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Seasonal changes in meat yields, chemical compositions and fatty acids of endemic Antalya barb (*Capoeta antalyensis*)

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Abstract

The study aimed to determine the seasonal changes in meat yield, chemical composition and fatty acid of *Capoeta antalyensis*. The specimens were caught using the gill nets (16x16, 20x20, 25x25, 30x30, 35x35 and 40x40 mm mesh size) in the Sorgun Dam (Aksu, Isparta, Türkiye). A total of 45 fish were used for this purpose. The lengths of the fish were 18.8 -36.7 cm and their weights were 71.85-452.00 g. Meat yields were determined between 50.20%-56.42% for the skinned fillets, and between 40.65%-48.45% for the skinless fillets. The highest protein value was determined (as 15.73±0.18%) in the autumn. The significant variations were not determined for fat and ash value seasonally (p>0.05). The moisture content was lower in autumn than in other seasons. In the analysis of *C. antalyensis*, 27 different fatty acids were determined.

Key words: protein, fat, ash, moisture, EPA, DHA

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Endemik Antalya sarıbalığının (*Capoeta antalyensis*) et veriminde, kimyasal bileşimlerinde ve yağ asitlerinde mevsimsel değişiklikler

Özet

Çalışma, *Capoeta antalyensis*'in et verimi, kimyasal bileşimi ve yağ asidindeki mevsimsel değişiklikleri belirlemeyi amaçlamıştır. Örnekler, Sorgun Barajı'nda (Aksu, Isparta, Türkiye) solungaç ağları (16x16, 20x20, 25x25, 30x30, 35x35 ve 40x40 mm gözenek büyüklüğü) kullanılarak yakalandı. Bu amaçla toplam 45 balık kullanılmıştır. Balıkların uzunlukları 18.8-36.7 cm ve ağırlıkları 71.85-452.00 g idi. Et verimleri derili filetolar için% 50.20 -% 56.42 arasında ve derisiz filetolar için% 40.65 -% 48.45 arasında belirlenmiştir. En yüksek protein değeri sonbaharda belirlendi (% 15.73 ±% 0.18). Mevsimsel olarak yağ ve kül değeri için anlamlı farklılıklar saptanmadı (p> 0.05). Nem içeriği sonbaharda diğer mevsimlere göre daha düşüktü. C. antalyensis analizinde 27 farklı yağ asidi belirlenmiştir.

Anahtar kelimeler: protein, yağ, kül, nem, EPA, DHA

1. Introduction

The fish is eliminated by natural mortality, hunting mortality, or effects of predators, from the populations which they are found in. When considered within this perspective, our determined fish species, which spread in our inland waters, and the number of which is increasing day by day, complete their life without being used in any way and disappear by natural mortality. Catching these species from lakes, ponds, and rivers with suitable fishing gears and methods and using them with different processing techniques will contribute to the economy and human feeding.

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The most economical using way a resource is closely linked with recognizing every attribute of the resource. As a result of the fauna determinate studies that have been completed and continued in recent years, it has been shown that the inland water fish potential of our country is quite rich qualitatively [1, 2, 3] (There are 409 fish species in inland water and including 194 of which are endemic). By determining the nutritive characteristics of these species, the extant fisheries pressure on certain species in inland waters will thus be reduced.

The species belonging to the *Capoeta* genus, which spread on four continents, most of them are found in Turkey. Recent studies from Turkey shown 23 species were identified [1, 4, 5]. Those species in Turkey are consumed in various regions as human food. It is especially preferred with its hard structure, and flavor of the meat. However, the species is not a commercial fisheries subject. This is due to that it is not commercially made into a product by any processing method. The lack of knowledge of the nutritional properties of the species is another handicap. In this study, it was aimed to reveal the meat yield, chemical composition, and fatty acids of *Capoeta antalyensis* (Antalya barb). Thus, different perspectives related to this species (aquaculture or fisheries studies) will be developed.

2. Materials and methods

The fish used in the study were caught in a one-time fish sampling were carried out at Sorgun Dam in every season (Figure 1). The gill nets (16x16, 20x20, 25x25, 30x30, 35x35, 40x40 mm mesh) were used for sample fishing. A total of 45 fish were used for this purpose. All of them 14 of these were caught in spring, 10 in summer, 10 in autumn, and 11 in winter. In this study, no experimental study was done on animals (fish).

