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Fatty Acid Compositions in Marine Fish Samples of Bangladesh

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Abstract

A total of twenty six marine fish samples of sixteen different species were collected from three different local markets of Chittagong. Fish oil was extracted by Solid phase dispersion (SPD) method. Saponification and esterification was carried out by AOAC reference procedure with some simple modifications. The fatty acid methyl esters (FAME) were then analyzed by Gas chromatograph equipped with Flame ionization detector (GC-FID). Among the marine fish samples, saturated fatty acids (SFAs) i.e., lauric Acid (1.33-11.34%), myristic acid (0.64-3.84%), palmitic acid (1.41-39.27%), stearic acid (0.47-18.89%) and arachidic acid (2.88-43.28%) were predominant. Among the unsaturated fatty acids mainly monounsaturated fatty acids(MUFAs) and polyunsaturated fatty acids (PUFAs)palmitoleic acid (3.12-18.28%), linoleic acid (*cis, cis*-9,12-Octadecadienoic acid)(1.30-38.13%), oleic acid ((*9Z*)-Octadec-9-enoic acid) (5.03-46.27%), elaidic acid ((*E*)-octadec-9-enoic acid) (0.61-9.90%) and erucic acid ((*Z*)-Docos-13-enoic acid) (2.95-28.94%) were predominant. Highest quantity of saturated (74.50%) and unsaturated (78.59%)fatty acid were found in *Megalapsis cordya* (Surma) and *Parastromateus niger* (Kalochanda) respectively. This study also reveals that the percentage composition of different fatty acids are higly varible depending on the fish species.

Keywords: Marine fish; SPD; AOAC; GC-FID; Fatty acids

Introduction

The Bay of Bengal is situated at the southern part of Bangladesh with 710 km costal area which supplies about 511 marine species including shrimps, crabs, sea food and different other marine species [1]. Both the fresh water fish and marine fish are naturally available in the country, and cheap and easily affordable. As a result, people of all classes consume fish as sources of protein, carbohydrate, fat, minerals, vitamins, micronutrients and a variety of essential saturated and unsaturated fatty acids which are beneficially for human health [2,3]. In general, fish is an inseparable part of our total economy and contributes in employment, exporting and nutrition including 63% of animal protein intake for human being [4]. Again both the consumption and production of fish has been increased in the recent years and hence it is required to enhance the output and quality of the fish [5]. In human health, fish lipid and several fatty acids have an important induction in membrane biochemistry, and membrane-mediated action such as osmoregulation, nutrients assimilation and transport [6]. Depending on the nature and habit of the fish species and both the biotic and abiotic factors, fatty acid compositions is highly variable quantitatively in fish lipids [7]. Beneficiary polyunsaturated fatty acids (PUFAs) such as Eicosapentaenoic acid (EPA; $C_{20:5}$) (ω-3 fatty acid) and Docosahexaenoic acid (DHA; $C_{22:6}$) (ω-3 fatty acid) to human health are mainly found in fish lipids [8]. Both these acids are helpful in prohibition and treatment of many diseases such as coronary heart disease, rheumatoid arthritis, asthma, cancers, diabetes and others in human body [9]. Very little analysis was done about the fatty acids composition in marine water fish of Bangladesh. As fish is an important source of beneficiary fatty acids (PUFAs), the objective of our work is to determine fatty acid compositions in marine fish samples for evaluation of nutritional values in these species.

Material and Methods

Sample collection

Sixteen different species of marine fish samples (n=26) were purchased randomly from three different local markets of Chittagong area near to the coastal site of Bay of Bengal. Sampling, location etc. is described elsewhere [10].

Chemical reagents

Analytical or laboratory grade solvents and chemicals were used for all experiments and were purchased from Merck, Germany. Analytical grade n-hexane, acetone, boron trifluoride-methanol mixture were purchased from Sigma-Aldrich, Merck, Germany. Sulphuric acid (95-98%) purchased from Merck. Germany was also used. Standard fatty acids were purchased from Sigma-Aldrich which was used for the identification of fatty acids in fish samples according to their retention times.

