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Hearts of palm in conserve: identity and quality aspects and their implications on food safety

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Abstract: The current study aimed to evaluate the safety aspects of 30 samples of hearts of palm in conserve from 10 different Brazilian commercial brands by determining the pH value and evaluating the adequacy of the labels with respect to the labeling norms defined in current Brazilian legislation. The results showed that none of the 30 samples analyzed showed pH values above 4.5, being in accordance with the value specified in the legislation. On the other hand, 90% of the brands failed to conform to current labeling norms with respect to one or more parameters, showing that monitoring programs should be carried out periodically by the sanitary vigilance authorities.

Keywords: Hearts of palm, labeling, safety, quality

Introduction

Hearts of palm are considered to be an exotic and special product when compared to other vegetables in conserve. The following species stand out amongst those more appropriate for commercialization: Jucara (*Euterpe edulis mart*), Acai (*Euterpe oleracea mart*) and Pupunha (*Bactris gasipaes*) (Rodas et al., 2005). Hearts of palm present a pH value above 4.5, frequently between 5.6 and 6.2 (Chaimsohn, 2002), and are thus susceptible to the multiplication of spore forming pathogens such as *Clostridium botulinum*. *C. botulinum* is a gram-positive, strictly anaerobic spore-forming rod that produces a potent neurotoxin. The first symptoms of botulism are gastrointestinal, such as nausea, vomiting and diarrhea, which may be followed by intestinal constipation. The symptoms associated with the action of the neurotoxin include fatigue and muscle weakness followed by blurred vision, dryness of the mouth, and difficulty to swallow and control the tongue (Johnson, 2000). The disease has a very high mortality rate, almost always culminating in death of the individual or in the presence of serious sequels (Rhodehamel *et al.*, 1992).

Heart of palm is a product of vegetable origin with possible soil contact, having the chance of being contaminated with *C. botulinum* spores. Since its pH is naturally in the low acid range and it does not withstand high temperature treatments of above 100ºC, due to sensory (color) alterations, the pH of the product is reduced to below 4.5 (pH value below which *C. botulinum* cannot multiply and produce neurotoxin) and its microbiological stability is assured by a combination of the acid pH and pasteurization. Its presence has been related in several processed foods, as chamomilla (Bianco *et al.,* 2008), mascarpone cheese and other milks products (Giovanna *et al.,* 1999), honey (Kuplulu et al*., 2006;* Koepke *et al.,* 2008) and fish (Lalitha and Surendram, 2002), as well as periodic surveys in several countries (Carlin *et al*., 2004; Hosseini *et al*., 2009). Recently, an outbreak of botulism in Tawain has been reported, and the probable source of such outbreak was a fermented food (Tseng *et al.*, 2009).

According to data from the São Paulo Epidemiology Vigilance Center (São Paulo, 2004),

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between 1999 and 2004, more than 20 cases of *C. botulinum* involving various foods including hearts of palm, were confirmed in Brazil. Subsequent sanitary investigations showed failures in the process of producing hearts of palm in conserve, and found a great number of products of clandestine origin, which not presented safety control and quality criteria. The products presented inadequate labeling or superimposition of labels from different origins and no batch numbers, impeding identification of the origin, no manufacturing date, expiry date or controls related to its manufacturing process. This has lead the National Sanitary Authorities to demand that all hearts of palm processing plants implant the Good Manufacturing Practices (GMP) and the Hazard Analysis and Critical Control Points (HACCP) system, in accordance with Resolution RDC nº 18/1999 (Brazil, 1999b). This resolution also gives great importance to product labeling, and this item could aid in controlling fraud during production, avoiding clandestine origins, guaranteeing traceability and providing information to the consumer about the product he is acquiring and consuming. Since labeling and control of the operations (in this case, pH as an indicator of the efficiency of control in the acidification step) are important items in the good manufacturing practices program and the base for implantation of food safety guarantee systems, the objective of the present study was to evaluate the safety aspects of hearts of palm in conserve by determining the equilibrium pH value and labeling, checking adherence to the current legislation in Resolution RDC nº 18/1999.

Material and Methods

Sampling

Samples of hearts of palm in conserve were acquired in 500 g jars (net weight) from different supermarket chains in the city of Rio de Janeiro, Brazil. The overall sample consisted of 30 individual samples from 10 different brands (A, B, C, D, E, F, G, H, I, J) with 3 samples from the same batch for each brand.

