AQUATIC RESEARCH

AQUATIC RESEARCH
E-ISSN 2618-6365

Aquat Res 6(1), 11-18 (2023) • https://doi.org/10.3153/AR23002 Research Article

Investigation of fatty acid profiles in some economically important fish species living in Atatürk Dam Lake, Adıyaman, Türkiye

Yasin YAKAR[1], Arif PARMAKSIZ[2], Yaşar DÖRTBUDAK[3], Necmettin DOĞAN[4]

Cite this article as:
Yakar, Y. Parmaksız, A., Dörtbudak, Y., Doğan, N. (2023). Investigation of fatty acid profiles in some economically important fish species living in Atatürk Dam Lake, Adıyaman, Türkiye. *Aquatic Research*, 6(1), 11-18. https://doi.org/10.3153/AR23002

[1] Harran University, Organized Industrial Zone Vocational School, Food Processing Department, 63100, Şanlıurfa, Türkiye

[2] Harran University, Faculty of Science and Art, Department of Biology, 63100, Şanlıurfa, Türkiye

[3] Harran University, Faculty of Veterinary Medicine, Department of Fisheries and Diseases, 63100, Şanlıurfa, Türkiye

[4] Adıyaman Bilim Sanat Merkezi, Esentepe mahallesi, 02230 Adıyaman, Türkiye

ORCID IDs of the author(s):
Y.Y. 0000-0003-3297-3379
A.P. 0000-0003-0321-8198
Y.D. 0000-0001-7966-5678
N.D. 0000-0001-7125-6319

Submitted: 28.06.2022
Revision requested: 06.07.2022
Last revision received: 04.09.2022
Accepted: 04.09.2022
Published online: 17.11.2022

Correspondence:
Arif PARMAKSIZ
E-mail: aprmksz@gmail.com

© 2022 The Author(s)

Available online at
http://aquatres.scientificwebjournals.com

ABSTRACT

This study aims to determine the fatty acid profile of 10 fish species (*Carassius gibelio (Bloch, 1782), Chondrostoma regium (Heckel, 1843), Cyprinus carpio (Linnaeus, 1758), Carassius auratus (Linnaeus, 1758), Alburnus sellal (Heckel, 1843), Planiliza abu (Heckel, 1843), Capoeta trutta (Heckel, 1843), Arabibarbus grypus (Heckel, 1843), Mastacembelus mastacembelus (Banks & Solander 1794)*) caught from Atatürk Dam Lake, sold by fishermen and consumed by local people. Accordingly, the fish species identification was made and the individuals belonging to the determined species were randomly selected and muscle tissue was taken from each sample for fatty acid analysis and put into tubes. Extraction of fats from muscle tissue was carried out using a chloroform-methanol solvent mixture. The methylation process of fatty acids was carried out using the TS EN ISO 12966:2 method. Analyzes were performed with Thermo brand Trace GC model GC with FID (Flame Ion Detector) detector. A 60 m HP-88 column was used in the analysis. It has been determined that 10 fish species contain a total of 26 different fatty acids. Palmitic acid is the major fatty acid among saturated fatty acids (SFA). Palmitic acid values vary between 18.31 % and 25.51 %. It was determined the most in *C. carpio* and the lowest in *C. auratus*. Among the mono unsaturated fatty acids (MUFA), oleic acid is the major fatty acid and was found between 12.70 % and 29.77 %. It was detected at most in *A. sellal* with a rate of 29.77 % and in *P. abu* with a minimum rate of 12.70 %. Of the polyunsaturated fatty acids (PUFA), docosahexaenoic acid is seen as the major fatty acid. It was detected at most in *C. trutta* with a rate of 14.24 %, and at a minimum in *C. carpio* with a rate of 0.62 %.

Keywords: Atatürk Dam Lake, Economic fish species, Fatty acid, Fish meat, Nutrition

Introduction

Fisheries are very important source of natural life, as it contributes to the economy of countries with a certain investment and labor, as well as human nutrition. A healthy and balanced diet can be provided by making high use of marine and freshwater fish (Doğan, 2007). Atatürk Dam Lake, built on the Fırat (Euphrates) River, is Türkiye's largest dam lake, and besides electricity generation, and agricultural irrigation, it also constitutes a significant source of aquaculture for the local people (Alhas et al., 2009; Fırat et al., 2018).

About 28 fish species from eight families live in the Fırat (Euphrates) River. Some of them are caught by the fishermen of the region due to their economic value. (Oymak, 1998). These caught fish are important both in terms of providing the food needs of the local people and in terms of creating employment opportunities. The meat of fish is an important food due to its chemical properties, low cholesterol content, being rich in minerals and vitamins, as well as having essential amino acids (Kaçar et al., 2016). The interest in the fatty acid profiles of fish has increased day by day with the understanding that the omega-3 group fatty acids contained in fish oil are also good for hypertension, cardiovascular diseases, depression, cancer and similar diseases (Kaçar, 2010).

Lipids in fish, which are considered a great source of essential fatty acids recommended in human nutrition, are important biochemical components that perform energy and structural functions, and the lipid component of muscle tissue is largely represented as the composition of the total lipid content. It is important to determine the fatty acid profiles of fish species consumed by the public (Kaçar et al., 2018).

