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Avaliação do padrão de identidade e qualidade de polpas de caju convencional (não pasteurizadas) e pasteurizada comercializadas no Estado do Ceará, Brasil

Assessment of the standard of identity and quality of conventional (not pasteurized) and pasteurized cashew pulps commercialized in the State of Ceará, Brazil

Evaluación de la identidad y el estándar de calidad de las pulpas de anacardo convencionales (no pasteurizadas) y pasteurizadas que se venden en el Estado de Ceará, Brasil

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Resumo

O presente estudo teve como objetivo avaliar a qualidade das polpas de caju congeladas convencionais (não pasteurizadas) e pasteurizadas, de acordo com sua identidade e padrão de qualidade (aspectos físico-químicos e microbiológicos). Assim, foram analisadas quatro marcas de polpa de caju, duas convencionais (não pasteurizadas) 1 e 2 e duas pasteurizadas 3 e 4. Foram determinados os seguintes parâmetros em relação às análises físico-químicas: teor de sólidos solúveis, sólidos totais, pH total, pH, total acidez expressa em ácido cítrico e ácido ascórbico. As análises microbiológicas realizadas foram coliformes a 35 ° C e 45 ° C, bolores, leveduras e Salmonella. Os resultados mostraram que todas as marcas apresentaram níveis de sólidos solúveis, pH, acidez total expressa em ácido cítrico e ácido ascórbico de acordo com a legislação vigente, com pequenas oscilações entre as marcas. As análises microbiológicas revelaram contaminação por fungos e leveduras acima da permitida pela legislação vigente. Assim, conclui-se que a pasteurização nem sempre pode ser considerada um método eficaz na destruição de microrganismos nos alimentos, sugerindo uma melhoria na higiene dos equipamentos.

Palvras-chave: Cajueiro; Polpas congeladas; Segurança alimentar; Legislação; Condições higiênicas.

Abstract

The present study aimed to evaluate the quality of conventional (unpasteurized) and pasteurized frozen cashew pulps according to their identity and quality standard (physicochemical and microbiological aspects). Thus, four cashew pulp brands were analyzed, two conventional (non-pasteurized) 1 and 2, and two pasteurized 3 and 4. The following parameters with respect to physical-chemical analyzes were determined: soluble solids content, total solids, pH, total acidity expressed in citric acid and ascorbic acid. The mycorbiological analyzes performed were coliforms at 35 °C and 45 °C, molds, yeasts and Salmonella. The results showed that all brands had levels of soluble solids, pH, total acidity expressed in citric acid and ascorbic acid according to the current legislation, with small oscillations between the brands. Microbiological analyzes revealed mold and yeast contamination above that allowed by current legislation. Thus, it is concluded that pasteurization cannot always be considered an effective method in the destruction of microorganisms in food, suggesting an improvement in equipment hygiene.

Keywords: Cashew tree; Frozen pulps; Food safety; Legislation; Hygienic conditions.

Resumen

El presente estudio tuvo como objetivo evaluar la calidad de las pulpas de anacardo congeladas convencionales (no pasteurizadas) y pasteurizadas de acuerdo con su identidad y estándar de calidad (aspectos fisicoquímicos y microbiológicos). Así, se analizaron cuatro marcas de pulpa de anacardo, dos convencionales (no pasteurizadas) 1 y 2, y dos pasteurizadas 3 y 4. Se determinaron los siguientes parámetros con respecto a los análisis físico-químicos: contenido de sólidos solubles, sólidos totales, pH, total acidez expresada en ácido cítrico y ácido ascórbico. Los análisis micorbiológicos realizados fueron coliformes a 35 ° C y 45 ° C, mohos, levaduras y Salmonella. Los resultados mostraron que todas las marcas tenían niveles de sólidos solubles, pH, acidez total expresada en ácido cítrico y ácido ascórbico de acuerdo con la legislación actual, con pequeñas oscilaciones entre las marcas. Los análisis microbiológicos revelaron la contaminación por hongos y levaduras por encima de lo permitido por la legislación vigente. Por lo tanto, se concluye que la pasteurización no siempre puede considerarse un método eficaz en la destrucción de microorganismos en los alimentos, lo que sugiere una mejora en la higiene del equipo.

