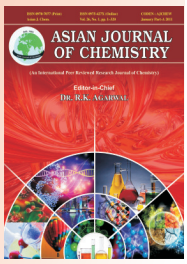
Asian Journal of Chemistry; Vol. 26, No. 10 (2014), 2974-2976

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2014.16202



Comparative Study of Fatty Acid Profile in Muscle of Three Major Carp Species (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*)

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Received: 17 August 2013; *Accepted*: 27 November 2013; *Published online*: 10 May 2014; AJC-15161

Fatty acid profiles of three major carps *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* found and consumed in West Bengal, India were investigated and compared to draw a conclusion on how rich they are in their fatty acid composition in their most consumed part *i.e.* their muscle tissues. After analysis we have found that all the three carps investigated are rich in poly unsaturated fatty acid and the major poly unsaturated fatty acids are docosahexaenoic acid, eicosapentaenoic acid and arachidonic acid. The major saturated fatty acids detected in all the three carps are palmitic acid (C16:0) and stearic acid (C18:0). Oleic acid (C18:1 n-9) is the major mono unsaturated fatty acid present in these carps. Erucic acid (C22:1 n-9), which is reported to be an antinutritional factor is present in very low concentration. Thus one can conclude that these three fish species if farmed meticulously *i.e.* given the proper growing conditions, can be nutritious and low cost healthy diet for the population of Bengal.

Keywords: Carps, Fatty acid profile, Poly unsaturated fatty acid, Mono unsaturated fatty acid, Saturated fatty acid, Erucic acid.

INTRODUCTION

Now-a-days the names like poly unsaturated fatty acid, DHA, EPA, Ω-3-fatty acids are so much and so frequently used that a scientific mind is bound to get attracted to it. Systematic studies have revealed that these names are directly linked to human health and nutrition[1-7]. Furthermore, DHA, EPA also has disease curative properties[8-11]. Polyunsaturated fatty acids are something that a body cannot make and needs to obtain it from daily diet. The best possible source of such polyunsaturated fatty acid is fish, be it of salt water or fresh water. An article in circulation[12] reported that eating oily fish at least twice a week may help prevent sudden death from heart attack, as fatty acids in the fish block dangerous heart rhythms. Studies of individual heart cells showed that the fatty acids blocked excessive sodium and calcium currents in the heart, which could otherwise cause dangerous unpredictable changes in its rhythm. French researchers concluded that, people who eat fish at least once a week had a far lower risk of being diagnosed with dementia[13]. Harvard medical school and Brigham Women's Hospital in the USA found that a diet rich in oily fish raised the bodies' production of an antiinflammatory fat, thus possibly reducing the effects of arthritis[14]. Edinburgh and Stirling Universities in connection with Edinburgh Royal Hospital for sick children, suggested that oily fish could help deal with the effects of childhood autism. Such is the utility of the consumption of unsaturated fatty acids and the best and source of such acids is fish oil. So, tremendous work is going on throughout the world to detect and preserve fish species (both salt and fresh water) rich in such unsaturated fatty acids[15-18].

India and specially West Bengal is well known for her huge resources of fresh water fishes apart from those obtained from salt water. In India this huge fish resource have not been properly utilized for human and animal consumption till now, although attempts have been undertaken in this field in different laboratories. With the increase in population, food for all and that too nutritious and low cost is becoming a major concern for developing countries (like India). Thus farmed fish is gradually becoming the main contributor to India's nutrition supplement. So it is gradually becoming important to keep a vigil on the type of fishes farmed, their feed and their growing conditions. Keeping this in mind, herein we wish to report our study on the fatty acid content of three major and popular carps namely *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* found and farmed in the state of West Bengal, India. Here, this farming is carried out in either of the two ways. First way is methodical, maintaining a rigid vigil on the fish feed, growing condition *etc*. and the second method is simple where the spawns are just released in reservoirs or ponds and allowed

to grow as if in the wild. We have chosen to study the second case, where the spawns are allowed to grow without any monitoring, to draw a conclusion on how rich they are in their fatty acid composition in their most consumed part *i.e*. their muscle tissues. This study on the long run will help proper farming of these major carps *i.e*. by giving them proper growing conditions, proper feed *etc*. so that these fishes can be nutritious and healthy diet for the population of Bengal.

