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Original Article

# FATTY ACID PROFILE AND MONTHLY VARIATION OF TOTAL FATTY ACID AND LIPID OBTAINED FROM THE OIL OF STRIPED SNAKEHEAD *CHANNA STRIATA*

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**ABSTRACT**

**Objective:** This project was taken up for a period of two years to assess the nutritional capacity of *Channa striata*, which is consumed as a cheap, nutritious food in most parts of India and East Asian countries by determining its fatty acid profile and monthly variation of lipid and fatty acid in its most edible part.

**Methods:** Total lipid was extracted by conventional methods laid down by Folch and his associates and was then saponified to obtain the total fatty acid. The fatty acid mixture thus obtained was then converted to their methyl esters and was subjected to Gas Chromatograph using a flame ionization detector to detect the individual fatty acids.

**Results:** Our investigation shows that the total lipid and fatty acid in the edible part dip to its minimum in the month of July, as one should expect during the breeding season because the stored lipid, as well as fatty acids, are mobilized to the gonads for their development during the reproductive season which is monsoon. *C. striata* contain more of MUFAs (64.34%) and PUFAs (16.21%), which are more beneficial to human health than SFAs (12.5%), which are most hazardous to health.

**Conclusion:** *C. striata* can definitely be marked as a cheap, nutritious food source, with its share of negativity. Our work will surely enlighten future works on this species in the spheres of preservation, organized farming, and maintaining the biodiversity of the place where it thrives.

**Keywords:** *Channa striata*, Fatty acid profile, Monthly variation, EPA, DHA, Palmitoleic acid, Erucic acid


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## INTRODUCTION

As fatty acids possess numerous health benefits [1-9] they are recognized as essential nutrients in both human and animal diets. Fatty acids are also used in the pharmaceutical industry. It is now a well-established fact that saturated fatty acids can cause cardiovascular diseases, whereas unsaturated fatty acids have cardio-protective properties and promote cellular function. Since essential fatty acids have anti-inflammatory properties, they are effectively used in the nutritional treatment of asthma, arthritis, allergies, and many skin disorders. Diabetes, menopausal problems, memory and learning disabilities, depression, eye, and digestive disorders can be improved by dietary supplementation of essential fatty acids. Even cases of immune system disorders like multiple sclerosis, cancer, and lupus have been reported to be lowered by essential fatty acids [10-14].

Fishes are known to be rich sources of polyunsaturated fatty acids (PUFA). ω-3 and ω-6 PUFA's are known to be beneficial to human health [15, 16]. Due to the multi-dimensional nutritional benefits of unsaturated fatty acids, its consumption as a dietary supplement has gained popularity. Fish is the most important natural source of fatty acids; thus the study of the fatty acid profile of fishes has gained importance.

We have chosen to study the most consumed part i.e. the muscle tissues of wild *Channa striata,* also known as striped snakehead fish (locally shoul) belonging to the Channidae family. This fish is a freshwater, air-breathing predator, consumed as a valuable protein source. Studies on this fish have also revealed it's pain-relieving and wound healing properties [17-22].

Though the fatty acid composition of various Channa sp. fish has been studied in various Asian countries [23-27], very little is known about such composition of this fish species found in the Indian peninsular region [28]. So we have taken up the task of studying the fatty acid profile and also the monthly variation of lipid and fatty acid content in the muscle tissues of *Channa striata* found in West Bengal, India to determine its nutritional capacity. Such extensive studies are very much required for preservation, systemic farming, and maintaining the biodiversity of a region.

## MATERIALS AND METHODS

The study was carried out from March 2017 to March 2019. Three wild live fish samples were collected from the local market of Chinsurah, Hooghly, West Bengal, India in the first week of every month. Maintaining this strict time frame every month, they were brought to the laboratory and stored at-30 °C [29] in a freezer after killing them by hitting on their heads. The average weight of the fishes was about (825±86.60) Gms.

Their proximate compositions were analyzed according to the method of AOAC [30]. The muscle and tissues, which are the edible portions, were separated from the head, skin, and viscera. The body muscles were cut into small pieces after removal of the bones and blended in a sterilized blender for 30 seconds. For extraction and purification of the total lipids, the method prescribed by *Folch et al.* [31] was followed using 5 Gms of the minced pieces in chloroform: methanol mixture. The total lipids thus obtained were then saponified and collected. Acidification of this saponified portion was then done by adding 6(N) hydrochloric acid till pH 1 was reached. The total fatty acids obtained were dried and weighed in a 0.0001 gm sensitive balance. The total fatty acid percentage was found by means of the total lipid. The result obtained is shown in table 1. Using the $BF_3$-MeOH mixture the methyl esters of the extracted fatty acids were prepared and were recovered in heptanes. The Fatty Acid Methyl Esters (FAME) thus obtained were purified and analyzed by Gas Chromatograph, Shimadzu Gas Chromatograph (Model: GC-2010, Shimadzu, Japan), with a Flame ionization detector (FID) on a split injector.

