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Fatty acid and amino acid composition of three local Malaysian *Channa* spp. fish

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Abstract

The objective of this current study was to analyze the biochemical compositions of three Malaysian *Channa* spp. fish. The proximate analysis revealed that the protein content of *Channa lucius*, *Channa micropeltes* and *Channa striatus* was 19.9%, 22.1%, 23.0% (% of dry weight), respectively. The total lipid content was generally high, ranging from 5.7% to 11.9% and crude ash ranged from 1.0% to 1.8%. The major amino acids were glutamic acid, aspartic acid and lysine, ranging from 9.7% to 21.7%, and the most abundant fatty acid in *Channa* spp. was C16:0, ranging from 25.6% to 30.4%. The other major fatty acids detected were C22:6, C18:1 and C18:0. The level of arachidonic acid (C20:4) was unusually high in *C. striatus* (19.02%). The levels of DHA in these fish would also explain the use of *Channa* spp., especially *C. striatus*, which has been used for centuries for reducing pain, inflammation and promote wound healing in Malaysia.

Keywords: Fatty acids; Amino acids; *Channa* spp.; Malaysian fish

1. Introduction

Channa striatus, Channa micropeltes and *Channa lucius*, 'haruan', 'toman' and 'bujuk', respectively, in Malay, are snakehead fish belonging to the Channidae family. They are indigenous to many tropical and subtropical countries including Malaysia and are fresh water, air breathing, carnivorous fish, which are a valuable source of protein throughout the Asia Pacific region (Mohsin & Ambak, 1983).

C. striatus has been studied extensively for its putative effects on wound healing (Baie & Sheikh, 2000; Mat Jais, McCulloh, & Croft, 1994; Wee, 1982). It is used by patients in the post-operative period to promote wound healing (Mat Jais, Dambisya, & Lee, 1997) and to reduce pain (Zakaria, Somchit, Sulaiman, & Mat Jais, 2004). The other two closely related *C. micropeltes* and *C. lucius* have been not extensively reviewed for their medicinal purposes. Recently, we reported that all three *Channa* spp. fish possess anti-inflammatory properties (Somchit et al., 2004). Furthermore, only Mat Jais et al. (1994) have reported preliminary analysis of fatty and amino acid of *C. striatus* and there are no previous reports of the other two species with respect to these biochemical parameters.

Fish is known to contain certain polyunsaturated fatty acids that can regulate prostaglandin synthesis

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and hence induce wound healing (Bowman & Rand, 1980; Gibson, 1983). ω-3 and ω-6 polyunsaturated fatty acids (PUFA) have been shown to have positive effects on cardiovascular diseases and cancers (Conner, 1997). PUFA composition may vary among species of fish, even among fresh water and marine fish (Abd Rahman, The, Osman, & Daud, 1995). Certain amino acids like aspartic acid, glycine and glutamic acid are also known to play a key role in the process of wound healing (Chyun & Griminger, 1984). Thus, this study was carried out to determine the fatty acid and amino acid composition of three common Malaysian *Channa* spp. fish.

2. Materials and methods

Adult *Channa striatus* (1.0–2.0 kg/fish), *Channa micropeltes* (2.0–2.3 kg/fish) and *Channa lucius*(0.7–1.2 kg/fish) were caught from the wild in Kuala Terengganu (East Coast of Malaysia), Kangar (North of Malaysia), Serdang Selangor (Central Malaysia) and Muar Johor (South of Malaysia) (Fig. 1) and were verified by the State Fisheries Department, Ministry of Agriculture, Malaysia.

Samples were kept in plastic bags and transported in an insulated icebox to the laboratory. Within 12 h, samples were gutted, washed and filleted. Samples were pooled according to their location of sampling. Proximate analysis to determine crude protein, fat, ash and moisture was performed in triplicate for each location of sampling according to methods of Wahbeh (1997). Moisture, ash and fat contents were assayed by the Association of the Official Analytical Chemists (AOAC, 1984) methods 14004 (1984), 14009 (1984) and 14006 (1984), respectively. Nitrogen was determined using the Kjeldahl method. The quantity of protein was calculated as $6.25 \times N$ (method 7015, AOAC, 1984).

