CONTENT OF LONG CHAIN OMEGA-3 FATTY ACID COMPOSITION IN SOME IRANIAN CANNED FISH

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Abstract

BACKGROUND: Ecological studies have found a negative correlation between the risk of developing heart disease and fish consumption because of their long chain omega-3 fatty acids. This study was undertaken to determine the amounts of the common fatty acid content of several commercial canned fish marketing in Iran, with particular attention to long chain omega-3 fatty acids.

METHODS: The most consumed available brands of canned fish were randomly selected seven times from products available in supermarkets. Total lipids were extracted by using the Folch method and prepared for fatty acid analysis. Individual fatty acids were quantified by gas chromatography (GC) with 60 meter capillary column and flame ionization detector.

RESULTS: The most common saturated fatty acids (SFA) in Iranian canned fish was palmitic acid (C16:0) followed by stearic acid (C18:0). The amount of all trans fatty acids (TFAs) except elaidic acid (C18:1 9t) was 0%. The highest amount of polyunsaturated fatty acids (PUFAs) related to long chain omega-3 fatty acids include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The most abundant monounsaturated fatty acids (MUFAs) were oleic acid (C18:1 9c).

CONCLUSION: This study showed higher contents of EPA and DHA in Iranian commercially available canned fish compared to the canned fish in other countries.

Keywords: Iranian canned fish, fatty acids, long chain omega-3 fatty acids, gas chromatography.

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Introduction

There is a direct relationship between the state of health and diet.[1] Several studies have clearly remarked the nutritional benefits of fish consumption. The importance of fish consumption in diet for cardiovascular protection has been well documented over many years.[2] The beneficial effects of a diet containing fish on cardiovascular or other diseases have been associated with their proteins, vitamins, minerals, and especially essential omega-3 polyunsaturated fatty acids.[3,4] Also, other investigations have showed the importance role of the dietary fatty acids content in the process health-illness.[5] Well established evidences suggest that high intakes of long chain omega-3 fatty acids can markedly reduce the risk of certain illnesses such as coronary heart disease, hypertension, rheumatoid arthritis, inflammatory answer, and arterial pressure.[1,6,7] The omega-3 fatty acids believed to be mainly responsible for these effects include EPA (eicosapentaenoic acid, C20:5n-3) and DHA (docosahexaenoic acid, C22:6n-3).[6] A diet containing fish have high content of long chain polyunsaturated fatty acids such as EPA and DHA.[4,5] Canned fish is one of the shapes of fish consumption. Most tuna is packed in vegetable oil, but some is packed in an

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oil-free water broth.[1] The production of canned fish has increased at such a rate that it is now the most important canned seafood of the United States. In 2002, the United States per capita consumption of canned fishery products was 2.2 kg/y,[8] and canned tuna (1.4 kg/y) being the 2nd most common seafood.[9,10] Although this high protein food is canned in large quantity, relatively little is known about the fatty acid composition of this kind of food. The aim of the present study was to determine the fatty acid composition of some Iranian canned fish.

Materials and Methods

Four brands of canned fish were randomly selected seven times from products available in supermarkets in Isfahan city. To have a homogenous sample of each brand, its content was homogenized by blender. Ten g sample was drawn and prepared for fatty acid analysis.

Total lipids were extracted by using the Folch method.[11] Ten g of sample was mixed with 30 ml of a chloroform-methanol (2:1, v/v) mixture in a 250 ml Erlenmeyer flask for 45 min. Then, the mixture was filtered and the solid phase was re-extracted with the same volume of extract two times more. The liquid phases were mixed in a separatory funnel. Fourteen ml of saturated sodium chloride in water and 0.2 g of $NaClO_4$ were added, and was shaken. After this separation, the chloroform phase was filtered, dried with sodium sulfate and filtered again. Finally, the extractant was dried in a N_2 current until constant weight.[11]