For FAME analysis an SP-2560 capillary column (100 m long x 0.25 mm i. d) was used. As a carrier gas, oxygen-free nitrogen was used at a flow rate of 33.9 ml/minute. The oven temperature was gradually raised to 240 °C at a rate of 4 °C/min. with intervals of 5 min from 140 °C. Finally, the temperature was held at 240 °C for 20 min.

Finally, the injector and detector temperature were fixed at 260 °C. The volume injected 1 µl with a split ratio of 1:30. Comparing the retention time of the peaks obtained with that of standard fatty acid methyl esters helped in the identification of the fatty acids. The percentage compositions of individual fatty acids were computed from the GC peak areas. Table 2 depicts the result thus arrived at.

## RESULTS AND DISCUSSION

The two most important biological properties associated with the total life span of a fish are 'Reproduction and nutritional physiology' [32-35]. Thus according to its need, a fish stores the lipids and fatty acids in its various organs and tissues and utilize accordingly. This storage of lipids and fatty acids in various organs and tissues is highly dependable on seasons and varying water temperatures [36-41]. The lipid stored in various organs and tissues of a fish needs to be mobilized to the gonads for their development during its reproduction season [42], which results in the lowering of the lipid/fatty acid concentration in those organs/muscle tissues.

In India, the peak spawning time of *C. striata* coincides with peak monsoon in the subcontinent [43]. The data enumerated in table 1 shows the same tendency of gradual depletion in both total lipid and total fatty acid content in the edible portion of *C. striata* during the months from April to August, being the least in the month of July. As the peak spawning season comes to an end, i.e. with the advent of the nutritional season, which starts late August, the total lipid and total fatty acid content in the muscle tissues of striped snakehead starts increasing due to the process of storing energy for future use i.e. during the scarcity of food or the reproduction process.

**Table 1: The monthly variation of total lipid and total fatty acid in muscle tissue of *Channa striata* (Shoul)**

| Month | Total lipid % | | Total fatty acid % | | Approximate total fatty acid % with respect to total lipid % | |
|---|---|---|---|---|---|---|
| **Session** | **17-18** | **18-19** | **17-18** | **18-19** | **17-18** | **18-19** |
| March | 6.38±0.02 | 6.39±0.03 | 5.02±0.04 | 5.05±0.03 | 78.62±0.69 | 79.03±0.16 |
| April | 5.32±0.04 | 5.21±0.09 | 4.18±0.05 | 4.07±0.04 | 78.63±0.71 | 78.19±1.64 |
| May | 2.36±0.02 | 2.38±0.02 | 1.81±0.04 | 1.79±0.04 | 76.59±1.85 | 75.35±1.40 |
| June | 2.04±0.05 | 2.15±0.05 | 1.57±0.01 | 1.70±0.04 | 76.95±1.40 | 79.08±3.16 |
| July | 1.85±0.02 | 1.95±0.07 | 1.52±0.02 | 1.57±0.04 | 81.99±1.23 | 80.25±2.66 |
| August | 2.15±0.05 | 2.18±0.04 | 1.61±0.05 | 1.65±0.03 | 74.93±1.48 | 75.58±0.94 |
| September | 3.13±0.17 | 3.24±0.13 | 2.13±0.03 | 2.21±0.02 | 68.06±3.24 | 68.24±2.47 |
| October | 3.77±0.08 | 3.92±0.12 | 2.62±0.05 | 2.61±0.10 | 69.53±2.62 | 66.64±4.56 |
| November | 4.06±0.05 | 4.12±0.05 | 2.87±0.01 | 2.87±0.04 | 70.61±0.54 | 69.53±1.66 |
| December | 5.20±0.02 | 5.28±0.04 | 3.82±0.03 | 3.80±0.03 | 73.40±0.21 | 71.97±0.55 |
| January | 5.41±0.03 | 5.39±0.03 | 4.24±0.02 | 4.29±0.02 | 78.31±0.55 | 79.58±0.09 |
| February | 5.80±0.07 | 5.79±0.05 | 4.44±0.04 | 4.48±0.05 | 76.55±1.28 | 77.42±0.58 |

mean±SD, n= 3, It is evident from table 2 that Shoul contains more MUFA's (64.34%) and PUFA (ω-3 = 16.21% and ω-6 = 1.9%) compared to saturated fatty acids (SFA = 12.5%). The only SFA present in a considerable amount is Heptadecanoic acid (6.57%). The MUFA's that are present in considerable amount is Myristoleic acid (2.36%), Palmitoleic acid (33.96%), cis-10-Heptadecanoic acid (12.88%), Elaidic acid (11.8%). Among the ω-6, PUFAs Linolelaidic acid (14.6%) is present in the highest amount. Besides this linoleic acid, *cis*-8,11,14-Eicosatrienoic acid and Arachidonic acid are also present. The ω-3 PUFAs present in the fish is Linoleic acid, EPA, and DHA.

