

## Seasonal changes in biochemical composition and meat yield of Shabut (*Barbus grypus*, Heckel 1843)

Ilkan Ali Olgunoglu\* ; Mine Percin Olgunoglu; Engin Artar

Adiyaman University, Aquaculture and Fisheries Program, Kahta Vocational Training School, 02400 Kahta-Adiyaman, Turkey.

\*Corresponding author's email: [iolgunoglu@adiyaman.edu.tr](mailto:iolgunoglu@adiyaman.edu.tr)

Received: April 2010

Accepted: July 2010

**Keywords:** Shabut, *Barbus grypus*, Meat yield, Biochemical composition

According to the records of FAO (Food and Agriculture Organization), Shabut, also known as *Barbus grypus*, is one of the most significant fish species listed in the fresh waters of Iraq and in the rivers along South and Southwest Iran, the Karoon river, and also in The Euphrates River and Tigris Rivers in Turkey (Selki et al., 2005; Zivotofskya & Amar, 2006; Dorostghoal et al., 2009). This fish with dark anal and tail fins and other light colored fins (Selki et al., 2005) is one of the leading fish species from the Atatürk Dam Lake with great importance in economy (Olgunoğlu et al., 2009). Atatürk Dam is one of the largest earth-and-rock filled dams in the world, having been built on the Euphrates River in south-eastern Anatolia, Turkey, with a total area of 817 km<sup>2</sup>, is the biggest reservoir in Turkey and has a high fishing potential (Oymak et al., 2009). Through a retrospective study of the literature, it was recognized that the analysis carried out so far on *Barbus grypus* was insufficient and the data on its nutritional value was inadequate. However, it is extremely important to determine and keep a record

of the nutritional quality of such type of nutrients for healthy consumption. In this study, Shabut (*Barbus grypus*) was examined for amino acid sufficiency and balance, additionally the seasonal changes in nutritional values of mineral substances and fatty acids which are known to have extremely important effects on human health were identified with this research. The samples of Shabut (*Barbus grypus*) used in the research were classified according to their length and then the amounts that were edible and inedible were identified with a 0.1g precision scale to obtain meat yield. The ratio of the remaining weight of meat to the total body weight after removing the head, fins, scales and all internal organs was measured as the net edible meat yield and reported in percentage (%) (Izci & Ertan, 2004). For the spring and summer seasons 22 pairs and for autumn and winter seasons 21 pairs (86 fish) were used in this study. The average crude protein, fat, moisture, ash, carbohydrates, energy, copper, (Cu), zinc (Zn), iron (Fe), phosphorus (P) and calcium (Ca) amounts

and analysis of fatty acids and amino acids on edible meat samples were carried out in the Industrial Services Laboratories of TUBITAK–MAM (The Scientific & Technological Research Council of Turkey at Marmara Research Centre). The protein analysis belonging to the samples was carried out according to the Kjeldahl Method (Association of Official Analytical Chemists) (AOAC, 1995), the fat analysis was carried out according to the Acid Hydrolysis Soxhlet System (AOAC, 1995), the moisture analysis was made by dehydrating the homogenized samples to a fixed weight with an incubator, and the raw ash was analysed by burning the samples at 550°C (AOAC, 1995). The carbohydrate and energy calculation of samples were evaluated with the Method of Watt and Merrill (1975), Cu, Zn and Fe were identified according to Atomic Absorption Spectrophotometric

(AAS) Method (AOAC, 2005). The amino acid analysis was carried out on the Varian GC, CP-3800GC by using the devices (Anon, 1998), the fatty acids that belong to the samples were prepared according to the lipids methyl esters IUPAC II. D.19. (1979). Methods and analyses were carried out by using the Elmer Autosystem XL Gas Chromatography and Flame Ionization Detector (FID). Supelco 2330 Fused Silica Capillary Column (30mx0.25mmx0.20µm film width) was used for determining the fatty acid composition. For data analysis, standard deviation and ANOVA were employed by using SPSS 13.0 Windows software. Significance of differences was defined at  $p < 0.05$ . The average meat yield and biochemical composition values of Shabut (*Barbus grypus*) for four seasons are displayed on Table 1.

