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The Proximate Composition and Fatty Acid Profiles of Edible Parts of Two Freshwater Mussels

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Abstract

The proximate compositions and fatty acid profiles of the freshwater mussels *Unio terminalis* and *Potamida littoralis* were compared. The crude protein (11.87-11.97%), lipid (2.55-1.05%), ash (1.68–1.61%) and moisture (80.36-81.69%) contents of *U. terminalis* and *P. littoralis* were observed. Lipid content of *U. terminalis* was found to be significantly ($P<0.05$) higher than in *P. littoralis*. The percentages of total saturated fatty acids (SFA) and total monounsaturated fatty acids (PUFA) were higher in *U. terminalis* than in *P. littoralis*, whereas the corresponding total polyunsaturated fatty acids (MUFA) content was lower. The *n*3/*n*6 ratio of *U. terminalis* and *P. littoralis* were 1.54-1.40, respectively. The data obtained indicate that the % composition of *n*3 PUFAs is greater for *U. terminalis*. Both of these species are good sources of EPA and DHA. Therefore, it was concluded that freshwater mussels *U. terminalis* and *P. littoralis* are suitable as healthy food choice.

Keywords: *Unio terminalis*, *Potamida littoralis*, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA).

İki Tatlı Su Midyesinin Yenilebilir Kısımlarının Besin Kompozisyonu ve Yağ Asidi Profilleri

Özet

Tatlı su midyesi *Unio terminalis* ve *Potamida littoralis*'in besin kompozisyonu ve yağ asidi profilleri karşılaştırılmıştır. *U. terminalis* ve *P. littoralis*'in ham protein (%11,87-11,97), lipit (%2,55-1,05), kül (%1,68-1,61) ve nem (%80,36-81,69) içerikleri incelenmiştir. *U. terminalis*'in lipit içeriği *P. littoralis*'inkine göre önemli ölçüde ($P<0,05$) yüksek bulunmuştur. *U. terminalis*'in toplam çoklu doymamış yağ asitleri (MUFA) içeriği *P. littoralis'*inkine oranla daha düşük iken; toplam doymuş yağ asidi (SFA) ve toplam tekli doymamış yağ asidi (PUFA) yüzdeleri daha yüksek bulunmuştur. *U. terminalis* ve *P. littoralis*'in *n*3/*n*6 oranları sırasıyla 1,54-1,40 olarak tespit edilmiştir. Bulgular, *n*3 PUFA yüzde kompozisyonunun *U. terminalis* için daha yüksek olduğunu göstermiştir. Her iki türün EPA ve DHA'nın iyi birer kaynağı olduğu tespit edilmiştir. Sonuçta, tatlı su midyeleri *U. terminalis* ve *P. littoralis* sağlıklı gıda seçenekleri olarak uygun bulunmuştur.

Anahtar Kelimeler: *Unio terminalis*, *Potamida littoralis*, doymamış yağ asidi, EPA, DHA.

Introduction

Freshwater mussels *U. terminalis* and *P. littoralis* are farmed throughout southern region of Turkey and are the most commercially important shellfish in both domestic and export markets.

Turkey has potentially rich sources of seafood, in terms of variety and species. Contrary, consumption of molluscs and shellfish is considerably low. Whereas, both the amount of fatty acid and the proportions of saturated, monounsaturated and polyunsaturated fatty acids in shellfish contribute to a healthful diet. Shellfish also contain significant amounts of "good" fats called omega-3 fatty acids. Shellfish such as mussel contains approximately 20 percent to 28 percent calories from fat. The types of fat in mussels are also favourable. Shellfish also provide high quality protein with all the dietary essential amino acids for maintenance and growth of the human body. For this reason, shellfish should be considered a low-fat, high-protein food-one that can be included in a low-fat diet (King *et al*., 1990).

Factors such as water temperature, nutrient availability and reproductive cycle of mussels can influence biochemical composition of bivalve molluscs (Fernandez-Reiriz *et al*., 1996; Okumus and

Stirling, 1998; Orban, Di Lena *et al*., 2002). The overall quality of mussels is the result of biological, chemical and organoleptic characteristics such as aspect of the shells, meat aspect and yield typical taste and flavour, absence of undesirable components.

Gölbaşı Lake is a natural lake located in the South-eastern Mediterranean Region of Turkey area and it is one of the most important freshwater reservoirs in the South-eastern Mediterranean. Total lake area is about 1,200 ha which consists of 400 ha with marshy. The lake depth changes, depending on the season, from 4 m to 6 m. The most important fish and mussel populations of the lake are *Clarias gariepinus*, *Cyprinus carpio*, *Leuciscus lepidus*, *Anguilla anguilla*, *Tilapia* sp., *Carasobarbus luteus*, *Mugil saliens*, *U. terminalis*, *P. littoralis*, *Unio tigridis* and *Anodonta pseudodopsis*.

