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Nutritional Evaluation of three Marine Macroalgae on the Coast of Kanyakumari District

P. Mary Saroja*

Department of Chemistry, Holy Cross College (Autonomous), Nagercoil – 629004, Tamil Nadu, India

*Corresponding Author E-mail: pmarysaroja@gmail.com

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ABSTRACT

The nutritional evaluation of carbohydrate, protein and lipid in three selected seaweed (marine macroalgae) species such as Ulva lactuca, Sargassam wightii and Gracilaria edulis from Muttom and Kanyakumari coasts of Kanyakumari district was determined. The samples were collected in two seasons, pre monsoon (Aug. 2015) and post monsoon season (Dec. 2015). The carbohydrate content of three seaweeds varied from 49.2 ±3.2% dw to 33.6 ±1.6% dw. The protein content of the selected seaweeds ranged from 21.9 ± 1.4% to 11.2 ± 0.3 % dw. The level of lipid of the three seaweeds varied from 2.6 ± 0.4% dw to 0.8 ± 01% dw. Among the three seaweeds, U. lactuca contained higher amount of carbohydrate (49.2 ±3.2% dw) and protein (21.9 ±1.4% dw) however G. edulis possessed maximum lipid (2.6 ±0.4% dw). The study of seasonal variation showed that the best season for harvesting seaweeds for food is pre monsoon season. The carbohydrate and lipid content are found maximum in the samples from Muttom coast and protein content is found maximum in the samples from Kanyakumari coast.

Key words: *Ulva lactuca, Sargassam wightii,Gracilaria edulis, Nutritional evaluation, Season*

INTRODUCTION

Marine macro algae or seaweeds are plant-like organisms that generally attached to rock or other hard substrate in coastal areas. Generally the seaweeds are found in the marine eco-system in varying densities depending upon the adaptability of the species to the specific environment. They are good sources of proteins, carbohydrates, vitamins and minerals in human nutrition. They are nutritionally valuable as fresh or dried vegetables, or as ingredients in wide prepare foods[1]. The seaweeds are also known to contain bioactive products that display antibacterial, antiviral and antifungal properties[2]. Seaweeds are the raw material for many industrial productions like agar-agar, alginate derivatives and carrageenan but they continue to be widely consumed as food in Asian countries[3]. Nutrientcontent of seaweeds vary with species, geographical location, season, humidity and temperature[4]. Seaweeds are also considered as low calorie foods with high contents of minerals, vitamins, proteins and carbohydrates. Being rich in minerals, vitamins, traceelements and bioactive potential substances, seaweeds are also called medical food for the 21st century[5]. Seaweeds can also be used to prepare seaweed meals as supplementary to the daily ration of the cattle, poultry and other farm animals[6].

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It has been established that seaweed meal increases fertility and birth rate of animals and also improves yolk colour in eggs.

The changes in ecological conditions have an influence on the synthesis of nutrients[7]. Studies on the chemical composition of seaweeds have shown that these are good sources of minerals, trace elements, proteins, lipids and carbohydrates[8,9]. Seaweed collections are mainly centered along the southeastern coast of India from Rameswaram to Kanyakumari[10]. Studies of seasonal variation in the chemical composition of some red and brown seaweed have been investigated in previous studies of *Gracilaria cervicornis, Sargassum vulgare*[11] and *Grateloupia turuturu*[12]. Seasonal variation in biochemical constitutions of *Sargassum wightii* with special reference to yield in alginic acid content from Pudumandapam has been reported[13]. Selvaraj and Sivakumar (1998) studied the biochemical composition of three species of Sargassum from Pamban coast[14]. Seasonal variation in growth and biochemical constitutions such as protein, carbohydrate and lipid in *Hypneavalentiae, Acanthophora spicifera, Laurencia papillosa, Enteromorpha compressa, Ulva lactuca* and *Caulerpa ra cemosa* were observed for one year from Mandapam coast[15]. Seasonal variation of carbohydrate, protein and lipid in seaweeds has been carried out from different localities of southeast coast of India[16,17]. The nutritional properties of seaweeds and their seasonal oscillation are poorly known and are normally evaluated from their chemical composition[18]. The objective of the present investigation is to evaluate the nutritional composition such as carbohydrate, protein and lipid of the green algae *Ulva lactuca*, brown algae *Sargassam wightii* and red algae *Gracilaria edulis* from Muttom and Kanyakumari coasts of Kanyakumari district. The seasonal and locational variations on the nutrient content of the selected marine macro algae are also studied.