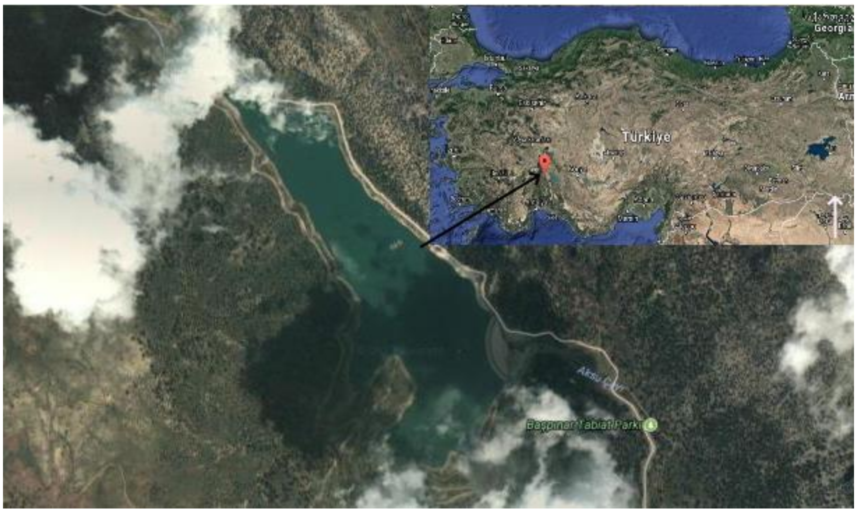

Figure 1. Study area

2.1 Physical measurements and assays

For meat yields and chemical compositions analysis, the fish caught in seasonal fishing were cooled with ice batteries in the transport cabinet and brought to the laboratory with a vehicle type refrigerator. Their lengths were measured (total length, with a 1mm precision measuring board), and their weights were weighed (with a 0.01 g precision digital balance). The sexual identification of fish was conducted macroscopically. The ages of the fish were determined from the scales. Visceral organs, heads, backbones, and fins were separated for the determination of meat yields. The skinned and skinless fillets weights, internal organs, spine and fins and head weights were weighed [6]. Then, fillets were homogenized with a blender, and total protein, total fat, moisture, and ash analyses were performed. Sufficient fish samples were kept for fatty acid analysis and stored at -80^{o}C until analysis.

2.2 Chemical composition analysis

The moisture (%) was determined gravimetrically by automatic moisture determination device (Kern DBS, Germany). The total amount of fat (%) and the amount of ash (%) were determined according to Lovell [7]. Total protein (%) was determined by the Kjeldahl method (Nx6.25) according to AOAC [8] (Method no. 940: 25, (modified)). Carbohydrate (%) was determined mathematically by using a formula, (100- (Moisture + Fat + Protein + Ash)) [9].

2.3 Fatty acids analysis

The 5 g of previously homogenized fish meat was weighed and extracted by chloroform/methanol method. The chloroform was evaporated to procure the fish oil. 0.01 g of oil was weighed and 2 ml of hexane and 4 ml of 2M KOH were added. The mixture was shaken for 2 minutes by the vortex. After centrifugation for 10 minutes at 4000 rpm in the centrifuge, the upper clear hexane phase was taken into vials and read in the device [10].

GC conditions: The device Shimadzu TQ 8040 GC analyzer and MS detector were used. Column TRCN 100 (100 m x 0.25mm x 0.20µm). Column temperature 140°C, Injection temperature 240°C, Column temperature program 140°C 6 min, 4°C/min increase to 240°C and 10 min waiting time, Split rate 1/100, carrier gas He, flow rate 1.18 ml/min. Pressure 274.6 kPa, Injection Volume: 1µL, FAME, and NIST libraries were used.

MS conditions: Ion source temperature: 200ºC, Interface temperature: 240ºC, Solvent cutting time: 7.35 min, Scanning speed 1428, Mass range 41-450 m/z é = 70V.

2.4. Statistics

One-way ANOVA was used to determine the variance differences of the data obtained. The DUNCAN multiple comparison tests were used to compare the groups at the 0.05 significance level [11].

