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Meat yield, amino acid, fatty acid composition and lipid quality values in Prussian carp (*Carassius gibelio* (Bloch, 1782)) in Bafra fish lakes

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Abstract
The present study aimed to define of meat yield, amino acid composition, fatty acid composition, lipid quality values of Prussian carp (*Carassius gibelio* Bloch, 1782), which has shown rapid population growth in recent years. In addition, the adverse effects of this fish on other fish populations in the Bafra lake of Samsun (Turkey) were investigated.
Mean meat yield and condition factor of the fish were determined as (23.45±0.26%) and (1.65±0.01), respectively. The protein value was determined to be 17.56%±0.36%, and the fat value was 3.21±0.23%. The total amino acid value was calculated as 18.96±0.06, the EAA value as 8.68±0.03, and the NEAA value as 10.28±0.09 g/100 g. Examining the fatty acid composition, the ΣSFA value was 28.49±0.45%, the ΣMUFA value was 29.32±0.41%, the ΣPUFA value was 40.68±0.32, the EPA value was 7.82±0.12%, and the DHA value was 13.49±0.38%.
It was determined that Prussian carp, an invasive species in many water sources in Turkey, has high protein and low-fat content and is a valuable food source in terms of fatty acids.

Keywords: *Carassius gibelio*, meat yield, amino acid, fatty acids, lipid quality value

Introduction
Carp production has long been one of the leading fish species in the aquaculture industry in countries in Asia, Africa, Europe and Latin America (Gatlin 2002) [13].
Cyprinidae familyasında yer alan *Carassius cinsi Avrupa* ile Asya kıtalarında yaygındır and these species are *Carassius*, *Carassius cuvieri*, *Carassius gibelio* (Bostancı, 1782) [43], *Carassius auratus*, *Carassius langsdorfii*.
Although the origin of *Carassius gibelio* is unclear, some studies have been reported in the literature. It has been determined that its homeland belongs to Central Europe, originates from the Far East and is located in Europe (Kottelat 1997) [20]. In recent studies, it has been found that it naturally occurs in Middle East Europe (Kottelat *et al*. 2007; Rylkova *et al*. 2013) [21, 31].
The Prussian carp species (*Carassius gibelio*) belongs to the *Cyprinidae* family (Kalous *et al*. 2004; Alagöz *et al*. 2006) [18, 1]. It has been thought that Prussian carp has subsequently entered many inland water resources in Turkey and has direct or indirect effects on fish species living in its habitat. Since consumers do not prefer this species for various reasons, including its characteristic taste, odor, bony body structure, and undesirable texture characteristics, it has a low economic value compared to other fish species (Süle 2011) [37].
The present study aimed to determine the meat yield, amino acid composition, fatty acid composition, and lipid quality values of Prussian carp, which its population increased excessively in Bafra Fish Lakes and threatens the existence of other species in the ecosystem and is not preferred much for consumption.

Material and Method
The Prussian carp (*Carassius gibelio*) used in the study was obtained from fishermen fishing in Gıcı, Tatlı Lakes, one of the Fish Lakes in the Bafra District of Samsun.
Sampling was carried out in monthly periods, and trammel nets were used for catching. The fish were brought to the Sinop University Fisheries Faculty Feed Technology Laboratory, and their biometric measurements were carried out. The 1 mm ruler and the 0.01 g precision digital scale were used to measure the total length and weight of the fish, respectively.

For meat yield evaluations, parts of the fish such as the head, fins, internal organs, skin and bones were cut using forceps, scalpel and scissors, and the weights of each part were determined on a digital scale with a sensitivity of 0.01g.
Afterwards removing the head, fins, skin, bones, and all visceral organs, the meat weights of the fish were measured, and the ratio of this to the total body weight was expressed as the edible net yield (Erkoyuncu *et al*. 1994) [12].