For amino acid analysis, methods of Vidotti, Viegas, and Carneiro (2003) were employed. Triplicate samples were hydrolysed with 6 N hydrochloric acid for 24 h at

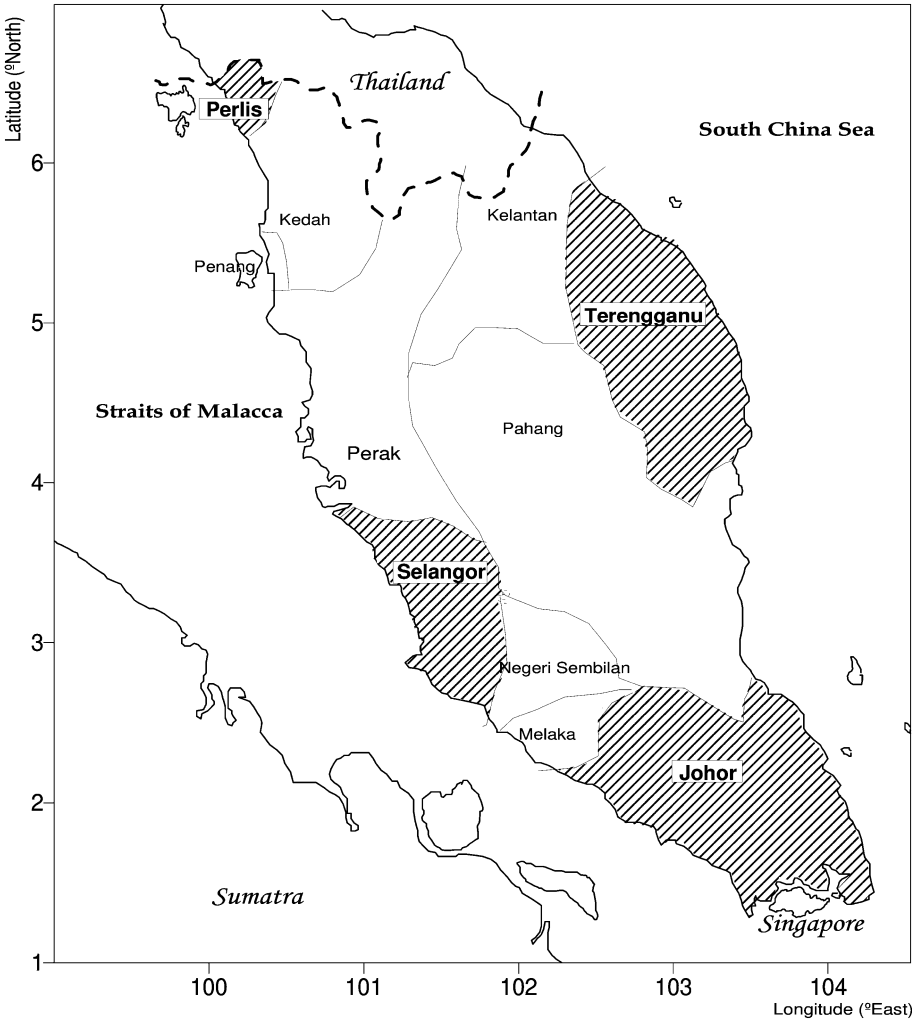

Fig. 1. Map of Peninsular Malaysia and locations of *Channa* spp. sampling.

110 °C. The hydrolysed samples were then analysed using an automatic amino acid analyzer L-8500 (Hitachi, Japan) with a ninhydrin reagent and lithium buffer system by injecting 20 μl (Yamamoto, Unuma, & Akiyama, 1998). The reproducibility of the results was within approximately 3%. The net height of each peak produced by the chart recorder of the analyzer (each representing an amino acid) was measured and calculated.

Total lipid extraction of the samples was carried out in triplicate according to a modified Folch method (1957) as described by Rajion (1985), using a chloroform:methanol (2:1, v/v) solvent system. Transmethylation was carried out using 14% methanolic boron trifluoride. The derived fatty acid methyl esters (FAMEs) were separated on a Quadrex 007 series bonded phase fused silica capillary column (Quadrex Corporation, New Haven, CT, USA) (30 m × 0.25 mm ID, 0.20 mm film thickness, 007 Carbowax/BTR) in a 5890 Hewlett-Packard Gas-Liquid Chromatograph (Hewlett-Packard Co., Avondale, PA). Individual fatty acids were identified and quantified by comparison with retention times and peak areas of FAMEs standards from Supleco.

