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Fatty acid composition of tench (*Tinca tinca* L., 1758): A seasonal differentiation

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Abstract

Seasonal variations of proximate compositions and fatty acids of tench (*Tinca tinca*) captured from Seyhan Dam Lake were investigated. The results showed that seasonal fatty acid compositions of tench fillets in July, August and November ranged from 29.59% to 33.71% for saturated fatty acids (SFA), from 20.50% to 21.69% for monounsaturated fatty acids (MUFAs) and from 26.50% to 41.85% for polyunsaturated fatty acids (PUFAs). Lipid contents of tench fillets in all seasons were statistically different (p<0.05). The major fatty acids of tench sampled in different seasons were palmitic acid (16:0), stearic acid (18:0), palmitoleic acid (16:1ω7**)**, oleic acid (18:1ω9), linoleic acid (LA, 18:2ω6), arachidonic acid (ARA, 20:4ω6**),** eicosapentaenoic acid (EPA, 20:5ω3) and docosahexaenoic acid (DHA, 22:6ω3). The proportions of DHA ranged from 5.51% to 17.33%. DHA+EPA compositions of tench fillets were in the highest level of 22.47% in November. The highest ARA content was determined in November at 10.88%. The results showed that tench is a good protein and fatty acid source in human nutrition.

Keywords: *Tinca tinca*, Seasonal changes, Fatty acids, Proximate composition

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Introduction

One of the best sources of polyunsaturated fatty acids (PUFA) are fish and recent scientific interest is focusing on fish and their fatty acid composition. Human and other mammals can synthesize saturated and some monounsaturated fatty acids, but they lack the enzymes necessary to insert a cis double bond at the ω-6 or the ω-3 position of a fatty acid. Thus ω-3 and ω-6 fatty acids are known as essential fatty acids in human nutrition. The main fatty acid of omega-3 series is linolenic acid (ALA, 18:3ω3), and the parent fatty acid of omega-6 series is linoleic acid (LA, 18:2ω6). Dihomo-γ-linolenic acid (DGLA; 20:3ω6) and arachidonic acid (ARA, 20:4ω6) can be synthesized from LA. Long-chain ω-3 fatty acids, such as eicosapentaenoic acid (EPA, 20:5ω3) and docosahexaenoic acid (DHA, 22:6ω3) can be synthesized from ALA. This conversion can be limited in human due to the lack of enzymes, some metabolic factors and diseases. Since EPA and DHA are effectively synthesized only by aquatic organisms, marine/freshwater products are the best source of long chain ω3 series fatty acids which are essential for development and growth and they play a key role in the prevention and management of coronary heart diseases, hypertension, diabetes etc.

The chemical composition of fish is under the effect of seasonal climatic changes in water temperature and natural food abundance. Especially lipid content and fatty acid composition are under the effects of physiological status and climatic changes. External factors such as seasonal water temperature, food composition and internal factors such as species, life cycle, feeding habits etc. are the main factors effecting fat and fatty acid composition of fish (Buchtová *et al*., 2004). Tench (*Tinca tinca*) from the cyprinidae family naturally lives in many regions in almost all over Europe and Asia. They exist naturally in many lakes and dam lakes of Turkey. Tench is a demersal fish and usually prefers to live in areas which have low water flow. Due to the economical importance of tench in Turkey, the study was carried out to investigate the seasonal variations in proximate and fatty acid compositions. The results of this study are important for the commercial fish processing industry and to prepare diet tables.

Materials and methods

Sample preparation

Tench (*T. tinca*,L.,1758) used in the present study was obtained from the local fisherman of Seyhan Dam Lake (Turkey) in July, August and November except during the reproduction season which is in the period between April and June. Twenty individuals were sampled in each sampling period and fish were immediately iced and transported to the Fish Processing Laboratories of Faculty of Fisheries. The mean length and weight of sampled tench were 21.54±1.62cm and 168.09±48.22g, respectively in July, 22.44±2.21cm and 189.48±59.86g, respectively in August, 25.70±0.55cm and 243.05±18.53g, respectively in

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November. The fish were immediately gutted, filleted and minced for chemical composition analyses. Triplicate analyses were performed for each analysis.

