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Research Article Araştırma

Nutrient and Fatty Acid Composition of Pike Perch (*Sander lucioperca*) and Evaluation of Important Indexes Related to Human Health

Sudak Balığının (*Sander lucioperca*) Besin ve Yağ Asidi Kompozisyonu ve İnsan Sağlığı ile İlişkili Önemli İndekslerin Değerlendirilmesi

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Abstract: The nutrient and fatty acid composition of the muscle tissues in the dorsal (D), ventral (V), and caudal (C) regions of the pike perch were determined in this study. Pike perch had 19.63% protein, 0.92% lipid, 78.36% moisture, and 1.04% ash. The whole muscle (WM) (0.92%) of pike perch had the highest lipid content, followed by C (0.82%), V (0.73%), and D regions (0.69%). The results of the study revealed that total polyunsaturated fatty acid (PUFA) (32.37%–37.05%) values were higher than those of total saturated fatty acids (SFA) (29.96%–31.76%) and monounsaturated fatty acid (MUFA) (17.26%–20.81%) in all whole muscle (WM) and different regions (D, V, and C) of the pike perch. The highest SFA, MUFA, and PUFA amounts were in D, WM, and D regions, respectively. In all groups, the amount of Docosahexaenoic acid (DHA) (12.97-15.43%) was higher than Eicosapentaenoic acid (EPA) (5.66-6.97%). While there was no difference between regions in terms of EPA value, the difference between regions in terms of DHA values was found to be important ($p <0.05$). The highest EPA and DHA values were detected in the D region. Atherogenicity index (AI) (0.47–0.48), thrombogenicity index (TI) (0.33–0.35), hypocholesterolemic/hypercholesterolemic ratio (H/H) (2.01-2.07) and n-6/n-3 (0.47–0.51) ratios were at recommended levels in all regions (WM, D, V, and C) and there was no regional difference ($p > 0.05$). The results showed that the fatty acid composition of the pike perch varies according to different body regions, it is rich in nutrient content and has the recommended level of AI, TI, H/H, and n-6/n-3 ratios. It can be concluded that pike perch has beneficial health effects on human nutrition.

Keywords

- Atherogenicity index
- Thrombogenicity index
- Fatty acid composition
- Different muscle tissue
- *Sander lucioperca*

Özet: Bu çalışmada Sudak balığının dorsal (D), ventral (V) ve kaudal (C) bölgelerindeki kas dokularının besin ve yağ asidi bileşimi belirlenmiştir. Sudak balığı % 19.63 protein, % 0.92 lipit, % 78.36 nem ve % 1.04 kül içeriğine sahip olduğu saptanmıştır. Sudak balığının en yüksek lipit içeriği (WM) bölgesinde (0.92%) bulunurken bunu C (%0.82), V (%0.73) ve D bölgeleri (%0.69) izlemiştir. Çalışmanın sonuçları, Sudak balığının tüm (WM) ve farklı bölgelerindeki kaslarda (D, V ve C) toplam çoklu doymamış yağ asitleri (PUFA) (%32.37 -37.05) değerlerinin toplam doymuş yağ asitlerinden (SFA) (%29.96-31.76) ve tekli doymamış yağ asidi (MUFA) (%17.26-–20.81) değerlerinden daha yüksek olduğunu göstermiştir. En yüksek SFA, MUFA ve PUFA miktarları sırasıyla D, WM ve D bölgelerinde belirlenmiştir. Tüm gruplarda Docosahexaenoik asit (DHA) (%12.97-15.43) miktarı, eikosapentaenoik asitten (EPA) (%5.66-6.97) daha yüksek bulunmuştur. EPA değeri açısından bölgeler arasında fark olmadığı tespit edilirken, DHA değerleri açısından bölgeler arasındaki fark önemli bulunmuştur ($p <0.05$). En yüksek EPA ve DHA değerleri D bölgesinde tespit edilmiştir. Atherogenicity indeks (AI) (0.47-0.48), thrombogenicity indeks (TI) (0.33-0.35), hipokolesterolemik/hiperkolesterolemik