Research on mussel species in Gölbaşı Lake has focused on its reproductive characteristics, growth performance (Çek and Şereflişan, 2006) and metal concentrations (Türkmen and Ciminli, 2007); but, no information is available on the nutritional quality of mussels *U. terminalis* and *P. littoralis* living in the freshwaters of Turkey. For this reason, an investigation of the proximate composition and fatty acids profiles of these species were aimed in this study. It is anticipated that the determination of the composition and fatty acid profiles of these species will provide necessary information of the nutrient value of this food for both consumers and guide the farmers, cultivating this species, on its feeding requirements.

Materials and Methods

Sample Preparation

Mussels *U. terminalis* and *P. littoralis* with similar shell length were collected from the Lake Gölbaşı, located in the South Eastern Mediterranean region of Turkey. The collected mussels were transported to the laboratory with ice freezing. Stainless steel scalpel blades were used to cut open the mussels and remove the soft tissues, which were then thoroughly rinsed with deionized water to remove extraneous material and homogenized by blender for analysis.

Proximate Analyses

Proximate composition analyzses of the samples were done in triplicate for protein, moisture, lipid and ash contents. The crude protein was determined by the Kjeldahl procedure (AOAC, 1984). Moisture was determined by oven drying at 105ºC to constant weight (AOAC, 1990). Total lipid was extracted from the muscle tissues using Bligh and Dyer (1959) method. The lipid content was gravimetrically determined. Ash was determined gravimetrically in a muffle furnace by heating at 550 ºC constant weight (AOAC, 1990).

Fatty Acid Analyses

The lipids were esterified according to Metcalfe *et al*. (1966). The fatty acid methyl esters were analyzed on a Thermo quest trace gas chromatograph equipped with SP-2330 fused silica capillary column, 30x0.25 mm ID 0.20 µm film thickness. Column injector and detector temperatures were 240 and 250°C, respectively. Carrier gas, helium; split ratio 1/150; column flow 75 ml/min; make-up 30 ml/min (He) range 1; sample injection 0.5 µl. The fatty acid methyl mixture No. 189-19 was used for standards (Sigma). The fatty acids were calculated by percentage of total lipid.

Statistically Analysis

Analysis of variance was used to evaluate the analysis data and significant differences among means were determined by Independent Samples-T Test (P=0.05). Statistical calculation was performed with SPSS 15.0 for windows.

Results and Discussion

The results of proximate analysis of two freshwater mussels, *U. terminalis* and *P. littoralis* from Gölbaşı Lake are shown in Table 1.

While crude protein, lipid, ash and moisture of *U. terminalis* were 11.87, 2.55, 1.68 and 80.36%, respectively, those values in *P. littoralis* were 11.97, 1.05, 1.61 and 81.69%, respectively. However, lipid content of *U. terminalis* was found to be higher than in *P. littoralis*. For several mussel species, similar total lipid contents were reported by Şengör *et al*. (1997) and Mclean and Bulling (2005). Statistical analysis results showed that no significant differences were observed between *U. terminalis* and *P. littoralis* in terms of protein, ash and moisture.

Table 2 gives the percentage as a mean value of fatty acid for each species.

The major fatty acids identified in both mussel were palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1), C18:3*n*6; C22:2*n*6; C18:3*n*3; EPA (C20:5*n*3) and DHA (C22:6*n*3). These results are in agreement with previous studies on fatty acids of other species (Freites *et al*., 2002; Uno *et al*., 1999; Vernocchi *et al*., 2007).

The total saturated fatty acids were 32.13% in *U. terminalis* and 30.21% in *P. littoralis*. Similar ΣSFA values were found for other species (Freites *et al*., 2002). Total saturated fatty acids were significantly ($P<0.05$) higher in *U. terminalis* than in *P. littoralis*.

Palmitic acid and stearic acid in *U. terminalis and P. littoralis* were found to be present at the

Table 1. Proximate composition (%) of *U. terminalis* and *P. littoralis*

Mussel Species	Moisture	Protein	Lipid	Ash
U. terminalis	80.36±0.84	11.87±0.14	2.55±0.13[a]	1.68±0.03
P. littoralis	81.69±0.92	11.97±0.07	1.05±0.03[b]	1.61±0.05

Results are means ± standard deviation of triplicates.
Means within the same column that have no common letters are significantly different (P<0.05).

Table 2. Fatty acid profiles (% total fatty acids) of *U. terminalis* and *P. littoralis*