3. Results

3.1 Mean values for meat yield of C. antalyensis

The lowest and highest values of weight for skinned and skinless fillets were obtained in spring. The lowest value of the skinned fillet was 37.01 g and for the skinless fillet 32.32 g. The highest weight was 255.00 g for the skinned fillet, and 219.00 g for the skinless fillet. The lowest and highest meat yields for skinned fillets were calculated as 50.2% and 56.42%. These values in skinless fillets were 40.65% and 48.45%, respectively. As a result of statistical comparison, visceral organs and heads weights showed significant differences in all seasons. Skinned and skinless meat yields in the summer were showed significant differences compared to other seasons (Table 1 and Table 2).

Table 1. The lowest and highest seasonal data of fish used to determine meat yields

Season		Total length (cm)	Weight (g)	Visceral Organ W (g)	Head weight (g)	Backbone and fins weight (g)	Skinned fillets weight (g)	Skinless fillet weight (g)	Skinned meat yield (%)	Skinless meat yield (%)
Spring	Min.	18.8	71.85	12.19	10.43	10.31	37.01	32.32	51.51	44.98
(n=14)	**Max.**	36.5	398.80	51.17	73.16	66.20	200.21	173.02	50.20	43.39
Summer	Min.	19.9	75.00	5.00	13.00	12.00	42.00	36.00	56.00	48.00
(n=10)	**Max.**	36.7	452.00	38.00	67.00	74.00	255.00	219.00	56.42	48.45
Autumn	Min.	24.9	149.80	16.91	21.10	24.12	81.18	71.57	54.19	46.87
(n=10)	**Max.**	28.8	223.28	25.35	33.04	40.98	122.52	104.65	54.87	47.78
Winter	Min.	22.0	106.03	6.29	15.97	21.85	58.83	51.02	50.89	40.65
(n=11)	**Max.**	26.1	152.37	13.29	28.20	27.00	77.54	61.94	55.48	48.12

Table 2. The seasonal mean data of fish used to determine meat yields

Criteria \ Season	Spring	Summer	Autumn	Winter
Total length (cm)	23.51±0.45^{a}	26.62±1.62^{a}	26.45 ± 0.42^{a}	26.42 ± 0.42^{a}
Weight (g)	132.31±6.22^{a}	08.28±39.54^{a}	195.20±43.04^{a}	173.16±9.01^{a}
Visceral organ weight (g)	10.07±0.88^{b}	35.68±9.12^{a}	20.10±4.25^{ab}	19.57±1.70^{ab}
Head weight (g)	17.59±1.42^{b}	35.56±6.61^{a}	31.50±6.54^{ab}	25.73±1.58^{ab}
Backbone and fins weight (g)	25.87±1.36^{a}	29.88±5.85^{a}	30.00±7.14^{a}	28.41±1.77^{a}
Skinned Fillet Weight (g)	71.28±2.89^{a}	101.29±18.08^{a}	104.50±23.75^{a}	94.48±5.02^{a}
Skinless Fillet weight (g)	61.90±2.56^{a}	87.48±15.76^{a}	90.60±20.36^{a}	81.79±4.27^{a}
Skinned meat yield (%)	54.06±0.66^{a}	49.87±0.98^{b}	53.29±1.16^{a}	54.56±0.62^{a}
Skinless meat yield (%)	46.98±0.84^{a}	43.19±1.01^{b}	46.46±1.11^{a}	46.26±0.72^{a}

* The difference among the values indicated by the same letter was insignificant (p> 0.05).

3.2 Seasonal variations of chemical compositions values

Ash values of *C. antalyensis* varied between 1.00 ± 0.03% (winter) and 1.42 ± 0.21% (autumn) (Table 3). The highest moisture content was obtained in the spring (81.73 ± 0.18%) and the lowest autumn (79.83 ± 0.12%). The highest protein value was determined in autumn (15.73 ± 0.18%) and the lowest summer (14.06 ± 0.38%). Total fat contents varied between 2.38 ± 0.11 (spring) and 2.87 ± 0.37 (summer). The lowest carbohydrate (CH) content was calculated in the spring and the highest in the autumn.

