Abstract: The aim of the present study was to concentrate on different group of seaweeds like green (Ulva reticulata, Enteromorpha compressa, Cladophora glomerata, Halimeda macroloba and Halimeda tuna) brown (Dictyota dichotoma, Turbinaria ornata and Padina pavonica) and red (Gelidiella acerosa, Gracilaria crassa and Hypnea musciformis) were collected from Vedalai coastal waters, Southeast coast of India for analyzed proximate composition. The protein content was recorded maximum in G. acerosa and minimum in D. dichotoma; carbohydrate level was observed in T. ornata and minimum in P. pavonica. The lipid content was acquired higher level in H. tuna and minimum in H. macroloba.

Key words: Proximate composition • Various group of seaweeds • Vedalai coastal waters and Southeast coast of India

INTRODUCTION

Seaweeds are marine macro algae and primitive type of plants, growing abundantly in the shallow waters of sea, estuaries and backwaters. They flourish wherever rocky, coral or suitable substrata are available for their attachment. They belong to three groups namely green, brown and red based on pigmentation, morphological and anatomical characters.

Seaweeds have been used since ancient times as food, fodder, fertilizer and as source of medicinal drugs, today seaweeds are the raw material for industrial production of agar, algin and carrageenan but they continue to be widely consumed as food in Asian countries [1]. They are nutritionally valuable as fresh or dried vegetables, or as ingredients in a wide variety of prepared foods [2]. In particular, certain edible seaweeds contain significant quantities of lipids, protein, vitamins and minerals [3-5], although nutrient contents vary with species, geographical location, season and temperature [6, 7].

The seaweeds show great variation in the nutrient contents, which are related to several environmental factors as water temperature, salinity, light and nutrients [8]. Most of the environmental parameters vary according to season and the changes in ecological conditions can stimulate or inhibit the biosynthesis of several nutrients [9]. The nutritional properties of seaweeds are poorly known and normally are evaluated from the chemical composition [10]. In the context, the chemical composition (protein, carbohydrate, lipids, fiber, ash and nitrogen) of two seaweeds (Gracilaria cervicornis and Sargassum vulgare) from North-east Brazil was investigated in order to evaluate their potential nutritive value.

Seaweeds are traditionally consumed in the orient as part of the daily diet. Currently, human consumption of green algae (5%), brown algae (66.5%) and red algae (33%) is high in Asia, mainly Japan, China and Korea [8]. However demand for seaweed as food has now also extended to North America, South America and Europe. The different species consumed present a great nutritional value as source of proteins, carbohydrates, minerals and vitamins.

Extensive works were carried out by Lewis and Gonazalves [11-15]; Lewis [16-21] on aminoacids present in free state on protein and peptide hydrolysates in many green, brown and red seaweeds. The considerable amount of work on the volatile components, biochemical composition, proteins, amino acids, nutritive values, fats, lipids, vitamins and mineral composition of different species of Enteromorpha have been reported [22, 23].

Seasonal variation of carbohydrate, protein and lipid in seaweeds has been carried out from different localities of southeast coast of India [24-26]. Studies of fatty acids in seaweeds have investigated their seasonal variation [27, 28]. Kaliaperumal et al. [26] observed the seasonal variation in growth and biochemical constituents such as protein, carbohydrate and lipid in Hypnea valentiae,
Acanthophora spicifera, Laurencia papillosa, Enteromorpha compressa, Ulva lactuca and Caulerpa racemosa. Sukran et al. [29] has studied 12 taxa (175 species) from the Chlorophyta, Phaeophyta and Rhodophyta collected from different depths at Gemlik-Karacaali and Erdek-Ormanlı for total protein, total soluble carbohydrate, chlorophyll a, chlorophyll b, chlorophyll c and carotenoid contents. Poppy Mary Vimalalai [30] was analyzed carbohydrate and vitamin-C from monthly samples of 26 species of macro algae collected from the intertidal habitats of Tuticorin coast. Hannah Vasanthi and Rajamanickam [31] studied the chemical analysis of the red algae Hypnea valentiae, a carrageenan yielding seaweed collected from Tuticorin and Mandapam coasts in the Gulf of Mannar region was carried out for proteins, carbohydrates, lipids, fats and water soluble vitamins and the major, minor and trace mineral elements. The fatty acid profile of selected seaweeds namely Ulva reticulata, Padina boergeseni, and Hypnea valentiae were estimated using gas chromatography by Hannah Vasanthi et al. [32].

