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Fatty Acid Composition of Commercial Smoked Salmon Products

Ticari Somon Füme Ürünlerinin Yağ Asidi Kompozisyonu

Türk Denizcilik ve Deniz Bilimleri Dergisi

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ABSTRACT

In this study, the fatty acid composition of smoked salmon fillets sold in grocery stores in Türkiye was investigated. Gas chromatography (GC) was used to determine fatty acid composition from extracted lipid. The main saturated fatty acids observed in smoked salmon samples were myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0); monounsaturated fatty acids were palmitoleic acid (C16:1), oleic acid (C18:1n9), and vaccenic acid (C18:1n7); polyunsaturated fatty acids (PUFA) were linoleic acid (C18:2n6), eicosapentaenoic acid (EPA, C20:5n3) and decosahexaenoic acid (DHA, C22:6n3). Among the monounsaturated fatty acids, oleic acid was found to be the fatty acid with the highest value. Oleic acid amounts were found to vary between 27.22% and 35.52%. PUFA values in smoked salmon fillet groups were determined as 27.77%, 27.49%, 32.94% and 30.62%. The highest EPA value was determined in F1 group with 4.29% and the lowest value was determined in F2 group with 2.07%. DHA amounts were between 11.74% and 6.22%. The ratio of Σn6/Σn3 was between 0.80 (F4 group) and 1.16 (F2 group). As a result, it was concluded that the smoked fish fillets examined had high nutritional quality in terms of fatty acids. Among the groups, especially F3 and F4 groups were found to have rich content in terms of PUFA and Σn3 values.

Keywords: Smoked, Fatty acid profile, PUFA, Gas chromatography

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ÖZET

Bu çalışmada, Türkiye'de marketlerde satışa sunulan tütsülenmiş somon filetolarının yağ asidi kompozisyonları araştırılmıştır. Ekstrakte edilmiş lipitten yağ asidi kompozisyonunu belirlemek için gaz kromotografisi (GC) kullanılmıştır. Füme somon örneklerinde gözlenen başlıca doymuş yağ asitleri miristik asit (C14:0), palmitik asit (C16:0) ve stearik asittir (C18:0); tekli doymamış yağ asitleri palmitoleik asit (C16:1), oleik asit (C18:1n9) ve vaksenik asittir (C18:1n7); çoklu doymamış yağ asitleri (PUFA), linoleik asit (C18:2n6), eikosapentaenoik asit (EPA, C20:5n3) ve dekosaheksaenoik asittir (DHA, C22:6n3). Tekli doymamış yağ asitlerinden en yüksek değere sahip olan yağ asidi oleik asit olarak tespit edilmiştir. Oleik asit miktarları %27.22 ile %35.52 arasında değişim gösterdiği tespit edilmiştir. Tütsülenmiş somon fileto gruplarındaki PUFA değerleri %27.77, %27.49, % 32.94 ve %30.62 olarak belirlenmiştir. En yüksek EPA değeri %4.29 ile F1 grubunda, en düşük değer ise %2.07 ile F2 grubunda tespit edilmiştir. DHA miktarlarının ise %11.74 ile %6.22 aralığında olduğu belirlenmiştir. Σn6/Σn3 oranının en az 0.80 (F4 grubu) ve en yüksek 1.16 (F2 grubu) arasında olduğu belirlenmiştir. Sonuç olarak incelenen füme balık filetolarının yağ asitleri açısından besinsel kalitesinin yüksek olduğu kanaatine varılmıştır. Gruplar arasında ise özellikle F3 ve F4 gruplarının PUFA ve Σn3 değerleri açısından zengin içeriğe sahip oldukları belirlenmiştir.