Palabras clave: Anacardo; Pulpas congeladas; Inocuidad de los alimentos; Legislación; Condiciones higiénicas.

1. Introduction

Originating in the Northeast region of Brazil, the cashew tree is a plant which has good development and adaptation in dry soils, high temperatures and water scarcity. These specificities have turned this crop into a considerable source of income for the Brazilian Northeast through generating work in the field and in industries, even in the driest periods of the year (Embrapa, 2019).

According to data from the Brazilian Institute of Geography and Statistics (*IBGE* 2015) and the *Companhia Nacional de Abastecimento* (*CONAB* 2015), cashew production in Brazil directly and indirectly generated around 250 thousand jobs in the Northeast region. It is possible to use approximately everything of the cashew tree to obtain new products, such as its peduncle (pseudofruit) which is benefited in industries and/or small factories for producing juice, frozen pulp, soft drinks, jams, or even the traditional cashew (Embrapa, 2019).

The Ministry of Agriculture, Livestock and Supply (*MAPA*) Normative Instruction No. 49, of September 26, 2018, establishes the complementation of Identity and Quality Standards for Fruit Juice and Pulp in the entire Brazilian national territory, and the Normative Instruction No. 37, of October 1, 2018, establishes in the form of its annexes the analytical physicochemical parameters of fruit juice and pulp, through the list of fruits and other items complementary to the identity and quality standards already set by MAPA in Normative Instruction No. 49 (Brasil, 2018).

Normative instruction No. 37 defines cashew pulp as the product obtained from the edible part of the cashew (*Anacardium occidentale* L.) by means of an appropriate technological process. With regards to microbiological standards, IN MAPA No. 49, RDC No. 12, of January 2, 2001 by *ANVISA* regulates the microbiological quality standards of fruit pulps, seeking to protect the health of the population (Brasil, 2001).

The pulp quality is related to the conservation of its nutrients, its physicochemical, sensory and sanitary hygienic aspects. These should approach the fruit as much as possible in its fresh form, seeking to comply with the standards required by current legislation (Santos, et al., 2016).

Thus, due to the growth of fruit production in the lower Jaguaribe region in Northeast Brazil, and the consequent appearance of several fruit processing industries, the objective of this work was to evaluate the suitability for the identity and quality standards of frozen cashew pulps sold in the state of Ceará, having as a parameter of distinction the technology applied to its processing (pasteurized and non-pasteurized).

2. Materials and Methods

This is a quantitative laboratory study presenting results by collection and applied in a monitored environment employing numerical data which can be analyzed statistically, thereby enabling better understanding of the results obtained in the research (Pereira AS *et al.* 2018). This study was conducted in the food chemistry and microbiology laboratories of the Federal Institute of Education in Science and Technology of Ceará - Limoeiro do Norte campus, during the months of September and October 2019.

Four different brands of cashew pulps were used, two non pasteurized pulps (1 and 2) acquired from a market in the city of Limoeiro do Norte, Ceará, and two pasteurized pulps (3

and 4) from a market in the city of Fortaleza, Ceará, due to the lack of commercialization of pulps which undergo this type of heat treatment in the city of Limoeiro do Norte. Three distinct lots of each brand were purchased and the analyzes took place in triplicate for each lot.

The physical-chemical parameters analyzed were those required in Normative Instruction No. 37 of 2018 from the Ministry of Agriculture, Livestock and Supply for the Identity and Quality Standards of frozen cashew pulp, carried out according to the methods of (Aoac, 1995), with the following parameters being determined: content of soluble solids (SS), total solids (TS), pH, and total acidity expressed in citric acid and ascorbic acid.

Soluble solids (SS) were determined by refractometry using a digital bench refractometer at room temperature, and the results were explained in °Brix at 20 °C. The pH was obtained with the use of a portable pH meter by inserting a previously-calibrated electrode with buffer solutions of pHs 4 and 7 directly into the sample with reading in triplicate. Total titratable acidity was obtained by titration with 0.1 N NaOH solution and expressed as a percentage of citric acid (Aoac, 1995).