Saponification of fats for fatty acid analysis

Approximately, 50-100 mg of fish oil extracted from fish sample was taken in a pear shaped flask and 2.0 mL of 0.5M methanolic NaOH was added to it. The mixture was ultrasonicated for 1 minute and then refluxed at 40°C for 30 minutes. The mixture was evaporated with a rotavapour to dryness and was dissolved in water. The pH of the solution was adjusted to 4.5 (just acidic) with 2 M HCl in which the blue litmus paper was turned to red. The mixture was shaken vigorously and then extracted with n-hexane. The organic layer was collected in another pear shaped flask and was evaporated to dryness in a rotavapour.

Conversion of fatty acids into methyl esters

1.0 mL of Boron trifluoride-methanol mixture was added in the pear shaped flask containing fatty acids and was ultra-sonicated for 1 min. The mixture was heated water bath at 60°C for 30 min. The acetylated mixture was evaporated to dryness. To more trace amount reagent it was completed dried by adding hexane for two more times.

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After that 1.0 mL of n-hexane was added to the flask, the mixture was ultrasonicated for 1 min. Then it was filtered through cotton filter by a Pasteur pipette and transferred into GC vial for analysis of by GC-FID.

Identification and quantification of fatty acids

A mixture of methyl esters of thirteen fatty acids standard was used as the reference. The identification of fatty acids were done by comparing retention times of the samples with that of the corresponding fatty acid standards in the chromatograms. Quantification was carried out by accounting the areas of individual fatty acids and the results were expressed in terms of the relative percentages composition (Table 1). The amount of individual fatty acids present in the fish extracts were calculated by using the following formula:

$$Amount\ of\ individual\ fatty\ acids\ (\%) = \frac{PeakAreaofeachfattyacids}{Totalpeakarea}$$

Results and Discussion

Thirteen fatty acids were estimated quantitatively through the analysis of lipid content in the marine fish samples and saturated fatty acids (SFAs), unsaturated fatty acids (USFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) were separately determined (Tables 1 and 2). From the Figure 1 (Where Average values were used for the same species), it is seen that most of the analyzed fish samples contain comaratively higher ammount of unsaturated fatty acids (MUFAs and PUFAs) than saturated fatty acids. The SFAs content was highly variable and the maximum amount of total SFAs was found in *Megalapsis cordya* (surma) (74.50%) and the minimum amount was found in *Parastromateus niger* (kalochanda) (24.45%). Lauric Acid (1.33-11.34%), myristic acid (0.64-3.84%), palmitic acid (1.41-39.27%), stearic acid (0.47-18.89%) and arachidic acid (2.88-43.28%) were predominated saturated fatty acids in nearly all species. Other SFAs i.e., Behenic, capric and caprylic acids were found in trace level. Among the unsaturated fatty acids, palmitoleic acid (3.12-18.28%), linoleic acid (1.30-38.13%), oleic acid (5.03-46.27%), elaidic acid (0.61-9.90%) and erucic acid (2.95-28.94%) were predominant. Among the MUFAs, elaidic acid was present predominately in *Otolithoides pama* (poa) (9.90%) which decrease the cholesterol level due to the increase activity of plasma cholesterylester transfer protein (CETP) [11], oleic acid in *Parastromateus niger* (kalochanda) (46.27%), eruic acid in *Coilia ramcarati* (ulua) (28.94%) and palmitoleic acid in *Platycephalus indicus* (undurabailla) (18.28%) fish. The consumption of MUFAs is involved with lowering low-density lipoprotein (LDL) and increasing of high-density lipoprotein (HDP) cholesterol [12]. The amount of MUFAs are higher amount followed by PUFAs and SFAs, where linoleic acid (ω-6), palmitoleic acid (ω-6), oleic acid

