

PHYSICOCHEMICAL AND SENSORY QUALITY ATTRIBUTES OF THE MANGROVE CRAB, *Ucides cordatus*, FROM THE PARNAÍBA RIVER'S DELTA ENVIRONMENTAL PROTECTION AREA

Atributos de qualidade físico-química e sensorial do caranguejo-uçá, *Ucides cordatus*, coletado na Área de Proteção Ambiental do Delta do Rio Parnaíba

Thiago Fernandes Alves Silva¹, Fabiola Helena dos Santos Fogaça^{2*}, Sidely Gil Alves Vieira³, Irani Alves Ferreira⁴, Luiz Gonzaga Alves dos Santos Filho⁵, João Avelar Magalhães^{2,6}, Jefferson Francisco A. Legat^{2,7}

ABSTRACT

*The proximate composition and sensory quality attributes of mangrove crab, *Ucides cordatus*, were investigated. The aim of this study was to demonstrate the nutritive value and sensory parameters of meat of crabs collected at different salinity points. There were no significant differences in the moisture content on meat, but protein and ash contents were significantly higher ($P < 0.05$) in some sites. The sensory analysis showed that these differences influenced the odor and appearance of crab meat. The quality attributes depend on the crab collection site.*

Keywords: mangrove crab, *Ucides cordatus*, physicochemical attributes, Parnaíba River's delta, Environmental Protection Area.

RESUMO

*A composição centesimal e os atributos sensoriais de qualidade do caranguejo-uçá, *Ucides cordatus*, foram avaliados com o objetivo de caracterizar o valor nutritivo e os parâmetros sensoriais da carne de caranguejos coletados em pontos com diferentes salinidades. Não houve diferença significativa na umidade da carne, porém os valores de proteína e cinzas foram estatisticamente maiores ($P < 0,05$) em alguns locais. As análises sensoriais mostraram que essas diferenças influenciaram no cheiro e na aparência da carne do caranguejo. Os parâmetros de qualidade dependem do local de coleta do caranguejo.*

Palavras-chaves: caranguejo-uçá, *Ucides cordatus*, atributos físicoquímicos, delta do Rio Parnaíba, Área de Proteção Ambiental.

¹ Mestrando em Aquicultura, Centro de Aquicultura da UNESP, Jaboticabal, SP. E-mail: thg_silva@hotmail.com

² Pesquisadora, Embrapa, Centro de Pesquisa Agropecuária do Meio-Norte, Parnaíba, PI, 64200-970. E-mail: fabiola.fogaca@embrapa.br

³ Graduanda em Engenharia de Pesca, Universidade Federal do Piauí, Campus de Parnaíba, PI, 64202-020. E-mail: sidelygil@hotmail.com

⁴ Pesquisadora, Department of Cell Biology and Molecular Genetics, University of Maryland, Washington, EUA. E-mail: bioirani@hotmail.com

⁵ Graduando em Engenharia de Pesca, Universidade Federal do Piauí, Campus de Parnaíba, PI, 64202-020. E-mail: luizgonga@hotmail.com

⁶ Pesquisador, Embrapa, Centro de Pesquisa Agropecuária do Meio-Norte, Parnaíba, PI, 64200-970. E-mail: joao.magalhaes@embrapa.br

⁷ Doutorando em Aquicultura, Universidade Federal de Santa Catarina. E-mail: jflegat@yahoo.com.br

* Corresponding author.

INTRODUCTION

Marine crustaceans are being widely used as food and feed supplement around the world, and crabs are considered as an important shell fishery product (Gokoolu & Yerlikaya, 2003). The mangrove crab, *Ucides cordatus* (Linnaeus, 1763), is a species of economic and social interest to Brazilian communities with geographical distribution on the Atlantic coast, occurring from Florida (USA) to Santa Catarina (Brazil) (Melo, 1996). This species stands out among crustaceans owing to its large adult size (Hattori & Pinheiro, 2003), good taste, affordable market price and simple method of capture that does not require expensive, sophisticated equipment and techniques.

