SUPPLEMENTARY MATERIAL

Proximate composition, amino acid and fatty acid composition of fish maws

Jing Wen^a, Ling Zeng^{b*}, Youhou Xu^c, Yulin Sun^a, Ziming Chen^b and Sigang Fan^d

^a Department of Biology, Lingnan Normal University, Zhanjiang, 524048, China

^b Department of Chemistry, Lingnan Normal University, Zhanjiang, 524048, China

^c Guangxi Key Laboratory of Beibu Gulf Marine Biodiversity Conservation, Qinzhou University, Qinzhou, 535000, China

^d Key Laboratory of South China Sea Fishery Resources Exploitation & Utilization, Ministry of Agriculture; South China Sea Fisheries Research Institute, Chinese Academy of Fisheries Sciences, Guangzhou 510300, China

* Corresponding author. E-mail: karine126@126.com

Abstract

Fish maws are commonly recommended and consumed in Asia over many centuries because it is believed to have some traditional medical properties. The present study highlights and provides new information on the proximate composition, amino acid and fatty acid composition of fish maws *Cynoscion acoupa*, *Congresox talabonoides* and *Sciades proops*. The results indicated that fish maws were excellent protein sources and low in fat content. The proteins in fish maws were rich in functional amino acids and the ratio of FAA: TAA (functional amino acids: total amino acids) in fish maws ranged from 0.68-0.69. Among species, croaker *C. acoupa* contained most PUFA (polyunsaturated fatty acids), AA (arachidonic acid), DHA (docosahexaenoic acid) and EPA (eicosapentamethanoic acid), showing the lowest value of IA (index of atherogenicity) and IT (index of thrombogenicity), showing the highest value of HH (hypocholesterolemic / hypercholesterolemic ratio), which is the most desirable.

Keywords: fish maw; proximate composition; amino acids; fatty acids

3. Experimental

3.1. Sample preparation

The dried fish maw samples of *C. acoupa*, *S. proops* and *C. talabonoides* were purchased from the Yidelu dried seafood retail market in Guangzhou, China. For each species, there were 30 maw samples which were divided into three groups for three different analyses. The samples were ground using a grinder into fine powder. For each analysis, 100 g maw powder was used.

3.2. Proximate chemical composition

Moisture, protein, fat and ash contents were determined according to AOAC (1990).

3.3. Amino acid analysis

Amino acid content of samples was measured according to Wen et al. (2010). Amino acids were expressed in mg/g of crude protein: amino acid content (% w/w) $\times$ 1000 / crude protein content (% w/w).

3.4. Amino acid score

Essential amino acid scores were calculated according to reference amino acid requirements of adults (FAO/WHO/UNU, 2007) and child (FAO/WHO/UNU, 1985). The amino acid score was calculated using the following formula: amino acid score = amount of amino acid per test protein (mg g⁻¹) / amount of amino acid per protein in reference pattern (mg g⁻¹) $\times$ 100.

3.5. Fatty acid analysis

Fatty acid content of samples was measured according to Wen et al. (2010). Gas chromatography–mass spectrometry (GC-MS) was performed on an Agilent Technologies 5973 instrument. Individual components were identified using mass spectral data and by comparing retention time data with those obtained for authentic and laboratory standards. Peak area was quantified and expressed as percentage of total fatty acids.

3.6. Indexes of fat quality

The nutritional quality of the fats were determined from the data on the fatty acid composition, the following three indexes were calculated: (1) Index of atherogenicity (IA) (Ulbricht & Southgate, 1991): $IA = [(C12:0 + (4 \times C14:0) + C16:0)] / (\Sigma MUFA$

+ Σ n-6 PUFA + Σ n-3 PUFA). (2) Index of thrombogenicity (IT) (Ulbricht & Southgate, 1991): $IT = (C14:0 + C16:0 + C18:0) / [(0.5 \times \Sigma \text{ MUFA}) + (0.5 \times \Sigma \text{ n-6 PUFA}) + (3 \times \Sigma \text{ n-3 PUFA}) + (\Sigma \text{ n-3 PUFA} / \Sigma \text{ n-6 PUFA})]$. (3) The hypocholesterolaemic/ hypercholesterolaemic ratio (HH) (Santos-Silva, Bessa, & Santos-Silva, 2002): $HH = (C18:1 \text{ cis-9} + C18:2 \text{ n-6} + C20:4 \text{ n-6} + C18:3 \text{ n-3} + C20:5 \text{ n-3} + C22:5 \text{ n-3} + C22:6 \text{ n-3}) / (C14:0 + C16:0)$.

3.7. Statistical analysis

All analyses were repeated in triplicate. Results were expressed as mean values $\pm$ standard deviation and analysis of variance were carried out using a statistical analysis system (SPSS Version 12). Differences between species were compared by the Tukey's test. Differences were considered to be significant when $P < 0.05$.

Tables

Table S1. Proximate composition (% w/w) of fish maws (mean values $\pm$ standard deviation).