Anahtar sözcükler: Tütsüleme, Yağ asidi profili, PUFA, Gaz kromatografisi

1. INTRODUCTION

Climate change and environmental degradation have negative impacts on the world's natural resources. On the other hand, the human population will exceed 9 billion by the middle of the twenty-first century, making it even more difficult to provide healthy food (FAO, 2018). The food industry, which is already growing day by day, is growing even more as the demand for healthy food increases. Consumers, on the other hand, tend to prefer natural foods that are more beneficial in order to minimize increasing health risks. With this increasing demand for healthy nutrition in recent years, the consumption of seafood is also increasing. The digestible protein content, mineral substances and polyunsaturated fatty acids are the three main topics that come to mind in the nutritional composition of seafood. The most prominent feature in the nutritional composition of seafood is the polyunsaturated fatty acids (PUFA) they contain. It is widely acknowledged and frequently advised by experts that fish oil is essential for human health and nutrition. The primary cause of this is that fish oil contains long-chain polyunsaturated fatty acids like EPA and DHA. Fish oils have been found as a way to lower mortality risks, especially in cardiovascular disorders, due to their high content of essential fatty acids, which have been connected to brain development and cardiovascular health (Durmus, 2018; Raatz and Bibus, 2016; Fung *et al*., 2009; Mol, 2008). Due to their rich fatty acid content, health organizations recommend regular consumption of seafood; for example, the American Heart Association Nutrition Committee recommends fish consumption 2 or 3 times a week (Mnari *et al.*, 2007). Consumption of polyunsaturated fatty acids, particularly EPA and DHA from the omega-3 fatty acid series, can reduce risk factors like heart rhythm, blood pressure, triglyceride levels, and platelet aggregation, which in turn can prevent many diseases in humans, particularly cardiovascular disorders (Fung *et al*., 2009; EFSA, 2012; Durmus, 2018). However, with this increase in demand for seafood, there have been problems in product supply and these problems have led to growth in the aquaculture and processed seafood industries.

Especially with the Covid-19 pandemic, consumers have tended to pay more attention to their nutrition and the place of fish in the consumer diet has increased. During this period, processed and packaged products were preferred over fresh or chilled products worldwide (Chenarides *et al*., 2021; Fernández-González *et al.*, 2021; Kitz *et al*., 2022; Knorr and Khoo, 2020; Li *et al*., 2021; Oliveira *et al*., 2021; White *et al*., 2021). The consumption of processed products in Europe increased from 424 thousand tons to 511 thousand tons from 2019 to 2020 with the pandemic (EUMOFA, 2021). The increase in consumers' preference for processed and packaged products over fresh or chilled products has also increased production. For example, canned food consumption increased in Portugal (21%), Italy (14%) and Luxembourg (13%) during the pandemic (European Commission, 2021). The increase in consumer preference for processed products led to a significant increase in imports of raw and processed fish in Europe in 2020 (EUMOFA, 2021). Imported seafood products are processed with different processing techniques and offered to consumers. Although methods such as marinating, canning, salting, salting, drying, smoking are traditionally used in many parts of the world, smoking is a processing technology for which demand has increased in recent years due to the different taste and aroma in the final product (Kose and Erdem 2004, Ayas 2006, Atar and Alçiçek 2009; Düzarduç, 2021). In this context, smoked products have an important market share among the processed seafood products offered to consumers in Europe (EUMOFA, 2021).

Smoking is a complicated process technique. Factors such as the wood material used in the application, temperature and humidity inside the oven should be taken into consideration (Ünal and Çelik, 1995; Ceylan and Şengör, 2015). During the application of this technology to seafood, the compounds in the smoke content come into contact with the food and these compounds add flavor and color to the product. If smoking technology is not applied consciously and in a controlled manner, it is inevitable that undesirable compounds will appear in the food to be consumed. Therefore, it is important to investigate the nutritional content of this technique in order not to adversely affect the nutritional content of the smoked product and consumer health. It is also especially important to determine the effect of the smoking process on the fatty acids in seafood products. However, research on the contents of smoked seafood products in our country is limited. Therefore, in this study, fatty acid compositions of processed salmon fillets offered for sale in grocery stores were investigated.

2. MATERIALS AND METHODS

2.1. Smoked fish

The smoked salmon used in the study was obtained from an international hypermarket in Adana. Then they were delivered to Çukurova University, Faculty of Fisheries, Processing Technologies Laboratory. The samples were stored in the refrigerator until the day of analysis. The analyzed samples were coded as F1, F2, F3 and F4 (Table 1).

Table 1. Characteristics of sampled smoked fish.

Code	Content	Weight	Origin	Date of production
F1	Salmon meat, salt, sugar, wood smoke	250 g	Norway	7 Nov 2022
F2	Turkish salmon, salt, preservative (sodium benzoate), natural wood smoke	100 g	Türkiye	15 Nov 2022
F3	*Salmo trutta labrax*, salt, natural wood smoke	100 g	Türkiye	8 Nov 2022
F4	Salmon (*Salmo salar* 98%), salt, sugar, spice mixture (mustard, onion, etc.)	200 g	Norway	19 Oct 2021

2.2. Lipid Analysis

Lipid analysis was performed according to the method of Bligh and Dyer (1959). 15 g of homogenized sample was mixed in a homogenizer after adding 120 mL of methanol/chloroform (1/2, v/v). Then 20 mL of 0.4% $CaCl_2$ solution was added to these samples and the samples were filtered through filter paper (Scleicher and Schuell, 5951/2 185 mm) and placed in an oven at 105 °C for 1 hour and filtered into tared balloon jugs. These flasks were sealed airtight and kept in a dark place for 1 night and the next day the top layer of methanol-water was removed with the help of a separating funnel.