The highest production of “uçá” crab (*Ucides cordatus*) in Brazil comes from the environmental protection area (APA) of Parnaíba River’s delta, in the states of Maranhão and Piauí, Northeastern Brazil. The individuals caught in this area are very popular in the regional cuisine, being marketed in a small scale locally and largely traded in the big cities.

The chemical composition and nutritive value of mangrove crab meat have been investigated (e.g., Ogawa *et al.*, 1973; Pedrosa & Cozzolino, 2001; Moucherek-Filho *et al.*, 2003; Ogawa *et al.*, 2008). The crab meat has high protein (20 to 24%), mineral (1.5 to 2.3%), and low fat contents (2 to 3%). According to sensory analysis, the specific odor and taste can be related to the presence of amino acids like arginine, glycine and alanine, which accounts for a major proportion of the chemical composition of the crab’s meat (Ogawa *et al.*, 2000).

However, the crab’s biochemical composition is influenced by habitat, nutritional state and life cycle depending on the season of the year (Oliveira *et al.*, 2003; Oliveira *et al.*, 2007). According to Rainbow (1985), decapod crustaceans, such as the mangrove crab, can regulate its internal concentration of essential elements under a varying environment, channeling them through hemolymph to maintenance of the organism and carapace. In other words, a high-salinity environment can influence on crab meat nutrition content.

Therefore, it is important to study the proximate composition and the organoleptic aspects of crab meat from distinct environments, since different elements in the environments can interfere on the preference for some species stocks over others. Thus, the main goal of the present study was to analyze and correlate the composition and organoleptic aspects of *Ucides cordatus* meat, collected from distinct points in the Parnaíba River’s delta Environmental Protection Area.

MATERIAL AND METHODS

Material

Adults of mangrove crab, *Ucides cordatus*, were caught by a professional fisherman from six sites of the mangroves of the Parnaíba Delta’, in Maranhão, Piauí and Ceará states, between September and October of 2011. The six collection sites are the following: Barroquinha county in Ceará state; Barra Grande, in Piauí state; and Melancieiras, Pantanal, Torto and Canárias islands, in Araioses county, Maranhão state (Table I). The crabs were collected at these six points because of their wide salinity amplitude reported from July, 2009 to June, 2010.

Sample preparation

The crabs (300 males) were transported alive inside plastic boxes protected internally with wet foam, following the method proposed by Legat & Puchnick-Legat (2009), to the Laboratory of Food Analysis and Technology of Embrapa Meio-Norte. Weight measurements of 20 samples from each location were recorded using a scale (Shimadzu, Tokyo, Japan).

Once transported, the crabs were pre-washed by immersion in water at room temperature (28°C), stunned in water and ice (1:1) for 15 minutes, starved by perforating their ventral region, followed by a bleeding period of 15 minutes. Crabs were cleaned with a brush in water at 10°C, the legs and claws were tied with rubber bands, immersed in 1% of citric acid for five seconds, and drained in a sieve

Table I - Sampling sites of *Ucides cordatus* and average salinity from July, 2009 to June, 2010.

Location	Geographic coordinates	Average salinity (ppm)
Barroquinha/CE	02°56'5"S; 41°19'0"W	43.00 ± 5.3
Barra Grande - Cajueiro da Praia/PI	02°54'8"S; 41°25'4"W	40.60 ± 4.7
Melancieiras - Araioses/MA	02°43'2"S; 42°07'9"W	36.30 ± 5.3
Pantanal - Araioses/MA	02°51'7"S; 41°58'5"W	14.40 ± 7.0
Torto - Araioses/MA	02°47'8"S; 41°55'5"W	11.62 ± 7.0
Canárias - Araioses/MA	02°44'2"S; 41°19'7"W	6.27 ± 2.2

for five minutes in ice. The samples were labeled, vacuum packed, frozen in a freezing tunnel at -30 °C and subsequently stored in a freezer at -18°C. Out of the total 50 samples collected from each site, 10 were used for microbiological analysis, 30 for sensory analysis and 10 for proximate composition analysis.

