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CANJIQUEIRA FRUIT JELLY: SENSORY EVALUATION AND STABILITY DURING STORAGE

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ABSTRACT

This study aimed to evaluate the physical, chemical, microbiological and sensory characteristics of jelly obtained of green (GFJ) and ripe fruits (RFJ) of canjiqueira (*Byrsonima cydoniifolia* A. Juss), and verify changes during storage. Common-type jellies were made, sensorial characterized and later stored at room temperature (30°C), being analyzed just after processing and every 45 days for 135 days for pH, soluble solids, titratable acidity, color and microbiological parameters (mesophilic bacteria, yeasts and molds, and *Salmonella spp.*). Sensory analysis shows that RFJ had acceptability index greater than 70%, being a viable alternative to take advantage of the canjiqueira fruits. All scores attributed to ripe fruit jelly were higher ($p<0.01$) when those from green fruit jelly. The purchase intent test showed that 71% of judges would buy the ripe fruit jelly, thus indicating a good acceptability by consumers. The storage resulted in an increase in pH, titratable acidity and soluble solids values ($p<0.05$) without compromising the stability of jellies. The color parameters of the jellies L*, b* and H° were increased according to the storage time, and had greater clarity and intensity in RFJ. The microbiological parameters of GFJ and RFJ remained stable during storage, all in agreement with legislation standards.

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INTRODUCTION

The Pantanal biome has been impacted by socio-economic development through cattle ranching and agriculture, and the consequence of these activities is loss of biodiversity. The scientific research is needed to improve conservation on the basis of scientific methods in order to achieve sustainable use in the region. The study of the richness and diversity of species are research priority topics for science-based conservation (Alho, 2011). The species *Byrsonima cydoniifolia* A. Juss., popularly known as canjiqueira, belongs to the Malpighiaceae family. It is found under different ecological conditions, both in dry areas and in regions subject to floods in rain season (Albuquerque and Silva, 2008). The species fruits from September to March in the Pantanal, forming large clusters called *canjiqueirais*, thus favoring the collection of fruits by rural communities (Damasceno Junior and Souza, 2010).

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Canjiqueira fruits are abundant in Pantanal regions of Mato Grosso do Sul state (MS), Brazil (Santos *et al*., 2008) where are used as juice by local communities. This species has an asynchronous fructification. Non-ripe and ripe fruits are permanently available throughout the rainy season within the community. Nevertheless, a fructification peak generally occurs between December and February. There is a potential and growing market for the use of native fruits use on diet, but under-utilized by local communities and explored only on extractive way (Ribeiro and Rodrigues, 2006). The exotic flavor can improve the consume of fruits, either fresh or processed way (Nogueira *et al*., 2009). It is essential the increase of scientific knowledge about native species, favoring its conservation and sustainable use (Ribeiro *et al*., 2012). Adding value to this fruits can contribute to the increase of family's income and expand the national fruit industry. Processing cause nutritional changes in food but also makes them sensorially more attractive to the consumers and increases its shelf life (Silva *et al*., 2006). Jellies can be considered an important processing to add value to fruits and it is also a product of easy to manufacture (Maciel *et al*., 2009).

In face of the abundance of the native species of canjiqueira and the absence of information on literature, this work aimed at evaluating the acceptance by consumers of jellies made of green and ripe canjiqueira fruits and its stability during ambient storage through physical, chemical and microbiological parameters.

MATERIAL AND METHODS

Jelly processing

Fruits were collected next to Pantanal Studies Base (19º34'37"S; 57º00'42"W) of Universidade Federal de Mato Grosso do Sul (UFMS), in Corumbá-MS, packed and transported in plastic boxes under ambient conditions to Food Technology and Public Health Unit of UFMS. Fruits were visually selected, those that were rotten or damaged were discarded, and were classified into non-ripe (green) and ripe (yellow). Then, fruits were washed with running water, immersed into a sodium hypochlorite solution (100 mg L^{-1}) for 20 minutes, rinsed in running water, packed and frozen for later processing. In order to make the jellies, fruits were thawed and pulped using a food processor (Walita), separating the seeds from the pulp (pulp + peel). Total pectin content was determined by colorimetric method according to Bobbio and Bobbio (2003). Both jellies (GFJ - green fruit jelly and RFJ - ripe fruit jelly) were formulated with 60% sugar and 40% pulp, which are known as common-type jellies, and produced according to the methodology proposed by the Food Technology Institute (Moura and Tavares, 2011).

