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Proximate and Fatty Acid Composition of the Liver of Cultured Asian Redtail Catfish (*Hemibagrus nemurus*) and African Catfish (*Clarias gariepinus*)

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ABSTRACT

Catfish species are popular fish group consumed in Malaysia. African catfish, *Clarias gariepinus* and Asian redtail catfish, *Hemibagrus nemurus* are two of these catfish species. Unfortunately, some parts of these fish are removed during processing. This includes the liver which contained considerable amount of extractable lipid with both monounsaturated and polyunsaturated fatty acids. The fish samples were purchased and transported in ice box to the laboratory. Liver was extracted and analyzed for crude protein, crude lipid, moisture, ash, carbohydrate contents and fatty acid composition. Results were compared between male and female *C. gariepinus* and *H. nemurus*. Liver of female *H. nemurus* contained the highest amount of ash, crude lipid and carbohydrate and the lowest amount of moisture. Male *H. nemurus* had the lowest amount of protein, ash and crude lipid content. Moisture was found to be the highest in male *C. gariepinus*. The main fatty acid content of Asian redtail catfish and African catfish liver were C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1n-9, C182n-6, C183n-3, C204n-6, C24:1, C205n-3, C225n-3, C226n-3. The most abundant fatty acids in both species were oleic acid (18:1n-9) and palmitic acid (16:0). In conclusion, this study showed that *H. nemurus* and *C. gariepinus*, are two valuable source of protein and polyunsaturated fatty acid.

Key words: Catfish, *Clarias gariepinus*, *Hemibagrus nemurus*, fatty acid

INTRODUCTION

Fish is the primary source of animal protein for an estimated 1/6th of the world's population (Adebayo and Popoola, 2008). Fish consumption and production has been on the rise in Malaysia with consumption increased from 49 kg per capita in 2000 to 53 kg in 2005 (Farah *et al.*, 2011) and aquaculture production risen from 170 tons per capita in 2000 to 210 tons in 2007 (FAO, 2011). Furthermore, government allocated RM82 million to aid the aquaculture industry (Junaidi and Hashida, 2010). Catfish is one of the common daily diet among Malaysian families due to its taste and low market prices. Two species *C. gariepinus* and *H. nemurus* are catfishes highly consumed in Malaysia. In addition to Malaysia, catfish is an important fish in the aquaculture industry throughout the world (Mukai and Lim, 2011).

There is a direct relation between production and fish waste. The rise of fish waste production causes finance waste as well as environmental pollution. The marine captured fishes total produced almost 25% wastage (Norziah *et al.*, 2009). The most rejected parts in processing pathway are skin, head, bones and liver. These discarded parts contained nutritional values in terms of protein and essential fatty acid compounds that can be used in the production of fishmeal and fish oil. As a matter of fact, fish oil contained the most beneficial fatty acids (Celik *et al.*, 2005; Thammapat *et al.*, 2010) for human such as eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and Arachidonic Acids (AA). Muscle and liver are two organs involved in the lipids storage (Kandemir and Polat, 2007). Therefore, consumers demand more choices in the types of fish oil as population grow. Proximate and fatty acid composition is influenced by some parameters such as species (Rahnan *et al.*, 1995; Jabeen and Chaudhry, 2011) and sex (Luzia *et al.*, 2003; Guil-Guerrero *et al.*, 2011). For example, fatty acid composition of the liver of winghead shark was totally different from the liver of sandbar shark (Saify *et al.*, 2003). In addition, the quality of fatty acid can vary between different organs (Saify *et al.*, 2003). However, the information on proximate and fatty acid differences between species and influence of sex on these parameters are scarce.

MATERIALS AND METHODS

Sample preparation: Fish samples were purchased from a wet market (Pasar Borong Selangor, Malaysia) and a fish farm in Semenyih Selangor, Malaysia. Total length and weight were recorded. Livers was extracted and kept at -20°C for further analysis. All samples were prepared in triplicates.

Proximate composition and fatty acid analysis: AOAC methods (AOAC, 2005) were used in all the proximate composition analysis. Fatty Acid Methyl Ester (FAME) was prepared according to method described by Ramezani-Fard *et al.* (2011). Fatty acid methyl ester was then analyzed by a Gas Chromatography (Agilent 7890N).

Statistical analysis: All data were statistically analyzed by one-way ANOVA method using SPSS 16.0. The mean differences were compared using Duncan's multiple range test at $p<0.05$.

