ORIGINAL RESEARCH ARTICLE

Current Research on Biosciences and Biotechnology **4** (1) 2022 256-261

Current Research on Biosciences and Biotechnology

www.crbb-journal.com

# Lipid content and fatty acid profile of commonly consumed freshwater and marine fish of Bangladesh

Mohammad Shoeb*, Md. Mazharul Islam, Khandoker Tahmina Tasnim, Sunjida Akter, Md. Iqbal Rouf Mamun

Department of Chemistry, University of Dhaka, Dhaka-1000, Bangladesh

ABSTRACT

The objectives of this research were to determine total lipid content and corresponding fatty acid profiles in freshwater (n=10) and marine fish (n=11) samples commonly consumed in Bangladesh. Lipid was extracted by Solid Phase Dispersion method. Saponification and esterification were carried out by the association of official analytical chemists (AOAC) reference procedure with some simple modifications. The fatty acids were analyzed as their methyl ester by gas chromatography equipped with flame ionization detector (GC-FID) by comparing the retention time of 13 standard methyl ester of fatty acids. Total lipid content was 0.97-8.05% and 0.97-4.33% in freshwater and marine fish, respectively. Unsaturated fatty acid in freshwater fish was found in highest amount than saturated fatty acid. Among unsaturated fatty acids, palmitoleic acid was found in highest concentration and ranged from 26.02-46.80%. Palmitic acid was found in highest amount among saturated fatty acids and ranged from 3.96-13.91%. Among the marine fishes unsaturated fatty acids (MUFAs and PUFAs) i.e; palmitoleic acid (28.97-41.61%), oleic acid (2.78-29.63%) and linoleic acid (1.40-14.45%) were predominant. Among the saturated fatty acids myristic acid (0.97-9.08%), palmitic acid (1.61-11.35%) and stearic acid (1.03-21.53%) were found to be predominant.

*Article history:*

Received 31 Jul 2022
Revised 30 Aug 2022
Accepted 31 Aug 2022
Available online 31 Aug 2022

*Keywords:*

Freshwater fish
health benefits
marine fish
fatty acid
solid phase dispersion

*Corresponding authors:
shoeb71@yahoo.com

DOI: 10.5614/crbb.2022.4.1/J1LQ0XTP



## 1. Introduction

Unsaturated fatty acids like ω-3 and ω-6 have been well evaluated for their effective contribution to reduce health risk associated with cardiovascular disease and associated disorders (Apurba et al., 2019; Mori et al., 2004; Jabeen et al., 2011). Alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) are the three main ω-3 fatty acids found mainly in fish/fish oil, flaxseed, soybean, and canola oils. Darren and Bruce found an inverse relation between the dietary consumption of fish containing EPA/DHA and mortality from coronary heart disease in their epidemiological studies (Darren and Bruce et al., 2004). Consumption of marine ω-3 polyunsaturated fatty acids (PUFA) (EPA and DHA) were also found to be associated with a reduced risk of impaired cognitive function in this middle-aged population (45-70 years old) and intake of cholesterol and saturated fat with an increased risk (Kalmijn et al., 2004). Noncommunicable diseases and associated mortality in Bangladesh has significantly increased in the last few decades (Saquib et al., 2012; Karar et al., 2009). According to the WHO data published in 2020, death due to coronary heart disease in Bangladesh has reached 15.16% of total deaths (https://www.worldlifeexpectancy.com/bangladesh-coronary-heart-disease). This trend is increasing day by day as the food intake pattern is not well balanced. It has been recommended that a high-quality fish oil supplement/concentrate and functional foods enriched in EPA/DHA would be of clinical interest for combined lipid-lowering for diverse cardioprotective effects (Darren and Bruce, 2004).

Fatty acid is a long chain aliphatic carboxylic acid in saturated and unsaturated form and exists as three main classes such as triglycerides, phospholipids and cholesteryl esters (Moss et al., 1997). The fatty acid is to be called as a monounsaturated fatty acid (MUFA) if it contains only one double bond and as polyunsaturated fatty acid (PUFA) if it has more than one double bond in the carbon chain (Lunn et al., 2006). ω-6 and ω-3 series are not possible to synthesize in human body but function as a prostaglandin synthesis regulator and hence wound healer, and thus must be supplied by edible food items (Amiramrazer et al., 1998; Roche, 1999). The dietary fat of fish contain fatty acids those have a significant contribution in human health and work as a metabolic and signaling mediator, energy and membrane ingredients (Zhang et al., 2020; Pereira et al., 2000). Fish lipids are simply assimilated and useful to avoid the cardiovascular complexity (Baker et al., 2000). Since the optimal composition of fatty acid in diet is an influential factor the sufficient amounts of dietary fat are crucial for health (FAO and WHO, 1998). Due to the easy availability, cheapness and excellent food values the fish can act as a bridge between the gap of economic advantages and nutritional context for the developing countries like Bangladesh (Waseem, 2007).

