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The Fatty Acid Composition of Golden Mullet Fillet *Liza aurata* As Affected by Dry-Salting

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Abstract: Golden mullet *(Liza aurata)* is one of the bony fish in the South basin of Caspian Sea and this work was conducted to study the fatty acids profiles with special emphasis on the omega-3 essential fatty acids in oils extracted from golden mullet fillet in fresh and salted condition. The fatty acids composition has been determined by gas-liquid chromatography. The results showed that unsaturated fatty acids were dominated in both fresh and salted tissues with 53.49 and 63.51%, respectively. Amounts of EPA and DHA in fresh tissue were 3.43 and 2.57% and in salted were 7.62 and 5.84%, respectively. Amount of total omega-3 fatty acids in the fresh and salted tissues were 6.62 and 14.57%, respectively. It was found that the amount of PUFA, especially EPA and DHA in the salted tissue had a higher amount than the fresh, while the lipid content is lower. These results were significant at a level of 95% ($p<0.05$). Golden mullet *Liza aurata* is a good source of PUFA and is one of the best sources of omega-3 essential fatty acids compared to some of freshwater fish of Caspian Sea.

Key words: Omega-3, *Liza aurata*, lipid, dry salting

INTRODUCTION

The major sources of fats and oils are plants and animals which are composed of different fatty acids and triesters of glycerol called triglycerides. Fish oils (Richard, 2006; Shahidi and Wanasundara, 1998) are the main source of n-3 fatty acids. Fat is stored in various parts of the fish, mainly in the liver, muscles and in the perivisceral and subcutaneous adipose tissues (Ben-Smida *et al*., 2009; Sheridan, 1994).

During recent years, fish lipids have been focused as being beneficial for human health. Today, it is known that n-3 fatty acids or a balanced n-3/n-6 ratio in the diet are essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery disease, diabetes, hypertension and cancer (Kalyoncu *et al*., 2009).

Metabolism of unsaturated fatty acids produces energy. These fatty acids are obtained from dietary intake (Seidelin *et al*., 1992). In addition to the energy purpose, every living cell needs essential fatty acids like omega-3 and omega-6. It has been observed that omega-3 Essential Fatty Acids (EFAs) reduce the risk of atherosclerosis by lowering plasma triglyceride levels (Goodnight *et al*., 1982; Philipson *et al*., 1985).

Atherosclerosis is characterized by deposition of cholesterol, triglyceride fats, fibrous tissue and red blood cells. It restricts blood flow through artery. When coronary artery is

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involved it leads to Ischemic Heart Disease (IHD) and finally to Atherosclerosis. Unsaturated omega-3 (EFAs) help in reducing the cholesterol level (Potter and Kiss, 1995). Fish lipids are well known to be rich in long chain n-3 polyunsaturated fatty acids, especially Eicosapentaenoic acid (EPA) and Docasahexaenoic acid (DHA). These fatty acids play vital roles in human nutrition, disease prevention and health promotion. Long chain n-3 PUFAs cannot be synthesized by humans and must be obtained through the diet (Alasalvar *et al*., 2002).

Omega-3 EFAs also help in stopping blood platelets from clinging to one another (Trubo and Carroll, 1997). It has been observed that fish oils are the good source of omega-3 EFAs (Bays and Lansing, 1994). Fish oils containing the omega-3 EFAs Eicosapentaenoic acid (EPA) and Docasahexaenoic acid (DHA) show positive effect in prevention and therapy of cardiovascular diseases (Korstanje *et al*., 1991).

Golden mullet (*Liza aurata*) is one of the mullet species which is a coastal migratory fish and important for food and roe. It is a principal economic fish of Caspian Sea and consumers prefer it for nutrition. Especially mullets caught from the Caspian Sea have very delicious taste. Golden mullet usually live in sea and is very durable to ecological factors (as salinity, oxygen, etc.) except cold water.