Evaluation of the equilibrium pH value

The equilibrium pH value was determined by homogenizing the entire contents of each jar (hearts of palm and brine solution) and determining the pH using a pH meter (Quimis, model Q400A, Diadema, Brazil), using the methodologies outlined by Instituto Adolf Lutz (2005). Aliquots of the homogenate were removed and the pH determined in triplicate for each sample. An equilibrium pH value of 4.5 was considered as the limit for the analyzed samples, once above this value, there is a high possibility of the growth and production of the neurotoxin by *C. botulinum*.

Evaluation of the labels

The labels were evaluated based on current legislation for the labeling of hearts of palm in conserve and bottled foods (Brazil, 2003a; 2003b; 2003c; 2002; 1999a; 1999c; 1999d; 1999e). The adequateness index was calculated for the labels with respect to the norms (percentage of non-conformities), and the non-conformities discriminated in the case of labels not in line with current legislation.

Statistical analysis

Initially, pH values had their normality and variance homogeneity evaluated by Hartley's test. As a second step, one-way analysis of variance (ANOVA) was carried, followed by Fisher LSD test. Probability values below 0.05 indicated significant difference among the samples.

Results and Discussion

Evaluation of the equilibrium pH value

Figure 1 shows the results for the determination of the equilibrium pH and the confidence interval of 95% for the means. Using the Hartley's test, homogeneous variances were observed ($P = 0.922$), suggesting the robustness of the experimental data. According to the Fisher LSD *pos-hoc* test, differences ($P < 0.001$) among samples were obtained, which is completely normal when pH values are determined in different food systems, once there are differences in concentrations of ingredients, water physicochemical features, addition of acids, among others. The lowest value found for the equilibrium pH value was 3.19 for brand "B". The highest value was 4.13 for brand "J". Thus, none of the 10 brands analyzed showed pH values above 4.5, all conforming to the pH limit stipulated for this food, indicating adequate processing conditions with respect to the control of acidification of the batches. Only one of the brands ("J") presented a mean pH value higher than 4.0, while the others (90%) presented pH values below this value. From the food safety point of view, this fact can be considered important, constituting a safety margin in relation to the critical limit of pH = 4.5; however it should not prejudice product acceptance on account of an excessively acid taste due to pH values as low as the mean value of 3.19 found for sample "B".

Thus, the consumption of these samples presented no health risk to the consumer, since

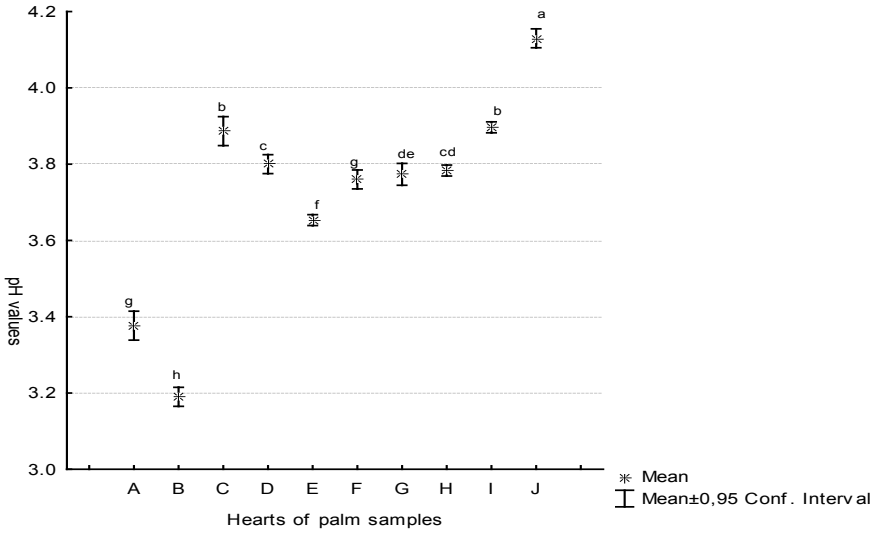

Figure 1. pH values of hearts of palm in conserve marketed in Brazil.