3. Results

The proximate analysis of the three *Channa* spp. fish is shown in Table 1. Water content (% wet weight) ranged from 80.0% to 83.5%. The crude protein content ranged from 19.9% in *C. lucius* to 23.0% in *C. striatus*. The total lipid content was generally high ranging from 5.7% to 11.9%. Crude ash ranged from 1.0% to 1.8% (all in% dry weight).

The fatty acid composition (% of total fatty acid) of the three fish species is summarized in Table 2. The most abundant fatty acid in *Channa* spp. is C16:0 ranging from 25.6% to 30.4%. The other major fatty acids are C22:6, C18:1 and C18:0. *C. striatus* has the ω-3:ω-6 ratio of lower than 1 (0.55), whereas *C. micropeltes* and *C. lucius* has 2.37 and 1.21, respectively. The PUFA/Saturated (P/S) ratio obtained ranged from 0.82 to 1.06 (Table 3).

The amino acid composition (% of total protein) is illustrated in Table 4. The major amino acids are glutamic acid, aspartic acid and lysine (Ranging from 9.7% to 21.7% of total). Levels of different amino acids are from 0.9% to 21.7% in *C. striatus*, 0.1% to 19.4% in *C. micropeltes* and 0.6% to 21.2% in *C. lucius*.

4. Discussion

The nutritive quality of three *Channa* spp. fish as a source of protein and fatty acid was investigated. All three species were rich in amino acid (Table 4) and fatty acid (Tables 2 and 3). Based on total fat content, *C. striatus* was approximately 5% by weight, while *C. micro-*

Table 1
Proximate composition of three *Channa* spp. fish

Species	Crude protein (% DW)	Crude fat (% DW)	Crude ash (% DW)	Moisture (% WW)
C. striatus	23.0 ± 0.7	5.7 ± 1.9	1.8 ± 0.07	83.5 ± 6.7
C. micropeltes	22.1 ± 0.6	9.3 ± 2.7	1.0 ± 0.01	82.1 ± 9.1
C. lucius	19.9 ± 1.3	11.9 ± 4.2	1.2 ± 0.11	80.0 ± 5.4

Values are mean ± SD of three separate determinations.
DW, dry weight; WW, wet weight.

Table 3
Fatty acid ω-3/ω-6 and polyunsaturated/saturated fatty acid ratio in three *Channa* spp. fish

Species	ω-3:ω-6 ratio	Ratio of P/S
C. striatus	0.55	0.89
C. micropeltes	2.37	0.82
C. lucius	1.21	1.06

P/S, polyunsaturated/saturated fatty acid ratio.

Table 2
Fatty acid composition of three *Channa* spp. fish

Fatty acid	*Channa striatus*	*Channa micropeltes*	*Channa lucius*
C14:0 (Myristic acid)	ND	2.69 ± 0.02	ND
C16:0 (Palmitic acid)	30.39 ± 0.23	26.20 ± 2.01	25.63 ± 1.45
C18:0 (Stearic acid)	15.18 ± 0.15	12.62 ± 1.18	13.43 ± 1.04
C20:0 (Arachidic acid)	ND	0.89 ± 0.03	ND
C16:1 (Palmitoleic acid)	2.98 ± 0.07	4.8 ± 0.34	11.79 ± 0.85
C18:1 (Oleic acid)	12.04 ± 0.54	21.44 ± 0.98	17.01 ± 1.27
C18:2 (Linoleic acid)	8.34 ± 1.01	5.39 ± 0.27	4.91 ± 0.34
C18:3 (Linolenic acid)	ND	1.38 ± 0.63	ND
C20:4 (Arachidonic acid)	19.02 ± 0.78	4.71 ± 0.95	12.41 ± 1.18
C20:5 (Eicosapentanoic acid)	ND	3.10 ± 0.21	ND
C22:6 (Decosahexanoic acid)	15.18 ± 1.12	21.83 ± 2.31	20.84 ± 1.42

Values are % of total fatty acid expressed as mean ± SD of three separate determinations.
ND, not detected.

