Journal of Algal Biomass Utilization
J. Algal Biomass Utln. - Copyright © PHYCOSPECTRUM
ISSN: 2229 – 6905

Biochemical composition and lipid characterization of marine green alga *Ulva rigida*- a nutritional approach

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Abstract

Biochemical composition of the green alga *Ulva rigida* (Ulvophyceae) was investigated by determination of moisture, protein, carbohydrate, total lipid, phenol and chlorophyll content.The moisture content of the alga was 76% whereas total protein was 6.64%, and carbohydrate content was 22%. The total lipid and phenol content were 12% and 23% whereas chlorophyll a, b and total chlorophyll were determined as 13%. 7.5% and 21% respectively. Carotenoid was present in considerable quantities (4.5%). The total free amino acid was found to be 8.9%. Fatty acid composition of total lipid was determined by gas chromatography. The major fatty acids in total lipid were 14:0, 16:0, 18:0, 18:1, 18:2 and 18:3. It was found that major of the biochemical parameters of this alga were higher except the protein content.

Key words: Biochemical composition, Seaweed, Fatty acid, Gas chromatography

Introduction

Seaweeds are an important source for food, fodder fertilizer and medicine from the ancient times. 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 (Mishra *et al*, 1993). Macroalgae are nutritionally valuable as fresh or dried vegetables, salads, or as ingredients in a wide variety of prepared foods (Robledo *et al*, 1997). Certain edible seaweeds contain significant quantities of protein, lipids, minerals and vitamins (Norziah *et al*, 2002). Nutrient content of seaweeds vary with species, geographical location, season, humidity and temperature (Dawes *et al*, 1993 & Kachler *et al*, 1996).

Marine algae are an important source of dissolved organic carbon in coastal waters. Carbohydrates, polysaccharides, nitrogenous and polyphenolic materials, represent the organic carbon (Craigie & Melachlan, 1964; Sieburth & Jensen, 1968). Studies of amino acid composition of some common marine algae were reported by Munda & Gubensek, (1976) and Dave & Pasekh (1978). The amino acids of algae have a wide application in human and animal feed nutrition industries (Borowitzka, 1988). Utilization of algae in food supplements was also studied by Ahmed and Hamza (1990).

Around 10% of the green algae are marine in habitat and mostly found in tropics.
They are direct source of food, fertilizer, medicine and fodder. Among the various species of green algae *Ulva* and *Enteromorpha* are used for human consumption in Japan, East Asia, West and South-East Asia, North and South America and Oceania. Other species of green algae are also found their application as human food and medicine in certain regions (Johnston, 1966; Neish, 1976; Saito, 1976 & Chapman, 1970). Considering the commercial importance of this alga, the biochemical composition was analysed and the results obtained on this aspect are presented in this paper.

There are about 8,000 species of seaweeds along the world's coast live and they may extend as deep as 270m (Luning, 1990). A total of 25 species of green sea weeds, 90 species of brown and 350 species of red sea weeds are found in the world sea area that are commercially important because of their protein, amino acids and mineral contents (Santhanam *et al*, 1980). Different species of sea weeds especially protein rich seaweeds are used as human food in different countries all over the world.

Considering the importance of seaweeds, it can be said that, sea weeds can play a vital role in various aspects compared to other aquatic resources. Much attention should be given on seaweed to compensate the food problem to some extent and fulfill the deficiency of nutrition for erecting the economy of several countries. The present study can be the future directions on the detailed study of specific seaweed.

Material and Methods

The green alga *Ulva rigida* was collected from marine coastal region of Chilka Lake (19° 55' N, 85° 34' E). The algal sample was collected in polythene bag with the help of long forceps and was brought to the laboratory for biochemical characterization. After collecting the sample it was washed repeatedly under running tap water and then distilled water to remove the adhering impurities. The sample was then air-dried and biochemical composition was carried out.

The protein content was analysed by the revised method of Lowry *et al* (Hartree, 1972). The carbohydrate content was analysed by Anthrone-sulfuric acid method with glucose as a standard. The total lipid was extracted by the method suggested by Bligh and Dyer (1959) using chloroform-methanol extract and characterized by Gas chromatography (JEOL GC mate). All these values were expressed as percentage of dry weight. Pigments were determined by Acetone extraction and saponification method. Moisture was determined by drying samples in a freeze dryer for 72h. Phenol was analysed by Folin-Ciocalteau reagent in 80% ethanol and 20% sodium carbonate with Catechol as a standard. Total free amino acid was determined by Ninhydrin reagent with Diluent solvent and citrate buffer (pH-5.0).

Results

The biochemical parameters of *Ulva rigida* are shown in Fig. 1. Protein content was 6.64% , whereas carbohydrate and total lipid contents were 22% and 12% respectively. Phenol and moisture content was also higher 23% and 76%. Total free amino acid was found to be 8.9%. Pigment composition was also varied greatly due to the presence of Chlorophyll a (13%), chlorophyll b (7.5%) and Carotenoids (4.5%) (Fig 2). Total Chlorophyll was measured as 21%. Total protein was much lesser in comparison with other biochemical parameters. From the Table.1 it was evident that the major fatty acids were C16:0, C18:2, C18:3, C22:0 and PUFA in the sample. The amount of unsaturated fatty acid was greater than the saturated fatty acids.