Due to the consistency of pulps, we added water (1:1 m/m) and the mixture was boiled under stirring, when sugar was added. The cooking was done in a stainless steel pot with a capacity of three liters; up to 68°Brix measured using a refractometer. The heating was immediately stopped and tartaric acid was added to reduce the pH to 3.0. Then, 300 g of the hot jellies (85-90^{o}C) were packed in previously sterilized glass jars. Jars were closed using a metallic cover and then inverted for 5 min in order to sterilize the covers. After the filling, jars were gradually cooled by immersion in water, in order to prevent the growth of thermophile microorganisms, and jars were stored under light at room temperature (± 30°C).

Sensory evaluation

The sensory analysis was carried out upon the approval by the Human Ethics Committee of UFMS (Protocol no. 66812 of August 9th, 2012), after two days of processing. The acceptance, preference and purchase intent tests followed the standards of Adolfo Lutz Institute (Brasil, 2005), using a group of 65 consumers. Pure samples of approximately 20g jelly were placed in plastic cups of 50 mL capacity, which were coded with three digits and randomly given to panelists at room temperature. In order to clear the palate, natural mineral water was given to the panelists before and between samples. The color, odor, flavor, texture (consistency), spreadability attributes and overall evaluation on cookie were evaluated by the consumer in the acceptance test through a hedonic scale of 9 points, 1 - extremely dislike and 9 - extremely like (Meilgaard *et al*., 2006). In the purchase intent tests, the judges were asked to mark on each sample if they would buy it or not. The preference test was carried out in the same evaluation sheet, where judges identified the code of the preferred sample. In sensory evaluation sheets there was a field for comments by consumers on the samples.

Jelly stability

The physical, chemical and microbiological analyzes were performed in triplicate, after processing and every 45 days, during 135 days, in order to assess the stability of the new product. The jellies were analyzed on total soluble solids (^{o}Brix) using a digital refractometer (Hanna HI 96801), pH using a digital potentiometer (Analyser, 300M) and total titratable acidity (Brasil, 2005).

The objective evaluation of color was measured in both jelly samples using the spectrophotometer device (CM 508-d, Minolta, Japan). This equipment performs color measurements through the L*, a* and b* indexes, representing values of L* (lightning), which vary from zero to 100, where black is the minimum and white is the maximum value; values of a* vary from -60 to + 60, where green is the minimum and red is the maximum value; values of b* vary from -60 to +60, where blue represents the minimum value and yellow represents the maximum value. The values of a* and b* were used to calculate Chroma, using the equation $C = (a^2 + b^2)^{½}$, and Hue Angle, by equation H° = arctg (b/a).

Coliforms, thermotolerants coliforms, the standard plate count (mesophilic bacteria), yeasts and molds, and *Salmonella* spp. were determined in 25 g jelly (Silva *et al*., 2007). It was used a totally casualized experimental design, with three replicates for physical, chemical and microbiological analyses. Results of the sensory analysis of green and ripe fruit jelly were evaluated through the variance analysis (ANOVA), at 5% probability level ($p<0.05$) and the averages were compared using Student t-test. To calculate the Acceptability Index (AI) of the product, we used the equation AI (%) = 100 A/B, where: A = average product score and B = maximum product score. Values of AI ≥ 70% have been considered as good repercussion (Dutcosky, 1996). Results of physical, chemical and microbiological parameters during storage were evaluated through ANOVA, followed by regression analysis at 5% probability level ($p<0.05$). All statistical analyzes were carried out with the Origin 7.0 software by OriginLab, Northampton, MA.

RESULTS AND DISCUSSION

Sensory analysis

Table 1 shows averages scores and acceptability indexes for sensory attributes (color, smell, flavor, texture, spread ability and overall evaluation) of green fruit jelly (GFJ) and ripe fruit jelly (RFJ) made of canjiqueira. It was observed statistical difference ($p<0.05$) between RFJ and GFJ for all attributes evaluated, with high scores for RFJ. The most acceptable attributes by panelists were color and spread ability, with averages for RFJ = 8 (referring to "liked it a lot") and averages for GFJ = 7 (referring to "liked it moderately"). These values result in higher acceptability indexes for RFJ (89.23% for color and 87.86% for spreadability) when compared to other attributes. Canjiqueira ripe fruits have a bright yellow color that could have contributed to the high color scores. According to Souza *et al*. (2008) color is one of the most important sensory to the commercial acceptance of food products. The high scores attributed to spreadability in canjiqueira jellies can be attributed to the high pectin content, responsible for the gel formation in the jellies. Unripe and ripe canjiqueira fruits have 2.82 and 2.64 g/100g of total pectin content, respectively (results expressed in fresh matter).

