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# PROXIMATE ANALYSIS AND FATTY ACID PROFILE OF SOME BROWN MACROALGAE COLLECTED FROM THE NORTHEASTERN MEDITERRANEAN COAST

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## ABSTRACT

In current study, proximate compositions (ash, lipid and protein) and fatty acid profiles of 5 different brown macroalgae (*Stypopodium schimperi, Halopteris scoparia, Cystoseira compressa, Padina pavonica, Sargassum vulgare*) collected from Iskenderun Bay (Arsuz and Kale regions) in July 2019 were determined. The highest and lowest ash values were found in *Halopteris scoparia* (28±0.1%) and *Cystoseira compressa* (21±0.1%), respectively. The lowest and highest lipid amounts of brown algae tested in the study were found in *Cystoseira compressa* (2.00%) and *Stypopodium schimperi* (6.36%), respectively. While the highest protein content was determined in *Halopteris scoparia* (9.79±0.02%) and *Cystoseira compressa* (9.50±0.3%), the lowest protein content was obtained from *Padina pavonica* (4.20±0.16%). The saturated(SFA) and monounsaturated (MUFA) fatty acid compositions of brown algae were 75.11-92.45% and 4.44-23.1%, respectively. In conclusion, biochemical compositions and especially, the high levels of palmitic acid indicated that brown macroalgae can be considered as a potential resource in terms of obtaining biologically new products in the nutraceutical industry and food industry.

**KEYWORDS:**
Brown macroalgae, Proximate analysis, Fatty acids

## INTRODUCTION

Seaweeds or macroalgae are a group of marine organisms consisting of several thousand species. Marine macroalgae are grouped into three main groups according to the presence of pigments they contain. These are brown (Phaeophyta), green (Chlorophyta) and red algae (Rhodophyta) [1]. Macroalgae are generally between 1-2 cm and 40-50 m in size depending on the species; plant organisms that form the feeding, shelter and reproduction environment for aquatic creatures [2]. In addition to their high nutritional content, macroalgae, which are used especially in health areas due to their therapeutic properties, have also been an important food source for humans for years [3]. Red and brown algae are groups that are widely used as human food [4]. Macroalgae are in many areas in search of raw materials that are shaped in line with the new needs of the industries; it has been the main market of Middle Eastern countries for centuries in the food, medicine and cosmetics sectors. Thanks to the valuable metabolites in its composition, its usage areas continue to spread in a wide range [5-8]. Besides valuable metabolites, macroalgae also contain important fatty acids such as eicosapentaenoic acid - EPA (C20: 5n3) and docosahexaenoic acid - DHA (C20: 6n3) [9].

There are studies on the biochemical content of macroalgae on the coasts of Turkey. However, in our study, the basic nutritional components and fatty acids of 5 different brown algae (*Stypopodium schimperi, Halopteris scoparia, Cystoseira compressa, Padina pavonica, Sargassum vulgare*) collected from Iskenderun Bay (Arsuz and Kale regions) were investigated.

## MATERIALS AND METHODS

The samples were collected by hand in Iskenderun Bay, Kale and Arsuz regions in July 2019. Five brown macroalgae species were identified as belonging to Phaeophyta (*Stypopodium schimperi, Halopteris scoparia, Cystoseira compressa, Padina pavonica, Sargassum vulgare)*.

**Preparation of the samples.** Macroalgae collected in cooler containers Iskenderun Teknik University, Algal Biotechnology Laboratory. First, the brown macroalgae were rinsed in distilled water and then drained. Thus, sand and other unwanted objects

were removed. The next step was to dry the samples at 60°C for 3 hours using a laboratory oven. Thoroughly dried samples were ground with a laboratory type mixer. Samples for analysis were stored at −20°C until use.

**Proximate composition of the samples.** The nitrogen content of macroalgae samples were analyzed by using Kjeldahl method [10]. Additionally, the crude protein content using a conversion factor of 6.25 to calculate protein content [10]. The ash and lipid content of macroalgae were determined according to Vollenweider [11], Bligh and Dyer [12], respectively. The values were given as g/100g dw.

**Analysis of fatty acid content.** Fatty acid contents were made according to Garces and Mancha [13]. Analysis of fatty acid methyl esters was performed with a gas chromatography mass spectrometer (GC) equipped with an SP-2330 fused capillary column (30 90.25 mm) using hydrogen as carrier gas and the temperature program.

**Statistical analysis.** Results are expressed as mean ± standard deviation. Statistical comparisons were made using SPSS 12 (Version 12.0, SPSS, Chicago, IL) Windows. Statistical comparisons were made by OneWay Analysis (ANOVA). Differences between averages were determined using Duncan's multiple comparison tests. Differences were considered statistically significant when $p<0.05$ [14].