Proximate analysis

Meat from the body and claw portions was separated manually, combined, homogenized, and then stored at -18°C until analysis of proximate composition, performed on meat crab according to standard analytical methods (AOAC, 2005). All samples were stored at -18°C and thawed at 5°C for 24 hours prior to analysis. Four samples were taken from each treatment and analyses were performed with three replicates. Moisture content was determined by the weight difference of 2.0 gr of sample before and after heating in an oven (Fanem, São Paulo, Brazil) for 16 hours at 105°C. The total level of nitrogen was determined by the Kjeldahl procedure and levels of protein were estimated using 6.25 conversion factor. Ash was determined by the weight difference at 550°C for 6 hours in a muffle furnace (Quimis, São Paulo, Brazil). Lipids were determined by extraction with petroleum ether in Soxhlet apparatus.

Microbiological analyses

The samples were submitted to microbiological analyses to detect the presence of *Salmonella* sp., coagulase-positive staphylococci and coliforms count at 45°C. The microbiological criteria required by the actual law for baked fish products are: absence of *Salmonella* sp. in 25 gr of the sample; coliforms at 45 °C until 10²/gr; and coagulase-positive staphylococci up to 5x10²/gr (ANVISA, 2001).

The results of microbiological analyses are shown on Table II, and since they are within the microbiological limits required by law, the crabs were used for sensory analysis. The absence of coagulase-positive staphylococci and *Salmonella* sp showed that the sanitary and hygiene procedures were properly performed, since collection to product process (Simões *et al.*, 2007). The absence of coliforms indicated that there is no contamination by domestic effluents at collection environment. These pathogenic organisms are common in fish products, since they can be transmitted from handlers to the food product (Cunha Neto *et al.*, 2002).

Table II- Microbiological analysis of *Ucides cordatus* at the sampling sites.

Location	<i>Salmonella</i> sp	Coagulase-positive staphylococci	Coliforms at 45°C
Barra Grande	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹
Barroquinha	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹
Canárias	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹
Melancieiras	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹
Pantanal	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹
Torto	Absence	< 1.0 x 10 CFU.g ⁻¹	< 1.0 x 10 CFU.g ⁻¹

CFU: Colony-forming unit.

Sensory evaluation

The global acceptance test (Stone & Sidel, 1992) was used to evaluate the sensory quality of crab of each collection site. In this test, the panelists have expressed, through a verbal structured hedonic scale, their liking of general features of the product (general appearance, odor, rupture of the exoskeleton, meat appearance, flavor and texture of legs and chest meat). The score ranged from 3 (most like) to 1 (less pleasant) for attributes such as odor and rupture of the exoskeleton, and from 5 (most like) to 1 (less pleasant) for general appearance of crabs, meat appearance, flavor and texture of legs meat.

The crab samples used in sensory analysis were cooked in hot water (90°C), with 2.0 gr of salt/liter of water, inside a steel container. They were cooked for 20 minutes after the water reached boiling point. After that, the samples were drained for 3 minutes and served to the panelist on a white plastic plate, at 40-45 °C, from containers labeled with three random numbers.

The sensory analysis has been performed at the Sensory Analysis Laboratory at Piau University – FAP. A total of 30 panelists were randomly selected. The sensory evaluations were carried inside individual booths, where each panelist received one labeled sample per time. Saltine cracker and water was offered to the panelists during the break of different samples evaluation.

This project was evaluated and approved by Technical Committee of Embrapa Meio-Norte, in 2008 July.

Statistical analysis

Statistical analysis was performed using the *software* ASSISTAT 7.6 beta (2011). The data was submitted to the normality test of Shapiro-Wilk ($\alpha=5\%$). The proximate composition ($P>0.05$; Shapiro-Wilk) was analyzed using a variance analysis

(ANOVA, $\alpha=5\%$). Since significant differences were found between means ($P<0.05$), they were tested using Duncan test. The Kruskal-Wallis test was applied to the sensory analysis ($P<0.05$; Shapiro-Wilk), followed by multiple comparisons, non-parametric using Bonferroni method to compare the average of points.

RESULTS

Proximate analysis

Table III gives the proximate composition of mangrove crab. The moisture content among sites was not significantly different ($p>0.05$). Protein contents of Canarias, Melancieiras, Pantanal and Torto were significantly higher ($p<0.05$) than those found in Barroquinha and Barra Grande. On the other hand, ashes from Barroquinha and Barra Grande samples were significantly higher ($p<0.05$) than those from the others sites. Lipid values of Barroquinha, Barra Grande and Pantanal were very low, followed by Melancieiras and Torto with median values and Canarias with the highest percentage ($p<0.05$).

