Fatty Acid Composition and Cholesterol Content of Some Turkish Fish Species

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It is well known that fish lipids are effective against cardiovascular diseases due to their high contents of polyunsaturated omega-3 (n-3) fatty acids. In order to determine a suitable fish diet, the fatty acid compositions and total lipid and cholesterol contents of 9 common fish species obtained from the central fish market in İstanbul were determined. Palmitic (C-16:0) and oleic acid (C-18:1) were the predominant saturated and monounsaturated fatty acids. The predominant polyunsaturated fatty acids were eicosapentaenoic (C-20:5) acid and docosahexaenoic (C-22:6) acid. The amounts of cholesterol in fish lipids did not differ significantly. Sardine (*Sardina pilchardus*) and mackerel (*Scomber scombrus*) were found to be the most suitable pelagic species for a preventive diet. Of the groundfishes, only red mullet (*Mullus surmuletus*) were found to be suitable.

Introduction

Polyunsaturated omega-3 (n-3) fatty acids, eicosapentaenoic acid (EPA, C-20:5) and docosahexaenoic acid (DHA, C-22:6), are of interest because they reduce the risk of cardiovascular diseases[1−3]. Since these fatty acids occur in high amounts only in seafoods, it is necessary to determine their fatty acid compositions and total lipid and cholesterol contents, for recommendation of a suitable preventive diet. In this study 9 species sold on the Turkish fish market were investigated in terms of these properties.

Experimental

Fish Samples and Lipid Extraction

The fresh fishes were purchased from the central fish market in İstanbul (Table 1) and stored in deep freeze after removal of their internal organs. The edible parts of each whole fish (with skin) were homogenized and 5g of homogenized sample was mixed well with 10g cleaned sea sand and 20g anhydrous sodium sulfate, and then percolated overnight with a hexane-acetone mixture (2:1) in a glass column with a teflon stopcock. After evaporation of the solvent from the percolate (600 ml) under vacuum, the remaining fat residue was weighed.

Table 1. Fatty acid composition of fish species.

English name / Latin name* / Fishing month	12:0	14:0	15:0	16:0	16:1 n-7	17:0	18:0	18:1 n-9	18:2 n-6	18:3 n-3	18:4 n-3	20:0	20:1 n-9	20:3 n-3	20:4 n-6	20:5 n-3	22:1 n-11	22:2 n-6	22: n-6
Groundfish																			
Common bass / *Dicentrarchus labrax* / April	-	8.1	0.6	22.8	8.5	-	7.0	23.3	2.7	-	0.9	-	1.7	-	3.7	8.3	-	-	0.4
Dentex / *Dentex dentex* / October	-	7.8	0.5	26.6	11.4	-	8.1	26.6	2.8	-	0.5	-	1.3	-	2.5	3.8	-	-	-
Pandora / *Pagellus erythrinus* / October	0.4	5.7	0.8	22.7	5.9	-	11.3	21.7	1.9	0.3	1.1	0.7	5.4	0.1	3.5	4.2	0.2	-	1.2
Sargo / *Diplodus sargus* / October	-	5.0	0.9	26.2	7.9	-	8.4	28.7	1.2	1.2	1.3	-	5.2	-	2.4	3.4	-	-	0.8
Red mullet / *Mullus surmuletus* / October	-	3.6	0.8	25.6	13.3	-	7.0	27.3	2.5	-	1.0	0.6	4.4	-	1.4	5.0	-	-	0.7
Sole / *Solea solea* / April	1.5	7.0	1.2	24.0	12.2	2.7	6.1	17.4	2.0	-	0.9	0.4	2.9	-	2.7	2.6	0.3	-	0.8
Pelagic-fish																			
Mackerel / *Scomber scombrus* / April	-	4.0	0.5	22.0	3.3	1.4	5.5	21.5	2.1	-	2.8	-	4.3	-	2.1	5.8	3.1	0.9	-
Bluefish** / *Pomatomus saltatrix* / April	-	7.0	0.5	19.2	7.9	-	6.0	26.3	1.9	-	0.7	0.7	12.1	-	-	0.7	11.5	-	-
Bluefish*** / *Pomatomus saltatrix* / April	-	7.6	0.5	20.6	10.4	-	5.2	27.6	2.0	-	1.0	-	8.6	-	-	2.4	7.2	0.7	-
Sardine / *Sardina pilchardus* / October	-	7.1	0.7	22.9	6.0	-	5.5	24.3	2.7	-	1.9	2.1	5.9	-	-	6.7	3.8	0.5	-

* Turkish names (according to sequence): Levrek, sinarit, mercan, karagöz, tekir, dil, uskumru, lüfer, çinekop and sardalya.

** 25-35 cm

*** 10-20 cm

Other: Total percentage of unidentified peaks

Fatty Acids and Cholesterol Analysis

The total lipids (2-2.5g) were saponified for 3h at $100°$ C in alcoholic KOH. From the saponification mixture, the non-saponifiable material and the fatty acids were extracted with diethyl ether, directly and after acidification with H_2SO_4, respectively. After evaporation of diethyl ether under vacuum, the residues were weighed. The free fatty acids were converted into their methyl esters with diazomethane and analyzed on a 10% Silar-10C column (on 100-120 mesh Gas-Chrom Q II; 2m × 2mm ss) with a Varian 1400 gas chromatograph equipped with FID. The injector and the detector temperatures were $250°$ C and $260°$ C, respectively. The following temperature program was used: initial oven temperature, $175°$ C for 12 min, rising to $215°$ C at $6°$ C/min and a final hold time of 35-45 min. The gas flow rates were as follows: nitrogen 11 ml/min, hydrogen 20 ml/min and air 300 ml/min. The standard fatty acid methyl esters (Applied Science and Sigma) was used for the identification of peaks. The areas of the peaks were measured and the relative amounts of the fatty acids were calculated by Waters 730 data module.