**Table 1: Average meat yield and biochemical composition values of Shabut (*Barbus grypus*) for four seasons**

Season	Protein (g/100g)	Fat (g/100g)	Moisture (g/100g)	Ash (g/100g)	Carbo-hydrate (g/100g)	Energy (kcal/100g)	Meat yield (%)
Autumn	19.81±0.04 <sup>a</sup>	2.00±0.20 <sup>a</sup>	76.93±0.26 <sup>a</sup>	1.09±0.09 <sup>a</sup>	0.17±0.01 <sup>a</sup>	98±0.10 <sup>a</sup>	68.79±1.90 <sup>a</sup>
Winter	19.63±0.09 <sup>a</sup>	5.73±0.12 <sup>b</sup>	72.40±0.18 <sup>a</sup>	1.24±0.02 <sup>b</sup>	1.00±0.02 <sup>b</sup>	134±0.13 <sup>b</sup>	71.83±4.80 <sup>a</sup>
Spring	17.56±0.04 <sup>b</sup>	3.05±0.16 <sup>a</sup>	76.26±0.21 <sup>a</sup>	0.86±0.01 <sup>c</sup>	2.24±0.02 <sup>c</sup>	107±0.12 <sup>a</sup>	70.35±2.07 <sup>a</sup>
Summer	20.38±0.05 <sup>a</sup>	5.40±0.21 <sup>b</sup>	73.02±0.19 <sup>a</sup>	1.07±0.07 <sup>a</sup>	0.13±0.01 <sup>a</sup>	131±0.20 <sup>b</sup>	68.66±6.47 <sup>a</sup>
Seasonal average	19.34±1.23	4.04±1.81	74.65±2.27	1.06±0.16	0.88±0.99	117.5±17.75	69.91±1.49

Values are shown as means ± SD of triplicate measurements

Mean values in the same row having the same superscript are significantly different ( $P < 0.05$ )

The seasonal averages of protein, ash and moisture amounts displayed similarity to Papan & Moghaddam’s (2008) findings, the meat yield values of Shabut was higher compared to the other species reported by Özcan & Balık 2006; Şen et al.,1996; Duman et al., 2003. Considering that, energy amounts are commonly associated

with the fish fat content, the highest fat amount was found in winter and the energy value was also at the highest in this season. Shabut’s average copper (Cu), zinc (Zn), iron (Fe) phosphorus (P) and calcium (Ca) values according to seasons are displayed on Table 2.

**Table 2: Average amount of mineral substances in Shabut (*Barbus grypus*) according to seasons (mg/100g)**

Season	Cu	Zn	Fe	P	Ca
Autumn	0.36±0.12 <sup>a</sup>	0.81±0.02 <sup>a</sup>	0.61±0.05 <sup>a</sup>	305.9±4.51 <sup>a</sup>	42.79±3.01 <sup>a</sup>
Winter	0.08±0.00 <sup>b</sup>	1.07±0.04 <sup>b</sup>	0.13±0.02 <sup>b</sup>	252.7±2.94 <sup>b</sup>	12.38±2.06 <sup>b</sup>
Spring	0.18±0.01 <sup>c</sup>	1.37±0.03 <sup>b</sup>	1.28±0.08 <sup>c</sup>	263.3±4.54 <sup>b</sup>	31.38±3.21 <sup>a</sup>
Summer	0.24±0.01 <sup>c</sup>	0.95±0.05 <sup>a</sup>	0.73±0.11 <sup>a</sup>	237.4±4.59 <sup>b</sup>	65.24±3.21 <sup>c</sup>
Seasonal average	0.21±0.12	1.05±0.23	0.68±0.47	264.82±29.37	37.95±22.1

Values are shown as means ± SD of triplicate measurements

Mean values in the same row having the same superscript are significantly different ( $P < 0.05$ ).

The Fe amount obtained in our study is found close to the value that was reported by Oymak et al. (2009). From this point of view it can be said that Shabut is a significant source of Fe. Zn and Cu

findings were slightly higher than the reported values in the study carried out by Oymak et al., (2009). Shabut's fatty acid amounts according to seasons are displayed on Table 3.