The average weight variations of the samples are shown on Table IV. In the present research work, the crab collection was performed following traditional collection techniques and environmental legislation which require a minimal collection size of 6.0 cm. The samples from Canarias, Melancieiras and Pantanal islands have not shown significant differences in the weight ($p>0.05$), while Barroquinha crabs demonstrated the lowest weight.

Sensory evaluation

The profiles of each attribute obtained through sensory analysis are presented in Figure 1, and the comparative results of all evaluated attributes are shown in Table V. There was no significant difference ($P>0.05$), among all samples, for attributes such as general appearance and rupture of the exoskeleton, as well as flavor and texture of legs' meat.

Table IV - Average weight of mangrove crab, *Ucides cordatus*, according to sampling site.

Location	Weight (g)
Barra Grande	148.53 ± 23.57 ^{bc}
Barroquinha	128.94 ± 25.60 ^c
Canárias	190.94 ± 29.08 ^a
Melancieiras	163.37 ± 27.33 ^{ab}
Pantanal	176.57 ± 51.50 ^{ab}
Torto	147.42 ± 25.57 ^{bc}

In the second column, the means followed by the same superscript are not significantly different ($P>0.05$), according to Tukey test.

The samples from Barroquinha showed better legs and chest meat appearance. During the study a greater acceptance and preference for the whiter meat was found to occur. The most attractive odor, with typical quality, and the better chest meat flavor ($p<0.05$) were observed in samples collected in Barra Grande. Regarding to the chest, meat attributes the taste of samples from Barra Grande and Barroquinha was more tasteful than the samples collected from other locations. Comparing all chest meat attributes, samples from Canarias have showed lowest scores, and the meat from these crabs was qualified as "disliked" on chest meat sensory analysis (Figure 1).

Table III - Proximate composition of mangrove crab, *Ucides cordatus*, in the sampling sites.

Location	Crude protein (%) [*]	Lipid (%) [*]	Moisture (%)	Ash (%) [*]
Barra Grande	69.67 ± 0.55 ^b	0.44 ± 0.25 ^c	71.50 ± 19.55 ^a	15.74 ± 0.23 ^b
Barroquinha	69.28 ± 3.62 ^b	0.32 ± 0.19 ^c	70.92 ± 4.15 ^a	16.76 ± 0.26 ^a
Canárias	77.06 ± 2.38 ^a	1.23 ± 0.17 ^a	83.77 ± 0.36 ^a	1.78 ± 0.26 ^d
Melancieiras	78.51 ± 2.91 ^a	0.85 ± 0.18 ^b	83.97 ± 0.54 ^a	2.17 ± 0.39 ^c
Pantanal	78.43 ± 1.36 ^a	0.52 ± 0.19 ^c	84.48 ± 0.81 ^a	2.04 ± 0.17 ^{cd}
Torto	79.71 ± 4.89 ^a	0.88 ± 0.20 ^b	83.11 ± 11.32 ^a	1.91 ± 0.14 ^{cd}

Results are mean + SD values of four replicates; values within the same column followed by the same superscript are not significantly different ($p>0.05$).

^{*}Expressed as % on a dry weight basis.

