Notas Científicas

Chemical composition and fatty acid contents in farmed freshwater prawns

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Abstract – The objective of this work was to evaluate the chemical composition and fatty acid contents of Amazonian and giant river prawns. After four-month farming, with the same diet for both species, palmitic and stearic acids were the main saturated fatty acids. Oleic acid was the main monounsatured fatty acid, and the eicosapentaenoic and docosahexaenoic acids were the most abundant polyunsaturated acids. Amazonian prawn has higher levels of protein and polyunsaturated fatty acids than those of the giant river prawn, which shows its potential for aquaculture.

Index terms: *Macrobrachium amazonicum*, *Macrobrachium rosenbergii*, amino acid, fatty acids, meat quality.

Composição química e teor de ácidos graxos em camarões de água doce cultivados

Resumo – O objetivo deste trabalho foi avaliar a composição química e os teores de ácidos graxos do camarão-amazônico e do camarão-da-malásia. Após cultivo de quatro meses, com a mesma dieta para ambas as espécies, os principais ácidos graxos saturados foram o palmítico e o esteárico. O oleico foi o principal ácido graxo monoinsaturado, e o eicosapentaenoico e o docosahexaenoico foram os ácidos poli-insaturados mais abundantes. O camarão-amazônico apresenta níveis mais elevados de proteínas e de ácidos graxos poli-insaturados do que os do camarão-da-malásia, o que mostra seu potencial para a aquicultura.

Termos para indexação: *Macrobrachium amazonicum*, *Macrobrachium rosenbergii*, aminoácido, ácidos graxos, qualidade da carne.

The potential for substantial, technically feasible farming expansion of freshwater prawns remains an opportunity yet to be exploited in South and Central America countries (New, 2009). Therefore, there is great pressure to use indigenous species in aquaculture. Among the native species to South America, the Amazon River prawn (*Macrobrachium amazonicum*) offers great potential for aquaculture (Moraes-Valenti & Valenti, 2009). Since 2001, a multidisciplinary and multi-institution program has been devoted to the development of technology for the culture of *M. amazonicum* in Brazil (Marques & Moraes-Valenti, 2012). Preliminary studies have reported high survival rates, and that the species exhibits rapid growth and development in ponds, as well as high resistance to diseases (Araujo & Valenti, 2007). Amazon River prawn is a target species for regional fisheries, and a candidate for aquaculture in Brazil (Anger et al., 2009).

Exotic species *M. rosenbergii* was first introduced in Brazil in 1977 by the Universidade Federal de Pernambuco; since then, a number of other public and private institutions have conducted their own introductions (Cavalcanti, 1998). Currently, Brazilian commercial aquaculture projects with this species present good economic viability, with high rate of return and low investiment in technology (Marques & Moraes-Valenti, 2012).

In aquaculture, the chemical composition is very important for animal nutritional requirements, and the effect of diet on nutrient accumulation in meat of cultured species is important for human health. The chemical composition of aquatic animals can be influenced by many parameters including genetic factors, geographic origin, domestication level, availability and quality of food, and season (Mairesse et al., 2006). Thus, data comparison for *Macrobrachium*

species is useful because it can show the influence of genetic factors on the chemical composition of farmed species under similar conditions.

The objective of this work was to evaluate the chemical composition and fatty acid contents of Amazonian and giant river prawns.

Macrobrachium amazonicum post-larvae (0.01 g) at 140.000 post-larvae per m^3 were stocked in 12 ponds (Caunesp, Jaboticabal, SP, Brazil). Commercial marine shrimp diet HD32, containing 32% (minimum) protein, 7% (minimum) lipid, 13% (maximum) moisture, 13% crude fiber (maximum), and 6% mineral matter (maximum) (Fri-Ribe, Pitangueiras, SP, Brazil) was supplied twice a day. Prawns were harvested at the end of four months and were randomly sorted for composition analyses. *M. rosenbergii* were simultaneously cultured under the same conditions for comparison.

Maximum and minimum water temperatures were monitored daily in the morning and afternoon, respectively. Dissolved oxygen 550A (Yellow Springs Instruments, OH, USA), pH F-1002 (Bernauer Aquacultura, Indaial, SC, Brazil), and conductivity F-1000 (Bernauer Aquacultura, Indaial, SC, Brazil) were measured weekly in the morning, at 30 cm depth, in the surrounding cage and net pen areas. Water samples were collected bi-weekly to determine alkalinity, total ammonia, nitrite, nitrate and total phosphorous. All analyses were carried out according to American Public Health Association (2005).