Table 1. Assessment of the information displayed on the labels of the heart of palm samples

Parameters / Brands	Name	Address and consumers' information service	National register of firms	Net weight	Lot, production date/ Expiration date	Ingredients	Instructions	Registration number on Ministry of Health	Nutritional information
A	C	C	C	C	C	C	NC	C	C
B	C	C	C	C	C	NC	NC	C	C
C	C	C	C	C	C	NC	NC	C	C
D	C	C	C	C	C	NC	NC	C	C
E	C	C	C	C	C	NC	NC	C	C
F	C	C	C	C	C	C	NC	C	C
G	C	C	C	C	C	NC	NC	C	C
H	C	C	C	C	C	C	C	C	C
I	C	C	C	C	C	NC	NC	C	C
J	C	C	C	C	C	NC	NC	C	C

C = conformity; NC = non-conformity.

with a pH value below 4.5 there was no possibility of *Clostridium botulinum* growing and producing toxin. The variation in equilibrium pH between the samples of the different brands could be attributed to a natural variation in pH between batches of hearts of palm received by the processing industries. Small variations between samples of the same batch can be attributed to a certain variation in size of the hearts of palm sticks (this being an important control point during production due to the final equilibrium pH value), or a natural variation in the hearts of palm depending on the portion used. Another important point to consider is that during storage of the product, there is a natural adjustment of the pH of the sticks, starting at the surface and working inwards to the center of each stick, and depending on the hardness of the tissue, this diffusion of the citric acid is facilitated or otherwise.

At this point it is important to emphasize the correct use of the acidification curve for each batch of hearts of palm processed by an industry. Since each batch can have a variable pH value, one should avoid standardized procedures with respect to the amount of acid to add to the brine solution, since the amount chosen may not always be sufficient to reduce the pH value to below 4.5 and culminate in the multiplication of *C. botulinum* and the production of neurotoxin. However, Rodas *et al.*(2005) analyzed 62 samples of hearts of palm in conserve commercialized in the State of São Paulo, Brazil between 2003 and 2005, and reported that the majority presented pH values between 3.5 and 4.5, and that only 2 samples showed a pH value above the maximum limit permitted of 4.5. Berbari *et al.* (2008) produced canned acidifed and pasteurized hearts of palm of three different cultivars and the authors verified that 100% of products presented adequate pH (below the 4.5 value).

Any food that allows for the growth and survival of anaerobic microbial spores after processing and that is not heated before consumption can be associated with botulism (INPPAZ, 2001). In Brazil, hearts of palm are mostly commercialized in conserve and thus, the consumption habits of the product can also be related to the risk of toxinosis by *C. botulinum*. In their survey regarding the acceptance of *pupunha* type hearts of palm and consumer habits, Verruma-Bernardi *et al.* (2003) showed that the greatest consumption of this vegetable was in the form of salad (81.5%), followed by fillings for savories (50.6%), meat dishes (13.6%) and in the pure form (12.4%). The use of this product for direct consumption or in the preparation of dishes not submitted to any type of heat treatment reveals the importance of a strict control during production. Various failures can lead to the multiplication of *C. botulinum* in the packaged product, such as uncalibrated balances used to weigh the acid added to the brine, operational failures in the weighing and homogenization of the brine and natural variations in pH between the batches of hearts of palm to be processed, leading to a final pH above 4.5. In their study, Berbari *et al.* (2003) observed that the amount of citric acid required reducing the pH of 100g of hearts of palm to below 4.5 can vary according to the species of hearts of palm used for processing. The variation of up to 43% in the amount of acid required to acidify hearts of palm to pH values below 4.5 is of importance in food safety, since it is the correct acidification of the product pH that eliminates the probability of the growth of *C. botulinum* and production of its toxin.

Evaluation of the labels

Table 1 shows the results obtained for each parameter mentioned in the legislation in the evaluation of the labels from the products analyzed. Only brand "H" conformed to the legislation for all the parameters. Brands "B", "C", "D", "E", "G", "I" and "J" did not conform with respect to the parameter "ingredients" and all the brands, with the exception of "H" did not conform with respect to the item "instructions to be placed on the product label". Thus only one brand, representing 10% of the brands analyzed, conformed to all the parameters considered for labeling.

All the brands of hearts of palm analyzed were considered to be in accordance with the item indicating that the labels should contain a minimum of information about the manufacturer, such as name, address, national register of firms (CNPJ) (Brazil, 1999a). These data should also be printed on the metal lids of glass jars in a visible manner even considering the seal (Brazil, 2003a). The manufacturer should also declare the registration number in the Ministry of Health on the label, according to the regulation covering the labeling of foods filled into packages (Brazil, 2003b).