**Table 3: The seasonal percent of fatty acid composition in Shabut (*Barbus grypus*)**

Fatty acids	Autumn	Winter	Spring	Summer	Seasonal Average
C14:0	1.88±0.01 <sup>a</sup>	2.36±0.02 <sup>b</sup>	2.39±0.01 <sup>b</sup>	2.44±0.00 <sup>b</sup>	2.27±0.26
C 14:1	0.09±0.01 <sup>a</sup>	-	0.29±0.01 <sup>b</sup>	0.13±0.01 <sup>a</sup>	0.13±0.12
C15:0	0.38±0.01 <sup>a</sup>	0.76±0.01 <sup>b</sup>	0.79±0.02 <sup>b</sup>	0.36±0.02 <sup>a</sup>	0.57±0.23
C16:0	19.42±0.03 <sup>a</sup>	23.34±0.09 <sup>b</sup>	22.81±0.10 <sup>b</sup>	20.55±0.07 <sup>a</sup>	21.53±1.85
C16:1	6.98±0.03 <sup>a</sup>	9.55±0.05 <sup>b</sup>	11.08±0.02 <sup>b</sup>	7.58±0.03 <sup>a</sup>	8.80±1.88
C17:0	0.62±0.01 <sup>a</sup>	0.91±0.02 <sup>b</sup>	1.07±0.02 <sup>b</sup>	0.44±0.01 <sup>c</sup>	0.76±0.28
C17:1	-	0.82±0.01 <sup>a</sup>	1.09±0.02 <sup>a</sup>	-	0.47±0.56
C18:0	4.55±0.01 <sup>a</sup>	6.17±0.02 <sup>b</sup>	5.15±0.03 <sup>c</sup>	3.72±0.06 <sup>d</sup>	4.89±1.03
C18:1	20.80±0.02 <sup>a</sup>	27.30±0.03 <sup>b</sup>	25.97±0.12 <sup>b</sup>	21.47±0.04 <sup>a</sup>	23.88±3.23
C18:2 n-6	2.32±0.01 <sup>a</sup>	0.74±0.01 <sup>b</sup>	2.45±0.02 <sup>a</sup>	2.12±0.01 <sup>a</sup>	1.91±0.79
C18.3 n-3	0.99±0.01 <sup>a</sup>	0.24±0.01 <sup>b</sup>	0.78±0.02 <sup>c</sup>	1.56±0.01 <sup>d</sup>	0.89±0.55
C20:1	1.22±0.01 <sup>a</sup>	-	-	1.02±0.01 <sup>a</sup>	0.56±0.65
C20:2	0.30±0.01 <sup>a</sup>	-	0.24±0.01 <sup>a</sup>	0.32±0.01 <sup>a</sup>	0.21±0.15
C20:3 n-3	0.30±0.01 <sup>a</sup>	-	-	0.31±0.00 <sup>a</sup>	0.15±0.18
C20:5 n-3 (EPA)	4.32±0.01 <sup>a</sup>	2.15±0.01 <sup>b</sup>	1.66±0.02 <sup>c</sup>	4.75±0.01 <sup>a</sup>	3.22±1.54
C22:2	2.95±0.15 <sup>a</sup>	-	-	3.11±0.03 <sup>a</sup>	1.51±1.75
C22:6 n-3 (DHA)	15.89±0.08 <sup>a</sup>	10.30±0.11 <sup>b</sup>	11.52±0.14 <sup>b</sup>	13.63±0.11 <sup>a</sup>	12.83±2.46
ΣSFA	26.85	33.54	32.21	27.51	30.03
ΣMUFA	29.09	37.67	38.43	30.20	33.85
Σ PUFA	27.07	13.43	16.65	25.80	20.74
PUFA/SFA	1.01	0.40	0.51	0.94	0.71
Σ n-3	21.5	12.69	13.96	20.25	17.09
Σ n-6	2.32	0.74	2.45	2.12	1.91
n-6 / n-3	0.11	0.05	0.17	0.10	0.11
DHA/EPA	3.68	4.79	6.94	2.87	4.57
unknown	16.99	15.36	12.71	16.49	16.13

Values are shown as means ± SD of triplicate measurements.

Mean values in the same line having the same superscript are significantly different ( $P < 0.05$ )

As displayed in Table 3, the highest fatty acid levels found in Shabut throughout all seasons were 16:0, 18:1, 22:6 n-3 ve 20:5 n-3. Palmitic acid (C 16:0) of the saturated fatty acids (SFA) was observed

as the primary fatty acid which remained predominant in Shabut in all seasons. In many studies carried out by researchers such as Rahman et al. (1995), Haliloğlu et al. (2002), Çelik et al. (2005) and Zlatanov

and Laskaridis (2007) it was notified that the predominant primary saturated fatty acid (SFA) in fresh water fish was palmitic acid.