Chemical composition analyzes were performed on meat; prawn cephalothorax, legs and abdominal skeleton were removed. Muscle samples were ground and homogenized. Analyses for moisture, total nitrogen, protein levels, and ash were based on procedures set by the Horwitz (2005). Lipids were extracted using the method described by Folch et al. (1957). Energy content was estimated using 17.9 kJ g^{-1} wet weight for proteins, and 37.7 kJ g^{-1} wet weight for lipids (Schakel et al., 2009). After extraction, lipids were esterified according to Hartman & Lago (1973). Gas chromatography was performed using a gas cromatograph (Shimadzu, Kyoto, Japan) equipped with a fused silica capillary column Supelcowax 10, 30 m, 0.25 mm internal diameter (Sigma- Aldrich Co., St Louis, MO, USA), a flame ionization detector, and a split injector.

Dry matter samples (25 mg) were hydrolyzed with 6 mol L^{-1} HCl for 22 hours at 110°C. A 25 mg subsample of hydrolyzate was filtered and dissolved in sodium citrate buffer, pH 2.2 (Spackman et al., 1958). Amino acid analysis was performed on an ion exchange amino acid analyzer model DX300 (Dionex, Corporation, Sunnyvale, CA, USA). Tryptophan was quantified according to Spies (1967). Amino acid analyses were performed only for *M. amazonicum*.

Higher levels of lipids and proteins were found in *M. amazonicum* than in *M. rosenbergii* (Table 1). Prawn fat content is species-specific, and can be affected by season, geographical variation, reproductive maturation, growth, water temperature, and dietary energy intake (Karapanagiolidis et al., 2010). However, lipid content of crustacean species is generally between 1 and 2% (Karapanagiolidis et al., 2010).

Protein content in a foodstuff is estimated by multiplying the nitrogen content by a nitrogen-to-protein conversion factor, usually 6.25; however, the nitrogen/protein ratio varies according to the foodstuff considered (Mariotti et al., 2008). This value for the conversion factor has been widely questioned (Mariotti et al., 2008). If protein percentage according to the amino acid profile is divided by the level of nitrogen in samples of *M. amazonicum*, a 5.89 conversion factor for shrimp is calculated. Thus, if 6.25 is applied, protein is overestimated by 6% (Table 1). Overestimated protein value lead to higher energy values, therefore, it is important to find the true value of the correction factor for proteins in prawns.

The predominant fatty acids in both species were $C_{16:0}$ (palmitic acid), $C_{18:0}$ (stearic acid), $C_{18:2\ n-6}$ (linoleic acid), $C_{20:4n-6}$ (arachidonic acid), $C_{20:5n-3}$ (eicosapentaenoic acid, EPA) and $C_{22:6n-3}$ (docosahexaenoic acid) (Table 2). Arachidonic acid is normally present in lipids of freshwater fish and prawns from temperate latitudes in a ratio to DHA ranging from 0.5:1 to 1:1 (Li et al., 2011). This relationship can be observed for the two species. Furuya et al. (2006) found only 0.4% arachidonic acid for *M. amazonicum*, with 1:17, arachidonic acid:DHA. This value was found probably due to incorrect fatty acid identification.

The sum of the major fatty acid concentration was approximately 80% of the total. Similar results have been reported by Bragagnolo & Rodriguez-Amaya (2001) for *M. rosenbergii*.

The sums for saturated fatty acids (∑SFA), monounsaturated fatty acids (∑MUFA) and

polyunsaturated fatty acids (∑PUFA) followed the order PUFA>SFA>MUFA for both species. Of the SFAs, palmitic acid and stearic acid were found in high amounts for both species.

The present results reflect the fatty acid composition of the diet used. A distinguishing feature of crustaceans is that $C_{20:5n-3} \geq C_{22:6n-3}$, as observed in Table 2 for the two species. Despite the fact that prawns contain small amounts of fat, they were found rich in n-3 fatty acids.

Table 1. Chemical composition (wet weight) and percentage of fatty acid composition (mean±standard deviation) of *Macrobrachium amazonicum* and *M. rosenbergii* prawns[1].