Meat Yield (%) = Weight of Fish Consumed (g)/Total Fish Weight (g) * 100

Dry matter and crude (protein, oil, ash) analyses of the sampled fish were performed in the Laboratory of the Faculty of Fisheries in Sinop University. For biochemical analysis, the filleted samples were homogenized. Moisture ingredient was defined with drying the specimens in furnace at (105±1 °C) (Ludorf and Meyer, 1973) [22], protein analysis was defined with the Kjeldahl method (AOAC, 1995) [3], fat analysis was carried out adopting the ether distillation method in a Soxhlet device (AOAC, 1995) [3], ash determination was carried out employing the incineration method in a muffle furnace (550±1 °C) (Mattissek *et al*., 1988) [23] in three parallels.
The amino acid and fatty acid analyses of the samples in the study were carried out at Sinop University Scientific and Technological Research Center (SUBİTAM) through service procurement. Amino acid analyses were performed using the Jasem LC-MS/MS amino acid test kit, and fatty acids analyses were performed using the Thermo Scientific ISQ LT model GC/MS.
The data were reported as the average values with standard error. The IBM SPSS 21 statistics package application was used for statistical analysis. The differences between the values were tested with the one-way analysis of variance (ANOVA), and these differences were compared with the Tukey test (p<0.05).

Results

A total of 630 Prussian carp were sampled in the study. The average length of the fish was 16.25±0.16 cm, and the average weight was 83.43±2.29 g.
Meat yield was determined to be 23.45±0.26%, and the condition factor was 1.65±0.01 (min-max: 1.02-2.29). The VSI ratio of the samples was determined to be 14.12±0.18%, the GSI ratio was 6.76±0.19%, and the HSI ratio was 1.46±0.21%. Fish meat protein value was 20.25±0.32%, the fat value was 1.29%±0.10, the ash value was 2.57±0.18%, and the dry matter value was 20.01±0.01.
As a result of the analyses performed on muscle tissue, essential amino acid values are given in Table 1, and non-essential amino acid values are given in Table 2.

Table 1: Prussian carp essential amino acid composition (g/100 g)

Amino Acids (g/100 g)	Fillet
Histidine	0.66±0.03
İsoleucin	0.64±0.01
Leucine	1.46±0.05
Lysin	1.91±0.01
Methionine	0.47±0.01
Phenylalanine	0.87±0.01
Threonine	0.85±0.03
Valine	0.75±0.01
TEAA	8,68±0,03
TAA	18,96±0,06
TEAA/TAA	0,458

Table 2: Prussian carp non-essential amino acid composition (g/100 g)

Amino Acids (g/100 g)	Fillet
Alanine	1.35±0.01
Arginine	1.08±0.01
Aspartic Acid	2.35±0.09
Sistin	0.02±0.00
Glutamic Acid	2.45±0.01
Glycine	1.93±0.01
Proline	0.75±0.01
Serine	0.76±0.04
Tyrosine	0.62±0.01
TNEAA	10.28±0.09
TAA	18.96±0.06
TNEAA/TAA	0.542

The total amino acid value was calculated as 18.96±0.06, the EAA value as 8.68±0.03, and the NEAA value as 10.28±0.09 g/100 g. The EAA/NEAA ratio was found to be 0.84±0.01. Also, the long chain amino acid (LCAA) value was 2.85±0.05, the sulfur-containing amino acid (SCA) value was 0.49±0.01, the acidic amino acid value was 4.80±0.08, the basic amino acid value was 3.65±0.02 g/100 g, and the aromatic amino acid value was defined to be 1.48±0.02 g/100 g. Fatty acid values are given in Table 3.