Table 1. Average scores and acceptability indexes for sensory attributes (color, smell, flavor, texture, spreadability and overall evaluation) of newly processed canjiqueira green fruit jelly (GFJ) and ripe fruit jelly (RFJ)

Attributes	Green fruit jelly		Ripe fruit jelly	
	Average ± SD*	Acceptability Index (%)	Average ± SD*	Acceptability Index (%)
Color	$6.49^{b} \pm 1.80$	72.14	$8.01^{a} \pm 0.92$	89.23
Smell	$5.78^{b} \pm 1.94$	64.27	$6.75^{a} \pm 1.55$	75.04
Flavor	$5.27^{b} \pm 2.29$	58.63	$6.56^{a} \pm 1.87$	72.99
Texture	$5.76^{b} \pm 2.22$	64.10	$6.87^{a} \pm 1.69$	76.41
Spreadability	$6.63^{b} \pm 1.88$	73.68	$7.90^{a} \pm 1.16$	87.86
Overall Evaluation	$5.87^{b} \pm 1.85$	65.30	$6.92^{a} \pm 1.55$	76.92

*SD = Standard Deviation. Means followed by the same letter in the line do not differ statistically by Student t-test ($p<0.05$).

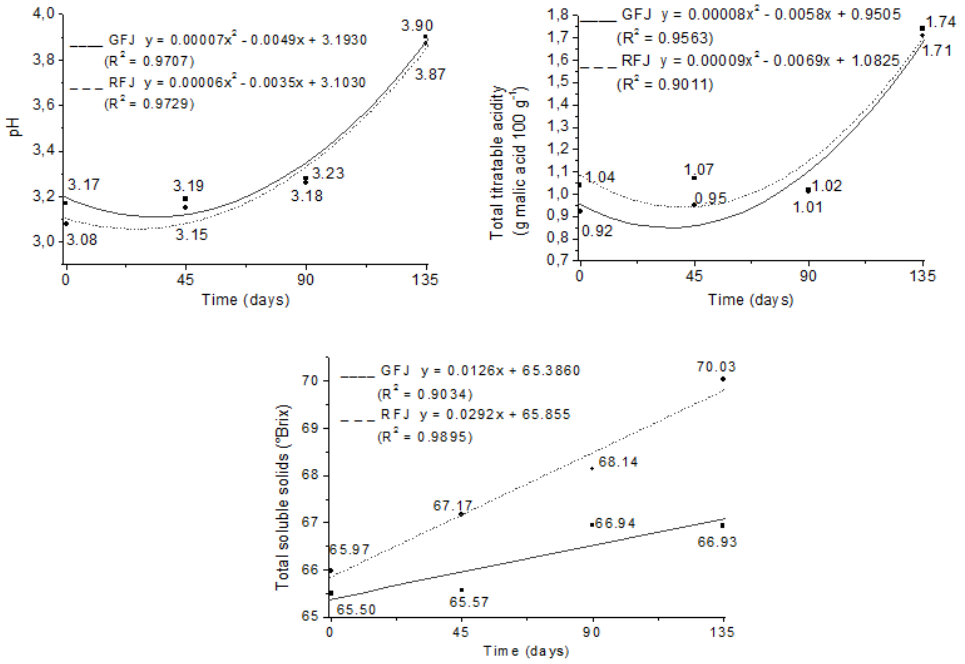

Figure 1. Changes in pH values, total titratable acidity (g of malic acid 100 g^{-1}) and total soluble solids (°Brix) of green fruit jellies (GFJ) and ripe fruit jellies (RFJ) of canjiqueira, during storage at ambient temperature (± 30ºC) for 135 days

