Composition of fatty acids and lipid content of liver and muscle tissues of *Sepia pharaonis* in the Persian Gulf

Keivandokht Samiee[1], Maryam Darvish[2], Abdolhossein Rustaiyan [3], Nahid Naghdi[4]

[1]Faculty of Biological Sciences, Shahid Beheshti University, Tehran, Iran
[2]Faculty of Marine Sciences and Technology, North Tehran Branch, Islamic Azad University, Tehran, Iran
[3]Department of Chemistry, Science & Research branch, Islamic Azad University, P.O. Box 14515-775, Tehran, Iran
[4]Faculty of Marine Sciences, Science & Research branch, Islamic Azad University, Tehran, Iran
k.samiee@yahoo.com

Abstract: In this investigation, the liver and muscle tissues of *Sepia pharaonis* in the Persian Gulf, Iran in Dec 2012 were separately extracted for their fatty acids composition and lipid content using the method of Blight & Dyer (1959). The compounds were determined by Gas Chromatography-Mass Spectrometry (GC- MS). The components were detected in the liver and muscle tissues, including saturated fatty acids Palmitic acid and Stearic acid, polyunsaturated fatty acids (PUFA) Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA) 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 muscle tissue were Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA). Also, the dominant fatty acid in liver tissue was Palmitic acid.
[Samiee K, Darvish M, Rustaiyan A, Naghdi N. **Composition of fatty acids and lipid content of liver and muscle tissues of *Sepia pharaonis* in Persian Gulf**. *Nat Sci* 2013;11(2):78-81]. (ISSN: 1545-0740).
http://www.sciencepub.net/nature. 15

Keywords: fatty acids, lipid content, liver, muscle, *Sepia pharaonis,* Persian Gulf

1. Introduction

Sepia pharaonis are native to the western Indian Ocean, including the Red Sea and the Persian Gulf (Reid et al., 2005). It is the most common species of cuttlefish caught in the Persian Gulf. *Sepia pharaonis* (Figure 1) belongs to the family Speiidae of the cephalopoda class which includes cuttlefish, squid, octopus and nautilus. They play an important role in the trophic web of the marine ecosystems (Passi et al., 2002).

Figure 1. *Sepia pharaonis*

Aquatic animals are important to health-conscious consumers due to their high content of polyunsaturated fatty acids (PUFA) particularly omega-3 FA (Bousquet et al., 2008). Aquatic animal fats are good sources of essential fatty acids that are not synthesized in the human body (Simopoulos, 2002). They consist not only of essential fatty acids, but are also a significant source of omega-3 fatty acids – especially eicosapentaenoic acid (EPA, C20:5n3) and docosahexanoic acid (DHA, C22:6n3). These fatty acids play a vital role in human nutrition, disease prevention and health promotion. There are reports that EPA can help prevent heart disease (Uauy *et al*., 2001) since it decreases triglycerides (Chattipakorn et al., 2009) and VLDL (very low-density lipoprotein) cholesterol (Frenoux *et al*., 2001); whereas DHA is a primary component of membranes in the brain, and possibly delays the onset of Alzheimer's disease (Cunnane *et al*., 2009).

The objective of this study was to identify the lipid content especially fatty acids of the liver and muscle tissues of *Sepia pharaonis* in the Persian Gulf.

2. Material and Methods

In this research, 30 *Sepia pharaonis* samples were obtained from the Bandar abbas Zone in Persian Gulf. Initially the liver and muscle tissues were weighed separately and mixed into a soft uniform mixture.

Mixtures of chloroform and methanol were added as a solvent for 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 a 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 the fatty acid composition and the lipid content in the liver and muscle tissues of *Sepia pharaonis*.

The results are shown in Tables 1 and 2. The chloroform phase is discussed in this research because the fat content of the muscle tissue is extracted by chloroform (Blight & Dyer, 1959). The components identified by GC-MS analysis of the chloroform phase of the liver samples is shown the below Table 1.

Table 1. The compound identified in the chloroform phase of liver tissue of *Sepia pharaonis* from Bandar abbas Zone in the Persian Gulf.

