INFLUENCE OF THE TYPE OF PROCESSING OF CRAB MEAT IN THE PHYSICAL-CHEMICAL AND MICROBIOLOGICAL PARAMETERS

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ABSTRACT

Crab meat, a source of great nutritional and chemical wealth, is much appreciated for its distinctive taste in culinary preparations. However, because it is a fish, it is a highly perishable product, making due care necessary to ensure food safety and thus make it possible to enjoy the benefits of its consumption. In general, in Brazil, the crustacean is processed by the riverside artisans, without the necessary attention to hygienic-sanitary procedures. This article shows a possibility of semi-automated processing, as an alternative to the manual method practiced in the country, aiming at a better quality meat. The aim of this paper was to analyze the influence of manual and semi-automated processing on meat quality through physical-chemical and microbiological analyzes.

KEYWORDS: Crab Meat, Equipment, Microbiology & Physicochemical

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1. INTRODUCTION

The portunids include several species of interest, mainly of the genus Callinectes, where the *C. sapidus*, popularly known as blue crab is the most abundant species and of greater economic importance, because it is a fishing resource very appreciated gastronomically. In Brazil, they are widely distributed, from Paraíba to the Rio Grande do Sul.

The world average of fish consumption has increased in the last decades (Delgado, 2003), mainly for the search of the consumers for healthier foods, paper that the fish carries out very well, since it represents an important source of protein of high biological value, it is rich in polyunsaturated fatty acids and has high digestibility, which makes it quite healthy (Ordóñez, 2005).

However, the high availability of amino acids in fish is also responsible for making fish one of the most perishable foods. The high rate of water activity associated with the high nutrient content facilitates the proliferation of microorganisms, in addition, the phospholipids contents and the action of destructive enzymes present in their viscera contribute to the deterioration processes (Gaspar, 1997; Leitão et al, 1997). The risk of contamination is one of the most commonly observed aspects of food safety and is important at all stages of fish processing, which begins to change immediately after capture.

In Brazil, the activity of fishing and processing of these crustaceans is predominantly handmade and the improvement of techniques is fundamental both to improve fishermen's quality of life and to guarantee innocuous products, from the hygienic-sanitary point of view. Commonly the crab discarding is done manually by the fishermen and during the process, there are several irregularities and non-conformities with GMP (Good Manufacturing Practices). Negligence and lack of such practices put the health of the consumer at risk, as the

health aspects are seriously compromised.

Through a process that prioritizes the quality of the crab meat and that is able to improve the working conditions of the people who perform this activity, a new technique, using the principle of suction for descaling, has been developed. The purpose of this technique was to reduce the handling of the meat and, consequently, to minimize the possibilities of contamination, bringing quality to the product. In this way, this paper aimed to analyze the influence of manual and semi-automated processing on meat quality through physical-chemical and microbiological analyzes.

2. MATERIALS AND METHODS

2.1 Machine

The methodology adopted in the machine for extraction of crab meat construction was proposed by Pahl et al (1996), and the project was developed from the following methodological guidelines: Planning phase, design stage, preliminary design and detailed design.

2.1.1. Planning

It begins by identifying the need for a new product and covers the detailed analysis of the design problem by raising all the information necessary for its full understanding. Scope and basic guidelines are defined to obtain the specifications, functionality and expected performance. The objective is to develop a set of information to provide the basis for extracting whole-grain crab meat and directing subsequent decisions.

In order to understand the existing manual removal processes, field trips to the city of Laguna-SC were carried out in fishing communities and a Processing Industry.

2.1.2. Conception

It is the stage of the process that generates a design for the product in order to meet the identified need efficiently. The possibilities for achieving the objective and specifications are investigated and then a functional product modeling plan is carried out.

In order to achieve the purpose, the conceptual design is divided into stages, which cover the identification of the initial problems of crab meat extraction, the establishment of structures and functions, research of principles and solutions and culminate in the realization of design variants.

2.1.3. Preliminary Project

The best concept is chosen from the conceptions generated by the previous activities, which will be transformed into final product. For decision making to be successful, it is necessary to use selection methods. One of the most commonly used selection methods is the decision matrix method that uses evaluation criteria, which may be customer specifications or requirements. Solutions are presented to meet the functionalities required, so that, through the structural confection of the machine, a preliminary design is conceived. With the preparation of the prototype, it is possible to check the errors and make adjustments to meet the specifications of the product.

