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Effect of gamma radiation and pasteurization on the shelf-life of juçara pulp (*Euterpe edulis*)

Efecto de la radiación gamma y la pasteurización en la vida útil de la pulpa de Juçara (*Euterpe edulis*)

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Abstract

Several studies about juçara palm fruit (*Euterpe edulis)* have emphasized its high antioxidant capacity. However, there is a lack of studies comparing the effects of conservation technologies on the physicochemical and sensory quality of juçara pulp. This work aimed at evaluating the effects of gamma radiation (^{60}Co) and pasteurization process on the physicochemical and sensory quality of juçara pulp. The irradiated (2.5 ± 0.06 kGy) and pasteurized (80°C/5 minutes) pulps were stored at 6°C, 90% RH, for 30 days (3 periods of analysis) and were analyzed for their microbiological, physicochemical (titratable acidity, soluble solids content, color, phenolic compounds, anthocyanin content, polyphenol oxidase and peroxidase activity) and sensory parameters (acceptance test). The physicochemical results were submitted to ANOVA for the 'F' test and the statistical difference of averages ($P < 0.05$) was determined by the Tukey's test. The results of the sensory analysis were submitted to Principal Component and Cluster Analysis. The gamma radiation did not show satisfactory results in the preservation of juçara pulp since there was a significant decrease in total phenolics and anthocyanin content. The pasteurized pulp maintained its physicochemical and sensory characteristics during storage. Therefore, we recommend the pasteurization as a good conservation technique to this kind of product, which presented a shelf-life of around 15 days.

Keywords: Anthocyanins; *Euterpe edulis;* Irradiation; Non-Thermal Processing; Tropical Fruits.

Resumen

En varios estudios se ha demostrado el efecto antioxidante del fruto de palma juçara (*Euterpe edulis)* no obstante no existen estudios de los efectos de las tecnologías de conservación en la calidad fisicoquímica y sensorial de la pulpa de esta fruta. En este trabajo se evaluaron los efectos de la irradiación gamma (^{60}Co) y el proceso de pasteurización sobre la calidad fisicoquímica y sensorial de la pulpa de juçara. La pulpa irradiada (2.5 ± 0.06 kGy) y pasteurizada (80 °C/5 minutos) fue almacenada a 6 °C, 90% HR, durante 30 días divididos en tres períodos de análisis que incluyeron características microbiológicas, fisicoquímicas (acidez, contenido de sólidos solubles, colorantes, compuestos fenólicos, contenido de antocianinas, actividad polifenoloxidasa y peroxidasa) y parámetros sensoriales. Los resultados fisicoquímicos se analizaron por ANOVA y prueba 'F' y diferencia estadística ($P < 0.05$) mediante la prueba de Tukey. Los resultados del análisis sensorial se agruparon por componente principal. La radiación gamma no mostró resultados satisfactorios en la preservación de la pulpa de juçara, ya que se encontró reducción significativa en el contenido total de fenoles y antocianinas. La pulpa pasteurizada conservó sus características fisicoquímicas y sensoriales durante el tiempo de almacenamiento, siendo ésta una buena técnica de conservación para este tipo de producto, que presentó una vida útil de 15 días.

Palabras clave: Antocianinas; *Euterpe edulis;* Irradiación; Procesamiento no térmico; Frutas tropicales.

Introduction

Juçara fruit pulp (*Euterpe edulis*): a native palm from the Brazilian Atlantic Forest, has been studied in the recent years. This fruit is usually consumed as pulp or juice; for this, it is macerated and homogenized with water in order to separate the peel and seeds. This process results in a creamy liquid, with an intense dark purple color and a characteristic taste (Bicudo, Ribani, and Beta, 2014). The fruit present a great amount of anthocyanin (between 2300 and 2956 mg 100 g^{-1} dry weight of total anthocyanin content) a compound with antioxidant activity. The main health benefits associated to its consumption are the decrease of risks of coronary artery diseases, obesity and hypoglycaemia, memory enhancement and protection of the brain tissue in fetus (De Brito et al., 2007; Vieira et al,. 2017). In this context, juçara has a potential to provide anthocyanins to be used by the industry as pigments or in novel functional foods, for example (Bicudo et al., 2014. However, juçara pulp is very perishable; its conservation at room temperature is not recommended because of the changes in its characteristics. The microbial, enzymatic and chemical effects are responsible for changes in the colour and anthocyanin levels, causing product deterioration. Consequently, these effects result in significant losses in its sensory quality (Alexandre, Cunha, and Hubinger, 2004; Neves et al., 2015).