Compound	MF	KI	% of total
Fatty acid			
Saturated fatty acid Palmitic acid (Hexadecanoic acid)	$C_{16}H_{32}O_2$	1537	35.52
Stearic acid	$C_{18}H_{36}O_2$	1632	3.42
Polyunsaturated fatty Acid Eicosapentaenoic acid (EPA)	$C_{22}H_{32}O_2$	1869	20.45
docosahexaenoic acid (DHA)	$C_{20}H_{30}O_2$	1847	30.65
Ester			
Palmitic acid –methylester (Hexadecanoic acid ,methyl ester)	$C_{17}H_{34}O_2$	1516	3.89
Stearic acid-methylester (Octadecanoic acid, methyl ester)	$C_{19}H_{38}O_2$	1630	2.70
Alkane			
Hexadecane	$C_{16}H_{34}$	1310	0.42
Heptadecane	$C_{17}H_{36}$	1816	0.54
Octadecane	$C_{18}H_{38}$	1619	0.34

MF: Molecular Formula
KI: Kovats Index
%: Percent of the compound

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 *Sepia pharaonis* from Bandar abbas Zone in the Persian Gulf

Compound	MF	KI	% of total
Fatty acid			
Saturated fatty acid Palmitic acid (Hexadecanoic acid)	$C_{16}H_{32}O_2$	1537	19.45
Stearic acid	$C_{18}H_{36}O_2$	1632	2.21
Polyunsaturated fatty Acid Eicosapentaenoic acid (EPA)	$C_{22}H_{32}O_2$	1869	27.68
docosahexaenoic acid (DHA)	$C_{20}H_{30}O_2$	1847	32.89
Ester			
Palmitic acid –methylester (Hexadecanoic acid ,methyl ester)	$C_{17}H_{34}O_2$	1516	4.89
Stearic acid-methylester (Octadecanoic acid, methyl ester)	$C_{19}H_{38}O_2$	1630	2.62
Alkane			
Hexadecane	$C_{16}H_{34}$	1310	2.61
Heptadecane	$C_{17}H_{36}$	1816	0.21
Octadecane	$C_{18}H_{38}$	1619	2.55

MF: Molecular Formula
KI: Kovats Index
%: Percent of the compound

The present study indicates that compounds identified are common between liver and muscle tissues such as saturated fatty acids Palmitic acid (35.52 % in the liver and muscle 19.45%) and Stearic acid (3.42% in the liver and muscle 2.21%) polyunsaturated fatty acids Eicosapentaenoic acid (20.45% in the liver and muscle 27.68%) and Docosahexaenoic acid (30.65 % in the liver and muscle 32.89%), two esters of fatty acid consist Palmitic acid –methylester (3.89% in the liver and

muscle 4.89%) and Stearic acid-methylester (2.7 % in the liver and muscle 2.62 %) and Alkane including Hexadecane (0.42 % in the liver and muscle 2.61 %), Heptadecane (0.54 % in the liver and muscle 0.21 %) and Octadecane (0.34% in the liver and muscle in 2.55%). Amounts of alkanes are identified in the liver and muscle tissues which are regarded as environmental pollution.

4. Discussions

In the present study, the results indicate that the dominant fatty acids in muscle tissue are Docosahexaenoic acid (DHA) (32.89%) and Eicosapentaenoic acid (EPA) (27.68%). DHA and EPA are Omega-3 fatty acids and essential fats. They can be synthesized from alpha-linolenic acid or obtained directly from the diet (Guesnet & Alessandri, 2011). EPA is also a precursor to docosahexaenoic acid (DHA) (Rees, 2006). Docosahexaenoic acid (DHA) is a primary structural component of the human brain, cerebral cortex (Harbige et al., 2001), skin, sperm, testicles and retina. DHA was found to inhibit growth of human colon carcinoma cells, more than other omega-3 PUFAs (Schonberg et al., 2006). Among omega-3 fatty acids, it is thought that EPA in particular may possess some beneficial potential in mental conditions, such as schizophrenia and studies have suggested that EPA may be effective in treating depression (Song& Zhao, 2007). Omega−3 Fatty acids lower blood pressure (Teres et al., 2008; Calo et al., 2005), effects on inflammatory disease (Gil, 2002; Grimm et al., 2002), improve lipids (HDL) (Harris et al., 2004), benefit on cardiovascular disease risk factors (Reiffel & McDonald, 2006; Allen & Harris, 2001), effects on glycemia in patients with type 2 diabetes (Stirban, 2012) and effects on cancer (Hardman, 2002). Comparison of these study results and similar studies by Phillips *et al* (2002) Thanonkaew et al (2006), Ozyurt et al (2006) and Jacoeb et al (2012) indicated that the lipid of the cuttlefish contains a high percentage of polyunsaturated fatty acid (PUFA) with a high content of DHA.