The aim of this study is to determine the fatty acid profile of 10 fish species that are sold by fishermen from Atatürk Dam Lake and consumed by local people. Accordingly, the types and amounts of fatty acids belonging to the consumed species will be revealed and the chance to be preferred for diet will be obtained. In this way, it will be possible to compare the fatty acid profiles of fish caught and sold at the same time by fishermen at the species level. Seasonal changes of fatty acid amounts of some fish species related to fatty acid analysis were studied (Satar et al., 2012; Kaçar et al., 2016; Yılmaz et al., 2016; Kaçar et al., 2018; Dağtekin et al., 2018). However, the amount of fatty acid in the fish consumed by the public and sold at the same time has not been determined. In this study, these analyzes were made and the data of the species were compared.

Material and Methods

The fishes used in the study are the samples caught from the Atatürk Dam Lake fed by the Euphrates (Euphrates) River in October 2020 and were purchased from fishermen in Adıyaman. Fish species that are especially consumed by people were selected for the study. Individuals belonging to the species identified by species identification were randomly selected and muscle tissues was taken from each sample for fatty acid analysis and put into tubes.

Extraction of oils from fish muscles was carried out using a solvent mixture of chloroform and methanol (2:1) according to the method specified by Folch et al (1957). The methylation process of fatty acids was carried out according to the TS EN ISO 12966:2 method. For this, 100 mg of oil sample was weighed in a 10 ml capped test tube, 2 ml of isooctane and 100 µl of 0.2 M methanolic potassium hydroxide solution were added. The cap of the test tube was closed and mixed in vortex for 1 minute. 2 ml of 40% NaCl solution was added into the tube and shaken again. The isooctane phase was transferred to a vial and mixed by adding about 1 g of sodium hydrogen sulfate. After waiting for about 30 minutes, 1 µL of the upper phase was taken and injected into the device.

Analyzes were carried out with GC with Thermo brand {Trace GC model with FID (Flame Ion Detector)} detector. A 60 m HP-88 column was used for the analyses. Detector and injection block temperatures were set at 280 °C and 250 °C, respectively. A temperature program was applied to the column: After it was kept at 50 ºC for 2 minutes, it was increased to 180 ºC with an increase of 20 ºC / min, and from this temperature to 230 ºC with an increase of 5 ºC / min, and waited at this temperature for 5.5 minutes. The split ratio was set at 1/50 and the injection amount was 1 µL.

Atherogenic and Thrombogenic Health Lipids Indices

The atherogenicity (AI) index indicates the risk of developing diseases such as the accumulation of fat on the artery walls. Thrombogenicity (TI) describes the likelihood of a blood clot forming. Fatty acid data of fish oils were used to calculate (AI) and (TI) indices (Garaffo et al., 2011). AI and TI indices were calculated according to the following formulas:

$$AI=(4\times C14{:}0+C16{:}0)/(\Sigma MUFA+\Sigma PUFA);$$

$$TI=[(C14{:}0+C16{:}0+C18{:}0)/(0.5\times\Sigma MUFA+0.5\times\Sigma n6\ PUFA+3\times\Sigma n3\ PUFA+(n3/n6))].$$

Statistical Analyzes

Statistical analyzes of the obtained data were performed with the SPSS (22.0) computer program. For all samples, the analysis was performed in triplicate. Results were reported as mean value and standard deviation (mean±SD). Fatty acids were analyzed by analysis of variance (ANOVA) and comparisons between means were made with the Tukey test. The differences between the means were considered statistically significant at the $p<0.05$ level.

Results and Discussion

A total of 26 different fatty acids were determined in 10 fish species collected from Adıyaman Province, sold by fishermen and consumed by the public. Fatty acid compositions of fish species are given in Table 1. When Table 1 and Figure 1 are examined, it is seen that palmitic acid is the major fatty acid among saturated fatty acids (SFA). Palmitic acid values vary between 18.31 % and 25.51 %. It was determined the most in *C. carpio* and the lowest in *C. auratus* ($p<0.05$). Among the mono unsaturated fatty acids (MUFA), oleic acid is the major fatty acid and was found between 12.70 % and 29.77 %. It was detected at most in *A. sellal* with a rate of 29.77 % and in *P. abu* with a minimum rate of 12.70 % ($p<0.05$) (Table 1 and Figure 1). Of the polyunsaturated fatty acids (PUFA), docosahexaenoic acid is seen as the major fatty acid. It was detected at most in *C. trutta* with a rate of 14.24 %, and at a minimum in *C. carpio* with a rate of 0.62 % ($p<0.05$) (Table 1 and Figure 1).

Total (SFA) were highest in *C. carpio* (41.60%), least in *A. sellal* species (27.83 %) ($p<0.05$), total (MUFA) were highest in *A. sellal* species (44.34 %), at least in *C. trutta* (27.91 %) ($p<0.05$), total (PUFA) were the most in *C. auratus* (35.18 %), the least in *C. carpio* type (18.92 %) ($p<0.05$) (Table 1 and Figure 1). ω-3 fatty acids are highly beneficial on diseases such as cardiovascular diseases, diabetes, cancer, depression, various mental illnesses, age-related cognitive decline, rheumatoid arthritis, and periodontal disease (Shahidi and Ambigaipalan, 2018). Although ω-3 fatty acids, which are very important for health, are observed to be the most in *C. trutta* species, it has been determined that *P. abu, C. gibelio, C. auratus,* and *C. regium* species also contain high levels of ω-3 fatty acids. The poorest species in terms of ω-3 was *C. carpio* with 6.33 % (Table 1 and Figure 1).