During the Spring and Summer, golden mullet migrates to the coastal waters containing abundant food, whereas it migrates to deep waters in Winter (Khoroshko, 1981). Its primary foods are zooplanktons, mollusks larvae, detritus, algae, prephyton and some small aquatics (Belyaeva *et al*., 1989) on the bed of Sea. Spawning period of this fish is comparatively long; from July to September in the Southern Caspian Sea in the depths between 300 to 600 m (Khoroshko, 1981). Its fecundity is 441,000 to 742,000 eggs (Khoroshko, 1981). In Northern of Iran, golden mullet roes and flesh are processed by dry-salting method and submitted to the local consumers. The dry-salting of fish is one of the common methods of preservation and consumption of fish in the Southern coasts of Caspian Sea, Northern Iran.

In last decades polyunsaturated fatty acids (PUFAs) of ω3 family have been recognized to be essential components of humans' diet (Gladyshev *et al*., 2006). These acids, particularly EPA 20:5 ω3 and DHA 22:6 ω3, appeared to play a key role in ontogenesis, especially neural development, functioning of cardiovascular system and immune systems (Broadhurst *et al*., 2002; Lauritzen *et al*., 2001). Regular consumption of food with appropriate content of EPA and DHA provides prevention and treatment of depressions, cardiovascular and some other diseases (Arts *et al*., 2001; Okita *et al*., 2002; Silvers and Scott, 2002).

This work was conducted to study the fatty acids composition with special emphasis on omega-3 essential fatty acid due to its importance from medical point of view, in oils extracted from golden mullet (*Liza aurata*) in fresh and salted conditions.

However, information on the fatty acids of Iranian fish species is lacking. The main goal of present study was to investigate the fatty acid compositions of fresh Caspian Sea golden mullet fillet of Iranian origin and effects of dry-salted on them.

MATERIALS AND METHODS

Sample Preparation

Golden mullet (*Liza aurata*, Risso, 1810) samples were obtained from Southern Caspian Sea in Winter, 2007. The average total length of golden mullet was 39.22 cm and the average weights of the fish were about 0.632 kg. Prior to analysis, the fish were divided in two groups. The first group select fresh and second group were salting under condition of medium salting with 16% salts.

The fish were gutted and filleted. Fish fillets were used as fresh. All fresh and salted samples were immediately transferred to the laboratory.

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 methods (AOAC, 1990) using petroleum ether for 6 h in soxhelet extraction apparatus. Lipids of the fresh samples were obtained using the same method after the membrane was removed from tissues. The fatty acid compositions of golden mullet fresh fillet and salted oils were determined by Gas Chromatography (GC) technique (Gladyshev *et al*., 2006). For determination of fatty acid composition, the oil samples were converted to their corresponding methyl-esters by BF3-methanol esterification by the AOCS official method Ce 2-66 (AOCS, 1972).

The fatty acid methyl-esters were quantified by gas-liquid chromatography method using a packed column, D.E.G.S -15% and Flame-Ionization Detector (FID) in Shimadzo 14-A gas chromatograph (Japan). Helium (99.999% pure) was used as the carrier gas at a flow rate of 45 mL min^{-1}. The detector and injector temperatures were chosen as 210 and 200°C, respectively. The oven temperature was set to 140°C for 5 min and heated to 190°C with a heating rate of 5°C min^{-1} and the temperature of the oven was also isothermal. Peaks were identified by comparing the retention times with those of a mixture of standard methyl-esters (Sigma Chemical Co. Ltd., Poole, UK). All of the other chemicals used in the experiments were analytical grade (Merck, Darmstadt, Germany).

Statistical Analysis

Each sample was analyzed 3 times and its averages were calculated (Mean±SD). Calculations of Standard Errors (SE) and student's t-test were carried out in the conventional way (Campell, 1967). The lipid and fatty acid contents in the fresh and salted samples were compared statistically, using t-test and excel for windows (Sushchik *et al*., 2007) at a level of 95% ($p<0.05$).

RESULTS

The average fatty acid profiles of Caspian Sea golden mullet *Liza aurata* in fresh and salted tissues is shown in Table 1. The composition of kinds of fatty acids series of *Liza aurata* is shown in Table 2. The amount of fish lipid was 4.53 and 2.21% in fresh and salted fillets, respectively.