2.1.4. Detailed Project

At this stage all components must be fixed, the shape, dimensions, and layout of all structures must be definitively established and all materials and technical feasibility specified. According to Pahl et al (1996), the level of detail to be

reached at this stage should include Establishment of the definitive layout (general arrangement and spatial compatibility); Preliminary design of forms (component and material format); Production procedures and Establishment of solutions for any auxiliary function.

2.2 Samples

The crabs were captured in Laguna-SC through collections conducted between June and August 2017, one part was submitted to manual processing by the crab collectors and the other to the processing by semi-automated suctioning equipment, in the laboratory.

In the manual process, the crabs were initially cooked and its locomotive limbs were removed. After the carapace was removed and the joints between the thoracic sternum and the locomotor limbs were extracted, and a longitudinal cut of the thoracic sternum was performed in order to leave the exposed fibers for manual extraction. removed from the meat of the locomotive limbs and then the meat was packed and goes for commercialization.

In the processing of the crab performed in the laboratory, the crabs had the carapace removed and were later cleaned, removing the gills and the viscera, only after cleaning, to be routed to steam. After cooking, the locomotor limbs were removed and the crabs were passed through the procedure of extraction of the meat by the equipment through suction.

In both manual and semi-automated processing, the samples were packed in sterile plastic bags, hermetically sealed, and analyzed with 1 day of refrigeration and 10 days of freezing, by the Laboratory of Analyzes of the Department of Food Science and Technology, Federal University of Santa Catarina (LABIAL / UFSC).

2.3 Microbiology

2.3.1. Quantification of thermotolerant coliforms (CT)

It was performed by the official method through Normative Instruction N°. 62 of 08/26/2003. Cultures were inoculated into tubes containing EC broth at 45 ± 0.2 °C for 24 to 48 hours in a shaking water bath. The presence of thermo tolerant coliforms was confirmed by gas formation (minimum 1/10 of the total Durham tube volume) or effervescence when gently shaken. Through the dilution used it was possible to express the result in CFU / g.

2.3.2. Quantification of coagulase-positive staphylococci

It was weighed 25 ± 0.2 g of the sample, 225 ml of 0.1% peptone saline solution was added, homogenized for approximately 60 seconds in stomacher and inoculated on the dry surface of Baird-Parker agar, 1 mL and with the aid of Drigalski's loop was spread until complete absorption. The inverted plaques were incubated at 36 ± 1 °C for 30 to 48 hours, whereby the colonies were selected and 0.3 ml of each culture tube was transferred into BHI for sterile tubes containing 0.3 mL of rabbit plasma. Incubate at 36 ± 1 °C for 6 hours and clot formation was observed.

2.3.3. Search for Salmonella

Performed according to ISO 6579: 2002. Pre-enrichment in the non-selective liquid medium was done by a 1:10 dilution of the peptone-water-enriched sample buffered at 37 ± 1 °C for $18 \text{ h} \pm 2 \text{ h}$. Subsequently, the enrichment was carried out in a selective liquid medium, where the culture of the pre-enrichment broth was inoculated in the RVS medium and incubated at 41.5 ± 1 °C for $24 \text{ h} \pm 3 \text{ h}$. For the identification of cultures obtained from selective enrichment, the samples were tested on XLD agar, which was incubated at 37 ± 1 °C and examined after $24 \text{ h} \pm 3 \text{ h}$.

2.3.4. Psychrotrophic Counting

Samples were serially diluted to 10⁻⁸ in sterile peptone (0.1%) water. Successive dilutions were inoculated on PCA plates to determine the total count of psychrotrophs. Plates were incubated at 7 °C and counts were performed on plates containing between 30 and 300 colonies.

2.4. Physicochemical

2.4.1. Ammonia - Eber Reaction (Qualitative)

In 25 ml tube was placed 5 ml of the reagent composed of 1 part hydrochloric acid, 1 part ethyl ether and 3 parts ethyl alcohol. The sample was attached to a wire hook fitted with a stopper which closes the tube and was inserted therein so that the sample was 1cm away from the reagent. When ammonia is present in the sample, a cloud of vapors is formed which surrounds the sample in a few seconds in an amount that depends on the ammonia content present.

