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FATTY ACID DISTRIBUTION IN THE LIPOID EXTRACTS OF VARIOUS ALGAE

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The fatty acid composition of the lipoid extracts of four marine alga species, Halopteris scoparia *(L.) Sauvagau,* Scinaia furcellata *L.,* Sargassum natans *(L.) J. Meyer,* Padina vickersiae *Hoyt, and the sea grass* Posidonia oceanica *L. as well as six freshwater alga species, namely* Cladophora fracta *(Dilw.) Kutz,* C. glomerata *(Dilw.) Kutz,* Zygnema pectinatum *(Vauch.) C. A. Agardh,* Maugeotia sp. *(C. A. Agardh),* Vaucheria sessilis *(Vauch.) De Candolle, and* Spyrogyra gratiana *Link. together with the aquatic plant Potomogeton perfoliatus L., collected from Turkish waters, was characterized by capillary GC-MS. Only the saturated fatty acids were found in the species investigated.*

Key words: Fatty acid, GC-MS, macroalga, aquatic plant.

Oceans and freshwaters are habitats of numerous species of organisms. As marine organisms are prolific sources of novel and diverse metabolites, extensive phytochemical and bioactivity research have focused on marine natural products over the past two decades [1]. Macroalgae, one of the large and diverse groups of marine organisms, are eaten as food, particularly in the Asian-Pacific region [2]. Recently, macroalgae have received great attention due to their low calorie content and high vitamin, mineral, and dietary fiber ingredients which make them more attractive to both consumers as well as the cosmetic and food industries [3–6]. Previous studies have demonstrated that marine algae also possess a number of biological activities beneficial for human health, including antimicrobial, cytotoxic, antimitotic, anticancer, and antimutagenic activities [7–12]. The fatty acid contents of macroalgae have also attracted the attention of chemotaxonomists due to distinguishing features of taxonomic value [13–14]. On the other hand, fatty acids are important for a wide array of cell structure components and for many chemical reactions in the body including hormonal and energy activities. They play a vital role in establishing a healthy lipid barrier in the skin to block irritants and infections and some of them have beneficial effects on human health such as cardioprotective activity [16].

The present study was conducted to characterize the fatty acid composition of the lipoid extracts of four marine alga species, *Halopteris scoparia* (L.) Sauvagau (**HS**), *Scinaia furcellata* L. (**SF**), *Sargassum natans* (L.) J. Meyer (**SN**), *Padina vickersiae* Hoyt (**PV**), and the sea grass *Posidonia oceanica* L. (**PO**) as well as six freshwater alga species, namely *Cladophora fracta* (Dilw.) Kutz (**CF**), *C. glomerata* (Dilw.) Kutz (**CG**), *Zygnema pectinatum* (Vauch.) C. A. Agardh (**ZP**), *Maugeotia sp.* (C. A. Agardh) (**M**), *Vaucheria sessilis* (Vauch.) De Candolle (**VS**), and *Spirogyra gratiana* Link. (SG) together with the aquatic plant *Potomogeton perfoliatus* L. (**PP**) collected from Turkish waters.

The major fatty acid components found in the lipoid extracts of the alga and plant extracts analyzed in this study were palmitic, oleic and stearic acids along with capric and myristic acids as the minor constituents whereas none of the unsaturated fatty acid such as linoleic, γ-linolenic, and linolenic acids were detected.

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TABLE 1. Collection Sites, Dates, and Herbarium Numbers of the Marine/Aquatic Plant and Alga Species

Species analyzed	Collection site	Collection date	Herbarium No.
H. scoparia (HS)*	Alanya	August, 1999	GUE 2173
P. vickersiae (PV)*	Alanya	August, 1999	GUE 2175
S. furcellata (SF)*	Tekirdag	September, 2000	GUE 2190
S. natans (SN)*	Kusadasi	August, 2000	GUE 2201
P. oceanica (PO)*	Kusadasi	August, 2000	GUE 2200
C. fracta (CF)**	Beysehir Lake	May, 1999	GUE 2179
C. glomerata (CG)**	Beysehir Lake	May, 1999	GUE 2178
Z. pectinatum (ZP)**	Mogan Lake	April, 1999	GUE 2177
P. perfoliatus (PP)**	Mogan Lake	April, 1999	GUE 2191
V. sessilis (VS)**	Mogan Lake	April, 1999	GUE 2228
S. gratiana (SG)**	Mogan Lake	April, 1999	GUE 2180
Maugeotia sp. (M)**	Sariyer Damn	May, 1999	GUE 2181

Aquatic origin: * - Marine, ** - Fresh-water.