The total solids were determined based on the mass loss by drying in an oven under reduced pressure at 70 °C. The titrometric method in Tillman solution (DFI-2,6 dichlorophenol indophenol) 0.02% standardized with a standard ascorbic acid solution was used to determine ascorbic acid (Vitamin C) (g $100g^{-1}$) in the samples (Strohecker & Henning, 1967).

Samples for microbiological analyses were prepared in a conical flask with 90 mL of 0.85% saline and 10 g of each sample was added, then followed by homogenization to obtain a 10^{-1} dilution. Next, the other two serial decimal dilutions10^{-2} and 10^{-3} were performed.

The direct plating on the surface method was used to analyze molds and yeasts. To do so, 0.1 ml of each dilution (10^{-1}, 10^{-2} and 10^{-3}) was transferred to the stages containing a Potato Dextrose Agar medium, which were then incubated at 28 ºC for 3 to 5 days. The results were presented from the number of Colony Forming Units per gram of material (UFC g^{-1}) according to (Apha, 2001).

A series of three tubes with 9 mL of Lactated broth containing an inverted Duhran tube (presumptive test) received 1 mL of each dilution (10^{-1}, 10^{-2} and 10^{-3}) for the the analysis of coliforms at 35 °C and 45 °C, which were then incubated at 35 °C and 45 °C for 24-48 hours. Confirmatory tests were carried out for coliforms at 35 °C in Bile Brilliant Green broth at 35 °C for 24-48 hours, and coliforms at 45 °C in *Escherichia coli* (EC) broth at 45 °C for

24 hours for turbid tubes and gas formation in the Duhran tube (positive reading). The values of NMP g^{-1} were calculated and obtained according to Siqueira (1995).

Salmonella analysis started with the pre-enrichment phase, in which a 25 g portion of each pulp sample was transferred to a flask containing 225 mL of Lactated broth and incubated at 35 °C for 24 hours. Next, 1 ml was transferred to 10 ml of Rappaport-Vassiliadis broth (RV) and incubated at 35 °C for 24 hours.

For the differential plating, Hectoen Enteric Agar (HE) and Bright Green Agar (VB) were used at 35 °C for 24 hours to verify the presence of development of typical Salmonella colonies (Apha, 2001).

The STATISCA version 7 program was used for statistical analysis to obtain the mean, standard deviation, analysis of variance (ANOVA) and Tukey test with a 5% significance level to compare the means between the conventional fruit pulp brands (not pasteurized) and pasteurized fruit pulp brands.

3. Results and Discussion

The results found in the physicochemical analysis of frozen cashew pulps (conventional and pasteurized) are shown in Table 1.

Table 1. Results of physical-chemical analyzes performed on cashew pulps.

Brand	SS	ST	pH	Acidity	A. Ascorbic
1	11,27±1,20a	11,50±1,07ab	4,84±0,11a	0,24±0,05c	750,55±85,86a
2	11,07±0,81a	12,24±0,64a	4,30±0,09c	0,30±0,02b	427,67±43,40c
3	11,52±0,43a	10,79±0,76b	4,38±0,15c	0,22±0,01c	476,00±54,23c
4	11,53±0,20a	11,62±0,69ab	3,80±0,07b	0,40±0,01[a]	322,22±5,26b
*Standards	10	10,5	3,8	0,18	80

* Standards referring to Normative Instruction No. 37, of October 1, 2018. ** Same lower case letters in the same column indicate that there was no significant difference by the Tukey test ($p \geq 0.05$). Source: Authors.

All the analyzed parameters were presented according to the legislation in force for the brands evaluated in this study, however, with the exception of the soluble solids (SS) parameter, a significant difference was observed when comparing the results found between

the brands, indicating that there is no standardization during the fruit pulp processing.

According to Batista et al., (2015), soluble solids (SS) are the dissolute substances present in the fruits and whose main component is sugars. Their concentration is taken into account as a factor of acceptability of the fruit depending on the market in which it is found. The maturation stage directly affects the amount of SS.