Irradiation can be an alternative to preserve the juçara pulp, since it is a non-thermal technology with few effects in physicochemical, nutritional and sensory characteristics. Furthermore, irradiation is efficient in the reduction of microbial contamination, supporting food safety. At the same time, this technology does not use chemical reagents, besides avoiding the discard of wastes in the environment (Arvanitoyannis, Stratakos, and Tsarouhas, 2009).

Another methodology used to improve the quality of juçara pulp is pasteurization. In a recent study, the pasteurization of juçara smoothie preserved the bioactive compounds flavonoids and phenolic acids (de Oliveira Ribeiro et al., 2018). It is responsible for removing pathogenic microorganisms, inactivating enzymes and decreasing the water activity in order to extend pulp shelf-life. The temperatures generally employed are below 100 °C; the time depends on the product characteristics (Campbell-Platt, 201)1. However, the process does not sterilize the final product; thus, other preservation technologies could be applied to improve its quality (Silva and Gibbs, 2004).

Several studies about juçara pulp have shown its biological activity. Nevertheless, there are no studies comparing the effects of conservation technologies on the physicochemical and sensory quality of juçara pulp. Therefore, this work aimed to evaluate the effects of the gamma radiation (^{60}Co) and pasteurization process on the physicochemical and sensory quality of juçara pulp.

Materials and methods

Juçara pulp

Juçara palm fruit (*Euterpe edulis*) was collected in Mogi das Cruzes (23º 40' 26" S, 46º 11' 05" W, São Paulo State, Brazil). Fruits were selected by size, purple color and appearance (absence of damage caused by microorganisms or physical damage) washed and sanitized using a chlorine solution (200 mg L^{-1}) (S-Dichloro triazinatrione dihydrate Sodium) for 15 minutes. The samples were swollen by soaking in water at 40 °C for 20 minutes. The pulp was extracted on a stainless steel pulper with water (2:1). Juçara pulp was packed in Low Density Polyethylene (LDPE) bags (100 mL) and maintained under freezing (-18 °C) until the treatment with gamma radiation (^{60}Co).

Juçara pulp irradiation

The irradiation of the pulp was performed at the Nuclear and Energy Research Institute (IPEN/USP), University of São Paulo (São Paulo, SP, Brazil) using 2.5 ± 0.06 kGy. The irradiation was conducted using a rate of 40.0 Gy min^{-1}. The freezed polystyrene bags were kept inside the irradiation chamber 50 cm away from the source guard. Subsequently, the samples were stored in a cold room at 6 °C, with 90% of Relative Humidity (RH) and protected from light for 30 days.

Juçara pulp pasteurization

The pasteurization of the thawed pulp was performed in open boiling pans at 80 °C for 5 minutes and cooled to 25 °C in a cold water bath. The temperature was instrumentally checked during the process using a thermocouple (Termopar Novus – My PC lab, São Paulo, SP, Brazil) considering four measurement points. The pasteurized pulp was packed in LDPE bags (100 ml) and stored in a cold room at 6 °C, protected from light, for 30 days. A control treatment (unprocessed juçara pulp) was stored under the same conditions.

Microbiological quality

The microbiological analysis of the juçara pulp was performed to comply with Brazilian regulations for vegetal products (Brazil, 2001). Most Probable Number (MPN) of coliforms using multiple tubes test and the presence of *Salmonella* spp. using the kit "*Salmonella* 1-2 test" (Bio Control, USA) according to AOAC (AOAC, 2005).