Methyl-esterification of lipid extract was done by the BF3-MeOH method.[12] The amount of 2 ml of 0.5 mol/l NaOH-methanol solution were added to 20 mg of extracted lipid content of the samples, and the mixture was heated at 100ºC for 7 min. After cooling, 3 ml of 14% BF3-MeOH reagent was added, and the vessel was sealed and heated at 100ºC for 5 min. After cooling, 2 ml of hexane and 7 ml of saturated NaCl solution were added, followed by a thorough shaking. The resulting hexane layer was used for gas chromatography (GC). Two milligrams of internal standard was added as a chloroform solution before esterification, and the solvent was removed under nitrogen.[12] The fatty acid methyl esters were measured using a Younglin capillary gas chromatography equipped with flame ionization detectors and capillary column of TR-CN100 (60 m, 0.25 mm inside diameter, 20 μm film thickness). Injection and detector temperature were 240ºC and 250ºC, respectively. GC condition were: 90ºC (initial temperature), initial time was 5 min; 150ºC for 10 min; 200ºC for 15 min and 240ºC (final temperature) for 20 min. Helium used as the carrier gas, with a pressure of 20 psi and a split ratio of 20:1. For each sample methyl ester prepared for one times.

Statistical analyses were performed with SPSS statistical package (version 15.0). Different superscripts (a, b, c and d) in the same row show significantly different values ($P < 0.05$.) as determined by one-way ANOVA followed by the Tukey post hoc test.

Results

The content of total fat and saturated fatty acids (SFAs) in each of the canned fish is presented in table 1. SFAs content of canned fish is varied from 28.9 to 39.5 g/100g $_{food}$. The most common SFA was palmitic acid (C16:0) followed by stearic acid (C18:0) as 20.8 g/100g $_{food}$ and 8.4 g/100g $_{food}$ respectively. The amount of short chain fatty acids (C4:0 (Butyric acid); C6:0 (Capric acid); C8:0(Caprylic acid) is 0 g/100g $_{food}$ expect canned fish.[1]

According to table 2, elaidic acid (C18:1 9t) is the only trans fatty acid (TFA) that exists in canned fish with ranged from 2.2 to 4.4 g/100g $_{food}$. The amount of other TFAs is 0 g/100g $_{food}$.

In table 3 cis-mono and polyunsaturated fatty acids content of different canned fish are presented. These data indicated that the main group of fatty acids belongs to polyunsaturated fatty acids (PUFAs) include long chain omega-3 fatty acids such as EPA (C20:5n-3) and DHA (C22:6n-3) followed by linoleic acid (C18:2). Arachidonic acid (C20:4n-6) was ranged from 0.2 to 1.5 g/100g $_{food}$. The most common monounsaturated fatty acids (MUFAs) is oleic acid (C18:1 9c). The amount of long chain fatty acids show significant difference among four groups ($P < 0.01$) and it is higher in canned fish.[2, 3]

The main group of fatty acids belongs to polyunsaturated, being omega-3 family the more important.

Table 1: Total fat and Saturated fatty acid (SFA) content (g/100g_{food}) of different Iranian canned fish.

Fatty acids	Canned fish 1 (n = 21)	Canned fish 2 (n = 21)	Canned fish3 (n = 21)	Canned fish 4 (n = 21)	P-value
Total fat	3.8 ± 2.25^{a}	1.4 ± 0.30 ^{a}	4.4 ± 0.56^{a}	24.2 ± 1.5^{b}	< 0.05
C4:0	0.2 ± 0.04^{a}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	< 0.01
C6:0	0.1 ± 0.02^{a}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	< 0.01
C8:0	0.3 ± 0.03^{a}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	< 0.01
C10:0	0.5 ± 0.04^{a}	0.2 ± 0.01^{b}	0.1 ± 0.02^{c}	0.0 ± 0.0^{d}	< 0.01
C12:0	0.8 ± 0.53^{a}	0.5 ± 0.03^{b}	0.2 ± 0.04^{c}	0.2 ± 0.1^{c}	< 0.01
C14:0	4.4 ± 0.23^{a}	4.1 ± 0.38^{a}	1.8 ± 0.36^{b}	1.4 ± 0.39^{b}	< 0.01
C16:0	21.1 ± 1.1^{ab}	20.9 ± 1.55^{ab}	19.7 ± 1.1^{a}	22.0 ± 1.40^{b}	< 0.01
C17:0	0.01 ± 0.003^{a}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	0.0 ± 0.0^{b}	< 0.01
C18:0	11.6 ± 1.31^{a}	11.4 ± 1.18^{a}	9.9 ± 0.71^{b}	5.1 ± 0.37^{c}	< 0.01
C20:0	0.5 ± 0.04 ^{a}	0.5 ± 0.04^{a}	0.3 ± 0.02^{b}	0.1 ± 0.05^{c}	< 0.01
Total SFA	39.5 ± 2.16 ^{a}	37.9 ± 2.56 ^{a}	32.2 ± 1.23 ^{b}	28.9 ± 1.51 ^{c}	< 0.01

