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RESEARCH ARTICLE

Evalution of total lipid content and fatty acids composition of processing waste from a freshwater food fish, *Catla catla* (Ham.).

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Abstract

Total lipid content (TLC) and fatty acids composition of the processing waste (head, liver, intestine, kidney, testis, and ovary) of an Indian major carp, *Catla catla* (Ham.) of three weight groups (250-500g, 501-750g, and 751-1000g) were analyzed. The TLC of each of the processing waste organs increased with an increase in the fish body weight. Maximum TLC (23.00± 0.60 %) was found in the intestine of 751-1000g weight group. The minimum TLC (7.73± 0.53%) was recorded in the liver of 250-500g weight group fish. Highest values of total n-3 fatty acids (18.05±3.88%) were observed in intestine and lowest (4.97±0.78%) in the kidney. The total n-6 PUFAs were highest in the liver (13.02±3.20%). The maximum mean MUFAs (36.50±3.86%) were present in the testis and the minimum (20.45±4.76%) in the intestine. It may be concluded that the processing waste of fish (head and visceral organs) is a rich source of total lipids and the essential fatty acids, particularly the polyunsaturated fatty acids, which can be utilized by the industry and processed for human consumption.

Introduction

Fish and fish products play an important role in human's life. Fish lipids are excellent sources of the essential polyunsaturated fatty acids (PUFAs), such as docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) derive mainly from fish (Vignesh 2012), however, Fish processing waste has a huge unexploited potential for value addition. This waste can find its use in foods, functional foods and biochemical products for human consumption (Galardy *et al* 1984) and preparing animal feeds. Visceral mass constitutes approximately 20% of live weight of freshwater fishes and is a rich source of protein and lipids especially polyunsaturated fatty acids (PUFA) (Bhaskar *et al* 2010, Sachindra *et al* 2010). As per recent global estimates (FAO 2012), the fish processing industry generates more than 63 mmt of processing waste which is rich in various biomolecules such as lipids, protein, chitin and carotenoid (Bhaskar *et al* 2010). Total fish production of India, which stands second in the inland fish production, is 7.5 million tonnes, out of which 4.5 million tonnes is produced in the coastal areas and 3 million tonnes in ponds and other inland water bodies (Lohumi 2011). India is the third largest producer of fish in the world, and second in inland fish production (Anonymous 2008). Freshwater fish species viz., catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) are two major carps in India next to rohu (*Labeo rohita*).These carps formed the major species of the total inland fish production (953106 tonnes inland catch and 3479000 tonnes aquaculture) in India in 2008 (Anonymous 2010). In recent years, the significance of polyunsaturated fatty acids especially the n-3 and n-6 fatty acids, has gained much attention because of their various biological activities in health and disease management. These fatty acids play an important role in the prevention and treatment of cardiovascular disease, autoimmune diseases, eye sight and the improvement of learning ability (Martins 2013). Thus, it is important to assess the lipid content and fatty acid composition of the Indian major carps. Hence, the study on the total lipid content and fatty acid composition of *C. catla* was undertaken.

Materials and methods

2.1 Collection of the fishes

Fresh specimens of the fish species of three weight groups (250-500g, 501-750g and 751-1000g) were obtained from the local fish market. Each fish was individually wrapped in labeled clean air-tight ziplock polythene bags and embedded in abundant crushed ice in the ice box. Ambient temperature was recorded at the time of collection of the samples. They were transported to the Lab within 30-45 minutes and stored in a quick freezer at -30 ^{0}C.

2.2. Biometric Measurements

Fish samples were thawed for 7 to 8 hours in a refrigerator at 5°C and individual data for total length (cm), standard length (cm) and weight (g) were recorded along with ambient temperature. Total length and standard length were measured using a measuring scale. The weight was taken with a Goldtech top pan electronic weighing balance model GTA 6K / Fabr. Nr.01113254.

2.3. Sample Preparation

Each fish sample was cleaned with tap water. Various organs of the processing waste including Liver, kidney, testes, ovaries and intestine were removed from the fishes and their weights were recorded. Each of these organs collected from different individuals of the same species of particular weight group were thoroughly mixed to form the composite samples. The whole procedure took about 10 minutes, which was done on ice. Heads were cut with the help of a mechanical cutter. The individual weights of the heads were recorded and soft portion of the heads were weighed and thoroughly mixed together to form a composite sample.

2.4 Estimation of total lipid content

The total lipid content was estimated by Soxhlet lipid extraction/ solvent extraction method (AACC 1976).

2.5. Fatty acid composition

Fatty acid composition was determined by Gas Chromatography (GC) (Applequist, 1968).

2.6. Statistical analysis

One-way and Multifactor ANOVA were used to determine the inter-specific and weight group differences in the total lipids and fatty acid profiles of the waste from the two species of fish. The analyses were performed using Microsoft EXCEL and STATGRAPHICS statistical packages.

