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FATTY ACID COMPOSITION OF *SARGASSUM DENTICULATUM* AND *S. LATIFOLIUM* AS INFLUENCED BY THE TIME OF COLLECTION AND THE PLANT ORGAN

By

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تركيب الأحماض الدهنية في سرجاسم دينتيكيولاتم وسرجاسم لاتيفوليم وتأثره بوقت جمع العينات والعضو النباتي

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هذا البحث هو محاولة لدراسة الأحماض الدهنية للسرجاسم وبيان مدى تأثر هذه الأحماض بوقت ومكان جمع العينات وأيضاً العضو النباتي المستخدم . ولتبيان ذلك تم اختيار نوعين من السرجاسم ينتشران بكثرة على ساحل البحر الأحمر لمصر . وهذين النوعين هما سرجاسم دينتكيولاتم وسرجاسم لاتيفوليم .

دلت نتائج هذه الدراسة أن الأحماض الدهنية في هذين النوعين من السرجاسم قد تعرضت كماً ونوعاً لتغيرات موسمية كبيرة ، وأنها قد اختلفت بشكل واضح باختلاف العضو النباتي المستخدم .

تميز هذان النوعان من السرجاسم باحتوائهما على كميات عالية من الحمضين الدهنيين ١٦ : ٠ ، ١٣ : ٠ . في نفس الوقت وجد أنهما قد احتويا بشكل غير عادى على كميات محسوسة من الحامض الدهني ١٧ : ٠ . وهذا الحامض نادر وجوده في الطحالب البنية .

تبين من خلال هذه الدراسة أن الليبيدات المستخلصة من هذين النوعين قد احتوت على نسب عالية من الأحماض الدهنية المشبعة مما يوضح أن هذين النوعين يمكن اعتبارهما مصدرا مفضلا لهذه الأحماض .

Key Words: Sargassum denticulatum, Sargassum latifolium, Brown algae, Fatty acid composition, Season, Plant organ,

ABSTRACT

Fatty acid profile of two species of *Sargassum* namely, *S. denticulatium* (Forsk). Borgesen and *S. latifolium* (Turn) Ag., from the Red Sea coast of Egypt was studied. Fatty acid data indicate that there is a strong seasonal variations in distribution patterns and in the relative percentages of fatty acid components. Our analyses show that the fatty acid composition of both species was also affected by the plant organ. In most cases, however, these variations in fatty acid composition were species-specific. The characteristic feature of both species was their high content of 16:0 and 13:0. The local *Sargassum* species were unusual in containing 17:0 with estimable amounts. Lipids extracted from these species were found to have considerably higher levels of saturated fatty acids indicating that these species are potentially a better source of these acids.

INTRODUCTION

Fatty acid compositions in marine algae have aroused considerable interest among researchers. Jamieson and Reid [1]., Khotimchenko and Svetashev [2,3], Khotimchenko and Vaskovsky [4] and Dembitsky *et al.* [5] reported that distribution of fatty acids in marine algae may be useful for taxonomic purposes. Differences in fatty acid composition can be notable even among closely related species [6-9] as well as within the same species depending on their natural milieu [2]. Studies of algal fatty acids can also be useful because of the remarkable role of algae as nutrients for many marine organisms and to the high concentration of polyunsaturated acids which when included in the diet, can reduce the probability of heart and vascular diseases [5].

Recently, the effect of environmental factors on the lipids and fatty acid compositions in marine algae has been re-

ported. The limited data available indicate that the amounts of phosphatidylglycerol, triacylglycerol and nonesterified fatty acid increased during the winter in *Polysiphonia lanosa* [10]. Khotimchenko [9] found that palmitic and C20 polyunsaturated acid contents varied in algae collected form different sites.

Little is known about the fatty acid composition of Egyptian marine algae. References dealing with this subject are restricted to the algae of the Mediterranean Sea [11-14]. Nothing is known about the fatty acid composition of seaweeds of the Red Sea.

The following study was carried out to investigate and compare the fatty acid compositions of two Red Sea species of *Sargassum (S. denticulatum and S. latifolium)* during the different seasons of the year. In addition, ,more emphasis was imposed on the distribution of fatty acids in different parts of plant.

