A Comparative Study on the Fatty Acid Composition of Sweet-water Fishes, Meats, Fats and Oils.

Salamatullah Quazi, Anwar Hossain, Md. Mohiduzzaman, Badrun Nahar & Md. Abdul Malek

Institute of Nutrition and Food Science, University of Dhaka, Bangladesh.

Introduction

The fatty acid pattern of fats from animal and vegetable origins widely differ in chemical composition. The animal fat consists of mainly the saturated fatty acids, while vegetable oils contain larger amounts of unsaturated fatty acids. Also the per cent composition of different fatty acids in animal fats like beef, mutton, chicken, butter, ghee and of vegetable oils like soybean, rapseed, sesame, palm varies in different countries due to geographical condition[1,2]. It is also important to know the chemical nature of fish oil fatty acids for the evaluation of the nutritional significance of fatty acids in fish oil. As because marine fish oils are reported to have the ability to lower blood cholesterol levels in both human and experimental animals, researchers are interested to know the fatty acid composition of fish oils[3].

Although other factors may be involved[4], the effect of fish and other polyunsaturated oils in lowering serum cholesterol appears to be largely due to their abundant supplies of polyunsaturated omega-3 fatty acids. The per cent composition of Bangladeshi fish oils has not been studied. The persent investigation deals with the fatty acid composition of body oils of sweet water fish in Bangladesh. The data are compared with those of meats, fats and oils available in the local market.

Materials and Methods

Medium size sweet water fishes like hilsa, pangas, tengra, pabda, shing, shrimp, magur, khalla payesha, mola, ywaire, koi, puti, katla, shole, tilapia, sarputi and ruhi were purchased fresh frozen from local markets between February, 1988 to January, 1989. Beef and mutton fats from different parts of the body, medium size chicken, and fats and oils such as vanaspati, ghee, butter oil, palm oil, soybean oil, sesame oil, mustared oil were also purchased from local markets. Edible portions from individual fish and chicken, and also individual beef and mutton were grinded and 10g of samples were extracted with chloroform: methanol (2:1), and processed according to the method of Slover et al[5]. Finally an aliquot (10 ml) of the total extract in triplicate was taken in small test tubes and dried under nitrogen. Heptadecanoic acid was added to each sample as an internal standard. Fish and meat samples were saponified with 12.5 ml of 6% alcoholic potassium hydroxide per g of dried sample by refluxing for one hour. In case of fats and oils, the samples were refluxed for 45 minutes. After saponification, the volume of the sample was doubled by

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adding distilled water. Nonsaponifiable fractions were then extracted 3 times using 15 to 18 ml of n-hexane. The residue containing the potassium salt of fatty acids was saponified with 6N Hcl. The free fatty acids were extracted with n-hexane similarly as in the case of non-saponifiable matters. The fatty acids were then methylated with boron trifloride methanol according to the method of Morrison and Smith[6] and fatty acid pattern determined by gas liquid chromatography (Pye Unican, GC 304). A glass column, 1500mmX4mm of 10% DEGS on 100-120 mesh Diatomite CAW, was used. Nitrogen was used as the carrier gas at flows of 32 ml/min. The colum temperature was different for different types of samples. Injector and detector temperature were same for all samples. The standards were carried out through the same procedure. The amount of each fatty acid was quantitated by triangulation method and each fatty acid was expressed as a percentage of the total sum.

Results

The fatty acid percentage composition of body oils of fresh water fishes are shown in table 1. There were difference in percentage composition of individual fatty acids among the fishes studied. The distribution of oleic acid (18:1), for example, which is generally thought to be the most common monoenoic acid in fish oil, varied from 10.4 in khalla payesha to 40.4% in sarputi. Linoleic acid (18:2) varied from 0.7 in hilsa to 13.8% in puti. The highest amount of linolenic acid (18:3) was observed in mola (9.7%) and the lowest in hilsa body oil (0.8%). Rather larger amounts of palmitoleic acid (16:1) were found in khalla payesha (17.4%), ruhi (15.7%), hilsa (13.2%), and pangas (12.1%). Docasahexanoic acid (22:6) was observed only in five fishes and the highest amount was present in katla (4.6%), while ruhi contained only 0.8% of the total fatty acids. In case of saturated fatty acids, palmitic acid (16:0) was usually about 23 to 25% of the total, but fishes like tengra contained higher (31.6%) and shole had lower (18.0%) 16:0 fatty acid, stearic acid (18:0) apparently ranged from 8 to 12% of the total.