2.4.2. Total Volatile Bases (Volatile Basic Nitrogen)

I was weighed 10 g of sample into 100 ml beaker and transferred to distillation flask with aid of 20 ml of water. 2 g of magnesium oxide was added. Steam distillation was carried out for 30 minutes or until there was no alkaline reaction with indicator paper. The Erlenmeyer distillate was collected containing 25 ml of 4% boric acid solution with 2 drops of Tashiro mixed indicator. The ammonia and volatile amines distilled were titrated with a 0.1N hydrochloric acid solution until turning from green to grayish blue. The calculation was carried out with the following formula:

$$\text{Volatile basic nitrogen in mg of N / 100g of fish} = \frac{V \times f \times 140}{P}$$

At where:

V = ml of a solution of HCl 0,1N spent in the titration (in case of receiving the distillate in boric acid)

f = 0.1 N HCl solution factor.

P = weight of the sample in grams.

2.4.3. Reaction to Sulfuric Gas

It was weighed 10 grams of the sample into an Erlenmeyer flask and 25 mL of distilled water was added. The Erlenmeyer was closed with a ground stopper cap and a tape containing lead acetate attached to the cap and facing into the vessel, which was heated for approximately 10 minutes in a water bath. Because it is volatile, the heating releases the sulfuric gas from the sample, if present. Subsequently, the gas reacts with the lead acetate present in the tape and forms the lead sulfide, characterized by black coloration, which qualifies the sample as positive.

2.4.4. Humidity / Protein Ratio

It was weighed 1 g of sample and transferred to the Kjeldahl tube, 5 g of a catalytic mixture and 20 ml of p.a. sulfuric acid was added; subsequently, the sample was heated in a digester block, initially, slowly, maintaining the temperature of 100 °C for 1 hour, the temperature was raised gradually until reaching between 400 and 410 °C. When the liquid became clear and clear, blue-green in hue, it was removed from the heating, cooled and water (50 mL) was added. An Erlenmeyer containing 25 mL of 4% boric acid solution with 4 or 5 drops of mixed indicator solution was coupled to

the distiller and the Kjeldahl tube containing the digested sample was adapted to the distiller and the hydroxide solution of sodium 50% until it became black (about 40 mL). Distillation was continued for a sufficient time to distill the entire ammonia. Titrate with 0.05 mol / L sulfuric acid solution or until the indicator turns.

2.4.5. pH (Hydrogenation Potential)

The pH meter was buffered with buffer pH 7 at 20 °C. About 50g of sample processed in a blender was placed in a 100 ml beaker, and the pH meter was read directly into the prepared sample.

3. RESULTS AND DISCUSSIONS

The manual removal activity, whose substitution for mechanical activity is the scope of this paper, has been studied in detail with the colony of fishermen who for generations have practiced informally this manual work of removal crab meat in Laguna city.

It has been observed that traditionally it is an exclusively manual processing, unhealthy and costly. This rudimentary process is used by the crab collectors, who do not meet the standards of the regulatory bodies; they generally operate in precarious facilities and conditions.

The crab undergoes rapid cooking and has its locomotive limbs removed (Figure 1), after the carapace is removed (Figure 2), and then with the aid of a knife, the meat is extracted from the joints and locomotive members. Finally, a longitudinal cut is made in the thoracic sternum in order to expose the existing musculature and remove it (Figure 3). Once the removal procedure is finished, the product is packed in the transparent plastic material (Figure 4) and goes on for commercialization.

In this processing, no GMP (Good Manufacturing Practices) regulations are followed, which compromises the food safety of the products and may endanger the consumer's health. Some of the factors that may pose a risk of contamination are the quality of the water used, the absence of gloves in the handling, equipment that does not go through adequate hygiene and sterilization processes, storage without temperature control, etc. In addition, in the carapace removal step, cuts and injuries are quite common due to the use of the knives in the carapace removal stage.

Figure 1: Cooked Crab without Locomotive Limbs

Figure 2: Removal of the Carapace

Figure 3: Manual Withdrawal of Crab Meat

Figure 4: Crab Meat Ready for Commercialization

From these observations began the development of suction meat extraction equipment. The first step was the planning stage, where the task was defined using the brainstorming technique, whereby some questions were formulated and answered to better understand of the opportunity, justify it and bring some important characterizations, as shown in table 1.