C4:0(Butyric acid); C6:0 (Capric acid); C8:0(Caprylic acid); C10:0(Capric acid); C12:0(Lauric acid); C14:0(Myristic acid); C16:0(Palmitic acid); C17:0(Heptadecanoic acid); C18:0(Stearic acid).
Value in the same row with different superscript (a, b, c and d) are significantly different (P < 0.05.)

Table 2: Trans fatty acid (TFA) content (g/100g_{food}) of different Iranian canned fish.

Fatty acids	Canned fish 1 (n = 21)	Canned fish 2 (n = 21)	Canned fish3 (n = 21)	Canned fish 4 (n = 21)	P-value
C16:1 t	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	< 0.01
C18:1 6t	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	< 0.01
C18:1 9t	3.9 ± 0.52 ^{a}	3.0 ± 0.40 ^{a}	2.2 ± 0.39 ^{b}	4.4 ± 0.45 ^{c}	< 0.01
C18:1 11t	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	< 0.01
C18:1 13t	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	< 0.01
C18:2 9t,12t	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	0.0 ± 0.0 ^{a}	< 0.01
Total TFA	3.9 ± 0.52 ^{a}	3.0 ± 0.40 ^{a}	2.2 ± 0.39 ^{b}	4.4 ± 0.45 ^{c}	< 0.01

(t = trans)
C16:1 t (Palmitelaidic acid); C18:1 9t (Elaidic acid); C18:1 6t (Petroselaidic acid); C18:1 11t (trans-vaccinic acid); C18:1 13t (trans 13-octadecenoic acid);
C18:2-9t 12t (Linolelaidic acid).
Value in the same row with different superscript (a, b, c and d) are significantly different (P < 0.05)

Table 3: Unsaturated fatty acid content (g/100g_{food}) of different Iranian cnned fish

Fatty acids	Canned fish 1 (n = 21)	Canned fish 2 (n = 21)	Canned fish3 (n = 21)	Canned fish 4 (n = 21)	P-value
C16:1	8.1 ± 0.40^{a}	7.8 ± 0.56^{a}	2.3 ± 0.30^{b}	8.2 ± 0.62^{a}	< 0.01
C18:19c	14.7 ± 5.11^{a}	11.3 ± 1.11^{b}	10.7 ± 0.5^{b}	24.3 ± 2.59^{c}	< 0.01
Total MUFA	22.7 ± 1.71^{a}	19.2 ± 1.23^{b}	13.1 ± 1.00^{c}	32.5 ± 2.27^{d}	< 0.01
C18:2	4.3 ± 0.56^{a}	1.9 ± 0.26^{b}	0.5 ± 0.03^{c}	4.9 ± 0.67^{a}	< 0.01
CLA	0.0 ± 0.0^{a}	0.0 ± 0.0^{a}	0.0 ± 0.0^{a}	0.0 ± 0.0^{a}	< 0.01
C18:2	7.9 ± 0.67^{a}	0.7 ± 0.03^{b}	8.1 ± 0.38^{a}	9.8 ± 0.96^{c}	< 0.01
C20:4	1.5 ± 0.25^{a}	0.2 ± 0.03^{b}	0.3 ± 0.03^{b}	1.1 ± 0.21^{c}	< 0.01
C20:5	4.4 ± 0.28^{a}	6.8 ± 0.68^{b}	6.1 ± 0.52^{c}	2.5 ± 0.36^{d}	< 0.01
C22:6	4.0 ± 0.22^{a}	14.8 ± 1.05^{b}	19.4 ± 1.10^{c}	1.5 ± 0.30^{d}	< 0.01
Total PUFA	22.3 ± 0.12^{a}	24.6 ± 1.48^{b}	34.5 ± 1.85^{c}	19.8 ± 1.35^{d}	< 0.01

