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Fatty acid profile of Tra Catfish (*Pangasius hypophthalmus*) compared to Atlantic Salmon (*Salmo solar*) and Asian Seabass (*Lates calcarifer*)

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Abstract: The fatty acid composition of farmed Tra catfish (*Pangasius hypophthalmus)* was determined and compared to farmed Atlantic salmon (*Salmo solar*) and to wild-caught Asian seabass (*Lates calcarifer*). Saturated fatty acids (SFA) were most abundant in catfish (42.6%) while salmon (37.2%) and seabass (39.0%) were rich in polyunsaturated fatty acids (PUFA). Tra catfish contains Docosahexaenoic acid (DHA), but its percentage was lower (4.7%) than salmon (20.2%) and seabass (18.7%). It is interesting that the absolute content of DHA and eicosapentaenoic acid (EPA) in Tra catfish by fillet wet weight did not differ from Asian seabass. Among the three fish, Tra catfish and seabass had lowest fat content. Regarding to nutritional aspect, Tra catfish fillet is a potential source of omega-3 fatty acids and low-fat food.

Keywords: pangasius, Tra catfish, fillets, fatty acids, DHA, EPA

Introduction

Pangasius hypophthalmus, also known as freshwater Tra catfish, is the main commercial farmed fish in the Mekong Delta of Vietnam (Hung *et al.*, 2004). The fish is exported to many countries, including Australia, where it is widely available to consumers and commercially named as freshwater Basa catfish. It is favoured for its tender flesh and sweet taste. In Australia, Atlantic salmon (*Salmo solar*) is farmed, especially in Tasmania, and is widely available to consumers. Asian seabass (*Lates calcarifer*) is imported from Asian countries like Myanmar, Taiwan, Thailand and Vietnam (Yearsley *et al.*, 2003).

Few studies have been done on the chemical composition of this fish. These include the proximate composition of basa catfish, a closely related family of Tra catfish, where the fat percentage was 24.4% for the flesh and 20.6% for the viscera (Mai, 1998). In other studies (Men *et al.*, 2005; Nhu, 2003), the FA composition of the visceral oil from both species was high in the saturated fatty acids (SFA) palmitic and stearic acids and the monounsaturated fatty acid (MUFA) oleic acid but low in the long-chain polyunsaturated fatty acids (PUFA) docosahexahenoic acid (DHA) and eicosapentaenoic acid (EPA). However, the above results focused only on the viscera oil of the Tra catfish and the fatty acid profile of its flesh has remained so far unknown.

The FA profile of Atlantic salmon farmed in Australia has been reported (Mooney *et al.*, 2002; Nichols *et al.*, 1998) and is known to be rich in long-chain PUFA. Atlantic salmon farmed around the world is well-known to have particularly high levels of EPA and DHA (Hamilton *et al.*, 2005; Ackman, 1989) mainly because they are usually fed with fishmeal containing marine oils (Torstensen *et al.*, 2005). Although extensively known, the analysis of salmon flesh in this study was to ascertain the presence of DHA and EPA in the Tra catfish flesh.

The aims of the current study were to determine the fatty acid profile of farmed Tra catfish and compared it to farmed Atlantic salmon and wild-caught Asian seabass because there is a paucity of data on these fish in the world's market.

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Materials and Methods

Fish fillets

Skinless fillets of farmed freshwater Tra catfish imported from Vietnam, Atlantic salmon farmed in Tasmania in saltwater and wild-caught Asian seabass imported from Myanmar were obtained from four different local seafood stores in Central Coast, New South Wales, Australia. All fillets were kept at -20°C until analysed.

Sample preparation

Samples of the frozen fish fillets were defrosted according to AOAC method 937.07 (Hungerford, 1995). The 2.0 cm-thawed cuts were then ground in an Omni Mixer Homogeniser (Lomb Scientific Australia Pty Ltd, Sydney, NSW, Australia) for 3.0 min with manual removal of all connective tissues from the minced paste at the end of the homogenisation.

FA analysis

Fat extraction: Fat extraction for gas chromatography (GC) analysis was done using chloroform, methanol and water (4:4:1 ratio by volume, respectively) according to the method described by Sathivel *et al.* (2002). 10g of minced fish was used for each batch. The slurry was mixed for 10 min using a SMI Vortexer (American Supply Corp., Miami, FL, USA) and the homogenate was then filtered through Whatman No.1 filter paper. The filtrate was then centrifuged in a J2-MC Beckman Centrifuge (Beckman Coulter Australia Pty Ltd, Gladesville, NSW, Australia) for 20 min at 2400 rpm at 5°C. The chloroform (lower) layer was collected and any water was removed with 10g of anhydrous sodium sulfate. The solvent was dried off under a nitrogen stream in a Dry Block Heater (Ratek Instruments Pty., Ltd., Victoria, Australia) set at 40°C. The extracted fat was then stored at -18°C until analysis. Nine extractions were done for each of the three types of fish - three extractions for each of three batches.

