# FATTY ACID COMPOSITION OF SELECTED FISH SPECIES FARMED IN BIOFLOC SYSTEM

Bioresearch Communications
Volume 10, Issue 2, July 2024

DOI: doi.org/10.3329/brc.v10i2.74585

Sumaiya Mamun[1]*, Mohua Islam Sadia[1], Alamgir Kabir[2], Mohammad Abduz Zaher[1] and Mohammad Ata Ullah[3]

[1]Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh.
[2]Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh.
[3]Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka-1205, Bangladesh.

**ABSTRACT**

Bangladesh is well known for the abundant range of fish. Though fish consumption and variety are very high in Bangladesh, the biodiversity has been alarmingly declining in recent years due to a number of factors including the country's rapid population growth, industrial water pollution, natural disasters, sea intrusion, salinity, overexploitation of fisheries, use of harmful gear, and dewatering of waterbodies. Given that 60% of Bangladesh's rural poor are functionally landless, lack of access to land and water for agricultural production, and rely, in part, on shared resources like fish for their livelihoods and food, the loss of fish biodiversity could pose a special challenge for them. Considering all of this, biofloc technology ensures safe food and higher productivity in high-density fish farming in a limited area by being sustainable and ageless. In order to satisfy the demands, more creative and effective techniques for growing and harvesting fish have been created as the fishing business has developed. Present study analyses the fatty acid profile of two commonly consumed fish species *Oreochromis niloticus* (Tilapia) and *Systomus sarana* (Shorputi). These fishes were farmed in biofloc system. They were fed commercial feeds and organic feed. Later the the fatty acid profile of both groups were measured. The organic feed group showed higher level of PUFA, omega 3 & 6 fatty acid. Through biofloc technology it is possible to produce fish species with high nutritional level using minimum land and water resources. Sustainable food system can be developed through more research in Bangladesh.

**KEYWORDS:** Environment, Biofloc, Fish farming, Nutrition, Fatty acid.

**RECEIVED: 19 March 2024, ACCEPTED: 23 May 2024**

**TYPE: Original Research**

***CORRESPONDING AUTHOR: Dr. Sumaiya Mamun, Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh.**
**Email: sumaiya.mamun@du.ac.bd**

## Introduction

One of the main sources of animal protein for the people in Bangladesh is the freshwater fisheries. Fish muscle, which is a staple food, is the subject of the majority of lipid investigations (Ghosh and Dua 1997, Ackman et al. 2002). According to Kolakowska et al. (2002), the predominant monounsaturated fatty acids (MUFA) in fish lipids are oleic and palmitoleic acids, while palmitic (C16:0) and myristic (C14:0) acids dominate the saturated fatty acids (SFA) in fish lipids, followed by stearic acid. Omega-3 fatty acid sources that are thought to be significant include fish oils (Gbogouri et al. 2006). Additionally, through potentially stabilising the heart's rhythm and lowering blood clotting, omega-3 FAs have a number of significant biological impacts on a variety of cellular activities that may delay the onset of heart illnesses and lower mortality rates among individuals with coronary heart disease. According to several review studies, Omega-3 FAs can help with inflammation as well as diabetes, cancer, and cardiovascular diseases (CVDs) (Ellulu et al., 2015). The low incidence of ischemic heart disease among the Eskimo, coastal Turkish, and Japanese populations was likely attributed to their diets high in fatty fish and marine oils (Kagawa et al., 1982). Hard data from multiple preventive studies showed the value of fish oil for treating patients' heart disease (GISSI-Prevenzione investigators, 1999; Yokoyama et al., 2007; Burr et al., 1989; Nilsen et al., 2001; Bucher et al., 2002; Studer et al., 2005).

Varying fish within the same species may have varying fatty acid compositions due to differences in nutrition, location, gender, and environmental factors (Me et al.,2017). It has been discovered that fish lipid fatty acid content is influenced by water temperature. The percentage of unsaturated fatty acids in neutral and phospholipids rises with decreasing temperature (Farkas, Csengeri, Majoros, & Ola´h, 1980). Many studies have been conducted on the raising environment and how nutrition affects the fatty acid profiles of fish flesh. According to the findings (Wang et al., 2022), the fatty acid composition of fish is similar to that of the diet. Currently, a portion of an HFD is fed to farmed fish in order to speed up growth and increase financial gains. On the other hand, fish on a high-fat diet have a significant build-up of fat in their bodies, which not only compromises the fish's health but also lowers the quality of their meat (Lv et al., 2020). Exercise training and HFD together increased the amount of important flavouring compounds in meat, such as methyl stearate, ethyl ester, and hexadecenoic acid, which improved the meat's scent (Cai et al.,2023).