## RESULTS AND DISCUSSION

The aim of study was to reveal the proximate compositions (protein, lipid and ash,) and fatty acid profiles of 5 different brown macroalgae (*Stypopodium schimperi, Halopteris scoparia, Cystoseira compressa, Padina pavonica, Sargassum vulgare*) collected from Iskenderun Bay (Arsuz and Kale regions). The proximate compositions (protein, lipid and ash) and fatty acid compositions of brown macroalgae are summarized in Table 1 and Table 2, respectively.

Protein contents of the macroalge ranged from 4.20±0.16% to 9.79±0.02%. The highest protein values were obtained from *Halopteris scoparia* (9.79±0.02%) and *Cystoseira compressa* (9.50±0.3%). The lowest value was found to be 4.20±0.16% in Padina *pavonica*. It has been reported that the protein content is generally between 15-30% in red and green algae [15], and between 3-15% in brown algae [4]. Tabarsa et al., [16] found a protein content of 11.83% in *Padina pavonica,* which they collected in April in southern Iran (Persian Gulf). Studies have shown that seasonal changes have caused changes in the biochemical structure of macroalgae.

The lowest and highest lipid amounts of brown algae were found in *Cystoseira compressa* (2.00%) and *Stypopodium schimperi* (6.36%), respectively. The lipid values of the four brown algae except for *Stypopodium schimperi* varied between 2.00±0.5% and 3.18±0.8%. Lipid level is generally low in macroalgae, between 1-5%. Low lipid content depends on light intensity, salinity and temperature conditions [17].

The highest and lowest ash values were found in *Halopteris scoparia*(28±0.1%) and *Cystoseira compressa* (21±0.1%), respectively. The ash content of *Stypopodium schimperi* they collected from Iskenderun Bay Polat and Özoğul [18], 17.98%; Ozgun and Turan [19] found 4.66% and Polat and Özoğul [20] found 2.73% and 3.75% in spring and summer, respectively. The results of Polat and Özoğul [18] were similar to the results of our study. Studies have shown that seasonal changes have caused changes in the biochemical structure of macroalgae. Wahbeh [21] found the protein, lipid, and ash content of the macroalgae *Panida pavonica* collected at the beach in Aqaba, Jordan to 17.4%, 4.4% and 23.1%, respectively. Tabarsa et al. [16], the ash content of macroalgae varies between 8% and 40% of their dry weight. Factors such as geographical location and season might be important factors in change the ash content of macroalgae [22]. The protein, lipid and ash amounts of five algae species are summarized in Table 1.

**TABLE 1**
**Proximate composition (g/100g dw) of the brown macroalgae in the Iskenderun Bay.**

| Composition | *S. schimperi* | *H.scoparia* | *C. compressa* | *P. pavonica* | *S. vulgare* |
|---|---|---|---|---|---|
| Protein (%) | 8.53±0.11$^{b}$ | 9.79±0.02$^{a}$ | 9.50±0.3$^{a}$ | 4.20±0.16$^{d}$ | 6.29±0.12$^{c}$ |
| Lipid (%) | 6.36±0.22$^{a}$ | 2.85±0.3$^{b}$ | 2.00±0.5$^{d}$ | 3.18±0.8$^{b}$ | 2.58±0.4$^{cd}$ |
| Ash (%) | 23±0.8$^{b}$ | 28±0.1$^{a}$ | 21±0.1$^{b}$ | 22±0.2$^{b}$ | 27±0.5$^{a}$ |

Mean values, n=3, dry weight basis. Different letters between the columns indicate significant difference at 5% by Duncan multiple range test.

**TABLE 2**
**Fatty acid compositions (%) of brown macroalgae in the Iskenderun Bay.**

| Fatty Acids | *S.schimperii* | *C.compressa* | *H. scoparia* | *P. pavonica* | *S. vulgare* |
|---|---|---|---|---|---|
| C14:0 (*Myristic acid*) | 8 | 3.29 | 8.64 | 5.14 | 5.41 |
| C16:0 (*Palmitic acid*) | 40.60 | 22.86 | 37.47 | 29.84 | 50.34 |
| C17:0 (*Heptadecanoic acid*) | 43.85 | 58.07 | 29 | 39.55 | 24.55 |
| C18:0 (*Stearic acid*) | ND | ND | ND | 1.56 | 1.58 |
| Total SFA | 92.45 | 84.22 | 75.11 | 76.09 | 81.88 |
| C16:1(*Palmitoleic acid*) | ND | ND | 12.52 | 2.80 | 3.25 |
| C18:1(*Oleic acid*) | 4.44 | ND | 10.58 | 6.49 | 10.60 |
| Total MUFA | 4.44 | ND | 23.1 | 9.29 | 13.85 |
| TFA | 96.89 | 84.22 | 98.21 | 85.38 | 95.73 |
| ND | 3.11 | 15.78 | 1.79 | 14.62 | 4.27 |

ND:Not Detected; SFA:Saturated Fatty Acid; MUFA:Mono Unsaturated Fatty Acid; TFA:Total Fatty Acid.