Anahtar kelimeler

- Atherogenicity indeks
- Thrombogenicity indeks
- Yağ asitleri kompozisyonu
- Farklı kas dokuları
- *Sander lucioperca*

oran (H/H) (1.53-1.57) ve n-6/n-3 (0.47-0.51) oranı tüm bölgelerde (WM, D, V ve C) önerilen seviyelerde olup bölgesel fark bulunmamıştır (P> 0.05). Sonuçlar, sudak balığının yağ asidi bileşiminin vücudunun farklı bölgelerine göre değiştiğini, besin içeriği açısından zengin olduğunu ve önerilen AI, TI, H/H ve N-6/N-3 oranlarına sahip olduğunu göstermiştir. Sudak balığının insan beslenmesinde yararlı sağlık etkileri olduğu sonucuna varılabilir.

1. INTRODUCTION

Fish is one of the most important foods that contribute to a healthy diet of people due to its nutritive qualities such as being rich in essential amino acids, unsaturated fatty acids, minerals, and vitamins (Can et al., 2015; Çağlak & Karslı, 2017), and trace metals and being easy to digest due to the absence of connective tissue (Can et al., 2015). In addition, fish is the only important source of polyunsaturated fatty acid (PUFA) in the human diet, especially those in the n-3 group characterized by eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are considered essential since they are not synthesized by the human body and must be obtained through diet (Carvalho et al., 2006; Briggs et al., 2017). n-3 fatty acids, which have a protective effect against many diseases such as colon cancer, cardiovascular diseases, and immune system disorders, have an important role in human health (Lee et al., 2020; Kheiri et al., 2022). Studies have shown that fish consumption helps prevent cardiovascular diseases, high blood pressure, cholesterol, Alzheimer's disease, and various types of cancer (McNaughton et al., 2008; Guler et al., 2011). Therefore, consumers are becoming increasingly aware, in recent times, of the beneficial effects of n-3 PUFA in preventing, delaying, and intervening in many diseases (Liu et al., 2022).

To create effective seafood consumption policies, each country is very concerned with trends and forecasts of global seafood consumption (Coro et al., 2016). Moreover, it is stated that in addition to the geographical, social, and cultural characteristics of consumers, some sensory (taste, smell, texture, etc.) and non-sensory factors (behaviour, beliefs, personal characteristics, risk perception, etc.) affect fish consumption, frequency, and preferences (Honkanen et al., 2005; Pieniak et al., 2011). In general, consumers in Turkey consume fish mostly fresh and without removing the skin of the dorsal (D) and ventral (V) muscles of the fish, as in many Asian countries (Ling et al., 2013; Can et al., 2015).

The fish pike perch (*Sander lucioperca*) is one of the most important species for aquaculture in terms of its rapid growth, high meat quality, and economic value (Zakęś, 1997; Hamza et al., 2008; Yanes-Roca et al., 2020). Pike perch, which has an important economic value in Turkey, especially in the Central Anatolian region (Cakmak et al., 2012), is also widely available in Central, Eastern, and Northern Europe (Yanes-Roca et al., 2020). This species, which has the potential to offer quality and valuable products due to being a white, delicious, and low-fat fish (Tönißen et al., 2022), has become popular both in the aquaculture and gastronomy sector (Yanes-Roca et al., 2020), as well as for consumers and anglers- fisherman (Kánainé Sipos et al., 2019). Pike perch is a valuable carnivorous fish species (Kánainé Sipos et al., 2019) belonging to the Percidae family (Tönißen et al., 2022) that lives in fresh and less salty waters and usually feeds on small fish and invertebrates. They reproduce in April and May depending on weather conditions and water temperature (Çınar et al., 2006; Öksüz et al., 2019).

Gelingüllü Dam is located in the southeast of the Yozgat province in the Central Anatolia Region, Turkey, at 39°36'30"N latitude and 35°03'20"E longitude coordinates (S. G. Kırankaya & Ekmekçi, 2007). The most important river source feeding the dam built on Delice Irmak, a branch of Kızılırmak, is Kanak Stream (Kırankaya & Ekmekçi, 2004). In general, the growth properties and reproductive biology of fish in this dam lake have been evaluated (Ekmekçi & Özeren, 2003; Kırankaya & Ekmekçi, 2004;2007). Moreover, there are lots of studies about reproduction, food and feeding characteristics (Özvarol & İkiz,1999; Özvarol, 2006), and meatballs quality characteristics of pike perch (Unlüsayın et al., 2002; Bilgin & Metin, 2021). However, no reports have been published about the nutritional values and fatty acid composition of pike perch in Gelingüllü Dam Lake. Therefore, it is important to emphasize collecting data on the nutritional content and lipid composition of pike perch in this reservoir if recommendations for human consumption are to be considered. Therefore, this study aims to determine the nutritional composition of pike perch and the fatty acid compositions in their different body parts (D, V, and caudal C) muscles and human health-related indexes of pike perch.