Fatty Acids (%)	*U. terminalis*	*P. littoralis*
C12:0	0.06±0.04[a]	0.05±0.00[a]
C14:0	1.40±0.04[a]	1.31±0.03[a]
C15:0	1.13±0.04[a]	0.89±0.04[b]
C16:0	15.49±0.11[a]	14.84±0.40[a]
C17:0	1.79±0.02[a]	1.63±0.01[b]
C18:0	5.96±0.04[a]	4.57±0.11[b]
C20:0	0.75±0.02	1.35±0.02
C21:0	1.20±0.01[a]	0.73±0.03[b]
C22.0	1.42±0.02[a]	1.70±0.00[b]
C23:0	1.41±0.04[a]	1.71±0.06[b]
C24:0	1.52±0.04[a]	1.43±0.06[b]
∑SFA	32.13	30.21
C14:1	0.64±0.01[a]	0.42±0.03[b]
C15:1	1.16±0.01[a]	0.91±0.03[b]
C16:1	6.94±0.01[a]	11.62±0.47[b]
C17:1	1.46±0.01[a]	0.65±0.01[b]
C18:1	6.07±0.11[a]	6.63±0.12[b]
C20:1	0.82±0.01[a]	0.77±0.01[b]
C22:1	0.65±0.03[a]	0.30±0.01[b]
C24:1	1.86±0.01[a]	1.54±0.01[b]
∑MUFA	19.60	22.84
C18:2*n*6	0.78±0.01[a]	0.64±0.02[b]
C18:3*n*6	4.91±0.01[a]	5.44±0.18[b]
C20:2*n*6	0.74±0.04[a]	0.67±0.02[a]
C20:4*n*6	1.53±0.02[a]	2.52±0.01[b]
C22:2 *n*6	6.71±0.02[a]	4.25±0.18[b]
C18:3*n*3	3.29±0.01[a]	4.12±0.22[b]
C20:5*n*3	12.00±0.04[a]	8.90±0.06[b]
C22:6*n*3	7.12±0.03[a]	5.87±0.10[b]
∑PUFA	37.08	32.41
∑*n*3	22.57	18.89
∑*n*6	14.67	13.52
*n*3/*n*6	1.54	1.40
Unknown	11.03	14.54

Values are expressed as mean ± standard deviation, *n*=3.
Within the column values with different letters are significantly different (P<0.05).
ΣSFA, Total saturated fatty acids; ΣMUFA, Total monounsaturated fatty acids; ΣPUFA, Total polyunsaturated fatty acids.

highest levels among the saturated fatty acids. Analysis of variance showed insignificant differences between palmitic acid levels of *U. terminalis* and *P. littoralis* (15.49% and 14.84%, respectively). However, stearic acid level of *U. terminalis* (5.96%) was significantly (P<0.05) higher than in *P. littoralis* (4.57%) (Table 2). Similar results of these fatty acids for *M. galloprovincialis* were also reported in the literatures (Freites *et al*., 2002; Vernocchi *et al*., 2007).

Total monounsaturated fatty acids were found to be 19.60% (*U. terminalis*) and 22.84% (*P. littoralis*) (Table 2), with palmitoleic acid and oleic acid fatty acids showing the highest levels. These fatty acids were significantly (P<0.05) higher in *P. littoralis* than in *U. terminalis*, and oleic acid has been attributed health-giving properties due to monounsaturated status (Larsen *et al*., 1999). Similarly, to our finding, Vernocchi *et al*. (2007) reported that the oleic acid and palmitoleic acid levels for *M. galloprovincialis* captured from Adriatic Sea were 2.34-6.34% and 9.88-36.33%, respectively. Total monounsaturated fatty acids were significantly (P<0.05) higher in *P. littoralis* than in *U. terminalis*.

Total polyunsaturated fatty acids in *U. terminalis* and *P. littoralis* were found to be 37.08%

and 32.41%, respectively. PUFAs-*n*3 in both species were greater than PUFAs-*n*6. The most abundant amoung PUFAs-*n*3 was C20:5*n*3 (EPA) with ranges 12.00% and 8.90% in the *U. terminalis* and *P. littoralis*, respectively. Similar results were reported for mussel *M. trossulus* (Uno *et al*., 1999). EPA is the most important essential fatty acid of the *n*3 series in the human diet because it is the precursor to the *n*3-series eicosanoids (Chen *et al*., 1995). Total polyunsaturated fatty acids were higher in *U. terminalis* than in *P. littoralis*.

The *n*3/*n*6 ratio is a good index for comparing relative nutritional value of fish oils (Pigott and Tucker, 1990). The U.K. Department of Health recommends an ideal relationship of *n*3/*n*6 of 4.0, at maximum (HMSO, 1994). A higher ratio is of great importance in order to diminish coronary heart diseases, plasma lipid levels and cancer risks (Kinsella *et al*., 1990). In this study, the present data show that the *n*3/*n*6 ratio was 1.54 and 1.40 for *U. terminalis* and *P. littoralis*, respectively. Among the *n*3 series, both species are good sources of EPA and DHA. EPA and DHA were reported to be interchangeable by retrogradation (Von Schacky and Weber, 1985). In this study, EPA and DHA were higher in *U. terminalis* than in *P. littoralis*.

Recent studies suggest that eating fish oil daily reduces the risk of heart disease death. The most efficient way to add these important oils to your diet is to eat two meals per week of fish rich in this fatty acid prepared without additional oil. The British Nutrition Foundation has recommended that for a balanced and healthy diet, we should all consume 0.2 g of EPA+DHA daily or 1.5 g on a weekly basis.

In the light of these findings, it may be concluded that these freshwater mussel species are suitable items in the human diet.

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