There were also variations in percentage proportions of the individual fatty acids among the fats from beef, mutton and chicken (Table 2). The highest difference was observed in stearic acid (18:0). Mutton, chicken and beef contained 36.1, 20.8 and 15.8% stearic acid, respectively. All the meat samples contained good amounts of 18:1 acid (beef,31.7%; mutton, 31.5%; chicken, 28.9%). The highest amount of linoleic acid (18:2) was observed in chicken (13.5%) and lowest in mutton fat (3.6%). Arachidonic acid (20:4) was found in beef (4.1%) and chicken fat (3.1%) only.

Palmitic acid (16:0) was observed in larger percentage proportions in palm oil (37.6%), butter oil (30.2%), ghee (25.8%) and vanaspati (22.4%) than in vegetable oils like soybean (10.8%), sesame (9.3%) and mustard oil (4.0%) (Table 3). Similar results were observed in case of stearic acid (18:0). On the other hand, soybean (56.3%), sesame (41.6%) and mustard oil (18.5%) contained higher amounts linoleic (18:2) acid compared to vanaspati (16.2%), ghee (13.4%), palm oil (11.4%) and butter

Table 1. Fatty Acid Composition of Body Oils of Freshwater Fishes[1]

Name of Fishes		Fatty Acid Percentage Composition													
Common	Scientific	10:0	12:0	14:0	16.0	16:1	18:0	18:1	18:2	18:3	20:1	20:4	22.0	22:1	22:6
Hilsha	Hilsha ilisha	-	T	7.8	29.0	13.2	8.2	22.9	0.7	0.8	1.9	1.5	1.0	-	0.9
Pangas	Pangasius pangasius	-	T	5.2	25.2	12.1	9.1	32.4	1.4	1.3	1.2	1.5	0.9	4.2	1.1
Tengra	Mystus vittatus (Bloch)	-	-	3.2	31.6	6.8	9.9	31.6	3.4	1.5	2.8	-	-	-	-
Pabda	Ompok pabda (Hamilton Buchaner)	-	0.4	1.8	27.9	6.0	20.1	34.2	7.9	1.7	1.2	-	-	-	-
Sing	Heteropheustes fossilis (Bloch)	-	-	2.8	29.7	6.1	9.3	23.4	8.9	-	-	-	-	-	-
Shrimp	Macrobrachium rosenbergii	-	0.2	1.9	27.4	5.9	11.0	31.3	8.8	-	-	-	-	-	-
Magur	Clarius batrachus	T	1.9	4.4	23.0	9.2	13.1	26.0	5.0	0.9	2.1	4.1	-	-	-
Khalla payesha	Mugil parsa	-	-	6.0	36.3	17.4	4.6	10.4	1.4	2.1	1.7	2.5	-	-	-
Mola	Amblypharyngodon mola	0.1	0.5	6.4	24.8	8.5	9.0	15.2	4.1	9.7	4.6	2.3	1.4	-	-
Ywaire	Mystus aor	0.5	0.4	1.9	22.0	3.7	9.5	17.5	5.4	2.0	0.5	11.6	5.6	-	-
Koi	Anabas testudineus	-	0.2	1.9	23.2	5.2	9.2	40.2	11.4	2.8	1.3	2.2	T	T	-
Puti	Puntius chola	-	0.2	2.2	24.0	6.0	9.7	31.9	13.8	4.1	0.8	3.2	T	-	
Ruhi	Labeo rohita	T	0.2	2.9	28.6	15.7	5.2	14.3	8.8	9.5	1.8	3.1	1.2	-	0.8
Katla	Catla catla	-	0.1	3.5	23.2	9.6	7.6	19.2	4.5	4.6	1.4	4.8	1.5	-	4.6
Shole	Channa Striatus	-	0.1	1.9	18.0	7.5	10.6	17.3	4.6	2.6	0.9	7.3	T	-	-
Tilapia	Oreochromis mossambica	-	0.2	4.3	23.8	9.2	7.8	17.2	4.6	6.0	1.8	3.5	2.2	-	2.7
Sarputi	Puntius sarana	-	-	2.2	23.3	5.5	11.9	40.4	3.4	1.2	3.1	4.2	-	-	-