2. MATERIAL and METHODS

2.1. Fish material

Pike perch (*S. lucioperca*) used in this research, were caught from Gelingüllü Dam Lake in 2019 in the summer season (July). Ten individual fish were sampled for nutrient and fatty acid composition analysis from this area. Gender differences were not taken into account. The caught fish were immediately placed in a frosted styrofoam box and transferred to the laboratory. The weight and length of all fish were measured and labeled, and they were stored at −24°C until analyzed. The mean length and weight values were 44 cm and 792 g, respectively, in July for pike perch. At the beginning of the analysis, the frozen fish was thawed in a refrigerator (2–4°C) overnight. After thawing, the fish was immediately gutted and the D, V, and C parts of fish muscle (Figure 1) were removed by knife and minced for proximate and fatty acid analyses. Analyses were performed in triplicate.

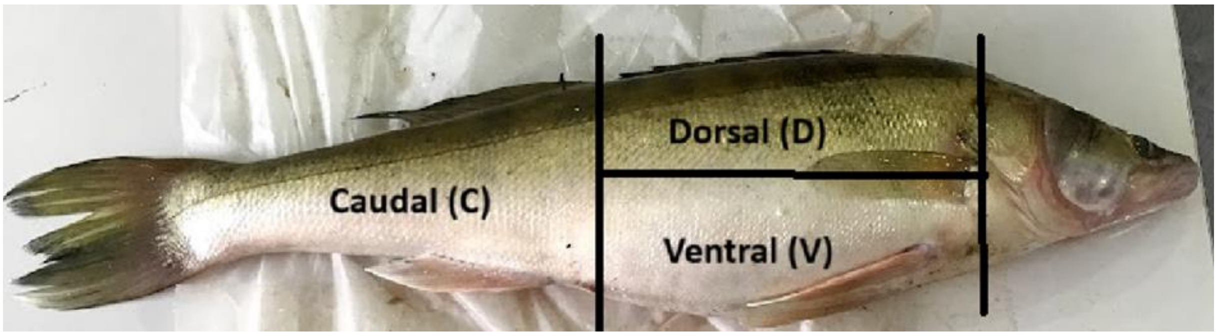

Figure1. The different (D, V, and C) portions of pike perch used in the analysis.

2.2. Determination of proximate compositions

Ash and moisture contents of pike perch were determined by AOAC method (Association of Official Analytical Chemists, 1984), protein by Kjeldahl method (AOAC, 1998), and lipid by Bligh and Dyer method (Bligh & Dyer, 1959).

2.3. FAME (Fatty Acid Methyl Esters) analyses

Methyl esters were prepared by transmethylation using 2M KOH in methanol and n-heptane according to the method as described by Ichihara et al. (Ichihara et al., 1996) with minor modifications. Extracted lipids (10 mg) were dissolved in 2 ml heptanes followed by 4 ml of 2M methanolic KOH. The tube was then vortexed for 2 min. After centrifugation at 4000 rpm for 10 min, the heptanes layer was taken for Gas chromatography (GC) analyses. GC conditions: The fatty acid composition was analyzed by GC Clarus 500 with an autosampler (Perkin Elmer, USA) equipped with a flame ionization detector and a fused silica capillary SGE column (30 m × 0.32 mm, ID x 0.25 lm, BP20 0.25 UM, USA). Three replicates of GC analyses were carried out and the results were expressed in GC area % as mean value ± standard deviation.