Fish Samples (Local name)	Collecting Area		Fatty acid composition (%) in marine fish samples												
			Saturated Fatty Acids							Unsaturated Fatty Acids				
		Lauric	Myristic	Palmitic	Stearic	Arachidic	Behenic	Capric	Caprylic	Linoleic	Elaidic	Oleic	Eruic	Palmitoleic
Undurabailla	KD	4.43	0.84	26.18	4.25	2.88	-	-	-	1.31	6.27	17.70	12.92	4.49
Koral		-	2.67	37.87	1.68	4.26	-	-	1.01	29.95	2.38	15.56	4.48	5.93
kalochanda		-	-	1.41	2.04	21.00	-	-	-	5.71	-	46.27	18.86	7.75
Poa		2.84	0.64	39.27	3.07	14.00	-	0.38	-	12.83	4.51	17.33	11.57	13.93
Lakkha		3.09	-	22.89	11.73	23.19	-	-	-	38.13	-	15.50	9.00	11.56
Loitta		4.78	-	30.38	5.53	9.74	-	-	-	6.78	-	17.82	17.42	9.56
Poa	RB	2.44	-	28.78	10.62	6.80	-	-	-	4.20	4.74	15.12	15.27	13.24
Takchanda		11.34	0.89	33.02	5.41	4.55	0.41	-	0.21	13.92	1.28	19.63	10.03	13.38
Surma		1.39	-	16.78	12.49	43.28	-	-	-	8.67	7.00	12.67	-	7.90
Shadhachanda		3.26	0.78	30.23	0.47	5.84	0.87	-	-	15.42	0.61	19.38	10.39	6.33
Lakkha		3.45	0.71	33.57	11.40	5.96	2.80	0.13	-	36.83	-	18.65	10.27	10.15
Undurabailla		4.64	0.84	25.13	4.85	3.08	-	-	-	1.30	6.28	17.69	12.91	3.12
Koral		2.35	0.95	29.26	12.69	9.28	-	-	1.01	28.90	-	22.06	11.03	7.39
Loitta		9.78	-	8.49	-	-	25.26	-	-	8.89	-	19.00	15.00	13.76
Poa	FG	1.34	-	19.79	6.28	26.21	-	-	-	11.49	9.90	5.03	-	12.21
Riksha		3.56	-	20.57	4.90	19.91	-	-	-	17.60	3.31	15.14	5.97	9.42
Pata		-	-	5.06	15.96	13.19	-	-	-	-	-	24.08	17.71	-
Tuitta		1.33	3.84	10.77	9.94	36.40	-	-	-	10.67	-	5.80	2.95	14.69
Undurabailla		4.56	1.05	25.74	9.35	6.74	-	-	-	20.76	-	10.59	-	18.28
Faissha		2.46	-	23.97	14.14	22.40	-	-	-	21.69	-	7.25	-	8.08
Chapila		11.34	0.89	33.02	5.41	4.55	-	-	-	13.92	7.28	9.63	15.03	13.38
Koral		-	-	26.46	17.09	13.65	-	1.39	1.01	22.55	5.00	19.66	13.95	4.21
Chingri		2.29	1.12	21.76	18.89	19.74	-	0.47	0.38	15.43	-	6.97	3.36	9.58
Loitta		5.05	-	36.90	2.49	13.78	-	-	-	17.37	5.49	16.49	13.15	11.24
Surma		3.97	-	26.17	3.35	12.06	-	-	-	11.23	8.83	5.91	3.41	9.35
Ulua		2.55	-	21.20	6.65	10.50	-	-	-	8.75	-	10.26	28.94	4.12

Note: KD=KazirDaori, RB=Reazuddin Bazar, FG= Fishery Ghat, "-" Marks indicate trace amount.

Table 1: Fatty acid compositions (%) in Marine fish samples.