Table 3: Prussian carp fatty acids composition (%)

Fatty Acid (%)	Fillet
Lauric acid (C12:0)	0.09±0.01
Tridecanoic acid (C13:0)	0.04±0.01
Myristic Acid (C:14:0)	3.14±0.17
Pentadecanoic Acid (C15:0)	0.97±0.03
Palmitic Acid (C16:0)	12.49±0.13
Heptadecanoic Acid (C17:0)	1.50±0.01
Stearic Acid (C18:0)	7.81±0.12
Arachidic Acid (C20:0)	0.91±0.02
Henicosanoic Acid (C21:0)	0.02±0.01
Behenic Acid (C22:0)	0.12±0.01
Tricosanoic Acid (C23:0)	0.02±0.01
Lingoceric Acid (C24:0)	2.07±0.01
ΣSFA	28,49±0,45
Myristoleic Acid (C14:1)	0.53±0.03
Pentadecanoicacid (C15:1)	0.53±0.04

Palmiteloic acid (C16:1)	0.98±0.01
Heptadecanoic Acid (C17:1)	1.22±0.04
Oleic Acid (C18:1n-9c)	10.29±0.27
Elaoidic Acid (C18:1n-9t)	6.93±0.17
Eicosanoic Acid (C20:1n-9c)	2.85±0.34
Erusik Asit (C22:1n-9)	2.28±0.08
Nervonic Acid (C24:1)	3.90±0.11
ΣMUFA	29,32±0,41
Linoleaidic Acid (C18:2n-6t Omega-6)	0.20±0.02
Linoleic Acid (C18:2n-6c Omega-6)	0.55±0.03
a-Linolenic Acid (C18:3n-3 Omega-3)	5.44±0.25
g-Linolenic Acid (C18:3n-6)	0.55±0.04
cis- Eicosadinoic Acid (C20:2)	0.20±0.01
Eicosatrienoic Acid (C20:3n-3 Omega-3)	0.12±0.01
Eicosapentaenoic Acid (C20:5n-3 EPA Omega-3)	7.82±0.12
Arachidonic Acid (C20:4n-6)	9.70±0.21
Docosahexaenoic Acid (C22:6n-3 DHA Omega-3)	13.49±0.38
Docosadienoic Acid (C22:2)	0.70±0.05
CİS-8,11,11- Eicosatrienoic Acid (C20:3n-6)	1.91±0.03
ΣPUFA	40.68±0.32
Σn-3	26.87±0.24
Σn-6	12.91±0.11
Σn-9	22.34±0.23
n-3/n-6	2.08±0.01
n-6/n-3	0.48±0.01
EPA+DHA	21.31±0.50
EPA/DHA	0.58±0.01
PUFA/SFA	1.43±0.01
AI	0.36±0.01
TI	0.23±0.01
h/H	2.69±0.06

As a consequence of the fatty acids analysis defined in the fillets in the investigation, palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1n-9-c), linoleic acid (C18:2n-6c), linolenic acid from fatty acids (C18:3n-3), eicosapentaenoic acid (C20:5n-3), arachidonic acid (C20:4n-6) and docosahexaenoic acid (C22:6n-3) values were found to be higher than other fatty acids defined.

As a consequence of the calculations of the data obtained with the analysis, it was defined that the PUFA value was higher than the SFA and MUFA values.

Discussion and Conclusion

The present study aimed to define the meat yield, amino acid and fatty acid composition, lipid quality values of Prussian carp, which have negative effects on other fish populations, by showing a rapid increase in the Bafra (Samsun) lakes. Although many investigations have been maked on the population and growth characteristics of Prussian carp, there are few studies on meat yield and biochemical compositions.

In studies on the determination of the nutritional characteristics of the Prussian carp species, it has been reported that it prefers benthic and planktonic invertebrates as feed (Balık *et al*. 2003) [4], has a different diet composition in the stomach content and shows both omnivorous and opportunistic feeding habits (Yazıcı *et al*. 2022) [42]. It has been stated that the species benefited from most of the nutrients in the environment and showed omnivorous feeding characteristics (Ali *et al*. 2001; Zhou *et al*., 2003; Yılmaz *et al*. 2007) [2, 46, 43].

The biochemical composition of fish meat and meat yield are important in the food preference of fish. In addition, knowing the meat yield and biochemical composition is a factor that directly affects the processing of the product, so it is of great importance for both the consumer and the processing technology (Cibert *et al*. 1999) [7].