The results showed that oleic acid (C18:1) in both fresh and salted tissues was dominate with 30.00 and 25.66%, respectively. The Palmitoleic acid was second dominated

Table 1: Fatty acids profile of Caspian Sea golden mullet *Liza aurata* in fresh and salted tissues (g/100 g lipid)

Fatty acids	Fresh	Salted
Miristic (C14:0)	4.14±0.12^{a}	4.68±0.25^{a}
Mirostoeic (C14:1)	1.40±0.32^{a}	2.30±0.12^{b}
Plamitic (C16:0)	24.34±2.41^{a}	16.35±0.21^{a}
Palmitoliec (C16:1)	13.45±0.75^{a}	13.35±1.54
Stearic (C18:0)	6.71±0.34^{a}	10.63±0.31^{b}
Oleic (C18:1)	30.00±0.15^{a}	25.66±0.14^{a}
Linoleic (C18:2)	0.51±0.07^{a}	0.66±0.06^{a}
α-Linolenic (C18:3)	0.46±0.06^{a}	1.11±0.78^{a}
Arashidoeic (C20:1)	1.51±0.13^{a}	3.94±0.21^{b}
EPA (C20:5)	3.41±0.34	7.62±0.22^{b}
DHA (C22:6)	2.75±0.23^{a}	5.84±0.31^{b}

N = 3, Mean±SD. The data are expressed as the average of three samples. Values with different letter(s) show significant difference at $p<0.05$ in fresh and salted oil

Table 2: Fatty acids composition in Caspian Sea golden mullet *Liza aurata* in fresh and salted tissues (g/100 g lipid)

Fatty acid series	Fresh	Salted
Saturated	35.19±0.57[a]	31.66±1.21[a]
Unsaturated	53.49±2.05[a]	63.51±2.08[b]
Monoenoic	46.36±1.43[a]	45.25±1.34[b]
Polyenoic	7.13± 0.32[a]	15.23±0.43[b]
Omega-3 (ω-3)	6.62±0.21[a]	14.57±0.32[b]
EPA+DHA	6.16±0.24[a]	13.46±0.14[b]
HUFA	6.17±0.43[a]	13.46±0.08[b]
Lipid	4.53±0.21[a]	2.21±0.11[b]

N = 3, Mean±SD. The data are expressed as the average of three samples. Values with different letter(s) show significant difference at $p<0.05$ in fresh and salted oil

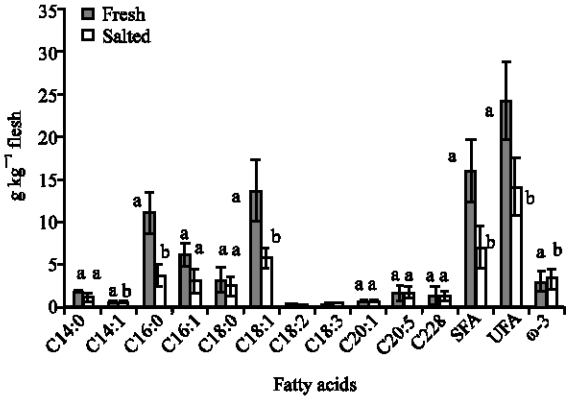

Fig. 1: Real average of fatty acid profile of Caspian Sea golden mullet in fresh and salted tissues (g kg^{-1} meat-flesh). N = 3, Mean±SD. The data are expressed as the average of three samples. Different letters show significant difference at $p<0.05$ in fresh and salted oil

unsaturated fatty acid in salted fish with 13.35%. Amounts of EPA and DHA in fresh mullet were 3.43 and 2.57% and in salted mullet were 7.62 and 5.84%, respectively.

The lowest fatty acid in both fresh and salted fish was α-linolenic with 0.46 and 0.66%, respectively.

Amount of total omega-3 fatty acids (ω-3) in the fresh and salted tissues were 6.62 and 14.57%, respectively.

There was significant difference between fresh and salted fillet in amounts of Mirostoeic, Stearic, Arachidoeic, EPA and DHA, statistically ($p<0.05$). In addition, there was significant difference in some FA series such as ω-3, PUFA and HUFA series between fresh and salted fillet of golden mullet, statistically ($p<0.05$).

The real amounts of fatty acid profiles in fresh and salted fillets in g kg^{-1} of meat (fish flesh) is shown in Fig. 1.

As the Fig. 1 is shown, the real amounts of Unsaturated Fatty Acids (UFA) in the fresh flesh was higher, because its lipid contain (with 4.53%) was more than the salted fish (with 2.21%).