MATERIALS AND METHODS

Area of study

In the present study, the selected coastal villages namely Muttom and Kanyakumari are located in the Kanyakumari district. Kanyakumari district is the southernmost tip of India which lies between 77°15' and 77°36' of the eastern longitude and 8° 35' and 8° 35' of the northern latitude. This district enjoys the unique feature of being bordered by the three oceans *viz*: the southeast coast bordered by the Gulf of Mannar, south by the Indian Ocean and the southwest by the Arabian Sea.

Collection and Processing of Samples

The selected samples were collected in two seasons, pre monsoon (August2015) and post monsoon season (December2015). About 50 g of each species were collected and the samples were thoroughly washed with distilled water to remove dirt particles, debris and other epiphytes followed by shade-drying. It was then ground well using the mixer grinder. The powdered samples were stored in an air tight container and used for the nutrient evaluation analysis.

Estimation of Carbohydrate, Protein and Lipid

The estimation of total carbohydrate was done by using Anthrone reagent on following the procedure of Seifter *et al*., 1950[19]. The protein was estimated by using the Folin phenol reagent on following the procedure of Lowry *et al*., 1957[20]. The extraction of lipid was done by the chloroform-methanol mixture Folch et *al*., 1957[21]. The optical density was measured using Jasco UV-Visible spectrophotometer.

RESULTS AND DISCUSSION

Carbohydrate

The seasonal variation of carbohydrate content in the selected seaweed samples from Kanyakumari coast is presented in **Table 3.1**.

Table 3.1 Carbohydrate, Protein, Lipid content (%dw) of selected seaweeds from Kanyakumari coast during the study period August (pre monsoon season) and December (post monsoon season) 2015

Species	Seasons	Carbohydrate (% dw)	Protein (% dw)	Lipid (% dw)
U. lactuca	Pre monsoon	43.8 ± 2.1	21.9 ± 1.4	1.4 ± 0.2
	Post monsoon	43.1 ±1.9	19.4 ± 1.1	0.8 ± 0.1
S. wightii	Pre monsoon	39.3 ±1.2	16.3 ± 0.9	2.5 ± 0.3
	Post monsoon	38.7 ±1.7	15.0 ± 0.8	1.8 ± 0.2
G. edulis	Pre monsoon	36.2 ± 1.3	15.6 ± 1.1	1.8 ± 0.1
	Post monsoon	33.6 ± 1.6	18.8 ± 1.2	2.5 ± 0.2

dw: dry weight

Carbohydrate is the most important component for metabolism and it supplies the energy needed for respiration and other metabolic processes[22]. The level of carbohydrate in the selected seaweeds are ranging from 33.6 ± 1.6 to 43.8 ± 2.1% dw. The carbohydrate content in *U. lactuca* is found to be 43.8 ± 2.1% dw during pre monsoon season and 43.1 ± 1.9% dw in post monsoon season. Similarly for *S.wightii* , it is recorded as 39.3 ± 1.2% dw in pre monsoon season and 38.7 ± 1.7% dw in post monsoon. The observed carbohydrate content in *G. edulis* is 36.2 ± 1.3% dw during premonsoon season and 33.6 ± 1.6% dw in post monsoon season. In general, the carbohydrate content is slightly higher during pre monsoon season than post monsoon season in the selected marine macro algae. The maximum carbohydrate is registered for *U. lactuca* (green) followed by *G. edulis* (red) and *S. wightii* (brown). Similar findings were obtained for the selected seaweed samples from the Muttom coast (**Table 3.2**).