Through the study, oleic acid (C18:1), a monounsaturated fatty acid type (MUFA), was observed as the predominant primary fatty acid throughout four seasons. Palmitholeic acid (C 16:1) was identified as the secondarily important monounsaturated fatty acid. In many studies carried out in order to determine the fatty acid composition of different fresh water fish, it has been revealed that the predominant characteristic MUFA's are oleic acid and palmitholeic acid (Oliveira et al., 2003; Çelik et al. 2005;

Gonza'lez et al., 2006; Güler et al. 2008; Suloma et al. 2008; Łuczynańska et al. 2008; Akpınar et al. 2009; Osibona et al. 2009). Through the study, C22:6 n-3 (DHA) and C20:5 n-3 (EPA) of polyunsaturated fatty acids were identified as the predominant primary fatty acids throughout four seasons. Information stating that DHA's and EPA's were predominant in fresh water fish out of total PUFAs was similarly reported by many researchers (Oliveira et al., 2003; Çelik et al., 2005; Sushchik et al., 2007; Güler et al., 2008, Łuczynańska et al., 2008). The amino acid amounts in Shabut according to seasons are displayed in Table 4.

**Table 4: The seasonal amino acid amounts (mg/100g) in Shabut (*Barbus grypus*)**

Amino acids	Autumn	Winter	Spring	Summer	Seasonal average
Alanine (Ala)	872.00±8.41 <sup>a</sup>	1233.85±15.48 <sup>b</sup>	1025.70±29.27 <sup>b</sup>	929.70±9.14 <sup>a</sup>	1015±158.89
Glycine (Gly)	687.10±9.14 <sup>a</sup>	1053.05±20.01 <sup>b</sup>	933.00±25.73 <sup>b</sup>	638.50±8.36 <sup>a</sup>	827.91±197.85
*Valine (Val)	845.70±4.12 <sup>a</sup>	1276.95±1.62 <sup>b</sup>	1066.60±0.14 <sup>c</sup>	882.90±2.15 <sup>a</sup>	1018.03±197.78
*Leucine	1148.8±11.56 <sup>a</sup>	1835.65±18.87 <sup>b</sup>	1674.05±23.40 <sup>b</sup>	1233.60±9.05 <sup>a</sup>	1473.02±333.84
*Isoleucine	858.10±9.25 <sup>a</sup>	1230.3±8.34 <sup>a</sup>	1050.10±10.46 <sup>c</sup>	892.0±7.40 <sup>a</sup>	1007.62±170.41
*Threonine	756.10±6.41 <sup>a</sup>	999.5±7.77 <sup>b</sup>	844.00±11.59 <sup>c</sup>	763.80±7.10 <sup>a</sup>	840.85±112.99
Serine (Ser)	553.30±3.84 <sup>a</sup>	769.05±1.06 <sup>b</sup>	678.05±2.61 <sup>c</sup>	579.80±2.10 <sup>a</sup>	645.05±98.55
Proline (Pro)	562.80±4.02 <sup>a</sup>	829.05±8.13 <sup>b</sup>	769.95±7.42 <sup>c</sup>	575.10±5.06 <sup>a</sup>	684.2±135.40
Aspartic acid	2341.4±7.63 <sup>a</sup>	2376.55±12.09 <sup>a</sup>	3076.80±3.81 <sup>b</sup>	2054.40±6.23 <sup>c</sup>	2462.3±434.30
*Methionine	394.70±3.58 <sup>a</sup>	617.45±10.68 <sup>b</sup>	264.90±0.84 <sup>c</sup>	425.80±4.54 <sup>a</sup>	432.4±146.10
Hydrochl-proline	100.50±5.36 <sup>a</sup>	135.45±3.04 <sup>a</sup>	173.30±6.08 <sup>b</sup>	57.00±4.41 <sup>c</sup>	166.5±49.60
Glutamic acid	2272.50±14.35 <sup>a</sup>	2286.65±7.84 <sup>a</sup>	2739.30±16.66 <sup>b</sup>	2242.50±10.01 <sup>a</sup>	2385.2±236.70
*Phenylalanine	476.40±9.24 <sup>a</sup>	897.45±8.27 <sup>b</sup>	787.70±30.12 <sup>c</sup>	493.80±15.14 <sup>a</sup>	663.8±211.30
*Lysine(Lys)	1369.10±14.06 <sup>a</sup>	1604.6±14.21 <sup>b</sup>	1225.00±36.76 <sup>c</sup>	1501.70±13.47 <sup>d</sup>	1425.1±164.60
*Histidine	357.20±3.74 <sup>a</sup>	700.9±5.03 <sup>b</sup>	337.15±1.48 <sup>a</sup>	409.10±3.54 <sup>c</sup>	449.9±170.10
Tyrosine (Tyr)	647.10±11.41 <sup>a</sup>	1117.9±5.11 <sup>b</sup>	474.45±15.20 <sup>c</sup>	669.70±8.17 <sup>a</sup>	727.3±274.60
Tryptophan	-	-	-	-	-
Arginine (Arg)	-	-	-	-	-

\*Essential amino acids

Mean values in the same rows having the same superscript are significantly different ( $P < 0.05$ ).