Morzelle *et al*. (2015) studied pectin content in murici (*Byrsonima crassifolia*) fruits and related 0.75 g/100g in fresh matter. The authors classified this fruit as a high pectin content, thus indicating this potential in jelly processing. Canjiqueira fruits has higher pectin then murici fruits. The correct equilibrium between acidity and soluble solids content during jelly processing contributes to the right gel formation during the cooking (Moura and Tavares, 2011), which can also explain the high spreadability scores. Similar results were reported by Santos *et al*. (2012) for cagaita (*Eugenia dysenterica* DC.) jellies. The authors evaluate color, smell, flavor, texture and overall evaluation, and observed the higher scores for color (8.1 average, in a 9-point hedonic scale), referring to "liked it a lot". Caetano *et al*. (2012) evaluate color, smell, flavor, texture parameters and overall evaluation of jam produced with acerola (*Malphigia emarginata*) pulp and juice, and obtained the highest scores for spreadability (7.5 average, in a 9-point hedonic scale). Regarding the attribute flavor (Table 1), for GFJ 28% of panelists referred to “liked it moderately" and for RFJ 22% referred to “liked it a lot”. These results can be related to the sharp flavor of canjiqueira fruits, resulting in an acceptability index of 72.99% for RFJ and 58.63% for GFJ. Native fruits have peculiar and intense color, smell and flavor (Agostini-Costa and Vieira, 2005). The acceptability of jellies made could be increased through new formulations with the homogenization of pulp prior to processing or with the addition of pulp in lower proportions, in order to minimize the sharp flavor of the fruits.

Santos *et al*. (2012) found similar results for cagaita (*Eugenia dysenterica* DC.) jellies, with lower scores for the attribute flavor, “liked it regularly”; however, the result had little influence on the acceptability of the product, which was 81.67%. GFJ had high astringency, a characteristic reported by 40% of panelists in the observation field in the sensory evaluation form. The astringent flavor is caused by the presence of non-polymerized tannins in immature fruits (Lesschaeve & Noble, 2005). With fruit maturity they turn into condensed forms, reducing the astringency in ripe fruits. In recent studies realized by this author, results were showed for tannin content in unripe and ripe canjiqueira fruits and jellies. Unripe fruits showed 195.94 mg of tannic acid equivalent per 100 g, almost four times higher than ripe fruits. After jelly processing, almost 60% of tannins of unripe fruits were retained, while it was observed the decrease of 93% in ripe fruit jelly (Prates *et al*., 2015). Also, in the study of 2015, we found high levels of trypsin inhibitors and phytic acid in unripe and ripe canjiqueira fruits. However, the trypsin inhibitor activity decreased and the phytic acid was eliminated after processing, indicating that the consumption of processed pulp is recommended to reduce the effects on protein bioavailability/digestibility. The judges scored texture as “liked it moderately” for RFJ and “liked it slightly” to GFJ, with acceptability indexes of 76.41% and 64.10%, respectively (Table 1). The homogenization of the pulp with water in a blender prior to processing could contribute to reduce the average size of dispersed solid particles, thus improving the