Chemical analysis

Ash and moisture contents were determined as described by AOAC (935.10, 1984). Protein content was determined by Kjeldahl's method (AOAC 981.10, 1998). Lipid content was determined by the method of Bligh and Dyer (1959).

Methyl esters were prepared as described by Ichiara *et al*. (1996) with minor modifications. Extracted oil (10 mg) was dissolved in 2 mL n-heptane followed by 4mL of 2 M methanolic KOH. Then, the n-heptane layer was taken for GC analysis. Fatty acid composition was analyzed by GC Clarus-500 with auto sampler (Perkin Elmer, USA). FAs were identified by comparing the retention times of FAME with the Standard 37 component FAME mixture. Triplicate GC analyses were done and the results were expressed in GC area % as a mean ±SD. The FAs were calculated as a percentage. For conversion of the percentile values to units of weight, the formula recommended originally by Weihrauch *et al*. (1977) was used. Then Paul and Southgate (1988) and Soriguer *et al.* (1997) were employed.

Statistical analysis

All data obtained separately for each sampling period were subjected to analysis of variance (one-way ANOVA), at 5% confidence level using the Duncan multiple range test.

Results

Proximate composition

Table 1 shows the seasonal variations in the proximate composition of tench. Protein contents of tench fillets in all seasons ranged from 16.74% to 16.86% and no statistical differences were found. The highest lipid content of tench fillets was determined in August as 1.22%. Lipid contents of tench fillets in all seasons were statistically different (p<0.05). The moisture content of tench in November was significantly higher than those of the content in August (p<0.05). İzci and Ertan (2004) reported that moisture, lipid, protein and ash contents of tench captured in Beyşehir Lake (Turkey) were 83.19%, 1.11%, 12.68% and 1.13%, respectively. Tench is important for local markets as a low priced fish for poor people and it is a good protein source in all seasons. It seems that lipid and moisture contents statistically change according to fishing seasons.

Table 1: Proximate composition of tench (%) captured in different seasons.

	Protein	Lipid	Moisture	Ash
July	16.82±0.12^{a}	1.05±0.03^{b}	80.89±0.13^{a,b}	1.02±0.01^{b}
August	16.74±0.00^{a}	1.22±0.07^{c}	80.70±0.05^{a}	1.04±0.01^{b}
November	16.86±0.48^{a}	0.69±0.08^{a}	81.26±0.32^{b}	0.96±0.03^{a}

Means followed by different letters within the same column are significantly different (p<0.05). The values are expressed as mean±standard deviation, n=3.

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Fatty acid compositions

Fatty acid compositions of tench sampled in different seasons are shown in Table 2. The major fatty acids in tench for all the seasons were palmitic acid (C16:0), palmitoleic acid (16:1), stearic acid (18:0), oleic acid (18:1ω9), linoleic acid (LA), arachidonic acid (ARA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA). The total proportions of these eight fatty acids in November, July and August were 66.70%, 70.74% and 82.70%, respectively.

Table 2: Fatty acid compositions of tench sampled in different seasons (% of total fatty acids).