Species	Moisture	Protein	Fat	Ash
<i>Cynoscion acoupa</i>	17.55 $\pm$ 0.27a	81.26 $\pm$ 0.24a	0.51 $\pm$ 0.01b	0.68 $\pm$ 0.01c
<i>Congresox talabonoides</i>	18.14 $\pm$ 0.28a	79.34 $\pm$ 0.33b	1.08 $\pm$ 0.01a	1.40 $\pm$ 0.02b
<i>Sciades proops</i>	17.86 $\pm$ 0.38a	79.75 $\pm$ 0.45b	0.56 $\pm$ 0.01b	1.83 $\pm$ 0.01a

Values in the same column bearing different letters are significantly different ($P < 0.05$).

Table S2. Amino acid composition (mg/g crude protein) of fish maws (mean values $\pm$ standard deviation).

Amino acid	<i>Cynoscion acoupa</i>	<i>Congresox talabonoides</i>	<i>Sciades proops</i>
Asp ^b	64.6 $\pm$ 0.99a	65.4 $\pm$ 1.09a	60.4 $\pm$ 0.88b
Ser	31.0 $\pm$ 0.56a	29.2 $\pm$ 0.64a	33.2 $\pm$ 0.66a
Glu ^b	119 $\pm$ 1.89a	107 $\pm$ 1.63c	113 $\pm$ 1.70b
Gly ^b	216 $\pm$ 4.04a	215 $\pm$ 3.96a	213 $\pm$ 3.95a
Ala	116 $\pm$ 1.84b	120 $\pm$ 1.89a	106 $\pm$ 1.77c
Pro ^b	130 $\pm$ 2.14a	125 $\pm$ 2.04b	127 $\pm$ 2.08b
Arg ^b	90.2 $\pm$ 1.67a	91.1 $\pm$ 1.73a	89.5 $\pm$ 1.66a
Val ^a	24.8 $\pm$ 0.46b	30.9 $\pm$ 0.54a	31.6 $\pm$ 0.58a
Met ^{a, b}	23.5 $\pm$ 0.42a	21.8 $\pm$ 0.39a	18.5 $\pm$ 0.33b
Ile ^a	12.6 $\pm$ 0.28c	16.0 $\pm$ 0.36b	20.6 $\pm$ 0.42a
Leu ^{a, b}	33.5 $\pm$ 0.65b	31.4 $\pm$ 0.58b	36.7 $\pm$ 0.76a
Tyr ^{a, b}	9.00 $\pm$ 0.24b	10.4 $\pm$ 0.28b	18.5 $\pm$ 0.30a
Phe ^a	25.5 $\pm$ 0.53b	23.7 $\pm$ 0.50b	28.0 $\pm$ 0.55a
His ^a	9.10 $\pm$ 0.25c	13.4 $\pm$ 0.30b	17.3 $\pm$ 0.39a
Lys ^a	45.9 $\pm$ 0.83a	43.2 $\pm$ 0.79a	37.2 $\pm$ 0.73b
Thr ^a	37.2 $\pm$ 0.78a	32.3 $\pm$ 0.66b	38.0 $\pm$ 0.76a
Trp ^{a, b}	7.12 $\pm$ 0.15a	8.09 $\pm$ 0.17a	7.51 $\pm$ 0.17a
EAA / NEAA	0.30	0.31	0.34
FAA / TAA	0.69	0.68	0.68

Notes: Asp, aspartic acid; Ser, serine; Glu, glutamic acid; Gly, glycine; Ala, alanine; Pro, proline; Arg, arginine; Val, valine; Met, methionine; Ile, isoleucine; Leu, leucine; Tyr, tyrosine; Phe, phenylalanine; His, histidine; Lys, lysine; Thr, threonine; Trp, tryptophan; EAA / NEAA, essential amino acids / nonessential amino acids; FAA / TAA, functional amino acids / total amino acids.

Values in the same row bearing different letters are significantly different ($P < 0.05$).

^a Essential amino acids.

^b Functional amino acids.

Table S3. Essential amino acids scores of fish maws.

Amino acid	Reference ^a	Score (for adults)			Reference ^b	Score (for children)		
		<i>Cynoscion acoupa</i>	<i>Congresox talabonoides</i>	<i>Sciades proops</i>		<i>Cynoscion acoupa</i>	<i>Congresox talabonoides</i>	<i>Sciades proops</i>
Val	39	64	79	81	35	71	88	90
Met	22	107	99	84	25	94	87	74
Ile	30	42	53	69	28	45	57	74
Leu	59	57	53	62	66	51	48	56
Phe + Tyr	30	115	114	155	63	55	54	74
His	15	61	89	115	19	48	71	91
Lys	45	102	96	83	58	79	74	64
Thr	23	162	140	165	34	109	95	112
Trp	6	119	135	125	11	65	74	68

Abbreviations of amino acid are as in Table S2.

^a Reference amino acid requirements of adults (FAO/WHO/UNU, 2007).

^b Reference amino acid requirements of child (FAO/WHO/UNU, 1985).