Results and discussion

3.1 Total lipid content of the processing waste

Values obtained on the total lipid content (TLC) of the processing waste of *C. catla*have been depicted Table 1. It has been observed that the TLC was significantly differ ($p<0.05$) in all the three weight groups of *C. catla*. TLC was higher in weight group (751-1000g) as compared to the 1st and 2nd weight group except intestine. The maximum TLC (24.66±1.33%) was found in the intestine of *C. catla* (501-750g). *C. catla*had lower TLC in the heads than in the head of tuna (18.8±0.71%) and seer fish (30.10±1.28%) as reported by Narayan *et al* (2012) but close to that in the head of *C. carpio* (4.0%) as reported by Swapna *et al* (2010).

The TLC in the liver of *C. catla* of all the three weight groups has been found to be close to that of *C. catla* (7.43±0.12%) as investigated by Hassan *et al* (2010) but lower than in wild and farmed sea bass (32% and 37.5%, respectively) as recorded by Bhouri *et al* 2010.

Total lipid content in the liver of fishes belonging to Rajidae family was relatively high, ranging between 30.67-46.41%, the highest observed in *D. dipterura* as reported by Garcia *et al* (2014). The TLC in the kidney of *C. catla* (17.80%) was much higher than observed for rainbow trout (6.88%) as by Castell *et al* (2011). In the ovaries of *C. catla*, TLC was between (15.76% and 19.60%), which was higher than that of Zoarces viviparous (2.5%) as

determined by Pekkarinen (1980) but lower than that reported for Tilapia (a freshwater fish species) ovaries (38.68%) and close to that of silver perch (19.56%), which is again a freshwater fish as recorded by Sulmona and ogata (2012) and also close to that recorded by Suhaila *et al* (2014). In testis of *C. catla*, TLC was between (18.10 and 21.90%), which was lower than that reported for *Rhabdosargussarba* testis (34.0%) reported by Suhaila *et al* (2014). Generally, in all the studied organs ofthe fish species, the TLC increased with an increase in the weight of the fish (Table 1).

3.2. Major fatty acids in head and visceral organs

3.2.1 Major fatty acids in head

Total n-3 PUFAs were in the ranges of 4.82±0.25% to 7.76±0.37% in the head of *C. catla*. These were significantly different ($p<0.05$) in the head of the fishes of the three different weight groups. The total n-3 values in *C. catla* were close to that of tuna (7.01%) as reported by Khoddami *et al* (2012). The total n-3 PUFAs of *C. catla* were also close to those determined for cultured Labeo rohita (6.03±0.05%) but less than for the wild form (13.74±0.28%) of this fish species (*L. rohita*). The n-3 PUFA content of the heads were also close to those reported in the sardine (Suriah *et al* 1995, Khoddami *et al* 2009). The total n-6 fatty acids of the head of the presently studiedfishes (4.24±0.18% and 8.34±0.37%) were close to those determined by Sharma *et al* (2011) in the head of the *L. rohita* which was cultured (8.81±0.24%) and caught from the wild (9.3±0.32%) and also to those studied by Khoddami *et al* (2012) for *Sardinella lemuru* (9.60%) and were close to that (4.46%) reported by Muhamad and Mohamad (2012) for *C. idella*. The n3/n6 ratio was ranging between (0.99-1.14%) in *C. catla*. The n3/n6 ratios differed significantly ($p<0.05$) in respect of the weight groups of the fish species (Table 2). Total PUFAs varied between 9.06±0.36% and 16.11±0.65% in the head of *C. catla*. The total PUFAs were largely composed of linolenic and linoleic acids. The values of total PUFAs of *C. catla* of 751-1000g weight group (16.11%) are close to those reported by Khoddami *et al* (2012) in the head of *Euthynnus affinis* (17.18%), Kandemir and polat (2007) in *ra*inbow trout* (25.1%), and Khoddami *et al* (2012) in *Sardinella lemuru* (26.39%).

Total MUFAs were maximum (33.54±0.95%) in 751-100g weight group of *C. catla* and minimum was (23.24±0.15%) in 250-500g weight group. In *C. catla*, there was increase in total MUFAs with increase in weight group. The differences in total MUFA's were statistically significant ($p<0.05$) with respect to the three weight groups of *C. catla*. Total SFAs differed significantly ($p<0.05$) with respect to the weight groups of *C. catla*. The fish had higher SFA content in 250-500g and 501-750g weight groups and lower in 751-1000g weight group.

