ± 0.98	19.41 ± 1.21
13	*Enteromorpha prolifera*	15.53 ± 0.96	0.5 ± 0.1	52.57 ± 0.61	12.37 ± 1.51	2.1 ± 0.87	37.21 ± 1.27
14	*Halimeda tuna*	11.65 ± 1.22	0.59 ± 0.14	36.14 ± 2.17	10.15 ± 1.21	0.42 ± 0.07	20.69 ± 1.54
15	*Udotea indica*	13.44 ± 1.47	0.98 ± 0.19	29.88 ± 1.87	11.68 ± 0.99	1.23 ± 0.27	2.45 ± 0.22
16	*Ulva fasciata*	7.4 ± 0.56	0.65 ± 0.35	48.57 ± 0.99	16.1 ± 1.28	1.02 ± 0.21	7.33 ± 0.98
17	*Ulva lactuca*	8.83 ± 0.51	1.03 ± 0.15	23.07 ± 0.91	16.07 ± 1.87	0.98 ± 0.11	52.33 ± 1.87
18	*Ulva reticulate*	10.17 ± 0.55	1.6 ± 0.26	25.57 ± 1.22	15.83 ± 2.11	0.93 ± 0.14	44.13 ± 3.47

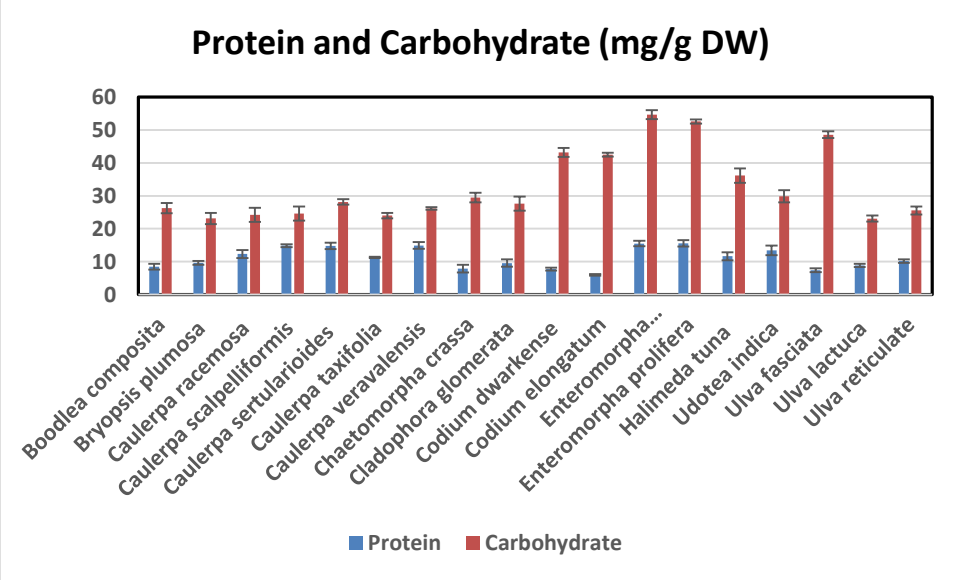

Fig. 2: Protein and Carbohydrate content of seaweed collected from Okha and Beyt Dwarka

