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Nutritional composition of Spiny eel *(Mastacembelus mastacembelus)* caught from the Atatürk Dam Lake in Turkey

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Abstract

In the study, the proximate, fatty acid and mineral element compositions of spiny eel (*Mastacembelus mastacembelus*) caught from Atatürk Dam Lake were investigated. Accordingly, the moisture, ash, protein and lipid contents were found as 75.05%, 1.15%, 19.53% and 3.33%, respectively. The fatty acid composition were found to consist of 38.49% monounsaturated (MUFA), 33.87% saturated (SFA), 21.47% polyunsaturated (PUFA), 1.62% eicosapentaenoic acid (EPA), and 8.41% docosahexaenoic acid (DHA). Total n-3/n-6 ratio was determined as 2. Among the mineral contents, K had the highest proportion. As a result of the study, spiny eel was concluded to be a beneficial food source for both human health and nutrition.

Key words: *Spiny eel*, *Mastacembelus mastacembelus*, Proximate composition, Mineral content, Fatty acids

INTRODUCTION

Fish is one of the important foods for human health because of high protein content of fish and they also contain polyunsaturated fatty acids (PUFAs) known as n-3 fatty acids. These fatty acids have an essential role in the prevention and treatment of coronary artery disease, diabetes, cancer and hypertension [1-4]. Moreover, n-3 PUFAs have been reported to be useful for neurodevelopment in infants as well as brain and eye development [2, 3]. However, some nutritional components such as mineral elements are important for human nutrition [5].

Spiny eel (*Mastacembelus mastacembelus*), a new species of Mastacembelidae family in fresh water sources of Turkey, has recently been detected [6]. The fresh water sources of Iran and Syria were reported as the main living area of this species in the first registration studies in literature [7]. In addition, considering the records of this species, it has been reported in some publication and data bases [8-10].

One of the details that must be known to determine the commercial importance of the fish is the determination of chemical composition of fish body. Knowledge of the nutritional value of fish is quite important for consumer. However, besides this knowledge, it could be more appropriate to investigate other cultivation techniques and the convenience for cultivation.

There is inadequate information about nutritional composition of spiny eel. Therefore, it is aimed in this study to determine approximate, fatty acid and mineral element compositions of spiny eel (*Mastacembelus mastacembelus*) caught in Atatürk Dam Lake and especially to evaluate these data in terms of human health.

MATERIALS AND METHODS

Sample Preparation

Fish samples caught from the Ataturk Dam Lake in July and August 2008. Fish were 1 day post-capture on arrival at the laboratory, packed in insulated polystyrene boxes with ice. Their mean weight and length were 555.79±27.11 g and 61.68±0.96 cm, respectively. Two lots of fish were prepared. Ten individuals were sampled for each lot. The fish were beheaded, gutted, filleted and homogenized for analyses.

Analysis

The muscle of spiny eel was analysed for proximate chemical composition: protein by Kjeldahl method (method 925.52), ash by heating at 550 ^{0}C, and moisture by air drying (method 925.10) according to the AOAC procedures [11]. Total fat by soxtec method [12], and mineral analysis according to the AOAC procedures were carried out [12]. The elements Ca, Na, K, Cu, Mn, Fe and Zn were determined using a Perkin Elmer AA 700 atomic absorption spectrometer (Norwalk, CT).

The fatty acid methyl esters were prepared using the method described by Ichiara, Shibahara, Yamamoto and Nakayama [13] with a minor modification–through transmethylation using 2M KOH in methanol and *n*-heptane. The fatty acids were analysed by a GC Clarus 500 with autosampler (Perkin Elmer, USA) equipped with a flame ionization detector and a fused silica capillary SGE column (30 m × 0.32 mm, ID × 0.25 µm, BP20 0.25 UM, USA). The oven temperature was heated to 140 ^{0}C, held for 5 min at this level, and raised to 200 ^{0}C by 4^{0}C.min^{-1} and to 220 ^{0}C by 1 ^{0}C.min^{-1}, while the injector and the detector temperature were set at 220 ^{0}C and 280 ^{0}C, respectively. The sample size was 1 µl and the carrier gas was helium 16 psi with a split ratio of 1:100. Fatty acids were identified by comparing the retention times of FAME with a Standard 37 component FAME mixture (Supelco). The fatty acid GC analysis was performed in three replicates and the results expressed in GC area % as a mean value ± standard deviation.

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of spiny eel is shown in Table 1. Accordingly, protein, lipid, ash and moisture contents were found as 19.53%, 3.33%, 1.15% and 75.05%, respectively.