Through the gathering of the information, the needs that the machine was supposed to supply were determined, among which are: to remove the crab meat with a dry and fibrous appearance, need for refrigeration, to have facilities for use, assembly and disassembly, operation and repair, ensure safety and have an extended service life.

In addition, a technical feasibility analysis was elaborated, clarifying questions related to the production of the equipment, the suppliers, and the region of use, the technical profile of the team, the production process and the customers.

Once the task specifications had been elucidated, it was possible to proceed to the next machine design stage and, in order to determine the possibilities to meet the objectives outlined in the previous step, a physical-mechanical materials study were carried out. Through brainstorming and checklist, it was possible to list the required functions and then identify the best resources to meet them, as can be seen in Table 2, where the selected alternative to the functionalities is highlighted.

Table 1: Definition of the Task of the Crab Meat Extraction Equipment

Item	Questioning	Conclusion
Opportunity	What is it about? What does it consist of? How useful?	Crab Meat Extraction Method that meets hygienic sanitary requirements for safe handling of food. It consists of equipment capable of enabling the automation of the process improving the quality of the product as well as the ergonomic working conditions of the operator.
Justification	Are there similar machines? Is it a new concept? Is it a Market Need?	Other machines with the principle have already been patented inside and outside the country, but none with the specifications of removal of meat with fibrous consistency. Therefore, it is a new concept that is fully justified considering the current methodologies used for the extraction of crab meat.
Use	What is the frequency of use? Where is it used?	The equipment will be used within the industry, in the companies of beneficiation of crab, and in the communities of collectors or associations, having a daily frequency of use.
Description	Is there a standard to follow? What are the requirements? What materials can be used?	Surveillance recommends standards for food handling; materials should be easily sanitized and cannot be toxic.

The most suitable alternative for the operation of the equipment is alternating electric current since it offers the greater availability of energy and through the power, it is possible to do the dimensioning of the thickness of the cables.

The various control devices and valves have been chosen to provide safety, ease of use and process efficiency. The selection of materials for the pipe, most suitable for each function, depends on several factors, such as the working temperature and the type of fluid to be conducted, where important aspects such as contamination and corrosion should be considered, as well as safety and flow resistance. After a study of the levels of tensile strength, expansion and thermal resistance, ductility and hardness, the non-toxic hose was the best option to suction the product, separate it and guide it to the reservoir, since it is light, high corrosion resistance, lower cost than other options, reduced coefficient of friction, low thermal and electrical conductivity, is translucent and allows visualization of the product and is also easy to manufacture and handle.

Table 2: Analysis of Structures and Functions

Function	Principles of Solution	
Turn on	Type of energy	Electric power (direct current) Electricity (alternating current) ✓ Thermal energy (combustion) Solar energy
To control	Device Types	Switch: lever Switch: button ✓ Touch sensor Level sensor ✓ Vacuum Gauge ✓ Flow regulator ✓ Line Filter ✓ Potentiometer ✓
Control and stop	Devices	Programmable Logic Controller (PLC) ✓
Extract the meat from the crab	Suction	Venturi -type vacuum generator: compressed air Venturi -type vacuum generator: water Vacuum pump ✓
Guide the meat to a suitable tank	Pipes of various diameters	Carbon steels Cast iron Alloy steels Wrought Iron Stainless steel ✓ Aluminum Brass Nickel and alloys
Separate products	Connections with variations in dimensions	Polyvinyl chloride (PVC) Stainless steel ✓ Non-toxic hose
Connect the pipes	Means of connection of pipes	Threaded connections Welded connections Flanged connections Tip and bag connections Compression connections O-ring ✓
Store the meat	Reservoirs	Material: Stainless steel ✓ Plastic Materials Glass Porcelain
System feedback	Reservoir capacity	Visual Automatic ✓

✓:a Selected alternative to the required function

It was chosen as a refrigerated reservoir and of easy hygiene, to offer greater sanitary security, since the fish is a highly perishable food.

After concluding the conceptual study, we selected the best designs and proceeded to the stage of execution of the preliminary project where several prototypes were made with different configurations and dimensions, where we tested types of pipes, pumps and other components. In the initial tests it was not possible to obtain the dry meat/muscle fibers, because the resulting product had high water contents, so from these results were made improvements and adjustments and reached a structure that met the requirements required to ensure the extraction of the muscle fibers of the crab (Figure 5). During the mechanization stage, vacuum generation, electro -pneumatic, and artificial vision techniques were used.