Thirty percent of the brands analyzed ("A", "F", "H") were in accordance with Resolution nº 259/2002 (Brazil, 2002). On the other hand, the brands "B", "C", "D", "E", "G", "I" and "J", representing 70% of the brands analyzed did not conform with this regulation, since they failed to indicate the function of the food additive used in the hearts of palm conserves. This additive, citric acid, should appear at the end of the list of ingredients with its name and/or INS number (International Numbering System, *Codex Alimentarius* FAO/OMS) and its function discriminated. Only brands "A", "F" and "H"

indicated the function of the citric acid (acidulant). The list of ingredients should be contained on the label preceded by the expression "Ingredients", all being included in decreasing order according to the respective proportion (Brazil, 2002). Although it can be not assured that citric acid was not added in brine during the production of these products, the absence of such acidulant during the manufacturing process makes the safety factor questionable. Thus, the conditions of acidity can allow for the growth of *C. botulinum*, and consequently, the production of toxin. Consumers should carefully observe this fact before acquiring certain known risky foods, as heart of palm in conserve.

One fact that could be observed on the labels of all the analyzed packages was the instructions about how to conserve the product after opening. Brand "F" failed to state the conservation time after opening. The instructions about how to conserve and store the product after opening were only found dispalyed on the labels of brands "D" and "H", representing 20% of conformity. The inclusion of a caption with the necessary precautions to maintain product quality is obligatory on the labels of food products, including the maximum and minimum temperatures for their conservation. The same applies to products whose characteristics may change after opening the package. Thus, this type of food should contain instructions like: "Maintain in a cool dry place" or "After opening, conserve the product in the refrigerator at 5-10ºC for a maximum of "x" days" (Brazil, 2002*)*.

Another instruction that was checked for on the packages was a statement concerning the presence or absence of gluten. This instruction is considered mandatory on all food products according to the Resolution nº 10.674/2003 (Brazil, 2003c), which determined that the packages should contain the inscriptions "contains gluten" or "does not contain gluten", as applicable, on the label and in the instructions for the use of all industrialized foods, as also on posters and other marketing materials, in highlighted characters that are clear and easy to read. This law was created due to the need to know about the presence or otherwise of this protein by those suffering from celiac disease, who cannot consume gluten. Hearts of palm do not contain gluten, and thus the instruction "does not contain gluten" should appear on the label. Adherence to this instruction was only observed for brands "E", "G", "H" and "I", the others not adhering to this law, indicating 60% of non-conformity to this legislation by the brands analyzed.

The Brazilian Resolution nº 360/2003 (Brazil, 2003b) made it obligatory to give the nutritional information about packaged foods on the label, the date limit for adherence to this norm being 31st July, 2006. All the brands, with the exception of "J" provided the nutritional information on the label, representing 90% of conformity to this legislation. Rodas *et al.* (2005), in their study on the evaluation of sanitary aspects critical to the safety of hearts of palm in conserve, observed that of the 62 samples examined, 15 (24.2%) were unsatisfactory and 2 (3.2%) did not present labels. The main reasons for failure on the basis of labeling were: the lack of the indication of which manufacturing unit produced the batch (21.9%), absence of an expiry date (16.1%), absence of the name of the hearts of palm species and absence of the manufacturer's address (8.1%) and also a list of the ingredients and the manufacturer's name (6.5%). Also according to these authors, despite efforts to regularize hearts of palm in conserve, the product still requires the attention of the sanitary vigilance authorities in order to guarantee its innocuousness and traceability. Another important point to consider is that irregularities concerning labeling found in the samples produced and commercialized in the state of Rio de Janeiro were also found in the state of São Paulo (Rall *et al.*, 2003). This should represent a control focus and concern of sanitary vigilance authorities. A greater control of the information made available to consumers, and also the use of packaging material as a means to educate and help the population to choose, prepare and maintain foods could be an important ally in guaranteeing the quality and innocuousness of food products marketed in Brazil.

The results of this study indicated that 100% of the brands of hearts of palm in conserve were adequate with respect to the pH, suggesting that this product does not represent a risk with respect to botulism. However, 90% of the brands presented a lack of conformity with respect to one or more parameters of current legislation concerning labeling, demonstrating that monitoring programs should be carried out periodically by the sanitary vigilance authorities to guarantee commercialization of the product within the identity and quality standards, thus assuring its innocuousness.

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