Considering the obtained results, the proximate composition of spiny eel is similar to those of trout, sea bass and bream which are important for consumers and commonly used in Turkey.

Table1. Proximate composition of spiny eel [%]

Constituent	Content
Protein	19.53 ± 1.99
Fat	3.33 ± 1.37
Ash	1.15 ± 0.07
Moisture	75.05 ± 3.28

Data are expressed as mean ± standart deviation from triplicate determinations.

Alasavar et al. [14], carried out a study on natural and cultivated sea bass, and accordingly, protein, lipid, ash and moisture compositions were determined in natural individuals as 19.26%, 1.4%, 1.5% and 75.5%, respectively, while these composition were 20.7%, 5.2%, 1.5% and 72.2% for cultivated individuals. Similarly, Erkan and Özden [15] determined proximate composition of sea bass and bream in culture as 20.35% protein, 6.10% lipid, 1.66% ash and 70.71% moisture and 19.81% protein, 15.11% lipid, 1.35% ash and 63.52% moisture, respectively.

Proximate chemical composition values (74.4% moisture, 20.03% protein and 3.90% fat) for cultured sea bream have been reported by Grigorakis et al. [16]. On the other hand, summer sample of cultured sea bream composition was found, 69.91% moisture, 8.25% protein, 10.37% lipid and 1.22% ash, respectively [17]. Çelik et al. [4], have found meat composition of rainbow trout caught from Atatürk Dam Lake as 71.65% moisture, 19.60% protein, 4.43% lipid and 1.63% ash. Despite the similarities between nutritional compositions of fish species, protein and fat compositions could also be different especially under some conditions. Individuals fed on high fatty feeds (15-20%) in culture conditions and lack of movement is known to have a fattier profile than those hunting in natural environment. In addition, differences in nutritional composition of fish are closely related to nutrition, living environment, fish size, hunting season, sex differences and other environmental conditions [14].

Mineral content

The mineral content of spiny eel is given in Table 2. Minerals may play an important role in the maintenance of colloidal system and regulation of acid-base equilibrium. In addition, minerals constitute a major component of hormones, enzymes, and enzymatic activators [5, 15].

Table 2. Mineral content of spiny eel

Macroelements	[mg.kg^{-1}]
Calcium	254.01 ± 41.75
Sodium	650.05 ± 46.89
Potassium	3829.55 ± 54.67
Microelements	[mg.kg^{-1}]
Copper	0.76 ± 0.19
Manganese	0.17 ± 0.05
Iron	4.04 ± 0.73
Zinc	11.10 ± 0.54
Calculated Sodium/Potassium ratio	1 / 5.89

Data are expressed as mean ± standart deviation from triplicate determinations.

The highest macro element determined in spiny eel was potassium (K) in the present study, it was followed by Na, Ca, Zn, Fe, Cu and Mn, respectively. The K and Na contents were found to be 3829 mg.kg^{-1} and 650 mg.kg^{-1}. These results are similar to the K and Na contents of sea bream (3938-289 mg.kg^{-1}) and sea bass (4597-773 mg.kg^{-1}) [15], Baltic herring (ranging from 2993-4742 mg.kg^{-1}; 452-802 mg.kg^{-1}) [18], sharpsnout sea bream (ranging from

3860-4240 mg.kg^{-1}; 280-370 mg.kg^{-1}) [19]. On the other hand, Na/K ratio may change between 1/2-1/10 in fish meat. This range is very convenient for a healthy diet [20]. Sodium/Potassium (Na/K) ratio was found 1/5.89 in the present study.

This rate were reported in previous studies as 1/5.9 in sea bass, 1/13.6 in sea bream [15], 1/11.5-13.7 in sharpsnout sea bream [19] and 1/5.9-6.6 in Baltic herring [18]. The Ca content was found as 254 mg.kg^{-1} in this study. Our result shows a similar tendency with the results of other researchers. Calcium values of 220-230 mg.kg^{-1} have been reported for sharpsnout sea bream [19]. Baltic Herring Ca level was found to change between 44 and 1158 mg.kg^{-1} [18] and Martinez-Valverde et al. [21], found 177 mg.kg^{-1} of Ca in blue whitling.