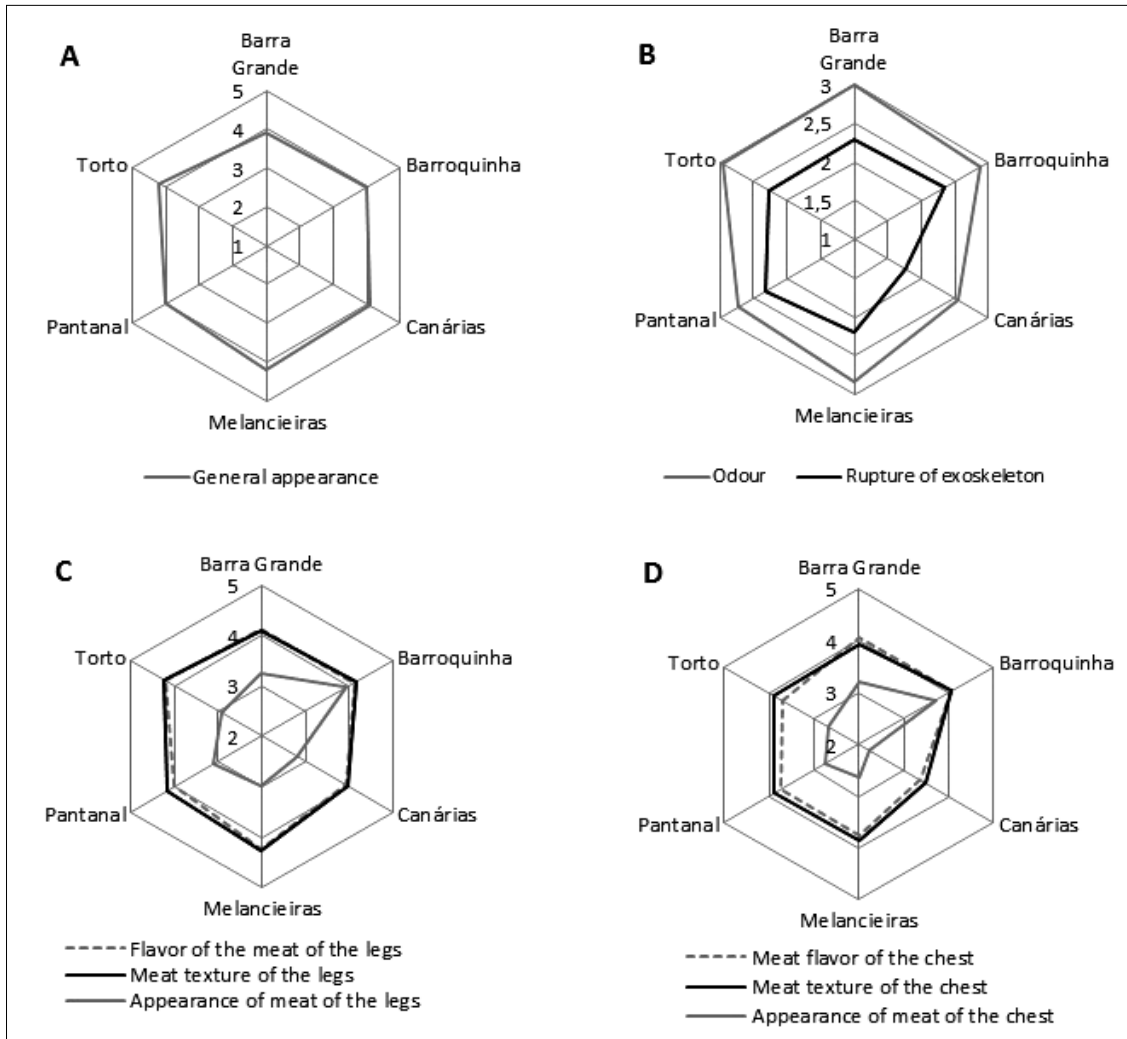


Figure 1 - Sensory profile analysis of general appearance (A); odour and rupture of the exoskeleton (B); appearance, texture and flavor of the legs meat (C) and appearance, texture and flavor of the chest meat (D) of *Ucides cordatus* according to sampling site.

Table V - Sensory attributes of mangrove crab, *Ucides cordatus* according to sampling site.