From the chloroform-lipid portion remaining in the balloons, chloroform was evaporated using a rotary evaporator in a water bath at 60 °C. The flasks were then placed in an oven at 60 °C for half hour to evaporate all the chloroform, cooled to room temperature in a desiccator and weighed on a 0.1 mg sensitive precision balance.

2.3. Fatty acids analysis

The method of Ichihara *et al.* (1996) was used to create fatty acid methyl esters from extracted lipid. 4 mL of 2M KOH and 2 mL of n-heptane were added to 25 mg of the isolated lipid sample. After being centrifuged for 10 minutes at 4000 rpm and vortex-mixed for 2 minutes at room temperature, the heptane layer was analyzed using gas chromatography (GC).

2.4. Gas chromatography conditions

Fatty acid analysis was performed using a GC Clarous 500 instrument (Perkin-Elmer, USA), a flame ionization detector and an acid silicide salt tube SGE (30 m x 0.32 mm ID x 0.25 lm BP20 0.25 UM, USA). Injector and detector temperatures were set to 220 °C and 280 °C, respectively. Meanwhile, the oven temperature was kept at 140 °C for 5 minutes. Then it was increased by 4 °C every minute up to 200 °C and from 200 °C to 220 °C by 1 °C every minute. The sample size was 1 mL and the carrier gas was controlled at 16 ps. A split ratio of 1:100 was used. Fatty acids are identified by comparing the standard 37-component FAME mixture based on arrival times.

2.5. Statistical analyses

SPSS 22.0 was used to determine for statistical analysis. All collected data were analyzed by one-way ANOVA ($p<0.05$) confidence level using the Duncan multiple range test (Duncan, 1955). The level of significance was taken as $p<0.05$.

3. RESULTS AND DISCUSSION

3.1. Fatty acid changes

The main saturated fatty acids observed in smoked salmon samples were myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0); monounsaturated fatty acids were palmitoleic acid (C16: 1), oleic acid (C18:1n9) and vaccenic acid (C18:1n7); polyunsaturated fatty acids were linoleic acid (C18:2n6), eicosapentaenoic acid (EPA, C20:5n3) and decosahexaenoic acid (DHA, C22:6n3). The saturated fatty acid composition of smoked salmon fillets is given in Table 1.

According to the findings of present study, it was determined that the total SFA amounts of the smoked salmon fillets examined varied between 16.84% and 25.01%. In addition, it was determined that there was a statistical difference between smoked salmon fillets in terms of the results ($P < 0.05$). Espe *et al.* (2004) investigated the quality of smoked salmon from 3 different origins (Norwegian, Scottish, and Irish) collected in a French hypermarket. The researchers determined the SFA value of Norwegian, Scottish and Irish smoked salmon as 24.5, 23.2 and 23.7 g $100g^{-1}$ lipid, respectively. In the study conducted by Keskin *et al.* (2022), SFA amounts similar to our study were reported. Among the saturated fatty acids, the fatty acids with the highest values were myristic acid (C14:0), palmitic acid (C16:0) and stearic acid (C18:0) in all smoked salmon samples. The highest myristic acid value was determined in the F1 group (2.40%), while the lowest value was determined in the F2 group (1.92%). Although there was no statistical difference between F1 and F4 groups, it was determined that there was a statistical difference between the other groups. It was determined that the fatty acid with the highest value among saturated fatty acids was palmitic acid. Many researchers have reported that palmitic acid has the highest amount among saturated fatty acids (Keskin *et al.*, 2022; Erdem et *al.*, 2020). The amount of palmitic acid in smoked salmon samples was determined as F3 (16.29%), F2 (15.08%), F4 (10.73%) and F1 (10.25%) groups in order from highest to lowest. Regarding the amount of stearic acid, the highest value was found in the F3 group (5.31%) and the lowest value was found in the F1 group (3.01%). Erdem *et al.* (2020) reported the myristic acid content of Atlantic salmon as 3.24% in their study.