The objective of this study was to measure the fatty acid profile of the same fish species reared in biofloc setting with two different fish feeds.

## Materials and Methods

### *Sample collection and preparation*

Two fish species *Oreochromis niloticus* (Tilapia) and *Systomus sarana* (Shorputi) were collected from biofloc pond. They were divided into two groups based on their feed type. Tilapia 1 and Shorputi 1 were fed commercial feed whereas, Tilapia 2 and Shorputi 2 were fed organic feed (Zaher et al, 2024). All of the collected composite samples were processed in the laboratory of Institute of Nutrition and Food Science (INFS). After collection from selected places, the composite samples were washed thoroughly with distilled water and the surface water was drained out to remove all extraneous materials. The edible portion for each region was separated and minced. The minced composite samples were collected as thoroughly as possible, and their wet weight was recorded and stored in air tight Ziploc bag in frozen state. Fatty acid was analyzed using AOAC method at Bangladesh Council of Scientific and Industrial Research (BCSIR).

### *Analysis*

AOAC Official Method 991.39 was used to analyze fatty acids. Text segments are weighed into screw-cap glass tubes with Teflon lining and suitable internal standards. Oil fatty acids undergo derivatization to produce methyl esters; ethyl or methyl esters don't need to undergo derivatization. The GC equipment, which comprises a flame ionisation detector, an oxygen scrubber in the carrier gas line, and a fused silica column coated with bonded polyglycol liquid phase, is used to analyse the prepared methyl esters. The procedure calculates the absolute weights (mg/g sample) of DHA (all-cis-4,7,10,13,16, and 19-docosahexaenoic acid, or 22:6-3) and EPA (all-cis-5,8,11,14, and 17-eicosapentaenoic acid, or 20:5n-3). It also calculates the area percentages of 24 fatty acids [24].

## Results

Table 1 shows the saturated fatty acid (%) composition among the two fish species *Oreochromis niloticus* (Tilapia) and *Systomus sarana* (Shorputi) which are fed two different feeds. All fish species were rich in C16:0 (19 -26.33%) and C18:0 (5.00 – 9.00%). Total saturated fatty acids were low in organic feed Tilapia but higher in commercial feed Shorputi.

**Table 1.** Saturated Fatty acid composition of fish species

| Fatty acids (%) | Tilapia 1 | Tilapia 2 | Shorputi 1 | Shorputi 2 |
|---|---|---|---|---|
| **Saturated** | | | | |
| C12:0 | – | – | – | 0.27 |
| C14:0 | 4.45 | 3.51 | 1.47 | 1.56 |
| C15:0 | 0.64 | 0.58 | 0.38 | 0.42 |
| C16:0 | 19.37 | 17.06 | 25.32 | 26.33 |
| C17:0 | 0.75 | 0.76 | 0.55 | 0.6 |
| C18:0 | 5.88 | 5.88 | 8.19 | 9.01 |
| C20:0 | 0.51 | 0.48 | 0.26 | 0.23 |
| C21:0 | 0.56 | 0.64 | 0.51 | 0.58 |
| C24:0 | 1.59 | 2.2 | 1.43 | 1.66 |
| **∑SFA** | **33.75** | **31.11** | **38.11** | **40.66** |

Table 2 depicts the monounsaturated (MUFA) fatty acid (%) composition among fish species. All species showed high percentage of C18:1 n9 MUFA. Total MUFA was higher in organic feed species than the commercial feed species.

**Table 2.** Monounsaturated Fatty acid composition of fish species

| Fatty acids (%) | Tilapia 1 | Tilapia 2 | Shorputi 1 | Shorputi 2 |
|---|---|---|---|---|
| **Monounsaturated** | | | | |
| C14:1 | 0.65 | 0.53 | – | – |
| C15:1 | – | – | – | 0.19 |
| C16:1 | 5.83 | 4.22 | 0.97 | 0.62 |
| C17:1 | 0.44 | 0.34 | 0.24 | 0.2 |
| C18:1 n9 | 15.82 | 12.86 | 42.95 | 37.63 |
| C18:1 n11 | 3.74 | 3.36 | – | – |
| C20:1 | 2.5 | 2.59 | 0.91 | 0.7 |
| C22:1 | – | 0.93 | 0.24 | 0.27 |
| C24:1 | 0.27 | 0.32 | – | – |
| **∑MUFA** | **29.25** | **25.15** | **45.31** | **39.61** |

In table 3, Total Polyunsaturated Fatty Acid (PUFA) (%) composition was higher among all organic feed species. Both ω3 and ω6 fatty acids were higher among organic feed species than the commercial feed one.