Location	Sensory attributes								
	General characteristics			Legs meat characteristics			Chest meat characteristics		
	General appearance	Rupture of exoskeleton	Odor	Legs meat appearance	Legs meat flavor	Legs meat texture	Chest meat appearance	Chest meat flavor	Chest meat texture
Barra Grande	3.92 ± 0.95 ^a	2.28 ± 0.74 ^a	3.00 ± 0.00 ^a	3.24 ± 0.88 ^b	4.12 ± 0.67 ^a	4.08 ± 0.57 ^a	3.20 ± 1.12 ^b	4.08 ± 0.64 ^a	3.92 ± 0.64 ^a
Barroquinha	4.00 ± 1.00 ^a	2.36 ± 0.57 ^a	2.88 ± 0.33 ^c	3.92 ± 0.91 ^a	4.12 ± 0.78 ^a	4.16 ± 0.90 ^a	3.72 ± 0.98 ^a	4.08 ± 0.76 ^a	4.08 ± 0.86 ^a
Canárias	4.08 ± 1.00 ^a	1.76 ± 0.88 ^a	2.56 ± 0.71 ^f	2.80 ± 0.87 ^f	3.92 ± 0.81 ^a	3.96 ± 0.73 ^a	2.24 ± 0.66 ^c	3.36 ± 0.76 ^c	3.48 ± 0.82 ^a
Melancieiras	4.20 ± 0.96 ^a	2.20 ± 0.65 ^a	2.84 ± 0.37 ^d	3.00 ± 0.91 ^d	4.24 ± 0.93 ^a	4.28 ± 0.54 ^a	2.64 ± 1.15 ^d	3.76 ± 0.97 ^c	3.84 ± 0.99 ^a
Pantanal	4.00 ± 1.32 ^a	2.32 ± 0.69 ^a	2.72 ± 0.61 ^e	3.12 ± 1.13 ^c	4.00 ± 1.32 ^a	4.16 ± 0.90 ^a	2.76 ± 1.23 ^c	3.76 ± 1.20 ^b	3.88 ± 1.13 ^a
Torto	4.20 ± 0.82 ^a	2.28 ± 0.74 ^a	2.96 ± 0.20 ^b	2.92 ± 0.76 ^e	4.20 ± 0.71 ^a	4.24 ± 0.60 ^a	2.68 ± 0.99 ^c	3.72 ± 0.79 ^d	3.88 ± 0.60 ^a

Averages, within the same column, followed by the same superscript are not significantly different ($P > 0.05$), according to Kruskal-Wallis test, at 5% probability. N = 30 samples of each location.

DISCUSSION

The proximate composition is the sum of the nutrient percentages, which approaches 100%. The lower crude protein value of samples from Barroquinha and Barra Grande (12 percent less than others) was balanced with higher values of ash (around 15%) (Table III).

The differences observed on nutrient content among locations are common due to environmental factors of the collection sites (Oliveira *et al.*, 2003; Souchet & Laplante, 2007). The ash variation was specifically caused by the higher salinity from Barra Grande and Barroquinha (average above 40.0 ppm) in comparison to the average from the other locations (16.75 ppm) (Table I).

Lower values of salinity in estuaries are related to low concentration of magnesium and calcium ions used by crabs for the hardening of new carapace during moult cycle (Pinheiro & Fiscarelli, 2001). On the Barroquinha and Barra Grande locations, the greater amount of ions (observed through salinity) caused a higher mineral composition in the crab meat studied.

The differences in salinity are due to the influence of tides on estuaries and mangroves, since tides are related to organic elements and nutrient variations in the ground of these environments (Cuzzuol & Campos, 2001). Possibly, the crabs can have a differentiated diet on environments of higher and lower salinity, which explains the variation in lipids content of the analyzed samples (Maia, 1999). Locations with higher salinity have showed lower lipid percentage compared to other sites (Table III). Regardless of the differences, the lipid level of the mangrove crab is reduced, around 0.32 to 1.23%, compared to other shellfish species (Lira *et al.*, 2007).

Huang *et al.* (2004) and Liang *et al.* (2008) studied salinity effects on chemical composition of *Litopenaeus vannamei* and reported that the chemical composition of the muscle, including moisture and protein, varied with changes in salinity. It was observed that when salinity increased, the protein content of muscle increased, and the moisture decreased. In the present study, the protein of Barra Grande and Barroquinha was significantly lower ($p < 0.05$) than of the others sites with higher salinity. Therefore, it was concluded that the protein content of the "uçá" crab has an inverse relationship with environmental salinity (Table III).

The average weight variations of the samples may have also influenced the different compositions (Table IV). It was observed that the higher weight

crabs (Canárias) have the highest percentage of lipids content, owing to deposition of this nutrient in tissues be related to a larger body mass.