2.4. Fat nutritional quality indices

Atherogenicity index (AI) Eq.(1) and Thrombogenicity index (TI) Eq.(2) according to Ulbricht and Southgate (1991), Santos-Silva et al. (2002) with changes and Hypocholesterolemic/Hypercholesterolemic ratio (H/H) Eq. (3) indices were calculated as follows:

$$AI = [(C12{:}0 + (4 \times C14{:}0) + C16{:}0)] / [MUFA + \sum (n-6) + \sum (n-3)]. \quad (1)$$

$$TI = (C14{:}0 + C16{:}0 + C18{:}0) / [(0.5 \times \Sigma MUFA) + (0.5 \times \Sigma n\text{-}6 + (3 \times \Sigma n\text{-}3) + (\Sigma n\text{-}3/\Sigma n\text{-}6)] \quad (2)$$

$$H/H = [(C18{:}1n\text{-}9 + C18{:}2n\text{-}6 + C18{:}3n\text{-}3 + C20{:}4n6 + C20{:}5n3 + C22{:}5n\text{-}3 + C22{:}6n\text{-}3) / (C14{:}0 + C16{:}0)] \quad (3)$$

2.5. Statistical Analysis

Analysis per sample was carried out in triplicates and the results are shown as mean and standard deviation. All data obtained separately for each sampling period were subjected to analysis of variance (one-way ANOVA), and the Duncan's Multiple Range Test was applied to determine significant differences at a p-value of <0.05 using the software SPSS version 22 (SPSS, Chicago, Illinois).

3. RESULTS and DISCUSSION

3.1. Proximate composition

The protein, moisture, ash, and fat contents of pike perch, as well as the fat content of the D, V, and C regions, are given in Table 1.

Table1. Nutritional composition of *Sander luciaperca*

	Nutritional values			
	Protein	**Lipid**	**Moisture**	**Ash**
S. luciaperca (WM)	19.63±0.40	0.92±0.07[a]	78.36±0.32	1.04±0.04
Dorsal (D)		0.69±0.15[b]		
Ventral (V)		0.73±0.08[ab]		
Caudal (C)		0.82±0.10[ab]		

Data are shown as mean ± standard deviation. Different letters in the same column show that there are significant differences between regions in terms of the amount of oil in pike perch (p<0.05).

In this study, it was found that the pike perch fish caught from the Gelingüllü dam in July contained 19.63% protein, 0.92% lipid, 78.36% moisture, and 1.04% ash. Similarly, Öksüz et al. (2019) reported the protein content of pike perk as 19.9% in Beysehir Lake, Turkey. Bilgin et al. (2005), Çelik et al. (2005) and Bouriga et al. (2020) reported that moisture and ash contents were similar to our results. However, they reported lower protein content for pike perch from Eğirdir Lake and Seyhan Dam Lake, from the Turkish Lake Eğirdir, and from the dam of Sidi El Barrak, respectively. Bilgin et al. (2005) reported the total lipid content of pike perk as 0.93% in Beysehir Lake, Turkey similar to our results; while Guler et al. (2011) found higher (1.18%) values in winter and lower values in summer (0.60%) than our results. Differences in protein and fat content can be attributed to the fishing season and regional fish diet.

In the present study, the caudal part body of pike perch had the highest lipid content (0.82%), followed by the V part (0.73%) and the D part (0.69%) (Table 1). The lipid content of pike perch was higher especially in the V and C parts than in the dorsal part ($p < 0.05$). Similar results were observed in the studies of Asian catfish (*Pangasius bocourti*) (Thammapat et al., 2010) and rainbow trout (Fjellanger et al., 2001). It is stated that factors such as the season in which the fish are caught, nutrition, sexual maturity status, and the size of the fish have a significant effect on the amount of lipid and fatty acids in the fish (Guler et al., 2011; Cakmak et al., 2012). Even between different muscles of a fish, there is a significant variation in fat content. In a study, the amount of fat in the white muscle of Thunnus alalunga was 2.98%, in the dark muscle 3.69%, and in the abdominal muscles 10.43% (Perez-Villarreal & Pozo, 1990). Moreover, it has been determined that the lipid and protein contents of cultured fish are dependent on exercise or fish muscle movement, as well as nutrition. Therefore, there are high differences in protein and lipid contents in different fish portions (Nakamura et al., 2007; Thammapat et al., 2010).