Chemical composition (g 100g^{-1})	*M. amazonicum*	*M. rosenbergii*
Moisture	76.5±0.28a	78.4±0.02b
Lipid	1.5±0.07a	1.2±0.04b
Ash	1.3±0.01a	1.3±0.00a
Protein[2]	21.5±0.84a	18.5±1.25b
Protein[3]	20.00±0.79	17.41±1.16
Protein[4]	20.24±0.64	-
Energy (kJ 100g^{-1})	440.7±12.4a	389.26±5.69b
Fatty acid[5]		
Saturated		
$C_{14:0}$	1.33±0.13a	1.04±0.12b
$C_{16:0}$	21.35±0.11a	20.01±0.38b
$C_{17:0}$	1.08±0.04a	0.98±0.08a
$C_{18:0}$	10.93±0.23a	11.59±0.50b
ΣSFA	34.69±0.34a	34.35±0.71a
Monounsaturated		
$C_{16:1n-7}$	3.11±0.55a	1.39±0.10b
$C_{18:1n-7}$	4.59±0.41a	3.10±0.01b
$C_{18:1n-9}$	18.13±0.82a	20.02±0.31b
ΣMUFA	25.88±1.48a	24.51±0.39a
Polyunsaturated		
$C_{18:2n-6}$	13.21±0.20a	15.90±0.46b
$C_{18:3n-3}$	1.44±0.09a	1.50±0.27b
$C_{20:2n-9}$	0.98±0.01a	1.09±0.03b
$C_{20:4n-6}$	5.24±0.07a	5.53±0.42a
$C_{20:5n-3}$	11.71±1.10a	11.69±0.04a
$C_{22:5n-3}$	1.15±0.10a	0.80±0.01b
C22:6n-3	6.11±0.56a	4.33±0.02b
ΣPUFA	39.48±1.90a	40.83±1.19a
ΣPUFA n-3	20.40±1.66a	18.31±0.34a
ΣPUFA n-6	18.45±0.23a	21.43±0.88b
EPA+DHA	17.82±1.66a	16.01±0.06a
ΣPUFA n-6/ ΣPUFA n-3	0.91±0.06a	1.23±0.12b

[1]Different letters within a row denote significant differences, at 5% probability. [2]Usual conversion factor. [3]Sosulki & Imafidon (1990). [4]Calculated from the amino acid profile determined in this study. [5]SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid.

The most abundant amino acids in *M. amazonicum* were glutamic acid, aspartic acid, lysine, leucine and arginine. The sum of these amino acids accounted for more than 50% of the total amino acids (Table 2). The highest amino acid score was obtained for *M. amazonicum* muscle from lysine. Usydus et al. (2009) reported that fish products are good sources of lysine, which is severely restricted in cereals, the most important staple foodstuff in the world. Only methionine was a limiting amino acid (values score less than 100).

In general, Amazon River prawn (*M. amazonicum*) and giant river (*M. rosenbergii*) are good sources of n-3 fatty acids, and docosahexaenoic and eicosapentaenoic acids are the dominant polyunsaturated fatty acids in both species. Protein levels were higher, 20% and 14%, and lipid levels were higher, 1.5% and 1.2%, respectively, in Amazon River prawn than in giant river prawn.

Table 2. Amino acid composition of *Macrobrachium amazonicum* prawns.

Amino acid[1]	Content	Requirement[2]	Amino acid score[3]
	---------- (mg g^{-1} protein) ---------		
Essential			
Threonine	41	23	178
Valine	45	39	115
Methionine	10	16	63
Isoleucine	46	30	153
Leucine	83	59	141
Phenylalanine	39	39	100
Histidine	25	15	167
Lysine	95	45	211
ΣEAA	384		
Nonessential			
Aspartic acid	114	-	-
Serine	40	-	-
Glutamic acid	168	-	-
Glycine	61	-	-
Alanine	71	-	-
Tyrosine	27	-	-
Proline	41	-	-
Tryptophan	12	-	-
Arginine	81	-	-
ΣNEAA	616	-	-
ΣTAA	1,000	-	-

[1]EAA, essential amino acids; NEAA, nonessential amino acids, TAA, total amino acids. [2]Protein and amino acid requirements in human nutrition (2007). [3](Amino acid content / Requirement in human nutrition)100.

Acknowledgements

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes), for scholarship grant; and to Jorge Mancini Filho and Rosangela Pavan Torres, for chromatographic analyses.

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Received on March 29, 2011 and accepted on July 29, 2013