For the validation of the prototype were made analyzes of possible faults and defects, and performed tests to verify interference, to then make all necessary adjustments for its full operation.

The proposal of the prototype with the principle of generation of vacuum was able to extract the meat with its less damaged muscle fiber from the crab, as well as the separation of the more humid meat (crab paste) (Figure 6).

Figure 5: Equipment Prototype

Figure 6: A) Dry Meat; B) Wet Meat

Based on the results obtained with the prototype, the development phase of the machine itself was moved, where the dimensions and materials were adapted to meet hygiene, safety, and efficiency specifications.

The constituent parts of the machine include an operating table on which is a flexible hose with a nozzle adapted for suction fitted in a stainless steel "Y" connection, which attach to hoses for separation of the dried meat of crab and paste (wet meat) that extend to the cooled reservoirs, which have a temperature and level sensor, and these reservoirs are connected to a vacuum pump with flow regulation, a vacuum gauge, and a PLC.

The finished crab meat suction equipment can be observed in Figure 7, where it can be seen that for the rigid structures of the machine the stainless steel material was selected because it was inert, did not form microcracks, had a hygienic ease and had resistance corrosion and mechanics. These characteristics together ensure the chemical and biological safety of the handled product. In the suction and conduction structures of the product, which are flexible, non-

toxic food hoses were used, which do not transfer undesirable odor or taste to the product, have high temperature and abrasion resistance and are easy to clean.

The suction method used by the machine developed in this work allows the resulting products to be less exposed to contamination since the absence of direct human contact ensures better conditions of sanity and safety to the product.

At the end of the process, two products were obtained, the wet meat and the dried and fibrous meat, which is an innovation for the market, since it presents completely different characteristics of the currently available products (Figure 8).

Figure 7: Equipment for Extraction of Crab Meat

Figure 8: Dry Meat obtained by the Suction Process in the Final Equipment

Physical-Chemical and Microbiological Analyzes

The psychrotrophic count is an important indicator for the verification of the shelf life of the food since some microorganisms have the capacity to continue in deterioration activity in freezing temperatures. In Brazil, there is no legislation to define the limit of these microorganisms, but high psychrotrophic counts are indicative of contamination, a general state of conservation and shelf life (FRANCO; LANDGRAF, 2005; SILVA et al., 2007). This increase can lead to alterations, some enzymes produced, such as lipases and proteases, modify the flavor, resulting in Sanchez and bitterness in foods (Jefrey and Damien, 1990).

For meat samples manually withdrawn with 1 day of refrigeration the average was 3.8×10^6 CFU / g and in 10 days under freezing conditions, the mean was reduced to 5.6×10^4 CFU / g. For the 1-day refrigeration machine, the average was 7.0×10^4 CFU / g, which reduced to $<1.0 \times 10^2$ CFU / g for 10 days under freezing.

The bacterial count for the fish at the time of capture varies from 2 to 5 log CFU / g, and an increase of more than 6 log CFU / g indicates the handling conditions and long storage periods (ICMSF, 1986).

As can be seen in figure 9, the freezing for 10 days, both in the manual method and in the automated method, decreases the count of psychrotrophic in 2 log cycles. The decrease of psychrotrophs was also observed by Cordeiro (2007), after processing and freezing mussels. Storage of the samples for a period of 90 days under freezing conditions reduced the count of these microorganisms in a logarithmic cycle demonstrating that there was a decrease in viable cells.

However, it is important to observe that the manually manipulated samples had a high number of psychrotrophic ones, indicating the beginning of deterioration, which even after the freezing remained superior to those obtained by the automated method, which compromises the quality of the product. This increase can be explained by the conditions under which they were handled since the fish has high water activity and undergoes the enzymatic and microbiological proteolytic action (França Filho et al., 2006).

A work with beef conducted by Porto (1997) showed that shelf life of the product varies according to its initial contamination of psychrotrophs, if the count is 10 CFU / g estimated shelf life is 3 weeks, to 10^2 UFC / g of 14 days, to 10^3 CFU / g of 10 days, count of 10^4 CFU / g of 8 days and of 2 to 6 days in a count of 10^5 CFU / g. Considering the high perishability of the fish and taking into account the counts obtained in this study, samples processed manually would be prone to a shorter shelf life than those processed by the equipment.