Values are shown as means ± SD

Aspartic acid of the non-essential amino acids (Asp) and glutamic acid (Glu) were revealed as the amino acids with the highest levels in all seasons, while lysine (Lys), leucine (Leu) and valine (Val) were reported as the essential amino acids with the highest amounts. Similar results were reported for many fresh water species by many researchers (Adeyeye 2009; Kaya et al., 2008; Gonza'lez et al., 2006).

In conclusion, it is revealed that Shabut has a high meat efficiency containing protein, fatty acids and amino acids, besides being a species rich in mineral content such as Cu, Zn, and Fe.

#### Acknowledgements

This Research Project was supported by Adiyaman University Research Foundation (Project No: KMYO BAP-2008/1).

#### References

- Adeyeye, E. I., 2009.** Amino acid composition of three species of Nigerian fish: *Clarias anguillaris*, *Oreochromis niloticus* and *Cynoglossus senegalensis*. *Food Chemistry*, 113, 43–46.
- Association of Official Analytical Chemists, 1995.** Method 925.10 and 990.03. Association of Official Analytical Chemists Official Methods of Analysis 16<sup>th</sup> ed. Washington
- Association of Official Analytical Chemists, 2005.** Method 999.10. Official Methods of Analysis of AOAC International. Methods 18<sup>th</sup>.Ed. AOAC International, Gaithersburg, MD,USA
- Akpinar, M. A., Görgün, S. and Akpinar, A. E., 2009.** A comparative analysis of the fatty acid profiles in the liver and muscles of male and female *Salmo trutta macrostigma*. *Food Chemistry*, 112, 6–8.
- Celik, M., Diler, A. and Küçükgülmez, A., 2005.** A comparison of the proximate compositions and fatty acid profiles of zander (*Sander lucioperca*) from two different regions and climatic conditions. *Food Chemistry*, 92, 637–641.
- Dorostghoal, M., Peyghan, R., Papan, F. and Khalili, L., 2009.** Macroscopic and microscopic studies of annual ovarian maturation cycle of Shirbot *Barbus grypus* in Karon river of Iran. Shiraz University. *Iranian Journal of Veterinary Research*, 27, 172–179.
- Duman, E., Yüksel, F. and Pala, M., 2003.** The investigation of growth characteristics and meat yield of *Barbus capito pectoralis* (Heckel, 1843). *Ege University Journal of Fisheries & Aquatic Sciences*, 20(3–4), 391–398 (in Turkish)
- Gonza'lez, S., Flick, G. J., O'Keefe, S. F., Duncan, S. E., McLean, E. and Craig, S. R., 2006.** Composition of farmed and wild yellow perch (*Perca flavescens*). *Journal of Food Composition and Analysis*, 19, 720–726.
- Guler, G. O., Kiztanir, B., Aktümsek, A., Cital, O. B. and Ozparlak, H., 2008.** Determination of the seasonal changes on total fatty acid composition and  $\omega 3/\omega 6$  ratios of carp (*Cyprinus carpio* L.) muscle lipids in Beysehir Lake (Turkey), *Food Chemistry*, 689–694.
- Haliloglu, H. I and Aras, N. M., 2002.** Comparison of muscle fatty acids of three trout species (*Salvelinus alpinus*, *Salmo trutta fario*, *Oncorhynchus mykiss*) raised under the same conditions. *Turkish*