3.2. Fatty Acid Composition of pike perch

The fatty acid composition of the whole muscle (WM) and different body regions (D, V, and C) of the muscle tissues of the pike perch caught from Gelingüllü dam is given in Table 2. We identified a total of 27 fatty acids. In all groups, essential fatty acids included myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), palmitoleic acid (C16:1), oleic acid (C18:1n9), waxenic acid (C18:1n7), linoleic acid (C18:2n6), linolenic acid (C18:3n3), arachidonic acid (C20:4n6), EPA (C20:5n3), and DHA (C22:6n3).

Table 2. Variations on total (%) fatty acid compositions in different part of body muscle lipids of the *Sander luciaperca* from Gelingüllü Dam Lake

Fatty acids	Whole Muscle (WM)	Dorsal (D)	Ventral (V)	Caudal (C)
C12:0	0.03±0.01[ab]	0.03±0.01[ab]	0.04±0.00[a]	0.03±0.00[b]
C14:0	1.56±0.49[a]	1.12±0.09[a]	1.31±0.01[a]	1.27±0.35[a]
C15:0	0.63±0.21[a]	0.46±0.02[a]	0.50±0.01[a]	0.45±0.02[a]
C16:0	19.34±0.73[b]	20.79±0.14[a]	20.63±0.53[a]	20.47±0.58[a]
C17:0	0.63±0.06[a]	0.64±0.02[a]	0.68±0.02[a]	0.68±0.05[a]
C18:0	7.48±0.90[a]	8.43±0.07[a]	7.60±0.19[a]	8.25±0.33[a]
C20:0	0.19±0.02[a]	0.19±0.01[a]	0.20±0.01[a]	0.20±0.01[a]
C22:0	0.03±0.00[a]	0.03±0.00[a]	0.05±0.00[a]	0.03±0.00[a]
C24:0	0.06±0.00[a]	0.06±0.01[a]	0.06±0.01[a]	0.08±0.01[a]
ΣSFA	**29.96±0.99[b]**	**31.76 ±0.06[a]**	**31.07±0.33[ab]**	**31.44±1.20[ab]**
C14:1	0.26±0.05[a]	0.18±0.02[c]	0.24±0.01[ab]	0.20±0.02[bc]
C15:1	0.22±0.01[a]	0.19±0.01[b]	0.22±0.01[a]	0.20±0.01[b]
C16:1	5.30±1.67[a]	3.42±0.22[b]	4.18±0.03[ab]	3.52±0.25[b]
C17:1	0.11±0.06[a]	0.10±0.01[a]	0.11±0.02[a]	0.10±0.02[a]
C18:1n9	10.51±0.37[ab]	9.28±0.34[c]	10.96±0.31[a]	10.27±0.11[b]
C18:1n7	3.51±0.20[a]	3.02±0.14[b]	3.27±0.04[ab]	3.17±0.06[b]
C20:1n9	0.04±0.01[b]	0.14±0.01[a]	0.14±0.03[a]	0.11±0.01[a]
C22:1n9	0.13±0.02[a]	0.03±0.00[b]	0.15±0.01[a]	0.15±0.01[a]
C24:1n9	0.74±0.16[a]	0.90±0.17[a]	0.81±0.07[a]	0.90±0.04[a]
ΣMUFA	**20.81±1.44[a]**	**17.26±0.57[c]**	**20.08±0.26[ab]**	**18.60±0.28[bc]**
C18:2n6	4.36±0.55[a]	4.40±0.07[a]	4.85±0.13[a]	4.46±0.16[a]
C18:3n6	0.12±0.02[a]	0.11±0.00[a]	0.11±0.00[a]	0.10±0.01[a]
C18:3n3	2.69±0.27[b]	2.58±0.03[b]	3.05±0.13[a]	2.61±0.19[b]
C20:2 cis	0.30±0.02[a]	0.30±0.01[a]	0.31±0.00[a]	0.30±0.00[a]
C20:3 n6	0.50±0.00[a]	0.51±0.00[a]	0.51±0.01[a]	0.48±0.01[b]
C20:4 n6	5.73±0.37[c]	6.64±0.23[a]	6.13±0.07[bc]	6.27±0.22[ab]
C20:5n3	5.66±2.86[a]	6.97±0.23[a]	6.42±0.10[a]	6.16±0.15[a]
C22:2 cis	0.03±0.01[b]	0.11±0.01[a]	0.11±0.00[a]	0.08±0.04[a]
C22:6 n3	12.97±0.99[c]	15.43±0.36[a]	13.59±0.34[bc]	14.27±0.51[b]
ΣPUFA	**32.37±2.22[b]**	**37.05±0.77[a]**	**35.08±0.42[a]**	**34.72±0.67[a]**
AI	0.48±0.02[a]	0.47±0.01[a]	0.47±0.01[a]	0.48±0.04[a]
TI	0.35±0.04[a]	0.33±0.01[a]	0.34±0.00[a]	0.35±0.02[a]
H/H	2.01±0.12[a]	2.07±0.02[a]	2.05±0.02[a]	2.03±0.09[a]
PUFA/SFA	1.08±0.09[a]	1.16±0.02[a]	1.13±0.01[a]	1.11±0.06[a]
Σn3	21.33±2.31[b]	24.98±0.57[a]	23.06±0.38[ab]	23.03±0.54[ab]
Σn6	10.71±0.53[b]	11.66±0.23[a]	11.60±0.15[ab]	11.31±0.09[ab]
n6/n3	0.51±0.08[a]	0.47±0.01[a]	0.50±0.01[a]	0.49±0.01[a]
DHA	12.97±0.99[c]	15.43±0.36[a]	13.59±0.34[bc]	14.27±0.51[b]
EPA	5.66±2.86[a]	6.97±0.23[a]	6.42±0.10[a]	6.16±0.15[a]
DHA/EPA	2.98±2.08[a]	2.21±0.02[a]	2.12±0.04[a]	2.32±0.05[a]