The results of the microbiological analyzes for thermotolerant coliforms, coagulase positive staphylococci, and *Salmonella* spp. performed with samples of crab benefited manually and by the use of suction equipment, can be observed in table 3.

Resolution RDC N°. 12 of January 2, 2001, of the National Health Surveillance Agency (BRASIL, 2001) establishes, for crab meat, the following reference values: 5×10 CFU of Coliforms at 45 °C per gram; 10^3 CFU of *Staphylococcus* coagulase positive per gram and absence of *Salmonella* spp. in 25 grams.

In the analyzes of thermotolerant coliforms all the samples had $< 1.0 \times 10^1$ CFU / g, that is, they are within the limits established by the legislation. There was no *Salmonella* occurrence in any of the samples, demonstrating that all are in accordance with the legislation and corroborating with the one found by Vieira et al (2006) in his work with crabs.

Regarding the coagulase positive staphylococcal count, there was no difference between the samples, all of which are in accordance with current legislation, with a count of $< 1.0 \times 10^2$ CFU / g. Vieira et al. (2006) found contamination by staphylococci coagulase positive in counts higher than that allowed in 27% of the crab samples benefited in Paraná. An increased value was expected for manual processing, where food remains longer exposed in the environment, which would accelerate bacterial proliferation, but it is believed that these samples were processed during the winter months in southern Brazil process has been minimized. In work with seafood conducted by Popovic et al. (2010), bacterial counts also presented lower values in winter compared to summer, corroborating with the results found in this study.

The results of the physicochemical analyzes for Ammonia, Hydrogen Sulphide, Volatile Bases, Moisture / Protein Ratio and pH are presented in table 4.

Figure 9: Counting of Psychrotrophic Microorganisms in Samples Benefited Manually and in Samples Processed by the Suction Equipment

Table 3: Results for Microbiological Analyzes

Sample	Thermo tolerant coliforms	Coagulase positive staphylococci	Salmonella spp
Machine (1 day refrigerated)	$< 1.0 \times 10^1$ CFU / g	$< 1.0 \times 10^2$ CFU/g	Absence in 25g
Manual (1 day refrigerated)	$< 1.0 \times 10^1$ CFU / g	$< 1.0 \times 10^2$ CFU/g	Absence in 25g
Machine (10 days frozen)	$< 1.0 \times 10^1$ UFC/g	$< 1.0 \times 10^2$ CFU/g	Absence in 25g
Manual (10 days frozen)	$< 1.0 \times 10^1$ UFC/g	$< 1.0 \times 10^2$ CFU/g	Absence in 25g

Table 4: Results of the Analyzes for the Physicochemical Analyzes

Sample	Reaction of Eber-Ammonia	Total Volatile Bases	Reaction of Eber-Hydrogen sulfide gas	Humidity / Protein Ratio	pH
Machine (1 day refrigerated)	Positive	32,51 mg/100g	Negative	3,49 g/100g	8,03
Manual (1 day refrigerated)	Positive	21,62 mg/100g	Negative	4,26 g/100g	8,14
Machine (10 days frozen)	Positive	29,20 mg/100g	Negative	3,98 g/100g	7,57
Manual (10 days frozen)	Positive	21,31 mg/100g	Positive	4,61 g/100g	7,86

All the samples of crab evaluated were positive for Eber reaction (ammonia). Ammonia is released at the beginning of protein degradation and is detected in the Eber reaction by the formation of ammonium chloride in the presence of hydrochloric acid. When positive, indicates the action of deteriorating psychrotrophic, which can act under refrigeration temperatures. These results corroborate with the microbiological analyzes of the samples tested, since to a lesser or greater degree, all had a count of psychrotrophic microorganisms.

The Eber reaction for hydrogen sulfide gas was positive only for the 10 -day frozen meat sample processed manually. The reaction for sulfuric gas is based on the formation of lead sulfide which has a dark coloration. This gas appears in more advanced stages of decomposition, originating from the degradation of sulfur amino acids and is produced by mesophilic microorganisms, which indicate exposure to room temperature for long periods, evidencing that the manipulation and storage were not adequate.

