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Nutritional composition, fatty acids and cholesterol levels in Atlantic white shrimp (*Litopenaeus schimitti*)

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Abstract

The purpose of this study was to determine the chemical composition, cholesterol levels and fatty acids profile of legitimate white shrimp (*Litopenaeus schimitti*). Two lots of samples were collected in winter and spring in *Ilha da Madeira*, Itaguaí, Rio de Janeiro. Chemical composition was performed using the edible part of shrimps and data were analyzed by analysis of variance (ANOVA) and Tukey's test ($p < 0.05$). According to the results, the moisture, protein, ash and lipids had an average value of 76.80 g 100 g^{-1}, 18.37 g 100 g^{-1}, 1.59g 100g^{-1} and 1.13 g 100g^{-1}, respectively. Significant differences were observed for cholesterol levels (115.17; 401.05 g. 100g^{-1}). Regarding the fatty acids profile, 18 compounds were observed. Palmitic (C16: 0) (134.86; 102.46 mg. 100g^{-1}), docosahexaenoic (C22: 6n-3, DHA) (101.25; 97.43mg. 100g^{-1}), and eicosapentaenoic (C20: 5n-3, EPA) (83.79; 80.55mg. 100g^{-1}) acids were the prevalent fatty acids in both lots. White shrimp is a good source of proteins, with low lipids level and reduced caloric values. Polyunsaturated fatty acids were predominant and polyunsaturated/saturated fatty acids ratio was beneficial to health, demonstrating that white shrimp is a marine food of importance to human diet.

Introduction

Fish includes a wide range of marine and freshwater species, and represents an important source of nutrients for human diet. The group of crustaceans belonging to the Decapoda order includes prawns, lobsters, and crabs, and has received attention because it is a food rich in lipids, proteins, and other nutrients such as minerals and vitamins (Larsen *et al*., 2011; Bono *et al*., 2012). Shrimp *Litopenaeus schimitti*, popularly known as white shrimp or legitimate shrimp, occurs in the western Atlantic, from Central America to South America, from the West Indies (23º30`N) to Brazil, Rio Grande do Sul (29º45`S). Adults are found in marine areas, near at estuary regions, from small depths up to 30 meters, with occurrences up to 47 meters in the state of Rio de Janeiro (Santos *et al*., 2008).

Legitimate white shrimp and natural populations of other shrimp species from the coast of South America have suffered strong pressure due to overfishing and cultivation of exotic species (Luvesto and Galletti-Junior, 2005). However, from 2008 to 2011, production of legitimate white shrimp increased from 3913.0 to 4115.7 tons, which represents an increase of approximately 5.2% (MPA, 2013). In Brazil, the *L. schimitti* is considered an important fishing resource and this native species has high commercial value (Barros *et al*., 2014), but the overfishing and environmental degradation in the Brazilian coast has affected their stocks (D'incao *et al*., 2002). Shrimp fisheries are typically artisanal, although the industrial fisheries have been also practiced. Few studies address the characteristics of fishing and its resources in the state of Rio de Janeiro.

Despite its high protein content, shrimp is also rich in cholesterol, which may be considered a negative nutritional aspect, since excess cholesterol in food is a risk factor for developing cardiovascular diseases. Moreover, as in other marine foods, there are plenty of polyunsaturated fatty acids (PUFA) of the omega-3 category (n-3) in shrimp muscles, especially eicosapentaenoic acid (EPA, 20: 5n-3) and docosahexaenoic acid (DHA, 22: 6n-3), which have been extensively studied due to their functional properties related to degenerative diseases. Thus, the consumption of such food has been encouraged, since there is a positive association between n-3 PUFA intake and health maintenance due to its action on biological membranes and in various metabolic

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pathways (Li *et al*., 2011; Simon *et al*., 2012; Hernández-Becerra *et al*., 2014).

The EPA and DHA fatty acids (FA) are precursors for eicosanoids with anti-inflammatory, antithrombotic and vasodilatory activities, related to the prevention of certain diseases such as dyslipidemia and hypertension. The omega-6 fatty acids (n-6) as linoleic and arachidonic acids are precursors for pro-inflammatory eicosanoids, thus inducing inflammation when ingested in excess, which is the initial stage for development of coronary chronic diseases, diabetes, arthritis, certain cancers and osteoporosis. Western diet is characterized by high n-6 PUFA and low n-3 PUFA levels. The ratio between n-6 and n-3 PUFA ranges from 15: 1 to 20: 1, while the Food and Agriculture Organization of the United Nations recommends ratios ranging from 5: 1 to 10: 1 (FAO, 2010; Simon *et al*., 2012).

