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FATTY ACID COMPOSITION OF MORE BROWN SEAWEEDS (PHAEOPHYTA) FROM THE COAST OF KARACHI

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ABSTRACT: Six species of multicellular, thalloid, brown algae, belonging to five genera of the classes Laminariophyceae and Fucophyceae were collected from the coastal areas of Buleji near Karachi (Pakistan) during October 1997 and February 1998. They were extracted in chloroform:methanol, saponified, subjected to column chromatography (CC, TLC), esterified and analysed for fatty acid (FA) composition initially by gas-liquid-chromatography (GLC) and finally by gas chromatography-mass spectrometry (GC-MS). They displayed only a few SCFAs, PUFAs and substituted FAs, no VLCFA, C22 UFA, CFA, DCFA and monoynoic FA, large amount of C16:0, very large quantity of C18:1, very small RCCL and FA-diversity, C18 UFAs up to four DBs, C20 UFAs up to three DBs only. They were characterized by the largest amount of C18:1, lowest degree of unsaturation of C20 UFAs, lack of C22 UFAs, the shortest RCCL and the smallest FA-diversity as compared to other phyla.

KEYWORDS: Algae, Phaeophyta, Fucophyceae, Laminariophyceae, Fatty acids, Pakistan.

INTRODUCTION

From time to time researches have been conducted on the fatty acid (FA) composition of green seaweeds occurring in the coastal waters of Karachi (Usmanghani *et al.,* 1985; Qasim, 1986; Shameel, 1987, 1990, 1993; Aliya *et al.,* 1995) as well as green algae growing in the freshwater habitats of Sindh Province of Pakistan (Ghazala *et al.,* 2003, 2004, 2005; Ghazala and Shameel, 2005; Valeem and Shameel, 2006a,b). But only a few investigations were undertaken on the brown seaweeds of this region (Usmanghani *et al.,* 1987; Shaikh *et al.,* 1990, 1995, 1999; Atta-ur-Rahman *et al.,* 1997). Therefore, a research programme was prepared to conduct a detailed study on FA-composition of the phylum Paeophyta thriving in the seawaters of Karachi, Pakistan (Valeem and Shameel, 2007). The present study is a continuation of that programme.

MATERIALS AND METHODS

The brown seaweeds were collected from the coastal areas of Buleji, near Karachi during October 1997 and February 1998 (Table I). The intertidal algae were detached from the rocks, pebbles and boulders during low tide, when the rocks were emerged. The drift algae were picked up from the tidal pools while wading during rising tides. A small portion of the fresh material was preserved in 4 % formalin solution in seawater for taxonomic determination. A few healthy and reproductive specimens were mounted on herbarium sheets as voucher specimens, which were deposited in the Seaweed Biology and Phycochemistry Lab. (Room No. 18), M. A. H. Qadri Biological Research Centre (BRC), University of Karachi, Pakistan.

The algal material in bulk was washed thoroughly with tap water to remove epiphytes, epizoons, animal castings, attached debris and sand particles. The healthy, mature and clean thalli were selected, rinsed with distilled water and dried under shade with sufficient aeration to avoid the break down of long-chain FAs under sunlight and high temperature. The dried

thalli of seaweeds (0.5 - 1.5 kg) were chopped into small pieces and milled. The dried and chopped algal material was kept for cold percolation in chloroform:methanol (1:1, v/v) at room temperature for a period of one month to obtain a total soluble extract. This extract was then evaporated under reduced pressure in rotary evaporator and a dark brown or brownish-black, thick residue of 30 to 50 g was obtained depending on the colour and quantity of the algal material. This process was repeated two to three times for each algal species. The methods used for the saponification, esterification and identification of the FAs were the same as described earlier (Valeem and Shameel, 2007). The details of techniques and instruments used such as CC, TLC, GLC and GC-MS have already been given there.

RESULTS AND DISCUSSION

Six species have been collected from marine environment of Karachi, Pakistan and investigated (Table I). The explanation for different abbreviations used here, were given in the Table I of Valeem & Shameel (2007). It was observed that the investigated species resembled other brown algae in having short RCCL (C8-C24), low FA-diversity (4-22), absence of VLCFA, monoynoic and cyclic FAs, scarcity of substituted FAs, SCFAs and PUFAs (Table II), but differed in having slightly long RCCL, larger FA-diversity, presence of SCFA and one PUFA as compared to the brown algae described previously (Valeem and Shameel, 2007).

Table I. Algal collection data of the species obtained from Buleji (Karachi) and systematically arranged according to Shameel (2001).

Algal Taxa	Habitat	Date
CLASS LAMINARIOPHYCEAE		
ORDER Scytosiphonales		
Family Scytosiphonaceae		
Colpomenia sinuosa (Mertens *ex* Roth) Derbès *et* Solier	Rocky ledge	February 1998
Iyengaria stellata (Børgesen) Børgesen	Rocky ledge	January 1998
CLASS FUCOPHYCEAE		
ORDER Fucales		
Family Cystoseiraceae		
Cystoseira indica (Thivy *et* Doshi) Mairh	Sandy pool	January 1998
Jolyna laminarioides Guimarâes	Edge of rock	October 1997
Family Sargassaceae		
Sargassum swartzii (Turner) C. A. Agardh	Drift	January 1998
Sargassum tenerrimum J. G. Agardh	Rocky pool	January 1998

Table II. Fatty acid composition of algal species from Laminariophyceae and Fucophyceae (Phaeophyta) in relative percentages.