Mineral elements such as Zn, Fe, Mn and Cu are essential. These elements have vital functions in human body [5]. Zinc, Fe, Mn and Cu were found to be 11.10, 4.04, 0.17 and 0.76 mg.kg^{-1}, respectively, in our study. Martinez-Valverde et al. [21] reported that blue whitling contained 5.3 mg.kg^{-1} Zn, and 4 mg.kg^{-1} Fe. Alasavar et al. [14] found Zn content as 45-43 mg.kg^{-1} and 51-62 mg.kg^{-1} in cultured and wild sea bass, respectively. The levels of Zn and Fe were reported as 5.45 mg.kg^{-1} Zn and 4.15 mg.kg^{-1} Fe in rainbow trout [4].

In our study, the essential mineral elements Cu and Mn were determined as 0.76 g.kg^{-1} and 0.17 mg.kg^{-1}, respectively. Alasavar et al. [14] determined the same elements as 3.87-7.25 in culture sea bass and 2.96-6.53 mg.kg^{-1} in culture sea beam, respectively. Çelik et al. [4] were reported as 8.19-1.91 mg.kg^{-1} for trout caught in nature, Erkan and Özden [15] determined Mn content as 0.547mg.kg^{-1} in culture sea bass and 6.44mg.kg^{-1} in culture sea bream.

Fatty acid composition

The fatty acid profiles of spiny eel are listed in Table 3. Our results of fatty acids were presented in three main groups such as saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). The highest proportion was the MUFA and it was followed by SFA and PUFA in the present study. Çelik et al. [4] have found similar results in rainbow trout. On the other hand, Özoğul et al.[22] in different fresh water species, Özden [23] in rainbow trout determined the highest proportion of PUFA followed by MUFA and SFA.

There are numerous studies demonstrating that freshwater fish species contain lower amount of PUFA than the marine fish [4, 24, 25]. Furthermore, the fish living in cold water contain higher proportions PUFA than the warm water species [26-28]. Atatürk Dam Lake is a warm water lake and it has an average 20°C water temperature [29].

Total SFA content was found 33.87% and palmitic acid (C 16:0) was the primary SFA, contributing 58.63% to total SFA content of the lipids for spiny eel. Similar results have also been reported for cultured and wild sea bass [14] and other fish species in literature [3, 4, 22, 30, 31]. Among the fatty acid profile, MUFA was the major fatty acid group of spiny eel (38.49%). Oleic acid (18:1n9) was determined as the primary monounsaturated fatty acid (54.35% of total MUFA). These results are in agreement with the findings of the previous studies on MUFA and oleic acid composition of other species [4, 14, 30, 31].

The PUFA content of spiny eel lipid was 21.74%. Besides, spiny eel also contain EPA and DHA, which are especially very important for human health, with percentages 1.62% and 8.41%, respectively. Previous studies have suggested that EPA and DHA, only found in fish and sea food, possess extremely beneficial properties for the prevention of coronary artery disease and depression [2, 3].

Table 3. Fatty acid composition of spiny eel muscle.

Fatty acid	[%]
C14:0	2.67 ± 0.41
C15:0	0.02 ± 0.11
C16:0	19.86 ± 1.31
C17:0	0.52 ± 0.08
C18:0	3.15 ± 0.38
C20:0	0.02 ± 0.01
C22:0	0.06 ± 0.04
C23:0	0.67 ± 0.11
C24:0	6.89 ± 0.93
Sum of saturated fatty acids	33.87 ± 1.0
C14:1n9	0.31 ± 0.11
C15:1	0.26 ± 0.02
C16:1n9	7.48 ± 0.94
C16:1n7	0.88 ± 0.05
C17:1n9	0.27 ± 0.04
C18:1n9	20.92 ± 2.73
C18:1n7	4.92 ± 0.54
C20:1n11	0.12 ± 0.03
C20:1n9	1.72 ± 0.42
C22:1n11	0.03 ± 0.01
C22:1n9	1.6 ± 0.26
Sum of monounsaturated fatty acids	38.49 ± 2.24
C18:2n9	0.47 ± 0.25
C18:2n6	3.12 ± 0.85
C18:3 n6	0.08 ± 0.07
C18:3n3	1.93 ± 1.02
C18:4n3	0.66 ± 0.26
C20:2n6	0.28 ± 0.02
C20:4n6	3.63 ± 0.57
C20:3n3	0.57 ± 0.19
C20:4n3	0.97 ± 0.24
C20:5n3 [EPA]	1.62 ± 0.26
C22:6n3 [DHA]	8.41 ± 0.5
Sum of polyunsaturated fatty acids	21.74 ± 1.89
n-3	14.16 ± 1.52
n-6	7.11 ± 0.76
n-3/n-6	2 ± 0.15
Unidentified	5.9

Data are expressed as mean ± standart deviation from triplicate determinations.