DISCUSSION

The results showed that the Golden mullet *Liza aurata* is a good source of polyunsaturated fatty acids and the fish is one of the best sources of omega- 3 essential fatty acids.

Table 3: Fatty acid profiles in of some Caspian Sea and freshwater fish tissues (g/100 g lipid)

Fatty acids series	*Liza aurata* fresh	*Liza aurata* salted	*Sander lucioperca*	*Esox lusius*	*Acipenser stellatus*	*Mugil cephalus*
Saturated	35.19	31.66	29.03	22.80	10.66	31.00
Unsaturated	53.49	63.51	63.62	58.00	84.41	61.20
MUFA	46.36	45.25	43.93	14.90	63.87	25.2
PUFA	7.13	15.23	19.69	43.10	20.52	36.20
ω-3	6.62	14.57	8.46	27.80	16.64	2.70
HUFA	6.17	13.46	8.31	31.87	9.40	29.60
Reference	Present study	Present study	Hedayatifard and Jamali (2008)	Kucska *et al.* (2005)	Hedayatifard and Yousefian (2007)	Sengör *et al.* (2003)

Fish oils are the main source of n-3 fatty acids (Richard, 2006; Shahidi and Wanasundara, 1998). Fish oils generally contain 20% saturated and 80% unsaturated fatty acids (Chen *et al.*, 1995; Grün *et al.* 1999; Hedayatifard and Yousefian, 2007; Ludorff and Meyer, 1973; Suziki *et al.*, 1986).

It has been observed that omega-3 Essential Fatty Acids (EFAs) reduce the risk of atherosclerosis by lowering plasma triglyceride levels (Goodnight *et al.*, 1982; Philipson *et al.*, 1985). In present study, the amount of Polyenoic fatty acids (PUFA) and ω-3 in salted fillet were higher than fresh but is has been found the fresh fillet had a higher level of total lipid in tissue.

It also was found the amount of polyunsaturated fatty acids; especially EPA and DHA in the salted tissue have a higher amount than the fresh tissue, while the lipid content is lower.

The ratio of EPA+DHA/C16 is a useful index for determining of lipid oxidation (Jeong *et al.*, 1990). This ratio in present study was 0.82 after salting of mullet tissues, which indicate a suitable condition for fish fillet after dry-salting.

The variations in fatty acids composition may be due to processing method such as salting.

In recent years many studies were conducted on fish lipid and fatty acid composition, such as Grey mullet *Mugil cephalus* (Şengör *et al.*, 2003), Northern Pike *Esox lusius* (Kucska *et al.*, 2005), Stellate Sturgeon *Acipenser stellatus* (Hedayatifard and Yousefian, 2007) and Pike perch *Sander lucioperca* (Hedayatifard and Jamali, 2008).

These results were compared with some of Caspian Sea fresh water fish in Table 3.

Ackman (2005) summarized and reviewed numerous studies showing effects of freshwater fish location, age, diet, size and ambient temperature on the fatty acid profiles.

Fish flesh is composed of high quality proteins and lipids (oils) that are high in monounsaturated and polyunsaturated fatty acids (Ackman, 2005). Omega-3 EFAs also play an important role in decreasing blood pressure and plasma rigidity. It also slows the progress of breast cancer and other types of cancer, after a 5 week administration of 4-8 capsules of fish oil (containing omega-3 EFAs) corresponding to 1.26 to 2.5 g daily (Bach *et al.*, 1989).

Fatty acid components of fish oils vary with several factors such as sex, nutrition, catching season, species, maturity, temperature, etc. (Kietzmann *et al.*, 1969; Ustun *et al.*, 1996).

On the basis of Table 2 and Fig. 1, it is concluded that the fresh and salted golden mullet both can be successfully used for the cure/prevention of cardiovascular diseases, but we know that high salinity in the salted fish is harmful to use for cardiovascular diseases.

CONCLUSION

As mentioned above results, golden mullet *Liza aurata* is a good source of PUFA and is one of the best sources of omega-3 essential fatty acids compared to some of freshwater

fish living in Caspian Sea. The salted filet has a high amount of PUFA, especially EPA and DHA and as a recommendation, golden mullet can be salted and introduced as a suitable fish product in Northern of Iran and Caspian Sea coasts.

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