Derivatisation of FA: Fatty acid methyl esters (FAME) were prepared according to AOCS method Ce 1b-89 (Mehlenbacher, 1998). Approximately 50 mg of extracted fat was placed in a screw-cap tube containing 0.5 mg of tricosanoic acid (23:0) methyl ester internal standard, 1.5 ml of 0.5N alcoholic sodium hydroxide added and the solution was blanketed with nitrogen before heating at 100°C for 5 min. After cooling, 2 ml of BF_3/methanol was added and the solution heated at 100°C for 30 min. After cooling to 30-40°C, 1 ml of isooctane was added, the solution was vortexed for 30 sec and 5mL of saturated sodium chloride solution was immediately added. After vigorous agitation the tubes were left to stand until a clear isooctane layer (upper) was separated. The upper layer was collected and an additional extraction of the bottom layer was done using another 1ml of isooctane. The combined isooctane extractions were concentrated under a nitrogen stream to approximately 1 ml. The FAME samples were then stored at -18°C until analysed by GC.

Gas chromatography: Analysis of the FAME samples was carried out using a Shimadzu GC-17A (version 3) (Shimadzu Scientific Instruments, Rydalmere, NSW, Australia) equipped with a split/splitless injector, FDI detector and an EC-Wax column obtained from Alltech (Alltech Associates Australia, Baulkham Hills, NSW, Australia). The column was 30 m long and had a 0.32 mm ID and a 0.25 µm phase thickness (df). The operation parameters for the GC separation were set according to AOCS method Ce 1b-89 (Mehlenbacher, 1998). The column temperature was ramped up from 170°C to 225°C at 1.0°C/min. The temperatures in the injector port and the detector were 250°C and 270°C, respectively. The column flow rate was 2 ml/min with a split ratio of 1:50. Ultra high purity Helium (99.999%) (BOC Limited, Gosford, NSW, Australia) was used as carrier gas. The FAME samples (2µL) were manually injected into the GC.

The results were recorded and processed using the EZChrom™ Chromatography Data System (Version 6.6) (Scientific Software, Inc. CA, USA). The percent of each FA was computed from the total peak area. The absolute concentrations of EPA and DHA were calculated and converted to mg per 100 g wet weight of fish flesh using the empirical crude fat content.

Crude fat analysis

The acid hydrolysis method was used to analyse the crude fat content of the four fish following AOAC procedure 948.15 (Hungerford, 1995). Eight gram of minced fish samples were used each analysis. Nine extractions were done for each kind of fish and three extractions for each of three batches.

Experimental design and statistical analysis

Three batches (three fillets) of each kind of fish were used for oil extraction and crude oil analysis with three replications for each batch. The FAME samples were also injected three times into the GC and the average value for each of the three batches (from three replicates) was used for data analysis.

Data analysis was done using the SPSS 11.0 (Pearson Education Australia, NSW, Australia). The one-way ANOVA and Tukey's HSD tests were used to analyse the differences in fatty acids (%),

crude fat (g/100g wet weight) and EPA and DHA content (mg/100g wet weight) between the three fish. Significant differences were determined using $P<0.05$.

Results and Discussion

Crude fat content

The crude fat content (g/100g wet weight) of the Tra catfish, Atlantic salmon and Asian seabass fillets are shown in Table 1. The crude fat content of the Basa catfish was not significantly different from Asian seabass ($P>0.05$). However, the crude fat content of the two fish were at least four times lower than for the Atlantic salmon ($P<0.001$).

The crude fat content values for the three fish in this study were in agreement with previous studies. The crude fat content found in the present Tra catfish (2.55 g/100 g wet weight) was slightly lower than the average value (2.95 g/100g wet weight) reported by Men *et al.* (2005), and the crude fat content (0.67 g/100g wet weight) of the present wild-caught Asian seabass was also close to that of wild-caught Australian barramundi as reported by Mooney *et al.* (2002). The crude fat content of the present Atlantic salmon (9.92 g/ 100g wet weight) was in the reported data range for crude fat of 5.60 (Mooney *et al.*, 2002) to 16.59 g/ 100 g wet weight (Hamilton *et al.*, 2005) for this species. The high fat content of the Atlantic salmon was therefore not surprising as this has consistently been reported and is probably due to the high oil-containing diets usually fed to this fish, which lead to significant increases in the flesh lipid of the Atlantic salmon (Kennedy *et al.*, 2005).