Studies on the nutritional value of different shrimp species have been reported in Brazil (Bragagnolo and Rodriguez-Amaya, 2001; Furuya *et al*., 2006; Araujo *et al*., 2012) and other countries (Rosa and Nunes, 2003; Sriket *et al*., 2007; Li *et al*., 2011; Bono *et al*., 2012; Puga-López *et al*., 2013). However, the white shrimp *Litopenaeus schimitti* is commonly caught, intended for human consumption and its socioeconomic importance to the region, there is shortage of available and current information on the nutritional quality of white shrimp. Furthermore, although a rich source of proteins, shrimp has elevated cholesterol level that concerns due cardiovascular disease and consequently complications on health. On the other hand, shrimp are rich in polyunsaturated fatty acids, which are considered anticholesterolemic. For this reason the determination of these components are important. Thus, the aim of this study was to determine the chemical composition, cholesterol levels, and fatty acids profile of white shrimp *Litopenaeus schimitti* meat. And, also to observe the differences in the chemical composition and lipid profile among the two lots, due to sampling have been carried out in different seasons.

Material and Methods

Shrimps and post capture management.

About 4.0 kg of shrimp *Litopenaeus schimitti* were purchased in different seasons (Lot 1 in early September- winter in the southern hemisphere and lot 2, the samples were collected in November, in spring), from artisanal fishermen in *Ilha da Madeira*, located in Sepetiba Bay (latitude 22° 55'-23° 03'S and longitude 43° 48'-44° 02'W) (DHN, 2016-2017), municipality of Itaguaí, Rio de Janeiro.

The samples were placed in isothermal box and immediately transported to the Department of Food Technology of the Federal Rural University of Rio de Janeiro (DTA / UFRRJ). In the laboratory, shrimps were washed in running water and carapace and shell were manually removed, followed by evisceration, yielding edible portion of shrimp (muscles), which was again washed in running water and milled in domestic multiprocessor (Ri1364 / 02 Philips 220v / Walita) until homogeneous consistency. Then, 100 g of this material were packed in polyethylene bags, sealed (Selaplast), and stored under frozen storage (-18 ± 2°C). Prior to analysis, samples were thawed under refrigeration temperature (4± 2°C).

Determination of pH and proximate composition

The pH was measured using a digital pH meter (PG 2000 Multitec®) calibrated with buffer solutions of pH 4.0 and 7.0. Moisture content was determined by gravimetric method, at 105°C until constant weight. Protein was determined by Kjeldahl method, by multiplying the value obtained by the conversion factor 6.25. Lipids were determined by Soxhlet extraction method with hexane, and ash content was determined by incineration in a muffle at 550°C. These analyses were performed according to AOAC methods (2010), in triplicate, and the results expressed on a wet basis (WB).

The carbohydrate content was determined by NIFEXT fraction, using the following equation, according to the Oliveira *et al*. (1999).

Carbohydrates = 100-(g moisture + g protein + g fat + g ash).

The caloric value was determined using the Atwater factors, multiplying the lipid content for nine, and protein and carbohydrates levels for four (Furlan *et al*., 2011) according to the following equation:

Caloric value = 4 x (g protein +g carbohydrate) + 9 x (g lipids).

Determination of cholesterol and fatty acids levels

The cholesterol was extracted according to the methodology proposed by Saldanha *et al*. (2006), followed by derivatization with TMS trimethylsilyl ethers, according to Menendez-Carreno *et al*. (2008). The TMS derivatives were diluted in 1 mL hexane, filtered through a 22 µM filter (Millipore, Maryland, MD, USA), and injected into a gas chromatograph (Shimadzu GC 2010, Tokyo, Japan) equipped with a split injector (1: 50) and flame ionization detector, and capillary column Rtx-5-MS (30 m x 0.25 mm x 0.25 µm Restek, Bellefonte, USA). The operation

conditions were: initial temperature of 230°C (0 min); heating rate of 2°C / min up to 264°C (5 min); and then heating rate of 1°C / min up to a final temperature of 275°C (2 min). The injector and detector temperatures were 350°C and 290°C, respectively. The carrier gas used was hydrogen at a flow rate of 1 mL/min. Cholesterol identification was performed by comparing sample retention times with standard retention times (Sigma, Milford, MA, USA). The quantification was performed by external calibration curve with 10 points, at concentrations ranging from 10 to 1000 µg / mL.