Table 4
Amino acid composition of three *Channa* spp. fish

Amino Acid	*Channa striatus*	*Channa micropeltes*	*Channa lucius*
Aspartic acid	11.4 ± 0.12	11.7 ± 1.4	10.6 ± 1.23
Glutamic acid	21.7 ± 0.9	19.4 ± 1.9	21.2 ± 1.97
Serine	4.8 ± 0.03	5.2 ± 0.77	4.9 ± 0.26
Glycine	4.3 ± 0.19	3.7 ± 0.15	3.6 ± 0.06
Histidine	1.2 ± 0.02	1.7 ± 0.07	1.8 ± 0.04
Arginine	5.9 ± 0.15	7.2 ± 0.54	6.0 ± 0.17
Threonine	4.2 ± 0.06	4.6 ± 0.45	4.3 ± 0.26
Alanine	5.8 ± 0.73	4.2 ± 0.75	6.1 ± 0.34
Proline	3.2 ± 0.21	3.2 ± 0.23	3.0 ± 0.18
Tyrosine	3.6 ± 0.14	3.8 ± 0.51	3.6 ± 0.26
Valine	4.2 ± 0.09	4.4 ± 0.26	4.4 ± 0.51
Methionine	3.4 ± 0.11	4.0 ± 0.91	3.6 ± 0.16
Cystine	0.9 ± 0.15	0.1 ± 0.03	0.6 ± 0.05
Isoleucine	3.8 ± 0.25	4.0 ± 0.17	3.8 ± 0.14
Leucine	7.5 ± 0.85	7.4 ± 0.97	7.7 ± 0.76
Phenylalanine	4.3 ± 1.2	4.8 ± 0.65	4.6 ± 0.48
Lysine	9.7 ± 0.57	10.9 ± 1.05	10.1 ± 1.42

Values are % of total amino acid expressed as mean ± SD of three separate determinations.

peltes and *C. lucius* were approximately 9–11%. Osman, Suriah, and Law (2001) reported that low-fat fish have higher water content, as observed in this study (Table 1), *C. striatus* had the highest moisture content. Fat content is influenced by species, geographical regions, age, and diet (Piggott & Tucker, 1990).

All three *Channa* spp. fish contained arachidonic acid (C20:4), which is a precursor for prostaglandin and thromboxane biosynthesis (Pompeia, Freitas, Kim, Zyngier, & Curi, 2002). This will interfere the blood clotting process and its attachment to endothelial cells during wound healing (Abd Rahman et al., 1995). The level of arachidonic acid was unusually high in *C. striatus* (19.02%). This was in agreement with our previous study (Mat Jais et al., 1994). *C. striatus* has been used for centuries for reducing pain, inflammation and promote wound healing in Malaysia. The levels of DHA in these fish also would explain the use of *Channa* spp. especially *C. striatus* for muscle pain and inflammation (Mohsin & Ambak, 1983). DHA and EPA had been shown to have preventive effects on human coronary artery disease (Leaf & Webber, 1988). Therefore, fish have been suggested as a key component for a healthy diet in humans (Abd Rahman et al., 1995). Furthermore, our previous studies (Somchit et al., 2004; Zakaria et al., 2004) revealed *C. striatus* has potent anti-inflammatory and analgesic activities. Huang, Bisogno, and Petros (2001) demonstrated that a lipoamino acid, arachidonoylglycine suppressed edema and pain. Both arachidonic acid and glycine were detected in all three fish.

Both fatty and amino acids are important components for healing processes. Any deficiency in these essential components will hinder the recovery process (Mat Jais et al., 1994). Glycine, which is one of the major components of human skin collagen, together with other essential amino acids such as alanine, proline, arginine, serine, isoleucine and phenyl alanine form a polypeptide that will promote regrowth and tissue healing (Heimann, 1982; Witte, Thornton, Tantry, & Barbul, 2002). Dewan, Gupta, Gupta, and Uma (2003) reported supplementation of the diet with polyunsaturated fatty acids enhanced *Helicobacter pylori* eradication and duodenal ulcer healing. All three *Channa* spp. contained the required amino acids for promoting wound healing.

The ω-3:ω-6 ratio has been suggested to be a useful indicator for comparing relative nutritional values of fish oils. It was suggested that a ratio of 1:1–1:5 would constitute a healthy human diet (Osman et al., 2001). All three fish had the ω-3:ω-6 ratio within the recommended ratio. The P/S ratio revealed that all three fish were an average source of PUFA. It has been reported that marine fish are a good source of PUFA (Osman et al., 2001).

Fresh water and marine fish are very important components of the Malaysian diet, and fish constitute approximately 60–70% of the protein intake in Malaysia (Abd Rahman et al., 1995). In conclusion, based on our findings, all three *Channa* spp. fish are a good source of amino acids and fatty acids. These fish may provide an alternative source of protein and fat for the populations of developing countries.

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