**Table 3.** Polyunsaturated Fatty acid (PUFA) composition of fish species

| Fatty acids (%) | Tilapia 1 | Tilapia 2 | Shorputi 1 | Shorputi 2 |
|---|---|---|---|---|
| **Polyunsaturated** | | | | |
| C18:2 ω6 | 6.21 | 6.3 | 5.86 | 6.41 |
| C18:3 ω3 | – | 3.11 | – | 0.87 |
| C20:2 ω6 | 0.71 | 0.74 | 0.4 | 0.4 |
| C20:3 ω6 | 2.05 | 3.25 | 2.43 | 2.95 |
| C20:4 ω6 | – | 0.25 | – | – |
| C20:5 ω3 (EPA) | 8.05 | 9.1 | – | – |
| C20:6 ω3 (DPA) | 3.81 | 3.79 | 0.53 | 0.54 |
| C22:2 ω6 | 0.3 | 0.31 | – | – |
| C22:6 ω3 (DHA) | 6.61 | 8.49 | 2.26 | 2.89 |
| **∑PUFA** | **27.74** | **35.34** | **11.48** | **14.06** |
| **PUFA/SFA** | 0.82 | 1.14 | 0.30 | 0.35 |
| **USFA/SFA** | 1.69 | 1.94 | 1.49 | 1.32 |
| **∑ω3** | 18.47 | 24.49 | 2.79 | 4.3 |
| **∑ω6** | 9.27 | 10.85 | 8.69 | 9.76 |
| **∑ω3/∑ω6** | 1.99 | 2.26 | 0.32 | 0.44 |
| **∑ω6/∑ω3** | 0.50 | 0.44 | 3.11 | 2.27 |
| **DHA/EPA** | 0.82 | 0.93 | – | – |
| **Unidentified** | 9.24 | 8.21 | 5.11 | 5.25 |

## Discussion

Fish feed can affect the fatty acid composition of fish species. Cai et al. (2023) have found a positive effect of diet on the fish muscle texture and fatty acid composition. Numerous research have found the PUFA content between 2-50% which was similar to the current study (Sarowar et al., 2014, Reena et al. 1996, Dhameesh et al.,2012, Marichamy et al.,2009). There are very limited study on biofloc farmed fishes in Bangladesh. Present study shows that organic feed improved the unsaturated fatty acid content of fish. The results of this study showed that n-3 PUFA, and n-6 PUFA levels was raised in organic fish feed. Fatty acid redeployment and SFA's preference for energy provision may be linked to this fishing environment and feed (Cai et al.,2023, Li et al., 2016). Biofloc farming and quality of fish feed also improves growth and nutrient composition of fishes (Zaher et al., 2024).

The distinctive variations in the saturated, monounsaturated, and polyunsaturated fatty acid contents of fish lipids in various regions may be explained by seasonal variations, environmental effects on tropical fish species, as well as adjustments to the post-spawning period (Colin et al., 1993; Gamez-Meza et al., 1999). Palmitic, Stearic and Oleic acid were higher in the selected fish species which is similar to other studies (Begum et al., 2019). According to the study, selected fish have comparatively high EPA and DHA contents (Swapna et al.,2010). Similar to Memon et al. (2011) the current study demonstrates the high level of long chain PUFA and nutritional value of farm fish species. The two main PUFA identified in the species under analysis were eicopentanoic acid and docosahexanoic acid. Findings have indicated that fish species that consume the same diet varied significantly in their muscle fatty acid.

The overall PUFA content varied from 11.48% (shorputi) to 35.34% (Tilapia) among fish species which agrees with other researches (Hossein et al., 2024). Paul et al. (2023) has found that Biofloc-cultured fish also had high concentrations of saturated fatty acids (like palmitic and stearic acid) and n − 3 and n − 6 fatty acids. Nonetheless, the level of docosahexaenoic acid found in fish raised in BFT was much higher than that of fish raised in Ridha et al. [86] and Sontakke et al. [82], which showed 6.43–8.01%. The biofloc composition may be associated with increased levels of α-linolenic acid, arachidonic acid, and docosahexaenoic acid compared to the fish in TS tanks. The present study also showed similar results. Additionally, this study has concluded that the biofloc treatment increased the amount of n − 3 and n − 6 polyunsaturated fats in flesh, changing the fatty acid composition of the flesh.

