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

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According to the records of FAO (Food and Agriculture Organization), Shabut, also known as *Barbus grypus*, is one of the most signifcant 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^2, 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 insufficent and the data on its nutiritional value was inadequte. 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, aditionally 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 classfied according to their length and then the amounts that were edible and inedible were identified with a 0.1g precesion 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 & E rtan, 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 Reasearch 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 Hydrolosis Soxtec System (AOAC, 1995), the moisture analysis was made by dehyrating 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 Merril (1975), Cu, Zn and Fe were identified according to Atomic Absorbtion 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 Chromotography 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^{a}	2.00±0.20^{a}	76.93±0.26^{a}	1.09±0.09^{a}	0.17±0.01^{a}	98±0.10^{a}	68.79±1.90^{a}
Winter	19.63±0.09^{a}	5.73±0.12^{b}	72.40±0.18^{a}	1.24±0.02^{b}	1.00±0.02^{b}	134±0.13^{b}	71.83±4.80^{a}
Spring	17.56±0.04^{b}	3.05±0.16^{a}	76.26±0.21^{a}	0.86±0.01^{c}	2.24±0.02^{c}	107±0.12^{a}	70.35±2.07^{a}
Summer	20.38±0.05^{a}	5.40±0.21^{b}	73.02±0.19^{a}	1.07±0.07^{a}	0.13±0.01^{a}	131±0.20^{b}	68.66±6.47^{a}
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.

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

Season	Cu	Zn	Fe	P	Ca
Autumn	0.36±0.12[a]	0.81±0.02[a]	0.61±0.05[a]	305.9±4.51[a]	42.79±3.01[a]
Winter	0.08±0.00[b]	1.07±0.04[b]	0.13±0.02[b]	252.7±2.94[b]	12.38±2.06[b]
Spring	0.18±0.01[c]	1.37±0.03[b]	1.28±0.08[c]	263.3±4.54[b]	31.38±3.21[a]
Summer	0.24±0.01[c]	0.95±0.05[a]	0.73±0.11[a]	237.4±4.59[b]	65.24±3.21[c]
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 compostion in Shabut (*Barbus grypus*)

Fatty acids	Autumn	Winter	Spring	Summer	Seasonal Average
C14:0	1.88±0.01[a]	2.36±0.02[b]	2.39±0.01[b]	2.44±0.00[b]	2.27±0.26
C 14:1	0.09±0.01[a]	-	0.29±0.01[b]	0.13±0.01[a]	0.13±0.12
C15:0	0.38±0.01[a]	0.76±0.01[b]	0.79±0.02[b]	0.36±0.02[a]	0.57±0.23
C16:0	19.42±0.03[a]	23.34±0.09[b]	22.81±010[b]	20.55±0.07[a]	21.53±1.85
C16:1	6.98±0.03[a]	9.55±0.05[b]	11.08±0.02[b]	7.58±0.03[a]	8.80±1.88
C17:0	0.62±0.01[a]	0.91±0.02[b]	1.07±0.02[b]	0.44±0.01[c]	0.76±0.28
C17:1	-	0.82±0.01[a]	1.09±0.02[a]	-	0.47±0.56
C18:0	4.55±0.01[a]	6.17±0.02[b]	5.15±0.03[c]	3.72±0.06[d]	4.89±1.03
C18:1	20.80±0.02[a]	27.30±0.03[b]	25.97±0.12[b]	21.47±0.04[a]	23.88±3.23
C18:2 n-6	2.32±0.01[a]	0.74±0.01[b]	2.45±0.02[a]	2.12±0.01[a]	1.91±0.79
C18.3 n-3	0.99±0.01[a]	0.24±0.01[b]	0.78±0.02[c]	1.56±0.01[d]	0.89±0.55
C20:1	1.22±0.01[a]	-	-	1.02±0.01[a]	0.56±0.65
C20:2	0.30±0.01[a]	-	0.24±0.01[a]	0.32±0.01[a]	0.21±0.15
C20:3 n-3	0.30±0.01[a]	-	-	0.31±0.00[a]	0.15±0.18
C20:5 n-3 (EPA)	4.32±0.01[a]	2.15±0.01[b]	1.66±0.02[c]	4.75±0.01[a]	3.22±1.54
C22:2	2.95±0.15[a]	-	-	3.11±0.03[a]	1.51±1.75
C22:6 n-3 (DHA)	15.89±0.08[a]	10.30±0.11[b]	11.52±0.14[b]	13.63±0.11[a]	12.83±2.46
∑SFA	26.85	33.54	32.21	27.51	30.03
∑MUFA	29.09	37.67	38.43	30.20	33.85
∑ PUFA	27.07	13.43	16.65	25.80	20.74
PUFA/SFA	1.01	0.40	0.51	0.94	0.71
∑ n-3	21.5	12.69	13.96	20.25	17.09
∑ 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. Palmithic 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 caried out by researchers such as Rahman et al. (1995), Haliloğlu et al. (2002), Çelik et al. (2005) and Zlatanos