The ratio ω-3/ω-6 is used to compare the relative nutritional values of fish oils. It has been reported that this ratio is between 1-5 (Inhamuns, 2008; Fallah ve ark., 2011; Gökçe ve ark., 2011; Linhartova, 2018; Bayar ve ark., 2021). A balanced ω-3/ω-6 diet is essential for normal growth and development and plays an important role in the prevention of coronary artery disease, hypertension, cancer, and rheumatoid arthritis (Cengiz et al., 2010; Kaçar and Başhan, 2016). In this study, this value was determined as 0.69 in *C. carpio* species, while it was determined as 3.53 in *C. trutta* species (Table 1 and Figure 1). Bulut et al., (2006) determined the fatty acid composition of *C. carpio* species caught in Apa Dam Lake in Konya. In the study in which male and female fish were evaluated separately, they found the average SFA as 33.18 %, the average MUFA as 42.19 %, and the average PUFA as 7.86 %. They determined the total amount of ω-3 as 1.92 % and the amount of ω-3/ω-6 as 0.66. While the amount of ω-3/ω-6 they detected was similar to this study, there were differences in other values. Kaçar and Başhan (2016) carried out a study to determine the fatty acid composition of 12 different fish species grown in Atatürk Dam Lake. 6 of these species are similar to the species we used in this study. When we compared the fatty acid profiles of 6 similar species, in this study, the highest SFA, ω-3 and ω-3/ω-6 values were found in *C. trutta*, the highest MUFA in *C. luteus* and the highest PUFA in *C. auratus*. In the study of Kaçar and Başhan, 2016), the highest SFA and ω-3 values were found in *C. regium*, the highest MUFA and ω-3/ω-6 ratios in *C. trutta*, and the highest PUFA in *C. auratus*, similar to this study. Bayar et al. (2021) determined the highest SFA in S. erytroptholmus species, and the highest MUFA, PUFA, and ω-3 values in *A. anguilla* species in 2 species of freshwater fish they caught in Büyük Menderes River (Aydın/Türkiye). Öksüz et al., (2019) found the most SFA and MUFA in carp, and the highest PUFA and ω-3 values in Sudak in their study on Carp and Sudak species they obtained from Beyşehir Lake. Başhan and Kaçar (2017) determined the fatty acid composition of *C. trutta* species in Atatürk Dam Lake in their study. Compared to this study, they found lower SFA and PUFA values, and higher MUFA, ω-3, and ω-3/ω-6 values. Özyılmaz (2014) determined the fatty acids in 3 different freshwater fish in Atatürk Dam Lake. They found that the highest SFA, MUFA, and ω-3/ω-6 values were in *C. trutta* and the highest PUFA and ω-3 values were in *C. gibelio*. On the other hand, Taşbozan et al. (2013) found SFA, MUFA, and ω-3 values as 33.87 %, 39.96 %, and 13.96 %, respectively, in *M. mastacembelus* species they caught from Atatürk Dam Lake. These values are similar to the values in this study. They found a higher PUFA value and a lower ω-3/ω-6 value compared to this study.