Cholesterol analysis of the non-saponifiable part of the material were carried out according to the AOAC method [4] with some modifications. The same gas chromatograph and detector and 3% OV-17 on 100-120 mesh Gas-Chrom Q (2m × 2mm, glass) were used. Chromatographic conditions were as follows: injector and detector temperatures $300°$ C and column temperature $270°$ C (isothermal); carrier gas N_2 40 ml/min, H_2 30 ml/min and air 300 ml/min.

Results and Discussion

A simple and economical method [5] which permits work with small quantities of samples (5g) and reuse of the solvent mixture was used to extract the total lipid of the samples. The total lipid amounts in the fish species examined (Table 2) varied from 0.82% (sole, *Solea solea*) to 16.96% (sardine, *Sardina pilchardus*). Of the groundfishes, red mullet (*Mullus surmuletus*) was the fattiest (10%) and sole (*Solea solea*) the leanest (0.85%). The lipid contents of the examined pelagic fishes were higher than those of the groundfishes, bluefish (*Pomatomus saltatrix*) having the lowest (4.15%) and sardine (*Sardina pilchardus*) the highest (16.96%).

The fatty acid compositions of edible parts also varied (Table 1). Generally palmitic (19.2-26.6%) and oleic (17.4-28.7%) acids were the dominant fatty acids in all species. The amounts of EPA and DHA ranged from 0.7-8.3% and 3.8-17.5%, respectively. Of the groundfishes, the red mullet (*Mullus surmuletus*) had the highest (313 mg/100 g) and sole (*Solea solea*) the lowest (13 mg/100 g) EPA content. Of the pelagic fishes, the sardine (*Sardina pilchardus*) had the highest (958 mg/100 g) and bluefish (*Pomatomus saltatrix*) the lowest (22 mg/100 g) EPA content. The amount of DHA was significantly higher than that of EPA. Tanker *et.al.* [6] have examined the major fatty acids of 8 Turkish fish species. For 4 fish species – red mullet (*Mullus surmuletus*), pandora (*Pagellus erythrinus*), bluefish (*Pomatomus saltatrix*), and mackerel (*Scomber scombrus*) – the percentages found for the major fatty acids differed slightly from our results. In red mullet and pandora only the DHA percentages differed significantly. We assumed that this difference was due to the seasonal variations.

Fatty acid analysis results showed that under given chromatographic conditions, it was possible to separate a maximum of 25 fatty acid peaks (sole, *Solea solea*), 19 of which were identified. The unidentified peak numbers varied from 1 to 6 and their percentages from 0.6 to 5.1 in each fish species. Therefore, packed columns are still useful and sufficient for such fatty acid analyses.

The amounts of cholesterol in the fish species examined differed only slightly. Sargo (*Diplodus sargus*) had the highest (75.3 mg/100 g) ad pandora (*Pagellus erythrinus*) the lowest (40.3 mg/100 g) cholesterol

content. For a diet recommendation lipid, EPA, DHA and cholesterol contents of fishes examined must be taken all in consideration (Table 2). Furthermore, the supply and price of the fishes are also important. Of the rare and expensive groundfish species only red mullet (*Mullus surmuletus*), and of common pelagic species sardine (*Sardina pilchardus*) and mackerel (*Scomber scombrus*) were found suitable for preventive diet.

Table 2. Examined fish species and their total lipid, EPA, DHA, total n-3 fatty acid and cholesterol amounts

Fish Species	Total lipid (g/100 g)	EPA 20:5 n-3 (g/100 g)	DHA 22:6 n-3 (g/100 g)	Total n-3 (g/100 g)	Cholesterol (mg/100 g)
Groundfish					
Common bass					
Dicentrarchus labrax	2.30	0.176	0.218	0.430	42.9
Dentex					
Dentex dentex	1.52	0.038	0.066	0.113	48.2
Pandora					
Pagellus erythrinus	1.40	0.050	0.072	0.153	40.3
Sargo					
Diplodus sargus	4.40	0.120	0.145	0.407	75.3
Red mullet					
Mullus surmuletus	10.00	0.313	0.244	0.707	42.7
Sole					
Solea solea	0.85	0.013	0.035	0.068	58.4
Pelagic-fish					
Mackerel					
Scomber scombrus	6.05	0.287	0.866	1.351	63.4
*Bluefish**					
Pomatamus saltatrix	4.15	0.022	0.119	0.163	53.8
Bluefish****					
Pomatomus saltatrix	12.98	0.269	0.492	0.962	49.9
Sardine					
Sardina pilchardus	16.96	0.958	1.173	2.503	43.4

* 25-35 cm

** 10-20 cm

Acknowledgement

<div align="center">**References**</div>

1. C. von Schacky, **Ann Intern Med**, **107**, 890-99 (1987).

2. A. Leaf and P.C. Weber, **New Engl J Med.**, **318** , 549-57 (1988).

3. S.N. Willich and K. Winther, **Dtsch Med Wochenschr**, **120**, 227-33 (1995).

4. AOAC Official methods of analysis, 15th edn. AOAC, p.977, Arlington, Virginia, 1990.

5. Z. Imre, **Doğa-Tr J of Medical Sciences**, **14**, 185-95 (1990).

6. M. Tanker, S. Kurucu, N. Tanker, **Doğa-Tr. J. of Pharmacy**, **2**, 103-109 (1992).