1 Table S4. Fatty acid profiles (% of total fatty acids, mean values $\pm$ standard deviation) of fish
2 maws.

Fatty acid	<i>Cynoscion acoupa</i>	<i>Congresox talabonoides</i>	<i>Sciades proops</i>
C14:0	2.36 $\pm$ 0.05b	3.22 $\pm$ 0.05a	1.53 $\pm$ 0.03c
C15:0	0.77 $\pm$ 0.02b	1.39 $\pm$ 0.02a	1.23 $\pm$ 0.03a
C16:0	26.12 $\pm$ 0.58b	32.33 $\pm$ 0.78a	33.70 $\pm$ 0.82a
C17:0	1.45 $\pm$ 0.02b	2.66 $\pm$ 0.04a	1.75 $\pm$ 0.02b
C18:0	22.83 $\pm$ 0.61b	18.37 $\pm$ 0.37c	25.01 $\pm$ 0.56a
C20:0	0.86 $\pm$ 0.01a	0.80 $\pm$ 0.01a	0.87 $\pm$ 0.01a
C21:0	nd	0.20 $\pm$ 0.01	nd
C22:0	0.64 $\pm$ 0.02b	0.46 $\pm$ 0.01c	0.86 $\pm$ 0.02a
C23:0	0.22 $\pm$ 0.01b	0.19 $\pm$ 0.01b	0.33 $\pm$ 0.01a
C24:0	0.52 $\pm$ 0.01a	0.26 $\pm$ 0.01b	0.59 $\pm$ 0.02a
Σ SFA	55.77 $\pm$ 0.28c	59.88 $\pm$ 0.29b	65.87 $\pm$ 0.27a
C14:1	nd	0.18	nd
C15:1	0.51 $\pm$ 0.03	nd	nd
C16:1 n-7	3.65 $\pm$ 0.06a	3.69 $\pm$ 0.05a	3.13 $\pm$ 0.05b
C17:1	0.59 $\pm$ 0.02b	0.82 $\pm$ 0.01a	0.45 $\pm$ 0.01b
C18:1 n-9	15.30 $\pm$ 0.36b	18.69 $\pm$ 0.40a	19.39 $\pm$ 0.33a
C20:1 n-9	2.42 $\pm$ 0.03a	0.82 $\pm$ 0.02c	1.99 $\pm$ 0.02b
C22:1 n-9	0.42 $\pm$ 0.01a	0.23 $\pm$ 0.01b	nd
C24:1 n-9	1.83 $\pm$ 0.01a	0.82 $\pm$ 0.02b	0.69 $\pm$ 0.03b
Σ MUFA	24.72 $\pm$ 0.27a	25.25 $\pm$ 0.31a	25.65 $\pm$ 0.21a
C18:2 n-6	3.36 $\pm$ 0.06a	2.06 $\pm$ 0.03c	2.64 $\pm$ 0.03b
C18:3 n-6	nd	0.96 $\pm$ 0.01	nd
C20:2 n-6	0.24 $\pm$ 0.01b	0.37 $\pm$ 0.01a	nd
C20:4 n-6 (AA)	5.75 $\pm$ 0.10a	4.39 $\pm$ 0.06b	3.93 $\pm$ 0.06c
Σ n-6	9.35 $\pm$ 0.05a	7.78 $\pm$ 0.06b	6.57 $\pm$ 0.04c
C18:3 n-3	0.49 $\pm$ 0.01a	0.28 $\pm$ 0.01b	nd
C20:3 n-3	0.21 $\pm$ 0.01b	0.55 $\pm$ 0.02a	nd
C20:5 n-3 (EPA)	2.26 $\pm$ 0.02a	1.23 $\pm$ 0.02b	0.42 $\pm$ 0.01c
C22:6 n-3 (DHA)	7.20 $\pm$ 0.15a	5.02 $\pm$ 0.09b	1.50 $\pm$ 0.02c
EPA + DHA	9.46 $\pm$ 0.08a	6.25 $\pm$ 0.05b	1.92 $\pm$ 0.03c
Σ n-3	10.16 $\pm$ 0.07a	7.08 $\pm$ 0.06b	1.92 $\pm$ 0.03c
Σ PUFA	19.51 $\pm$ 0.09a	14.86 $\pm$ 0.06b	8.49 $\pm$ 0.06c

3 Notes: nd, not detected; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA,
4 polyunsaturated fatty acids; n-6, n-6 PUFA; n-3, n-3 PUFA.
5 Values in the same row bearing different letters are significantly different ($P < 0.05$).
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11 Table S5. Indexes of fat quality in fish maws.

Species	Σ PUFA / Σ SFA	Σ n-3 / Σ n-6	IA	IT	HH
<i>Cynoscion acoupa</i>	0.35	1.09	0.80	1.06	1.21
<i>Congresox talabonoides</i>	0.25	0.91	1.13	1.39	0.89
<i>Sciades proops</i>	0.13	0.29	1.17	2.72	0.79

12 Abbreviations of fatty acid are as in Table S4.

13 Notes: IA, index of atherogenicity; IT, index of thrombogenicity; HH, hypocholesterolemic /
 14 hypercholesterolemic ratio.

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