Table 1. Fatty acid compositions of 10 fish species used in the study

Fatty acids	*C. carpio*	*P. abu*	*A. grypus*	*M. mastacembelus*	*A. sellal*	*C. gibelio*	*C. auratus*	*C. regium*	*C. luteus*	*C. trutta*
(C14:0) MyristicAcid	1.95 ± 0.15^{b}	5.19 ± 0.36^{e}	4.45 ± 0.29^{d}	1.67 ± 0.12^{a}	2.57 ± 0.08^{c}	1.92 ± 0.20^{b}	2.08 ± 0.21^{b}	2.69 ± 0.20^{c}	1.97 ± 0.13^{b}	2.97 ± 0.19^{c}
(C14:1) MyristoleicAcid	0.17 ± 0.03^{ab}	0.25 ± 0.03^{bc}	0.53 ± 0.07^{e}	0.23 ± 0.06^{bc}	0.43 ± 0.06^{d}	0.29 ± 0.04^{c}	0.19 ± 0.03^{abc}	0.14 ± 0.01^{ab}	0.12 ± 0.02^{a}	0.18 ± 0.01^{ab}
(C15:0) PentadecanoicAcid	0.81 ± 0.09^{c}	2.25 ± 0.14^{e}	0.70 ± 0.05^{bc}	0.50 ± 0.10^{ab}	0.43 ± 0.06^{a}	0.67 ± 0.07^{bc}	0.79 ± 0.08^{c}	0.56 ± 0.06^{ab}	0.67 ± 0.05^{bc}	1.73 ± 0.09^{d}
(C15:1)-PentadecenoicAcid	0.61 ± 0.06^{d}	0.35 ± 0.03^{b}	0.36 ± 0.04^{b}	0.18 ± 0.03^{a}	0.21 ± 0.02^{a}	0.59 ± 0.07^{d}	0.40 ± 0.04^{bc}	0.31 ± 0.03^{ab}	0.52 ± 0.09^{cd}	0.37 ± 0.07^{b}
(C16:0) PalmiticAcid	25.51 ± 0.79^{e}	21.79 ± 0.28^{c}	20.38 ± 0.24^{b}	19.05 ± 0.36^{a}	18.75 ± 0.21^{a}	22.47 ± 0.23^{c}	18.31 ± 0.32^{a}	20.47 ± 0.29^{b}	23.82 ± 0.19^{d}	21.96 ± 0.27^{c}
(C16:1) PalmitoleicAcid	6.48 ± 0.18^{c}	15.41 ± 0.37^{g}	9.97 ± 0.17^{e}	5.22 ± 0.17^{a}	10.13 ± 0.17^{e}	6.54 ± 0.32^{c}	7.06 ± 0.19^{d}	11.94 ± 0.22^{f}	7.20 ± 0.22^{d}	5.76 ± 0.14^{b}
(C17:0) HeptadecanoicAcid	0.92 ± 0.08^{b}	0.66 ± 0.07^{a}	0.59 ± 0.04^{a}	0.62 ± 0.04^{a}	0.55 ± 0.06^{a}	0.93 ± 0.11^{b}	0.67 ± 0.08^{a}	1.01 ± 0.14^{b}	0.57 ± 0.08^{a}	0.62 ± 0.04^{a}
(C17:1)-HeptadecenoicAcid	0.39 ± 0.05^{b}	2.97 ± 0.10^{e}	0.54 ± 0.05^{bc}	0.52 ± 0.04^{bc}	0.64 ± 0.03^{c}	0.54 ± 0.06^{bc}	0.57 ± 0.04^{c}	1.26 ± 0.11^{d}	0.49 ± 0.05^{bc}	0.20 ± 0.02^{a}
(C18:0) StearicAcid	12.13 ± 0.32^{g}	3.50 ± 0.22^{a}	4.84 ± 0.12^{b}	11.41 ± 0.27^{f}	5.35 ± 0.22^{b}	10.25 ± 0.27^{e}	9.17 ± 0.23^{d}	7.45 ± 0.26^{c}	9.63 ± 0.10^{d}	10.23 ± 0.36^{e}
(C18:1n9c) OleicAcid	19.64 ± 0.21^{c}	12.70 ± 0.26^{a}	25.04 ± 0.28^{g}	23.39 ± 0.47^{f}	29.77 ± 0.38^{i}	21.48 ± 0.12^{d}	21.63 ± 0.13^{d}	22.51 ± 0.16^{e}	27.92 ± 0.25^{h}	17.35 ± 0.27^{b}
(C18:2n6c) LinoleicAcid	4.65 ± 0.17^{c}	2.56 ± 0.20^{a}	6.02 ± 0.13^{e}	5.30 ± 0.30^{d}	3.65 ± 0.26^{b}	4.40 ± 0.19^{c}	9.17 ± 0.26^{f}	3.72 ± 0.17^{b}	2.23 ± 0.12^{a}	2.29 ± 0.08^{a}
(C18:3n6) G-LinolenicAcid	0.50 ± 0.08^{d}	0.80 ± 0.08^{e}	0.26 ± 0.05^{c}	0.26 ± 0.04^{c}	0.07 ± 0.02^{a}	0.24 ± 0.06^{bc}	0.22 ± 0.04^{bc}	0.12 ± 0.01^{ab}	0.28 ± 0.03^{c}	0.20 ± 0.03^{bc}
(C18:3n3) A-LinolenicAcid	1.54 ± 0.10^{b}	1.95 ± 0.06^{c}	3.03 ± 0.16^{d}	1.98 ± 0.12^{c}	3.47 ± 0.21^{e}	2.01 ± 0.10^{c}	2.00 ± 0.11^{c}	3.59 ± 0.18^{e}	1.53 ± 0.13^{b}	1.16 ± 0.06^{a}
CLA c9-t11	0.08 ± 0.01^{abc}	0.06 ± 0.01^{ab}	0.07 ± 0.01^{ab}	0.20 ± 0.02^{e}	0.07 ± 0.01^{ab}	0.14 ± 0.01^{d}	0.07 ± 0.02^{ab}	0.05 ± 0.01^{a}	0.09 ± 0.01^{bc}	0.11 ± 0.02^{c}
CLA t10-c12	0.61 ± 0.07^{a}	3.16 ± 0.18^{e}	1.23 ± 0.07^{c}	0.41 ± 0.07^{a}	1.25 ± 0.14^{c}	0.66 ± 0.09^{a}	0.93 ± 0.06^{b}	1.46 ± 0.09^{c}	0.45 ± 0.07^{a}	2.77 ± 0.12^{d}
(C20:0)- ArachidicAcid	0.29 ± 0.04^{e}	0.17 ± 0.03^{bc}	0.11 ± 0.03^{a}	0.27 ± 0.02^{e}	0.19 ± 0.03^{c}	0.25 ± 0.05^{e}	0.28 ± 0.04^{e}	0.22 ± 0.02^{d}	0.15 ± 0.01^{b}	0.26 ± 0.04^{e}