Physicochemical analyses

Titratable acidity (TA) was measured by titration according to (AOAC, 2005) and the results were expressed as mg citric acid g^{-1} of pulp. Soluble Solids Content (SSC) were determined according to AOC (AOAC, 2005) using a digital refractometer (Krüss Optronic DR 201-95, Germany) (results expressed in °Brix). Pulp color was analysed using a colorimeter (Konica Minolta Chroma Meter CR-400, Japan) considering the parameters Luminosity (L), Hue angle (HUE) and Chromaticity (CHR) using illuminant C. The phenolic compounds (PC) were measured by a colorimetric test according to (Singleton, Orthofer, and Lamuela-Raventos, 1999) with the results in mg of Gallic acid 100 g^{-1} juçara pulp. The total anthocyanin content (TAC) was determined using the pH difference technique and the results were expressed in mg equivalent of cyanidin 3-glucoside 100 g^{-1} juçara pulp (AOAC, 2005. The polyphenoloxidase (PPO) and peroxidase (POD) determinations were adapted from a specific method and results were expressed in enzymatic activity per minute per ml of sample (EA $min^{-1}ml^{-1}$ of sample) (Cano et al., 1997).

Sensory evaluation – acceptance test using hedonic scale

This project was submitted and approved by the Research Ethics Committee of the Luiz de Queiroz College of Agriculture (University of São Paulo) (Process Number 64) in accordance with the Brazilian National Health Council Resolution 196/96.

The acceptance test using hedonic scale with seven points was performed to verify how much the panelists liked or disliked each treatment considering the attributes taste, aroma, color, texture, appearance and global impression (7 = really liked, 1 = disliked very much) according to Meilgaard, Civille and Carr, (2006). For the sensory evaluation, 50 untrained panelists (female and male) were invited, but only 36 panelists produced valid answers. Three samples were provided for the panelists irradiated (2.5 kGy) control (refrigerated pulp) and pasteurized pulp. The codified samples were served at 6 °C in plastic cups of 50 mL in individual cabins with white light. For the analysis, 10% of sugar (w/v) was added to the juçara pulp in order to obtain samples similar to 'açaí' pulp, a typical product consumed in Brazil.

Statistical analysis

The experimental design used in the physicochemical and sensory analyses was the randomized in factorial scheme (3 x 3), i. e., 3 treatments (control, irradiated and pasteurized) and 3 storage periods (1, 15 and 30 days) in triplicate. The results of the physicochemical analysis were submitted to Analysis of Variance (ANOVA) for the 'F' test. The standard deviation was calculated and expressed as a percentage of the mean and the statistical difference of the means at the level of 5% ($P < 0.05$) was determined by the Tukey's test. The results of the sensory analysis were submitted to multivariate analysis using the Principal Component Analysis (PCA) based on the Correlation Matrix to determine the sensory characterization of the treatments, and the Cluster Analysis (CA) was performed based on the characteristics of each observation. The statistical software used for these tests was SAS 9.3.

Results and Discussion

Physicochemical analyses

The irradiated pulp presented constant TA values during storage, with values 65% lower than the other treatments ($P < 0.05$) (Table 1). The evaluation of TA in fruit pulp provides information about its conservation. Normally, processing practices related to the decomposition of fresh products by hydrolysis, oxidation or fermentation, change the concentration of hydrogen ions, decreasing pH or increasing TA. The pasteurized and control pulps showed a similar pattern for TA values for 30 days, with high values at 15 days.

Regarding SSC content, all treatments presented the highest values in the first day, decreasing in the subsequent periods ($P < 0.05$). The pasteurized pulp showed the highest SSC (2.88 °Brix) during storage (Table 1). Sousa, Yuyama, Aguiar, Pantoja, and L. (2006) also observed an increase in the SSC of açaí pulp boiled for 5 minutes. This parameter is related to the content of acids, salts, vitamins, amino acids, pectin and sugar in vegetables. The decrease observed in the irradiated pulp could be related to the effect of the water radiolysis on the pulp, caused by gamma rays, since it is able to break proteins and other components, such as organic acids. However, the pasteurized pulp presented the highest SSC values during storage; this is desirable because these compounds are directly related to the flavor of the product.