Also, the results of this research show that the dominant fatty acid in the liver tissue of *Sepia pharaonis* is Palmitic acid (35.52 %). It is classified as a saturated fatty acid. Palmitic acid, or hexadecanoic acid in IUPAC nomenclature, is the most common fatty acid found in animals, plants and microorganisms (Gunstone et al., 2007). According to the World Health Organization consumption of palmitic acid increases the risk of developing cardiovascular diseases (Diet, 2003). Retinyl palmitate is an antioxidant and a source of vitamin A added to low fat milk to replace the vitamin content lost through the removal of milk fat. Palmitate is attached to the alcohol form of vitamin A, retinol, to make vitamin A stable in milk. Recently, a long-acting antipsychotic medication, paliperidone palmitate (marketed as INVEGA Sustenna), used in the treatment of schizophrenia, has been synthesized using an oily palmitate ester as a long-acting release carrier medium when injected intramuscularly. Palmitic acid is mainly used to produce soaps, cosmetics, and release agents. In industry, the dominant use of Palmitic acid is as its sodium salt (Anneken et al., 2006).The results of this research indicated that *Sepia pharaonis* is a health as seafood and it is also suitable in the processing industry.

Corresponding Author:
Dr. Keivandokht Samiee
Faculty of Biological Sciences, Shahid Beheshti University, Tehran, Iran
E-mail: k.samiee@yahoo.com

References

1. Allen K. G. and M. A. Harris. 2001. The role of n-3 fatty acids in gestation and parturition. Exp. Biol. Med. (Maywood) 226(6):498-506.
2. Anneken D, Sabine B, Christoph R, Fieg G, Steinberne U., Westfechte A. Fatty Acids in Ullmanns Encyclopedia of Industrial chemistry 2006, Wiley-VCH,Weinheim.
3. Blight, E.G., and Dyer, W.J. (1959) A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. 37, 911-917.
4. Bousquet, M., Saint-Pierre, M., Julien, C., Salem, N., Cicchetti, F. and 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*. 2008; 22: 1213-1225.
5. Calo L., Bianconi L., Colivicchi F., et al. N-3 fatty acids for the prevention of atrial fibrilliation after coronary artery bypass surgery. J AM Coll Cardio.2005; 45:1723-8.
6. Chattipakorn N., Settakorn, J. et al. 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. 2009; 29(10); 696-704.
7. Cunnane, S.C., Plourde, M., Pifferi, F., Bégin, M., Féart, C. and Barberger-Gateau P. 2009. Fish, docosahexaenoic acid and Alzheimer's disease. Progress in Lipid Research 48(5): 239-25.
8. Diet, Nutrition and the Prevention of Chronic Diseases, WHO Technical Report Series 916, Report of a Joint WHO/FAO Expert Consultation, World Health Organization, Geneva, 2003, p. 88(Table 10).
9. Frenoux, J. R., Pros, E. D., Bellelle, J. L. and Prost, J. L. 2001. A polyunsaturated fatty acid diet lowers