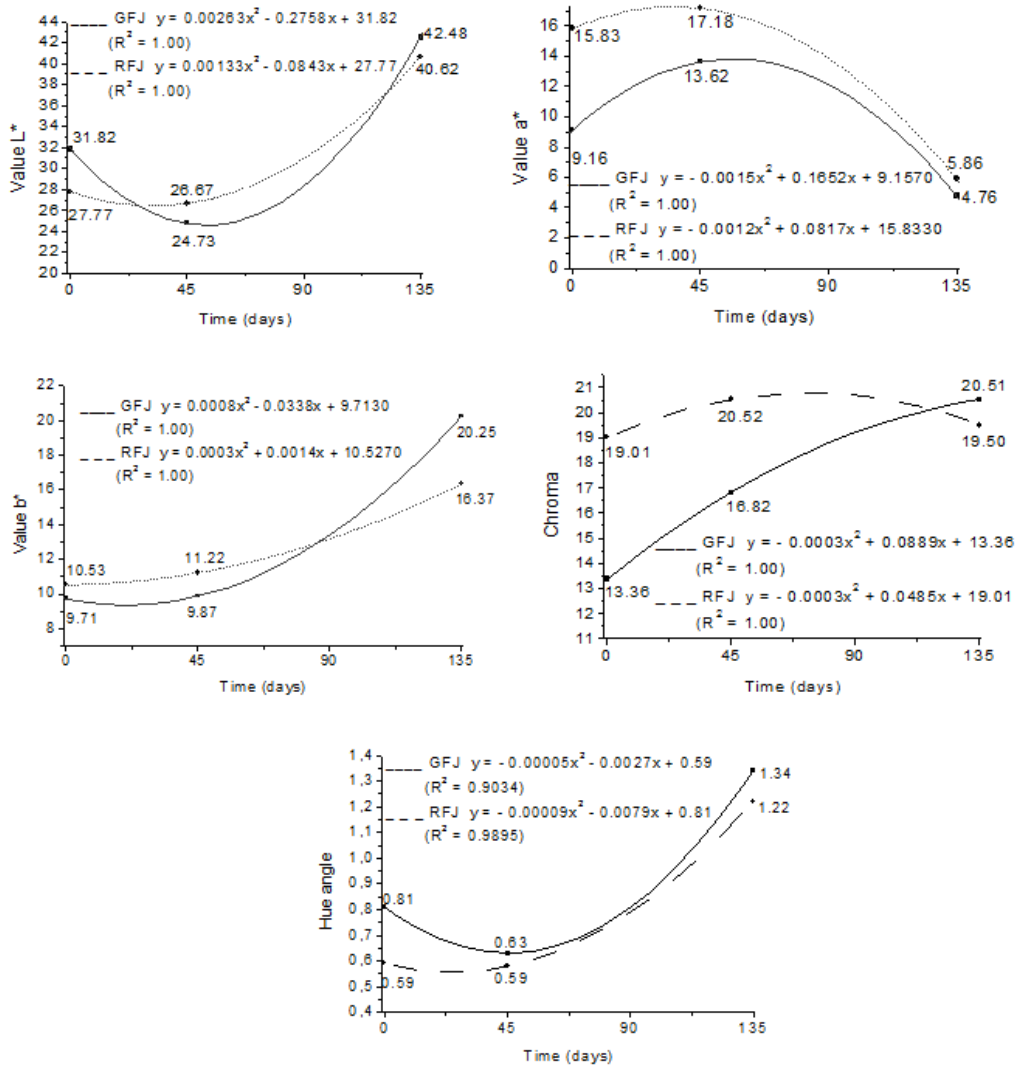

Figure 2. Color parameters (L*, a*, b*, Chroma and Hue angle) of green fruit jelly (GFJ) and ripe fruit jelly (RFJ) of canjiqueira, stored at 30°C for 135 days

product texture and the acceptability index for this attribute. In relation to the global evaluation RFJ presented higher averages point, with 34% of 8 ("liked it a lot") and 26% of 7 ("liked it moderately). GFJ received 7 points of 23% of panelists and 6 ("liked it slightly) of 17% of them. The acceptability indexes were 76.92% and 65.30%, respectively (Table 1). The results show that the jelly made of ripe canjiqueira fruits has a good potential for food utilization, since, as shown in Table 1, the Acceptability Index (AI) was higher than 70%, thus being considered as satisfactory (Dutcosky, 1996). The fruit ripening generally leads to an increase of sweetness due to the increased content of simple sugars, decreased acidity and astringency, reduction of acidic and phenolic content (Chitarra and Chitarra, 2005), making the fruit ripe, whether processed or *in natura*, more pleasant to the palate. Regarding the sample judges like the most, results shown that 72.3% (n=47) preferred RFJ, which had an average of acceptability index for all attributes evaluated of 79.4%, while 27.7% (n=18) preferred the GFJ. The purchase intent test showed that 71% of judges would buy RFJ, thus indicating a good acceptability by consumers, while 68% would buy GFJ.

Stability during storage

Figure 1 shows the effects of storage time on pH, titratable acidity and total soluble solids of green fruit jellies (GFJ) and ripe fruit jellies (RFJ) made of canjiqueira. All the physicochemical parameters evaluated in GFJ and RFJ showed significant difference ($p<0.05$), comparing the beginning (time 0) and the end (day 135) of the period evaluated. In both formulations there was a gradual increase ($p<0.05$), in pH during storage (Figure 1). The increase in pH during storage was also observed by Santos *et al*. (2012) in formulations of jelly of cagaita (*Eugenia dysenterica* DC.). Values of pH of approximately 3.2 are important to prevent the crystallization of saccharose and to balance the gel formed (Gava *et al*., 2009), whereas the increase of this parameter may have caused the destabilization of pectin gel. The acidity of the prepared jellies was increased ($p<0.05$), during storage at room temperature, and a polynomial mathematical model was used to fit the data (Figure 1). At the end of 135 days of storage there was an increase in acidity of 67.3% for RFJ and 85.7 % for GFJ. Jackix (1998) recommends that the acidity of jellies does not exceed 0.8 % and the pH is between 3.0 and 3.4. The newly processed canjiqueira jellies presented the titratable acidity above recommended value, which may have contributed to the obtained scores to taste during sensory analysis (average value of 5.27 for GFJ and 6.56 for RFJ). Excessive acidity is related to the dehydration and hydrolysis of pectin, causing reduction of the firmness of product and syneresis (Jackix, 1998). The variance analysis showed