**Table 2: Fatty acid profile in the muscle tissues of *Channa striata* (Shoul)**

| Fame | *Channa striata* |
|---|---|
| Caprylic acid (C8:0) | 0.96±0.0322 |
| Capric acid (C10:0) | 0.16±0.0209 |
| Undecanoic acid (C11:0) | 0.19±0.0275 |
| Lauric acid (C12:0) | 0.12±0.0219 |
| Tridecanoic acid (C13:0) | 0.38±0.0189 |
| Myristic acid (C14:0) | 0.12±0.0316 |
| Pentadecanoic acid (C15:0) | 1.07±0.0485 |
| Palmitic acid (C16:0) | 0.15±0.0109 |
| Heptadecanoic acid (C17:0) | 6.57±0.0433 |
| Stearic acid (C18:0) | 1.13±0.02 |
| Arachidic acid (C20:0) | 0.76±0.0141 |
| Heneicosanoic acid (C21:0) | 0.78±0.0167 |
| Behenic acid (C22:0) | 0.11±0.0141 |
| Σ SFA | 12.5±0.0948 |
| Myristoleic acid (C14:1) | 2.36±0.0209 |
| *Cis*-10-Pentadecenoic acid (C15:1) | 1.07±0.0141 |
| Palmitoleic acid (C16:1) | 33.96±0.0189 |
| *Cis*-10-Heptadecenoic acid (C17:1) | 12.88±0.0641 |
| Elaidic acid (18:1) | 11.8±0.0289 |
| *Cis*-11-Eicosenoic acid (C20:1) | 1.71±0.0244 |
| Erucic acid (C22:1) | 0.56±0.0228 |
| Σ MUFA | 64.34±0.0839 |
| Linolelaidic acid (C18:2) | 14.46±0.0303 |
| Linoleic acid (C18:2 n6) | 0.15±0.0189 |
| *Cis*-8,11,14-Eicosatrienoic acid (C20:3 n6) | 0.3±0.0252 |
| Arachidonic acid (C20:4 n6) | 1.3±0.0282 |
| Σ ω-6 PUFA | 16.21±0.0666 |
| Linolenic acid (C18:3 n3) | 0.31±0.0363 |
| *Cis*-5-8-11-14-17-Eicosapentaenoic acid (C20:5 n3) | 1.19±0.0328 |
| *Cis*-4-7-10-13-16-19-Docosahexaenoic acid (C22:6 n3) | 0.4±0.0303 |
| Σ ω-3 PUFA | 1.9±0.0346 |
| ω-6/ω-3 | 8.53±0.15 |

mean±SD, n= 3

Myristoleic acid, which is present in shoul, is known to induce apoptosis and necrosis in human prostatic LNCaP cells [44]. Palmitoleic acid, which is a major fatty acid present in the fish (33.96%) is another beneficial fatty acid. It is known to inhibit the destruction of pancreatic beta cells, which secrete insulin. It also increases insulin sensitivity by suppressing inflammation [45]. Elaidic acid, a *trans* monounsaturated fatty acid, has a negative impact on heart health [46] is also present in this fish. The presence of *Cis*-10-Heptadecenoic acid (C17:1), a minor constituent of ruminant fat in the muscle of shoul is unique, which has antioxidant properties [47].

Fish oils containing omega-3-Fatty acids *Cis*-5-8-11-14-17-Eicosapentaenoic acid (EPA) and *Cis*-4-7-10-13-16-19-Docosahexaenoic acid (DHA) helps in prevention and show a positive effect in the therapy of cardiovascular diseases. The presence of these fatty acids in the fish is definitely good news as these omega-3 fatty acids also help in reducing the cholesterol level and stops blood platelets from clinging to one another [48].

The presence of both EPA and DHA thus makes the striped snakehead fish a potentially nutritious fish. The ω-6: ω-3 ratio of unsaturated fatty acids in the fish obtained in our study is around 8.53. According to nutritional recommendations, a balanced ω-6/ω-3 ratio is of utmost importance for maintaining good health. According to many researchers, an ideal ratio may be between a values of 1:1 to 4:1 [49]. The presence of Arachidonic acid, present in the fish, is known to play a positive role in the overall development and normal growth of infants [50].

However, a word of caution also must be given that overconsumption of this fish may pose some health hazards. Elaidic acid, which is present in the fish in a considerable amount (11.8%), is reported to increase plasma cholesteryl ester transfer protein activity, which in turn raises VLDL and lowers HDL cholesterol [51]. Again, Erucic acid is an anti-nutritional factor present in the fish. It is known to induce an increased incidence of myocardial lipidosis in animals [52], though it is present in the fish in a very small amount (0.56%) only.

## CONCLUSION

The results obtained from the study should bring about consciousness in preserving this edible fish species not only for its nutritional value but also for maintaining a proper food chain in aquatic zones where they thrive. As we know, the concentration of both the lipid and fatty acid content in a fish depends on its habitat and feeding habit, which in turn depends on the food sources present in the reservoir where the fish completes its entire life cycle, our findings will definitely give an insight on the type of environment as well as fish feed required for properly maintaining and farming of such fish species (*C. striata*) and thereby increase its nutritive value. This in the long run, will help in supporting our masses with a cheap as well as a nutritious diet. We thus strongly believe that the information laid down here will definitely benefit future ventures in this area.

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## AUTHORS CONTRIBUTIONS

Both the authors have equal contribution to the project.

## CONFLICT OF INTERESTS

Both MD and PD declare 'no conflict' of interest.

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