Studies have shown that Prussian carp has a meat yield of 37.05% (Özyılmaz and Palalı 2014) [28] and 23.87%. In the present study, the meat yield was determined to be 23.45±0.26%. Meat yield may have been known to vary depending on the nutritional conditions, size, age, sex, and genotype of the fish.

In the studies carried out to determine the Prussian carp protein value, the following values have been reported; 17.99%, 18.51% (Süle 2011) [37], 17.4-18.7% (Dal Bosco *et al*. 2012) [9], 16.89%, 19.43% (Özyılmaz *et al*. 2016) [29], 19.01% (Saffar Shargh *et al*. 2017) [13], 15.60-16.47%, 16.49% (Zhelyazkov *et al*. 2018) [44], 17.40% (Öksüz *et al*. 2019) [26], 16.95% (Mocanu *et al*. 2022) [24]. In the present study, the protein ratio was determined to be 20.25±0.32%.

In the studies carried out to determine the Prussian carp fat value, the following values have been reported;4.62% (İzci 2010) [16], 3.78% (Süle 2011) [37], 1.59%-2.01% (Dal Bosco *et al*. 2012) [9], 1.3% (Zhang *et al*. 2012) [45], 1.61% (Özyılmaz and Palalı 2014) [28], 1.59%, 3.43% (Özyılmaz *et al*. 2016) [29], 2.01-3.49%. Different values have been reported, such as 0.25% (Zhelyazkov *et al*. 2018) [44], 3.33% (Öksüz *et al*. 2019) [26], and 1.92% (Mocanu *et al*. 2022) [24]. The fat value in the present study was found to be 1.29%±0.10.

The nutritional characteristics of the species have a decisive effect on the protein and fat values in the consumable part of the fish. Therefore, protein and fat values in the edible part of fish, as well as food preferences and meat, vary depending on the size, age, sex, and habitat differences of the fish.

As a result of the analyzes made on muscle tissue in the study, essential amino acids (EAA) were, in decreasing order, determined to be Lysine> Leucine> Phenylalanine>

Threonine> Valine> Histidine> Isoleucine> Methionine, while non-essential amino acids (NEAA), in decreasing order, determined to be Glutamic acid> Aspartic acid> Glycine> Alanine> Arginine> Serine> Proline> Tyrosine> Cystine. Saffar Shargh *et al*. (2017) [13] similarly found the highest EAAs in Lysine and Leucine, while the highest NEAAs were Glutamic acid and Aspartic acid.

In another study, the highest AUC values of Valine, Histidine and Lysine were found, while the highest NEAA values were Aspartic acid and Glycine. (Parmaksız *et al*. 2022) [30].

The EPA and DHA ratios are directly related to fish meat lipid quality. Omega-3 fatty acids are very beneficial and have been reported to reduce the risk of arrhythmia (URL 2016; 2017) [40-41]. Studies on Prussian carp ΣSFA, ΣMUFA, ΣPUFA, EPA, DHA, and EPA+DHA values are given in Table 5.

Table 5: ΣSFA, ΣMUFA, ΣPUFA, EPA**,** DHA, EPA+DHA values of *Carassius gibelio*

ΣSFA	ΣMUFA	ΣPUFA	EPA	DHA	EPA+DHA	Reference
32.95	32.21	34.87	-	-	-	Dönmez (2009) [11]
23.34-25.99	31.27-34.56	40.93	-	-	-	Bulut (2010) [6]
24.56	31.45	43.99	3.30	11.03	18.66	Çakmak *et al*. (2012) [8]
29.7-33.6	16.4-20.9	46.5-51.9	5.15-8.09	10.6-14.6	-	Dal Bosco *et al*. (2012) [9]
33.1	33.8	33.1	4.2	7.9	12.1	Zhang *et al*. (2012) [45]
26.76-30.44	27.29-38.89	30.67-45.95	2.37-4.44	8.01-17.89	-	Özparlak (2013) [27]
28.52	21.34	41.86	4.65	14.85	19.50	Özyılmaz and Palalı (2014) [28]
35.88-46.09	38.04-45.75	15.80-18.29	1.59-3.59	1.76-3.76	3.35-7.35	Saffar Shargh *et al*. (2017) [13]
29.40-30.35	41.28-44.82	21.52-25.02	7.88-8.86	3.42-6.25	11.3-15.11	Gözü Dağtekin (2018)
28.49±0.45	29.32±0.41	40.68±0.32	7.82±0.12	13.49±0.38	21.31±0.50	Present study