In the study, the fatty acid amounts of 5 different brown macroalgae were also determined. While the highest and the lowest Saturated Fatty Acid (SFA) (C14: 0, C16: 0, C17: 0, C18: 0) was found in *Stypopodium schimperii* (92.45%), and Halopteris *scoparia* (75.11%), respectively. The highest and the lowest Mono Unsaturated Fatty Acid (MUFA) (C16: 1, C18: 1) of brown macroalgae were *Halopteris scoparia* (23.11%) and *Stypopodium schimperii*. (4.44%), respectively. MUFA was not found in *Cystoseira compressa*. Palmitic acid (C16:0) and Heptadecanoic acid (C17:0) were the main fatty acids of brown macroalgae tested. Myristic acid (C14:0) were detected in low amounts in brown macroalgae. However, stearic acid (C18:0) was not determined except for *Padina pavonica* and *Sargassum vulgare species*. On the other hand, MUFA amounts of macroalgae were lower than SFA amounts. Palmitoleic acid (C16:1) was found except for *Stypopodium schimperii* and *Cystoseira compressa*. However, Oleic acid (C18:1) was determined in all species except for *Cystoseira compressa*. Seaweeds have been used as an important source of food because of their biochemical compositions such as protein, polysaccharides, vitamins, antioxidant, dietary fiber, essential fatty acids, carotenoids and minerals [23-28]. Brown algae represent a considerable part of the littoral biomass [29] and many of them are considered to be important for human consumption and industrial uses. Although seaweeds have been reported to have low lipid contents [30], PUFA composition is superior to those of terrestrial vegetables in regard to the human diet [31].

Turkey is one of the countries with the highest potential for seaweed production. However, information about the biochemical contents of seaweeds inhabitating in Turkish coasts is limited [32]. Kamenarskaa et al., [33] revealed that the most abundant fatty acid in the lipids of the brown alga *Padina pavonia* was palmitic acid, followed by oleic and myristic acids. Polat et al., [18] revealed that SFA amount of brown algae (*Stypopodium schimperii*) was lower than our study, but not MUFA. Sethi, [34] showed that the algae are a rich source of palmitic acid. Polat et al., [35] revealed that the fatty acid compositions of brown (*Sargassum acinarum, Halopteris scoparia, Taonia atomaria, Dictyota dichotoma*) and red (*Liagora sp*.) seaweeds species collected from Iskenderun Bay were in the range of 18.51-63.96% SFA, 15.25-23.02% MUFAs and 14.62-29.04 % PUFAs. Polat et al., [35] determined that SFA (Saturated Fatty Acids) of macroalgae were higher than the MUFA content. In addition, researcher revealed that the highest SFAs of macroalge analyzed in the study were palmitic acid (C16:0) and myristic acid (C14:0). Vizetto-Duarte et al., [36] revealed that SFA varied from 34% to 54% in *Cystoseira* genus. In addition, palmitic acid (C16:0) was the most abundant SFA in all tested species, ranging from 26% to 35% of total fatty acids (TFA) in *Cystoseira* genus. Researcher determined that MUFA ranged from 13% to 23% of TFA. Belattmania et al., [37] showed that the SFA content in *Cystoseira humilis* was about 33.44% with palmitic acid (C 16: 0) as the most abundant SFA. Bouafif et al., [38] determined that the FA profile of lipid extracts in 11 species of *Cystoseira* is characterized by high amounts of saturated fatty acids (SFAs) ranging from 40.51% to 57.91%. They also reported that palmitic acid was the most dominant in total fatty acids (> 30% of the total). It has been reported that the lipid, protein and fatty acid contents of seaweeds are influenced by the type of species, environmental parameters such as light intensity, temperature, salinity, season, genetic differences and locations [9, 39-44].

## CONCLUSION

It is known that macroalgae form the basis of the food chain in aquatic ecosystems. Macroalgae, which have a great variety in aquatic environments, have a potential economic impact on food, pharmaceutical industry and public health, thanks to their high nutritional values and important metabolites. From this point of view, marine macroalgae are promising organisms in terms of obtaining biologically new products.

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