Fatty acids (%)	July	August	November
C10:0	0.01±0.00	-	0.02± 0.00
C12:0	0.06± 0.00	0.03±0.01	-
C13:0	0.02±0.00	0.02±0.00	-
C14:0	2.60±0.09^{c}	1.71±0.08 ^{b}	0.87±0.14^{a}
C15:0	0.53±0.03	0.78±0.05	0.42± 0.00
C16:0	21.59±0.08^{a}	20.53±0.21^{a}	20.36±1.05^{a}
C17:0	0.54±0.02^{b}	0.85±0.06^{c}	0.18±0.02^{a}
C18:0	5.09±0.06^{a}	5.14±0.26^{a}	4.88±0.17^{a}
C20:0	0.90±0.71	0.12±0.01	-
C22:0	0.13±0.08	0.30±0.07	-
C23:0	1.29±0.18^{b}	2.19±0.17^{c}	0.43±0.64^{a}
C24:0	2.22±0.03^{a,b}	2.04±0.18^{a}	2.43±0.13^{b}
ΣSFA	34.98	33.71	29.59
C14:1	0.12±0.03^{b}	0.14±0.01^{b}	0.03±0.0^{a}
C15:1	0.01±0.01	0.01±0.00	-
C16:1ω7	9.91±0.19^{c}	6.61±0.50^{b}	5.08±0.10^{a}
C17:1	0.03±0.00^{a}	0.60±0.02^{c}	0.47±0.01^{b}
C18:1ω9	10.89±0.91^{a}	12.18±0.85^{a}	14.46±3.62^{a}
C20:1	0.41±0.04^{a}	0.43±0.08^{a}	1.65±0.37^{b}
C22:1ω9	0.28±0.05	0.49±0.03	-
C24:1	0.56±0.69	0.04±0.00	-
ΣMUFAs	21.69	20.5	21.69
C18:2ω6	5.06±0.32^{a}	4.27±0.46^{a}	4.57±1.24^{a}
C18:3ω6	0.28±0.02^{a}	0.59±0.09^{a}	1.95±2.69^{a}
C18:3ω3	1.38±0.04^{a}	1.37±0.11^{a}	1.70±0.18^{b}
C20:2cis	0.90±0.08	1.26±0.17	-
C20:3ω6	0.56±0.04^{b}	1.01±0.07^{c}	0.18±0.03^{a}
C20:4ω6	5.05±0.15^{a}	8.68±0.78^{b}	10.88±0.76^{c}
C20:5ω3	6.89±0.26^{c}	3.78±0.23^{a}	5.14±0.18^{b}
C22:2cis	0.18±0.02	0.03±0.01	0.10±0.00
C22:6ω3	6.26±0.60^{a}	5.51±0.68^{a}	17.33±1.01^{b}
ΣPUFAs	26.56	26.50	41.85
PUFAs/SFA	0.76	0.79	1.41
ω6/ω3	0.75	1.36	0.73
EPA/PUFAs	0.26	0.14	0.12
DHA/PUFAs	0.24	0.21	0.41
DHA/EPA	0.91	1.46	3.37
DHA+EPA	13.15	9.29	22.47
Unidentified	16.25	19.29	6.87

Different letters in the same row indicate significant differences (p<0.05); the values are expressed as mean±standard deviation, n=3.

Discussion

The proportions of total saturated fatty acids (SFA) of tench were found to be 34.98% in July and 33.71% in August and 29.59% in November. PUFAs were found as 26.56, 26.50% and 41.85% for

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the same periods. Hedayatifard and Yousefian (2010) reported that SFA and PUFA levels of golden mullet (*Liza aurata*) from Caspian Sea were 35.19% and 7.13%, respectively in winter. Cengiz *et al*. (2010) also reported that SFA and FUFA levels of Abu mullet (*Liza abu*) in Tigris River, Turkey, were 48.94% and 9.75%, respectively. Mısır *et al*. (2013) reported that SFA levels of pearl mullet (*Chalcalburnus tarichi*) ranged between 23.40% and 20.40% and PUFAs were between 30.34% and 28.16% for different seasons. The nutritional compositions including fatty acid composition of fish is known to be influenced by several factors such as species, diet composition, seasonal feeding and geographical region etc. The results showed that the proportion of PUFAs in November (41.85%) is far above many others and it has to be considered in diet preparation.