The ΣSFA, ΣMUFA, and ΣPUFA values determined in the study were lower than those defined in the literature, but most of the reports were similar. DHA and EPA data's were determined to be high. In this context, it can be argued that the food preferences of Prussian carp in different environments affect the fatty acid composition. The minimum recommended PUFA/SFA rate is 0.45. (HMSO 1994). In the study, the PUFA/SFA rate (1.43±0.01) was found to be above the recommended value.

Quality indexes based on the relative ratio of saturated to unsaturated fatty acids and certain lipids plays a role in determining the dietary value of fish (Senso *et al*. 2007; Jankowska *et al*. 2010; Stanec *et al*. 2011) [34, 17, 38]. It has been determined that fish have a higher value in terms of nutritional lipid quality index than eggs, dairy products, red meat and chicken meat (Kołakowska and Kołakowski 2001) [19]. The quality indices of lipids were determined according to (Atherogenic index-AI, Thrombogenicity index-TI (Ulbricht and Southgate 1991) [39]. Hypocholesterolemic / hypercholesterolemic (h/H) values were defined according to (Santos-Silva *et al*. 2002) [33].

The atherogenic (AI) and thrombogenicity (TI) indices, as suggested by Ulbricht and Southgate (1991) [39], give a signal to obtain a diyet or a combined food to prevent effect of atherosclerosis and platelets aggregation.

Ulbricht and Southgate (1991) [39] stated that low TI and AI values due to lipid intake are beneficial in the prevention of cardiovascular diseases. Ouraji *et al*., (2009) [25] determined that high quality lipids have a high h/H ratio. In the present study, AI (0.36±0.01) and TI (0.23±0.01) indices were measured less than 1.0, whereas h/H (2.69±0.06) was higher than 1.0. It has been reported that a high w/H ratio in terms of nutrition indicates high lipid quality (Santos-Silva *et al*. 2002; Sousa Bentes *et al*. 2009) [33, 36].

Dal Bosco *et al*. (2012) [9] have reported Prussian carp AI, TI, and h/H values as 0.35-0.48, 0.22-0.32, and 1.78-3.35, respectively. Saffar Shargh *et al*. (2017) [13] have reported the AI and TI values as 0.75-1.05 and 0.60-1.17, respectively have reported the AI value as 0.43-0.46, the TI value as 0.30-0.36, and h/H as 2.30-2.59. It was thought that the differences between studies were due to factors including feeding regime, environmental conditions, sampling time, sex, and breeding time.

Prussian carp, an invasive species in many water sources in recent years, has a high protein and low-fat content and is a valuable food source in terms of fatty acids. Compared to other fish species, it is not preferred by consumers due to its unique features such as taste, smell and high fiber structure. It will contribute to the consumption of the species and its economic evaluation. Also, with the increase in demand for the Prussian carp species, it is of great importance to encourage commercial fishing to protect the ecological balance in the water resources where they are invasive, as it will create an economic opportunity for local fishermen.