Table 3. Seasonal variations of the chemical composition of *C. antalyensis*

Season	Ash (%)	Moisture (%)	Protein (%)	Lipid %	CH*
Spring	1.31±0.12[a]	81.73±0.18[a]	14.44±0.02[ab]	2.38±0.11[a]	0.14[a]
Summer	1.30±0.04[a]	81.25±0.15[a]	14.06±0.38[a]	2.87±0.37[a]	0.52[a]
Autumn	1.42±0.21[a]	79.83±0.12[b]	15.73±0.18[c]	2.43±0.12[a]	0.59[a]
Winter	1.00±0.03[a]	81.26±0.54[a]	14.84±0.12[b]	2.59±0.03[a]	0.31[a]

The difference among the values shown with the same letter was insignificant (p> 0.05).
**These data were obtained by calculation*

3.3 Fatty acids analysis results

27 different fatty acids were identified in the seasonal analyses (Table 4). The number of fatty acids without double bonds (SFA) is 8, the number of fatty acids with one double bond (MUFA) is 7, and the number of fatty acids with two and more double bonds (PUFA) is 12. The five of these fatty acids were in the n-3 group, the six in the n-6 group, the two in the n-9 group, the one in the n-11 group, and the one in the n-12 group. C18:1n-11 and C19:0 in the autumn samples, and C22:2 fatty acids in the winter samples could not be detected (Table 4). n-6 / n-3 ratio was calculated in the lowest winter season (0.26) and highest in spring (0.37). The DHA / EPA ratio was determined in the lowest winter samples (1.48), and the highest autumn samples (1.97).

Table 4. Seasonal fatty acid values of *C. antalyensis* (%)

	Spring	Summer	Autumn	Winter
C4:0	0.80±0.30[a]	0.49±0.24[a]	0.92±0.2[a]	0.19±0.12[a]
C14:0	1.65±0.00[a]	1.92±0.80[a]	0.89±0.3[a]	1.34±0.08[a]
C15:0	0.61±0.08[a]	1.81±0.15[c]	1.81±0.2[c]	1.11±0.12[ab]
C16:0	10.58±4.1[ab]	10.78±3.2[ab]	8.31±0.91[ab]	14.55±1.35[ab]
C16:1	4.29±0.53[a]	7.57±1.29[ab]	6.37±0.87[ab]	6.17±1.37[a]
C17:0	4.40±3.49[ab]	4.73±2.44[ab]	8.40±1.47[b]	2.71±1.76[ab]
C17:1	0.28±0.08[a]	0.87±0.30[a]	0.31±0.04[a]	0.73±0.26[a]
C18:0	3.83±0.81[a]	3.30±0.39[a]	3.15±0.58[a]	3.75±0.91[a]
C18:1	3.83±0.81[b]	0.98±0.86[a]	1.79±0.34[ab]	2.79±0.91[ab]
C18:1n-9(c)	10.45±0.0[a]	12.19±2.2[a]	10.51±0.0[a]	9.55±2.38[a]
C18:2n-6(t)	0.79±1.36[a]	0.82±0.38[a]	2.32±0.28[ab]	0.63±0.55[a]
C18:2n-6(c)	0.89±0.00[a]	2.98±1.17[a]	2.43±0.19[a]	2.78±0.18[a]
C18:3n-6	1.50±0.74[a]	0.54±0.29[a]	0.56±0.07[a]	0.52±0.15[a]
C18:1n-12	0.23±0.00[a]	0.39±0.20[a]	0.1±0.00[a]	0.55±0.17[ab]
C18:1n-11	0.31±0.00[a]	0.86±0.31[a]		0.26±0.10[a]
C19:0	0.22±0.00[a]	0.36±0.00[a]		0.23±0.10[a]
C22:5n-3	2.98±0.00[a]	5.12±0.94[bc]	4.69±0.28[bc]	5.70±0.30[bc]
C20:0	4.75±0.32[b]	0.15±0.04[a]	0.18±0.06[a]	0.25±0.08[a]
C18:3n-3	0.30±0.00[a]	6.19±2.48[ab]	6.36±1.54[ab]	7.31±2.08[ab]
C20:1n-9	2.95±0.70[b]	0.78±0.45[a]	1.75±0.18[ab]	0.64±0.27[a]
C20:2n-6	0.65±0.06[b]	0.25±0.08[a]	0.24±0.05[a]	0.31±0.13[a]
C20:3n-6	0.66±0.26[a]	0.50±0.03[a]	0.66±0.11[a]	0.59±0.03[a]
C20:3n-3	0.84±0.00[a]	0.46±0.12[a]	0.36±0.22[a]	0.24±0.11[a]
C20:4n-6	6.05±0.80[a]	3.78±0.74[a]	4.77±0.27[a]	3.98±0.91[a]
C22:2	0.46±0.08[a]	0.23±0.00[a]	0.29±0.06[a]	
C20:5n-3	9.49±0.69[b]	6.95±0.48[ab]	7.14±0.33[ab]	8.08±1.52[b]
C22:6n-3	14.73±1.2[b]	11.17±2.2[ab]	14.08±0.7[ab]	11.99±3.16[ab]
Σ SFA	26.84	23.54	23.66	24.13
Σ MUFA	22.34	23.64	20.83	20.69
Σ PUFA n-3	28.80	30.12	32.92	33.32
Σ PUFA n-6	10.54	8.87	10.98	8.81
n-6 / n-3	0.37	0.29	0.33	0.26
DHA/EPA	1.55	1.61	1.97	1.48