MATERIALS AND METHODS

Over a full year, regular seasonal visits were made to Abu-Shaar and Ras-Gharib on the Red Sea coast of Egypt (Fig, 1). From these localties, *Sargassum denticulatum* (Forsk). Borgesen and *S. latifolium* (Turn). Ag. were taken, respectively from spring 1991 to winter 1992. The algal nomenclature used is that recommended by Aleem [15].

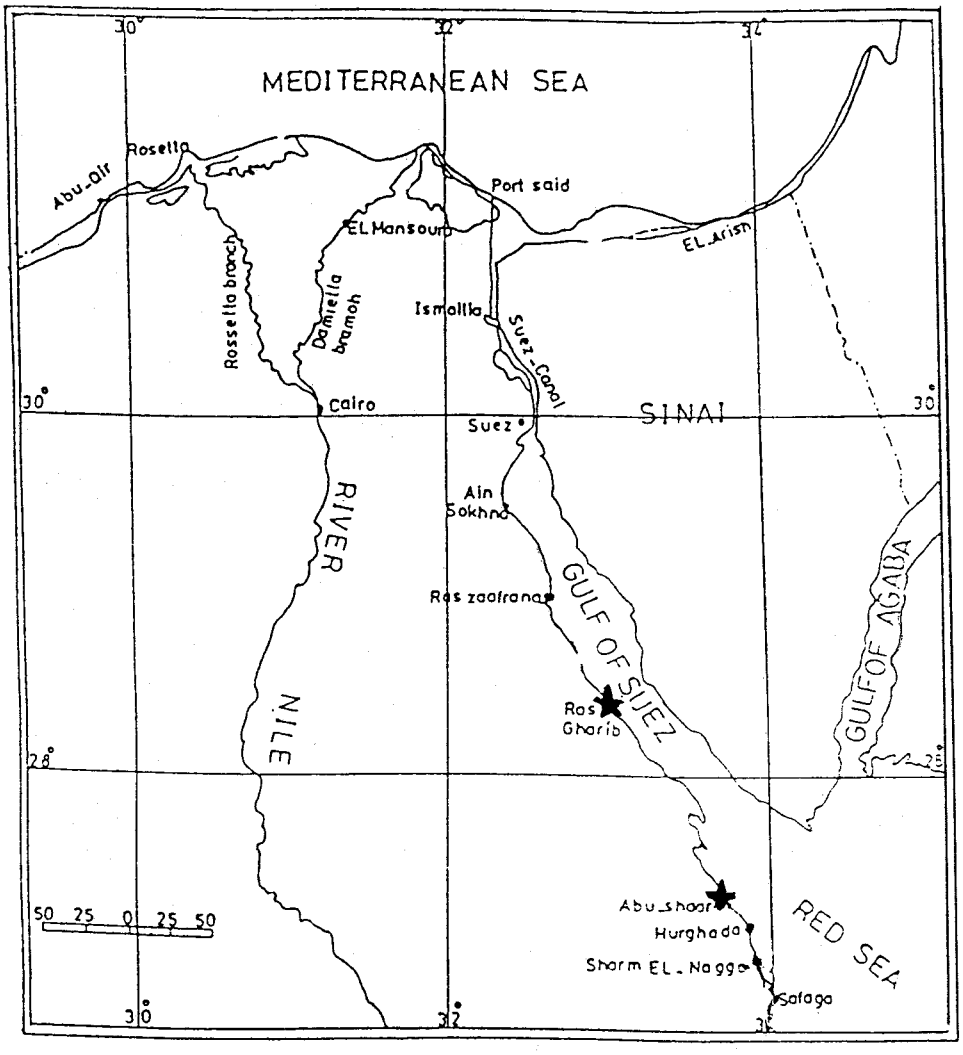

Fig.1. Sketch map to show the locality of the investigated stations (*) at Red sea coast of Egypt.

In order to make comparison between the fatty acid composition of different parts of thallus, some samples of the two species were separated into leaves and stipes.

The collected samples were cleaned up from epiphytes and non-living matrix in running tap water and rinsed many times in distilled water. The samples were then spread on string nets and allowed to dry in air. Air-dried samples were ground and stored in stoppered bottles at room temperature.