Data are shown as mean ± standard deviation (SD). SFA: Saturated fatty acid; MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid; DHA: Docosahexaenoic acid; EPA:Eicoesapentaenoic acid; Σn-6 PUFA: total n-6 polyunsaturated fatty acid; Σn-3 PUFA: total n-3 polyunsaturated fatty acid. In Table 2, different letters (a-c) in the same line show significant differences for dıfferent regıons of fısh ($p<0.05$).

Total PUFA values (32.37%–37.05%) were higher than total saturated fatty acids (SFA) (29.96%–31.76%) and total monounsaturated fatty acids (MUFA) (17.26%–20.81%) values in tissue samples obtained from the D, V, and C regions and WM. Carnivores, due to their consumption of other fish, which undergo a series of elongation and desaturation, were rich in longer-chain n-3 PUFAs (Guler et al., 2011). Moreover, Öksüz et al. (2019), Bouriga et al. (2020) and Töniben et al. (2022) also found that the total PUFA value was higher than the total SFA and MUFA for pike perch, a carnivorous fish species.

Total SFA was 29.96% in the WM and 31.07%–31.76% in the muscle tissues of different regions (D, V, and C) of pike perch (Table 2). These results are in line with previous studies on the fatty acid content of the pike perch (Çelik et al., 2005; Guler et al., 2011; Öksüz et al., 2019; Özogul et al., 2007; Özparlak, 2013).

In our study, the lowest total SFA value was found in the WM region, while the highest total SFA value was found in the D region ($p < 0.05$). Palmitic acid (C16:0) value was lowest in WM with 19.34% ($p < 0.05$), while in the D, V, and C regions, it varied between 20.47%–20.79%, and there was no significant difference between regions ($p > 0.05$). The value of stearic acid (C18:0) was between 7.60%–8.43%, and the lowest and highest value was found in WM and D regions, respectively. Stearic acid values showed no significant difference between different regions ($p > 0.05$). Guler et al. (2011) investigated the fatty acid content of pike perch in different seasons and found that stearic acid (7.05%), palmitic acid (22.20%), and total SFA (32.23%) values in the summer season were similar to those in our study, while the values taken in winter season were lower than those in our study.

Total MUFA showed variability ($p < 0.05$) according to different body regions of pike perch. The highest MUFA value (20.81%) was found in the WM region and the lowest MUFA value (17.26%) was found in D region. Similar to the previous studies with pike perch, palmitoleic acid (C16:1, 3.42%–5.30%), oleic acid (C18:1n9, 9.28%–10.96%), and vaccenic acid (C18:1n7, 3.02%–3.51%) were the major MUFA acids in our study (Çelik et al., 2005; Özogul et al., 2007; Guler et al., 2011; Özparlak, 2013; Öksüz et al., 2019). In addition, it was observed that the fatty acid composition in different body regions of the pike perch showed variation ($p < 0.05$).

