International Journal of Agricultural Sciences ISSN 2167-0447 Vol. 5 (1), pp. 386-389, January, 2015. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Omega-3 fatty acids composition and lipid content from liver and muscle tissues of *Sander lucioperca (Pike Perch)* in the south of the Caspian Sea, Iran

Abdolhossein Rustaiyan[1], Keivandokht Samiee[2] and Mohammadali Mohammadi[3]

[1]Department of Chemistry, Science & Research Branch, Islamic Azad University, Tehran, Iran.
[2]Faculty of Biological Sciences, Shahid Beheshti University, Tehran, Iran.
[3]Department of Marine Sciences and Technology, North Tehran Branch, Islamic Azad University, Tehran, Iran.

Accepted 08 July, 2014

Fish oils are the main source of omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) , keep the blood cholesterol level low and thus help in controlling the cardiovascular diseases. In the present study, the liver and muscle tissues of *Sander lucioperca* from Rasht region in the south of the Caspian Sea, Iran in June 2013 were separately extracted for their lipid content and fatty acids composition using the method of Blight and Dyer. The compounds were determined by Gas Chromatography-Mass Spectrometry (GC- MS). The components detected in the liver and muscle tissues, including saturated fatty acids Palmitic acid and Stearic acid, monounsaturated fatty acid Oleic acid, polyunsaturated fatty acids (PUFA) Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) and two methyl esters of fatty acids including Octadecanoic acid, methyl ester and Hexadecanoic acid, methyl ester. The results showed that the dominant fatty acids in liver and muscle tissues were Docosahexaenoic acid (DHA) and Palmitic acid.

Key words: Omega-3, fatty acids, lipid content, liver, muscle*, Sander lucioperca,* Caspian Sea.

INTRODUCTION

Sander lucioperca ***(****Zander)* is a species of fish from freshwater and brackish habitats in western Eurasia. It inhabits lakes, rivers, reservoirs and the coastal marine waters (in the catchment areas of the Caspian, Aral, Baltic, Black and North Sea's). It is now widespread in France and Western Europe, is rapidly extending its range in eastern and central England, and is acclimated to the waters of northern Africa (Algeria, Morocco and Tunisia), North America, and Asia. It is closely related to perch (Freyh and Kottelat, 2008). Zander are often called pikeperch as they resemble the pike with their elongated body and head, and the perch with their spiny dorsal fin (Figure 1).

The Caspian Sea is the largest enclosed inland body of water on Earth by area, variously classed as the world's largest lake or a full-fledged sea. The sea is bordered by the countries of Azerbaijan, Russia, Kazakhstan, Turkmenistan and Iran (Khain et al., 2007). Fatty acids are merely carboxylic acids with long hydrocarbon chains. There are two groups of fatty acids-saturated and unsaturated (monounsaturated, or polyunsaturated). Omega-3 fatty acids are a collection of polyunsaturated fatty acids (Allen and Harris, 2001). They are essential to human health but cannot be manufactured by the body. For this reason, omega-3 fatty acids must be obtained from food. There are two major types of omega-3 fatty acids in our diets: One type is alpha-linolenic acid (ALA), which is found in some vegetable oils, such as soybean, rapeseed (canola), and flaxseed, and in walnuts. The other type, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), is found in fatty fish. The body partially converts ALA to EPA and DHA (Nami et al., 2003).The omega-3 fatty acids in fish oil (EPA and DHA) are thought to be beneficial in treating hypertriglyceridemia (Simopoulos, 2002; Berglund et al., 2012) and possibly beneficial in preventing heart disease (Gulzarand Zuber, 2000; Ackman, 2005; Hedayatifard and Moeini, 2007; Rizos et al., 2012). Fish oil and omega-3 fatty acids have been studied in a wide variety of other conditions, such as clini-

*Corresponding author. E-mail: arustaiyan@yahoo.it

cal depression (Su et al., 2003; Naliwaiko et al., 2004), Alzheimer's disease (Sifferlin and Alexandra, 2012) and autoimmune diseases such as lupus and rheumatoid arthritis (Harbige and Fischer, 2001; Wright et al., 2008). Several studies report possible anticancer effects of n−3 fatty acids found in fish oil (particularly breast, colon and prostate cancer) (Hardman, 2002; Pala et al., 2001; Laurence and Jeremy, 2010).