References

1. Alagöz S, Ergüden D, Göksu MZL. Fish species detected for the first time in Seyhan Dam Lake (Adana), I. Fisheries and Reservoir Management Symposium, 07-09 Şubat, Antalya; c2006.
2. Ali M, Cui Y, Zhu X, Wootton RJ. Dynamics of appetite in three fish species (*Gasterosteus aculeatus*, *Phoxinus phoxinus* and *Carassius auratus gibelio*) after feed deprivation, Aquaculture Research. 2001;32:443-450. https://doi.org/10.1046/j.1365-2109.2001.00594.x.
3. AOAC. Official methods of analysis 16th Ed. Association of official analytical chemists. Washington DC, USA; c1995.
4. Balık İ, Karaşahin B, Özkök R, Çubuk H, Uysal R. Diet of silver crucian carp *Carasssius gibelio* in Lake Eğirdir. Turkısh Journal of Fisheries and Aquatic Scieneces. 2003;3(2):87-91.
5. Balon EK. The oldest domesticated fishes, and the consequences of an epigenetic dichotomy in fish culture. Aqua, International Journal of Ichthyology. 2006;11(2):47-86.
6. Bulut S. The variation of the fatty acid composition in muscle tissue of *Carassius gibelio* living in Seyitler Dam Lake (Afyonkarahisar). Electronic Journal of Food Technologies. 2010;5:69-75.
7. Cibert C, Fermon Y, Vallod D, Meunier FJ. Morphological screening of carp, *cyprinus carpio*