(C20:1n9)-EicosenoicAcid	1.00 ± 0.12^{de}	0.26 ± 0.04^{a}	0.34 ± 0.05^{b}	1.41 ± 0.10^{f}	0.85 ± 0.14^{d}	0.79 ± 0.09^{d}	1.27 ± 0.08^{e}	0.58 ± 0.07^{c}	3.11 ± 0.11^{g}	0.94 ± 0.13^{de}
(C20:2)-EicosadienoicAcid	0.49 ± 0.09^{d}	0.20 ± 0.02^{ab}	0.37 ± 0.06^{c}	0.90 ± 0.06^{f}	0.35 ± 0.04^{c}	0.28 ± 0.03^{bc}	0.67 ± 0.04^{e}	0.38 ± 0.03^{c}	0.13 ± 0.02^{a}	0.13 ± 0.01^{a}
(C20:3n6)- EicosatrienoicAcid	0.30 ± 0.03^{cd}	0.23 ± 0.03^{abc}	0.26 ± 0.03^{bcd}	0.58 ± 0.04^{f}	0.35 ± 0.03^{d}	0.28 ± 0.05^{cd}	0.52 ± 0.05^{ef}	0.44 ± 0.06^{e}	0.17 ± 0.03^{ab}	0.15 ± 0.03^{a}
(C20:4n6)- ArachidonicAcid	3.83 ± 0.14^{c}	3.18 ± 0.15^{b}	4.68 ± 0.27^{d}	5.65 ± 0.12^{e}	4.49 ± 0.26^{d}	4.03 ± 0.26^{c}	3.89 ± 0.22^{c}	2.65 ± 0.12^{a}	3.93 ± 0.15^{c}	3.98 ± 0.10^{c}
(C20:3n3)-EicosatrienoicAcid	$0.39\pm0.04f^{g}$	0.16 ± 0.01^{abc}	0.24 ± 0.03^{cd}	0.47 ± 0.06^{g}	0.41 ± 0.03^{g}	0.27 ± 0.04^{de}	0.22 ± 0.03^{bcd}	0.32 ± 0.02^{ef}	0.13 ± 0.02^{a}	0.14 ± 0.03^{ab}
(C20:5n3)-EicosatrienoicAcid	3.78 ± 0.07^{b}	10.81 ± 0.38^{f}	4.94 ± 0.31^{c}	0.97 ± 0.09^{a}	7.93 ± 0.10^{d}	5.30 ± 0.18^{c}	7.71 ± 0.27^{d}	9.38 ± 0.33^{e}	3.43 ± 0.17^{b}	7.81 ± 0.17^{d}
(C22:1n9)-ErucicAcid	0.27 ± 0.02^{cde}	0.53 ± 0.05^{f}	0.31 ± 0.03^{e}	0.29 ± 0.04^{de}	0.14 ± 0.01^{ab}	0.28 ± 0.03^{cde}	0.21 ± 0.04^{bc}	0.10 ± 0.02^{a}	0.15 ± 0.01^{ab}	0.22 ± 0.03^{bcd}
(C22:2)-DocosadienoicAcid	2.14 ± 0.09^{g}	0.47 ± 0.03^{b}	0.60 ± 0.08^{b}	2.22 ± 0.13^{g}	0.18 ± 0.03^{a}	1.79 ± 0.18^{f}	0.84 ± 0.09^{c}	0.85 ± 0.08^{c}	0.12 ± 0.02^{a}	1.12 ± 0.09^{d}
(C24:1n9) Nervonic Acid	9.34 ± 0.40^{e}	3.21 ± 0.35^{c}	2.87 ± 0.19^{bc}	4.49 ± 0.24^{d}	2.17 ± 0.15^{a}	1.84 ± 0.12^{a}	2.01 ± 0.33^{a}	2.43 ± 0.29^{ab}	1.94 ± 0.17^{a}	2.89 ± 0.14^{bc}
(C22:6n3) Docosahexaenoic Acid	0.62 ± 0.07^{a}	6.81 ± 0.31^{c}	7.16 ± 0.27^{c}	10.54 ± 0.22^{e}	5.37 ± 0.44^{b}	11.45 ± 0.24^{f}	8.93 ± 0.24^{d}	4.93 ± 0.33^{b}	9.22 ± 0.53^{d}	14.24 ± 0.31^{g}
SFA	41.60 ± 0.97^{e}	33.57 ± 0.69^{c}	31.07 ± 0.70^{b}	33.52 ± 0.28^{c}	27.83 ± 0.20^{a}	36.48 ± 0.64^{d}	31.30 ± 0.37^{b}	32.39 ± 0.41^{bc}	36.81 ± 0.28^{d}	37.77 ± 0.37^{d}
MUFA	37.90 ± 0.50^{d}	35.98 ± 0.52^{c}	39.96 ± 0.18^{e}	35.73 ± 0.56^{c}	44.34 ± 0.18^{f}	32.35 ± 0.22^{b}	33.35 ± 0.29^{b}	39.27 ± 0.19^{e}	41.43 ± 0.44^{f}	27.91 ± 0.23^{a}
PUFA	18.92 ± 0.52^{a}	30.40 ± 0.21^{e}	28.85 ± 0.68^{cd}	29.48 ± 0.59^{de}	27.59 ± 0.35^{c}	30.86 ± 0.74^{e}	35.18 ± 0.68^{f}	27.88 ± 0.49^{c}	21.72 ± 0.21^{b}	34.09 ± 0.40^{f}
ω-3	6.33 ± 0.08^{a}	19.73 ± 0.38^{f}	15.37 ± 0.43^{c}	13.96 ± 0.22^{b}	17.19 ± 0.71^{d}	19.03 ± 0.29^{ef}	18.86 ± 0.22^{ef}	18.21 ± 0.20^{de}	14.31 ± 0.24^{b}	23.35 ± 0.38^{g}
ω-6	9.28 ± 0.19^{b}	6.77 ± 0.09^{a}	11.23 ± 0.13^{c}	11.79 ± 0.36^{c}	8.55 ± 0.28^{b}	8.96 ± 0.37^{b}	13.81 ± 0.48^{d}	6.93 ± 0.29^{a}	6.61 ± 0.02^{a}	6.62 ± 0.04^{a}
ω-3/ ω-6	0.69 ± 0.00^{a}	2.91 ± 0.05^{e}	1.37 ± 0.03^{b}	1.18 ± 0.02^{b}	2.01 ± 0.14^{c}	2.13 ± 0.08^{c}	1.37 ± 0.04^{b}	2.63 ± 0.11^{d}	2.16 ± 0.03^{c}	3.53 ± 0.08^{f}
AI	0.85 ± 0.02^{g}	0.74 ± 0.03^{f}	0.64 ± 0.03^{cde}	0.60 ± 0.01^{cd}	0.49 ± 0.00^{a}	0.67 ± 0.03^{e}	0.54 ± 0.01^{ab}	0.60 ± 0.01^{bc}	0.66 ± 0.01^{de}	0.76 ± 0.02^{f}
TI	0.92 ± 0.03^{f}	0.37 ± 0.01^{ab}	0.41 ± 0.01^{cd}	0.48 ± 0.00^{e}	0.33 ± 0.01^{a}	0.44 ± 0.01^{d}	0.36 ± 0.00^{ab}	0.38 ± 0.00^{bc}	0.51 ± 0.00^{e}	0.39 ± 0.01^{bg}

