Omega-3 fatty acids composition and lipid content from liver and muscle tissues of *Esox lucius* in the Caspian Sea (Anzali Port)

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Abstract: In the present study, the liver and muscle tissues of *Esox lucius* fishing in the Anzali port in the south of the Caspian Sea, Iran in Mar 2013 were separately extracted for their lipid content especially omega-3 fatty acids composition using the method of Blight & Dyer. The compounds were determined by Gas Chromatography-Mass Spectrometry (GC- MS). The components detected in the liver and muscle tissues, include saturated fatty acids Palmitic acid and Stearic acid, monounsaturated fatty acid Oleic acid, polyunsaturated fatty acids Docosahexaenoic acid (DHA) and (PUFA) Eicosapentaenoic acid (EPA), two methyl esters of fatty acids including Octadecanoic acid, methyl ester and Hexadecanoic acid, methyl ester and Alkane including, Heptadecane and Octadecane. The results showed that the dominant fatty acids in liver and muscle tissues were Docosahexaenoic acid (DHA) and Palmitic acid.

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1. Introduction

Esox lucius (Northern pike) is a species of carnivorous fish of the genus *Esox* in the family Esocidae. They are typical of brackish and freshwaters of the northern hemisphere. They are prized as game fish for their determined fighting and have been food fish since ancient times (Rainer & Pauly, 2004).

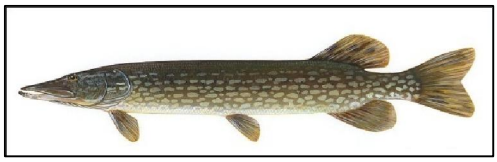

Figure1. *Esox lucius*

Health benefits from the consumption of fish or fish oil may be related to polyunsaturated fatty acids (PUFAs) especially omega-3 PUFAs (Allen & Harris. 2001). Omega−3 fatty acids including eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and α-linolenic acid (ALA). They are considered essential fatty acids, meaning that they cannot be synthesized by the human body but are vital for normal metabolism. Fish, plant, and nut oils are the primary dietary source of omega-3 fatty acids (Simopoulos, 2002). Previous studies reported that omega-3 PUFA intake, reduces the risk of contracting many diseases, such as cancer (Hardman, 2002; Schonberg et al., 2006; Simon et al., 2009), autoimmune diseases (Aronson et al., 2001; Harbige & Fischer, 2001; Kato et al., 2002), diabetes (Stirban et al., 2010), inflammation (Gil, 2002; Grimm et al., 2002; David, *et al*., 2005), lung diseases, depression (Kris-Etherton, *et al.,* 2001; Song& Zhao, 2007; Bousquet et al., 2008), Alzheimer's disease (Guesnet & Alessandri, 2011), in particular, cardiovascular diseases (Cunquer, 2000; Allen & Harris, 2001; Lemaitre et al., 2003; Reiffel & McDonald, 2006). The objective of this study was to identify of the lipid content especially omega-3 fatty acids of liver and muscle tissues of *Esox lucius* from the Anzali port in the south of the Caspian Sea.

2. Material and Methods

In this research, 30 *Esox lucius* samples were obtained from the Anzali port in the south of the Caspian Sea in the north of Iran (Figure 2).

Figure2. Map of sampling station from the Anzali port in the south of the Caspian Sea.

Initially the liver and muscle tissues were weighed separately and mixed into a soft uniform mixture. Mixtures of chloroform and methanol were added as the lipid extract (Blight & Dyer, 1959). This solvent system allows for extraction of both polar and non polar compounds. The lower chloroform layer includes the lipids and the top methanol-water layer generally contains the polar components. The lipid in the chloroform layer is removed using a rotary evaporator under vacuum, at temperature of 40 ° C. The weight of the lipid was determined.

The lipid extract obtained was injected into chromatograph equipment with a mass spectra detector (GC- MS). Components were identified by comparison of the retention time and mass spectra of the unknowns with those of authentic samples and also comparative analysis of kovats index & using references of Eight peak.

3. Results

This study investigated on the fatty acid composition and lipid content in the liver and muscle tissues of *Esox lucius*. The results are shown in Tables 1 and 2. Chloroform phase is discussed in this research because the fat content of the muscle tissue is extracted with chloroform (Blight & Dyer, 1959). The components identified by GC-MS analysis of the chloroform phase of liver samples is shown the below table.

Table 1. The compound identified in the chloroform phase of liver tissue of *Esox lucius* from the Anzali port in the south of the Caspian Sea

Compound	MF	KI	%of total
Fatty acid			
Saturated fatty acid			
Palmitic acid (Hexadecanoic acid)	$C_{16}H_{32}O_2$	1510	17.76
Stearic acid	$C_{18}H_{36}O_2$	1598	9.89
Monounsaturated fatty acid			
Oleic acid (9Z Octaecenoic Acid)	$C_{18}H_{34}O_2$	1578	5.32
Poly- unsaturated fatty acid			
Docosahexaenoic acid(DHA)	$C_{20}H_{30}O_2$	1845	23.96
Eicosapentaenoic acid (EPA)	$C_{22}H_{32}O_2$	1821	8.31
Ester			
Palmitic acid –methylester (Hexadecanoic acid, methyl ester)	$C_{17}H_{34}O_2$	1609	12.43
Stearic acid-methylester (Octadecanoic acid, methyl ester)	$C_{19}H_{38}O_2$	1788	6.87
Alkane			
Dodecane	$C_{12}H_{26}$	1144	2.96
Tetradecane	$C_{14}H_{30}$	386	2.75
Pentadecane	$C_{15}H_{32}$	954	2.64
Hexadecane	$C_{16}H_{34}$	1634	2.68
Heptadecane	$C_{17}H_{36}$	1675	2.32
Octadecane	$C_{18}H_{38}$	723	2.11

MF: Molecular Formula KI: Kovats Index

Table 2 shows the components identified by GC-MS analysis of the muscle samples from species.