The fatty acid methyl esters were determined as described by Saldanha *et al*. (2008), using a gas chromatograph (Shimadzu GC 2010, Tokyo, Japan) equipped with a split injector (1: 50) and flame ionization detector. The chromatographic separation was performed using a fused silica capillary column (CP-SIL 88, 50 mx 0.25 mm ID, 0.20 mm film thickness (Chrompack, Middelburg, Holanda). The chromatographic conditions were: initial temperature 100°C (5 min) followed by 5°C / min up to 160°C (zero min), 8°C / min to 230°C (12 min); injector and detector temperatures of 250°C and 280°C, respectively, carrier gas hydrogen (1 mL/min). Standard retention times of fatty acids methyl esters were used to identify the sample chromatograms. Quantification was performed by external calibration curve with 8 points, at concentrations ranging from 0.3 to 7 mg / mL. The results were calculated in mg per 100 g of sample (AOCS, 1989). All analyses were performed in triplicate and the results expressed on a wet basis (WB).

Nutritional quality indices

The nutritional quality of the lipid fraction was determined from the fatty acids profile (FA). The polyunsaturated and saturated fatty acids ratio (PUFA / SFA) and n-6 and n-3 ratio (n-6 PUFA / n-3 PUFA) were calculated, in addition to the index of atherogenicity (IA) and thrombogenic (IT). The IA correlates the atherogenic FA (C12: 0, C14: 0, and C16: 0) and the anti-atherogenic monounsaturated (MUFA), and polyunsaturated FA (n-3 and n-6 PUFA). The IT considers the thrombogenic C14: 0, C16: 0, and C18: 0, and the anti-thrombogenic MUFA and n-3 and n-6 PUFA, conferring a greater anti-thrombogenic effect to n-3 PUFAs (Lira *et al*., 2014).

IA and IT were calculated according to the following equations (Ulbricht and Southgate, 1991):

$$IA = [(C12:0)+(4xC14:0)+(C16:0)] \times [(PUFA\ n6+n3) + (MUFA)]^{-1}$$

$$IT = [(C14:0)+(C16:0)+(C18:0)] \times [(0,5 \times MUFA) + (0,5x\ n-6)+(3x\ n-3)+(n-3 \times n-6)^{-1}]^{-1}$$

Statistical analysis

The results of pH, chemical composition, cholesterol levels, and fatty acids profile of lots 1 and 2 were evaluated using analysis of variance (one-way ANOVA). The comparison between means was carried out by Tukey multiple comparison test, with $p < 0.05$. The Software Origin© 6.0 for Windows© (Origin Lab Corporation©, 2015) was used.

Results and Discussion

Determination of pH and proximate composition of white shrimp

The results for pH, chemical composition, caloric values, and cholesterol levels of white shrimp (*Litopenaeus schimitti*) muscles are shown in Table 1. The pH values ranged from 7.2 to 7.3 ± 0.01 in the different lots, These pH values were similar to those reported by Lira *et al*. (2013), who found pH of 7.3 in Sea-bob shrimp (*Xiphopenaeus kroyerii*) *in natura*. The pH in shrimp meat is resulting from biochemical changes in the muscles, and can also be influenced by reactions of endogenous and microbial origin. According to Fu *et al*. (2014), different slaughter methods cannot prevent the increase in pH in the muscle post mortem. Regarding the chemical composition, high moisture levels were observed (77.95 and 75.65 g.100 g^{-1}) which are commonly presented in fish. Significant differences were observed for moisture, ash, proteins, and lipids in both lots studied ($p < 0.05$). The results differed from those reported by Rosa and Nunes (2003), who found no significant differences in chemical composition of red shrimp (*Aristeus antennatus*), and pink shrimp (*Parapenaeus longirostris*) analyzed at different periods. Moura and Tenuta Filho (2002) observed similar results for moisture (78.2 g.100 g^{-1}) in pink shrimp *(Penaeus brasiliensis*).