*Difference between the values shown with the same letter was insignificant (p> 0.05)

4. Conclusions and discussion

According to the data obtained by seasonally, the lowest average total length for all individuals was measured as 23.51±0.45 cm in the spring. The highest mean total length was 26.62±1.62 cm in the summer. There was no statistically significant difference in the total length values obtained in the seasons (p> 0.05). It is seen that a similar change occurs in weights values in parallel with the obtained length values. The mean minimum and maximum weight values were weighed 132.31 ± 6.22 g and 208.28 ± 39.54 in the spring and in the summer. There were no seasonally differences between mean weight values ($p > 0.05$). The mean visceral organ weights were found to be lowest 10.07 ± 0.88 g in the spring and 35.56 ± 6.61 g in the highest summer season. The difference between the values obtained in the spring and summer seasons was significant ($p < 0.05$). This may be due to the fact that the breeding period of the species is between these two seasons. The data obtained in the autumn and winter seasons did not differ from statistically ($p > 0.05$). Head weights data were statistically similar to visceral organ weights data. There was no seasonal difference between the backbones and fins weights according to the results of the statistical evaluation ($p > 0.05$). No statistically significant difference was found between skinned and skinless fillets weights obtained according to the seasons ($p > 0.05$). Skinned and skinless meat yields obtained in the summer were significantly lower than those obtained in the other seasons ($p < 0.05$). This can be explained by the high internal organs weights of the individuals obtained during summer. Because it is known that the nutritional requirement of the fish increases in this period, which coincides with the reproduction period.

Flavor and meat yield, which are effective in price formation, are mentioned as the most important quality criteria of fish and are reported to be effective on consumer preference [12]. As a commercial enterprise can demonstrate its profitability or want to calculate the efficiency of its economic inputs, also a conscious consumer will also want to know the gained benefits by his money [13]. In particular, lack of sufficient information on both meat yields and biochemical compositions of inland water fishes limit to use beneficial from those species. In this context, the studies to determine meat yield and nutrient contents for those species will be guiding in terms of raw material selection and processing technologies of seafood processing plants.

It is reported that the fish have an average meat yield of 30-60% [14]. Fish size, age, sex, and anatomical shape of the body, head size, internal organ weight, and full or empty of the digestive system affected the yields of the fillets and meats [15]. As the gonads of the female fish have a significant effect on the meat yield compared to the male fish, so it is not recommended to catch in the reproduction period [15]. If fish that are known to be in the breeding period are not caught, they will help prevent economic losses for enterprises and ensure the fish to retain their natural balance in their waters.

It was aimed to use at least 10 fish to determine the meat yield in each season. The total length values of the fish used for this purpose were measured from 18.8 to 36.7 cm. The weight values were weighed between 71.85 g and 452.00 g. In order to determine the meat yields, the edible parts of the fish were also weighed separately. Visceral organs were between 5.00 g - 51.17 g, heads weights 10.43 g - 73.16 g, and backbones and fins weights ranged from 10.31 g to 74.00 g. Fillet weights, which form the basis of meat yield, were weighed between 37.01 g and 255.00 g skinned, and 32.32 g to 219.00 g skinless. The meat yield obtained by calculation was determined between 50.20% - 56.42% in skinned fillets and 40.65% - 48.45% in skinless fillets. Skinned fillet meat yields did not fall below 50% in any season. Since the scale and skin of this species do not exhibit an undesirable/unfavorable feature during consumption, it may be advisable to consume the fillet skinned.