In the control samples, L*, remained constant during storage ($P < 0.05$. It was verified that the irradiated pulp presented the lowest luminosity, contrasting with the pasteurized pulp. Although these values are considered low, when consider the numerical coordinate system of the Commission Internationale de L'Eclairage (CIE) it is noted that the L* means are close to the origin area of the coordinates, represented by gray tones with little or no chromaticity.

Table 1. Parameters of juçara pulp stored for 30 days at 6 °C.

Treatments	Period (days)		
	1	15	30
		Titratable acidity (TA)	
Control	0.184±0.01^{Ca}	0.298±0.02^{Aa}	0.218±0.02^{Ba}
2.5 kGy	0.062±0.01^{Ab}	0.063±0.01^{Ab}	0.065±0.01^{Ab}
Pasteurized	0.168±0.01^{Ca}	0.284±0.01^{Aa}	0.212±0.02^{Ba}
		Soluble Solids Content (SSC)	
Control	2.72±0.18^{Aa}	2.15±0.15^{Bb}	2.20±0.18^{Bb}
2.5 kGy	2.72±0.15^{Aa}	2.20±0.11^{Bb}	2.18±0.15^{Bb}
Pasteurized	2.88±0.16^{Aa}	2.57±0.20^{Ba}	2.78±0.19^{ABa}
		Luminosity (L*)	
Control	19.68±0.60^{Aa}	22.85±1.32^{Aa}	22.94±0.47^{Aa}
2.5 kGy	21.27±0.61^{Aa}	16.38±0.51^{Bb}	19.43±1.05^{ABb}
Pasteurized	18.93±1.74^{Ba}	23.65±1.12^{Aa}	21.10±0.56^{ABab}
		Chromaticity (CHR)	
Control	4.47±0.31^{Bb}	7.06±0.23^{Aa}	7.32±0.31^{Aa}
2.5 kGy	3.02±0.66^{Bc}	3.66±0.78^{Bc}	5.05±0.48^{Ac}
Pasteurized	5.95±0.41^{Aa}	5.44±0.34^{Ab}	6.10±0.67^{Ab}
		Hue angle (HUE)	
Control	28.78±2.85^{Bb}	48.08±1.14^{Aa}	49.36±0.84^{Aa}
2.5 kGy	46.47±3.99^{Aa}	32.56±4.32^{Ab}	40.32±0.84^{Aa}
Pasteurized	28.62±3.22^{Ab}	33.66±0.91^{Ab}	38.46±1.05^{Aa}
		Phenolic compounds (PC)	
Control	6.35±0.35^{Aa}	3.73±0.21^{Bb}	3.22±0.10^{Bb}
2.5 kGy	5.97±0.36^{Aa}	3.34±0.27^{Bb}	2.20±0.48^{Cc}
Pasteurized	6.15±0.24^{Ca}	8.08±0.13^{Aa}	6.87±0.23^{Ba}
		Total Anthocyanins Content (TAC)	
Control	22.77±1.27^{Ab}	2.54±0.85^{Bb}	0.50±0.03^{Bb}
2.5 kGy	37.87±3.98^{Aa}	10.69±3.00^{Bb}	8.72±2.04^{Bb}
Pasteurized	40.88±0.50^{Aa}	27.88±1.54^{Aa}	38.03±1.66^{Aa}
		Polyphenoloxidase activity (PPO)	
Control	9.93±0.92^{Bb}	18.27±1.38^{Aa}	5.60±0.43^{Cab}
2.5 kGy	17.87±2.90^{Aa}	8.17±2.50^{Bc}	7.34±1.22^{Ba}
Pasteurized	6.02±0.33^{Bc}	13.65±2.10^{Ab}	3.35±0.72^{Bb}
		Peroxidase activity (POD)	
Control	15.52±1.06^{Aa}	10.40±0.61^{Aa}	8.21±0.75^{Aa}
2.5 kGy	22.53±0.54^{Aa}	8.17±2.50^{Ba}	11.54±1.03^{Ba}
Pasteurized	2.94±0.46^{Ab}	3.92±0.57^{Aa}	3.77±2.44^{Aa}