3.2.2. Major fatty acids in visceral organs

Total n-3 fatty acids were varied between 3.34±0.29% and 30.43±1.17% in visceral organs of *C. catla*. In the head, liver, and intestine, on the other hand, these were higher in *C. catla* (7.76±0.37%, 7.32±0.14% and 30.43±1.17%, respectively). The total n-6 PUFAs were minimum (3.89±0.27%) in the testis of 250-500g weight group of *C. catla*. The n-3/n-6 ratio was maximum (6.99±0.52%) in the intestine of 501-750g weight group of *C. catla.*

3.3. Comparison of the major fatty acids in the processing waste (head and visceral organs)

Comparison of major fatty acids groups in the head (soft part) and various visceral organs revealed that there were variations in the pattern of occurrence of different groups of fatty acids in these organs. The mean total n-3 fatty acids in *C. catla* (Table 2) were maximum (18.05±3.88%) in the intestine and minimum (4.97±0.78%) in the kidney. The mean total n-6 fatty acids were maximum (13.02±3.20%) in the liver and minimum in the testis (4.29±0.14%).

Mean total PUFAs were maximum (23.33±3.48%) in the intestine and minimum (10.28±0.53%) in the testis. Similarly, the n-3/n-6 ratio was observed maximum (3.97±1.00%) in intestine and minimum (0.74±0.15%) in the liver. The maximum mean MUFAs (36.50±3.86%) were present in testis and the minimum (20.45±4.76%) in intestine. Similarly, the mean total SFAs were maximum (55.15±2.42%) in the liver and minimum (49.56±1.67%) in the intestine. The results show that amongst various organs forming the processing waste of *C. catla*, the intestine is the best as it contains maximum amount of n-3 fatty acids, highest n-3/n-6 ratio and minimum of the MUFAs and SFAs (Table 2) besides having maximum amount of the total lipids (Table 1).

Table 1: Total lipid content of the processing waste from *C. catla* (Ham.) of different weight groups.

Body weight/organ	Fish body weight (g)		
	250-500	501-750	751-1000
Head	8.37± 0.13[a]	12.66± 0.33[b]	19.43± 0.29[c]
Liver	7.73± 0.53[a]	9.56± 0.47[b]	11.06± 0.42[c]
Kidney	14.60± 0.73[a]	15.90± 0.70[b]	17.80± 0.45[c]
Testis	18.10± 0.60[a]	21.00± 0.81[b]	21.90± 0.80[b]
Ovary	15.76± 0.62[a]	17.83± 0.66[b]	19.60± 0.37[c]
Intestine	20.00± 0.57[a]	24.66± 1.33[b]	23.00± 0.60[b]

Values are mean ± S.E. values with same superscript in a row do not differ significantly (p>0.05)

Table 2: Comparison of major groups of fatty acids in the head and visceral organs of *Catla catla* (Ham.)

Fatty acids→		Total n-3	Total n-6	n-3/n-6 Ratio	Total PUFAs	Total MUFAs	Total SFAs
Head	Min	4.82±0.25	4.24±0.18	0.93±0.04	9.06±0.36	23.24±0.15	43.70±1.96
	Max	7.76±0.37	8.34±0.37	1.14±0.06	16.11±0.65	33.82±0.90	62.30±0.19
	Mean	6.09±0.50	6.09±0.69	1.02±0.04	12.18±1.20	29.30±1.82	53.31±3.11
Liver	Min	6.26±0.24	5.17±0.09	0.30±0.00	11.43±0.34	10.11±0.09	47.63±0.97
	Max	7.32±0.14	23.73±0.58	1.20±0.00	31.20±0.61	32.09±0.12	62.11±0.80
	Mean	6.95±0.20	13.02±3.20	0.74±0.15	20.02±3.38	21.77±3.68	55.15±2.42
Kidney	Min	3.34±0.29	4.49±0.33	0.32±0.03	8.43±0.47	22.35±0.14	44.60±0.81
	Max	7.64±0.10	10.37±0.90	1.34±0.01	13.71±1.03	37.58±1.98	57.51±0.14
	Mean	4.97±0.78	6.84±1.04	0.84±0.17	11.81±0.98	28.51±2.67	51.79±2.19
Testis	Min	4.27±0.54	3.89±0.27	1.02±0.15	8.53±0.43	23.42±0.31	39.09±2.17
	Max	6.93±0.18	4.73±0.98	1.72±0.02	11.67±0.86	45.45±3.30	61.67±1.33
	Mean	5.98±0.49	4.29±0.14	1.45±0.12	10.28±0.53	36.50±3.86	49.66±3.79
Ovary	Min	5.47±1.33	5.01±1.26	0.85±0.09	10.48±2.57	13.81±1.19	39.39±0.69
	Max	8.30±0.83	8.83±0.83	1.12±0.29	16.22±0.83	36.50±0.26	59.54±1.07
	Mean	7.05±0.48	7.07±0.64	1.02±0.05	14.13±1.06	26.01±3.81	52.81±3.87
Intestine	Min	7.31±0.55	4.17±0.09	1.00±0.05	14.54±0.71	10.72±0.47	44.03±1.67
	Max	30.43±1.17	7.23±0.16	6.99±0.52	34.86±1.70	36.84±1.60	53.77±0.09
	Mean	18.05±3.88	5.27±0.57	3.97±1.00	23.33±3.48	20.45±4.76	49.56±1.67

Values are mean±S.E.

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