The sensory analysis is also related to the proximate composition of the crab. The samples collected from Canárias have showed higher lipid level than the crabs from other locations, which may have influenced the darkening of the meat, changing of the odor and flavor of the chest meat. This collect site obtained the lowest scores for most of the evaluated attributes (Table V).

The best flavor and odor from Barra Grande samples are related to a higher salinity. Crustacean muscle contains high concentrations of free amino acids, particularly glycine, proline, arginine, glutamate and alanine (Ogawa *et al.*, 2000), which constitute the odor and flavor of crab meat. Liang *et al.* (2008) have showed that higher concentrations of these amino acids were found in the muscle extracts of crustacean samples reared in sea water versus lower concentrations founded in areas with low salinity water.

The highest scores for general meat appearance were observed in samples from Barra Grande and Barroquinha. The whiter and more attractive colors are due to the higher minerals and lower lipid contents of the meat (Table III).

Meat texture is related to its moisture level (Fiscarelli, 2004) as well as protein content (Cechi, 1999). In this study, the meat of mangrove crab did not show significant difference ($p > 0.05$) of moisture among samples from the different locations (Table III). The same sensory perception of meat texture by panelist may be possibly related to similar moisture levels and similar protein content (Table V).

CONCLUSIONS

Salinity influenced the proximate composition and the organoleptic aspects of crab meat collected from the Environmental Protection Area of Parnaíba River's delta, due to its whiter meat color and tasteful flavor. Crabs with higher weight showed lower acceptance and higher lipid deposition on tissues.

Acknowledgments - This paper was based on the research work funded by National Research Council (CNPq), in Brazil. We are thankful to ICMBio (Parnaíba) for the collaboration. We would like to thank helpers from EMBRAPA, namely Espedito and Marcelo; and from FAP, namely Carla and Adriany.