EXPERIMENTAL

Six catla (*Catla catla*), six rohu (*Labeo rohita*) and six mrigala (*Cirrhinus mrigala*) were caught from three different ponds where they were raised in Punduah, West Bengal, India in May 2012. The average weight for these fish species were catla (1150 ± 11.25 g) rohu (1100 ± 12.20 g) and mrigala (1200 ± 12.30) g. Fishes were killed by hitting on the heads and brought to the laboratory. Samples were stored at -30 °C in a freezer until they were used[19]. After measuring the total length and weight of the fishes their proximate compositions were analyzed[20]. The edible portions (the muscle tissues of the body) were separated from the head, skin, bone and viscera. The body muscles removed from the bones and cut into small pieces. They were then put in a clean blender, which had been sterilized before hand and minced for 30 s. 5 g of the minced pieces were used for extraction of the total lipids with a chloroform: methanol mixture considering the advices of Folch[21]. After extraction the total lipid in crude extract were separated and weighed. The total lipids were saponified and the unsaponified portions were discarded. The saponified part was acidified by adding 6 M hydrochloric acid. Thus the total fatty acids obtained were dried and weighed. The extracted lipids were esterified with boron trifluoride-methanol and recovered in heptane[20]. The purified fatty acid methyl esters (FAME) mixture obtained was analyzed with the aid of a Shimadzu Gas Chromatograph (Model: GC-2010, Shimadzu, Japan) with a flame ionization detector (FID) on a split injector. A SP-2560 capillary column (100 m long × 0.25 mm i.d) was used for purified fatty acid methyl esters analysis. Oxygen free nitrogen was used as a carrier gas at a flow rate of 33.9 mL/min. The initial oven temperature was 140 °C for 5 min which was then raised to 240 °C at a rate of 4 °C/min and finally held at 240 °C for 20 min. The injector and detector temperature were set at 260 °C. Volume injected 1 µL; split ratio, 1:30. Peaks were identified by comparison of their retention times with that of standard fatty acid methyl esters. The percentage compositions of the samples were computed from the G.C peak areas. The results obtained were placed in Table-2.

RESULTS AND DISCUSSION

The analysis of proximate composition of the carps namely *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* revealed that *L. rohita* (3.21 ± 0.02) contained higher lipid levels than *C. catla* (3.01 ± 0.01) and *C. mrigala* (2.78 ± 0.02) whereas the moisture content of *C. catla* (76.78 ± 0.39) is the highest among them as is given in Table-1. The fatty acid profiles of muscle tissues of the three carps under investigation is revealed in Tables 2 and 3. The muscle tissue of *C. catla* contain the highest level of saturated fatty acid (SFA) and poly unsaturated fatty acid (PUFA) compared to the other two carps whereas *C. mrigala* contains the highest level of mono unsaturated fatty acid (MUFA) amongst the three carps.

TABLE-1
PROXIMATE COMPOSITION (%) OF
Catla catla, Labio rohita AND *Cirrhinus mrigala*

Nutrients	*Catla catla*	*Labio rohita*	*Cirrhinus mrigala*
Protein	18.11 ± 0.19	18.82 ± 0.21	19.08 ± 0.30
Lipid	3.01 ± 0.01	3.21 ± 0.02	2.78 ± 0.02
Moisture	76.78 ± 0.39	75.64 ± 0.52	76.20 ± 0.62
Ash	2.09 ± 0.03	2.32 ± 0.05	1.93 ± 0.03

TABLE-2
FATTY ACID PROFILE IN MUSCLE TISSUES OF
Catla catla, Labio rohita AND *Cirrhinus mrigala*

FAME	*Catla catla*	*Labio rohita*	*Cirrhinus mrigala*
14:0	5.01 ± 0.05	4.61 ± 0.05	4.20 ± 0.04
15:0	1.22 ± 0.01	1.36 ± 0.01	1.06 ± 0.03
16:0	28.98 ± 0.08	28.68 ± 0.13	28.18 ± 0.03
17:0	1.25 ± 0.01	2.86 ± 0.08	3.29 ± 0.01
18:0	13.83 ± 0.01	12.30 ± 0.15	13.42 ± 0.04
16:1 n-9	5.23 ± 0.15	5.60 ± 0.15	5.57 ± 0.05
16:1 n-7	0.15 ± 0.03	0.21 ± 0.01	0.09 ± 0.01
18:1 n-9	10.73 ± 0.07	9.81 ± 0.11	12.36 ± 0.15
18:1 n-7	2.49 ± 0.02	3.01 ± 0.04	2.66 ± 0.01
20:1 n-9	0.18 ± 0.01	0.21 ± 0.03	0.17 ± 0.01
22:1 n-9	0.23 ± 0.00	0.70 ± 0.01	0.26 ± 0.00
18:2 n-6	5.96 ± 0.01	5.52 ± 0.08	5.27 ± 0.01
20:2 n-6	0.21 ± 0.00	0.26 ± 0.01	0.08 ± 0.00
18:3 n-3	2.16 ± 0.07	2.50 ± 0.01	2.43 ± 0.03
20:3 n-6	1.76 ± 0.03	0.40 ± 0.02	0.83 ± 0.01
20:4 n-3	4.92 ± 0.03	5.00 ± 0.20	5.86 ± 0.03
20:4 n-6	6.63 ± 0.03	6.89 ± 0.05	6.98 ± 0.04
20:5 n-3	2.88 ± 0.02	3.06 ± 0.03	2.18 ± 0.01
22:5 n-6	0.31 ± 0.01	1.00 ± 0.02	1.73 ± 0.01
22:6 n-3	5.86 ± 0.07	6.01 ± 0.40	3.37 ± 0.06

TABLE-3
AMOUNT OF TOTAL SATURATED FATTY ACID, MONO UNSATURATED FATTY ACID, POLY UNSATURATED FATTY ACID, AA, EPA, DHA, n-3, n-6 (g/100 g OF SAMPLE, n-3/n-6 RATIO AND SUM OF EPA AND DHA OF *Catla catla, Labio rohita* and *Cirrhinus mrigala*