relationship between morphology and fillet yield. Aquatic Living Resources. 1999;12(1):1-10. https://DOI.org/10.1016/S0990-7440(99)80009-6.
8. Çakmak YS, Zengin G, Güler GO, Aktümsek A, Ozparlak H. Fatty acid composition and ω3/ω6 ratios of the muscle lipids of six fish species in Sugla Lake, Turkey. Archives of Biological Sciences, Belgrade. 2012;64:471-477. DOI:10.2298/ABS1202471C.
9. Dal Bosco A, Mugnai C, Mourvaki E, Castellini C. Seasonal changes in the fillet fatty acid profile and nutritional characteristics of wild Trasimeno Lake goldfish (*Carassius auratus* L.). Food Chemistry. 2012;132:830-834. DOI: 10.1007/s11746-007-1070-4.
10. Davies SJ, Gouveia A. Comparison of yttrium and chromic oxides as inert dietary markers for the estimation of apparent digestibility coefficients in mirror carp *Cyprinus carpio* fed on diets containing soybean-maize and fish-derived proteins. Aquaculture Nutrition. 2006;12:451-458. https://DOI.org/10.1111/j.1365-2095.2006.00448.x.
11. Dönmez M. Determination of fatty acid compositions and cholesterol levels of some freshwater fish living in Porsuk Dam, Turkey. Chemistry of Natural Compounds. 2009;45(1):14-17. http://dx.DOI.org/10.1007/s10600-009-9219-z.
12. Erkoyuncu İ, Erdem M, Samsun O, Özdamar E, Kaya Y. A study on the determination of meat yield, chemical structure and length-weight relationship of some fish species hunted in the Black Sea. Istanbul University, Journal of Fisheries. 1994;8(1-2):181-191.
13. Gatlin III DM. Use of soybean meal in the diets of omnivorous freshwater fish; c2002. www.soymeal.org.
14. Dagtekin BB, Basturk O. The determination of meat yield and chemical composition of Prussian Carp (*Carassius gibelio* (Bloch, 1782)) in The Çıldır Lake. Yunus Research Bulletin. 2014;14(2):15-22. DOI: 10.17693/yunusaevi.235394.
15. Dagtekin (Gozu) BB, Balcık Mısır G, Kutlu S, Basturk O. Comparison of biochemical, fatty acids and lipid quality indexes of prussian carp (*Carassius gibelio*) caught from Lake Çıldır on different seasons, MedFAR. 2018;1(1):2-14.
16. İzci L. Utilization and quality of fish fingers from prusssian carp (*Carassius gibelio* Bloch, 1782). Pakıstan Veterinary Journal. 2010;30(4):207-210.
17. Jankowska B, Zakes Z, Zmijewski T, Szczepkowski M. Fatty acid profile of muscles, liver and mesenteric fat in wild and reared perch (*Perca fluviatilis*). Food Chemistry. 2010;118:764-768. DOI: 10.1016/j.foodchem.2009.05.055.
18. Kalous L, Memiş D, Bohlen J. Finding of triploid *Carassius gibelio* (Bloch, 1780) (Cypriniformes, Cyprinidae) in Turkey, Cybium. 2004;28(1):77-79. https://DOI.org/10.26028/cybium/2004-281-013.
19. Kołakowska A, Kołakowski E. The specific nutritional properties of fish. Przemysł spożywczy. 2001;6:10-13.
20. Kottelat M. European Freshwater Fishes Biologia. 1997;52(5):1-271.
21. Kottelat M, Freyhof J. Handbook of European freshwater fishes. Kottelat and Freyhof, Cornol and Berlin; c2007. p. 646.
22. Ludorf W, Meyer V. Fishe und fisherzeuge. Z. Auflage. Verlag Paul Parey In Berlin und Hamburg; c1973. p. 209-210.
23. Mattissek R, Shengel FM, Steiner G. Lebensmittel-Analytick Springer Verlag Berlin, Tokyo; c1988. p. 440.
24. Mocanu M, Oprea L, Crețu M, Cordeli AN, Dediu L. Meat biochemical composition of some fishes from Danube River, Romania. Scientific Papers. Series D. Animal Science. 2022;LXV(1):ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260.
25. Ouraji H, Shabanpur B, Abediankenari A, Shabani A, Nezami A, Sudagar M, *et al*. Total lipid, fatty acid composition and lipid oxidation of Indian white shrimp (*Fenneropenaeus indicus*) fed diets containing different lipid sources. Journal of the Science of Food and Agriculture. 2009;89:993-997. DOI: 10.1002/jsfa.3545.
26. Öksüz A, Dikmen M, Alkan ŞB, Yaylalı O, Kaplan T, Demirtaş S. Comparison of nutrient and fatty acid components of carp and zander fish caught from Beyşehir Lake. Aquatic Research, E-ISSN2618-6365. 2019;2(4):174-181. https://doi.org/10.3153/AR19016.
27. Özparlak H. Effect of seasons on fatty acid composition and n-3/n-6 ratios of muscle lipids of some fish species in Apa Dam Lake, Turkey. Pakistan Journal of Zoology. 2013;45(4):1027-1033.
28. Özyılmaz A, Palalı B. Meat yields, lipid levels, and fatty acid components of some fish from Ataturk Dam Lake. Yunus Research Bulletin. 2014;3:29-36. ISSN 1303-4456.
29. Özyılmaz A, Erguden S, Erguden D, Özeren A, Semerci RSN. The proximate compositions, carbohydrate contents and energy values of three freshwater fish from Seyhan River in Adana/Turkey. Journal of Entomology and Zoology Studies. 2016;4(4):1153-1155.
30. Parmaksiz A, Enes N, Egi K, Koyuncu I. Investigation of the amino acid profile of the species of *Carassius gibelio* (Bloch, 1782) living in euphrates and tigris river. Turkish Journal of Bioscience and Collections. 2022;6(1):1-5. https://DOI.org/10.26650/tjbc.20221013455.
31. Rylkova K, Kalous L, Bohlen J, Lamatsch DK, Petrtyl M. Phylogeny and biogeographic history of the cyprinid fish genus carassius (teleostei: cyprinidae) with focus on natural and anthropogenic arrivals in Europe. Aquaculture. 2013;380-383:13-20. DOI: 10.1016/ j. aquaculture.2012.11.027.
32. Saffar Shargh A, Zakipour Rahimabad E, Alizadeh E, Gheybi F. Amino acid and fatty acid profiles of materials recovered from Prussian carp, *Carassius gibelio* (Bloch, 1782), using acidic and basic solubilization/ precipitation technique. Caspian Journal of Environmental Science. 2017;15(3): 285-294. http://hdl.handle.net/1834/10524.
33. Santos-Silva J, Bessa RJB, Santos-Silva F. Effect of genotype, feeding system and slaughter weight on the quality of light lambs. II. Fatty acid composition of meat. Livestock Production Science. 2002;77:187-194. http://dx.doi.org/10.1016/S0301-6226(02)00059-3.
34. Senso L, Suarrez MD, Ruiz-Cara T, Garcıa-Gallego M. On the possible effects of harvesting season and chilled storage on the fatty acid profile of the fillet of farmed gilthead sea bream (*Sparus aurata*). Food Chemistry. 2007;101:298-307. DOI:10.1016/j.foodchem.2006.01.036.
35. Shargh AS, Rahimabadi EZ, Alizadeh E, Gheybi F. Amino acid and fatty acid profiles of materials recovered from Prussian carp, *Carassius gibelio* (Bloch, 1782),