Seaweeds belonging to the Rhodophyta possess high levels of proteins (10–30% DW) [33]. In some red seaweeds, such as Palmaria palmata (L.) Kuntze (dulse) and Porphyra tenera Kjellman (nori), the protein contents are 35 and 47% DW, respectively [34]. These levels are even comparable to that of the soybeans (35% DW).

However, only a few studies have been undertaken on the quality of seaweed protein [35-37] because of the difficulties of extraction and preparation of seaweed protein concentrates (PCs). The extraction of seaweed protein by classical procedures is hindered by the presence of large amounts of cell wall polysaccharides, such as the alginites of the brown seaweed or the carrageenans of some red seaweed. The present study endeavor on variation of proximate (9.65 ± 0.92) followed by seaweed protein concentrates (PCs). The protein content was ranged from 9.65 ± 0.92 to 31.07 ± 0.33%; higher protein was found in G. acerosa (31.07±0.33%) followed by H. macroloba (28.94±0.68%), H. tuna (23.12±0.86) and C. glomerata (20.38 ± 0.73%). The lower value of protein content was ranged from 9.65±0.92 followed by E. compressa (12.27 ± 0.88), U. reticulata (13.47 ± 0.60%) and P. pavonica (13.63 ± 0.43%) Fig 1.

The carbohydrate concentration of different seaweeds ranged from 14.73 ± 0.07 to 17.49 ± 1.18%, in that the highest carbohydrate concentration was recorded from brown seaweed T. ornata (17.49 ± 1.18%) followed by green alga H. macroloba (17.20 ± 0.71%), H. tuna (17.12 ± 0.44%), G. crassa (17.07 ± 0.75%), E. compressa (17.0 ± 0.65%) and red seaweed G. acerosa (16.62 ± 0.75%). The lowest value of carbohydrate content was observed from brown seaweed P. pavonica (14.73±0.07%) followed by C. glomerata (14.83±0.61%), U. reticulata (15.37 ± 0.41%) and D. dichotoma (16.86 ± 0.97%) Fig 2. The lipid content of seaweeds ranged from 0.26 ± 0.07 to 3.53 ± 0.25; in that the maximum lipid content was recorded from green alga

**Preparation of Seaweed Powder:** The seaweeds were collected from Vedalai coast Gulf of Mannar Marine Biosphere Reserve, southeast coast of India near Mandapam. The seaweed was shade dried and then kept in an oven 60°C for 4hrs dried seaweeds was ground to make powder approximately 10g of seaweeds powder was obtain form 1 kg of raw seaweeds.

**Protein Estimation:** The total protein was estimated using the Biuret method of Raymont et al., [38].

**Lipid Estimation:** The extraction of lipid was done by the chloroform-methanol mixture Folch et al., [39].

**Carbohydrate Estimation:** The total carbohydrate was estimated by following the Phenol-sulphuric acid method of Dubois et al. [40].

**RESULTS**

Eleven species of seaweeds belongs to 5 species like Enteromorpha compressa, Ulva reticulata, Cladophora glomerata, Halimeda macroloba and Halimeda tuna from green seaweeds (Chlorophyceae); 3 species from brown seaweeds (Phaeophyceae) such as Dicryota dichotoma, Padina pavonica and Turbinaria ornata; 3 species (Gelidiella acerosa, Gracilaria crassa and Hypnea musciformis) from Rhodophyceae (Red algae) collected from Vedalai coastal waters, southeast coast of India for proximate composition analysis.

The protein content was ranged from 9.65 ± 0.92 to 31.07 ± 0.33%; higher protein was found in G. acerosa (31.07±0.33%) followed by H. macroloba (28.94±0.68%), H. tuna (23.12±0.86) and C. glomerata (20.38 ± 0.73%). The lower value of protein content was ranged from 9.65±0.92 followed by E. compressa (12.27 ± 0.88), U. reticulata (13.47 ± 0.60%) and P. pavonica (13.63 ± 0.43%) Fig 1.