*: Values shown with different letters on the same line are statistically different from each other ($p<0.05$).

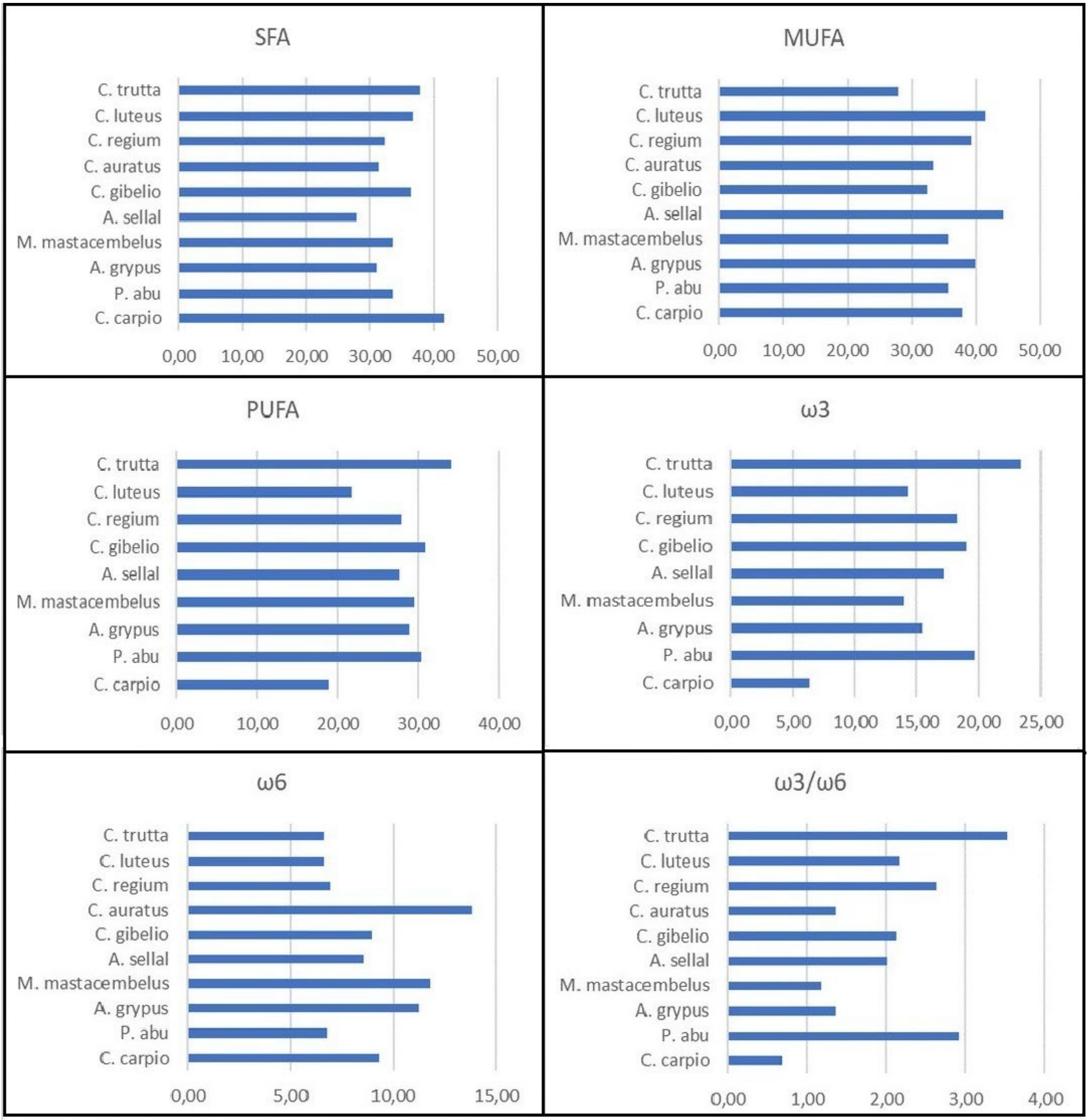

Figure 1. Some fatty acid values of the studied species (%)

The AI and TI indices are indicators of lipid quality that depend on the relative content of particular fatty acid groups, showing the potential effects of lipids on diet quality and the development of coronary disease (Ulbricht and Southgate, 1991; Cengiz et al., 2010; Kaçar and Başhan, 2016). AI and TI are desired to have low values, as they are indices of coronary diseases. It is recommended that AI and TI values in the diet should be less than 1.0 and 0.5, respectively (Woloszyn et al., 2020). In this study, the lowest AI and TI values were determined in the A. sellal species (0.49 and 0.33). The highest values were determined in C. carpio species (0.85 and 0.92). Kaya and Turan (2008) determined the AI and TI values of anchovy as 1.52 and 0.36 (January). Fallah et al. (2011) found it to be 0.45 and 0.33 in wild rainbow trout, respectively. Linhortova et al. (2018) found AI and TI values lower than the stated values in 13 different freshwater fish. They found a high TI value (0.61) only in Nile Tilapia.