Fatty acid types	*Catla catla*	*Labio rohita*	*Cirrhinus mrigala*
20:4 n-6 AA	6.63	6.89	6.98
20:5 n-3 EPA	2.88	3.06	2.18
22:6 n-3 DHA	5.86	6.01	3.37
Σ n-3	15.82	16.57	13.84
Σ n-6	14.87	14.07	14.89
Σ SFA	50.29	49.81	50.15
Σ MUFA	19.01	19.54	21.11
Σ PUFA	30.69	30.64	28.73
PUFA / SFA	0.529	0.555	0.539
EPA + DHA	8.74	9.07	5.33
n-3 / n-6	1.064	1.178	0.930

The major saturated fatty acids detected in the three carps are palmitic acid (C16:0) and stearic acid (C18:0). Palmitic acid is the predominant fatty acid in carp tissues comprised of 28.98 % (*C. catla*), 28.68 % (*L. rohita*) 28.18 % (*C. mrigala*) of the total saturated fatty acid.

The present study revealed that the total mono unsaturated fatty acid content of all the three carps were less than the total

saturated fatty acid and poly unsaturated fatty acid content. Oleic acid (18:1 n-9) is the main mono unsaturated fatty acid in all the fish species analyzed. Mrigala (12.36 %) showed the highest percentage compared to Rohu (9.81 %) and Catla (10.73 %).

The long chain n-3, n-6 fatty acids (poly unsaturated fatty acid) content of all the three fish species are lesser than total saturated fatty acid and total mono unsaturated fatty acid. The percentage of n-6 poly unsaturated fatty acid is slightly higher in Mrigala (14.89) compared to Catla (14.87) and Rohu (14.07). The n-3 poly unsaturated fatty acid content of Rohu is the highest (16.57) compared to Catla (15.82) and Mrigala (13.84). The observed high levels of arachidonic acid (20:4 n-6), EPA (20:5 n-3) and DHA (22:6 n-3) in all the fish species suggests that all these fishes have a tendency to conserve such highly unsaturated fatty acid suggesting a metabolic priority for their conservation[22]. Arachidonic acid, the principal n-6 fatty acid is the highest in Rohu than in Catla and Mrigala. This is in accordance with the finding of Ackman[23,24] that fresh water fishes have very high level of arachidonic acid. A precursor of n-6 fatty acids *i.e* linoleic acid (c-18:2 n-6) is also found in good amount, which explains the high level of arachidonic acid and n-6 fatty acids found in these fishes. EPA and DHA, the two important poly unsaturated fatty acids found in fresh water fishes are maximum in rohu than the other two fish species. One may thus conclude that the presence of higher levels of AA, EPA, DHA in these fish species is due to the presence of such fatty acids and their precursors in their naturally available food.

The three fish species under investigation have a n-3: n-6 ratio either slightly greater than 1 (*C. catla* and *L. rohu*) or slightly less than 1 as in *C. mrigala* (Table-3). As is known that n-3 : n-6 is a useful indicator for comparing relative nutritional values of fish oil and a ratio within 1:1 to 1:5 is considered a healthy human diet[25]. In all the three species n-3 : n-6 ratio falls close to this value suggesting all these fishes can be a good nutritional diet. Analysis of fatty acid profile of the muscle tissues of three carps shows very low levels of erucic acid (C22:1 n-9). This observation is of some importance as this fatty acid has been reported to be an anti nutritional factor and shown to be associated with an increased incidence of myocardial lipidosis in animals[26]. The percentage of EPA + DHA for the carps under investigation ranges from 5.33 to 9.07 % with *L. rohita* having the highest percentage followed by *C. catla* and *C. mrigala*. These values are of real importance and are also enterprising according to the recommendation of British Nutrition Foundation[27], which suggests that a persons balanced and healthy diet must contain 0.2 g of EPA + DHA daily or at least 1.5 g of EPA + DHA on a weekly basis. Thus we can say that the three major carps studied are potentially nutritious food with health benefits for the population of West Bengal, India.

In conclusion, our study has revealed that all the three carp species *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* is a good source of polyunsaturated fatty acid. It is known that poly unsaturated fatty acid is now synonymous to good and healthy life style so, such fish species can be a good choice in the human diet of West Bengal. The major poly unsaturated fatty acids are DHA, EPA and AA. The major saturated fatty acids detected in all the three carps are palmitic acid (C16:0) and stearic acid (C18:0). Oleic acid (C18:1 n-9) is the major mono unsaturated fatty acid present in these carps. Erucic acid (C22:1 n-9), which is reported to be an antinutritional factor is present in very low concentration. Another important conclusion that can be drawn from this study is that the nutritional value of these fish species can be improved by incorporating desired fatty acids, such as linoleic acid, linolenic acid, EPA, DHA into their feed. Thus meticulous farming is what is required for making such carps a healthy, nutritious food for all.

ACKNOWLEDGEMENTS

One of authors (Pinak Dutta) thank the UGC, New Delhi for the financial assistance extended through a minor research project (Project No. F.PSW-006/09-10).

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