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and Laskaridis (2007) it was notified that the predominant primary saturated fatty acid (SFA) in fresh water fish was palmithic 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 identifed 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 reavealed 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; £uczyñskaande 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 poly-unsaturated 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, £uczyñska 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^{a}	1233.85±15.48^{b}	1025.70±29.27^{b}	929.70±9.14^{a}	1015±158.89
Glycine (Gly)	687.10±9.14^{a}	1053.05±20.01^{b}	933.00±25.73^{b}	638.50±8.36^{a}	827.91±197.85
*Valine (Val)	845.70±4.12^{a}	1276.95±1.62^{b}	1066.60±0.14^{c}	882.90±2.15^{a}	1018.03±197.78
*Leucine	1148.8±11.56^{a}	1835.65±18.87^{b}	1674.05±23.40^{b}	1233.60±9.05^{a}	1473.02±333.84
*Isoleucine	858.10±9.25^{a}	1230.3±8.34^{a}	1050.10±10.46^{c}	892.0±7.40^{a}	1007.62±170.41
*Threonine	756.10±6.41^{a}	999.5±7.77^{b}	844.00±11.59^{c}	763.80±7.10^{a}	840.85±112.99
Serine (Ser)	553.30±3.84^{a}	769.05±1.06^{b}	678.05±2.61^{c}	579.80±2.10^{a}	645.05±98.55
Proline (Pro)	562.80±4.02^{a}	829.05±8.13^{b}	769.95±7.42^{c}	575.10±5.06^{a}	684.2±135.40
Aspartic acid	2341.4±7.63^{a}	2376.55±12.09^{a}	3076.80±3.81^{b}	2054.40±6.23^{c}	2462.3±434.30
*Methionine	394.70±3.58^{a}	617.45±10.68^{b}	264.90±0.84^{c}	425.80±4.54^{a}	432.4±146.10
Hydrochl-proline	100.50±5.36^{a}	135.45±3.04^{a}	173.30±6.08^{b}	57.00±4.41^{c}	166.5±49.60
Glutamic acid	2272.50±14.35^{a}	2286.65±7.84^{a}	2739.30±16.66^{b}	2242.50±10.01^{a}	2385.2±236.70
*Phenylalanine	476.40±9.24^{a}	897.45±8.27^{b}	787.70±30.12^{c}	493.80±15.14^{a}	663.8±211.30
*Lysine(Lys)	1369.10±14.06^{a}	1604.6±14.21^{b}	1225.00±36.76^{c}	1501.70±13.47^{d}	1425.1±164.60
*Histidine	357.20±3.74^{a}	700.9±5.03^{b}	337.15±1.48^{a}	409.10±3.54^{c}	449.9±170.10
Tyrosine (Tyr)	647.10±11.41^{a}	1117.9±5.11^{b}	474.45±15.20^{c}	669.70±8.17^{a}	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

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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), leusine (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 effciency containing protein, fatty acids and amino acids, besides being a species rich in mineral content such as Cu, Zn, and Fe.

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