Conclusion

In this study, 26 different fatty acid compositions detected in 10 different species living in Atatürk Dam Lake were compared. The ratio of ω3/ω6, which is used to compare the relative nutritional values of fish oils and which should be in balance for normal growth and development, was determined as 0.69 in *C. carpio* species and 3.53 in *C. trutta* species. When the species are examined in terms of ω-3 fatty acids content, which are important for health, it can be said that *C. trutta, P. abu, C. gibelio, C. auratus, C. regium, A. sellal* species are good sources. However, *C. carpio* was the poorest species in terms of ω3. Considering the AI and TI indices, it can be suggested that it would be more suitable for *A. sellal* .

Compliance with Ethical Standards

Conflict of interests: The authors declare that for this article they have no actual, potential, or perceived conflict of interest.

Ethics committee approval: Ethics committee approval is not required for this study.

Funding disclosure: -

Acknowledgments: -

Disclosure: -

References

Alhas, E., Oymak, S. A., Karadede Akin, H. (2009). Heavy metal concentrations in two barb, *Barbus xanthopterus* and *Barbus rajanorum mystaceus* from Atatürk Dam Lake, Turkey. *Environmental Monitoring and Assessment*, 148(1), 11-18.
https://doi.org/10.1007/s10661-007-0134-0

Başhan, M., Kaçar, S. (2017). Fatty acid composition of total lipid, phospholipid and triacylglycerol in the muscle and liver tissue of *Capoeta trutta* fatty acids of *Capoeta trutta*. *Journal of the Institute of Science and Technology,* 7(4), 43-50.
https://doi.org/10.21597/jist.2017.196

Bayar, İ., İnci, A., Ünübol Aypak, S., Bildik, A. (2021). Büyük Menderes Nehri'nden (Aydın) iki tatlı su balığı türünün kas dokularındaki total yağ asidi kompozisyonun araştırılması. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi,* 24 (2), 260-266.
https://doi.org/10.18016/ksutarimdoga.vi.723089

Bulut, S., Mert, R., Solak, K., Çevik, C. (2006). Apa Baraj Gölü'nde (Konya) Yaşayan *Cyprinus carpio* L.'Nun Kas Dokusu Yağ Asidi Kompozisyonu. *Afyon Kocatepe Üniversitesi Fen ve Mühendislik Bilimleri Dergisi,* 6(2), 51-57.

Cengiz, E.I., Ünlü, E., Başhan, M. (2010). Fatty acid composition of total lipids in muscle tissues of nine freshwater fish from the River Tigris (Turkey). *Turkish Journal of Biology*, 34(4), 33-438.
https://doi.org/10.3906/biy-0903-19

Dağtekin, B. B., Misir, G. B., & Kutlu, S. (2018). Comparison of biochemical, fatty acids and lipid quality indexes of Prussian carp (*Carassius gibelio*) caught from lake Çıldır on different seasons. *Mediterranean Fisheries and Aquaculture Research*, 1(1), 2-14.

Doğan, N. (2007). Atatürk Baraj Gölü'nde yaşayan *Tor grypus* (Heckel, 1843)'un büyüme ve üreme özellikleri. *Master Thesis, Harran University, Institute of Science*, Şanlıurfa, Turkey.

Fallah, A.A., SiavashSaei-Dehkordi, S., Nematollahi, A. (2011). Comparative assessment of proximate composition, physicochemical parameters, fatty acid profile and mineral content in farmed and wild rainbow trout (Oncorhynchus mykiss). *International Journal of Food Science & Technology,* 46(4), 767-773.

https://doi.org/10.1111/j.1365-2621.2011.02554.x

Fırat, Ö., Çoğun, H.Y., Aytekin, T., Firidin, G., Temiz, Ö., Sağ, H., Kargın, F. (2018). Atatürk Baraj Gölü'nün kirli ve temiz bölgelerinden yakalanan dokularındaki ağır metal düzeylerinin karşılaştırılması. *Süleyman Demirel Üniversitesi Eğirdir Su Ürünleri Fakültesi Dergisi*, 14(3), 173-183. https://doi.org/10.22392/egirdir.375767

Folch, J., Lees, M., G.H. Sloane-Stanley (1957). A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry,* 226(1), 497-509.
https://doi.org/10.1016/S0021-9258(18)64849-5

Garaffo, M.A., Vassallo-Agius, R., Nengas, Y., Lembo, E., Rando, R., Maisano, R., Dugo, G., Giuffrida, D. (2011). Fatty acid profile, atherogenic (IA) and thrombogenic (IT) health lipid indices, of raw roe of blue fin tuna (*Thunnus Thynnus* L.) and their salted product Bottarga. *Food and Nutrition Sciences,* 2(7), 736-743.
https://doi.org/10.4236/fns.2011.27101

Gökçe, M.A., Tasbozan, O., Tabakoglu, S.S., Çelik, M., Ozcan, F., Basusta, A. (2011). Proximate composition and fatty acid profile of shabbout (Barbus grypus, Heckel) caught from theAtatürk Dam Lake, Turkey. *Journal of Food, Agriculture & Environment,* 9(2), 148-151.