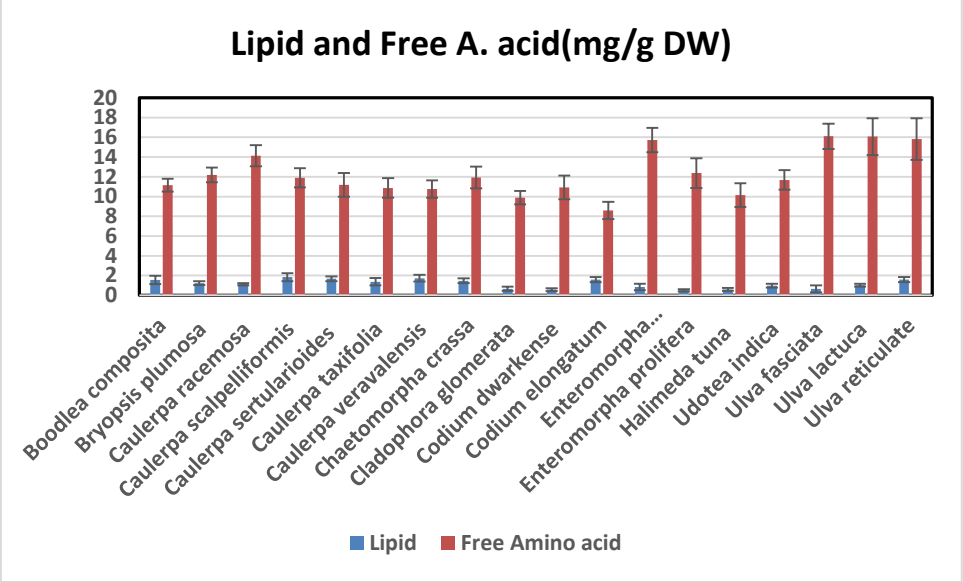

Fig. 3: Lipid and Amino acid content of seaweed collected from Okha and Beyt Dwarka