Fatty acid composition

The average percentages of SFA, MUFA and PUFA in the Tra catfish, Atlantic salmon and Asian seabass fillets are shown in Table 2. The SFA group was dominant (42.63%) in the Tra catfish whereas PUFA accounted for the highest proportion of FA in the Atlantic salmon (37.19%) and Asian seabass (39.04%). In contrast, the percentage of PUFA was the lowest in the Tra catfish (17.69%) and SFA was the lowest in the Atlantic salmon (29.56%). In the Asian seabass, the MUFA accounted for the lowest percentage (18.91%).

SFA

The Tra catfish fillets were therefore relatively enriched in SFA. The percentage SFA level was significantly higher in Tra catfish (42.63%) than in the Atlantic salmon (29.55%) and Asian seabass (34.15%) ($P<0.01$). The high percentage of SFA in the Tra catfish fillets in the current study (42.63%) was similar to the mean value for the oil of this fish (46.5%) reported by Men *et al.* (2005). Of the SFA, palmitic acid was found predominant in the Tra catfish fillets. It was reported that palmitic acid was the predominant in SFA group as found in freshwater channel catfish (*Ictalurus punctatus*) (19.2%) (Sathivel *et al.*, 2002), and in freshwater rainbow trout (*Oncorhynchus mykiss*) (21.3%) (Haliloglu *et al.*, 2004).

MUFA

The percentages of MUFA were not significantly different between Tra catfish (34.69%) and Atlantic salmon (31.61%) ($P>0.05$). However, the Asian seabass had a lower percentage of MUFA (18.91%)

Table 1. The crude fat (g/100g wet weight) and the DHA and EPA content (mg/100g wet weight) of Tra catfish (*Pangasius hypophthalmus*), Atlantic salmon (*Salmo solar*) and Asian seabass (*Lates calcarifer*)

	Tra catfish		Atlantic salmon		Asian seabass	
	Mean	SEM	Mean	SEM	Mean	SEM
Fat	2.55[a]	0.31	9.92[b]	0.94	0.67[a]	0.10
EPA	0.76[a]	0.24	61.12[b]	4.56	1.55[a]	0.44
DHA	10.00[a]	3.66	302.63[b]	10.79	12.90[a]	1.60

SEM: Standard Error of the Mean (n=3)
EPA: eicosapentaenoic acid; DHA: Docosahexaenoic acid
Means within rows followed by the same superscript(s) a or b are not significantly different ($P>0.05$) by Tukey's HSD test.

Table 2. Fatty acid composition (% total fatty acids by peak area) of Tra catfish (*Pangasius hypophthalmus*), Atlantic salmon (*Salmo solar*) and Asian seabass (*Lates calcarifer*)

Fatty acid	Tra catfish		Atlantic salmon		Asian seabass	
	Mean	SEM	Mean	SEM	Mean	SEM
C14:0	4.97[a]	0.25	0.35[b]	0.22	0.020[b]	0.001
C16:0	29.33[a]	1.70	19.71[b]	1.07	23.69[ab]	1.26
C18:0	7.58[a]	0.47	6.43[a]	0.23	9.36[b]	0.51
C20:0	0.28[a]	0.02	0.22[a]	0.02	0.76[b]	0.02
C24:0	0.47[a]	0.18	2.85[b]	0.39	0.32[a]	0.09
Σ SFA	42.63[a]	0.95	29.56[b]	1.32	34.15[b]	1.60
C16:1n-7	1.53[a]	0.32	6.34[b]	0.77	4.85[b]	0.33
C18:1n-7	0	0	4.56[a]	0.09	3.22[b]	0.18
C18:1n-9	30.93[a]	1.05	16.75[b]	0.66	8.09[c]	0.12
C20:1n-9	1.66[a]	0.43	2.56[a]	0.08	0.53[b]	0.03
C22:1n	0.57[a]	0.33	1.40[b]	0.05	2.22[b]	0.13
Σ MUFA	34.69[a]	1.57	31.61[a]	0.93	18.91[b]	0.13
C18:2n-6	8.43[a]	0.72	2.16[b]	0.33	1.27[b]	0.31
C18:3n-3	1.07[a]	0.19	0.30[b]	0.03	1.86[c]	0.19
C20:4n-6	1.03[a]	0.03	2.49[b]	0.11	11.39[c]	0.37
C20:5n-3 (EPA)	0.31[a]	0.08	8.27[b]	0.2	2.97[c]	0.54
C22:4n-6	0.82[a]	0.42	0.71[a]	0.10	1.31[a]	0.06
C22:5n-3	1.29[a]	0.04	3.06[b]	0.02	1.56[a]	0.17
C22:6n-3 (DHA)	4.74[a]	0.93	20.20[b]	0.76	18.68[b]	0.73
Σ PUFA	17.69[a]	1.26	37.19[b]	1.52	39.04[b]	0.39
Σn-3/ Σn-6	0.72[a]	0.05	5.94[b]	0.09	1.80[c]	0.05
Unknown	4.99		1.64		7.9	

