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Fatty Acid Compositions of Flathead Grey Mullet (*Mugil cephalus* L., 1758) Fillet, Raw and Beeswaxed Caviar Oils

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Abstract

The fatty acid compositions of flathead grey mullet fillet, raw and beeswaxed caviar oils were determined. Palmitic acid ($C_{16:0}$, 20.3%) was the dominant saturated fatty acid in flathead grey mullet fillet oil. The major unsaturated fatty acids of flathead grey mullet fillet oil were detected as palmitoleic acid ($C_{16:1}$, 13.9%), oleic acid ($C_{18:1}$, 10.8%), hexadecatetraenoic acid ($C_{16:4}$, 11.2%), and octadecatetraenoic acid ($C_{18:4}$, 12.5%). The most abundant unsaturated and saturated fatty acids of raw caviar oil were determined as palmitoleic ($C_{16:1}$, 23.6%), oleic ($C_{18:1}$, 18.8%), hexadecadioneic ($C_{16:2}$, 12.8%), octadecatetraenoic acid ($C_{18:4}$, 8.0 %), and palmitic acid ($C_{16:0}$, 5.9%).

Beeswaxed caviar oil contained palmitoleic ($C_{16:1}$, 14.6%), oleic ($C_{18:1}$, 18.6 %), hexadecadioneic ($C_{16:2}$, 7.9%), octadecatetraenoic acid ($C_{18:4}$, 13.8%), and palmitic acid ($C_{16:0}$, 6.7%) as major fatty acids. The total unsaturation fatty acids of raw (82.2%) and beeswaxed caviar oils (78.3%) were higher than that of flathead greymullet fillet oil (61.2%).

Furthermore, the amounts of docosadienoic acid ($C_{22:2}$) and docosahexaenoic acid ($C_{22:6}$) of raw and beeswaxed caviar oils were nearly 1.5-2.9 times higher than those of the flathead grey mullet fillet.

Key Words: Caviar, Fatty Acid Composition, Flathead Grey Mullet

Introduction

Flathead grey mullet (*Mugil cephalus* L.) is one of the mullet species which is a coastal migratory fish and important for food and roe. It is principal economic fish of Aegean Sea and consumers prefer it for nutrition. Especially mullets caught from the lagoon have very delicious taste. Flathead grey mullet usually live in sea and is very durable to ecological factors (as salinity, oxygen, etc.) except cold water. During the summer, flathead grey mullet migrates to coastal waters, enter small bays and harbours containing abundant food, whereas it migrates to deep waters in winter. Its primary foods are molluscs, algae and water plants on the sea bed. Spawning period of flathead grey mullet is comparatively long; from June to August (Balık *et al*., 1992). This period is suitable for processing mullet caviar. In Turkey, flathead grey mullet roes are processed by dry salting method and submitted to consumer (Şengör *et al*., 2002). Consumers are becoming increasingly aware of the importance of good nutrition and this is reflected in increasing consumption of fish and caviar.

Many studies have been conducted on fish flesh and its oil. Fish flesh is composed of high quality proteins and lipids (oils) that are high in monounsaturated and polyunsaturated fatty acids. Fish oils generally contain 20% saturated and 80% unsaturated fatty acids (Chen *et al*., 1995; Grün *et al*. 1999; Ludorff and Meyer, 1973; Suziki *et al*., 1986). Fatty acid components of fish oils vary with several factors such as nutrition, catching season, species, maturity, temperature, etc. (Kietzmann *et al*., 1969; Üstün *et al*., 1996). The caviar is an expensive product with a high nutritional value. The roes of sturgeon fish are the mostly consumed as caviar all over the world. However, the caviar produced from Mediterranean fish roes (*Mugil cephalus*) is as popular as sturgeon caviar. The fatty acid composition of the caviar generally resembles that of the fish flesh oils. There are many studies on the caviar microflora (Altuğ and Bayrak., 2003; Eun *et al*., 1994), processing (Hsu and Deng, 1980; Şengör *et al*., 2002), proximate composition and identification of caviar of fish species (Chen *et al*., 1996; Rehbein, 1985). However, information on the fatty acids of Turkish fish species and caviars are lacking. The goal of our study was to investigate the fatty acid compositions of flathead grey mullet fillet of Turkish origin, and its raw and beeswaxed caviar oils.