## Conclusion

Biofloc fish farming can is a sustainable procedure to cultivate nutritious fishes. Organic fish feed tends to improve the fatty acid composition of the fish species. The proper way of farming and feeding can positively improve the ω-6 fatty acid in different fish species which is beneficial for human health. The primary obstacles to this study are sampling species collection, time constraints, and financial constraints because most species in biofloc Tilapia (Oreochromis niloticus) and Shorputi (Systomus sarana) are cultivated in this manner. There is much need for future research in that area, including expanding the number of sample species and examining the nutrient content of biofloc fish in a different setting. In the context of Bangladesh where the land for fish farming is decreasing biofloc technology can be a great solution for producing fish species with high nutrient content.

## Acknowledgement

The authors are grateful to the Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh for providing analytical, technical, and other logistic support for conducting this research work. The authors are also grateful to the Centennial Research Grant of Dhaka University for partial funding of this project.

## Conflict of interest

The authors had no conflict of interest regarding the work in this paper.

## References

1. Ghosh M, Dua RD (1997) Principal fatty acids of lipid classes from fresh water fish (Callichrous pabada). J Food Lipids 4:129–135
2. Ackman RG, McLeod C, Rakshit S, Misra KK (2002) Lipids and fatty acids of five fresh water food fishes of India. J Food Lipids 9:127–145
3. Kolakowska A, Oleey J, Dunstan GA (2002) Fish Lipids. In: Chemical and functional properties of food lipids, ZE Sikorski, A Kolalowska (eds), CRC Press, Boston, USA, p 221–264
4. Gbogouri GA, Linder M, Fanni J, Parmentier M (2006) Analysis of lipids extracted from salmon (Salmo salar) heads by commercial proteolytic enzymes. Eur J Lipid Sci Technol 108:766–775
5. Ellulu, M. S., Khaza'ai, H., Abed, Y., Rahmat, A., Ismail, P., & Ranneh, Y. (2015). Role of fish oil in human health and possible mechanism to reduce the inflammation. *Inflammopharmacology*, *23*, 79-89.
6. KAGAWA, Y., NISHIZAWA, M., SUZUKI, M., MIYATAKE, T., HAMAOTO, T., GOTO, K., ... & EBIHARA, A. (1982). Eicosapolyenoic acids of serum lipids of Japanese islanders with low incidence of cardiovascular diseases. *Journal of nutritional science and vitaminology*, *28*(4), 441-453.
7. Bucher, H. C., Hengstler, P., Schindler, C., & Meier, G. (2002). N-3 polyunsaturated fatty acids in coronary heart disease: a meta-analysis of randomized controlled trials. *The American journal of medicine*, *112*(4), 298-304.
8. Burr, M. L., Gilbert, J. F., Holliday, R. A., Elwood, P. C., Fehily, A. M., Rogers, S., ... & Deadman, N. M. (1989). Effects of changes in fat, fish, and fibre intakes on death and myocardial reinfarction: diet and reinfarction trial (DART). *The Lancet*, *334*(8666), 757-761.
9. Marchioli, R., Barzi, F., Bomba, E., Chieffo, C., Di Gregorio, D., Di Mascio, R., ... & Valagussa, F. (2002). Early protection against sudden death by n-3 polyunsaturated fatty acids after myocardial infarction: time-course analysis of the results of the Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico (GISSI)-Prevenzione. *Circulation*, *105*(16), 1897-1903.
10. Nilsen, D. W., Albrektsen, G., Landmark, K., Moen, S., Aarsland, T., & Woie, L. (2001). Effects of a high-dose concentrate of n− 3 fatty acids or corn oil introduced early after an acute myocardial infarction on serum triacylglycerol and HDL cholesterol. *The American journal of clinical nutrition*, *74*(1), 50-56.
11. Studer, M., Briel, M., Leimenstoll, B., Glass, T. R., & Bucher, H. C. (2005). Effect of different antilipidemic agents and diets on mortality: a systematic review. *Archives of internal medicine*, *165*(7), 725-730.
12. Yokoyama, M., Origasa, H., Matsuzaki, M., Matsuzawa, Y., Saito, Y., Ishikawa, Y., ... & Shirato, K. (2007). Effects of eicosapentaenoic acid on major coronary events in hypercholesterolaemic patients (JELIS): a randomised open-label, blinded endpoint analysis. *The lancet*, *369*(9567), 1090-1098.
13. Wang, J. G., Rahimnejad, S., Liu, Y. C., Ren, J., Qiao, F., Zhang, M. L., ... & Luo, Y. (2022). Dietary L-carnitine supplementation affects flesh quality through modifying the nutritional value and myofibers morphological characteristics in largemouth bass (Micropterus salmoides). *Animal Feed Science and Technology*, *292*, 115432.
14. Cai, W., Liu, H., He, L., Fu, L., Han, D., Zhu, X., Jin, J., Yang, Y., & Xie, S. (2023). Exercise training combined with a high-fat diet improves the flesh flavour, texture and nutrition of gibel carp (*Carassius auratus gibelio*). *Food chemistry: X*, *17*, 100612. https://doi.org/10.1016/j.fochx.2023.100612
15. Reena PS, Nair PGV, Devadasan K, Gopakumar K. Proc APFIC working party on fish technology and marketing. Jan