Lipids were extracted with chloroform-methanol mixture (2:1 v/v) following the method of Holme and Hazel [16]. The lipids samples were saponified with ethanol KOH solution. After removal of unsaponifiable matter by extraction with ether the aqueous solution left was acidifed with 2.5% H_2SO_4 to liberate the fatty acids from their salts. The methyl ester derivatives of the fatty acids were then prepared using the procedure of Moussa [12]. Analysis of methyl ester derivatives was carried out using Pye Unicam Pu 4550 gas-liquid chromatograph on 1.5 m x 4 mm glass column packed with 10% polyethylene glycol adipate (PEGA). The carrier gas was nitrogen with flow rate of 30 ml/min. Column temperature programme was 70-190°c for 45 min. Detector temperature was 300°C . Identification off fatty acids was carried out by comparing retention times and co-chromatography with those of authentic samples. The quantitative analysis was carried out by measuring the peak areas. Analyses of fatty acids were carried out in duplicates.

RESULTS

Season

Fatty acid composition of *S. denticulatium* and *S. latifolium* at different seasons of the year is shown in Table 1. These data indicate that distribution patterns of fatty acids as well as the levels of the individual fatty acids in both species were affected by the season. In *S. denticulatum*, the number of fatty acids (FAs) ranged from a maximum of 12 FAs during autumn to a minimum of 5 FAs during summer. A wide range of fatty acids in *S. latifolium* was also observed; a minimum and a maximum of 12 FAs during autum to a minimum of 5 FAs during summer. A wide range of fatty acids in *S. latifolium* was also observed, a minimum and a maximum numbers of 5 and 13 FAs being observed in winter and autumn, respectively.

Throughout the period of investigation, it was noted that the fatty acids present in *S. denticulatum* were principally 10:0,14:0, 13:0 and 16:0. The principal acids in *S. latifolium* were 18:0, 13:0 and 16:0. Fluctuations of these acids were markedly different and appreared to indicate a difference with the season. It is interesting to note that lower concentrations of these were generally obtained during cold months (Table 1).

Table 1

Fatty Acid composition of *S. denticulatum* and *S. latifolium* at different seasons of the year (values expressed as g fattey acid/100 g total fatty acids).

	S. denticulatum				*S. latifolium*			
Fatty	1991			1992	1991			1992
Acid	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
8:0	0.8±0.1	-	0.1±tr	4.9±0.1	-	-	1.1±0.2	-
9:0	1.9±0.2	-	-	2.2±0.3	-	-	-	-
10:0	49.8±1.8	4.4±0.3	0.3±0.2	23.3±1.7	-	2.3±0.1	0.1±tr	17.7±0.4
11:0	-	-	-	0.9±0.1	-	2.5±0.2	-	-
12:0	-	4.7±0.2	1.0±0.1	-	0.8±0.1	-	20.2±0.3	-
13:0	7.7±0.2	14.5±0.4	36.8±2.0	4.5±0.2	10.6±0.5	33.8±0.7	33.5±0.6	2.8±0.1
14:0	8.5±0.4	50.6 ±1.8	0.3±tr	6.5±0.2	13.3±3.0	5.5±0.3	4.0±0.3	7.0±0.4
15:0	-	-	2.9±0.9	-	9.8±0.4	5.7±0.1	0.4±0.1	-
16:0	26.4±0.4	25.8±0.6	8.5±0.2	46.3±1.8	18.1±0.1	14.4±0.4	8.2±0.3	56.6±2.1
17:0	-	-	2.6±0.7	-	16.4±0.4	-	2.5±0.1	-
18:0	-	-	16.8±1.1	-	31.0±1.5	10.5±0.2	10.1±0.4	-
18:1	4.9±0.2	-	3.4±0.6	8.4±0.2	-	24.±1.0	4.0±tr	15.9±5.0
18:2	-	-	-	2.8±0.2	-	0.6±0.1	3.2±0.2	-
18:3	-	-	25.3±1.9	-	-	-	8.1±0.1	-
20:0	-	-	1.9±0.1	0.2±tr	-	-	4.4±0.3	-

Values are means ± s. d.
tr = trace (<0.05%)

As is evident from Table 1 the two species of *Sargassum* were characterized by their higher content of saturated fatty acids than of unsaturated fatty acids. The amounts of these components were varied according to the season. Highest amounts of unsaturated fatty acids in both species were detected during autum. Saturated fatty acids were particularly abundant in *S. denticulatum* and *S. latifolium* during summer and spring, respectively.