Materials and Methods

Sample Preparation

Flathead grey mullet (*Mugil cephalus*, L. 1758) samples were obtained from Sufa lagoon of Aegean University in September, 1998. The average weights of flathead grey mullet and its caviar were about 1.5 kg and 0.273 kg, respectively**.** Prior to analysis, head, tail, fins, viscera, and skin of fish were removed. Fish roes were processed by dry salt to obtain raw caviar

sample and then one portion of raw caviar samples was coated with beeswax. All fish and roe samples were frozen and stored at -20°C until use.

Lipid Extraction and Fatty Acid (FA) Analysis

The fish were filleted and homogenized. Lipids were extracted from the homogenized edible portion of flesh by the standard AOAC official method 948.15 (AOAC, 1990) using petroleum ether for 6 h in soxhelet extraction apparatus. Lipids of the caviar samples were obtained using the same method after the membrane and beeswax were removed from caviars. The fatty acid compositions of flathead grey mullet fillet and caviar oils were determined by Capillary Gas Chromatography (CGC) technique. For the determination of fatty acid composition, the oil samples were converted to their corresponding methyl esters by BF_3-methanol esterification by the AOCS official method Ce-2-66 (AOCS, 1972). Therefore, oil samples were first hydrolyzed for 10 min adding the specified amount of 0.5 N methanolic sodium hydroxide and then fatty acids were methylated using BF_3-methanol reagent. The obtained fatty acid methyl esters were dried with anhydrous sodium sulfate and stored under nitrogen in Teflon-capped vials at –20°C until analyzed.

The fatty acid methyl esters were quantified by gas-liquid chromatography method using a capillary column, Ultra 2 (25 m × 0.32 mm × 0.52 μm film thickness of 5% diphenyl and 95 % dimethyl polysiloxane) and flame-ionization detector in HP-5890 series II gas chromatograph (Hewlett Packard, Waldron, Germany). Nitrogen was used as the carrier gas at a flow rate of 1.72 ml/ min. Air and hydrogen flow rates were 400 and 30 ml/min, respectively. The detector and injector temperatures were chosen as 280°C and 225°C, respectively. The oven temperature was set to 150°C for 5 min and heated to 225°C with a heating rate of 5°C/min and maintained at this temperature for 30 min. Peaks were identified by comparing the retention times with those of a mixture of standard methyl esters (Supelco 37 FAME Component, Cat. Number: 4-7885)**.** Menhaden oil fatty acid methyl esters (Sigma Chemical Co. Ltd., Poole, UK) were also used as secondary standard. All of the other chemicals used in the experiments were analytical grade (Merck, Darmstadt, Germany).

Results and Discussion

The fatty acid compositions of flathead grey mullet and caviar (raw and waxed) oils are summarized in Table 1. Palmitic acid ($C_{16:0}$) was the dominant saturated fatty acid in all samples. The predominance of $C_{16:0}$, $C_{16:1}$, $C_{18:1}$ and $C_{18:4}$ fatty acids in flathead grey mullet and its caviar may be attributed to the fish diets. FA composition of fish lipid was highly dependent on a number of factors, especially fish diets (Fowler *et al*., 1994; Karakoltsidis *et al*., 1995; Ökkeş *et al*., 1996; Sathivel *et al*., 2002).

Levels of palmitoleic ($C_{16:1}$), oleic ($C_{18:1}$), hexadecatetraoneic ($C_{16:4}$), and octadecatetraenic ($C_{18:4}$) acids of flathead grey mullet fillet oil were 13.9%, 10.8%, 11.2%, and 12.5%, respectively. Other unsaturated fatty acid contents of flathead grey mullet fillet oil, such as eicosatetraenoic ($C_{20:4}$), docosadioneic ($C_{22:2}$), and docosahexaenoic ($C_{22.6}$) were significantly high (3.6%, 1.8%, and 1.6%, respectively).

Major fatty acids of raw and beeswaxed caviar oils were $C_{16:0}$, $C_{16:1}$, $C_{16:2}$, $C_{18:1}$ and $C_{18:4}$. These results agree with the results reported by Lu *et al.* (1979). They reported that the major saturated and unsaturated fatty acids of salted mullet roe were $C_{16:0}$, $C_{16:1}$, and $C_{18:1}$, respectively. Palmitic acid contents of raw and beeswaxed caviar oils were most similar each other, 5.9% and 6.7%, respectively. But $C_{16:1}$ and $C_{16:2}$ were found at significantly lower levels in beeswaxed caviar oil than in raw caviar oil, whereas $C_{18:4}$ showed the opposite trend.