The objective of this study was to identify of the lipid content especially omega-3 fatty acids of liver and muscle tissues of *Sander lucioperca*in the south of the Caspian Sea with special emphasis on omega-3 essential fatty acid due to their importance from medical point of view.

MATERIAL AND METHODS

In this research, 30 *Sander lucioperca* samples were obtained of Rasht region in the south of Caspian Sea (Figure 1). Initially the liver and muscle tissues were weighed separately and mixed into a soft uniform mixture.

Figure 1. Map of study area and location of sampling station in the south of the Caspian Sea

Mixtures of chloroform and methanol were added as the lipid extract (Blight and 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 and using references of Eight peak.

RESULTS

This study investigated on the omega-3 fatty acid composition and lipid content in the liver and muscle tissues of *Sander lucioperca.*

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 and Dyer, 1959). The components identified by GC-MS analysis of the chloroform phase of liver samples is shown the below table.

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

The present study indicates that compounds identified are common between liver and muscle tissue such as saturated fatty acids Palmitic acid (23.13% in liver and muscle18.23%) and Stearic acid (13.84% in liver and muscle 14.21%), Monounsaturated fatty acid Oleic acid (13.35% in liver and muscle 17.78%), polyunsaturated fatty acids Eicosapentaenoic acid (14.32% in liver and muscle 15.72%) and Docosahexaenoic acid (24.52% in liver and muscle 24.76%), two esters of fatty acid consist Palmitic acid –methylester (5.37% in liver and muscle 4.85%) and Stearic acid-methylester (4.11% in liver and muscle 2.58%) and Alkane including Heptadecane(0.58% in liver and muscle 0.42%) and Octadecane (0.78% in liver and muscle in 1.43%). The amounts of alkanes are identified in liver and muscle tissues that they are environmental pollution.

DISCUSSION

In the present research, the results indicate that *Sander lucioperca*is one of the most valuable fishes due to its lipid and unsaturated fatty acid composition (Table 1, 2). The dominant fatty acids in liver and muscle tissues of *Sander lucioperca* are Docosahexaenoic acid (24.52-24.76%) and Palmitic acid (18.23-23.13%).

Docosahexaenoic acid (DHA) is an omega-3 fatty acid that is a primary structural component of the human brain cerebral cortex, skin, sperm, testicles and retina (Rees et al., 2006; Schonberg et al., 2006; Song and Zhao, 2007; Cunnane et al., 2009). DHA is the most abundant omega-3 fatty acid in the brain and retina (Guesnet and Alessandri, 2011). In humans, DHA can be synthesized from alpha-linoleic acid or obtained directly from maternal milk or fish oil (Burdge and Wootton, 2002; Guesnet and Alessandri, 2011). Researches show that Docosahexaenoic acid (DHA) reduces inflammation (Kato et al., 2002) and may reduce the risk of diseases such as heart disease, cancer, rheumatoid arthritis and Alzheimer's disease (Stampfer *et al.,* 2000; Hedayatifard and Moeini, 2007; Rizos et al., 2012*).* In similar studies, Hedayatifard and Jamali (2008) found that the dominant unsaturated fatty acid in the pike perch fillet was Eicosapentaenoic acid (6.02%). In this research, Palmitic acid is the next dominant fatty acid and it is one of the most common saturated fatty acids found in animals, plants and microorganisms. Palmitic acid protects our lungs, making up

Table 1. The compound identified in the chloroform phase of liver tissue of *Sander lucioperca* from the south of the Caspian Sea.

Compound	MF	KI	% of total
Fatty acid			
Saturated fatty Acid			
Palmitic Acid (Hexadecanoic Acid)	$C_{16}H_{32}O_2$	1619	49.27
Stearic acid	$C_{18}H_{36}O_2$	1632	7.60
Mono-unsaturated fatty Acid			
Oleic Acid (9Z Octadecenoic Acid)	$C_{18}H_{34}O_2$	1679	12.19
Poly-unsaturated fatty acid			
Docosahexaenoic Acid (DHA)	$C_{20}H_{30}O_2$	1821	14.53
Eicosapentaenoic Acid (EPA)	$C_{22}H_{32}O_2$	1808	12.44
Ester			
Palmitic Acid methylester (Hexadecanoic Acid, methyl ester)	$C_{17}H_{34}O_2$	1545	2.44
Stearic Acid methylester (Octadecanoic acid, methylester)	$C_{19}H_{38}O_2$	1621	1.57

MF: Molecular Formula KI: Kovats Index

Table2. The compound identified in the chloroform phase of muscle tissue of *Sander lucioperca* from the south of the Caspian Sea.