(c = cis), MUFA= Monounsaturated fatty acid, PUFA=Polyunsaturated fatty acid.
C16:1 (Palmitoleic acid); C18:1 9c (Oleic acid); C18:2 (Linoleic acid);
C18:2-c9t 11c or C18:2, t10 c12 (Conjugated linoleic acid (CLA));
C18:3 (Linolenic acid).
Value in the same row with different superscript (a, b, c and d) are significantly different (P < 0.05.)

Discussion

Our results indicated that long chain fatty acid contents of canned fish show a great variation among four groups. Sum of EPA and DHA in Iranian canned fish was ranged from 4 to 25.5 g/100g $_{food}$.

Different essential fatty acids not only increase nitric oxide (NO) generation but also react with NO to produce their respective nitroalkene derivatives that produce vascular relaxation, inhibit neutrophil degranulation and superoxide formation, inhibit platelet activation, and release NO, thus prevent thrombus formation, platelet aggregation, atherosclerosis, and cardiovascular diseases.[13]

The results from determining the fatty acid composition of tuna canned in oil and in water coming from three fishing areas of the Mexican Pacific showed evident variation exists in the content of FA among areas, and the tuna in water is a richer food in omega 3 and omega 6 fatty acids that the tuna in oil, independently of the fishery area.[1]

Three canned fish species-Pacific saury (Cololabis saira), Pacific herring (Clupea harengus) and Baltic sprat (Sprattus sprattus)-most common and popular in Russia, were analyzed for fatty acids. Those results showed that Sums of EPA and DHA in saury, herring and sprat were, on average, 2.42, 1.80 and 1.43 g/100 g product, respectively.[14] In Mexico, the fatty acid profiles in sardine canned in tomato sauce coming from different fishing areas of the Mexican Pacific were analyses by GC with a flame ionization detector.

In all the areas they were identified and quantified as three omega 3 fatty acids (linolenic acid, EPA and DHA) and two omega 6 fatty acids (linoleic and arachidonic acid); this source is rich in FA monounsaturated and also presents a considerable quantity of trans fatty acids (18:1n9t and 18:2n6t). The DHA was the most abundant fatty acids in all the areas (3.064-4.704 g/100 g). Sardine canned in tomato sauce of the Mexican Pacific is a rich food in omega-3 and omega-6 FA, independently of the processing area.[5] Also, In Iranian canned fish, elaidic acid (C18:1 9t) was only TFA and other TFA isomers were not detectable. The distribution of the positional trans C18:1 isomers may indicate that partially hydrogenated fats were used in production of these samples.[15]

Evidence suggests that differences in fatty acid composition among various fish species may be due to differences in diet or to environmental factors such as temperature, salinity, and depth at which the fish are seized[4].The scientific evidence proposes "the omega-3" index as a new risk factor for sudden cardiac death. It is measured in red blood cells, and is defined as a percentage of EPA + DHA of total fatty acids. The omega-3 index can be used for treatment with EPA and DHA. An omega-3 index of > 8% as compared to an omega-3 index of < 4%, is associated with 90% less risk for sudden cardiac death.[16]

All the canned fish appeared to be highly valuable products for human nutrition concerning the content of EPA and DHA.[14]

To get the most omega 3 fats from your canned tuna, choose water-packed tuna rather than oil-packed. The oil mixes with some of the natural fat in canned tuna, so when you drain oil-packed tuna, some of its omega-3 fatty acids also go down the drain. Since oil and water don't mix, water-packed tuna won't leach any of its precious omega-3s.