Bangladesh is fortunate to have an extensive water resource in the form of ponds, lakes, canals, rivers and the Bay of Bengal situated at the south part of Bangladesh. Therefore, fish are naturally available in the country, cheapest and most frequently consumed as animal-source food (World Bank, 2006). Both the marine and freshwater fishes are available to consume in a cheap and affordable ways as the vital sources of micronutrients, proteins, fat, vitamins and essential fatty acid (Islam et al., 2018; Pervin et al., 2012). But people of Bangladesh prefer freshwater indigenous fishes more than the sea water fishes. Since the optimal composition of fatty acid in diet is an influential factor, current study has been designed to analyze the oil content in individual fish including the profiling of fatty acid such as saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), PUFA, total fatty acid, total UFA, total MUFA and total PUFA in both freshwater and marine fish samples targeted.

## 2. Materials and methods

### 2.1. Sample collection

Ten freshwater and eleven marine fish species were collected locally from different super markets like Agora, Nandan Mega Shop, Meena Bazar, Shwapno etc in Dhaka city (Fig. 1). All these fishes are the most commercially used for local consumption. Collected samples with their local name, English name and scientific name, length, weight and behavior were listed in Table 1. After cleaning and chopping the fish samples, they were required to make homogenous. Fish samples were homogenized and blended using normal kitchen blender (Miyako Chopper, Japan).