Figure 1 shows saturated, mono and polyunsaturated fatty acids contents of raw and beeswaxed caviar oils comparing with those of mullet fillet oil. The total monounsaturated fatty acid contents of mullet, raw and beeswaxed caviar oils were 25.2 %, 42.9 %, 36.8 %, respectively. On the other hand, total polyunsaturated fatty acid contents of mullet, raw and beeswaxed caviar oils were 36 %, 39.3%, and 41.5%, respectively.

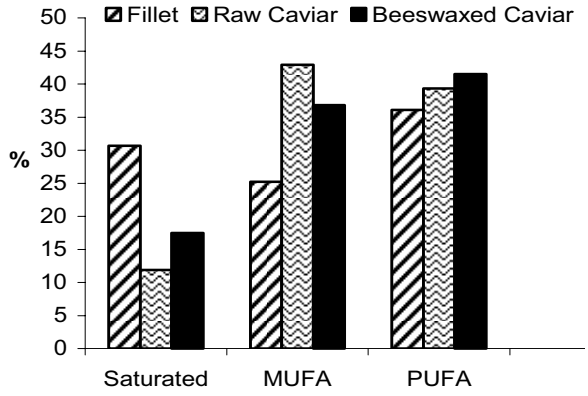

Figure 1. The fatty acid profiles of flathead grey mullet and caviar oils (wt %).

Table 1. Fatty Acid Compositions of Flathead Grey Mullet Fillet, Raw and Beeswaxed Caviar Oils (wt %)

Fatty Acid Components	Flathead Grey Mullet Fillet	Raw Caviar	Beeswaxed Caviar
C 14:0	3.3±0.1	0.8±0.2	1.0±0.1
C 15:0	1.1±0.2	1.2±0.3	2.9±0.3
C 15:1	0.2±0.1	0.3±0.1	3.2±0.4
C 16:0	20.3±1.2	5.9±0.3	6.7±0.3
C 16 : 1	13.9±1.3	23.6±1.5	14.6±1.3
C 16 : 2	1.9±0.3	12.8±1.4	7.9±0.6
C 16 : 4	11.2±0.7	2.1±0.1	3.1±0.2
C 17:0	2.0±0.4	1.0±0.2	1.5±0.2
C 17:1	< 0.1	< 0.1	0.1
C 18:0	1.7±0.7	1.1±0.2	3.1±0.3
C 18 : 1	10.8±1.3	18.8±2.2	18.6±2.1
C 18:2	1.6±0.5	2.2±0.3	1.9±0.3
C 18 : 3	0.3±0.1	0.7±0.3	0.9±0.2
C 18 : 4	12.5±1.2	8.0±1.3	13.8±1.0
C 20 : 1	0.3±0.1	0.2±0.1	0.3±0.1
C 20 : 2	0.6±0.2	1.9±0.2	2.1±0.2
C 20 : 3	0.2±0.1	2.0±0.2	1.5±0.2
C 20 : 4 n-6	3.6±0.8	2.7±0.3	2.1±0.3
C 20 : 5 n-3	0.7±0.2	0.7±0.2	0.8±0.2
C 22 : 2	1.8±0.3	2.8±0.3	2.8±0.3
C 22 :6 n-3	1.6±0.3	3.4±0.4	4.6±0.3
Not Identified/Trace	8.6±0.7	6.0±0.1	4.2±0.9
Saturated	30.7±0.9	11.9±0.2	17.5±0.1
MUFA	25.2±0.1	42.9±0.7	36.8±1.1
PUFA	36.1±1.0	39.3±0.4	41.5±0.2
n-3 Fatty Acids	2.3±0.5	4.1±0.2	5.4±0.5

* All samples were analyzed in duplicate and FA contents were reported as the average values (wt %).

In conclusion, this study revealed the fatty acid compositions of flathead grey mullet and caviar oils in spawning period of flathead grey mullet, which have not previously been studied in Turkey. $C_{16:0}$, $C_{16:1}$, $C_{18:1}$, $C_{18:4}$ acids were the most abundant fatty acids in fish and caviar oil samples. However, Ökkeş *et al*. (1996) reported that the amount of the fatty acids in *Capoeta capoeta umbla* showed significant seasonality in genders. To test this hypothesis, further experiments should be carried out on flathead grey mullet fillet oil of different seasonal periods.

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