It has been reported by many researchers that fish oils are a very important nutritional source especially in terms of unsaturated fatty acids in their structure (Durmus, 2018; Hrebień-Filisińska, 2021). Among these unsaturated fatty acids, monounsaturated fatty acids (MUFA) are known to reduce the risk of high blood pressure and protect against cardiovascular diseases by balancing cholesterol. Monounsaturated fatty acid compositions of smoked salmon fillets are given in Table 2.

Table 1. Composition and amount of saturated fatty acids in smoked salmon fillets

Fatty acids	Groups			
	F1	F2	F3	F4
C14:0	2.40±0.02[a]	1.92±0.01[c]	2.02±0.01[b]	1.94±0.02[c]
C16:0	10.25±0.07[c]	15.08±0.41[b]	16.29±0.05[a]	10.73±0.18[c]
C17:0	0.12±0.01[b]	0.15±0.00[a]	0.14±0.00[a]	0.13±0.01[b]
C18:0	3.01±0.01[c]	4.68±0.13[b]	5.31±0.06[a]	3.20±0.02[c]
C20:0	0.69±0.03[a]	0.43±0.01[b]	0.32±0.02[c]	0.27±0.00[c]
C24:0	0.38±0.01[c]	0.18±0.00[d]	0.94±0.03[b]	1.62±0.06[a]
∑SFA	16.84±0.11[d]	22.44±0.57[b]	25.01±0.07[a]	17.87±0.23[c]

Means sharing the same letter in the same row (a–d) is not significantly different ($p < .05$) using Duncan's multiple range test. The values are expressed as mean ± standard deviation, n = 3. C14:0 (Myristic Acid), C16:0 (Palmitic Acid), C17:0 (Heptadecanoic Acid), C18:0 (Stearic Acid), C20:0 (Arachidic Acid), C24:0 (Lignoceric Acid), ∑SFA (Total Saturated Fatty Acids).

Table 2. Composition and amount of monounsaturated fatty acids in smoked salmon fillets

Fatty acids	Groups			
	F1	F2	F3	F4
C14:1	0.13±0.00a	0.14±0.00[a]	0.12±0.07[a]	0.14±0.00[a]
C16:1	2.80±0.24b	4.04±0.09[a]	3.22±0.25[b]	2.22±0.08[c]
C17:1	0.10±0.01a	0.07±0.01[c]	0.08±0.00[b]	0.04±0.00[d]
C18:1n9	34.47±0.51a	32.13±0.74[b]	27.22±0.49[c]	35.52±0.72[a]
C18:1n7	4.08±0.05a	3.60±0.15[b]	3.16±0.05[c]	3.44±0.05[b]
C20:1n9	4.41±0.05a	2.62±0.01[b]	1.84±0.04[c]	2.74±0.16[b]
C22:1n9	0.56±0.01b	0.52±0.00[c]	0.43±0.01[d]	0.64±0.01[a]
∑MUFA	46.55±0.49a	43.11±0.67[b]	36.05±0.81[c]	44.74±0.61[ab]

Means sharing the same letter in the same row (a–d) is not significantly different ($p < .05$) using Duncan's multiple range test. The values are expressed as mean ± standard deviation, n = 3. C14:1 (Myristoleic acid), C16:1 (Palmiteloic acid), C17:1 (Heptadecanoic acid), C18:1n9 (Oleic acid), C18:1n7 (Vaxenic acid), C20:1n9 (Eicosenoic acid), C22:1n9 (Erusic acid), ∑MUFA (Total monounsaturated fatty acids)

The total MUFA amounts of smoked salmon fillets were found to vary between 36.05% and 46.55%. Similar to our study, Erdem *et al.* (2020) determined the MUFA values of natural and cultured trout and Atlantic salmon as 40.86%, 34.53% and 46.19%, respectively. In the present study, palmitoleic acid (C16:1), oleic acid (C18:1n9) and vaccenic acid (C18:1n7) had the highest values among total monounsaturated fatty acids. Oz (2019) reported similar monosaturated fatty acids in his study on trout. The highest amounts of palmitoleic acid and vaccenic acid were determined in F2 (4.04%) and F1 (4.08%) groups, while lower values were determined in F4 (2.22%) and F3 (3.16%) groups, respectively. Among the monounsaturated fatty acids, oleic acid was the fatty acid with the highest value. The amount of oleic acid, which is one of the most important MUFAs, was found to vary between 27.22% and 35.52%. The highest oleic acid was determined in F4 group, followed by F1 and F2 groups. Keskin *et al.* (2022) reported the oleic acid content of Turkish salmon and Atlantic salmon sold in the central Black Sea region as 28.58% and 43.99%, respectively, similar to the present study.