4–6. Colombo, Srilanka. Rome: Food and Agriculture organization of the United Nations 1996.
16. Dhaneesh KV, Noushad KM, Kumar TTA. Nutritional Evaluation of Commercially Important Fish Species of Lakshadweep. Archipelago 2012; 7 (9)
17. Marichamy G, Raja P, Veerasingam S, Rajagopal S, Venkatachalapathy R. Fatty Acids Composition of Indian Mackerel Rastrilligerkanagurta under Different Cooking Methods. Curr Res J BiolSci 2009; 1(3): 109–112.
18. Apu, N. A. (2014). Farmed fish value chain development in Bangladesh: Situation analysis and trends. *WorldFish/ILRI Project Report*.
19. Sarower, M. G., Ray, S., Hasan, M. A., Ferdous, S., & Iqbal, M. (2014). Antioxidant Potential and Nutrient Content in Selected Fish Species of Different Feeding Habits in Bangladesh. *American Journal of PharmTech Research*, *4*(4), 2249-3387.
20. Li, X. M., Yuan, J. M., Fu, S. J., & Zhang, Y. G. (2016). The effect of sustained swimming exercise on the growth performance, muscle cellularity and flesh quality of juvenile qingbo (Spinibarbus sinensis). Aquaculture, 465, 287–295. https://doi.org/10.1016/j. aquaculture.2016.09.021
21. Zaher, M. A., Islam, M. S., Mamun, S., & Paul, T. (2024). EFFECT OF MICRONUTRIENT COMPOSITION OF FISH FEED TO THE GROWTH AND NUTRIENT CONTENT OF FISHES: COST-EFFICIENT PRODUCTION OF NUTRITIOUS FISHES. *Bioresearch Communications-(BRC)*, *10*(01), 1453-1461.
22. Colin, F.M., S.M. Alister, H. Roy and S.A. Robert. 1993. The production of fish oils enriched in polyunsaturated fatty acid-containing triglycerides. J. Am. Oil Chem. Soc. 70(2): 133–138.
23. Gamez-Meza, N., L. Higuera-Ciapara, A.M. Calderon, L. Vazquez-Moreno, J. Noriega-Rodriguez and O.Angulo-Guerrero. 1999. Seasonal variation in the fatty acid composition and quality of sardine oil from Sardinops sagax caeruleus of the Gulf of California. Lipids 34: 639–642.
24. [AOAC] Assn. of Official Analytical Chemists. (2005). Fatty acids in encapsulated fish oils and fish oil methyl and ethyl esters. *Official methods of analysis*, 27-8.
25. Swapna, H. C., Rai, A. K., Bhaskar, N., & Sachindra, N. M. (2010). Lipid classes and fatty acid profile of selected Indian fresh water fishes. *Journal of Food Science and Technology*, *47*, 394-400.
26. Memon, N. N., Talpur, F. N., Bhanger, M. I., & Balouch, A. (2011). Changes in fatty acid composition in muscle of three farmed carp fish species (Labeo rohita, Cirrhinus mrigala, Catla catla) raised under the same conditions. *Food Chemistry*, *126*(2), 405-410.
27. Hossain, M. Belal, Rafikul Islam, Md Kamal Hossain, Afroza Parvin, Badhan Saha, As-Ad Ujjaman Nur, Md Monirul Islam, Bilal Ahamad Paray, and Takaomi Arai. "Minerals and fatty acid profile of small indigenous fish species from homestead ponds within a Sub-tropical coastal region." *Heliyon* 10, no. 2 (2024).
28. Paul, P., Islam, M. S., & Hasanuzzaman, A. F. M. (2023). Water Quality, Nutritional, Hematological, and Growth Profiles of Ompok pabda Fish Fry Reared in Biofloc Technology and Traditional Culture System with Different Stocking Densities. *Animals*, *14*(1), 90.