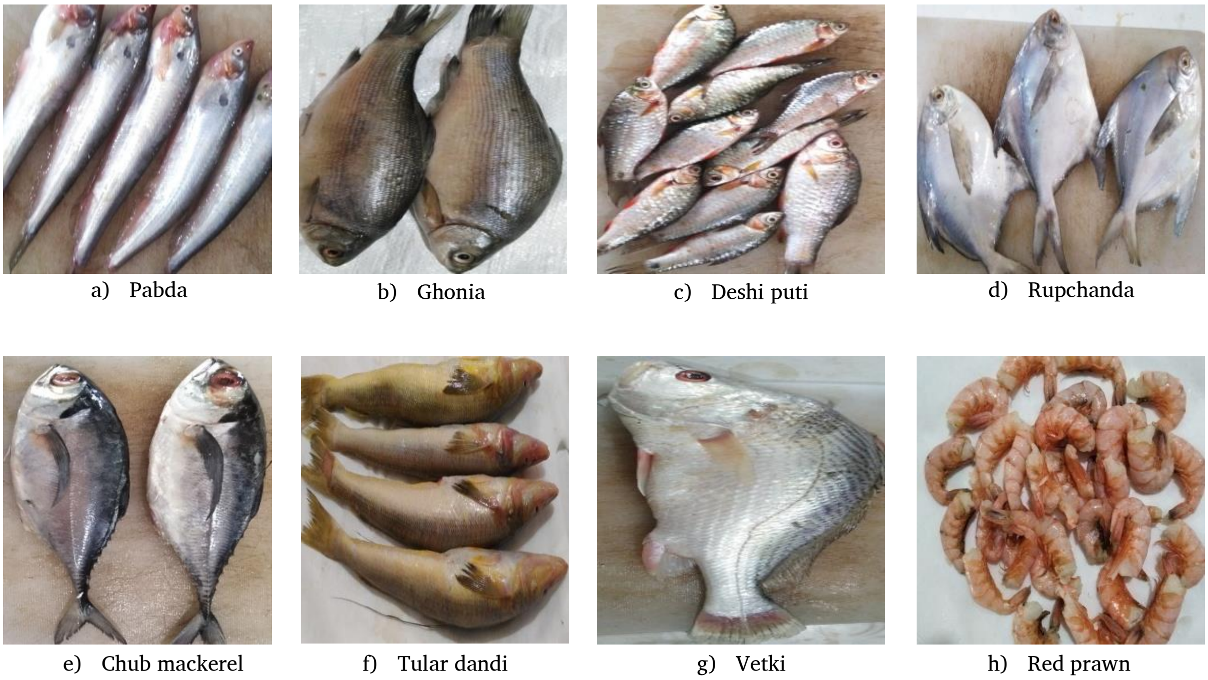


**Fig. 1.** Some collected freshwater (a-d) and marine (e-h) fish samples

**Table 1.** List of sample with narrow range of length (cm), weight (g) and behavior

| Local name | English name | Scientific name | Super shop | Length | Weight | Behaviour |
|---|---|---|---|---|---|---|
| Freshwater fish samples (n=10) | | | | | | |
| Deshi puti | Swamp barb | *Pethia ticto* | Nandan | 10-13 | 202 | Omnivorous |
| Kholla | Corsula | *Rhinomugil corsula* | Nandan | 39 | 664 | Omnivorous |
| Pholy | Bronze featherback | *Notopterus notopterus* | Agora | 27-30 | 509 | Carnivorous |
| Shorputi | Olive barb | *Puntius sarana* | Nandan | 22-23 | 365 | Omnivorous |
| Rupchanda | Chinese pomfret | *Pampus chinensis* | Agora | 19-21 | 370 | Carnivorous |
| Shorputi | Olive barb | *Puntius sarana* | Agora | 21-22 | 340 | Omnivorous |
| Pabda | Indian Catfish | *Ompok bimaculatus* | Nandan | 20-21 | 246 | Omnivorous |
| Baim | Tire track eel | *Macrognathus aculeatus* | Agora | 60 | 434 | Carnivorous |
| Ghonia | Boggut labeo | *Labeo boggut* | Agora | 30 | 812 | Omnivorous |
| Bhagna | Reba carp | *Cirrhina reba* | Agora | 19-22 | 407 | Omnivorous |
| Marine fish samples (n=11) | | | | | | |
| Chub mackerel | Chub Mackerel | *Scomber japonicus* | Shwapno | 28 | 405 | Pelagic |
| Vetki | Barramundi | *Lates calcarifer* | Nandan | 41 | 862 | Carnivorous |
| Beauty queen | Queen croaker | *Seriphus politus* | Meena bazar | 25 | 511 | Pelagic |
| Datina | Yellow sea bream | *Acanthopagrus morrisoni* | Shwapno | 22 | 335 | Demersal |
| Red prawn | Cardinal prawn | *Melicertus kerathurus* | Shwapno | 6 | 119 | Demersal |
| Sardin | Sardine | *Sardinella longiceps* | Meena bazar | 16 | 313 | Pelagic |
| Tular dandi | Gangetic Sillago | *Sillaginopsis panijus* | Meena bazar | 31 | 540 | Demersal |
| Rupchanda | Chinese pomfret | *Pampus chinensis* | Meena bazar | 21 | 328 | Benthopelagic |
| Tuna | Tuna fish | *Katsuwonus pelamis* | Shwapno | 44 | 1021 | Pelagic |
| Chapila | Gizzard Shad | *Gonialosa manmina* | Shwapno | 17 | 213 | Pelagic |
| Chub mackerel | Chub Mackerel | *Scomber japonicus* | Agora | 27 | 382 | Pelagic |

## 2.2. Sample preparation for fatty acid

The samples were brought out from the freeze and let them kept until normal temperature. At first the species were identified and then washed using fresh water. The length-weight data were taken for each fish (Table 1). Then the scales, fins, viscera and gills were removed. Each part of the samples was washed again with water. The fillets of different parts of the samples were ground to paste with the help of a blender. The homogenized fish samples were kept in refrigerator at 2-8$^0$C until lipid extraction was completed within two days of blending (Deepika et al., 2014).

## 2.3. Extraction of fish samples for lipid content

Ten gram of homogenized fish was taken into mortar with 10 g silica sand and 30 g of anhydrous sodium sulphate. The mixture was grinded and more sodium sulphate was added to make the sample float freely. The powder (sample, sand, sodium sulphate) was taken in a 250 mL ground joint conical flask and was extracted by shaking for 3 min successively with 60, 20, 20 mL ethyl acetate. The extracts were combined and then filtered in a round bottom flask using filter paper. The solvent was exchanged from ethyl acetate to n-hexane by evaporation. The extract was evaporated to dryness. Weight of the fat was collected and recorded (Table 2 and Table 4). This extraction procedure is known as solid-phase dispersion (SPD) method.

## 2.4. Saponification and esterification of fish lipid

Approximately 50-100 mg fish lipid extracted from fish sample was taken in a pear-shaped flask and 5.0 mL of 0.5 M methanolic NaOH was added to it. The mixture was ultrasonicated for 1 minute and then refluxed on boiling water at about 96 $^0$C for 30 minutes. The mixture was evaporated with a rotavapor to dryness and 2.0 mL of water was added to it. The pH of the solution was adjusted to 4.5 (just acidic) with 2 M $H_2SO_4$ 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. The hexane part was made free from water by adding anhydrous sodium sulphate ($Na_2SO_4$). The solution was filtered, evaporated to dryness and 2.0 mL of borontrifluoride-methanol ($BF_3$-MeOH) complex was added. The mixture was refluxed on a boiling water bath for 20 minutes and evaporated again to dryness and finally 2.0 mL of n-hexane was added and filtered through pasture pipette containing cotton filter containing sodium sulphate on it. The filtrate was concentrated to 1.0 mL and was analyzed by GC-FID to find out the fatty acid composition of fish lipid (AOAC, 1990; Joseph et al., 1992).

## 2.5. GC-FID analytical conditions

A GC Shimadzu (GC-2025) gas chromatograph having FID detector was used for identification and quantification of fatty acids. Separations were performed on WCOT quartz capillary (DB-5) column (30 m in length and 0.25 mm in diameter). The temperature program in the oven was as followed: 120 $^0$C for 1 min (hold) then increased by 7 $^0$C/min to 280 $^0$C and again hold for 6 min. $N_2$ was used carrier gas with a column flow rate of 2 mL/min. Injection volume 1.0 µL, injection mode splitlees/split (1:80), injector temperature 275 $^0$C, detector temperature 285 $^0$C carrier gas $N_2$, gas for flame $H_2$ and air, column flow 1.78 mL/min. and total program 28 min (Alinafiah et al., 2021).