Fatty	Algal Species					
Acids	1	2	3	4	5	6
C8:0	-	3.81	-	-	-	-
C11:0	-	1.20	-	-	-	-
C12:2	-	-	1.69	-	-	-
C13:0	-	-	1.11	-	2.41	-
C13:1	-	17.14	0.88	-	-	-
C14:0	9.81	0.81	3.46	-	11.58	-
C14:1	-	-	0.82	-	-	-
C14:3	2.20	-	5.34	-	-	43.17
C15:0	-	4.38	1.71	6.25	14.73	-
C15:1	-	-	-	-	2.41	-
^{s}C15:3	-	-	-	-	2.31	-
C16:0	22.92	22.57	30.32	35.17	39.89	7.26
C16:1	-	3.98	3.98	-	4.39	-
C16:2	-	-	-	-	-	6.81
C16:3	-	0.98	-	-	10.72	-
C17:0	8.57	4.70	10.77	-	3.59	-
C17:2	-	-	3.10	-	-	17.26
C18:0	-	9.83	3.06	7.34	-	-
C18:1	22.66	9.60	8.55	51.23	4.39	-
C18:2	-	-	1.79	-	-	-
C18:3	-	3.19	5.32	-	-	-
C18:4	14.25	-	1.57	-	-	-
C19:0	0.82	-	3.96	-	-	2.05
C20:0	3.74	5.80	2.53	-	-	-
C20:2	-	12.01	1.37	-	-	-
C20:3	7.60	-	-	-	-	-
C21:0	-	-	4.17	-	-	-
C22:0	4.72	-	3.32	-	3.59	18.31
C22:1	-	-	1.19	-	-	-
C24:0	2.70	-	-	-	-	-
C24:2	-	-	-	-	-	5.14
Acids	11	14	22	4	11	7

1 = *Colpomenia sinuosa*, 2 = *Iyengaria stellata*, 3 = *Cystoseira indica*,
4 = *Jolyna laminarioides*, 5 = *Sargassum swartzii*, 6 = *Sargassum tenerrimum*.

Palmitic acid was detected in all the six investigated species, it was not only the most common acid but also found in the most dominating quantity (7.26-39.89 %). Oleic acid was

present in five species and occurred in an overwhelming amount (4.39-51.23 %). In this regard, these species resembled other brown seaweeds investigated previously (Qasim, 1986; Shameel, 1987, 1990; Shahnaz & Shameel, 2007). The SFAs like C14:0, C15:0, C17:0 and C22:0 were the next common acids of these algae, they were found in four of the investigated species. The C8:0, C11:0, C12:2, C14:1, C15:1, ^{5}C15:3, C16:2, C18:2, C20:3, C21:0, C22:1, C24:0 and C24:2 were the least common acids as they occurred in any one of the investigated algae.

The class Laminariophyceae was represented by two species (# 1 & 2), they showed a larger RCCL (C8-C24), lower FA-diversity (11-14), presence of SCFA (C8:0), lack of substituted FA and PUFA, lower amounts of palmitic (up to 22.92 %) and oleic (up to 22.66 %) acids, and higher quantities of C13:1, C 18:4, C20:0, C22:2, C20:3 acids as compared to the class Fucophyceae, which was represented by four species (# 3-6). These algae possessed short RCCL (C12-C24), large FA-diversity (7-22), lack of SCFA, presence of a substituted FA (^{5}C15:3) and one PUFA (C18:4) and higher quantities of palmitic (up to 39.89 %), oleic (up to 51.23 %) and C14:0, C14:3, C15:0, C16:2, C16:3, C17:2, C18:3, C21:0, C22:0 and C24:2 acids than members of the other class. In general glycolipids are the main lipid classes in Laminariophyceae. Palmitic, oleic acids and PUFAs with 18 and 20 C atoms form the group of main acids (Khotimchenko, 1998; Kotimchenko and Kulikova, 1999).

The class Fucophyceae was represented by the single order Fucales, which included two families: two species (# 3 & 4) belonged to the family Cystoseiraceae and two (# 5 & 6) to the family Sargassaceae (Table II). Members of the former family showed RCCL from C12 to C22, FA-diversity from 4 to 22, lack of substituted FA, presence of PUFA (C18:4) and C12:2, C13:1, C14:1, C18:0, C18:2, C18:3, C20:0, C20:2, C21:0 and C22:1 acids, low quantity of C16:0 (30.32-35.17 %) and high amount of C18:1 (8.55-51.23 %). Whereas members of latter family exhibited RCCL from C13 to C24, FA-diversity from 7 to 11, lack of PUFA, presence of a substituted FA (^{5}C15:3) and C15:1, C16:2, C16:3 and C24:2 acids, high amount of C16:0 (7.26-39.89 %) and low quantity of C18:1 (4.39 %). In this way the two families differed from one another in their FA-compositions. Generally members of the class Fucophyceae have rather less of the C20:5 acid, slightly more of the C20:4 acid, and oleic, linoleic and linolenic acids are more abundant (Wood, 1974; Kanias *et al.,* 1992), but these observations were mainly based on the cold water marine species of the genus *Fucus*. In the present study (on warm water inhabitants) all such acids could not be detected except oleic acid which was found in only one species in small proportion (4.39 %).

In several investigated species of Fucophyceae from coastal zones of Qatar, myristic, palmitic, oleic, linoleic, eicosadienoic and lignoceric acids were found to be predominant (Heiba *et al.,* 1997). Saturated FAs like palmitic and stearic acid predominated in *Cystoseira crinata* from the eastern Mediterranean Sea, accompanied by a lower concentration of oleic acid (Kamenarska *et al.,* 2002). Present study agrees with such observations. Peculiarities of FA-composition were shown for members of Fucophyceae from the Russian Far East. They contained the highest percentages of C14:0 and C18:1 (n-9), the lowest amounts of (n-3) PUFAs and had a C20 non-methylene interrupted acid (Khotimchenko, 1998).

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