Table 2.The compound identified in the chloroform phase of muscle tissue of *Esox lucius* from the Anzali port in the south of the Caspian Sea

Compound	MF	KI	%of total
Fatty acid			
Saturated fatty acid			
Palmitic acid (Hexadecanoic acid)	$C_{16}H_{32}O_2$	1510	17.68
Stearic acid	$C_{18}H_{36}O_2$	1598	9.27
Monounsaturated fatty acid			
Oleic acid(9Z Octaecenoic Acid)	$C_{18}H_{34}O_2$	1778	5.21
Poly- unsaturated fatty acid			
Docosahexaenoic acid(DHA)	$C_{20}H_{30}O_2$	1845	24.21
Eicosapentaenoic acid(EPA)	$C_{22}H_{32}O_2$	1821	8.32
Ester			
Palmitic acid –methylester(Hexadecanoic acid,methyl ester)	$C_{17}H_{34}O_2$	1609	11.98
Stearic acid-methylester (Octadecanoic acid, methyl ester)	$C_{19}H_{38}O_2$	1788	6.42
Alkane			
Dodecane	$C_{12}H_{26}$	1144	2.64
Tetradecane	$C_{14}H_{30}$	386	2.68
Pentadecane	$C_{15}H_{32}$	654	2.72
Hexadecane	$C_{16}H_{34}$	1634	2.91
Heptadecane	C17H36	1675	2.97
Octadecane	C18H38	723	2.58

MF: Molecular Formula KI: Kovats Index

The present study indicates that compounds identified are common between liver and muscle tissue such as saturated fatty acids Palmitic acid (17.76% in liver and muscle 17.68%) and Stearic acid (9.89% in liver and muscle 9.87%), Monounsaturated fatty acid Oleic acid (5.32% in liver and muscle 5.21%), polyunsaturated fatty acids Docosahexaenoic acid (23.96% in liver and muscle 24.21%) and Eicosapentaenoic acid (8.31% in liver and muscle 8.32%) and two esters of fatty acid consist Palmitic acid–methylester (12.43% in liver and muscle 11.98 %) and Stearic acid-methylester (6.67% in liver and muscle 6.42%), and Alkane including Dodecane (2.96% in liver and muscle 2.64%), Tetradecane (2.75% in liver and muscle 2.68%), Pentadecane (2.64% in liver and muscle 2.72%), Hexadecane (2.68% in liver and muscle 2.91%), Heptadecane (2.32% in liver and muscle 2.97 %) and Octadecane (2.11% in liver and muscle 2.58%). Amounts of alkanes are identified in the liver and muscle tissues which are regarded as environmental pollution.

4. Discussions

In the present research, the results indicate that the dominant fatty acids in liver and muscle tissues of Tenualosa ilisha are omega-3 fatty acids Docosahexaenoic acid (21.24-22.64%) and Eicosapentaenoic acid (19.31-20.41%). Docosahexaenoic acid (DHA) is a primary structural component of the human brain, cerebral cortex, skin, sperm, testicles and retina. It can be synthesized from alpha-linolenic acid or obtained directly from fish and fish oil or maternal milk. Dietary DHA may reduce the risk of heart disease (Stampfer, et al., 2000; Reiffel & Mc Donald, 2006) by reducing the level of blood triglycerides (Hardman, 2002; Kato et al., 2002; Bousquet et al., 2008) and lower blood pressure (Frenoux et al., 2001; Calo et al., 2005; Teres et al., 2008;) in humans. DHA plays a crucial role in the growth and development of the central nervous system and visual abilities during the first 6 months of life. DHA is benefit for Alzheimer's disease (Guesnet & Alessandri, 2011). Eicosapentaenoic acid (EPA) is a polyunsaturated fatty acid (PUFA) that acts as a precursor for prostaglandin-3 (which inhibits platelet aggregation), thromboxane-3, and leukotriene-5 groups (all eicosanoids). Studies have suggested that EPA may be efficacious in treating depression (Kris-Etherton, et al., 2001; Song & Zhao, 2007; Bousquet et al., 2008), suicidal behavior and Schizophrenia (Rees et al., 2006; Schonberg et al., 2006; Bousquet et al., 2008; Cunnane et al., 2009; Simon et al., 2009). Research also suggests that EPA can improve patients' response to chemotherapy (Bousquet et al., 2008). EPA can also reduce the probability of developing particular kinds of cancer and autoimmune disease (Aronson et al., 2001; Kato et al., 2002; Schonberg et al., 2006).

Results of in this study showed that the liver and muscle tissues of *Esox lucius* are rich in fatty acids especially Omega-3 Docosahexaenoic acid (23.96-24.21%) and Palmitic acid (17.68-17.76%), so these fish are one of the healthiest seafood, and they are also suitable as a raw material in the processing industry.

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