## 2.6. 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 was done by comparing retention times of the samples with that of the corresponding fatty acid standards in the chromatograms. Sample (1.0 µL) was injected into the injector of GC at the same condition, as methyl ester of fatty acid standard and the retention time of each fatty acid was compared. Quantification was carried out by accounting the areas of individual fatty acids and the results were expressed in terms of the relative percentages. The amount of individual fatty acids present in the fish extracts were calculated by using the following formula:

$$\text{Amount of individual fatty acids (\%)} = \frac{\text{Peak Area of Each Fatty Acids}}{\text{Total Peak Area}} \times 100$$

# 3. Results and discussion

The lipid content was 0.97-8.05% in freshwater fish samples (Table 2) and 0.97-4.33% in marine fish samples (Table 4) on freshweight basis. The mean value of lipid content was 2.96% in freshwater fish samples and 2.08% in marine fish samples. The amount of lipid content in the fish varies species to species depending on the fat cells in the tissues of the body (Benion, 1997; Jacquot, 1961). Biochemically, the principal food values of fish samples such as protein, lipid, carbohydrate, minerals and water were also depended on environment, season, geographical origin, sex and age (Anthony et al., 2016). Depending on the amount of lipid or fat content in fish samples, they are classified as lean fish where fat content was less than 1%, medium fat fish with fat content 1-5% and fatty fish having fat content more than 5% (Greenfield et al., 2003; Abouel-Yazeed, 2013).

**Table 2.** Relative percentage of fatty acid composition (%) in fresh water fish samples

| Type | Fatty acids | Fatty acid compositions (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Deshi puti | Kholla | Pholy | Shorputi (Nandan) | Rupchanda | Shorputi (Agora) | Pabda | Baim | Ghonia | Bhagna |
| Saturated | Myristic | 2.18 | 3.33 | 4.31 | 1.65 | 6.17 | 2.05 | 2.97 | 9.17 | 2.14 | 4.07 |
| | Palmitic | 4.30 | 7.33 | 13.91 | - | 3.96 | - | 6.36 | 11.23 | - | 4.07 |
| | Stearic | 6.19 | - | 4.21 | - | 3.35 | - | - | 3.61 | 12.05 | 4.16 |
| | Arachidic | - | - | - | - | 0.75 | - | 2.59 | - | - | 0.36 |
| | Lauric | - | - | - | - | - | - | - | 0.88 | - | - |
| | Behenic | - | - | - | - | 0.38 | - | - | - | - | - |
| | Capric | - | - | - | - | - | - | - | - | - | - |
| | Caprylic | - | - | - | - | - | - | - | - | - | - |
| Unsaturated | Palmitoleic | 29.33 | 35.13 | 32.42 | 26.79 | 35.49 | 27.52 | 46.80 | 26.02 | 46.15 | 30.50 |
| | Linoleic | - | 3.16 | 6.78 | 11.53 | 10.22 | 17.45 | 19.29 | 6.65 | 9.09 | 4.82 |
| | Oleic | 35.30 | 21.01 | 19.73 | 5.14 | 15.81 | 22.10 | - | 19.29 | 30.56 | 25.59 |
| | Lenolenic | - | 0.57 | - | - | 0.65 | - | 3.30 | - | - | - |
| | Erucic | - | - | - | - | - | - | - | - | - | - |
| Lipid content (%) | | 5.43 | 6.29 | 1.59 | 1.54 | 2.19 | 1.61 | 8.05 | 2.13 | 0.97 | 1.37 |

This data implies that most of the samples were of medium fat fish category. Myristic acid (C14:0) (1.65-9.17%) was predominantly in all the freshwater fish samples analyzed with the highest amount in baim (9.17%) and the lowest amount in shorputi (1.65%) (collected from nandan) fish (Table 2). Palmitic acid (C16:0) (3.96-13.91%) was present in pholy, baim, kholla, pabda, deshiputi, bhagna, rupchanda, and not detectable in the shorputi and ghonia. Similarly, stearic acid (C18:0) was found to be present in highest amount in ghonia (12.05%) and lowest in rupchanda (3.35%). Arachaidic acid (C20:0) (0.36-2.59%) was found in three fishes such as pabda, rupchanda and bhagana only with the minor percent. Lauric acid (C12:0) was found in baim (0.88%) and behenic acid (C22:0) was found in rupchanda (0.38%) with negligible amount. Capric (C10:0) and caprylic (C8:0) acids were absent.

In another study shows that the amount of myristic, palmitic, stearic, arachaidic and behenic acid were 3.5, 33.7, 4.1 and 1.1%, respectively (Mukhopadhyay et al., 2004) in pholy those are almost same to the present study. The value of myristic acid found in shorputi (agora) is a similar (2.37%) to another previous study in Bangladesh (Mustafa et al., 2015). Lauric, palmitic, stearic, arachaidic, behenic, palmitoleic, and linolenic acid composition are comparative to another research in Bangladesh (Khandoker et al., 2020). Among the unsaturated fatty acid, palmitoleic (26.02-46.80%), a MUFA (C16:1 ω-7), was present in pabda (46.80%) as maximum and baim (26.02%) as minimum, Linoleic (3.16-19.29%), a PUFA (C18:2 ω-6), was present in pabda (19.29%) as maximum and minimum in kholla (3.16%) except in deshiputi, oleic acid (5.14-35.30%), a MUFA (C18:1cis, ω-9), is present in deshiputi, ghonia, bhagna, shorputi (agora), kholla, pholy, baim, rupchanda, and shorputi (nandan) except in pabda, lenolenic (0.57-3.30), a PUFA (C18:3 ω-6), is present in only three fish such as pabda (3.30%), rupchanda (0.65%) and kholla (0.57%) and undetectable in the rest and erucic acid, a MUFA (C22:1 ω-9) is undetectable in all the freshwater fish samples.