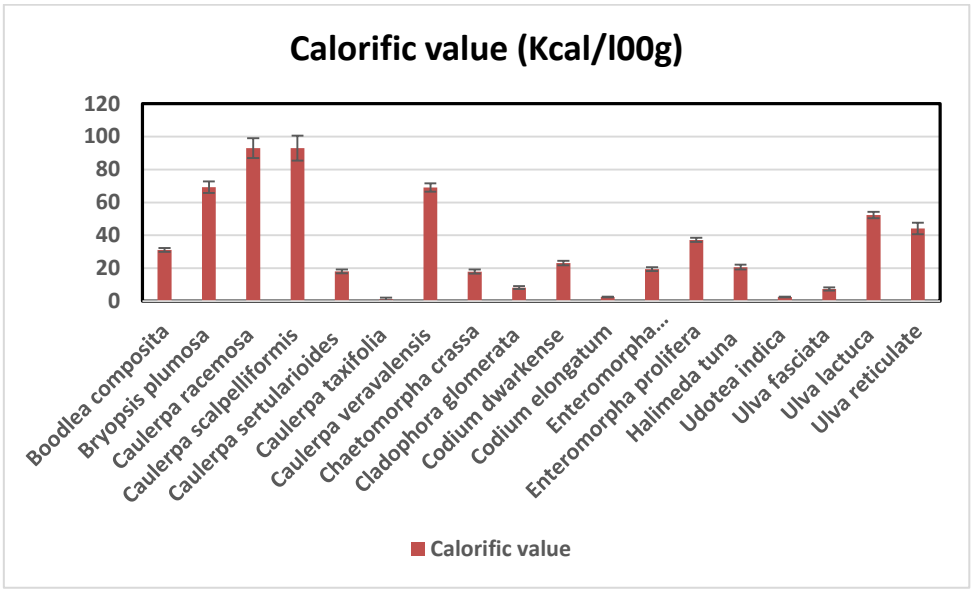

Fig. 4: Calorific value of seaweed collected from Okha and Beyt Dwarka

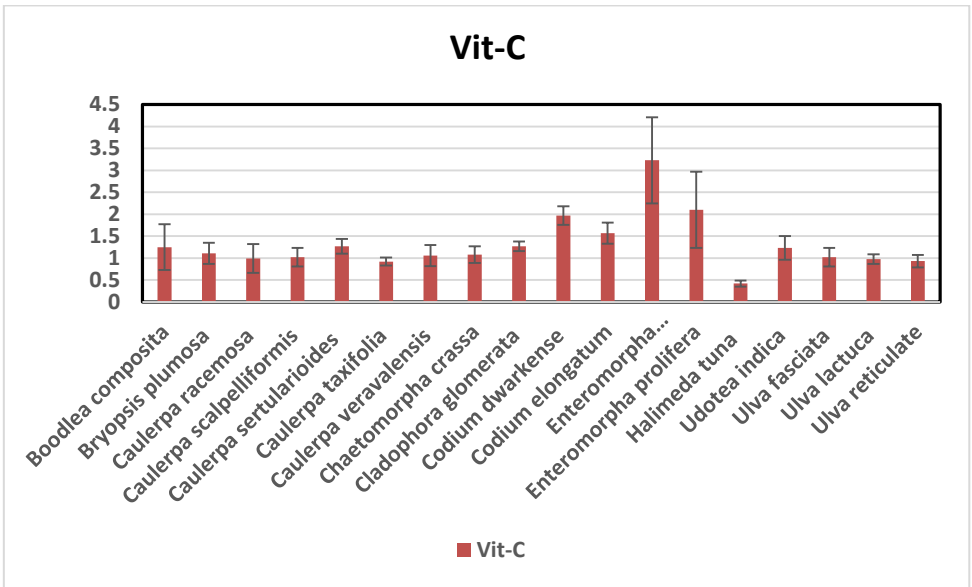

Fig. 5: Vitamin-C content of seaweed collected from Okha and Beyt Dwarka

Diversity survey

The results obtained from the diversity survey at both the site (i.e. Okha and Beyt Dwarka) are shown in Table-1. Altogether 18 species of Chlorophyceae were documented from both the Site. In general, Okha site has exhibited higher abundance of *Caulerpa racemosa*, *Caulerpa scalpelliformis* and *Caulerpa sertularioides.* While moderate/average abundance were observing in *Boodlea composita*, *Caulerpa veravalensis*, *Enteromorpha compressa* and Halimeda *tuna.* All the species of *Ulva* and *Udotea* was found to be highly abundant at the Okha coast.

On the other hand, collection site Beyt Dwarka has exhibited presence of 15 Chlorophyceae species. Only one species, *Codium dwrakense* was abundantly available during the survey. While *Caulerpa sertularioides* and *Caulerpa taxifolia* were moderately available.

Nutritive properties

The results obtained for the concentration of protein, lipid, carbohydrate, free amino acid, Vitamin-C and calorific values of the collected seaweeds are shown in the Table-2 (Fig. 2,3,4, & 5).

The protein content ranged from highest 15.53 $\pm$ 0.96 mg/g DW (in *Enteromorpha prolifera*) to 6.0 $\pm$ 0.26 mg/g DW (in *Codium elongatum*).

Lipid content ranged from highest 1.83 $\pm$ 0.41 mg/g DW (in *Caulerpa scalpelliformis*) to 0.5 $\pm$ 0.1 mg/g DW (in *Enteromorpha prolifera*).

Carbohydrate content ranged from highest 54.63 $\pm$ 1.35 mg/g DW (in *Enteromorpha compressa*) to 23.07 $\pm$ 0.91 mg/g DW (in *Ulva lactuca*). While free amino acid ranged from highest 16.10 $\pm$ 1.28 mg/g DW (in *Ulva fasciata*) to 8.6 $\pm$ 0.61 mg/g DW (in *Codium elongatum*).

Vitamin-C content was ranged from highest 3.23 $\pm$ 0.98 mg/g DW (in *Enteromorpha compressa*) to 0.42 $\pm$ 0.07 mg/g DW (in *Halimeda tuna*). While, calorific value ranged from highest 92.97 $\pm$ 7.66 mg/g DW (in *Caulerpa racemosa*) to 1.19 $\pm$ 0.87 mg/g DW (in *Caulerpa taxifolia*).

In the present study, it was observed that the seaweeds with higher concentration of carbohydrate showed lesser amount of protein and vice versa. The Protein content was found higher in genus *Enteromorpha*, *Ulva* and *Helimada*.

DISCUSSION

The values of protein and carbohydrate contents obtained in the present study are similar to the earlier findings by Sukran Dere *et a1*[15]., Marcia de Padua *et al*[6]., and Nada Kolb *et al*[9].

It is found that the percentage of carbohydrate content is higher in genus *Enteromorpha* followed by *Caulerpa* as reported earlier by Stella Roslin[14].

The higher value of vitamin-C reported in the *Enteromorpha* conforms to the earlier reports of higher values (<3.0 mg/g DW) of vitamin-C in the green seaweeds[10]. The vitamin- C content reported in the seaweeds are comparable to the concentration of vitamin-C in most of the common terrestrial vegetables and consumed.

The differences observed for the nutritive properties of seaweeds in the present study may be due to the prevailing ecological factors in this ecosystem. The present study reveals that, these seaweeds may be used in the food and pharmaceutical industry for various purposes. The amount of vitamin-C content varied with varying concentrations of carbohydrate in the species studied.

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