Inhamuns, A.J., Franco, M.R.B., (2008). EPA and DHA quantification in two species of freshwater fish from Central Amazonia. *Food Chemistry,* 107, 587-591.
https://doi.org/10.1016/j.foodchem.2007.07.032

Kaçar, S. (2010). Atatürk Baraj gölündeki bazı tatlısu balıklarının total lipit ve yağ asitlerinin mevsimsel değişimi. *PhD Thesis, Department of Biology, Graduate School of Natural and Applied Sciences*, Dicle University, Diyarbakır, Turkey.

Kaçar, S., Başhan, M., Oymak, S.A. (2016). Effect of seasonal variation on lipid and fatty acid profile in muscle tissue of male and female *Silurus triostegus*. *Journal of Food Science and Technology,* 53(7), 2913-2922.
https://doi.org/10.1007/s13197-016-2253-5

Kaçar, S, Başhan, M., Oymak, S.A. (2018). Effect of season on the fatty acid profile of total lipids, phospholipids and triacylglycerols in *Mastacembelus mastacembelus* (Atatürk Dam Lake, Turkey). *Grasas Aceites,* 69, 1-9.
https://doi.org/10.3989/gya.1108172

Kaçar, S., Başhan, M. (2016). Atatürk Baraj Gölü'ndeki tatlısu balıklarının lipid içeriği ve yağ asidi profilinin karşılaştırılması. *Türk Biyokimya Dergisi,* 41(3), 150-156.
https://doi.org/10.1515/tjb-2016-0025

Kaya, Y., Turan, H. (2008). Fatty acids composition of anchovy (Engraulis encrasicolus l. 1758) oil produced ın Sinopturkey. *Journal of Fisheriessciences.com,* 2, 693-697.
https://doi.org/10.3153/jfscom.2008036

Linhartová, Z., Krejsa, J., Zajíc, T., Masilko, J., Sampels, S., Mraz, J., (2018). Proximate and fatty acid composition of 13 important freshwater fish species in central Europe. *Aquaculture International,* 26, 695-711.
https://doi.org/10.1007/s10499-018-0243-5

Oymak, S.A. (1998). Atatürk Baraj Gölü'nde yasayan Silurus triostegus (Heckel, 1843) ve *Chondrostoma regium* (Heckel, 1843)'un biyo-ekolojik özellikleri. *PhD Thesis, Gazi University Science Science Institute*, Ankara, Turkey.

Öksüz, A., Dikmen, M., Alkan, Ş.B., Yaylalı, O., Kaplan, T., Demirtaş, S. (2019). Beyşehir Gölünden avlanan sazan ve sudak balıklarının besin ve yağ asidi bileşenlerinin Karşılaştırılması. *Aquatic Research,* 2(4), 174-181.
https://doi.org/10.3153/AR19016

Özyılmaz, A. (2014). Atatürk Baraj Gölü'nde avlanan bazı balıkların et verimleri, yağ seviyeleri ve yağ asitleri bileşenleri. *Yunus Research Bulletin*, (3), 29-36.
https://doi.org/10.17693/yunusae.v2014i21953.235724

Satar, E.I., Uysal, E., Ünlü, E., Başhan, M., Satar, A. (2012). The effects of seasonal variation on the fatty acid composition of total lipid, phospholipid, and triacylglycerol in the dorsal muscle of *Capoeta trutta* found in the Tigris River (Turkey). *Turkish Journal of Biology*, 36(1), 113-123.
https://doi.org/10.3906/biy-1008-81

Shahidi, F., Ambigaipalan, P. (2018). Omega-3 polyunsaturated fatty acids and their health benefits. *Annual Review of Food Science and Technology,* 9, 345-381.
https://doi.org/10.1146/annurev-food-111317-095850

Tasbozan, O., Gokce, M. A., Celik, M., Tabakoglu, S. S., Kucukgulmez, A., Basusta, A. (2013). Nutritional composition of Spiny eel (*Mastacembelus mastacembelus*) caught from the Atatürk Dam Lake in Turkey. *Journal of Applied Biological Sciences,* 7(2), 78-82.

TS EN ISO 12966-2. (2017). Hayvansal ve bitkisel katı ve sıvı yağlar- Yağ asitleri metil esterlerinin gaz kromotografisi- Bölüm 2: Yağ asitleri metil esterlerinin hazırlanması. *TSE publications*, Ankara, Turkey.

Ulbricht, T., Southgate D. (1991). Coronaryheartdisease: seven dietary factors. *Lancet*, 338, 985992. https://doi.org/10.1016/0140-6736(91)91846-M

Wołoszyn, J., Haraf, G., Okruszek, A., Wereńska, M., Goluch, Z., Teleszko, M. (2020). Fatty acid profiles and health lipid indices in the breast muscles of local Polish goose varieties. *Poultry Science*, 99(2), 1216-1224. https://doi.org/10.1016/j.psj.2019.10.026

Yilmaz, S. T., Cakli, S., Dincer, T., Sargin, H., Ucok, C. (2016). Evaluation of nutritional value of *Carassius gibelio* (Bloch, 1782). *Archiv für Lebensmittelhygiene,* 67, 139-146.