RESULTS

Proximate composition: Table 1 shows the liver proximate composition of *H. nemurus* and *C. gariepinus*. There was a significant difference between two species ($p<0.01$). Male *H. nemurus* showed the lowest amount of protein content comparing the other fish. The highest amount of ash content among the fish samples belonged to the female *H. nemurus* which was followed by

Table 1: Proximate composition (wet weight) of the liver from male and female of *C. gariepinus* and *H. nemurus*

Catfish	African		Asian redtail	
Body constituent	Male	Female	Male	Female
Protein	23.03±1.19[a]	21.50±0.46[a]	17.26±0.70[b]	22.43±0.60[a]
Ash	1.72±0.02[b]	1.73±0.02[b]	0.62±0.13[c]	2.74±0.03[a]
Moisture	69.45±1.27[a]	66.48±1.04[b]	66.11±0.53[b]	61.49±0.67[c]
Total fat	6.94±0.30[c]	9.83±0.02[b]	4.09±0.25[d]	12.40±0.14[a]
Carbohydrate	0.69±0.00[bc]	0.82±0.11[ab]	0.58±0.07[c]	0.92±0.08[a]

All values are in percentage. Standard deviations are given in parenthesis. Means sharing the same letter do not differ significantly at $p<0.05$. (a, b, c, d, e... express statistical differences among mean values)

C. gariepinus and male *H. nemurus*. The highest amount of moisture was observed in the liver of male *C. gariepinus* followed by female *C. gariepinus*, male *H nemurus* and female *H. nemurus*. Total fat found to be highest in female *H. nemurus* followed by female *C. gariepinus*, male *C. gariepinus* and male *H. nemurus*. The highest carbohydrate content was observed in female *H. nemurus* while the lowest value was observed in male *H. nemurus*.

Fatty acid composition: Liver fatty acid composition of *C. gariepinus* and *H. nemurus* are presented in Table 2. There was significant difference ($p<0.01$) between fish species and sex in term of fatty acid composition. Monounsaturated fatty acids (MUFAs) were found as the most abundant fatty acids in both species. Male *C. gariepinus* had the highest amount of 18:1n-9, while the male *H. nemurus* had the lowest amount of this fatty acid. Female *H. nemurus* had the highest amount of Saturated Fatty Acid (SFA) and it followed by male *H. nemurus* and male and female *C. gariepinus*. Palmitic acid (16:0) was found to be the major SFA. The palmitic acid observed was in female *H. nemurus*. Stearic acid (18:0) was the second major SFA with the values from 6.71% for female *C. gariepinus* to 8.80% for male *H. nemurus*. The omega-6 PUFAs measured in this study were linoleic acid (18:2n-6; 11.12-16.48%), arachidonic acid (20:4n-6; 1.36-4.10%) as well as gamma linolenic acid (18:3n-6; 0.44-1.00%). The 18:2n-6 was the most abundant n-6 PUFA observed in all the fish. Omega-3 PUFAs measured in this study were EPA (20:5n-3; 0.25-0.97%), DPA (22:5n-3; 0.36-0.54%) and DHA (22:6n-3; 1.17-4.17%). The main n-3PUFA was 22:6n-3 which was highest in female *H. nemurus* (4.17%).

Table 2: Fatty acid composition of the liver from male and female of *C. gariepinus* and *H. nemurus*

Liver (%)	*C. gariepinus*		*H. nemurus*	
Fatty acid	Male	Female	Male	Female
C12:0	0.29 ± 0.06^{c}	0.65 ± 0.03^{a}	0.44 ± 0.09^{b}	0.18 ± 0.00^{c}
C14:0	0.96 ± 0.37^{b}	1.01 ± 0.03^{b}	2.48 ± 0.05^{a}	2.29 ± 0.01^{a}
C15:0	0.23 ± 0.09^{ab}	0.15 ± 0.00^{b}	0.27 ± 0.01^{a}	0.26 ± 0.00^{a}
C16:0	23.58 ± 0.19^{d}	24.14 ± 0.08^{c}	26.63 ± 0.23^{b}	29.73 ± 0.09^{a}
C16:1	4.13 ± 0.04^{b}	4.74 ± 0.03^{a}	3.61 ± 0.03^{c}	3.54 ± 0.01^{d}
C17:0	0.23 ± 0.00^{b}	0.25 ± 0.05^{b}	0.38 ± 0.01^{a}	0.37 ± 0.00^{a}
C18:0	8.73 ± 0.04^{a}	6.71 ± 0.05^{c}	8.80 ± 0.21^{a}	8.49 ± 0.04^{b}
C18:1	42.52 ± 0.20^{a}	41.10 ± 0.04^{b}	36.47 ± 0.16^{c}	35.54 ± 0.02^{c}
C18:2n-6	12.13 ± 0.10^{c}	16.48 ± 0.00^{a}	12.88 ± 0.27^{b}	11.12 ± 0.02^{d}
C18:3n-6	0.44 ± 0.00^{d}	0.66 ± 0.00^{c}	1.00 ± 0.01^{a}	0.88 ± 0.01^{b}
C20:4n-6	4.10 ± 0.04^{a}	2.07 ± 0.09^{b}	1.36 ± 0.14^{c}	1.49 ± 0.00^{c}
C20:5n-3	0.25 ± 0.00^{c}	0.27 ± 0.02^{c}	0.76 ± 0.00^{b}	0.97 ± 0.00^{a}
C22:5n-3	0.53 ± 0.28^{a}	0.36 ± 0.01^{a}	0.54 ± 0.01^{a}	0.48 ± 0.00^{a}
C22:6n-3	1.17 ± 0.15^{c}	1.18 ± 0.05^{c}	3.72 ± 0.09^{b}	4.17 ± 0.00^{a}
C24:1	0.65 ± 0.20^{a}	0.20 ± 0.04^{c}	0.63 ± 0.04^{ab}	0.43 ± 0.01^{b}
Σ n-3PUFA	2.41 ± 0.42^{c}	2.48 ± 0.09^{c}	6.02 ± 0.09^{b}	6.52 ± 0.02^{a}
Σ n-6PUFA	16.24 ± 0.15^{b}	18.55 ± 0.10^{a}	14.24 ± 0.41^{c}	12.62 ± 0.02^{c}
Total MUFA	47.31 ± 0.45^{a}	46.04 ± 0.04^{b}	40.72 ± 0.18^{c}	39.52 ± 0.03^{d}
Total SFA	34.03 ± 0.18^{c}	32.92 ± 0.14^{d}	39.01 ± 0.33^{b}	41.33 ± 0.07^{a}
Total USFA	65.97 ± 0.18^{b}	67.07 ± 0.14^{a}	60.98 ± 0.33^{c}	58.67 ± 0.07^{d}