Results showed that palmitic acid was the major fatty acid of the total saturated fatty acids in all seasons. Citil *et al*. (2014) reported similar results for *T. tinca* captured in Karacaören Dam Lake, Turkey. The level of palmitic acid versus the total fatty acids of tench in July, August and November were found to be 21.59%, 20.53% and 20.36%, respectively. Similar results for palmitic acid content of some freshwater fish species were also reported by Konar *et al*. (1999), Turchini *et al*. (2007). The highest palmitoleic acid proportion was found in July at 9.91%. Polat *et al*. (2009) reported similar results for palmitoleic acid of different mullet species. Omega-7 fatty acid also known as palmitoleic acid plays an important role in the maintenance of healthy skin care. It is believed that ω7 acts as an *anti-melanogenic agent* preventing changes in skin exposed to UV-light. So foods rich in omega-7s are popular in recent years due to their possible antiaging effect. The highest palmitoleic acid was found in July at 9.91%. The results showed that tench is a good source of palmitoleic acid. Oleic acid proportions of tench ranged from 10.89% to 14.46% in different seasons. The results showed that oleic acid was the dominant fatty acid in MUFAs in all seasons. The level of oleic acid in MUFAs in November, July and August were observed at 66.67%, 49.03%, 59.41%, respectively. Citil *et al*. (2014) reported that oleic acid was the highest monounsaturated fatty acid (MUFAs) in *Cyprinus carpio* in Işıklı Dam Lake, Turkey. It has been a known fact that olive oil is rich in oleic acid and highly recommended for consumers in recent years. Rey G´omez-Serranillos *et al*. (2004) stated that oleic acid could reduce blood total cholesterol and low density lipoproteins but not high density lipoproteins. It seems tench fillet is a good source for oleic acid in all seasons.

The proportion of LA in tench fillets ranged from 4.57% to 5.06% in different seasons. ARA proportions of tench fillets were surprisingly high and ranged from 5.05 % to 10.88%. It is an already known fact that especially LA and ARA are essential omega-6 fatty acids. Linoleic acid is broken down to gamma-linolenic acid (GLA). GLA is then converted to ARA which is essential for brain, liver, and organs and

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the most important precursor of prostaglandins. Prostaglandins are produced in mammalian cells and their related compounds are prostacyclins, thromboxanes and leukotrienes (known as eicosanoids). Some of the physiological effects of prostaglandins are regulation of blood pressure, inflammatory response, induction of blood clotting, production of pain and fever, regulation of the sleep/wake cycle etc. The results showed that tench is a good source of ARA.

ALA can be converted with low efficiency to EPA and then DHA in human. Therefore, EPA and DHA are essential long chain omega-3 series fatty acids for human nutrition. Many fish species have an ability to convert ALA to other long chain ω-3 series fatty acids (Polat and Beklevik, 1999). The results showed that tench is also a good source of PUFAs. DHA contents ranged from 5.33% to 17.33% in different seasons and it seems tench is a good source of DHA. DHA is important for visual and neurological development. DHA can be converted to precursor of prostaglandins just as ARA. Thus, the recommended minimum value of PUFAs/SFA ratio is 0.45 and the recommended maximum dietary n-6/n-3 value is 4.0 (Anonim, 1994). The highest PUFAs/SFA ratio was found in November as 1.41, and the lowest was in July as 0.76 and all the PUFAs:SFA ratio values were higher than the recommended minimum value. The values of n-6:n-3 obtained in different seasons were between 0.75 and 1.36 and all the n-6:n-3 ratio values were lower than the recommended maximum levels for diets. Similarly, Mısır *et al*. (2013) reported that n-6:n-3 ratio of pearl mullet ranged between 0.27 and 0.29 in different seasons. Özoğul *et al*. (2011) reported that n6:n-3 ratio of seven marine fish species from the Mediterranean ranged from 0.09 to 0.37. It was conspicuous that the value of DHA/PUFA ratio was the highest at 0.41 in November. The spawning period of tench in Seyhan Dam Lake is in the period between April and June. Just after the spawning period of tench, the values of DHA: PUFA ratios obtained in July and August were lower than those of November. It seems, DHA is accumulated in eggs and sperm during the spawning period and the values of DHA: PUFAs ratios in July and August (just after the spawning period) were found at low levels compared with the results of November. As a final conclusion, the results showed that fatty acid compositions of tench are under the influence of fishing seasons and tench is a good source of palmitoleic acid, oleic acid, ARA and DHA. This case has to be considered in human nutrition.

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