using acidic and basic solubilization/precipitation technique, Caspian Journal of Environmental Sciences. 2017;15(3):285-294. http://hdl.handle.net/1834/10524.
36. Sousa Bentes A, Souza HAL, Simões MG, Mendonca XMFD. Caracterização física e química e perfil lipídico de três espécies de peixes amazônicos. Revista Brasileira de Tecnologia Agroindustrial. 2009;3:97-108. DOI: 10.3895/S1981-36862009000200011.
37. Süle Ö. Surimi Production and Determination of Chemical and Microbiological Quality by *Carassius gibelio*, Master Thesis, Süleyman Demirel University, Institute of Science and Technology, Department of Fishing and Processing Technology; c2011.
38. Stanec M, Borejszo Z, Dabrowski J, Janicki B. Fat and cholesterol content and fatty acid profiles in edible tissue of spiny-cheek crayfish, *Orconectes limosus* (Raf.) from Lake Goplo (Poland). Archives of Polish Fisheries. 2011;19:241-248. DOI: 10.2478/v10086-011-0030-7.
39. Ulbricht T, Southgate D. Coronary heart disease: seven dietary factors. Lancet. 1991;338:985-992.
40. URL. Fish-and-Omega-3-FattyAcids; c2016. http://www.heart.org/HEARTORG/Healthy Living /HealthyEating/HealthyDietGoals/Fish-and-Omega-3-FattyAcid, (19.10.2022).
41. URL. Fish, omega-3 and healthy heart; c2017. https://croi.ie/fish-omega-3-and-healthy-heart, (05.12.2022).
42. Yazıcı R, Yazıcıoğlu O, Yılmaz S, Polat N. Food composition and feeding strategies of an invasive species, *Carassius gibelio* (Bloch, 1782) inhabiting a eutrophic lake in Middle Black Sea region. Indian Journal of Fisheries. 2022;69(2):48-55.
43. Yılmaz M, Yılmaz S, Bostancı D, Polat N. Feeding regime of pond fish (*Carassius auratus gibelio*, Bloch, 1782) living in Bafra Fish Lakes, Journal of Fisheries Sciences.com. 2007;1(2):48-57. DOI: 10.3153/jfscom.2007007
44. Zhelyazkov GI, Georgiev DM, Peeva SP, Kalcheva SE, Georgieva KY. Chemical composition and levels of heavy metals in fish meat of the cyprinidae family from Zhrebchevo Dam, Central Bulgaria. Ecologıa Balkanıca. 2018;10(2):133-140.
45. Zhang DP, Zhang XY, Yu YX, Li JL, Yu ZQ, Wang DQ, *et al*. Intakes of omega-3 polyunsaturated fatty acids, polybrominated diphenyl ethers and polychlorinated biphenyls via consumption of fish from Taihu Lake, China: A risk–benefit assessment. Food Chemistry. 2012;132:975-981. http://dx.doi.org/10.1016/j.foodchem.2011.11.082.
46. Zhou Z, Cui S, Zhu X, Lei W, Xue M, Yang Y. Effect of feeding frequency on growth, feed utilization, and size variation of juvenile gibel carp (*Carassius auratus gibelio*), Journal of Applied Ichthyology. 2003;19(4):244-249. DOI:10.1046/j.1439-0426.2003.00453.x.