**Table 3.** Total fatty acid composition (%) in freshwater fish samples

| Fish samples | Total SFA (%) | Total USFA (%) | MUFA | PUFA | PUFA / SFA | USFA / SFA |
|---|---|---|---|---|---|---|
| Deshi Puti | 12.67 | 64.63 | 64.63 | - | - | 5.10 |
| Kholla | 10.66 | 59.87 | 56.14 | 3.73 | 0.35 | 5.62 |
| Pholy | 22.43 | 58.93 | 52.15 | 6.78 | 0.30 | 2.63 |
| Shorputi (Nandan) | 1.65 | 43.46 | 31.93 | 11.53 | 6.99 | 26.34 |
| Rupchada | 14.61 | 62.17 | 51.30 | 10.87 | 0.74 | 4.26 |
| Shorputi (Agora) | 2.05 | 67.07 | 49.62 | 17.45 | 8.51 | 32.72 |
| Pabda | 11.92 | 69.39 | 46.80 | 22.59 | 1.90 | 5.82 |
| Baim | 24.89 | 51.96 | 45.31 | 6.65 | 0.27 | 2.09 |
| Ghonia | 14.19 | 85.80 | 76.71 | 9.09 | 0.64 | 6.05 |
| Bhagna | 12.66 | 60.91 | 56.09 | 4.82 | 0.38 | 4.81 |

In freshwater fish samples, the ranges of total SFAs, USFAs, MUFAs and PUFAs were 1.65-24.89, 43.46-85.80, 31.93-76.71 and 3.73-22.59%, respectively (Table 3). Amount of USFAs were greater than SFAs and among the USFAs, MUFAs is present in greater level than PUFAs in all of the analyzed freshwater fish (Table 3). Baim has the highest amount of SFA and shorputi (nanadan) has the lowest. Ghonia contains highest amount of USFA and shorputi (nanadan) has the lowest amount of it. Among the SFAs, myristic, palmitic and stearic acids were the predominant and palmitoleic, linoleic and oleic were the most abundant USFAs. Again, more insight about the nutritional values of fatty acids was obtained from PUFA/SFA and USFA/SFA which was the indicator of cardiovascular health condition (Islam et al., 2018; Rincon-Cervera et al., 2020). The range of PUFA/SFA and USFA/SFA were 0.27-8.51 and 2.09-32.72, respectively for freshwater fish samples. The increment of total cholesterol level and LDL-cholesterol in serum is involved by the saturated fatty acids (Calder, 2015). Thus, the lower value of PUFA/SFA is the indicator of more cardiovascular problems (Rincon-Cervera et al., 2020). From the point of health benefits, the preferable values of PUFA/SFA for the diet that protect cardiovascular problems were 0.40 or more (Wood et al., 2003; Ospina-E et al., 2012). Among the studied freshwater fish, shorputi (nandan), rupchanda, shorputi (agora), pabda and ghonia transcend the limiting point (0.40) and they were more beneficial for sound health than deshiputi, kholla, pholy, baim and bhagna because they have lower values of PUFA/SFA ratios.

From the Table 4 for marine fish samples, it is seen that among the saturated fatty acids the myristic acid (0.97-9.08%) is present in rupchanda, tular dandy, sardine, chapila, chub mackerel (agora), beauty queen, tuna, chub mackerel (shwapno), vetki, datina and not found in red prawn, palmitic acid (1.61-11.35%) is present in chapila, sardine, beauty queen, tular dandy, chub mackerel (agora), tuna, rupchanda, chub mackerel (shwapno), vetki, datina and absent in red prawn, stearic acid (1.03-21.53%) is present in all analyzed marine fish sample. Arachidic, lauric, behenic, capric and caprylic acids were in undetectable level in all the marine fish samples. Among the unsaturated fatty acid, palmitoleic (28.97-41.61%), a MUFA (C16:1 ω-7), is present in rupchanda, red prawn, tular dandy, sardine, tuna, vetki, beauty queen, chapila, chub mackerel (agora), datina, chub mackerel (shwapno). Linoleic acid (1.40-14.45%), a PUFA (C18:2 ω-6), is present in beauty queen, vetki, tuna, chub mackerel (shwapno), chub mackerel (agora), chapila, rupchanda and below detectable limit in red prawn, tular dandy, sardin and datina, oleic acid (2.78-29.63%), a MUFA (C18:1cis, ω-9), is present in vetki, red prawn, tular dandy, chapila, chub mackerel (agora), sardine, datina, chub mackerel (shwapno), rupchanda, tuna and below detectable limit in beauty queen, lenolenic, a PUFA (C18:3 ω-6), is present in only red prawn in minor amount (0.65%) and below detectable limit in rest of the samples. Erucic acid, a MUFA (C22:1 ω-9) is undetectable in all the marine fish samples.