Compound	MF	KI	% of total
Fatty Acid			
Saturated fatty Acid			
Palmitic Acid (Hexadecanoic Acid)	$C_{16}H_{32}O_2$	1619	43.27
Stearic Acid	$C_{18}H_{36}O_2$	1632	11.70
Mono-unsaturated fatty Acid			
Oleic Acid (9Z Octadecenoic Acid)	$C_{18}H_{34}O_2$	1676	11.90
Poly-unsaturated fatty Acid			
Docosahexaenoic Acid (DHA)	$C_{20}H_{30}O_2$	1821	15.11
Eicosapentaenoic Acid (EPA)	$C_{22}H_{32}O_2$	1808	13.09
Ester			
Palmitic Acid methylester (Hexadecanoic Acid, methyl ester)	$C_{17}H_{34}O_2$	1545	2.50
Stearic Acid methylester (Octadecanoic acid, methylester)	$C_{19}H_{38}O_2$	1621	2.52

MF: Molecular Formula KI: Kovats Index

68 percent of lung surfactant. Palmitic acid is the first fatty acid produced during lipogenesis (fatty acid synthesis) and from which longer fatty acids can be produced. According to the World Retinylpalmitateisan antioxidant and a source of vitamin A added to low fat milk to replace the vitamin content lost through the removal of milk fat. Palmitic acid is mainly used to produce soaps, cosmetics, and release agents (Schonberg et al., 2006; Anneken et al., 2006). In similar

studies, HEDAYATIFARD and JAMALI (2008) found that the dominant saturated fatty acid in the pike perch fillet was oleic acid (39.39%).

Fatty acid composition of fish lipid was highly dependent on a number of factors, especially fish diets. In this research, Levels of Eicosapentaenoic acid (EPA) in liver and muscle tissues of *Sander lucioperca* were 14.32% and 15.72% respectively. EPA is a polyunsaturated fatty acid (PUFA) thatacts as a precursor for prostaglandin-3, thromboxane-3, leukotriene-5 groups and docosahexaenoic acid (Schonberg et al., 2006; Cunnane et al., 2009). The human body converts alpha-linolenic acid (ALA) to EPA (Guesnet and Alessandri, 2011).

This n-3 PUFA is known to have variety of health benefits against cardiovascular diseases (CVDs) including well-established hypotriglyceridemic and anti-inflammatory effects (Kris-Etherton et al., 2001; Chattipakorn et al., 2009). Also, various studies indicate promising antihypertensive, anticancer, antioxidant, anti-depression, antiaging, and antiarthritis effects. Moreover, recent studies also indicate anti-inflammatory and insulin-sensitizing effects of this fatty acid in metabolic disorders (Gil, 2002; Grimm et al., 2002).

Among omega-3 fatty acids, it is thought that EPA in particular may possess some beneficial potential in mental conditions, such as schizophrenia (Rees et al., 2006; Song and Zhao, 2007). The most crucial role for omega-3 fatty acids (DHA and EPA) in health is arguably in prevention of cardiovascular diseases like heart attack and stroke (Stampfer et al., 2000).

In the present investigation, we got the positive result for the presence of Omega-3 fatty acids DHA (24.52-24.76%) and EPA (14.32-15.72%) in the muscle and liver tissues of *Sander lucioperca* from Rasht region in the south of Caspian Sea. In conclusion, the results showed that the muscle and liver tissues *Sander lucioperca* are one the best sources of omega-3 essential fatty acids(DHA and EPA), and this research supports the effectiveness of using this sea food in health.

REFERENCES

Ackman RG(2005). Marin lipids and omega-3 fatty acids. In: Akon, C.C. (ed.), Handbook of Functional Lipids, Taylor and Francis Group, New York, USA. 311– 24.