Unsaturated fatty acids, which are among the most important determinants of the nutritional quality of seafood, are mostly in the form of omega-3 and omega-6 fatty acids. Omega fatty acids have an important role in the development of the brain and immune system. In addition, omega fatty acids have been reported to play an important role in the prevention of cardiovascular diseases, hypertension, immune, allergy and nervous disorders (Kinsella 1987; Leaf *et al.* 1988; Simopoulos 1991). The polyunsaturated fatty acid composition of smoked salmon fillets is given in Table 3.

Table 3 Composition and amount of polyunsaturated fatty acids in smoked salmon fillets.

Fatty acids	Groups			
	F1	F2	F3	F4
C18:2n6	12.37±0.04^{c}	13.56±0.13^{b}	15.41±0.20^{a}	12.64±0.07^{c}
C18:3n6	0.14±0.00^{a}	0.13±0.00^{a}	0.13±0.00^{a}	0.15±0.00^{a}
C18:3n3	3.99±0.06^{b}	2.67±0.04^{c}	2.33±0.15^{d}	4.99±0.03^{a}
C20:4n6	0.77±0.07^{c}	1.05±0.02^{b}	1.18±0.01^{a}	0.82±0.05^{c}
C20:5n3	4.29±0.22^{a}	2.07±0.11^{b}	2.16±0.04^{b}	4.24±0.27^{a}
C22:6n3	6.22±0.28^{c}	8.03±0.81^{b}	11.74±0.11^{a}	7.79±0.47^{b}
∑PUFA	27.77±0.41^{c}	27.49±0.78^{c}	32.94±0.21^{a}	30.62±0.59^{b}

Means sharing the same letter in the same row (a–d) is not significantly different (p < .05) using Duncan's multiple range test. The values are expressed as mean ± standard deviation, n = 3. C18:2n6 (Linoleic acid), C18:3n6 (γ-linolenic acid), C18:3n3 (Linolenic acid), C20:4 n6 (Arachidonic acid), C20:5n3 (Eicosapentaenoic acid) (EPA)), C22:6n3 (Docosahexaenoic acid (DHA)), ΣPUFA (Total polyunsaturated fatty acids).

Total polyunsaturated fatty acids (∑PUFA) are one of the most important indicators of food quality. In the present study, the PUFA values of smoked salmon fillets were determined as 27.77%, 27.49%, 32.94% and 30.62% and statistical differences were found between the groups except F1 and F2 groups. The most important fatty acids among PUFAs were linoleic acid (C18:2n6), eicosapentaenoic acid (EPA, C20:5n3) and decosahexaenoic acid (DHA, C22:6n3) in all groups. Among the smoked salmon samples, the highest value of linoleic acid was determined in F3 group with 15.41%, followed by F2 (13.56%) and F4 (12.64%) groups. Eicosapentaenoic acid (EPA) is one of the polyunsaturated fatty acids which has a very important value for human health. In the present study, the highest EPA value was found in the F1 group with 4.29% and the lowest value was found in the F2 group with 2.07%. DHA is another important polyunsaturated fatty acid. DHA amounts were found to vary between 11.74% and 6.22% and the highest DHA was found in the F3 group. It was determined that there was a statistical difference between the groups except F2 and F4 groups in terms of DHA ($p<0.05$). Pekcan (2016) reported the amounts of total PUFA, EPA and DHA in smoked salmon as 32.01, 3.63 and 6.68, respectively. Erdem *et al.* (2020) investigated the fatty acid content of Atlantic salmon and reported total PUFA and EPA values in similar ranges with the current study, while DHA value was reported as 5.00. The ΣPUFA/ΣSFA, Σn3, Σn6, n6/n3 and DHA/EPA changes of smoked salmon fillets are given in Table 4.

Table 4. Fatty acid index changes in smoked salmon fillets

Fatty acids	Groups			
	F1	F2	F3	F4
ΣPUFA/ΣSFA	1.65±0.01^{a}	1.22±0.00^{b}	1.28±0.05^{b}	1.71±0.01^{a}
Σn3	14.49±0.44^{ab}	12.76±0.89^{b}	15.23±1.41^{ab}	17.02±0.71^{a}
Σn6	13.28±0.03^{c}	14.73±0.11^{b}	16.72±0.21^{a}	13.61±0.12^{c}
Σn6/Σn3	0.92±0.03^{bc}	1.16±0.09^{a}	1.10±0.12^{ab}	0.80±0.04^{c}
DHA	6.22±0.28^{c}	8.03±0.81^{b}	11.74±0.11^{a}	7.79±0.47^{b}
EPA	4.29±0.22^{a}	2.07±0.11^{b}	2.16±0.04^{b}	4.24±0.27^{a}
DHA/EPA	1.45±0.01^{d}	3.87±0.18^{b}	5.44±0.05^{a}	1.84±0.00^{c}

Means sharing the same letter in the same row (a–c)) is not significantly different ($p < .05$) using Duncan's multiple range test. ∑n3 (Total omega 3 fatty acids), ∑n6 (Total omega 6 fatty acids).