SEM: Standard Error of the Mean (n=3)
SFA: Saturated fatty acids; PUFA: polyunsaturated fatty acids; MUFA: monounsaturated fatty acids EPA: eicosapentaenoic acid; DHA: Docosahexaenoic acid
Means within rows followed by the same superscript(s) a, b or c are not significantly different (P>0.05) by Tukey's HSD test.

than the other two fish. In all three fish, oleic acid (C18:1n-9) was the most prevalent MUFA and it was higher (P<0.001) in Tra catfish (30.93%) than in the Atlantic salmon (16.75%) and Asian seabass (8.09%). Oleic acid was also less abundant in the Asian seabass than in the other two fish. The high levels of oleic acid found in the Tra catfish farmed in fresh water is consistent with freshwater fish tending to have higher oleic acid levels than seawater fish. Steiner-Asiedu *et al.* (1991) found that freshwater tilapia (*Tilapia* sp.) had significantly higher oleic acid levels than flat sardine (*Sardinella* sp.) and sea bream (*Dentex* sp.). The level of oleic acid in American freshwater channel catfish flesh was also about 50% (Nettleton *et al.*, 1990) compared to less than 1% in sardine and sea mullet (Ackman, 1994).

PUFA

Of the three fish analysed, the Tra catfish had the lowest percentage of PUFA (17.74%). The PUFA percentages for Atlantic salmon and Asian seabass were 37.20% and 39.04%, respectively. Linoleic acid (C18:2n-6) was the major PUFA in Tra catfish (8.43%) whereas, DHA (C22:6n-3) was the dominant PUFA in Atlantic salmon (20.20%) and Asian seabass (18.68%). Of the three fish, Tra catfish also had the lowest percentage of EPA (0.31%) and Atlantic salmon the highest (8.27%) followed by Asian seabass (2.97%).

The absolute content of EPA and DHA in the three fish is listed in Table 1. The content of EPA was significantly lower ($P<0.001$) in Tra catfish (0.76 mg/100g) than in the Atlantic salmon (61.12 mg/100g). However, because of differences in total fat content, the content of EPA in the Tra catfish fillets (0.76 mg/100g) was not significantly different when compared to the Asian seabass (1.55 mg/100g).

Although low, it was noteworthy that the Tra catfish fillets in the present study had significant amounts of EPA and DHA, the FA which were not seen in previous reports on this species. The percentage of DHA in the Tra catfish was about eightfold higher in the present study (4.74%) than in Basa catfish (*Pangasius bocourti*) oil (0.59%) as reported by Nhu (2003). The low levels of DHA and EPA in the Tra catfish farmed in freshwater were not surprising as the levels of these two FA are generally lower in freshwater fish than in their seawater counterparts (Haard, 1992) because seawater fish obtain these omega-3 FA from oceanic plankton (Steffens, 1997) or are fed fishmeal containing these FA (Henderson, 1996). Haliloglu *et al.* (2004) reported that seawater rainbow trout flesh (*Oncorhynchus mykiss*) had a remarkably higher percentage of EPA than their freshwater counterparts.

Conclusions

This study has shown that fillets from Tra catfish farmed in freshwater contained similar amounts of fat to wild-caught Asian seabass but lower amounts than farmed Atlantic salmon. The SFA dominated in the Tra catfish fat whereas PUFA accounted for the highest proportion of FA in the Atlantic salmon and Asian seabass. The Tra catfish contained low but significant amounts (by wet weight) of EPA and DHA, which were similar to that of the Asian seabass but much lower than the amounts found in the Atlantic salmon.

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