Allen KG, HarrisMA(2001).The role of n-3 fatty acids in gestation and parturition. Exp. Biol. Med. (Maywood) 226(6):498-506.

Anneken D, Sabine B,Christoph R,Fieg G, Steinberne U, Westfechte A (2006). Fatty Acids in Ullmanns Encyclopedia of Industrial Chemistry 2006, Wiley-VCH,Weinheim.

Berglund L, Brunzell JD, Goldberg AC (2012). Evaluation and treatment of hypertriglyceridemia: an endocrine society clinical practice guideline". J. Clin. Endocrinol. Metab. 97(9):2969–89.

Blight EG, Dyer WJ (1959).A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., 37: 911-917.

Bousquet M, Saint-Pierre M, Julien C, Salem N, Cicchetti F,

Calon F (2008).Beneficial effects of dietary omega-3 polyunsaturated fatty acid on toxin-induced neuronal degeneration in an animal model of Parkinson's disease*. The FASEB Journal.* 22:1213-1225.

Burdge GC, Wootton SA (2002).Conversion of alpha-linolenic acid to eicosapentaenoic,docosapentaenoic and docosahexaenoic acids in young women". British J. Nutrition 88(4):411–20.

Burdge GC, Jones AE, Wootton SA (2002). "Eicosapentaenoic and docosapentaenoic acids are the principal products of α-linolenic acid metabolism in young men". Bri. J. Nutri. 88(4):355–363.

Calo L,Bianconi L, Colivicchi F (2005).N-3 fatty acids for the prevention of atrial fibrilliation after coronary artery bypass surgery. JAM Coll. Cardio.45:1723-8.

Chattipakorn N, Settakorn J (2009). Cardiac mortality is associated with low levels of Omega-3 and Omega-6 fatty acids in the heart of cadavers with a history of coronary heart disease.Nutr Res. 29(10):696-704.

Cunnane SC, Plourde M, Pifferi F, Bégin M, Féart C, Barberger-Gateau P(2009). Fish,docosahexaenoic acid and Alzheimer's disease. Progress in Lipid Research 48(5): 239-25.

Frenoux JR, Pros ED, Bellelle JL, Prost JL (2001). A polyunsaturated fatty acid diet lowersblood pressure and improves antioxidant status in spontaneously hypertensive rate. J. Nutri.131:39-45.

Freyh J, Kottelat M (2008). Sander lucioperca. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012. 2.

Gil A (2002). Polyunsaturated fatty acids and inflammatory disease. Biomed. Pharmacother. 56:388-396.

Grimm H, Mayer K, Mayser P, Eigenbrodt E (2002). Regulatory potential of n-3 fatty acids in immunological and inflammatory processes. Br. J. Nutr. 87 Suppl 1:S59:67.

Guesnet P, Alessandri JM (2011). "Docosahexaenoic acid (DHA) and the developing central nervous system (CNS) - Implications for dietary recommendations". *Biochimie* 93(1):7–12.

Gulzar S, Zuber M(2000). Determination of Omega-3 Fatty Acid Composition in Fresh Water Fish. Int. J. Agric. Biol., 2:342–3.

Harbige LS, Fischer BA (2001). Dietary fatty acid modulation of mucosally-inducedtolerogenic immune responses. Proc. Nutr. Soc. 60(4):449-456.

Hardman WE (2002). Omega-3 fatty acids to augment cancer therapy. J. Nutr. 132 (11 Suppl):3508S-3512S.

Hedayatifard M, Moeini S (2007). Loss of Omega-3 fatty acids of Sturgeon. Acipenserstellatus.