TA in mg citric acid g^{-1}, SSC in °Brix, Color (Luminosity, Hue angle and chromaticity). PC in mg gallic acid 100 g^{-1}, TAC in mg equivalent of cyanidin 3-glucoside 100 g^{-1}, PPO and POD activities in AE min^{-1} ml^{-1} sample. Averages in rows (n = 3) followed by the same uppercase and lowercase letters in the columns do not show statistical differences at 5% (Tukey).

The pasteurization process was more efficient in avoiding juçara pulp darkening in comparison to gamma radiation, since the effect of temperature over the inactivation of darkening enzymes (PPO and PDO) was more intense than irradiation (2.5 kGy. All treatments presented low chromaticity values (ranging from 3.00 to 7.50) indicating a mixture of colours in the pulp, which was also evidenced by the coefficient L* ($P < 0.05$) (Table 1).

In the pasteurized pulps, chromaticity was maintained during storage, in contrast to the other treatments. The irradiated pulp presented the most diffused colour, with the lowest values of chromaticity. Thus, this parameter demonstrated undesirable effects on the pulp, since it is related to pulp colour degradation. Regarding the Hue angle, the irradiated pulp showed the highest value in the first day (46.47°) ($P < 0.05$). After 15 days of storage, the Hue angle remained constant for all

treatments, without statistical differences between the irradiated and pasteurized pulps ($P < 0.05$). These results indicated changes in pulp colour, from purple (on the 1st day) to brown (after 30 days) related to the oxidation of anthocyanins, the incidence of light on the product or the presence of oxygen in the packages. This effect is not caused only by pigment degradation, but also by the monomeric anthocyanin changes to polymeric forms of higher molecular weight. The polymerized anthocyanins have a 'brownish' hue colour angle, differently from the purple-red coloration related to the monomeric anthocyanin forms (Pacheco-Palencia, Hawken, and Talcott, 2007).

Regarding PC, the control pulp presented the highest values (6.35 mg of gallic acid 100 g^{-1}) on the 1st day, with a progressive decrease by the end of storage ($P < 0.05$) (Table 1). The same pattern was observed in the irradiated pulp, with a decrease in PC around 3 times comparing the first and second periods. However, the pasteurized pulp showed the highest PC values in the end of storage ($P < 0.05$). These compounds, produced from the secondary metabolism of plants, include flavonoids, the most important and abundant polyphenol group in nature, with an important antioxidant activity (Sánchez-Moreno, 2002). The irradiation process was responsible for the degradation of a large amount of PC in the pulp; it could be related to the radiolysis of phenolic acids, which results in an extensive hydroxylation due to the addition of -OH radicals (Breitfellner, Solar, and Sontag, 2002). Garcia-Reyes and Narvaez-Cuenca (2010) evaluated the effect of pasteurization in an open pan on the quality of frozen cassava herbarium pulp for 60 days; the authors observed that the pasteurized samples showed a significant increase in PC in comparison to the control. This effect was observed in the pasteurized juçara pulps at 80 °C/5 minutes and could be related to an improvement in PC release after heating (Gil-Izquierdo, Gil, and Ferreres, 2002).

Regarding TAC, we observed a decrease of this parameter during storage from around 45 times and 4.5 times for the control and irradiated samples, respectively ($P < 0.05$). It indicates the efficiency of the irradiation process in maintaining the anthocyanins. Nevertheless, pasteurization was more efficient than irradiation, since the pasteurized pulps presented the highest values for TAC among the treatments. Probably, irradiation released free radicals in the pulp and, consequently, promoted anthocyanin oxidation.