The meat yield values obtained from different localities and species of *Capoeta* genus: for *Capoeta capoeta umbla* 61.44% in Karasu river [16]; for *Varichorinus (Capoeta) pestai* (skinned) 62.74% in Konya area [19]; 62.51% for *Capoeta trutta* (average) in Keban Dam [17]; for *Capoeta capoeta umbla* age groups III, IV and V in Keban Dam (average) for; 39.1 ± 0.9%, 46.7 ± 1.9%, 43.7 ± 5.3% respectively, and Hazar Lake; 40.3 ± 7.4%, 40.9 ± 2.5%, 41 ± 3.5%, respectively [18]; for *Capoeta trutta* species 54.66% in the Atatürk Dam [19]; 45.03 ± 0.02 [20]; for *Capoeta trutta* (average) 57.57%, and for *Capoeta umbla* 61.92% in Uzunçayır Dam [21] were observed to be obtained. The fillets meat yield values for *Capoeta capoeta umbla* species obtained by Köprücü and Özdemir [18] is lower than the findings obtained in our study, but the values obtained in other studies are higher. When the species examined in the studies are considered to differ from, it is necessary to evaluate the obtained results of comparing meat yields as normal.

There was no seasonal difference for ash values in statistical analysis ($p > 0.05$). On the other hand, autumn moisture value was lower than other seasons and this difference was significant ($p < 0.05$). Protein values obtained in spring showed similarity with summer and winter values but showed significant ($p < 0.05$) difference from values obtained in autumn. The highest protein value was 15.73 ± 0.18% in autumn. Lipid values did not differ significantly ($p > 0.05$). Carbohydrate (CH) values were obtained by calculation.

The chemical components of fish vary depending on various factors [6]. One of these factors is the season. Despite the low moisture content in autumn, high protein and ash content and low-fat content can be considered as an indicator that the species is well-fed before the winter season, and its somatic development increases during this season. The values of the protein content were varied between 14.06±0.38%-15.73± 0.18% which indicates that the species can be considered as a good protein source.

As a reliable study was couldn't find in the literature subjected chemical composition of *C. antalyensis* the comparison was made with the other species belonging to the genus *Capoeta*. Dry matter, crude protein, fat, and ash values of surimi made from *Capoeta capoeta umbla* were 17.62%, 18.16%, 1.45%, 0.62% respectively [22]. The crude protein, crude oil, crude ash and dry matter ratios of surimi obtained from *Capoeta capoeta capoeta* were between 18.18-18.61%, 1.06-1.41%, 0.49-0.74%, and 17.28-18.88%, respectively [23]. For the *Capoeta trutta* male individuals in the Ataturk Dam for protein 17.60 ± 0.29%, fat 1.30 ± 0.20%, dry matter 20.71% ± 0.54, ash 1.38 ± 0.06% values were obtained [26]. *Capoeta trutta* living in Atatürk Dam has a crude protein content 18.22 ± 3.13%, crude ash content 1.37 ± 0.50%, and 82.46 ± 0.30% the moisture is reported [24].

Seafood with a high digestible protein content has a low content of fat compared to other high protein foods. On the other hand, especially when the n-3 group fatty acids are examined in terms of, the seafood oil shows very high values. It has been reported that seafood oils are the natural resource for Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are among the n-3 group fatty acids, that have been shown to benefit on human health [25]. These fatty acids, which cause important biochemical and physiological changes in the human body, are recommended for their beneficial effects in the prevention and treatment of cardiovascular diseases, cancer, diabetes, and high blood pressure [26, 27, 28]. It is very important that the unsaturated fat content of the foods consumed is high. Fatty acids are collected in the eye, brain, testis, and placenta in the human body. It helps the eyes to function properly and perform brain functions properly. Regulates the concentration of fat in the blood [26].