Table 3.2 Carbohydrate, Protein, lipid content (%dw) of selected seaweeds from Muttom coast during the study period August (pre monsoon season) and December (post monsoon season) 2015

Species	Seasons	Carbohydrate (% dw)	Protein (% dw)	Lipid (% dw)
U. lactuca	Pre monsoon	49.2 ± 3.2	11.2 ± 0.3	1.8 ± 0.1
	Post monsoon	45.4 ± 2.6	11.9 ± 0.4	3.3 ± 0.2
S. wightii	Pre monsoon	46.5 ± 1.8	15.0 ± 0.5	2.3 ± 0.2
	Post monsoon	35.9 ± 1.6	15.6 ± 0.3	2.4 ± 0.3
G. edulis	Pre monsoon	45.8 ± 2.2	14.4 ± 0.2	2.6 ± 0.4
	Post monsoon	43.7 ± 2.1	16.6 ± 0.5	1.6 ± 0.2

The level of carbohydrate in the selected seaweeds from Muttom coast is ranging from 35.9 ± 1.6 to 49.2 ±3.2% dw. The carbohydrate content in *U.* lactuca is found to be 49.2 ± 3.2% dw during pre monsoon season and 45.4 ± 2.6%dw in post monsoon season. Similarly for S. *wightii*, it is registered 46.5 ± 1.8% dw in pre monsoon season and 35.9 ± 1.6% dw in post monsoon. The carbohydrate concentration in *G. edulis* is 45.8 ± 2.2% dw pre monsoon season and 43.7 ± 2.1 % dw in post monsoon season. The order of three seaweeds in terms of carbohydrate content lies in the order *U. lactuca* > *G. edulis* > S. *wightii*. Among the two selected locations, the samples from Muttom coast possessed higher amount of carbohydrate than Kanyakumaricoast. Kakoli *et al*., (2009) reported the similar findings when they collected samples from 6 locations in Indian Sundarbands and found differential levels of carbohydrate content in the same species[22]. It is evident that the carbohydrate synthesis and accumulation varies from species to species. Similar report is also given by Nirmal Kumar *et al*. (2010) and stated that the concentration of carbohydrate is higher in the most of the species of chlorophyta followed by phaeophyta and rhodophyta[23].

Protein

The data on the seasonal and locational variation of protein content of three selected seaweeds namely *U. lactuca,* S. *wightii* and *G. edulis* collected from Kanyakumari coast are given in **Table 3.1**. The protein content available in certain seaweeds has attracted the attention of food industries that produce food products both for human consumption and also for animal feeds. The protein content of the three selected seaweeds from Kanyakumari coast is ranging from 15.0 ± 0.8% dw to 21.9 ± 1.4% dw. The maximum protein content is recorded for the *U. lactuca* species and the minimum protein content is found in *S. wightii* species as similar to carbohydrate. The level of protein in *U. lactuca*is 21.9 ± 1.4% dw in pre monsoon season and 19.4± 1.1% dw in post monsoon season. It is observed that the protein level is little less during post monsoon season. Similarly for S. *wightii*, the protein content is 16.3 ± 0.9% dw during pre monsoon season and 15.0 ± 0.8% dw in post monsoon season. In *G. edulis*, the protein content is registered as 15.6 ± 1.1% dw during pre monsoon season and 18.8 ± 1.2 % dw in post monsoon season. The protein content in *G. edulis* is higher in post monsoon season than in pre monsoon season. Except *G. edulis, U. lactuca and S.* wightii recorded higher amount of protein during pre monsoon season. Kakoli Banerjee *et al*. (2009) reported the variation in the protein level in seaweed sample collected from Indian coast[22].