The presence of darkening enzymes, especially POD, may also have contributed to anthocyanin degradation. This enzyme is responsible for the discoloration of carotenoids and anthocyanins, as well as to catalyse non-enzymatic degradation reactions of unsaturated fatty acids, with a consequent production of volatile compounds (Campbell-Platt, 2011). The PPO activity decreased during the irradiated pulp storage ($P < 0.05$) (Table 1). Considering that PPO is a cell wall-bound enzyme, its inactivation observed after irradiation could be related to conformational changes caused by physical and chemical factors in the membranes (Hanotel, Fleuriet, and Boisseau, 1995).

The changes in the colour of the control pulps observed in the study might be related to the high PPO activity in the samples. The final products of the reactions catalysed by PPO are quinones–compounds that are highly reactive when combined with other food components and able to generate molecules with high molecular mass and dark color, such as melanins, for example; they are responsible for causing a brown pigmentation in the product (Eskin, 2013. POD activity remained constant during storage in the control and pasteurized samples, presenting no statistical difference among the periods evaluated ($P < 0.05$) (Table 1). The pasteurized pulp showed lower POD activity in all periods (2.94 – 3.77 AE min^{-1} mL^{-1} sample) compared to the other samples. Although there was no statistical difference between the treatments after 15 and 30 days ($P < 0.05$) the irradiated pulp presented the highest POD activity. Bastos, Rogez, and Pena (2008) observed a decrease of at least 90% in POD activity in pasteurized 'taperebá' pulp (*Spondias mombin*); this result might be related to the low pH of the product (pH = 2.6) which helped in the thermal inactivation of the enzyme. For the other treatment evaluated (85 °C/3 minutes) the authors demonstrated POD denaturation; thus, pasteurization was effective in the total POD inactivation.

Sensory evaluation

The sensory acceptance test was performed only on the 1st day after processing for the control and irradiated samples. For the pasteurized sample, it was performed until 15 days of storage, since after this time, the samples demonstrated deterioration, observed by color changes.

PCA is represented in Figure 1 by the projection of the sensory attributes (A) and the scatter plot of points, that is, the observations (B) CA is represented in Figure 2, in which the separation between the groups can be observed by the cut-off line (0.50) used to separate the groups shown in Figure 1.B (dotted circles). In this study, two main components (PC) were extracted from the total data set (Table 2) which explains 87% of the variance. The first main component (PC1) explained 63.26% of the statistical variance; it was positively correlated to global impression, flavour and texture attributes, and negatively correlated to colour. The second main component (PC2) explained 23.80% of the

statistical variance; it was positively correlated to aroma and appearance attributes.

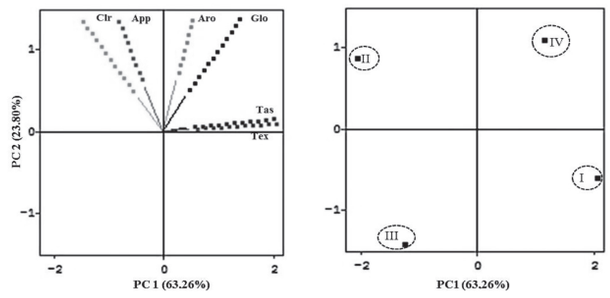

Figure 1. Graph of the cloud of variables (A) and observations (B) distribution obtained by the Principal Component Analysis of irradiated, pasteurized and control juçara pulp sensory attributes. PC = Principal Component.

A) Variables: Clr = Colour, App = Appearance, Aro = Aroma, Glo = Global, Tas = Taste, Tex = Texture. B) Observations: I = Control/day 1, II = 2.5 kGy/day 1, III = Pasteurized/day 1, IV = Pasteurized/day 15.

In the Cluster Analysis (Average Linkage Method) the observations presented in the projection of the observations (Figure 1B) were separated in four groups, from a cut-off of the means at 0.50 (dotted line) (Figure 2). This same cut-off was used to separate the circumscribed groups (dotted circles in Figure 1B).