Another study showed that the myristic (5.24%), stearic (5.31%), arachaidic (0.39%) and behenic (not detectable) acid in chub mackerel (Cho et al., 2014) is almost similar to this study. In vetki, the composition of myristic (2.35%), stearic (11.36%), oleic (16.67%), erucic (0.05%) and linoleic (5.49%) were shown in recent study (Bin et al., 2021) those are comparable to present analysis (Table 4). Myristic (7.0%) and stearic (4.9%) acid in sardine have recently been shown in a study that is almost similar to this research and palmitic and palmitoleic acids are in great difference (Bahurmiz et al., 2017). Recent study showed that tuna fish contained myristic (2.02%), palmitic (21.88%), stearic (11.69%), palmitoleic (2.49%), oleic (10.03%), linoleic (1.38%) and linolenic acid (0.13%) (Mahaliyana et al., 2015) those are comparative results with this study. In marine fish samples, the ranges of total SFAs, USFAs, MUFAs and PUFAs were 1.18-27.45, 41.59-79.88, 35.33-65.49 and 0.65-14.45%, respectively (Table 5). Amount of USFAs were greater than SFAs and among the USFAs, MUFAs was present in greater level than PUFAs in all of the analyzed marine fish (Table 5). Chapila contained largest amount of SFA (27.45%) and Red prawn has the smallest (1.18%).

**Table 4.** Relative percentage of fatty acid composition (%) in marine fish samples

| Type | Fatty acids | Fatty acid compositions (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Chub mackerel Shwapno | Vetki | Beauty queen | Datina | Red prawn | Sardin | Tular dandy | Rup chanda | Tuna | Chapila | Chub mackerel Agora |
| Saturated | Myristic | 4.09 | 1.79 | 5.53 | 0.97 | - | 8.16 | 8.45 | 9.08 | 4.68 | 7.88 | 5.88 |
| | Palmitic | 5.19 | 4.12 | 8.94 | 1.61 | - | 10.34 | 8.70 | 7.05 | 7.24 | 11.35 | 7.74 |
| | Stearic | 2.43 | 6.95 | 3.50 | 21.53 | 1.18 | 2.63 | 2.48 | 1.03 | 3.88 | 8.22 | 5.26 |
| | Arachidic | - | - | - | - | - | - | - | - | - | - | - |
| | Lauric | - | - | - | - | - | - | - | - | - | - | - |
| | Behenic | - | - | - | - | - | - | - | - | - | - | - |
| | Capric | - | - | - | - | - | - | - | - | - | - | - |
| | Caprylic | - | - | - | - | - | - | - | - | - | - | - |
| Unsaturated | Palmitoleic | 28.97 | 35.86 | 35.33 | 31.25 | 41.27 | 38.05 | 39.65 | 41.61 | 36.46 | 34.25 | 31.74 |
| | Linoleic | 12.12 | 14.39 | 14.45 | - | - | - | - | 1.40 | 14.20 | 8.94 | 11.20 |
| | Oleic | 9.89 | 29.63 | - | 10.34 | 15.70 | 10.92 | 12.37 | 8.48 | 2.78 | 12.21 | 12.21 |
| | Lenolenic | - | - | - | - | 0.65 | - | - | - | - | - | - |
| | Erucic | - | - | - | - | - | - | - | - | - | - | - |
| Lipid content (%) | | 3.06 | 1.72 | 1.29 | 0.97 | 1.08 | 1.93 | 1.13 | 4.33 | 2.74 | 2.45 | 2.25 |

**Table 5.** Total fatty acid composition (%) in marine fish samples

| Fish samples | Total SFA (%) | Total USFA (%) | MUFA | PUFA | $\frac{PUFA}{SFA}$ | $\frac{USFA}{SFA}$ |
|---|---|---|---|---|---|---|
| Chub Mackerel Shwapno | 11.71 | 50.98 | 38.86 | 12.12 | 1.04 | 4.35 |
| Vetki | 12.86 | 79.88 | 65.49 | 14.39 | 1.12 | 6.21 |
| Beauty queen | 17.97 | 49.78 | 35.33 | 14.45 | 0.80 | 2.77 |
| Datina | 24.11 | 41.59 | 41.59 | - | - | 1.73 |
| Red prawn | 1.18 | 57.62 | 56.97 | 0.65 | 0.55 | 48.83 |
| Sardin | 21.13 | 48.97 | 48.97 | - | - | 2.32 |
| Tular dandy | 19.63 | 52.02 | 52.02 | - | - | 2.65 |
| Rupchanda | 17.16 | 51.49 | 50.09 | 1.40 | 0.08 | 3.00 |
| Tuna | 15.80 | 53.44 | 39.24 | 14.20 | 0.90 | 3.38 |
| Chapila | 27.45 | 55.40 | 46.46 | 8.94 | 0.33 | 2.02 |
| Chub Mackerel Agora | 18.88 | 55.15 | 43.95 | 11.20 | 0.59 | 2.92 |

Vetki contained highest amount of USFA and Datina has the lowest amount of it. Among the SFAs, myristic, palmitic and stearic acids were the predominant and palmitoleic, linoleic and oleic were the most abundant USFAs. Again, more important information about the nutritional values of fatty acids were obtained from PUFA/SFA and USFA/SFA which are the indicator of cardiovascular health condition (Islam et al., 2018; Rincon-Cervera et al., 2020). The range of PUFA/SFA and USFA/SFA were 0.08-1.12 and 1.73-48.83, respectively for marine fish samples. Among the studied marine fish, chub mackerel (Shwapno), vetki, beauty queen, red prawn, tuna and chub mackerel (agora) transcend the limiting point (0.40) and they are more beneficial for sound health than datina, sardin, tular dandi, rupchanda and chapila because they contain lower values of PUFA/SFA ratios than 0.40. Most of the results of lipid and fatty acid profile for both freshwater and marine fish are consistent with the literature values. Many of the fishes are high sources of beneficiary fatty acids. It is recommended that the target fishes could be consumed by people to meet up the demand of essential unsaturated fatty acid.