MAPA Normative Instruction No. 37, of October 1, 2018, establishes in the form of its annexes that the SS parameter is ≥ 10 º BRIX at 20 ºC, thus all the evaluated brands (conventional 1 and 2 and pasteurized 3 and 4) were within the established standard. This result was also found by Santos et al., (2016) when evaluating the physicochemical and microbiological aspects of fruit pulps sold in Petrolina (PE) and Juazeiro (BA).

The statistical analysis between the brands for the SS parameter did not show a significant difference at 5% between the brands with the same treatment (conventional or pasteurized), nor when the conventional and pasteurized samples were evaluated separately. In a study called evaluation of the physicochemical quality of frozen fruit pulps marketed in the city of Cuiabá, MT, Brasil et al., (2016) observed that a brand of cashew pulp did not meet the current legislation for SS, citing failures in processing or distribution as a possible reason.

According to Castro (2015), fluctuations in the SS concentration are influenced by factors such as soil, season, production system and maturation. In addition, steps such as transportation, packaging, processing and storage have a direct influence on this parameter.

All brands met the standard established in the legislation regarding total solids (TS), with brand 2 (conventional) and brand 3 (pasteurized) respectively showing the highest and the lowest TS concentrations, and statistically differing from each other At the 5% level of significance.

Industries which use pasteurization generally process the concentrated pulp which, according to Silva (2013), is the natural product which passes through concentrators that keep the pulp at 60 ºC in order to remove approximately 60% of the water naturally present, thereby resulting in the concentrated pulp with a high content of TS, and subsequently being reconstituted by simply adding water; a fact which would explain the lower TS concentration of brand 3, since according to Araújo et al., (2018), a low TS concentration may occur due to adding water to the product during processing.

The pH is one of the factors which favors conservation of the pulp, preventing the development of yeasts and in some cases discarding the need for very high heat treatment with consequent loss of nutritional quality of the product (Brasil, et al., 2016).

All analyzed brands showed mean pH values according to current legislation, constituting a consistent result with those found by Santos et al., (2016). However, a replicate of lots 2 and 3 showed lower values than the current legislation. Brand 1 differed significantly from brand 4, which were different from other brands and which respectively presented higher and lower pH values.

Acidity is a parameter directly linked to extrinsic factors such as climate, soil and maturation time of the fruit itself, so each variety of fruit has unique values. High acidity values may be directly related to the ripeness degree of the fruit, which is due to the citric acid content being inversely proportional to ripening (Brasil, et al., 2016).

The four brands evaluated in this study had titratable acidity expressed in citric acid according to the current legislation. This is in line with Bomfim (2016), who found a value of 0.45 g $100g^{-1}$ of total acidity expressed in citric acid, where the current legislation determined at least 0.30 g $100g^{-1}$; however, the current legislation determines a minimum content of 0.18 g $100g^{-1}$ of total acidity expressed in citric acid. Brands 2, 3 and 4 differed at a significance level of 5% by the Tukey test, with brand 1 being statistically equal to brand 3, with both showing the lowest acidity values.

The ascorbic acid parameter (vitamin C) of the four analyzed brands remained within the established standards. This result was also found by Bomfim (2016). However, in evaluating the vitamin C content in five brands of frozen cashew pulps, Brasil et al., (2016) observed that two brands were found to have lower concentrations than recommended by legislation; this can be explained due to the high instability of ascorbic acid, as its degradation is favored by the action of oxygen and light during the processing steps. There may also be a reduction in the ascorbic acid concentration during the product storage, depending on the transparency of the packaging, the light incidence on the product and gas exchange (Bomfim, 2016).

The results found for the microbiological parameters of frozen cashew pulps (conventional and pasteurized) are shown in Table 2.

Table 2. Results of microbiological analyzes performed on cashew pulps.