Plant organ

Qualitative and quantitative distributions of different fatty acids in stipes and leaves of *S. denticulatum* and *S. latifolium* are shown in Table 2. In both species, the distribution of fatty acids in stipes and leaves was quite variable particularly in *S. denticulatum*, the number of fatty acids in stipes was two times that of the leaves. The stripes were characterized by the presence of 9:0, 11:0, 15:0 and 18:1.

As indicated in Table 2, 13:0 and 16:0 were the major fatty acids in the two parts of *S. denticulatum* but their content was the lowest in the stipes and the highest in the leaves. In this species, 14:0 was found to be more concentrated in the stipes than in the leaves. 18.1 though absent in the leaves was detected with high amount in the stipes.

Stipes and leaves of *S. latifolium* contained comparable number of fatty acids. 12:0, 13:0, 14:0, 15:0 and 16:0 were common in the two parts. However,, concentrations of these acids were found to vary with the plant organ (part). The stipes showed the highest concentrations of 16:00 and 12:00 while the leaves yielded the maximum amounts of 13:0, 14:0 and 15:0. In this connection, it may be mentioned that 18:1 and 18.2 were only detected in the stipes while the leaves were characterized by the presence of 18:0 (Table 2).

DISCUSSION

The data in this investigation clearly indicate that the fatty acid compositions of *S. denticulatum* and *S. latifolium* are very complicated. There is a strong seasonal variation in the distribution patterns and relative percentages of fatty acid components. Our analyses show that the fatty acid compositions of both species were also affected by the plant organ. In most cases, however, these variations in fatty acid composition were species - specific.

Throughout the period of investigation, the fatty acid composition of both species showed the presence of 8:0, 10:0, 11:0, 12:0, 13:0, 14:0, 15:0, 16:0, 17:0, 18:0, 18:1, 18.2, 18:3 and 20:0. *S. denticulatum* was characterized by the presence of 9:0. Pohl *et al.* [6], Hayashi *et al.* [17], Ackman and McLachlan [7], Kato and Ariga [18] and Khotimchenko and Svetashev [2] have reported the fatty acid compositions of different species of brown algae and their results are similar to those in the present investigation except that they did not report the presence of 8:0, 9:0, 10:0, 11:0, 12:0, 13:0, 15:0 and 17:0. It is interesting that the amount of 10:0 and 13:0 in the investigated species was high. 8:0, 11:0, 12:0, 15:0 and 17:0 in both species were detected either in estimable amounts or in traces.

Karawya *et al.* [11] reported the presence of 8:0, 10:0 and 12:0 with minor amounts in *Sargassum linifolium* and *Cystoseina barbata* collected from Alexandia, Egypt. 12:0 was also detected in several brown algae (1,9) and the levels ranged from0.05 to 0.20% of total FAs. Moreover, Abdel-Moien [13] found 11:0, 12:0 and 15:0 in *Dictyota dichotoma, Padina pavonia, Sargassum linifolium, Cystoseira barbata* and *colpomonia sinuosa* from Alexandria, but she did not find any 8:0 and 10:0.

Nothing was reported about 17:0 in *Sargassum* species

Table 2

Comparison of fatty acid composition of stipe and leaf of *S. denticulatum* and *S. latifolium* (Values expressed as g fatty acid/100 g total fatty acids)

Species	*S. denticulatum*		*S. latifolium*	
Fatty Acid	Stipe	Leaf	Stipe	Leaf
9:0	1.6±0.9	-	-	-
11:0	2.6±0.3	-	-	-
12:0	1.9±0.7	2.7±0.3	14.5±0.5	2.3±0.2
13:0	38.1±2.1	66.9±2.9	4.6±0.3	24.3±0.6
14:0	11.9±1.8	9.0±0.6	9.8±0.2	20.9±1.4
15:0	8.6±1.2	-	4.6±0.8	16.0±1.4
16:0	19.3±0.4	21.4±1.9	55.8±1.1	36.1±1.9
18:0	-	-	-	0.3±0.1
18:1	16.1±0.7	-	10.3±0.8	-
18:2	-	-	0.4±0.2	-

Values are means ± s.d

[11, 13, 17, 18], but Khotimchenko [9] who reported in the presence of this acid with minor amounts in seven species of Sargassum from different parts of the world. *Sargassum* species examined here contained estimable amounts of 17:0 (Table 1); the highest amount of 17:0 was observed in *S. latifolium* particularly in autumn.