## 4. Conclusion

This study provides the original data that will increase the awareness among the consumers in Bangladesh about the nutritional value such as lipid content and fatty acid profile of the analyzed fishes. The results will be utilized for the assessment of risk or health benefits by the consumers as well as the authoritarian body in Bangladesh. The ratio of PUFA/SFA revealed that most of the freshwater and marine fishes analyzed are beneficial to resist the cardiovascular diseases. Beneficiary fatty acids control the cholesterol level in serum. As the USFAs content in both categories of fishes were greater than SFAs, the consumption of those types of fishes is beneficial to the human health. Although, the seasonal as well as the origin-based variation of fatty acid composition in those fishes were not analyzed in this study but this will also be done in near future.

## Acknowledgement

The authors are grateful to International Science Program (ISP), University, Uppsala, Sweden for financial support.

## Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

## References

Abouel-Yazeed AM. 2013. Fatty Acids Profile of Some Marine Water and Freshwater Fish. *J Arab Aqua Soci* 8 (2): 283-292

Alinafiah SM, Azlan A, Ismail A, Mahmud AbRN. 2021. Method Development and Validation for Omega-3 Fatty Acids (DHA and EPA) in Fish Using Gas Chromatography with Flame Ionization Detection (GC-

FID). *Molecules* 26: 6592. doi:10.3390/ molecules26216592

Amiramrazer B, Kmin N, Fiorenza P, Mark O. 1998. Dietary fish lipid inhibits Δ6-desaturase Activity in vivo. *J Amer Lipid Chem Soci* 2(75): 241-245

Anthony O, Richard J, Elakhame L. 2016. Determination of Fatty Acids Content in Five Fish Species (C. latticeps; D. rostratus; S. schall; S. mystus and H. bebe) from River Niger in Edo State. *Int J Curr Microbiol App Sci* 5(3): 289-299. doi: 10.20546/ijcmas.2016.503.035

AOAC. 1990. Official Methods of Analysis. (15th ed.). Arlington, VA: AOAC. Sec. 969.33, Fatty acids in oils and fats, preparation of methyl esters., p. 963–964. Sec. 963.22, Methyl esters of fatty acids in oils and fats, gas chromatographic method., p. 964-965

Apurba RH, Ahmed KH, Shoeb M, Islam M. 2019. Fatty acid compositions in marine fish samples from kuakata sea beach. *J Bangladesh Chem Soc* 31(1): 40-45

Bahurmiz OM, Adzitey F, Ng WK. 2017. Nutrient and fatty acid composition of the flesh of oil sardine (Sardinella longiceps) and Indian mackerel (Rastrelliger kanagurta) from Hadhramout coast of the Arabian Sea, *Int Food Res J* 24(6): 2387-2393

Baker PW, Gibbong GF. 2000. Effect of dietary fish lipid on the sensitivity of hepatic lipid metabolism to regulation by insulin. *J Lipid Res* 41: 716-727

Benion M. 1997. Introductory foods (7 Eds.). MacMollan: New York, USA.

Bin CY, Hong LS, Ibrahim YS, Bachok Z, Anuar ST. 2021. Dynamic fatty acid profiles of asian sea bass (Lates calcarifer) from Setiu Wetlands, East Coast Peninsular Malaysia. Malaysian. *J Anal Sci* 25(1): 53-61

Calder PC. 2015. Functional Roles of Fatty Acids and Their Effects on Human Health. *J Parenter Enter Nutr* 39(1):18S-32S. doi: 10.1177/0148607115595980

Cho S, Kim S, Yoon M, Kim SB. 2014. Physicochemical Profiles of Chub Mackerel Scomber japonicus Bones as a Food Resource. *Fish Aquatic Sci* 17(2): 175-180, doi: 10.5657/FAS.2014.0175

Darren JH, Bruce JH. 2004. Omega-3 fatty acids from fish oils and cardiovascular disease. *Mol Cell Biochem* 263: 217–225

Deepika D, Vegneshwaran VR, Julia P, Cheema S, Sheila T, Heather JMB, Wade M. 2014. Investigation on Oil Extraction Methods and its Influence on Omega-3 Content from Cultured Salmon. *Int J Food Process Technol* 5(12): 401. doi:10.4172/2157- 7110.1000401

FAO and WHO. 1998. General conclusions and recommendations of the consultation. Expert Consultation on Fats and Lipid s in Human Nutrition. Rome: FAO. 3-9

Greenfield H, Southgate DAT. 2003. Food composition data. Production, Managements and Use (Second ed.). Rome: FAO

https://www.worldlifeexpectancy.com/bangladesh-coronary-heart-disease (accessed on February 21st, 2021)

Islam R, Islam MDM, Shoeb M, Nahar N. 2018. Fatty Acid Compositions in Marine Fish Samples of Bangladesh. *Nutr Food Sci* 8(5): 723. doi: 10.4172/2155- 9600.1000723