blood pressure and improves antioxidant status in spontaneously hypertensive rate. Journal of Nutrition 131: 39-45.
10. Gil A., 2002. Polyunsaturated fatty acids and inflammatory disease. Biomed. Pharmacother., 56: 388-396.
11. Grimm H., K. Mayer, P. Mayser, and E. Eigenbrodt. 2002. Regulatory potential of n-3 fatty acids in immunological and inflammatory processes. Br. J. Nutr. 87 Suppl 1:S59:67.
12. Guesnet, P., Alessandri, J.M. (2011). "Docosahexaenoic acid (DHA) and the developing central nervous system (CNS) - Implications for dietary recommendations". *Biochimie* 93 (1): 7–12.
13. Gunstone, F. D., John L. Harwood, and Albert J. Dijkstra. The Lipid Handbook with Cd-Rom. 3rd ed. Boca Raton: CRC Press, 2007.
14. Harbige L. S. and Fischer B. A., 2001. Dietary fatty acid modulation of mucosally-induced tolerogenic immune responses. Proc. Nutr. Soc. 60(4): 449-456.
15. Hardman W. E. 2002. Omega-3 fatty acids to augment cancer therapy. J. Nutr. 132 (11 Suppl):3508S-3512S).
16. Harris J.I., Hibbeln J.R., Mackey R.H., Muldoon M.F., Statin treatment alters serum n-3 and n-6 fatty acids in hypercholesterolemic patients. Prostaglandins, Leukotrienes and Essential Fatty Acids Volume 71, Issue 4, October 2004, Pages 263-269.
17. Jacoeb, A.M., Nugraha, R., Sulastri, S., Nurzakiah, A. and Karmila, S. Proximate, Nutrient and Mineral Composition of Cuttlefish (Sepia recurvirostra. Advance Journal of Food Science and Technology 4(4): 220-224, 2012.
18. Lord, R. S. and Bralley, J. A. 2002. Polyunsaturated Fatty Acid-Induced Antioxidant Insufficiency, Integrative Medicine Vol. 1, No. 1 Dec 2002/Jan 2003.
19. Ozyurt, G., O. Duysak, E., Akama and C. Tureli, 2006. *officinalis* L. (mollusca: cephalopoda) in the north eastern Mediterranean Sea. Food Chem., 95(3):382-385.
20. Passi, S., Cataudella, S., Marco, P., Simone, F. and Rastrelli, L. 2002. Fatty Acid Composition and Antioxidant Levels in Muscle Tissue of Different Mediterranean Marine Species of Fish and Shellfish. Journal of Agricultural and Food Chemistry 50(25): 7314–7322.
21. Phillips, K.L., P.D. Nichols and G.D. Jackson, 2002. Lipid and fatty acid composition of the mantle and digestive gland of four Southern Ocean squid species: Implications for food-web studies. Antar. Sci., 14(3): 212-220.
22. Reid, A., P. Jereb, & C.F.E. Roper 2005. Family Sepiidae. *In:* P. Jereb & C.F.E. Roper, eds. *Cephalopods of the world. An annotated and illustrated catalogue of species known to date. Volume 1. Chambered nautiluses and sepioids (Nautilidae, Sepiidae, Sepiolidae, Sepiadariidae, Idiosepiidae and Spirulidae)*. FAO Species Catalogue for Fishery Purposes. No. 4, Vol. 1. Rome, FAO. pp. 57–152.
23. Reiffel, J.A., McDonald, A. (August 2006). "Antiarrhythmic effects of omega-3 fatty acids". *The American Journal of Cardiology* 98 (4A): 50i–60i. doi:10.1016/j.amjcard.2005.12.027. PMID 16919517.
24. Rees, D., Miles, E.A., Banerjee, T., Wells, S.J., Roynette, CE, et al., 2006. Dose-related effects of eicosapentaenoic acid on innate immune function in healthy humans: a comparision of young and older men. A.M. J. Clin. Nutr., 83:331-42, 2006.
25. Schonberg S.A., Lundemo A.G., Fladvad T, Holmgren K, Bremseth H, Nilsen A, Gederaas O., Tvedt K.E., Egeberg K.W., Krokan H.E. (2006). "Closely related colon cancer cell lines display different sensitivity to polyunsaturated fatty acids, accumulate different lipid classes and downregulate sterol regulatory element-binding protein 1". *Cancer Lett.* 273 (12): 2749–65.
26. Simopoulos A. P. 2002. The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed Pharmacother. 56(8):365-79.
27. Song, C., Zhao S. (Oct 2007). "Omega-3 fatty acid eicosapentaenoic acid. A new treatment for psychiatric and neurodegenerative diseases: a review of clinical investigations". *Expert Opin Investig Drugs* 16 (10): 1627–38.
28. Stirban, A., Nandrean, S. et al., 2010. Effect of n-3 fatty acids on macro-and microvascular function in subjects with type 2 diabets mellitus. A. M. J. Clin. Nutr. January 2010.2874.
29. Teres, S., Barcelo-Coblijn G., Benet, M., Alvarez R.,Bressani R. et al.,2008. Oleic acid content is responsible for the reduction in blood pressure induced by olive oil. PNAS 2008, 105(37); 13811-6.
30. Thanonkaew A., Benjakul S.,Visessanguan W. Chemical composition and thermal property of cuttlefish (Sepia pharaonis) muscle. Journal of Food Composition and Analysis: an Official Publication of the United Nations University, International Network of Food Data Systems [2006, 19(2-3):127].

12/22/2012