Recently, 17:0 has been detected in the marine diatom *Nitzschia pungens* [19] but at much lower concentrations than that those in the local *Sargassum* species. In *N. pungens* it was present at 0.1-0.2% of the total FAs. The high percentage of 17:0 in the local *Sargassum* species (2.5-16.4% of total FAs) led us to conclude that this acid is a component of *Sargassum* lipids even if there is a possible contamination with diatoms.

In the present study, the presence of 13:0 in *Sargassum* species examined here was demonstrated in every season. Leaf parts of both species were also characterized by having high proportions of this acid. Abdel-Moien [13] did not detect 13:0 in lipids of the five species of brown algae from Alexandria but found only small amounts of 13:1.

Examination of the two *Sargassum* species for their fatty acid composition revealed that the major fatty acids of these species were found to respond differently to seasons of the year. As regards *S. denticulatum,* the major fatty acids present in spring were 10:0 and 16:0; in summer, 14:0, 16:0 and 13:0; in autumn 13:0, 18;3 and 18:0 and in winter, 16:0 and 10:0. in *S. latifolium,* the predominant acids found in spring were 18:0, 16:0 and 17:0; in summer, 13:0 and 18:0; in autumn, 13:0 and 12:0 and in winter, 16:0. Variations were also found in distribution pattern of fatty acids. Thoroughout the period of investigation, the number of fatty acids ranged from 5 to 12/13 FAs, with high number in autumn.

In the present study, it has been shown that the two species of *Sargassum* had high percentages of plamitic acid (16:0). Throughout the period of investigation, *S. denticulatum* contained an average of 26.8%, ranging from 8.5 to 46.3% the *S. latifolium* contained an average of 24.3% with the limits being 8.2 and 56.6. These data are similar to those published by Hayashi *et al.* [17], Kato and Ariga [18], Hamdy and Dawes [20] and Khotimchenko [9] for several other species of *Sargassum.* It is interesting that the 16:0 content in both species was very high in winter (Table 1).There are contradictory data about 16:0 in *S. linifolium* collected from Alexandria. Karawya *et al.* [11] found the maximum amounts in summer. This difference may be connected with an influence of environmental factors and charateristic features of algal species [9].

In this study, the fatty acid composition of the stipes and leaves of each alga exhibited remarkable differences. Significant variations were observed in quality and quantity of the fatty acid compositions between the stipe and leaves. Variations in distribution patterns of fatty acids between the different parts of the alga were more pronounced in *S. denticulatum* than in *S. latifolium.* Generally, the stipe tissues had higher number of fatty acides than leaf tissues. Oleic acid (18:1) was only detected in stipe tissues. Moreover, 13:0 was more abundant in the leaves than in the stipes. These variations probably result from differences in the morphological and anatomical structures. Morphological differentiation extends to the anatomical features as well, and ultrastructural features can be quantitatively correlated with physiological aspects of various tissues [21].

The high amounts of saturated fatty acids were characteristic feature of the fatty acid composition of the investigated species. These findings are in harmony with those of Karawya *et al.* [11] and Abdel-Moien [13] for the Egyptian Phaeophyta species collected from Alexandria.

Although the fatty acid compositions of *S. denticulatum* and *S. latifolium* were mostly composed of saturated type, there is a variation in the content and degree of unsaturation. The percentage of the unsaturated fatty acids to the saturated fatty acids differed according to the time of collection and plant organ. (Table 1 & 2).

Phaeophyta typically have high concentrations of C18 polyunsaturated fatty acids (PUFAs) [2]. This characteristic feature was also observed for the two local species. They contained estimable amounts of total C18 PUFAs particularly in autumn. An interesting feature is the C18 PUFAs ere not detected in certain seasons (Table 1). Linolenoic (18:3) predominated among C18 PUFAs in *Sargassum* species examined here. This acid has been reported to be a major component C18 PUFAs in different other species of *Sargassum*[9,17,18].

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