Total PUFA varied between 32.37%–37.05% and the highest and lowest value was found in D and WM regions, respectively. Similar results have been found by other researchers (Guler et al., 2011; Öksüz et al., 2019). Total PUFA value showed no difference between the D, V, and C regions of pike perch ($p > 0.05$). In our study, linoleic acid (C18:2n6, 4.36%–4.85%), linolenic acid (C18:3n3, 2.58%–3.05%), arachidonic acid (C20:4n6, 5.73%–6.64%), EPA (C20:5n3, 5.66%–6.97%), and DHA (C22:6n3, 12.97%–15.43%) were the most common PUFAs. It was determined that except EPA and linoleic acid, other acid values changed according to different regions of the pike perch ($p < 0.05$).

It has been determined that *S. lucioperca* is rich in PUFA, especially in DHA and EPA, which are the major ones, which is in line with the literature (Uysal & Aksoylar, 2003; 2005; Bouriga et al., 2020; Kheiri et al., 2022; Tönißen et al., 2022). In most carnivorous fish and invertebrates, DHA is generally more abundant than EPA. The limnetic food chain is characterized by linoleic acid, alpha-linolenic acid, and EPA fatty acids, and freshwater fish can obtain high levels of 20:4n-6 by consuming aquatic insects (Mısır, 2014). In this study, it was determined that the DHA value of pike perch, a carnivorous fish species, was higher than that of EPA and it contains a high rate of arachidonic acid (C20:4n6, 5.73%–6.64%).

Nutritionists recommend an n-6/n-3 ratio of 4 (Valencia et al., 2006). The low n-6/n-3 ratio in the diet helps to prevent coronary heart disease, while a high ratio is considered a major risk factor for coronary heart disease (Aberoumand & Baesi, 2022). In the present study, the n-6/n-3 ratio in all regions of the pike perch was between 0.47–0.51 and did not exceed the maximum recommended ratio. Özogul et al. (2007) determined that the n-6/n-3 ratio of zander is 0.46, which is similar to our result.

AI, TI, and h/H ratios were used due to the correlation between fatty acids and human health. AI and TI >1.0 are reported to be harmful to human health (Ouraji et al., 2009). The AI (0.47–0.48) and TI (0.33–0.35) values obtained in this study were lower than risky values in the WM and different body regions (D, V, and C) of the pike perch (Table 2), and it was determined that there was no risk for human health. Çağlak and Karsli (2017) found AI (0.38–0.49) and TI (0.22–0.31) values for *S. lucioperca*, which were similar to the values found in the results of our study. The H/H ratio has been used as one of the indexes to assess the nutritional and health aspects of the product (Rincón-Cervera et al., 2020). The H/H values for the WM and different body regions (D, V, and C) of the pike perch were found between 2.01-2.07 in this study.

4. CONCLUSION

There was no study in the literature that determined the nutritional content and fatty acid composition of pike-perch caught from Gelingüllü dam. In this study, the nutritional content and fatty acid profile of pike perch were determined and the difference in fatty acid between different body parts of the fish was investigated. It was found that pike perch had a high protein value; the C region had the highest fat content, followed by the V and D regions. The total PUFA value was higher than the total SFA and MUFA values. A significant difference in SFA and MUFA values between different regions of the fish was observed, except for the PUFA value. AI, TI, H/H, and n-6/n-3 ratios were found to be in the recommended range.

In conclusion, pike perch has high nutritional value, its fatty acids composition vary according to different body regions, and it can be beneficial for human consumption and health based on AI, TI, H/H, and n-6/n-3 ratios.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

EB: Designed the study, wrote the first draft of the manuscript, performed and managed statistical analyses, and read and approved the final manuscript.

ETHICAL STATEMENTS

Local Ethics Committee Approval was not obtained because experimental animals were not used in this study.

DATA AVAILABILITY STATEMENT

Data supporting the findings of the present study are available from the corresponding author upon reasonable request.

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