REFERENCES

- ANVISA. Resolução - RDC nº 12, de 2 de janeiro de 2001. Disponível em: www.abic.com.br/arquivos/leg_resolucao12_01_anvisa.pdf. Acesso em: 23 Jan. 2011.
- AOAC. *Official methods of analysis of the Association of Official Analytical Chemists*, 18.ed., Association of Analytical Chemists, 1094 p., Arlington, 2005.
- ASSISTAT. Disponível em: [HTTP://www.assistat.com](http://www.assistat.com). Acesso em: 01/06/2011.
- Cecchi, H.M. *Fundamentos teóricos e práticos em análise de alimentos*. Editora Unicamp, 23 p., Campinas, 1999.
- Cunha Neto, A.; Silva, C.G.M. & Stamford, T.L.M. *Staphylococcus enterotoxigênicos em alimentos in natura e processados no Estado de Pernambuco, Brasil. Ciên. Tecnol. Alimen.*, Campinas, v.22, n.3, p.263-271, 2002.
- Cuzzuol, G.R.F. & Campos, A. Aspectos nutricionais na vegetação de manguezal do estuário do Rio Mucuri, Bahia, Brasil. *Rev. Brasil. Bot.*, São Paulo, v.24, n.2, p.227-234, 2001.
- Moucherek-Filho, V.E.; Vaz, M.S.O. & Maranhão, S.C. Avaliação organoléptica e análise bromatológica, para fins nutricionais do camarão, caranguejo e sururu (*in natura*) consumidos na Ilha de São Luís - MA. *Cad. Pesq.*, São Luís, v.14, n.J, p. 24-34, 2003.
- Fiscarelli, A. G. *Rendimento, análise química bromatológica da carne e fator de condição do caranguejo-uçá, Ucides cordatus (Linnaeus, 1763) (Crustacea, Brachyura, Ocypodidae)*. Dissertação de Mestrado, Universidade Estadual Paulista, Programa de Pós-Graduação em Zootecnia, 92 p., Jaboticabal, 2004.
- Gokoolu, N. & Yerlikaya, P. Determination of proximate composition and mineral contents of blue crab (*Callinectes sapidus*) and swim crab (*Portunus pelagicus*) caught off the Gulf of Antalya. *Food Chem.*, v.80, p.495-498, 2003.
- Hattori, G.Y. & Pinheiro, M.A.A. Fertilidade do caranguejo de mangue *Ucides cordatus* (Linnaeus) (Crustacea, Brachyura, Ocypodidae), em Iguape (São Paulo, Brasil). *Rev. Bras. Zool.*, Curitiba, v.20, n.2, p.309-313, 2003.
- Huang, K. *et al.* The influence of salinity on the growth and biochemical composition of *Litopenaeus vannamei*. *Mar. Sci.*, v.28, p.20-25, 2004.
- Legat, J.F.A. & Puchnick-Legat, A. Metodologia para o transporte de caranguejo vivo com baixos índices de desperdícios. *Bol. Téc. Cient. CEPENE*, Tamandaré, v.17, n.1, p.115-121, 2009.
- Liang, M. *et al.* Comparison of flavor components in shrimp *Litopenaeus vannamei* cultured in sea water and low salinity water. *Fish. Sci.*, Tokyo, v.74, p.1173-1179, 2008.
- Lira, G.M. *et al.* Nutritional value of crustaceans from Lagoon-Estuary Complex Mundaú/Manguaba-Alagoas. *Rev. Inst. Adolfo Lutz*, São Paulo, v.66, p.261-267, 2007.
- Maia, E.L. Lipídios, p.49-55, in Ogawa, M. & Maia, E.L. (eds.), *Manual de pesca: ciência e tecnologia de pescado*. Varela, 430 p., São Paulo, 1999.
- Melo, G.A.S. *Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro*, Plêiade/FAPESP, 604 p., São Paulo, 1996.
- Ogawa, M.; Silva, A.I.M. & Ogawa, N.B.P. Adequações tecnológicas no processamento da carne de caranguejo. *Ciên. Tecnol. Alimen.*, Campinas, v.28, n.1, p.78-82, 2008.
- Ogawa, N.B.P. *et al.* Componentes do sabor do caranguejo. Parte 1 - Aminoácidos livres na carne in natura. *Rev. Cient. Prod. Anim.*, Fortaleza, v.2, n.2, p.152-156, 2000.
- Ogawa, M. *et al.* Industrialização do caranguejo, *Ucides cordatus* (Linnaeus). I Técnicas para o processamento da carne. *Arq. Ciên. Mar*, Fortaleza, v.13, n.1, p.31-37, 1973.
- Oliveira, G.T. *et al.* Circadian and seasonal variations in the metabolism of carbohydrates in *Aegla ligulata* (Crustacea: Anomura: Aegliidae). *Mem. Mus. Victoria*, v.60, n.1, p.59-62, 2003.
- Oliveira, G.T. *et al.* Seasonal variations in the intermediate metabolism of *Aegla platensis* (Crustacea, Aegliidae). *Comp. Biochem. Physiol.*, v.147, Part A, p.600-606, 2007.
- Pedrosa, L.F.C. & Cozzolino, S.M.F. Composição centesimal e de minerais de mariscos crus e cozidos da cidade de Natal/RN. *Ciên. Tecnol. Alimen.*, Campinas, v. 21, n. 2, p.154-157, 2001.
- Pinheiro, M.A.A. & Fiscarelli, A.G. *Manual de apoio à fiscalização do caranguejo-uçá Ucides cordatus*. UNESP/CEPSUL/IBAMA, 43 p., Curitiba, 2001.
- Rainbow, P.S. Accumulation of Zn, Cu and Cd by crabs and barnacles. *Est. Coast. Shelf Sci.*, v.21, p.669-686, 1985.
- Simões, M.R. *et al.* Composição físico-química,

microbiológica e rendimento do filé de tilápia tailandesa (*Oreochromis niloticus*). *Ciê. Tecnol. Alimen.*, Campinas, v.27, n.3, p.608-613, 2007.

Souchet, N. & Laplante, S. Seasonal and geographical variations of sterol composition in snow crab hepatopancreas and pelagic fish viscera from Eastern

Quebec. *Comp. Biochem. Physiol.*, v.147, Part B, p.378-386, 2007.

Stone, H. & Sidel, J.L. *Sensory evaluation practices*. Academic Press, 2nd edition, 338 p., San Diego, 1992.

Zar, J.H. *Biostatistical analysis*. Pearson Prentice-Hall, 5th edition. 944 p., Upper Saddle River, 2010.