During cold storage. Int. J. Agric. Biol. 9:598–601.
Hedayatifard M, Jamili Z (2008). Evaluation of Omega-3 Fatty Acids Composition in Caspian Sea Pike Perch (Sander lucioperca). Int. J. Agric. Biology.10, 2:114-118.
Kato T, Hancock RL, Mohammadpour H, McGregor B, Manalo P, Khaiboullina S, Hall MR, Pardini L, Pardini RS (2002). "Influence of omega-3 fatty acids on the growth of human colon carcinoma in nude mice". *Cancer Lett.* 187 (1–2):169–77.
Khain VE, Gadjiev AN, Kengerli TN (2007). Tectonic origin of the Apsheron Threshold in the Caspian Sea. Doklady Earth Sciences 414: 552–556.
Kris-Etherton P, Eckel RH, Howard BV, St. Jeor S,Bazzare TL (2001). AHAScience Advisory: Lyon Diet Heart Study. Benefits of a Mediterranean-style, National Cholesterol Education Program/American Heart Association Step I Dietary Pattern on Cardiovascular Disease. Nutritional Neuroscience 9(3):98-113.
Kuan-Pin Su, Huang SY, Chih-Chiang C, Winston SW
(2003).Omega-3 fatty acids in major depressive disorder. European Neuropsychopharmacology 13(4): 267–71.
Laurance J (2010-07-08). "Fish supplements may reduce risk of cancer". The Independent (London).J. cancer Epidemiday 8(5):114-118.
Naliwaiko K, Araújo RLF, Da Fonseca RV, Castilho JC, Andreatini R, Bellissimo MI, Oliveira BH, Martins EF, Curi R, Fernandes LC, Ferraz AC (2004). Effects of Fish Oil on the Central Nervous System. Nutritional Neuroscience 7(2):91–9.
Nami K, Yasuhiro A, Ryuchi M, Tohru M (2003). Lipid profile of krill *Euphasia Pacifica* collected in the Pacific Ocean near Funkabay, Hokkaido, Japan. Journal of Oleo Science, 53:1:45-51.
Pala V, Krogh V, Muti P, Chajès V, Riboli E, Micheli A, Saadatian M, Sieri S, Berrino F (2001). "Erythrocyte Membrane Fatty Acids and Subsequent Breast Cancer: a Prospective Italian Study". J. National. Cancer. Insti. 93(14):1088–95.
Reiffel JA, McDonald A (2006). Antiarrhythmic effects of omega-3 fatty acids. *Am. J. Cardiol.* 98 (4A): 50i–60i.
Rees D, Miles EA, Banerjee T, Wells SJ, Roynette CE (2006). Dose-related effects of eicosapentaenoic acid on innate immune function in healthy humans: a comparison of young and older men. AMJ. Clin. Nutr. 83:331-42, 2006.
Rizos EC, Ntzani EE, Bika E, Kostapanos MS, Elisaf MS (2012).Association between Omega-3 Fatty Acid Supplementation and Risk of Major Cardiovascular Disease Events: A Systematic Review and Meta-analysis. J.Ame. Med. Assoc. 308(10):1024–33.
Schonberg SA, Lundemo AG, Fladvad T, Holmgren K, Bremseth H, Nilsen A, Gederaas O, Tvedt KE, Egeberg KW, Krokan HE (2006). Closely related colon cancer cell lines display different sensitivity to polyunsaturated fatty acids, accumulate different lipid classes and down regulate sterol regulatory element-binding protein 1.*Cancer Lett.* 273(12): 2749–65.
Sifferlin A (2012). Fish Oil Fail: Omega-3s May Not Protect Brain Health After All. Progress in Lipid Research 33(5): 132-125.
Simopoulos AP (2002). The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed. Pharmacother. 56 (8): 365-79.
Song C, Zhao S (2007). Omega-3 fatty acid eicosapentaenoic acid. A new treatment for psychiatric and neurodegenerative diseases: a review of clinical investigations. *Expert OpinInvestig Drugs* 16(10):1627–38.
Stampfer MJ, Hu FB, Manson JE, Rimm EB, Willett WC (2000). Primary prevention of coronary heart disease in women through diet and lifestyle. N. Engl. J. Med. 343:1:16-22.
Teres S, Barcelo-Coblijn G, Benet M, Alvarez R, Bressani R (2008).Oleic acid content is responsible for the reduction in blood pressure induced by olive oil. PNAS 2008,105 (37); 13811-6.
Wright SA, O'Prey FM, McHenry MT, Leahey WJ, Devine AB, Duffy EM, Johnston DG, Finch MB, Bell AL, McVeigh GE (2008). A randomised interventional trial of ω-3-polyunsaturated fatty acids on endothelial function and disease activity in systemic lupus erythematosus. Annals of the Rheumatic Diseases 67(6): 841–8.