Fig. 1 Bar graph showing different biochemical parameters of *Ulva rigida* (% in dry biomass).

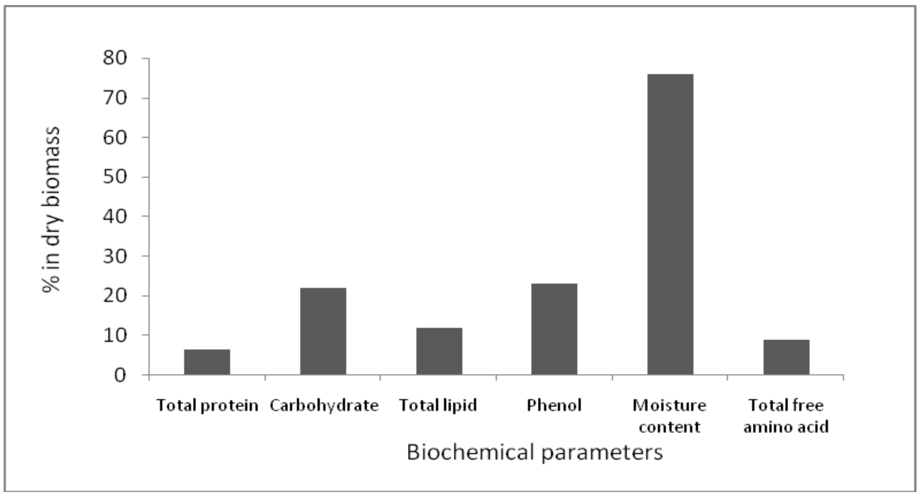

Fig. 2: Bar graph showing pigment compositions in the alga *Ulva rigida* (% in dry weight basis).

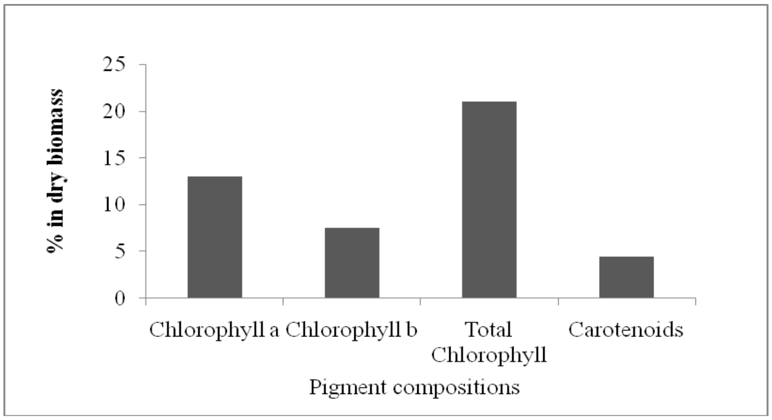

Table-1: Fatty acid composition of the alga *Ulva rigida.*

Genera	Major fatty acids	% of fatty acids
Ulva fasciata	C12:0	-
	C14:0	1.3
	C14:1	0.2
	C16:0	12.2
	C16:1	1.4
	C16:3	0.5
	C16:4	5.2
	C18:0	1.2
	C18:1	4.2
	C18:2	10.2
	C18:3	10.3
	C18:4	-
	C20:3	-
	C20:4	0.3
	C20:5	1.8
	C22:0	8.6
	C22:5	2.9
	C22:6	-
	Others	4.2
	PUFA	20.2
	MUFA	3.6

Discussion

The green alga *Ulva rigida* was characterized by its high carbohydrate and lipid content followed by phenol and moisture content. Protein and total free amino acids were found to be minimum than the other biochemical parameters. Vagas *et al* (1998) reported that the protein content was about 40% for filamentous N_2 fixing cyanobacteria but carbohydrate content was about 3 times to that of protein. In N_2 fixing cyanobacteria carbohydrate content varied from 60-70% (Vagas *et al,* 1998). Ricketts (1966) reported that protein ranged from 24-46%, lipid 14-48% and carbohydrate 5-57% of various golden brown algae in dry weight basis. Lipids and carbohydrate contents should obviously be very variable depending upon the state of nutrition cells (Ricketts, 1966). Total lipid was found to be 12% which contains simple lipid, glycolipid and complex lipids. Fatty acid compositions of the total lipids are shown in Table 1. Saturated fatty acids 16:0 and 22:0 and monounsaturated fatty acid 18:1 were the major fatty acids for simple lipids. This investigation was supposed to the data by Cohen *et al*. (1989) who found nearly similar results for the red alga *Porphyridium cruentum*. Among the unsaturated fatty acids 18:2 and 18:3 was highly observed. Polyunsatured fatty acid (PUFA) was found to be maximum (36.6%) in total fatty acid composition. Murakami et al (2003) reported that 16:0 and 18:3 were the major fatty acids in spinach *Spinacea oleracea*. Cohen et al. (1989) also reported the same result where he found that the major fatty acids in *Spinacea oleracea* are 16:0, 18:0, 18:1, 18:2, 18:3 and PUFA. So it may be concluded that *Ulva rigida* is a potential source of valuable simple and glycolipids.

Now a days seaweeds have been widely accepted by the people of coastal regions throughout the world due to their important sources of nutrients. Seaweeds may solve the problems of carbohydrate and mineral deficiency in human nutrition by consuming the seaweeds in near future.

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