The n-3/n-6 ratio is an important index for comparing nutritional quality of fish. In addition, n-3/n-6 ratio is estimated at 1:1 diet ratio for nutrient intake in human evaluation [32]. The present study results show n-3/n-6 as 2. Alasavar et al. [14] have reported that cultured and wild sea bass n-3/n-6 ratios were 2.88 and 3.02, respectively. Gökçe et al. [3] found that n-3/n-6 ratio changes between 1.45 and 3.48 for common sole in different seasons. Turan et al. [31] and Çelik et al. [4] reported that the n-3/n-6 ratios of thornback ray and rainbow trout caught from wild were 1.61 and 2.1, respectively. Bayır et al. [30] found the n-3/n-6 ratio in selected marine fish species from Turkish waters including anchovy (8.27), horse mackerel (12.61), grey mullet (8.64) and mackerel (5.63).

The percentage of n-3 series of PUFA in wild fish lipids is often higher than that in cultured fish because the commercial feeds usually contain high level of lipids rich in SFA and MUFA, but are deficient in n-3 PUFA [33].

CONCLUSIONS

In accordance with the results of this study, spiny eel shows similarities to the present commercial fish species in terms of protein and fat compositions and meat quality. Therefore, it is considered an important species for human consumption. In addition, it is regarded as an important fishery consumption source for human health and nutrition in terms of its mineral content, MUFA, PUFA, EPA levels and n-3/n-6 rate. Therefore, we concluded that spiny eel caught from Atatürk Dam Lake is recommended for human consumption as a good source of nutrition.

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REFERENCES

[1] Kinsella JE. 1987. Seafoods and fish oils in human health and disease. Marcel Dekker, New York, 317 pp. ISBN 0824777719.

[2] Conner WE. 2000. Importance of n-3 fatty acids in health and disease. The American Journal of Clinical Nutrition, 17(1): 171-175.

[3] Gökçe MA, Taşbozan O, Çelik M. Tabakoğlu ŞS. 2004. Seasonal variations in proximate and fatty acid compositions of female common sole (*Solea solea*). Food Chemistry, 88: 419-423.

[4] Çelik M, Gökçe MA, Başusta N, Küçükgülmez A, Taşbozan O, Tabakoğlu ŞS. 2008. Nutritional Quality of Rainbow Trout (*Onchorhynchus mykiss*) Caught from The Atatürk Dam Lake in Turkey. Journal of Muscle Foods, 1: 50-61.

[5] Lal SP.1995. Macro and trace elements in fish and shellfish. In A. Ruiter (Ed.), Fish and fishery products: composition, nutritive properties and stability. CAB International: 187–214.

[6] Fricke R, Bilecenoglu M, Sari HM. 2007. Annotated checklist of fish and lamprey species (Gnathostoma and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species. Stuttgarter Beiträge zur Naturkunde, **Ser. A,** 706: 1-172.

[7] Eschmeyer WN. 1998. Catalog of fishes, Species of fishes M - Z. Special Publication of the Center for Biodiversity Research and Information, California Academy of Sciences, San Francisco, 2: 959-1820.

[8] Anonymus. 1997. Fish registrations within the museum database of the Vertebrate Section of the Royal Museum for Central Africa. MRAC, Tervuren, Belgium. http://www.fishbase.org/References/SummaryRefList.php?ID=54832&GenusName=Mastacembelus&SpeciesName=mastacembelus. (01.03.2009)

[9] Anonymus. 1999. Fish collection database of the Natural History Museum, London (formerly British Museum of Natural History (BMNH)). http://www.fishbase.org/References/SummaryRefList.php?ID=54832&GenusName=Mastacembelus&SpeciesName=mastacembelus. (01.03.2009).

[10] Coad BW. 1996. Zoogeography of the fishes of the Tigris-Euphrates basin Zoology in the Middle East, 13: 51-70.

[11] Cunnif P. 1995. Ofiicial Methods of Analysis of AOAC International, 2 volumes.16th Ed. Arlington: AOAC International. ISBN 0935584544.

[12] Horwitz W, Latimer G. 2005. Ofiicial Methods of Analysis of AOAC International 18th ed. Gaithersburg: AOAC International. ISBN 0935584757.

[13] Ichiara K, Shibahara A, Yamamoto K, Nakayama T. 1996. An improved method for rapid analysis of the fatty acids of glycerolipids. Lipids, 31: 535-539.