Humans are not capable of synthesizing fatty acids have containing above 9 carbons atom double bonds when counted from the end of the carboxyl molecule. For example, linoleic acid (C18: 2n-6) that among the essential fatty acids non-synthesized in the human body, should be taken by the way foods [29]. The rate of fat in fish and their fatty acid composition contained in these oils may vary according to various factors such as species, individuals, body regions, nutrition, fishing season, and gender [26, 30]. The amount of fat in fish can be between 1% and 20% and in shellfish, it is less than 1% [26]. The fish oils contained 20% saturated and 80% unsaturated fatty acids, also 16, 18, 20, 22 carbons, and 1, 2, 3, 4, 5, 6 double bonds are reported. In addition to this, while free fatty acids are found in fish oil, the tocopherols with antioxidant properties very little contained, so oxidation in fish oils, color darkening, and rancidity are seen. Fat-free fish have phospholipids instead of triglycerides [31].

The fatty acids composition of fish oil increases the importance of fish in terms of nutrition. On the other hand, it is one of the factors that have a decisive effect on the aroma, flavor, and shelf life of the products during processing and storage of seafood products rich in fatty acids containing more than one double bond [30]. EPA and DHA, which are n-3 group fatty acids only found in fish, are found to be less in freshwater fish compared to marine fish [31]. Fatty acids of marine fish species are characterized generally by low levels of linoleic acid (18: 2n-6) and linolenic acid (18: 3n-3), and high amounts of long-chain n3 group polyunsaturated fatty acids [10]. The fatty acids composition of fish oils, particularly fatty acids (PUFAs) which contain more than one double bond, is varied according to the fatty acids of fats in foods consumed by fish. Fatty acids diversity varies according to the responses of the fish body adaptation mechanism against the changes in water temperature, salinity and depth [32]

In the seasonal analyses of *C. antalyensis* revealed 27 different fatty acids. C18: 1n-11 and C19: 0 were not detected in autumn samples, and C22: 2 fatty acids were not detected in winter samples. Among the without double-bonded fatty acids (SFA) C16: 0 had the highest value. Minimum and maximum values ranged between 6.95 ± 0.48% in summer and 9.49 ± 0.69% in spring for Eicosapentaenoic acid (EPA) whereas those for docosahexaenoic acid (DHA) between 11.17 ± 2.21% in summer and 14.73 ± 1.28% in spring. Low amounts of C19: 0 fatty acid was detected in the samples. The total values of without double-bonded fatty acids (SFA) were the lowest in summer 23.54% and the highest in winter 26.84%. The lowest total MUFA value was obtained in winter with 20.69%, and highest in summer with 23.64%. In the spring, the total value of n-3 group fatty acids was lower than the other seasons. The total values of n-6 group fatty acids were higher in spring and autumn compared to summer and winter seasons.

In another study in which the highest total MUFA value was obtained in summer, it was reported that this was due to increased enzyme activity during these months, and that fish could convert MUFA to n-3 and n-6 group fatty acids [33]. It is considered that the amount of palmitic acid (C16: 0), expressed as the key to metabolism, does not change depending on the presence of nutrients, but the fluctuating changes seen in some species may be related to water temperature [34].

It is reported that *Capoeta capoeta umbla* living in Keban Dam has higher fatty acids and nutritiousness are higher than *Capoeta trutta* [34]. It is reported that the first reaction to the change in environmental conditions is seen in total fat and fatty acids. So, in addition to the differences in habitat, the differences of the environmental conditions were effective on the fatty acids ratio and diversity in *Capoeta capoeta umbla* samples obtained Tuzla Creek and Tercan Dam [33]. The total SFA value in Tuzla Creek samples was higher (42.05% in summer) and the total MUFA value was generally higher in Tercan Dam samples, but, the highest value (28%) was obtained in Tuzla Creek in summer samples. While increasing the total amount of more than one double-bounded fatty acids (PUFA) and n-3 group PUFA of *Capoeta damascina*, which grown in freshwater and different salt ratio (6, 12, and 24 g/l) brackish water, although the ratio increasing of salt, the total amount of one double-bonded fatty acids significantly decrease [32]. Fallah et al., [32] reported that 100 g of the edible portion of *Capoeta damascina* grown in waters with a salt content of 6 and 12 g / l as well as freshwater is a good source of n-3 PUFA and especially EPA and DHA. A similar assessment is made for *Capoeta sieboldii* and *Capoeta baliki* according to the total lipid and fatty acid diversity in the liver and muscles and it is reported to have a high nutritional value for polyunsaturated fatty acids for human nutrition [35]

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