TABLE 2. Dry Weights (g) and Yields (%) of the Lipoid Extracts Analyzed

Extracts	Marine/Aquatic Plant and Alga Species											
	HS	PV	SF	SN	PO	CF	CG	ZP	SG	VS	PP	M
Dry weight (g)	3.00	0.84	2.74	0.61	0.74	1.72	0.96	0.51	1.20	1.3	0.61	1.07
Yield (%)	6	20.2	7.3	21.3	16.2	6.4	15.6	15.7	3.3	11.3	37.7	19.6

TABLE 3. Fatty Acid Composition of the Lipoid Extracts of the Marine/Aquatic Plant and Alga Spesies (Relative percentages of fatty acids in the alga species studied)

Species	Fatty acid (Retention time, min)			
	Myristic (8.43)	Palmitic (11.77)	Oleic (13.30)	Stearic (13.44)
HS*	-	7.49±0.12	5.06±0.04	10.82±0.99
PV	-	5.61±1.01	6.74±0.88	-
SF	-	9.00±0.05	2.80±0.78	4.02±0.97
SN	-	7.48±0.98	18.31±0.66	-
PO	-	6.37±0.45	4.89±0.43	5.23±0.79
CF	5.90±1.03	4.38±0.88	19.84±0.93	-
CG	-	7.54±0.36	30.73±0.24	8.84±0.22
ZP	-	31.05±0.38	53.44±0.41	-
SG	-	11.23±0.12	16.97±0.23	-
VS	6.11±0.08	13.57±0.11	-	2.25±0.91
PP	-	6.28±0.04	11.19±0.13	-
M	-	3.69±0.13	4.75±0.52	-

*Capric acid (11.41) - 1.00±0.28.

Of them, palmitic acid (hexadecanoic acid) is a saturated fatty acid principally found in palm oil. Oleic acid (cis-9-octadecenoic acid) is known as the major constituent of olive oil. A diet enriched with oleic acid is associated with decreased susceptibility of oxidation of LDL, improvement of fluidity of HDL, which is associated with a greater ability to stimulate cholesterol efflux from cells, and an increase in the fluidity of LDL which decreases atherogenicity [17]. It also triggers neutrophil aggregation and neutrophil adherence to both fibrinogen-coated surfaces and is also used asan emulsifying agent and to assist absorption of some drugs by the skin [18]. Stearic acid is a saturated fatty acid mainly found in animal products and a few plants.

The results obtained through GC-MS analysis of the lipoid extracts prepared from the aforementioned alga species have revealed that palmitic and oleic acids were most abundant fatty acids in all of the alga and plant species analyzed. The presence of stearic acid was also observed in *H. scoparia, S. furcellata, P. oceanica, C. glomerata*, and *V. sessilis*. Among all the lipoid extracts analyzed, H. scoparia only contained capric acid. Myristic acid was found in C. fracta and V. sessilis, which are of freshwater origin. No remarkable difference between the marine and the freshwater algae and plants were observed with respect to their fatty acid composition. *Z. pectinatum* extract was found to have the highest palmitic and oleic acid concentration (Table 3).

From the results presented here, it is apparent that alga extracts of marine and freshwater origin may be considered alternative sources of the saturated fatty acids, including palmitic, and stearic acids in particular. This is the first study on the fatty acid compositions of these species.

EXPERIMENTAL

Collection sites, dates, and herbarium numbers of eleven species of the alga examined are listed in Table 1. Identification of these species way made by Dr. T. Atici. Fresh samples of the materials are stored in formaldehyde solution at the Department of Biology, Faculty of Education, Gazi University, Ankara. Voucher specimens are kept at the Herbarium of the Department of Pharmacognosy, Faculty of Pharmacy, Gazi University (GUE), Ankara, Turkey.

Each alga was air-dried, powdered mechanically, and weighed accurately. The materials were macerated with petroleum ether for two days at room temperature. The extracts were filtered and concentrated to dryness under vacuum. Accurate weights and average oil yields of the materials are given in Table 2. The lipoid extracts from the alga species were mixed with boron trifluoride (BF_3)-methanol reagent (20%) in order to convert their fatty acids into the methyl derivatives [15]. The methyl esters of the fatty acids were dissolved in $CHCl_3$ and applied into a GC-MS apparatus (Hewlett Packard Model 6890/5972) equipped with a mass selective detector.

Experimental conditions for capillary GC-MS analysis were regulated as follows: Capillary column HP-5MS (5% phenylmethylsiloxane, 30 m $\times$ 250 μm, i.d., with 0.25 μm film thickness, model No. HP 190915-433), detector temperature 200°C, injector temperature 280°C, carrier gas helium (1 mL/min), flow rate 0.5 mL/min, split ratio 1/100, injection volume 0.2 μL, and mass range (m/z) 20–440. The temperature was programmed between 180–230°C and the rate was 2°C/min. Identification of the peaks was carried out through a Wiley library databank search as well as comparison with the standards. Relative percentages of the fatty acids detected along with SEM values were established from total ion chromatograms by a computerized integrator.

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