Brand	Lot	Total coliforms 35 °C (NMP.g-1)	Thermotolerant coliforms 45 °C (NMP.g^{-1})	Fungi and yeasts (UFC g^{-1})	*Salmonella* sp
	1	75	Absence	4,9x10^5	Absence
1	2	93	Absence	2,6x10^4	Absence
	3	36	Absence	6,9x10^3	Absence
	1	1100	Absence	1,6x10^4	Absence
2	2	150	Absence	7,5x10^4	Absence
	3	150	Absence	5,9x10^3	Absence
	1	3,6	Absence	2,5x10^3	Absence
3	2	<3,0	Absence	4,0x10^3	Absence
	3	<3,0	Absence	2,0x10^3	Absence
	1	<3,0	Absence	Ausencia	Absence
4	2	<3,0	Absence	4,8x10^3	Absence
	3	<3,0	Absence	7,0x10^3	Absence
*Standards		-	1 g	**C = 5,0x10^3 *P = 2,0x10^3	Absence

* Standards referring to Normative Instruction No. 49, of September 26, 2018. ** C = Conventional / P = Pasteurized. Source: Authors.

The microbiological parameters must be respected as they indicate whether the food is fit for consumption. Moreover, they enable evaluating the hygienic-sanitary conditions in which the product was processed. Brands 1 and 2 (conventional) showed mold and yeast contamination above the safety limits provided for in the legislation in all evaluated lots. Brands 3 and 4 (pasteurized) showed contamination above the safety limits required by legislation in lots 1 and 2, and 2 and 3, respectively.

The total coliform parameter is not required by legislation, however it is a good indicator of the sanitary conditions in which the product is processed. Brands 1 and 2 (conventional) showed high values, constituting different results from those found by Fechine et al., (2016) in evaluating the microbiological profile of frozen fruit pulp samples commercialized in the city of Missão Velha, CE. These authors did not find any type of contamination by total coliforms in frozen cashew pulp, thus constituting a result which is in agreement with those found for brands 3 and 4 (pasteurized) in this work, with the exception

of batch 1 of brand 3, which also showed the presence of total coliforms.

None of the brands showed contamination by thermotolerant coliforms. This result is different from those found by Souza et al., (2011) for cashew and siriguela pulps in a study named "Microbiological quality of frozen fruit pulps produced in the municipality of Russas - CE". According to Souza et al. (2020), the presence of thermotolerant coliforms in fruit pulp, although in concentrations below what is established by law, is a direct result of failures during the processing and/or filling of the product. It can cause damage to consumers' health.

According to the results found for molds and yeasts, none of the analyzed batches of the conventional brands (1 and 2) are within the standards required by current legislation, as well as batches 1 and 2 and 2 and 3, respectively, of pasteurized brands (3 and 4). According to Santos et al., (2016), contamination by molds and yeasts can cause deterioration to the product, as well as risk to the health of those who consume it, since some species of these microorganisms can produce mycotoxins. Bianchini et al. (2020) cites pasteurization as a prominent preservation method for food preservation, however it is necessary that it be carried out properly at risk of losing its effectiveness, as observed in some lots of the brands analyzed in the present study.

However, lot 3 of brand 3 showed values within the limits required by law, and lot 1 of brand 4 showed total absence for the mold and yeast parameter.

The analysis of *Salmonella* sp. was absent in all brands, which is in accordance with current legislation; these results are compared to those obtained by Souza et al., (2011).

The results found in this study are in agreement with several other studies cited here, but it is important to note that this is due to the fact that the physical-chemical conditions of the fruits are directly influenced by several extrinsic factors such as the type of fruit, soil, irrigation, cultivation and climate.

4. Conclusion

The physicochemical identity and quality standards of the analyzed brands were in accordance with current legislation. The microbiological standards for molds and yeasts were found to be in disagreement with the current legislation, even in the brands which use pasteurization as a conservation method. If done improperly, pasteurization does not ensure that the products have a microbiological profile in accordance with the legislation requirements. The industry must strengthen its quality control system during processing when

using pulp as a raw material that has gone through the concentration process in order to ensure that identity and quality standards are met.

Thus, for future research it is suggested that the sanitary hygienic conditions of the facilities of the industries, handlers, equipment, furniture and utensils which have direct contact with the product be evaluated, aiming to reduce the microbiological contamination of the pulps so that they respect the limits established by current legislation. For pasteurized pulps, it is interesting to evaluate the pasteurization process through the binomial time/temperature, as well as the operation conditions and maintenance of the pasteurizers.

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