variations ($p<0.05$) in soluble solids with storage only for RFJ and from 90 days of storage (from 6.17 to 70.03°Brix). In a study of the soluble solids of gabiroba jellies during storage for 6 months, the authors observed a significant increase ($p<0.05$) from 65.47 to 67.31°Brix (Freitas *et al*., 2008). Color is a quality attribute for fruits to be processed, and is affected by the time of the harvest and by the maturation status (Chitarra and Chitarra, 2005).

Figure 2 shows the effects of storage time on color parameters (L*, a*, b*, Chroma and Hue angle) of green fruit jellies (GFJ) and ripe fruit jellies (RFJ) made of canjiqueira. All parameters involved in the color analysis of jellies had significant differences ($p<0.05$) between samples and over the storage time (Figure 2). The L* value was increased ($p<0.05$) after 45 days of storage both for GFJ (31.80 - 42.48) and RFJ (27.77 - 40.62), thus indicating bleaching tendencies for both. GFJ was significantly clearer ($p<0.05$) than RFJ at the test beginning and completion. Regarding the value of a*, there was significant increase in samples after 35 days of storage, with later reduction at the 135 days of storage, thus indicating the reduction of the color red. There was gradual increase in the value of b* during the storage of both samples. The coordinate b*, whose higher values indicate the predominance of yellow, had higher values for RFJ (10.53 - 16.37), thus confirming the visual observations of ripe fruits *in natura*. The value of Chroma was significantly increased ($p<0.05$) for GFJ (13.36 - 19.50), remaining stable during the storage of RFJ ($p>0.05$). The Hue angle was significantly increased over the storage of GFJ (0.81 - 1.34) and RFJ (0.59 - 1.22), thus indicating the increased intensity of yellow in products. The increase of H° is due to the increased b* value observed in samples analyzed. Some authors analyzed ripe fruit pulp of murici (*Byrsonima crassifolia*), of similar color and same gender of canjiqueira, and found Hue angle of 80.6 (Canuto *et al*., 2010). The values found for jellies analyzed were much lower, thus indicating the degradation of pigments by the thermal process. All microbiological results of canjiqueira jellies were within the maximum limits established by RDC no. 12 of January 2th, 2001, of the Brazilian Sanitary Surveillance Agency (Brasil, 2001). There were no coliforms and thermotolerants coliforms in GFJ and RFJ after processing and with 45 days of storage. Results of these microorganisms were lower than 3.0×10^{-1} MPN/g after 90 and 135 days of storage. In both samples of jelly results of mesophilic bacteria, yeasts and molds were lower than 1.0×10^{-1} CFU/g in all analysis time. RFJ e GFJ showed absence of *Salmonella* during the storage. The results found during the period evaluated show the quality of fruits harvested and the use of good practices on the processing of jellies, such as proper sanitation of fruits and utensils used, in addition to the effectiveness of methods of conservation employed. The absence of microorganisms researched may also have occurred because of the chemical characteristics of the jellies produced, such as high soluble solids content and acidity and low pH (Figure 1). The high osmotic pressure caused in these conditions inhibits the growth of bacteria, yeasts and molds. Yeasts and molds can resist to environments with low water activity and high acidity, but they are heat-sensitive, being destroyed by heat treatments (Gava *et al*., 2009).

Conclusion

The jelly made of ripe canjiqueira fruits has a good potential for food utilization, since the acceptability index was higher than 70%. The purchase intent test showed that 71% of judges would buy the ripe fruit jelly. Both for green fruit jelly and ripe fruit jelly were attributed high scores for the attributes color and spreadability. Lower scores were given to the flavor of the jellies produced. The jelly made of ripe fruits had averages close to seven, which corresponded to the impression "liked it moderately", thus indicating the potential of this technological process to the use of canjiqueira fruits, whose sharp flavor may difficult the *in natura* consumption. Canjiqueira jellies made of green fruits and ripe fruits, stored for 135 days at ambient temperature (±30ºC) had variations in physicochemical parameters evaluated that did not compromise their stability as to the firmness of the gel and growth of microorganisms. The microbiological analyses carried out in jellies showed good sanitary conditions, thus ensuring the safety of products.

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