In the results for Volatile Bases - Volatile Basic Nitrogen (N-BVT), only the refrigerated sample for 1 day processed by the machine with 32.51 mg / 100g was outside the legislation, which recommends the maximum limit of 30 mg / 100g. The higher levels of N-BVT may be indicative of microbiological deterioration but are not suitable for use as prohibitive for consumption (Loughran and Diamond, 2000). In addition, the value of BVT may be high for certain species, including the crabs, without being properly deteriorated (Zenebon et al., 2008), then this analysis alone can not serve as a parameter for the evaluation of deterioration, as an aid in the set of microbiological and physicochemical analyzes.

Regarding pH, the legislation recommends that it should be below 6.5 in the fish, so all samples would be disapproved. However, it is important to emphasize that the legislation does not provide specifications on different types and species of fish, in addition, pH measurement may not be a safe index to evaluate deterioration due to the many fluctuations during the storage period (Ogawa and Maia, 1999). However, the higher values of the aerobic psychrotrophic bacteria counts (Table 4) also correspond to the higher pH values, evidencing direct interference of the high microorganism count with the pH of the meat.

The moisture/protein ratio is important to evaluate fish quality, to evaluate the possibility of applying technological processes, as well as the possible addition of wetting agents, however, in Brazil, there is still no specific legislation for legal limits of this parameter in fish. However, normative instruction nº 32, of December 3, 2010, establishes the minimum and maximum levels of humidity/protein contained in different cuts of chicken, in which the values vary from 3.03 to 4.72 g / 100g.

The results obtained for manually processed meat were 4.26 g / 100 g for the refrigerated 1 -day sample and 4.61 g / 100 g for the frozen sample for 10 days. For the samples benefited by the suction machine, values of 3.49 g / 100g were obtained for the samples with 1 day of refrigeration and 3.98 g / 100g in the samples with 10 days of freezing.

A study conducted by Yeannes et al. (2003) evaluated the moisture/protein ratio in 41 families of fresh and frozen fish, finding distinct values among the species. For shrimp samples, for example, refrigerated samples obtained an average of 4.8 g / 100 g, while frozen ones of 7.2 g / 100 g. In general, this ratio was increased for frozen samples compared to fresh samples, corroborating with the results obtained in this study.

4. CONCLUSIONS

By means of the finishing of the machine, with this new suction technique for crab meat removal, it was possible to obtain two distinct products, the meat with different organoleptic characteristics, white color and fibrous consistency, and a crab paste. These products represent great progress in terms of innovation, appearance and sanitary quality and, consequently, bring value to the product.

The industry, including the North American - a leader in the processing of crab meat, still does not have an efficient process and that guarantees high added value to the product. Based on this premise, it is understood that the market value of pure meat will encourage both fish companies and future breeding companies that can be set up, by moving the economy. The process will reduce labor accidents due to manipulation of cutting materials and will offer greater ergonomics to the manipulators, guaranteeing an efficient method both with regard to working methods and in meeting the standards of quality and food safety of the products. In addition, the labor force currently employed in the illegal and unsuitable informal dumping of the crab, which takes place around the families of fishermen, would naturally shift to the additional catch demanded by industrial -scale production without the need for transfer of workers to another productive activity.

It can be said that the provision of this equipment to fishing communities can stimulate the local economy and offer better working conditions, enabling the formalization of the business. The articulations between teaching, research and community are essential to broaden the view on social needs and give visibility to the important work developed by this social body, which is often considered as "underemployment". The promotion of the practice of cooperative, like the organization of associations and cooperatives, is capable of propitiating actions of public policies so that popular aspirations can be met. By stimulating dialogue among the various actors in the sector, it will be possible to draw up a strategy for socio-economic development that is best suited to recover from subalternity the beneficitation of the crab practiced by the riverside.

These factors have a positive impact, considering the increase in the supply of formal labor resulting from industrial -scale production, as well as the expansion of the potential of labor occupation in the activity of the crab.

Under microbiological and shelf-life conditions, the suction extraction method improved the quality of the product, especially the decrease in the count of psychrotrophs compared to the manual method. The values of pH and moisture/protein ratio were also better for the samples obtained by the machine, demonstrating that the process represents an efficient alternative for improving the quality of the product compared to manual processing.

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