[1]Edible Protions of medium size whole fishes were used for the analysis of different fatty acids. $^{C}20:0$ fatty acid was detected in tmce amount in pangas body oil only and no detectable amount of $^{C}20:5$ was observed anong the fishes studied.

oil (4.6%). Linolenic acid (18:3) was found in mustard oil (10.7%), soybean oil (6.7%), sesame oil (0.54%), and also in ghee (1.45%). Among the fats and oils analyzed, only mustard oil contained eicosenic (20:1) and eracic (22:1) acid.

Table 2. *Fatty Acid Composition of Beef, Mutton and Chicken*[1]

Fatty acid	Beef fat	Mutton fat	Chicken (meat)
$C_{8:0}$	--	0.20	--
$C_{10:0}$	0.25	--	0.36
$C_{12:0}$	0.25	--	--
$C_{14:0}$	2.98	1.54	1.49
$C_{16:0}$	18.34	17.18	20.42
$C_{16.:1}$	3.64	2.45	5.42
$C_{18:0}$	15.81	36.07	20.79
$C_{18:1}$	31.76	31.53	28.92
$C_{18:2}$	5.40	3.59	13.56
$C_{18:3}$	1.30	1.74	1.20
$C_{20:4}$	4.13	--	3.13
$C_{22:0}$	Trace	--	--

[1]There were no peaks observed for $C_{20:0}$; $C_{20:1}$; $C_{22:1}$ and $C_{22:6}$ in beef, mutton and chicken.

Table 3. *Fatty Acid Composition of Fats and Oils*[1]

Fatty acid	Fats and oils						
	Vanaspati	Ghee	Butter oil	Palm oil	Soybean oil	Sesame oil	Mustard oil
$C_{8:0}$	--	0.11	0.30	--	--	--	--
$C_{10.0}$	--	0.61	1.37	Trace	--	--	--
$C_{12:0}$	Trace	0.57	2.40	0.21	--	--	--
$C_{14:0}$	0.45	3.86	5.14	1.25	0.09	--	--
$C_{16:0}$	22.39	5.85	30.19	37.58	10.80	9.27	3.98
$C_{16:1}$	--	1.25	1.20	--	--	0.14	Trace
$C_{18:0}$	12.52	7.00	10.62	4.16	3.95	6.49	1.52
$C_{18:1}$	48.40	35.49	27.12	45.39	22.13	41.91	44.78
$C_{18:2}$	16.24	13.43	4.61	11.42	56.31	41.65	18.47
$C_{18:3}$	--	1.45	--	--	6.72	0.54	10.75
$C_{20:1}$	--	--	--	--	--	--	5.69
$C_{22:1}$	--	--	--	--	--	--	14.80

[1]$C_{4:0}$ and $C_{6:0}$ fatty acids in butter oil and ghee could not be detected. There were no peaks found for $C_{20:0}$, $C_{20:4}$, and $C_{22:6}$ among the fats and oils analysed.