Jabeen F, Chaudhry AS. 2011. Chemical compositions and fatty acid profiles of three freshwater fish species. *Food Chem* 125: 991–996. doi: 10.1016/j.foodchem.2010.09.103

Jacquot. 1961. Organic constituents of fish and others aquatic animal foods. Ing. Borgstron, fish as food. New York: Academic Press USA, pp. 146-209

Joseph JD, Ackman RG. 1992. Capillary Column Gas Chromatographic Method for Analysis of Encapsulated Fish Oils and Fish Oil Ethyl Esters: Collaborative Study. *J AOAC Int* 75(3): 488–506, doi:10.1093/jaoac/75.3.488

Kalmijn S, van Boxtel, MPJ, Ocké M, Verschuren WMM, Kromhout D, Launer LJ. 2004. Dietary intake of fatty acids and fish in relation to cognitive performance at middle age. *Neurology* 62 (2). doi: 10.1212/01.WNL.0000103860.75218.A5

Karar ZA, Alam N, Streatfield PK. 2009. Epidemiological transition in rural Bangladesh, 1986–2006. Glob Health Action, p. 2:1904

Khandoker TT, Sunjida A, Shoeb M, Waziha F. 2020. Fatty Acid Compositions and Heavy Metals in Marine Fish Samples of Banglades. *Org Chem Plus* 46-51 doi:10.37256/ocp.122020457

Lunn J, Theobald HE. 2006. Briefing paper: The health effects of dietary unsaturated fatty acids. British Nutrition Foundation, London, UK. Nutrition Bulletin 31: 178–224

Mahaliyana AS, Jinadasa BKKK, Liyanage NPP, Jayasinghe GDTM, Jayamanne SC. 2015. Nutritional Composition of Skipjack Tuna (Katsuwonus pelamis) Caught from the Oceanic Waters around Sri Lankae. *Am J Food Nutr* 3(4):106-111. doi: 10.12691/ajfn-3-4-3

Moss GP, Smith PAS, Tavernier D. 1997. IUPAC Compendium of Chemical Terminology. Pure and Applied Chemistry. 67 (2nd ed.). *IUPAC* 1307–1375. doi:10.1351/pac199567081307

Mori TA, Berlin LJ. 2004. Omega fatty acids and inflammation. *Curr Atheroscler Rep* 6: 461- 467

Mukhopadhyay, Kumar T, Nandi S, Ghosh S. 2004. Lipid Profile and Fatty Acid Composition in Eggs of Indian Featherback Fish Pholui (Notopterus notopterus Pallas) in Comparison with Body-Tissue Lipid. *J Oleo Sci* 53: 323-328. doi: 10.5650/JOS.53.323

Mustafa T, Naser MN, Murshed S, Farhana Z, Akter M, Ali L. 2015. Fatty acid composition of three small indigenous fishes of Bangladesh. *Bangladesh J Zool* 43(1):85–93, doi:10.3329/bjz.v43i1.26141

Ospina-E JC, Sierra-C A, Ochoa O, Pérez-Álvarez JA, Fernández-López J. 2012. Substitution of Saturated Fat in Processed Meat Products: A Review. *Crit Rev Food Sci Nutr* 52 (2): 113-122. doi: 10.1080/10408398.2010.493978

Pereira DM, Valentão P, Teixeira N, Andrade PB. 2013. Amino acids, fatty acids and sterols profile of some marine organisms from Portuguese waters. *Food Chem* 141(3):2412–2417

Pervin T, Yeasmin S, Islam R, Kamruzzaman, Rahman A, Sattar A. 2012. Studies on nutritional composition and characterization of lipids of Lates calcarifer(Bhetki). *Bangladesh J Sci Ind Res* 47: 393-400

Rincón-Cervera MA, González-Barriga V, Romero J, Rojas R, López-Arana S. 2020. Quantification and Distribution of Omega-3 Fatty Acids in South Pacific Fish and Shellfish Species. *Foods* 9 (233): 1-16. doi:10.3390/foods9020233

Roche HM. 1999. Unsaturated fatty acids. Proceedings of the Nutri Soci 58: 397–401

Saquib N, Saquib J, Ahmed T, Khanam MA, Cullen MR. 2012. Cardiovascular diseases and type 2 diabetes in Bangladesh: a systematic review and meta-analysis of studies between 1995 and 2010. *BMC Public Health* 12: 434

Waseem MP. 2007. Issues, growth and instability of inland fish production in Sindh (Pakistan) spatial–temporal analysis. *Pak Econ Soc Rev* 45(2): 203–230

World Bank, 2006. Aquaculture: Changing the Face of the Waters: Meeting the Promise and Challenge of Sustainable Aquaculture. World Bank, Washington DC

Wood JD, Richardson RI, Nute GR, Fisher AV, Campo MM, Kasapidou E, Sheard PR, Enser M. 2003. Effects of fatty acids on meat quality: a review. *Meat Sci* 66: 21-32

Zhang X, Ning X, He X, Sun X, Yu X, Cheng Y, Yu RQ, Wu Y. 2020. Fatty acid composition analyses of commercially important fish species from the Pearl River Estuary, China. *PLoS One* 15(1): e0228276. doi: 10.1371/journal.pone.0228276