The measured protein content is ranging from 11.2 ± 0.3% dw to 16.6 ± 0.5% dw for the selected seaweeds from Muttom coast (**Table 3.2**).The maximum protein content is observed for the *G. edulis* species. The minimum protein content is found in *U. lactuca* species. For *U. lactuca*, the protein content is 11.2 ± 0.3% dw in pre monsoon season and 11.9 ± 0.4% dw in post monsoon season. Similarly for *S. wightii*, the protein content is 15.0 ± 0.5% dw during pre monsoon season and 15.6 ± 0.3% dw in post monsoon season. In *G. edulis*, the protein content is observed to be 14.4 ± 0.2% dw during pre monsoon season and 16.6 ± 0.5% dw in post monsoon season. All the three selected samples possessed higher amount of protein during post monsoon season than pre monsoon season. The protein level is found to be higher in the samples collected from Kanyakumari coast than in Muttom coast. This observation corroborates the findings of Amany *et al*. (2000)[24], who studied the biochemical composition of Enteromorpha spp., in southern Baltic Sea observed the fact that the protein contents varied in different locations.

Lipid

The seasonal variation of lipid content in the selected seaweeds from Kanyakumari coast during the study period is provided in **Table 3.1**. In the present study, the estimated lipid is found to be low when compared to carbohydrate and protein. The lipid content is varied for each species. The amount of lipid ranged from 0.8± 0.1% dw to 2.5 ± 0.3% dw. The maximum lipid content is recorded for *S. wightii* and *G. edulis.* In *U. lactuca*, the lipid is estimated to be 1.4 ± 0.02% dw during pre monsoon season and 0.8 ± 0.1 % dw in post monsoon season. In the present study, *U. lactuca* recorded the minimum lipid content during post monsoon season which may be due to seasonal change. However *S. wightii* contains the maximum lipid content 2.5 ± 0.3% dw in pre monsoon season and lesser lipid content 1.8 ± 0.2% dw in post monsoon season. At the same time *G. edulis* recorded the maximum lipid content 2.5 ± 0.2 % dw in post monsoon season. Except *G. edulis*, *U. lactuca* and S. *wightii* recorded higher level of lipid during pre monsoon season when compared to post monsoon season.

The seasonal variation of lipid content in the selected seaweeds from Muttom coast during the study period is presented in **Table 3.2**. The amount of lipid ranged from 1.6 ± 0.2% dw to 3.3 ± 0.2% dw. The maximum lipid content 3.3 ± 0.2% dw is observed for *U. lactuca* during post monsoon season. Similarly *S.* wightii possessed higher lipid content 2.4 ± 0.3% dw in post monsoon season and little lesser lipid content 2.3 ± 0.2% dw in pre monsoon season. But *G. edulis* observed the maximum lipid content 2.6 ± 0.4% dw in pre monsoon season. Except *G. edulis*, *S. wightii* and *U. lactuca* recorded higher level of lipid during post monsoon season when compared to pre monsoon season. On comparing the lipid in the samples, it was found that greater lipid concentration in the samples collected from Muttom coast than in Kanyakumari coast. The seasonal changes in the nutrients like carbohydrate, protein and lipid showed variations which can be attributed due to the different environmental factors such as temperature, salinity, pH and other parameters like growing season.

The observed inter-species variations are in conformity to the observations made by earlier studies. Ortiz *et al*. (2006) made a comparative study of *U. lactuca* and *D. Antarctica* indicating the inter-species variation [25]. They recorded an overall carbohydrate level of 61.5 ± 2.3% dw in *U. lactuca* and 70.9 ± 2.7% dw in *D. Antarctica*.

CONCLUSION

In the present study, the selected green marine macro algae *U. lactuca* has been found to contain higher carbohydrate content than *G. edulis* and S. *wightii*. The order of three seaweeds in terms of carbohydrate content is *U. lactuca* (green) > *G. edulis* (red) > S. *wightii* (brown). Among the two selected locations, the samples from Muttom coast possessed higher amount of carbohydrate content than the samples from Kanyakumari coast. All the three selected samples possessed higher amount of protein during post monsoon season than pre monsoon season in the range between 11.2 ± 0.3%dw and 21.9 ± 1.4 %dw. The protein level is found to be higher in the samples collected from Kanyakumari coast than in the samples from Muttom coast. The lipid content is low, varying from 0.8 ± 0.1% dw to 2.6 ± 0.4%dw when compared to carbohydrate and protein content. The level of lipid is higher in the samples from Muttom coast than in the samples from Kanyakumari coast.

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