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**MATERIALS AND METHODS**

**Collection of Seaweeds:** Different species of seaweed (Chlorophyceae, Phaeophyceae and Rhodophyceae) was collected from Vedalai coastal waters (Gulf of Mannar); southeast coast of India. Collected seaweed was washed thoroughly with seawater to remove all the unwanted impurities, adhering sand particles and epiphytes. Then the sample was washed thoroughly using tap water to remove all the salt on the surface. The water was drained off and the seaweed was spread on blotting paper to remove excess water.
Fig. 1: Shows the protein concentration of different seaweeds

Fig. 2: Shows the carbohydrate concentration of different seaweeds

Fig. 3: Shows the lipid concentration of different seaweeds

*H. tuna* (3.53 ± 0.25%) followed by red seaweed *G. crassa* (1.99 ± 0.12%), *G. acerosa* (1.94 ± 0.06%) and brown seaweed *T. ornata* (1.67 ± 0.14%). The minimum lipid concentration was recorded from green seaweed *H. macroloba* (0.26 ± 0.07%) followed by the same green seaweed *E. compressa* (0.81 ± 0.07%) and *C. glomerata* (1.1 ± 0.16%) proteins, carbohydrates, fat, crude-fibre, sodium, potassium, calcium and phosphorus contents of

**DISCUSSION**

The biochemical contents of *Ulva lactuca*, *Sargassum wightii* and *Gelidiella acerosa* from Port Okha were studied in relation to ecological factors by Murthy and Radia [41]. They presented the month-wise proteins, carbohydrates, fat, crude-fibre, sodium, potassium, calcium and phosphorus contents of
these species. Dhargalkar [42], estimating the major metabolites such as proteins, carbohydrates, lipids, found carbohydrate is decreasing in Ulva reticulata in December, probably due to the extensive growth of the thallus. Protein values also followed the same trend while lipids did not show any significant seasonal variation. Marked changes in the chemical constituents were found to occur with change of seasons, environmental conditions as well as in the various phases of plants growth and fruiting cycle. In Central Marine Fisheries Research Institute studies were carried out on the chemical composition of the marine algae growing in the vicinity of Mandapam [43-46]. The present investigation is almost related to earlier study; here the proximate composition is varied within and between the species.

Poppy Mary Vimalabai [30] was analyzed carbohydrate and vitamin-C from monthly samples of 26 species of macro algae collected from the intertidal habitats of Tuticorin coast. Hannah Vasanthi and Rajamanickam [31] studied the chemical analysis of the red algae Hypnea valentiae, a carrageenan yielding seaweed collected from Tuticorin and Mandapam coasts in the Gulf of Mannar region was carried out for proteins, carbohydrates, lipids, fats and water soluble vitamins and the major, minor and trace mineral elements. The fatty acid profile of selected seaweeds namely Ulva reticulata, Padina boergesenii and Hypnea valentiae were estimated using gas chromatography by Hannah Vasanthi et al. [32]. The present study is contrast to earlier studies; here only concentrates proximate composition of within and between the species level from only one locality and same time which does not focused the seasonal variation.

Studies on the biochemical constituents such as protein, carbohydrate and lipid in green and brown marine algae have been carried out from different parts of Indian coast [47-51], biochemical studies of protein, amino acids, carbohydrate and iodine on three species like Sargassum ilicifolium, S. linearifolium and S. polycystum. Reeta Jayasankar [52] studied the seasonal variation in chemical constituents of S. wightii with reference to alginic acid content has been reported. Amino acids in free and combined state have been quantitatively estimated in three species of green algae viz., Halimeda tuna, Spongomorpha indica and Udotea indica collected from Okha Port by Dave and Parekh [53]. Some biochemical investigations on economically important species have been carried out [54-56].

In the present study protein contents different species of seaweeds ranged from 9.65±0.92 to 31.07±0.33% which is entirely contrast to the earlier works in several marine algae estimated by Chidambaram and Unny [57]; Sitakara Rao and Tipnis (58, 59). Species of Sargassum, Turbinaria and Gracilaria were analyzed by Chidambaram and Unny [57], the protein content was found to be less than 10%. Whereas in Acanthophora muscoides and Centroceras clavulatum it was estimated as 22-26%. Dave and Parekh [60]studied 8 genera of green algae of Saurashtra coast, found significant variation in protein in same species of algae grown in different localities and different periods.

In the present investigation is dissimilar to the earlier study of Solimbi et al. (1980) studied the biochemical constituents namely carbohydrate of Hypnea musciformis from Goa coast. Carbohydrate varied from 31% to 50% the present study exhibit 14.73±0.07 to 17.49±1.18%. According to the results obtained in this present investigation, the protein, lipid and carbohydrate level was optimum. Although the results of chemical composition of seaweed analysis had demonstrated that can be potentially good and same time more study is necessary to evaluate the nutritional value of this seaweed as food ingredients.

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