In the present study, the lowest ΣPUFA/ΣSFA ratio was determined in the F2 group (1.22) and the highest ratio was determined in the F4 group (1.71). HMSO (1994) reported that the ΣPUFA/ΣSFA ratio should be at least 0.45. According to the findings of the present study, all groups had ΣPUFA/ΣSFA ratio above the minimum limit value recommended by HMSO (1994). In terms of Σn3 and Σn6, the highest values were found in F4 group with 17.02 and F3 group with 16.72, respectively. It was determined that there was a statistical difference between F2 and F4 groups in terms of Σn3. The lowest amount of Σn6 was determined in the F1 group with 13.28. The n6/n3 ratio of unsaturated fatty acids is associated with the causes of mortality from cancer and cardiovascular diseases (Hoz *et al.*, 2004). This ratio has also been reported to be an important indicator used to compare the nutritional value of fish oil (Pigott and Tucker, 1990; Cengiz *et al.*, 2010) and should be kept as low as 1:1 or 2:1 in diets (Granados *et al.*, 2006). According to HMSO (1994), it was suggested that this ratio could be maximum 4. In the present study, the Σn6/Σn3 ratio was found to be between a minimum of 0.80 (F4 group) and a maximum of 1.16 (F2 group). Statistical differences were found between the groups ($p<0.05$). The results obtained in our study did not exceed the limit value of Σn6/n3 ratio recommended by HMSO (1994). The DHA/EPA ratio was found to vary between 1.45 and 5.44. A statistical difference was found between all groups. Erdem *et al.* (2020) calculated the DHA/EPA ratio of wild caught, farmed trout and Atlantic salmon as 3.22, 3.42 and 2.01, respectively. Aslan *et al.* (2007) reported the DHA/EPA ratio of wild-caught and farmed trout as 1.55 and 5.00, respectively. Similarly, Oz and Dikel (2015) found the DHA/EPA ratios of wild-caught and farmed trout to be 1.31 and 5.32. Pekcan (2016) investigated the effects of different salt concentrations on the quality of hot smoked salmon (*Salmo salar*), trout (*Snchorhynchus mykiss*) and mackerel (*Scomber scombrus*) fillets. They reported the Σn3, Σn6, Σn3/Σn6 and DHA/EPA values of salmon as 11.11%, 19.47%, 0.57% and 1.84%, respectively. While DHA / EPA values reported by Aslan *et al.* (2007) and Pekcan (2016) were similar to the present study, differences were observed in terms of Σn6, Σn3/Σn6 values. It is thought that these differences may be due to the quality, physico-chemical structure, technical differences in processing technology conditions or environmental conditions, as well as the feeding regime of the fish.

As a result, it was concluded that the smoked fish fillets examined had high nutritional quality in terms of fatty acids. Among the groups, especially F3 and F4 groups were found to have rich content in terms of PUFA and Σn3 values.

4. CONCLUSION

In this study, the fatty acid composition of processed salmon fillets sold in grocery stores was investigated. All of the smoked fish fillets investigated were found to be rich in unsaturated fatty acids, which are important for human health. However, it can be concluded that there were significant differences in fatty acid compositions between the groups, especially in total MUFA and PUFA. The highest and lowest EPA values were detected in the F1 and F2 groups, respectively. Additionally, the highest amount of DHA was found in the F3 group. The Σn6/Σn3 ratio in all groups is compatible with the recommended values for human health. With this study, it was concluded that smoked fillets contain a particularly good fatty acid composition in terms of nutrition and can be classified as beneficial to human health. With the increasing demand for processed seafood products, it is recommended that the nutritional content of other processed seafood products should be regularly examined in order to provide healthy products to consumers and sustainability.

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AUTHORSHIP CONTRIBUTION STATEMENT

All authors contributed to the conception and design of the experiments, their performance, interpretation of the obtained results, writing of the article.

CONFLICT OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICS COMMITTEE PERMISSION

No ethics committee permissions are required for this study

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