[14] Alasavar C,Taylor KDA, Zubcov E, Shahidi F, Alexis M. 2002. Diferentiation of cultured and wild sea bass (*Dicentrarchus labrax*): total lipid content, fatty acid and trace mineral composition. Food Chemistry, 79: 145–150.

[15] Erkan N, Özden Ö. 2007. Proximate composition and mineral contents in aqua cultured sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*) analyzed by ICP-MS. Food Chemistry, 102: 721–725.

[16] Grigorakis K, Taylor K, Alexis M. 2003. Seasonal patterns of spoilage of ice-stored cultured gilthead sea bream (*Sparus aurata*). Food Chemistry, 81(2): 263-268.

[17] Grigorakis K, Alexis M, Gialamas I, Nikolopoulou D. 2004. Sensory, microbiological, and chemical spoilage of cultured common sea bass (*Dicentrarchus labrax*) stored in ice: a seasonal differentiation. European Food Research and Technology, 219: 584–587.

[18] Tahvonen R, Aro T, Nurmi J, Kallio H. 2000. Mineral content in Baltic Herring and Baltic Herring products. Journal of Food Composition and Analysis, 13: 893–903.

[19] Orban E, Di Lena G, Ricelli A, Paoletti F. Casini I, Gambelli L. 2002. Quality characteristics of sharpsnout sea bream (*Diplodus puntazzo*) from different intensive rearing systems. Food Chemistry, 70 (1): 27–32.

[20] Baysal A. 2002. Beslenme. 9. Baskı. Hatipoğlu Yayınevi, Ankara, 520 p. ISBN 9789757527734.

[21] Martinez-Valverde I, Periago MJ, Santaella M, Ros G. 2000. The content and nutritional significance of minerals on fish flesh in the presence and absence of bone. Food Chemistry, 71(4): 503–509.

[22] Özoğul Y, Özoğul F, Alagöz S. 2007. Fatty acid profiles and fat contents of commercially important seawater and freshwater fish species of Turkey: A comparative study. Food Chemistry, 103: 217-223.

[23] Özden Ö. 2005. Changes in amino acid and fatty acid composition during shelf life of marinated fish. Journal of the Science of Food and Agriculture, 85: 2015–2020.

[24] Webster CD, Lowell RT. 1990. Response stripped bass larvae fed brine shrimp from different sources containing different fatty acid compositions. Aquaculture, 90: 49-61.

[25] Vlieg P, Body DR. 1988. Lipid contents and fatty acid composition of some New Zealand freshwater finfish and marine finfish, shellfish, and roes. New Zealand Journal of Marine and Freshwater Research 22: 151–162.

[26] Moris RJ, Culkin F. 19898. Marine Lipids: Analytical Techniques and Fatty Acid Ester Analyses. Oceanography and Marine Biology: An Annual Review**,** 14: 391-433.

[27] Lie Q, Lied E, Lambersen G. 1989. Hematological values and fatty acid composition of Erythrocyte phospholipids in cod *(Gadus morhua)* fed at different water temperatures. Aquaculture, 79: 137-144.

[28] Fodor E, Jones RH, Kitajika K, Dey I, Farkas T. 1995. Molecular Architecture and Biophysical Properties of Phospholipids during Thermal Adaptation in Fish. An Experimental and Model Study. Lipids, 30: 1119-1126.

[29] Atasoy ADS, Şeneş S. 2004. Atatürk Baraj Gölü'nde alabalık üretiminin oluşturduğu kirlilik yükünün araştırılması. Ekoloji, 14(53): 9–17.

[30] Bayır A, Haliloğlu Hİ, Sirkecioğlu AN, Aras NM. 2006. Fatty acid composition in some selected marine fish species living in Turkish waters. Journal of the Science of Food and Agriculture, 86: 163-168.

[31] Turan H, Sönmez G, Kaya Y. 2007. Fatty acid profile and proximate composition of the thornback ray (*Raja clavata*, L. 1758) from the Sinop coast in the Black Sea. J Fisheries Sciences, 1(2): 97-103.

[32] Simopoulos AP. 1989. Summary of NATO advanced research workshop on dietary n-3 and n-6 fatty acids: Biological effects nutritional essentiality. Journal of Nutrition, 199: 512–528.

[33] Ackman RG, Takeuchi T. 1986. Comparison of fatty acid and lipids of smolting hatchery-fed and wild Atlantic salmon (*Salmo salar*). Lipids, 21: 117–120.