Discussion

The per cent composition of fatty acids of body oils of fishes of different countries was compared by Gruger[3]. He concluded that the fatty acid composition varies not only from species to species, but often to an even greater extent from one fish to another of the same species. Lovern[1] and Swain[2] mentioned that geographic locations of catch and seasons of the year may be related to the proportions of fatty acids of fish oil. In our study, we also observed individual fatty acid variation from one species to another species. We did not find any 20:5 acid, which is available in marine fishes. Small amounts of other higher chain fatty acids such as 22:0, 22:1, 22:6 were observed in few fishes only. Natural oils in marine plant life, planktonic crustacea, and other planktons are consumed by the fish in varying degrees depending on feeding habits[1]. Feeding habits of fish can vary according to such factors as availability of food, which may be a geographic factor, periods of fasting and swarwning cycles. Klenk and Eberhagen[7,8] isolated from marine plankton a group of polyunsaturated fatty acids, which are like those found in fish and marine animal oils. Kelly et al[9]. reported that fishes fed a diet containing other fish oil, the fatty acids of the fresh water species changed to resemble the dietary fish oil. Olley and Duncan[10] showed comparisons between summer and winter catches, whereby the amount of 22:6 acid was nearly doubled from one time of the year to the other. In our study, we analyzed fatty acids of different fishes at different times of the year. On average, a trend was evaluated by comparing with the results of marine water fish oils that the distinctive points in Bangladeshi fresh water fish oils are the small proportions of unsaturated C_{22} acids, the reduced propotions of unsaturated C_{20} acids, increased proportions of palmitic (16:0) and stearic (18:0) acids, and in most of the cases with predominance of unsaturated C_{18} acids. The differences between marine and fresh water fish oils are conditioned by biological species factors or by differences in food and environment (e.g. salinity, climate or seasonal) conditions. The differences between marine and fresh water fish oils may largely result from differences in their dietary fats.

The number and kind of fatty acids of meats, fats and oils collected from local markets were similar, but the per cent composition of fatty acids was slightly different with those reported by Cocks and Rede[11], and Kuksis[12]. Hilditch and Williams[13] explained that the variation in the amount of fatty acids in vegetable oils is due to the variety of seeds, conditions of plant growth, and in animals due to differences in age, diet, and part of the body from which the fat is derived.

It may be concluded from the data presented in the present paper that

fish oils contain more long chain unsaturated fatty acids compared with those found in meats, fats and oils. However, total unsaturated fatty acids is highest in vegetable oils.

Summary

Fatty acid compositions of body oils of sweet water fishes like hilsa, pangas, tengra, pabda, shing, shrimp, khalla payesha, mola, ywaire, koi, puti, ruhi, katla, shole, tilapia, and sarputi were determined by gas liquid chromatography. Other sources of fats and oils such as beef, mutton, chicken, vanaspati, ghee, butter oil, palm oil, soybean oil, sesame oil and mustard oil were also analyzed and compared with those of fishes. Short chain fatty acid like caprylic acid (8:0) was not observed in any fishes studied, capric(10:0) and lauric (12:0) acids were available in small amounts in some fishes, meats, fats and oils. Sesame and mustard oil did not contain myristic acid (14:0). Fishes, meats, vanaspati, ghee, butter oil and palm oil contained almost similar amounts palmitic acid (16:0), but less values of this acid were observed in vegetable oils. Higher amounts of stearic acid (18:0) were found in meats as compared with those of fishes and most of the fats and oils. The most abundant fatty acid in fishes was oleic acid (18:1). However, per cent composition of oleic acid was found higher in meats, fats and oils as compared with those of fishes. Soybean (56.3%) and sesame (41.6%) oil contained maximum amounts of linoleic acid (18:2). However, mustard oil, vanaspati, ghee, palm oil, puti and koi also had good amounts of this acid. Linolenic acid (18:3) was found in meats, vegetable oils, and in most of the fishes studied. Mustard oil and most of the fishes studied contained eicosenoic acid (20:1). Eracic acid (22:1) was found only in mustard oil and pangas. Arachidonic (20:4) and decasohexanoic acids (22:6) were only observed in some fishes. It is concluded that fishes contained more long chain unsaturated fatty acids.

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