Table 1. Determination of pH, proximate composition (g. 100 g^{-1}), caloric values, and cholesterol levels (mg. 100 g^{-1}) of white shrimp (*Litopenaeus schimitti*)

Determination	Lot 1	Lot 2
pH	7.3± 0.01[a]	7.2± 0.01[a]
Moisture	77.95 ± 0.03[a]	75.65 ± 0.25[b]
Ash	1.24 ± 0.05[a]	1.93 ± 0.03[b]
Protein	17.74 ±0.40[a]	18.99 ±0.36[b]
Fat	1.40± 0.03[a]	0.86 ± 0.01[b]
Carbohydrates	1.67±0.13[a]	2.57±0.08[b]
Caloric value	83.56±0.12[a]	83.70±0.14[a]
Cholesterol	115.17±0.71[a]	401.05±2.36 [b]

*Different letters (a-b) in the same row are significantly different ($p \leq 0.05$)

The protein levels (17.74 and 18.99 g. 100 g^{-1}) were similar to those reported by Sriket *et al*. (2007) for exotic white shrimp (*Penaeus vannamei*) and tiger prawn shrimp (*Penaeus monodon*) with values of 18.8 and 17.1 g $100g^{-1}$, respectively.

Considering the total lipids found for *L. schimitti* (1.40 and 0.86 g. $100g^{-1}$), it can be considered lean meat (Simon *et al*., 2012). The results were similar to those obtained by Bragagnolo and Rodriguez-Amaya (2001), who found lipid levels ranging from 0.9 to 1.0 g. $100g^{-1}$ for this shrimp species. Other shrimp species studied by Bragagnolo and Rodriguez-Amaya (2001) (*P. brasiliensis* and *X. kroyeri*), Moura and Tenuta Filho (2002) (*P. brasiliensis*), Sriket *et al*. (2007) (*P. monodon* and *P. vannamei*), Li *et al*. (2011) (*L. vannamei*) and Puga-López *et al*. (2013) (*P. vannamei*) showed total lipid levels ranging from 1.00 to 1.34 g. $100g^{-1}$, which are close to those observed in this study. Lower values were obtained by Rosa and Nunes (2003) for *A. antennatus* (from 0.10 to 0.30 g. $100g^{-1}$) and *P. longirostris* (from 0.20 to 0.30 g. $100g^{-1}$), and Araujo *et al*. (2012) for *L. vannamei* (0.30 g.$100g^{-1}$). In contrast, higher lipid levels have been reported by Li *et al*. (2011) for *Exopalaemon annandalei* (1.78 g. $100g^{-1}$) species.

The chemical composition, especially the lipids in marine fish can vary between species and within the same species, being influenced by several factors including diet, overcrowding, growth stage, quality and salinity of the water, and variations attributed to the time of year. Changes in chemical composition lead to differences in the nutritional value, sensory attributes, and shelf life of shrimps (Sriket *et al*., 2007; Saldanha *et al*., 2008).

Few studies have reported the carbohydrate content in shrimps. The results for both lots (1.67 and 2.57 g. $100g^{-1}$) were higher than that observed by Simon *et al*. (2012) (0.80 g. 100 g^{-1}) for pitu shrimp (*Macrobrachium carcinus*). Regarding the caloric value, the present results (83.56 and 83.70 Kcal / 100g) were lower than that found by Simon *et al*. (2012) for *M. carcinus* (117.00 Kcal / 100g), and by Rosa and Nunes (2003) for *A. antennatus* (from 407.90 to 434.40 Kcal / 100g) and *P. longirostris* (from 397.10 to 426.20 kcal / 100g).

Cholesterol and fatty acids levels

Cholesterol levels varied between lots (115.17 and 417.05. $100g^{-1}$). The cholesterol level in lot 1 (115.17 mg. $100g^{-1}$) was similar to that reported by Bragagnolo and Rodriguez-Amaya (2001), who found cholesterol levels ranging from 114 to 139 mg. $100g^{-1}$ for marine shrimp species (*X. kroyeri*, *M. rosenbergii*, *P. brasiliensis* and P. schimitti). Opposite results were reported by Moura *et al*. (2013), who found higher levels for *L. vannamei* farmed in brackish water and *Farfantepenaeus schimitti*, with values ranging from (130.09 to 318.77 mg.$100g^{-1}$) and (218.20 to 361.17 mg.$100g^{-1}$), respectively. In F. schimitti, the cholesterol levels reached 361.17 mg $100g^{-1}$, which was higher than the results found in lot 1, but still below those in lot 2. The high difference observed among the lots may be due to the reproductive biology of the shrimp and seasonality. The cholesterol levels in lot 1 were in accordance with the recommended daily intake (<300 mg / day) (Lichtenstein *et al*., 2006), which was not observed in lot 2, with values above this limit. Moura and Tenuta Filho (2002) found far superior levels of cholesterol in fresh *P. brasiliensis*, reaching approximately 550 mg $100g^{-1}$. As shrimps are significant source of dietary cholesterol, it is believed that they may cause adverse health effects by increasing serum cholesterol levels (Lira *et al*., 2014). Shrimps have high cholesterol levels, but contain low levels of saturated fats, unlike red meat. Furthermore, they are rich in polyunsaturated fatty acids with health benefits (Abreu *et al*., 2010).