References

1. Castro Gónzalez MI, Montaño Benavides S, Pérez-Gil Romo F. Fatty acids of the tuna of different fishing areas of the Mexican Pacific, canned in oil and water. Arch Latinoam Nutr 2001; 51(4): 407-13. [in Spanish]
2. Iso H, Rexrode KM, Stampfer MJ, Manson JE, Colditz GA, Speizer FE, et al. Intake of fish and omega-3fatty acids and risk of stroke in women. JAMA 2001; 285(3): 304-12.
3. Domingo JL. Omega-3 fatty acids and the benefits of fish consumption: is all that glitters gold? Environ Int 2007; 33(7): 993-8.
4. Tanakol R, Yazici Z, Sener E, Sencer E. Fatty acid composition of 19 species of fish from the Black Sea and the Marmara Sea. Lipids 1999; 34(3): 291-7.
5. Castro Gónzalez MI, Montaño Benavides S, Pérez-Gil Romo F. Fatty acids in sardine canned in tomato sauce from different fishing areas of the Mexican Pacific. Arch Latinoam Nutr 2001; 51(4): 400-6. [in Spanish].
6. Pauwels EK, Kairemo K. Fatty acid facts, part II: Role in the prevention of carcinogenesis, or, more fish on the dish? Drug News Perspect 2008; 21(9): 504-10.
7. Mehta LR, Dworkin RH, Schwid SR. Polyunsaturated fatty acids and their potential therapeutic role in multiple sclerosis. Nat Clin Pract Neurol 2009; 5(2): 82-92.
8. Marine Fisheries Service. U.S. annual per capita consumption of canned fishery products, 1980–2002. Silver Spring, Md: NMFS. [Cited Oct 2003]. Available from URL: http://www.st.nmfs.gov/st1/fus/current/09_percapita2002.pdf.
9. Natl. Fisheries Institute. Top ten seafoods. London: NFI. [Cited July 2003]. Available from URL: http://www.nfi.org/?a=news&b=TopTenSeafoods&PHPSESSID=45bc1652a7e631e922f28b71d7878879.

10. Shim SM, Dorworth LE, Lasrado JA, Santerre CR. Mercury and Fatty Acids in Canned Tuna, Salmon, and Mackerel. J Food Science 2004; 69(9): 681-4.
11. Folch J, Less M, Sloane Stanley GH. A simple method for the isolation and purification of total lipides from animal tissues. J Biol Chem 1957; 226(1): 497-509.
12. University of Missouri Agricultural Experiment Station Chemical Laboratories. Preparations of Methyl Ester of Fatty Acids. AOCS Official Method Ce; 1996. p. 2-66.
13. Das UN. Essential fatty acids and their metabolites could function as endogenous HMG-CoA reductase and ACE enzyme inhibitors, anti-arrhythmic, anti-hypertensive, anti-atherosclerotic, anti-inflammatory, cytoprotective, and cardioprotective molecules. Lipids Health Dis 2008; 7: 37-54.
14. Gladyshev MI, Sushchik NN, Makhutova ON, Kalachova GS. Content of essential polyunsaturated fatty acids in three canned fish species. Int J Food Sci Nutr 2008; 60(3): 224-30.
15. Weggemans RM, Rudrum M, Trautwein EA. Intake of ruminant versus industrial trans fatty acids and risk of coronary heart disease-what is the evidence? Eur J Lipid Sci Technol 2004; 106(6): 390–7.
16. Von Schacky C, Harris WS. Cardiovascular benefits of omega-3 fatty acids. Cardiovasc Res 2007; 73(2): 310-5.
17. The George Mateljan Foundation. Is canned tuna a good source of omega 3 fats? How much omega 3s can I expect to consume when eating canned tuna? Available from URL: www.worldshealthiestfoods.com/genpage.php?tname=george&dbid=97