Fish Samples	Collecting Area	Total SFA (%)	Total USFA (%)	PUFA	PUFA / SFA	USFA / SFA
Undurabailla	Kazir Daori	37.98	42.67	1.30	0.05	1.12
Koral		47.49	58.30	29.95	0.63	1.23
kalochanda		24.45	78.59	5.71	0.23	3.21
Poa		59.82	60.17	12.83	0.21	1.01
Lakkha		60.90	74.19	38.13	0.62	1.22
Loitta		50.43	51.58	6.78	0.13	1.02
Poa	Reazuddin Bazar	48.64	52.57	4.20	0.09	1.08
Takchanda		55.62	58.24	13.92	0.25	1.05
Surma		74.50	36.24	8.67	0.12	0.48
Shadhachanda		41.45	52.13	15.42	0.37	1.25
Lakkha		57.80	75.90	36.83	0.64	1.31
Undurabailla		38.54	41.30	1.30	0.03	1.07
Koral		55.54	69.38	28.90	0.52	1.25
Loitta		43.53	56.65	8.89	0.20	1.31
Poa	Fishery Ghat	53.62	38.63	11.49	0.21	0.72
Riksha		48.94	51.44	17.60	0.36	1.05
Pata		34.21	41.79	-	-	1.22
Tuitta		62.28	34.11	10.67	0.17	0.55
Undurabailla		47.44	49.63	20.76	0.44	1.04
Faissha		62.97	37.02	21.69	0.34	0.59
Chapila		55.21	59.24	13.92	0.25	1.07
Koral		59.60	65.37	22.55	0.38	1.10
Chingri		64.65	35.34	15.43	0.24	0.55
Loitta		58.22	63.74	17.37	0.29	1.09
Surma		45.55	38.73	11.23	0.24	0.85
Ulua		40.90	52.07	8.75	0.21	1.27

Note: "-" Marks indicate trace amount

Table 2: Total fatty acid compositions (%) in marine fish samples.

(ω-9), elaidic acid (ω-9), erucic Acid (ω-9) were found among the MUFAs. The highest amount of PUFAs was found in *Eleutheronema tetradactylum* (lakkha) (38.13%) fish and lowest amount was found in *Platycephalus indicus* (undurabailla) and *Paraplagusia bilineata* (pata) fish in trace label. The ratio of PUFA/SFA which indicates the quality of lipid was found in lowest in *Paraplagusia bilineata* (pata) fish and highest in *Eleutheronema tetradactylum* (lakkha fish) (0.64). USFA/SFA is also calculated which also indicates the quality of lipids (Table 2). In this analysis, the ratio of PUFA to SFA was found to be 0.64 for the *Eleutheronema tetradactylum* (lakkha fish). But for healthy diet this ratio was recommended as 0.40 or more accordingly the Department of health of the United Kingdom [13]. Thus, the values of this ratio in the present study are in the recommended range.

Food and Nutrition Board of the National Academy of Medicine recommended fatty acids intake in the Dietary Reference Intakes (DRIs) which vary with age and sex. Adequate intake of ω-3 fatty acid in adult (19-50 years) male is 1.6 g and female is 1.1 g per day. Several global and national organizations have also published guidelines for infants and children, ranging from 50-100 mg per day of combined EPA and DHA [14].

Conclusion

Fatty acid composition is an important factor for the consumption of fish and people awareness is increasing day by day in this regard. This research reveals the fatty acid compositions in several most consumable marine fish samples in Bangladesh which broaden the knowledge and awareness among the consumers. Since amount of unsaturated fatty acids is comparatively higher than saturated fatty acids in marine fish samples, fish consumption has beneficiary effect on human health of the consumers in Bangladesh.

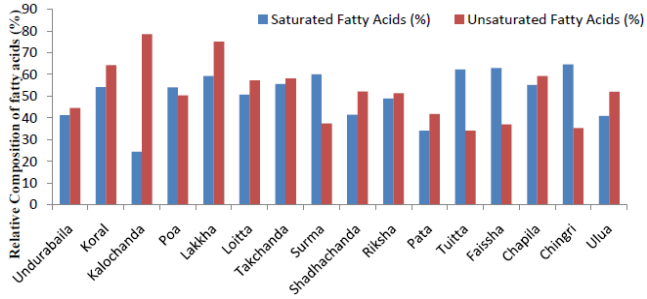

Figure 1: Variation of saturated and unsaturated fatty acids.

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