The fatty acid composition (FA) of *L. schimitti* muscles of both lots is shown in Table 2. Despite the low total lipids levels, white shrimp showed a high nutritional value concerning the FA composition. Eighteen FA were identified and quantified. The main FA found in both lots were palmitic acid (C16: 0), docosahexaenoic acid (DHA, C22: 6n-3), eicosapentaenoic acid (EPA, C20: 5n-3), and stearic acid (C18:0) and oleic (C18: 1n -9cis), similar to that reported by Rosa and Nunes (2003), who also found these predominant FA in *A.antennatus* and *P. longirostris* marine species, analyzed in two different seasons (summer and winter).

Palmitic acid, C16:0 (134.86 and 102.46 mg$100g^{-1}$), represented more than 50 % of saturated fatty acids (SFA) in both lots, followed by C18: 0 (81.40 and 70.25 mg. $100g^{-1}$). The C16: 0 was appointed as the main FA in white shrimp, similar to that reported for other crustaceans species such as *Penaeus brasiliensis*, Penaeus schimitti and *Xiphopenaeus kroyeri* (Bragagnolo and Rodriguez-Amaya, 2001), *M. carcinus* (Simon *et al* ., 2012), F. schimitti (Moura, 2013), and six shrimp species marketed in China (Li *et al*., 2011).

Among the monounsaturated fatty acids (MUFA), the oleic acid C18: 1n-9cis was the majority (75.66 and 66.54 mg 100 g^{-1}), as observed in other shrimp species including *P. braziliensis* and *X. kroyeri* (Bragagnolo and Rodriguez-Amaya, 2001), *P. monodon* and *P. vannamei* (Sriket *et al*., 2007), and *X. kroyeri* (Lira

et al., 2014). Polyunsaturated fatty acids (PUFA) were predominant (257.40 and 244.69 mg $100g^{-1}$) in the samples of the present study, and C22: 6n-3, DHA was observed at higher concentrations (101.25 and 97.43 mg $100g^{-1}$), followed by C20: 5n-3, EPA (83.79 and 80.55 mg 100 g^{-1}). There is no consensus on the predominant FA in shrimps. Although SFA appear in higher concentrations in some species, there may be differences within the same species. Moura *et al*. (2013) found higher SFA levels in F. schimitti. Environmental conditions and diet have been reported as factors that most influence the FA composition in crustacean muscles (Li *et al*., 2011).

Significant differences were observed among SFA, MUFA, and PUFA levels in lots 1 and 2. With regard to PUFAs, category of special interest because of their health benefits, EPA and DHA represented 71.89% and 72.74% of these fatty acids. The sum of EPA and DHA levels (185.04 and 177.98 mg. $100g^{-1}$) is relevant, since the recommended intakes of these PUFAs are 250 to 650 mg / day (Lira *et al*., 2014).

Table 2. Fatty acids ($mg.100g^{-1}$) in white shrimp (*Litopenaeus schimitti*) muscle in two collection periods (Lots)