The observations were individually separated in CA, since it presented different sensory characteristics. The Control pulps (day 1) (at the right of CP1) were characterized by high scores for taste, texture and global attributes. Likewise, the pasteurized pulp stored for 15 days presented similar scores for these parameters. Nonetheless, the pasteurized pulp (day 15) was the best evaluated regarding appearance in comparison to the other treatments. The irradiated sample (day 1) (at the left of CP1) was characterized by high scores for the attributes color, appearance and aroma. The results indicated that on the 1st day of evaluation the irradiated and pasteurized pulps were classified as 'Slightly liked'. In these treatments, the color attribute was the least accepted. The pasteurized juçara pulp showed similar acceptance during the refrigerated storage, also being classified as 'I liked it slightly'. Silva andSilva (2000) observed similar results for pasteurized cupuaçu puree (*Theobroma grandiflorum*) at 70 °C or 90 °C for 5 minutes; the authors verified that the product retained much of the original sensory properties of the fruit. In this study, no statistical difference (P > 0.05) was observed for flavor, aroma and color attributes between the two temperatures evaluated during storage.

Table 2. Acceptance test by hedonic scale (7 = I liked very much, 1 = I disliked very much) for flavor, aroma, colour, appearance, texture and Global attributes of juçara pulp samples (control, irradiated and pasteurized).

Treatments	Period (days)	
	1	15
Flavor		
Control	4.45 ± 1.60*	—
2.5 kGy	3.53 ± 1.91	—
Pasteurized	4.05 ± 1.72	4.74 ± 1.50
Aroma		
Control	4.41 ± 1.26	—
2.5 kGy	4.38 ± 1.61	—
Pasteurized	4.10 ± 1.55	4.39 ± 1.38
Colour		
Control	4.86 ± 1.36	—
2.5 kGy	5.71 ± 1.06	—
Pasteurized	5.19 ± 1.25	5.16 ± 1.34
Appearance		
Control	4.91 ± 1.19	—
2.5 kGy	5.21 ± 1.30	—
Pasteurized	5.10 ± 1.22	5.19 ± 1.14
Texture		
Control	5.32 ± 1.21	—
2.5 kGy	4.35 ± 1.52	—
Pasteurized	4.38 ± 1.72	4.94±1.21
Global		
Control	4.73 ± 1.12	—
2.5 kGy	4.32 ± 1.43	—
Pasteurized	4.24 ± 1.41	5.00 ± 1.13

*Average ± standard deviation.

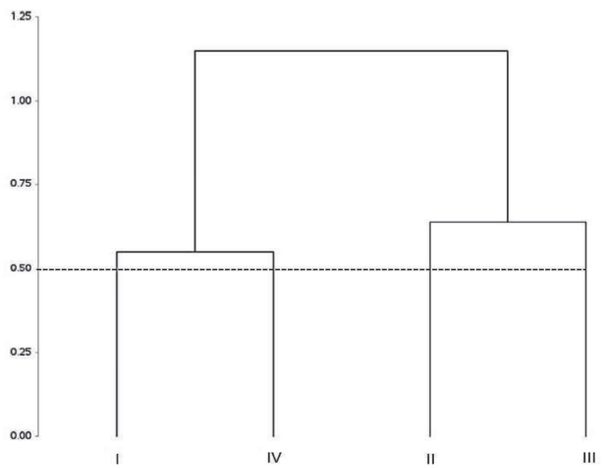

Figure 2. Dendrogram obtained from the sensory analysis of irradiated, pasteurized and control juçara pulp sensory attributes, by the Average Linkage method. I = Control/day 1, II = 2.5 kGy/day 1, III = Pasteurized/day 1, IV = Pasteurized/day 15.

Conclusions

Gamma radiation did not demonstrate satisfactory results in the preservation of juçara pulp, since there was a significant decrease in total phenolics and anthocyanin content. Besides, the pulps showed dark color and presented accelerated enzymatic activity. The pasteurized juçara pulp maintained its physicochemical and sensory characteristics during storage. The control (day 1) and pasteurized (day 15) samples were characterized by high scores for taste, texture and global attributes. Therefore, recommend the pasteurization as a good conservation technique for this kind of product, which presented a shelf-life of around 15 days.

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