All values are in percentage. Standard deviations are given in parenthesis. Means sharing the same letter do not differ significantly at $p<0.05$. (a, b, c, d, e... express statistical differences among mean values)

DISCUSSION

This study showed that proximate and fatty acid composition of liver varies significantly between *H. nemurus* and *C. gariepinus*. In addition, these results were influenced by sex. Sathivel *et al.* (2002) reported a high percentage of moisture (74.9%) and protein (11.4) in channel catfish (*Ictalurus punctatus*) but in this study the average protein was higher (17.26-23.3%). Viscera of Asian catfish (*Pangasius bocourti*) had less protein (1%) and more lipid (93.32%) than muscle. These finding suggested that proximate compositions can varies between organs which is in agreement with Thammapat *et al.* (2010). Kandemir and Polat (2007) reported that liver in rainbow trout (11.2-22.3%) contained more lipid than muscle (2.20-6.31). Total lipid in liver of wild (32%) and farmed (37.5%) sea bass (*Dicentrarchus. labrax*) was reported by Bhouri *et al.* (2010). Rainbow trout was estimated between 11.2-22.3% (Kandemir and Polat, 2007). In contrast, total fat observed in this study was much less (4.9-12.40%). Hassan *et al.* (2010) measured lipid content in wild (3.32-5.91%) and farmed (4.72-7.43%) *Catla catla*. This indicated that species has a huge effect on proximate composition of liver. There was no report on the comparison of liver proximate composition between sexes. Lipids storage organ varied between species and inactive fishes like catfish family tend to store lipid in liver more than muscle (Castell *et al.*, 1972; Kandemir and Polat, 2007). Therefore, study on the fatty acid composition of liver from these two commonly consumed species of catfish with a huge amount of wastage during processing is necessary. Fatty acid composition in the liver was directly affected by species and sex which is in agreement with Kandemir and Polat (2007). Approximately 15 fatty acids were found in the liver of *H. nemurus* and *C. gariepinus*. In agreement with Thammapat *et al.* (2010), MUFA observed as the most common fatty acids followed by SFA, n-6 PUFA and n-3 PUFA in both species. Liver in male and female *C. gariepinus* stored more n-6 and MUFA compared to male and female *H. nemurus*. However, male and female *H. nemurus* contained more n-3 and SFA. Therefore, the oil extracted from the liver of *H. nemurus* showed the characteristic of having a higher EPA and DHA. Higher n-3 PUFA benefits the heart condition; therefore, consumption of *H. nemurus* liver oil is better than C. *gariepinus*. The fatty acids C15:0, C16:1 and C24:1 found in this study were not found in *Catla catla* (Hassan *et al.*, 2010). However, pacific halibut (*Hippoglossus stenolepsis*) had all the above mentioned fatty acids (Bechtel and Oliveira, 2006). In term of fatty acid quality, the most common fatty acids in wild sea bass (Bhouri *et al.*, 2010) and *Sardinella lemuru* (Khoddami *et al.*, 2009) is SFA with majority of palmitic acid in *Sardinella* and stearic acid in sea bass. However, this study showed that MUFA, oleic acid in particular, is the most common fatty acids. However both omega-3 and omega-6 were higher in sea bass (*D. labrax*). In addition, main PUFA class in sea bass is omega-3. In contrast, this study showed that omega-6 is the main PUFA class. MUFA was also the main fatty acid compound in Pacific halibut (*Hippoglossus stenolepsis*) but overall percentage of omega-3 was also higher than omega-6 (Bechtel and Oliveira, 2006).

Comparing the other catfish species, Shirai *et al.* (2001) reported that PUFA is the most abundant fatty acids in the liver of wild and cultured *Silurus asotus* while palmitic acid was the highest fatty acid content in both catfish.

CONCLUSION

In conclusion, liver of *H. nemurus* and *C. gariepinus* are a valuable sources of protein and lipid with the excellent amount of omega-3, omega-6, MUFA, DHA and EPA that can be used for human consumption instead of being treated as waste.

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