Fatty acids	Lot 1	Lot 2
Lauric (C12:0)	1.12±0.03[a]	0.74±0.10[b]
Myristic (C14:0)	7.74±0.22[a]	5.12±0.00[b]
Pentadecanoic (C15:0)	5.29±0.11[a]	4.68±0.31[b]
Palmitic (C16:0)	134.86±1.51[a]	102.46±1.12[a]
Margaric (C17:0)	15.19±0.51[a]	8.35±0.87[b]
Stearic (C18:0)	81.40±1.20[a]	70.25±1.40[b]
ΣSFA	245.60±0.60[a]	191.60±0.63[b]
Myristoleic (C14:1n9)	0.71±0.21[a]	0.38±0.15[b]
Palmitoleic (C16:1n7)	41.34±1.02[a]	30.89±0.89[b]
Margaroleic (C17:1n7)	9.24±0.75[a]	3.87±0.33[b]
Elaidic (C18:1n9 trans)	1.80±0.60[a]	0.61±0.17[b]
Oleic (C18:1n9cis)	75.66±2.12[a]	66.54±1.15[b]
Nervonic (C24:1n9)	3.54± 0.81[a]	2.77± 0.00[b]
ΣMUFA	132.29±0.92[a]	105.06±0.45[b]
Linoleic (C18:2n6)	12.19±0.91[a]	9.83±0.61[b]
Linolenic (C18:3n6)	1.49±0.09[a]	2.74±0.13[b]
Linolenic (C18:3n3)	3.63±0.10[a]	4.28±0.52[b]
Arachidonic (C20:4n6)	55.05± 1.35[a]	49.86±0.90[b]
EPA (C20:5n3)	83.79± 1.41[a]	80.55± 1.09[a]
DHA (C22:6n3)	101.25± 1.90[a]	97.43± 1.60[a]
ΣPUFA	257.40±0.96[a]	244.69±0.81[b]
n-6	68,73±0.78[a]	62.43±0.54[b]
n-3	188.67±1.14[a]	182.26±1.07[a]
EPA+DHA	185.04±1.65[a]	177.98±1.35[b]
PUFA/SFA	1.05 [a]	1.28 [b]
n-6/n-3	0.36[a]	0.34[a]
IA	0.32 [a]	0.36[b]
IT	0.34[a]	0.28[b]

*Different letters (a-b) in the same row are significantly different ($p \leq 0.05$)

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Nutritional quality indices

Marine fish species generally display higher levels of long chain n-3 PUFA and lower levels of n-6 PUFA (Simon *et al*., 2012). The adequate n-6 / n-3 ratio (less than 4) is critical to formation of eicosanoids, preventing the development of various diseases (Lira *et al*., 2014). The values obtained in this study (0.36 and 0.34) are in accordance with the recommended doses (DHSS, 1994). Similar results were found for *X. kroyeri* (0.33) (Lira *et al*., 2014) and *P. brasiliensis*, which presented lower ratio (0.26 and 0.25, respectively) as reported by Bragagnolo and Rodriguez-Amaya (2001). Higher n-6 / n-3 ratios have been reported for *P. monodon* and *P. vannamei* (0.77 and 1.00, respectively) (Sriket *et al*., 2007), evidencing the variation of n-6 and n-3 fatty acid levels in shrimps.

The recommended minimum value of PUFA / SFA ratio is 0.45 for a balanced diet (DHSS, 1994). This ratio is lower than that found for both lots (1.05 and 1.28), which demonstrates a satisfactory nutritional quality of shrimp *L. schimitti*. Similar results were found for *M. carcinus* (Simon *et al*., 2012) and *X. kroyeri* (Lira *et al*., 2014), while lower values were reported for F. schimitti (Moura, 2013) and higher values for *P. brasiliensis* (Sriket *et al*., 2007). A diet with low PUFA / SFA ratio is not recommended as it is a risk factor for the increase in serum cholesterol. However, this factor should not be considered alone, since it does not take into consideration the health benefits of MUFA and C18: 0, even being a saturated fatty acid.

Low indexes of atherogenicity (IA) (0.32 and 0.36) and thrombogenic (IT) (0.34 and 0.28) were observed for both lots, which were lower than the values found for *M. carcinus* (0.53 and 0.45, respectively) (Simon *et al*., 2012) and *X. kroyeri* (0.46 and 0.34, respectively) (Lira *et al*., 2014). Moreover, these findings were higher than the IA and IT values found for *A. antennatus* (0.26 and 0.18, respectively) and *P. longirostris* (0.31 and 0.20, respectively). In addition, the IA value found for *L. schimitti* was lower than those reported for other animal products such as beef (0.72), pork (0.69), chicken (0.50), rabbit (0.82), and lamb (1.00) (Rosa and Nunes, 2003). Lower atherogenic and thrombogenic indices are desirable, since they represent the nutritional quality of lipids in relation to the risk of developing cardiovascular disease (Simon *et al*., 2012).

Conclusion

According to the results of the present study, the white shrimp *Litopenaeus schimitti* has proven to have good nutritional value, compatible with the shrimp species of greatest economic importance. It was observed significant difference in the chemical composition and lipid profile from the two lots collected in different season. Cholesterol levels varied between lots, the differences observed in the present study may be due to the reproductive biology of the shrimp and seasonality. The analysis confirmed high cholesterol contents in one of the lots, higher than expected for health maintenance, however, the other lot present lower level, presenting within the recommended daily intake. The samples showed high concentrations of omega-3 PUFA, especially EPA and DHA, which are considered a source of these functional compounds, and thus recommended from a nutritional point of view.

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