- Journal of Veterinary and Animal Science*, 26, 1097–1102.
- Anonymous, 1998.** Eppendorf Biotronik LC 3000 Amino Acid Analyzer, Operation Manuel 1998, June Phenomenex EZ Faast GC-FID Hydrolyzed Amino Acid Analysis Kit, Varian GC, CP-3800GC Manuel
- IUPAC 1979.** Standard Methods for Analysis of Oils, Fats and Derivatives, 6th Edition (Fifth Edition Method I.I.D.19) 96-102. Pergamon Pres, Oxford
- İzci, L. and Ertan, O. Ö., 2004.** Changes in meat yield and food component of smoked tench (*Tinca tinca* L., 1758). *Turkish Journal of Veterinary and Animal Sciences*, 28, 1037–1041.
- Kaya, Y., Turan H. and Erdem M. E., 2008.** Fatty acid and amino acid composition of raw and hot smoked sturgeon (*Huso huso*, L. 1758). *International Journal of Food Sciences and Nutrition*, 59(7–8), 635–642.
- Łuczynańska, J., Borejszo, Z. and Łuczynański, M. J., 2008.** The Composition of fatty acids in muscles of six Freshwater fish species from the Mazurian Great Lakes (Northeastern Poland). *Archives of Polish Fisheries*, 16(2), 167–178.
- Olgunoğlu, İ. A., Artar E. and Olgunoğlu M.P., 2009.** The fisheries situation and economic fish species caught in Adiyaman province. *Journal Agriculture Faculty of Harran University*, 13 (2), 29- 34.(in Turkish)
- Oliveira, E. R. N. de, Agostinho, A. A. and Matsushita, M., 2003.** Effect of Biological Variables and Capture Period on the Proximate Composition and Fatty Acid Composition of the Dorsal Muscle Tissue of *Hypophthalmus edentatus* (Spix,1829). *Brazilian Archives of Biology and Technology*, 46,1 105–114.
- Osibona, A. O., Kusemiju, K. and Akande G. R., 2009.** Proximate composition and fatty acids profile of the African Catfish *Clarias gariepinus*. *acta Satech*, 3(1), 85 – 89.
- Oymak, S. A., Akın, H. H. and Doğan, N., 2009.** Heavy metal in tissues of *Tor grypous* from Atatürk Dam Lake, Euphrates River-Turkey. *Biologia*, 64(1), 151—155.
- Özcan, G. and Balık, S., 2006.** The investigation of meat yield of *Chondrostoma meandrense* Elvira, 1987 in the Kemer Dam Lake. *Ege University Journal of Fisheries & Aquatic Sciences*, 23(3–4), 449–451.(in Turkish)
- Papan, F. and Moghaddam, A. X., 2008.** Nutritional Evaluation of Some Species of Fishes in Khuzestan and Determination of the Amount of Soy Bean Meal Used in the Fish Food Formula on the Basis of its Isoflavone Content. *Journal of Biological Sciences*, 8 (3), 667–670
- Rahman, S. A, Huah, T. S., Hassan, O. and Daud, N. M., 1995.** Fatty acid composition of some Malaysian freshwater fish. *Food Chemistry*, 54, 45–49.
- Selki, M. S., Başusta, N. and Çiftçiöğlü, A., 2005.** A Study On Shabbout Fish (*Tor grypous*) Culture National Water Day. *Turkish Journal Of Aquatic Life*, 3(4), 523–525. (in Turkish)
- Suloma, A., Ogata, H. Y., Garibay, E. S, Chavez, D. N. and El-Haroun, E. R., 2008.** Fatty Acid Composition of Nile Tilapia *Oreochromis niloticus* muscles: a Comparative Study With Commercially Important Tropical Freshwater fish in

Philippines 8<sup>th</sup> International Symposium on Tilapia in Aquaculture. 921–932.

- Sushchik, N. N., Gladyshev, M. I. and Kalachova, G. S., 2007.** Seasonal dynamics of fatty acid content of a common food fish from the Yenisei river, Siberian grayling, *Thymallus arcticus*. *Food Chemistry*, 104, 1353–1358.
- Şen, D., Duman, E., Duman, M. and Yapar, A., 1996.** A investigation of biological features of *Barbus esocinus* Heckel, 1843 and *Barbus xanthopterus* Heckel, 1843 populations living in Keban Dam Lake. Firat Univ., *Journal of Science and Engineering*, 8(1), 113–129.
- Watt, B. K. and Merrill, A. L., 1975.**

Composition of Foods: Raw, Processed and Prepared (Agriculture Handbook No. 8.). United States Department of Agriculture. Washington D.C. 190p.

- Zivotofskya, Ari Z. and Amar, Z., 2006.** Identifying the ancient shibuta fish. *Environmental Biology of Fishes*, 75, 361–363.
- Zlatanov, S. and Laskaridis, K., 2007.** Seasonal variation in the fatty acid composition of three Mediterranean fish – sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*) and picarel (*Spicara smaris*). *Food Chemistry*, 103, 725–728.